STANDARD EDP REPORTS

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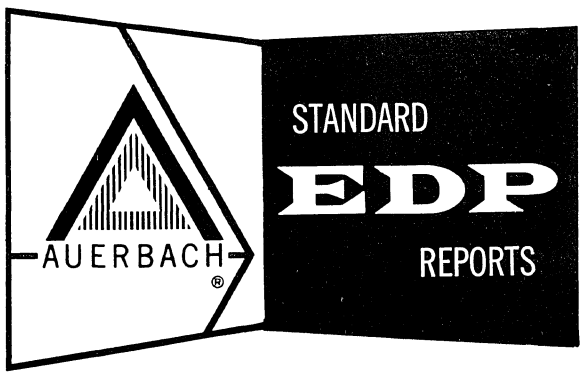
IBM 1401

International Business Machines Corp.



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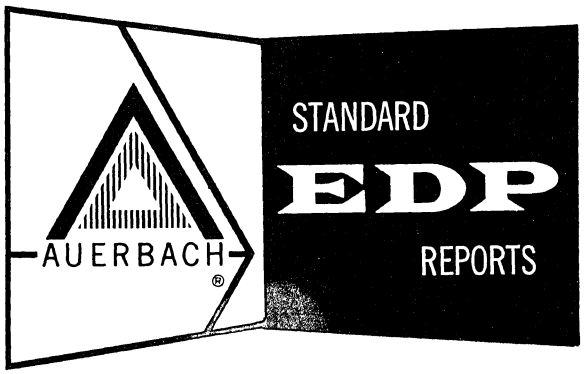
IBM 1401

International Business Machines Corp.



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INTRODUCTION

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The IBM 1401 is a small scale, solid-state computer system oriented toward business data processing applications. A wide range of peripheral devices and optional features are offered for 1401 systems. In addition to its primary function as a small scale business data processing system, the 1401 has found wide acceptance as an input-output processor for larger, tape-oriented systems such as the IBM 7070 and 7090 series. System rentals range from approximately $2,500 to $18,000 per month, but most installations fall within the $4,000 to $12,000 range. First customer deliveries of 1401 systems were made in September, 1960, and more than 4,000 have been installed to date.

Compatibility

The 1401 was the first member of the rapidly expanding IBM 1400 series of data processing systems, and it is now the second smallest in price and throughput. The IBM 1440 (Report 414:), the smallest member of the series, is program-compatible with (and slightly faster than) the 1401 with respect to internal processing, but the 1440 uses slower input-output units and different instructions to control them. The recently announced IBM 1460 (Report 415:) uses the same set of stored-program instructions as the 1401, so programs coded for a 1401 can, in general, be run without alteration on a 1460 with the same (or expanded) complement of input-output units and optional features. The 1460 is nearly twice as fast internally as the 1401 and uses most of the same peripheral devices. The faster, more expensive IBM 1410 (Report 402:) uses a different addressing method and instruction set, but can execute many 1401 programs without alteration through the use of built-in 1401 compatibility circuits.

Hardware

A 1401 system can have from 1,400 to 16,000 alphameric character positions of core storage. Each core position contains six data bits, a parity bit, and a word mark bit used to denote the end of a variable-length field. Core storage cycle time is 11.5 microseconds (compared to 11.1 microseconds in the IBM 1440, 6.0 in the 1460, and 4.5 in the 1410).

Up to five 1311 Disk Storage Drives can be used in a 1401 system. Each drive holds one replaceable Disk Pack at a time, providing random access storage for 2,000,000 alphameric characters in addressable sectors of 100 characters each. With the optional Track Record feature, a single 2,980-character record can be recorded on each track, increasing the capacity of a single Disk Pack to 2,980,000 characters. Up to 20,000 characters can be read or recorded without movement of the comb-like access mechanism, so the system is suitable for sequential as well as random processing. Total waiting time for access to a randomly-placed record averages 270 milliseconds; with the optional Direct Seek feature, the figure is reduced to 170 milliseconds.

The older 1405 RAMAC Disk Storage Unit provides 10,000,000 or 20,000,000 character positions of non-replaceable storage, in 200-character blocks. Average random access time is about 600 milliseconds.

The 1401 Processing Unit is a solid-state, alphameric processor with add-to-store logic. It has no accumulator. All operations are performed serially by character. The basic instruction format consists of a one-character operation code, two 3-character operand addresses, and a one-character modifier; instruction length can vary from one to eight characters and averages about six characters. Operands can be of any length up to the capacity of core storage. Operand length is not specified in 1401 instructions; instead each operation is terminated when a word mark bit is sensed in the operand itself. Instructions are executed at the rate of about 4,000 per second in typical 1401 routines.

A flexible editing capability is standard, but multiplication, division, indexing, three-way comparisons, sense switches, and multi-word internal transfers are all extra-cost

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options. Without these optional features, the processing capabilities of the 1401 are severely limited. In fact, the Advanced Programming Feature (which provides three index registers, instructions to store the address register contents, and the "move record" instruction) is nearly indispensable if the user hopes to take advantage of the much-heralded variable field length capabilities of the 1401.

The use of dynamically variable field lengths (i.e., fields whose lengths vary from record to record within the same file) deserves very serious consideration. The main advantage of variable field lengths is that the required input-output time is reduced, and this is a valid consideration when the input-output time is the limiting factor on overall processing time. The additional data manipulation required to utilize these fields of varying length and varying location within a record, however, can significantly increase the central processor time (sometimes to the point where it exceeds tape input-output time) and the programming complexity.

An alternative method of reducing total time requirements for a problem is the use of a variable record length technique employing combinations of variable and fixed length fields. All fields (usually numeric) that require considerable manipulation are assigned fixed lengths and fixed locations in the record, while any fields (usually alphabetic) that require very little manipulation form the variable portion (usually the end) of the record. This method effectively reduces total time requirements for most applications without unduly complicating the programming.

System operation is basically serial in nature (i.e., one operation at a time). Little overlapping of input-output operations with one another or with internal processing is possible unless optional features such as Print Storage, Processing Overlap, and Read Punch Release are added. Use of these features (described in Section 401:111) increases the system's capability for simultaneous operations, but also increases programming complexity and input-output area storage requirements.

The 1401 Card Read-Punch reads standard 80-column cards at a peak speed of 800 cards per minute and punches them at 250 cards per minute. The 1403 Printer prints up to 600 alphameric lines per minute. It features a unique, horizontal-chain printing mechanism that produces high qualtity printing and permits interchangeable character sets.

Up to six 729 and/or 7330 Magnetic Tape Units can be connected. Peak data transfer rates range from 7,200 to 62,500 characters per second. Only one tape read or write operation at a time is possible. The central processor is interlocked during tape read and write operations unless the Processing Overlap feature is added. With Processing Overlap, internal processing can be overlapped with tape start-stop times and (at transfer rates of 20,016 characters per second or below) with character transfers to or from a tape unit.

Up to four 7340 Model 2 Hypertape Drives can be connected to a 1401 through the Serial Input/Output Adapter. These new magnetic tape units are cartridge-loaded, have peak data transfer rates of 34,000 characters or 68,000 decimal digits per second, and are compatible with the faster Hypertape Drives used on IBM 7074, 7080, 7090, and 7094 systems (but not with the 729 or 7330 tape units).

The Serial Input/Output Adapter alternatively permits connection of any one of the following devices: a paper tape reader or punch, a magnetic or optical character reader, a data transmission terminal, or a direct system-to-system link with an IBM 1440, 1460, or another 1401.

Software

A wide variety of software has been developed and made available for the 1401 by both the manufacturer and 1401 users. Programs supplied by the manufacturer include:

- SPS-1 and SPS-2: basic symbolic assembly systems, usable on a card-only 1401.

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- 1401 Autocoder: more advanced assembly system, providing macro facilities; requires four magnetic tape units on the translating 1401.
- 1401-1311 Autocoder: utilizes 1311 Disk Storage instead of magnetic tape; otherwise similar to 1401 Autocoder.
- Input-Output Control Systems: provide macro instructions and corresponding generalized routines to facilitate coding of input-output operations; four versions are available for different system configurations.
- Report Program Generator: facilitates preparation of programs to produce printed reports from punched cards, magnetic tape, or 1311 Disk Storage.
- FARGO: a "load-and-go" report generator that produces IBM 407-type printed reports.
- Sorting and Merging: four generalized routines to handle sort/merge operations using either magnetic tape units or 1311 Disk Storage.
- Auto-Test: expedites testing and debugging of programs coded in Autocoder, SPS, and FARGO.
- Disk File Organization Programs: nine programs to assist in establishing and maintaining data files in 1311 Disk Storage, in either random or sequential arrangements.
- Utility Programs: a variety of routines to perform frequently-needed functions such as data transcription, multiplication, and program loading in card, tape, and Disk Storage systems.
- COBOL: translates programs coded in COBOL into symbolic form for Autocoder assembly; 2 versions are available, for 1401 systems with at least 4,000 and 12,000 core storage positions; both versions require 4 magnetic tape units and a number of special features.
- FORTRAN: compiles programs coded in a severely restricted subset of the full FORTRAN language; magnetic tape is not required, and "load-and-go" operation is possible.

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SUMMARY REPORT:
IBM 1401-G

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.01 INTRODUCTION

The IBM 1401-G is a low-cost, stored-program punched card processing system designed primarily to replace conventional punched card tabulating equipment in applications which are not large enough to justify installation of any of the higher-performance computer systems in IBM's 1400 series. The most significant feature of the 1401-G is that its introduction has reduced the rental price of a minimum IBM 1401 card system (consisting of central processor with 1400 core storage positions, card read-punch unit, and printer) from $2,475 (for a 1401 Model A) to $1,900 per month. This reduction in price is accompanied by a significant reduction in system performance capabilities: although the 1401-G Processing Unit has the same instruction set and processing speed as other 1401 models, the only models of the 1402 Card Read Punch and 1403 Printer available in 1401-G systems are considerably slower than their counterparts in other 1401 systems.

A 1401-G system consists of:

- A 1401 Model G Processing Unit with 1,400, 2,000, or 4,000 alphameric character positions of core storage and a cycle time of 11.5 microseconds.
- A 1402 Model 4 Card Read Punch that can read 450 cards per minute and punch 250 cards per minute.
- A 1403 Model 4 or 5 Printer that can print 465 single-spaced alphameric lines per minute; Model 4 has 100 print positions and Model 5 has 132.

No other peripheral devices, and only a limited number of the optional features available for other 1401 models, can be used in a 1401-G system. When the user's equipment needs increase, he will need to replace the 1401-G with a different model of the 1401 or with a 1460, both of which are program-compatible with the 1401-G.

Most of the programs and programming systems available for 1401 card systems can be used with 1401-G systems of adequate core storage capacity. These include SPS, Basic Autocoder, Report Program Generator, FARGO, and a variety of utility routines.

Initial customer deliveries of 1401-G systems are scheduled for October, 1964.

.02 DATA STRUCTURE

The 1401-G, like all IBM 1400 series computers, is a character-oriented system. Each core storage position consists of 8 bits (6 data bits, parity bit, and word mark bit) and can hold one alphameric character (i.e., a decimal digit, a letter, or a special symbol). Both data fields and instructions are variable in length, and their lengths are defined by word mark bits. Instruction lengths range from 1 to 8 characters and are most commonly 7 characters. Data fields may be of any length up to the capacity of core storage.

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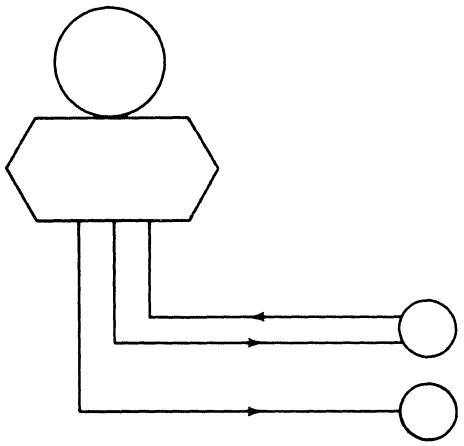
.03 SYSTEM CONFIGURATION

Typical Card System; Configuration I

Deviations from Standard Configuration:. . . printer is slower by 535 lines/minute.
card reader is slower by 550 cards/minute.
core storage is smaller by 4,000 characters.
multiply-divide hardware and index registers are not available.



Equipment	Rental
Core Storage: 4,000 positions	$1,180
Processing Unit: 1401 Model G3	
Card Read Punch Reads: 450 cards/min. Punches: 250 cards/min.	400
Printer: 465 lines/min. (132 print positions)	600
Optional features included: . . . . . High-Low-Equal Compare	75
Sense Switches	15
Expanded Print Edit	20
Additional Print Control	60
Read Punch Release	25
TOTAL:	$2,375

.04 INTERNAL STORAGE

Models G1, G2, and G3 of the 1401 Processing Unit contain 1400, 2000, and 4000 character positions, respectively, of core storage. The 1401-G differs from all other 1401 models in that the user may not expand its core storage capacity beyond 4000 positions by adding a 1406 Core Storage Unit. Cycle time is 11.5 microseconds for each access of one alphameric character. See Section 401:041 for further details on 1401 core storage.

None of the IBM Disk Storage Units may be used in a 1401-G system.

.05 CENTRAL PROCESSOR

The 1401 Model G Processing Unit is functionally identical with other 1401 models (Section 401:051) except that the range of peripheral devices and optional features that can be used with the 1401-G is severely restricted. The following 1401 optional features are not available in 1401-G systems:

- Advanced Programming (indexing, Store Address Register, and Move Record instructions)
- Multiply-Divide instructions
- Processing Overlap

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.05 CENTRAL PROCESSOR (Contd.)

- Column Binary
- Print Storage
- Numerical Print
- Selective Tape Listing
- Serial Input/Output Adapter.

The 1401-G Processing Unit uses add-to-storage logic and has no accumulator. All operations are performed serially by character. The basic instruction format consists of a 1-character operation code, two 3-character addresses, and a 1-character modifier. Instructions may contain various combinations of these four parts and range from one to eight characters in overall length. Operand lengths are not specified in 1401-G instructions; instead, most operations are terminated when a word mark bit is sensed in the operand itself.

Instructions (other than those that initiate I/O operations) are executed at the rate of about 4,000 per second in typical 1401-G routines. Processor speeds for the 1401-G are the same as those listed for the 1401 in Paragraph 401:051.4; for example:

For random addresses

c = a + b: . . . . . 207 + 46D μsec.
b = a + b: . . . . . 115 + 23D μsec.
Sum N items: . . . . . (115 + 23D)N μsec.
c = ab: . . . . . 466 + 3450D + 140D^2 μsec.
c = a/b: . . . . . 8680 + 2950D + 172D^2 μsec.

where D is operand length in decimal digits.

Optional Features

Bit Test: Permits a programmed branch if any bit in a specified core location matches the corresponding bit in the modifier character of the branch instruction.

High-Low-Equal Compare: Permits indicators to be tested for high, low, or equal conditions after a comparison.

Expanded Print Edit: Adds check protection, floating dollar sign, decimal control, and sign control left to the basic 1401 editing capabilities.

Read Punch Release: Permits use of the 35-millisecond card reader start time and the 37-millisecond card punch start time interlock periods for internal processing, thereby making more processing time available during each read or punch cycle.

Sense Switches: Six console switches and corresponding testable indicators which can be used for external control of the stored program.

Space Suppression: Provides program control of space suppression on the 1403 Printer.

.07 1402 CARD READ PUNCH, MODEL 4

The 1402 Model 4 consists of a 450 card-per-minute reader and a 250 card-per-minute punch for standard 80-column cards. The two units are housed within the same cabinet but are functionally independent of one another. All operating characteristics of the 1402 Model 4 are the same as those of the 1402 Model 1 used in other 1401 systems (Sections 401:071 and 401:072) except that Model 4 has a reading speed 350 cards per minute lower than Model 1 and includes the Early Card Read option as a standard feature.

Optional Features

Interchangeable Feed: Permits either 80-column or 51-column cards to be read by interchanging some hardware components.

Punch Feed Read: Adds a reading station ahead of the punching station so that results can be punched into the same cards from which input data was read.

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.08 1403 PRINTER, MODELS 4 AND 5

Models 4 and 5 of the 1403 Printer are slower versions of the 1403 Model 1 and 2 horizontal-chain printers used in other 1401 systems. Rated speed is 465 single-spaced alphameric lines per minute. All other characteristics are the same as those of Models 1 and 2, as described in Section 401:081. A dual-speed carriage provides skipping speeds of 75 inches per second for skips of more than 8 lines and 33 inches per second for shorter skips. The standard print set has 48 characters. The only difference between 1403 Models 4 and 5 is that Model 4 has 100 printing positions and Model 5 has 132.

Optional Features

Interchangeable Chain Cartridge Adapter: Permits the operator to replace the standard print chain with another chain containing a different type font or special character arrangement.

Auxiliary Ribbon Feeding: Permits satisfactory utilization of polyester film ribbons, which provide improved printing quality as required for optical character recognition.

.11 SIMULTANEOUS OPERATIONS

The basic 1401-G, like other 1401 systems, has a very limited capability for simultaneous operations. The Processing Unit is inhibited during all input-output operations except during a short period at the end of each card or print cycle. The optional Read Punch Release feature increases the amount of overlapping by permitting internal processing to continue during the card reader and punch "start times" (35 and 37 milliseconds, respectively). This feature introduces the possibility of an error halt if the read or punch instruction is not issued within the required interval after card feeding has been initiated. The Print Storage feature, which permits virtually complete overlapping of printing with internal processing in other 1401 models, is not available for the 1401-G.

The 1401-G has a new capability, called "interleaving" by IBM, that enables it to perform either a print-and-read or print-and-punch operation in the time normally required for a card read or punch operation alone. This is accomplished by overlapping the printing operation with either card reading or card punching. Card reading and punching, however, cannot be interleaved with one another. Time relationships for 1401-G input-output operations, including the times available for internal processing, are summarized in the table below.

Operation	Cycle Time, msec	Processing Time, msec	Cards/Lines per Minute
Card Reading:			
Without Read Punch Release	133.3	21	450
With Read Punch Release	133.3	56	450
Card Punching:			
Without Read Punch Release	240	22	250
With Read Punch Release	240	59	250
Printing	129	17	465
Print and Read	133.3	20	450
Print and Punch	240	22	250

.12 INSTRUCTION LIST

The 1401-G uses the same set of instructions as other 1401 systems, as listed in Section 401:121. (Those 1401 instructions which pertain to peripheral devices and optional features which are not available for the 1401-G naturally cannot be used in 1401-G programs.)

.14 DATA CODE TABLES

Same as IBM 1401; see Sections 401:141 through 401:144.

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.15 SOFTWARE

IBM 1401-G users will be able to utilize most of the programs and programming systems that have been developed for 1401 card systems by both the manufacturer and cooperating users. The principle programming systems available from IBM include:

- 1401 Basic Autocoder 4K — a symbolic assembly system for card systems with 4,000 positions of core storage. The language includes all the facilities of 1401 Autocoder, as described in Section 401:172, except macro instructions.

- 1401 Basic Autocoder 2K — a symbolic assembly system for card systems with 2,000 positions of core storage. The language is a subset of Basic Autocoder 4K and has the same capabilities except that no literals are permitted and symbolic names may not be used as operands in Origin and Equate statements.

- SPS-1 — a basic symbolic assembly system for card systems with the minimum 1,400 positions of core storage, as described in Section 401:171.

- FARGO and Card Report Program Generator — two systems that facilitate the preparation of reports from data in punched card files on 1401-G systems with 4,000 core storage positions; both are described in Section 401:151.

.20 SYSTEM PERFORMANCE

Internal processing speed of the 1401-G is the same as that of other 1401 models, except that the Advanced Programming and Multiply-Divide features, which can significantly reduce processing times, are not available for the 1401-G. Timing relationships for the input-output devices and their capabilities for simultaneous operations are discussed in Paragraph .11, above.

Since the 1401-G is a punched card system designed for business applications, the most meaningful standard test of its system performance is the generalized file processing problem, Standard File Problem A, as performed on Standard Configuration I, the "Typical Card System" shown in Paragraph .03. This problem involves updating a master file from information in a detail file and producing a printed record of each transaction. The standard problem is fully described in Section 4:200.1 of the Users' Guide.

For Standard Configuration I, both the master and detail files are on punched cards, and it is assumed that the two files have been collated off-line so that each detail card follows the two cards which comprise the associated master file record. Master file records with no activity (i.e., no corresponding detail cards) would, in most cases, be removed from the file before the computer run, so only the processing time at an activity factor of 1.0 is significant.

For each record processed at an activity factor of 1.0, it is necessary to read two master cards and one detail card, punch two updated master cards, and print one report line. This can be accomplished by means of two read operations, two punch operations, and one "interleaved" read-and-print operation in a total of 833 milliseconds per record. Taking full advantage of the optional Read Punch Release feature, a total of 164 milliseconds per record is available for internal processing, and this exceeds the 106 milliseconds required to perform the specified computations. The time required to process 10,000 master file records, therefore, is 139 minutes. (Standard Configuration I of the original IBM 1401, shown on page 401:031.100, can perform the same job in 100 minutes, though at a significantly higher cost, through the use of a faster card reader and printer plus the optional Advanced Programming, Multiply-Divide, and Processing Overlap features on a 1401 Model B4 Processing Unit.)

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.21 PHYSICAL CHARACTERISTICS

Equipment	Width (in.)	Depth (in.)	Height (in.)	Weight (lb.)	Power (KVA)	Heat (BTU/hr)
1401 Model G Processing Unit	58	31	60	1,840	4.0	6,700
1402 Model 4 Card Read Punch	58	30	45	1,260	*	3,500
1403 Printer, Models 4 and 5	48	29	53	750	*	3,000

*Included in Processing Unit Load.
Power requirements: 208 or 230 volt, 3-phase, 4-wire, 60-cycle AC.

.22 PRICE DATA

Equipment	Monthly Rental	Monthly Maintenance*	Purchase
1401 Processing Unit:			
Model G1; 1400 core positions	$ 950	$50.00	$65,750
Model G2; 2000 core positions	1,050	50.00	66,550
Model G3; 4000 core positions	1,180	52.00	69,750
1402 Model 4 Card Read Punch	400	38.25	28,000
1403 Printer:			
Model 4; 100 print positions	550	104.00	31,400
Model 5; 132 print positions**	660	112.75	34,950
Optional Features:			
Bit Test	20	0.50	800
Expanded Print Edit	20	0.50	750
High-Low-Equal Compare	75	1.75	2,800
Read Punch Release	25	0.50	950
Sense Switches	15	0.50	550
Space Suppression	75***	-	60
Interchangeable Feed (1402)	50	28.25	3,175
Punch Feed Read**	80	5.75	2,985
Interchangeable Chain (1403)	75	-	3,125
Auxiliary Ribbon Feeding	75	20.00	3,075

* Maintenance charges shown here apply for first 36 months, and are higher thereafter.
** Prices include cost of required control on Processing Unit.
*** Single use charge (one time only).

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DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Character:	8 bits	Alphamerics.
Sector:	200 char	1405 Disk Storage Unit record location.
Band:	5 sectors	1405 Disk Storage Unit.
Disc:	400 bands	1405 Disk Storage Unit.
Band:	2,000 char	1311 Disk Storage Unit.
Disc:	500 bands	1311 Disk Storage Unit.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	1 character.
Letter:	1 character.
Instruction:	1 to 8 characters.
Number:	1 to N characters, ended by word mark.
Block:	1 to N characters, ended by record or group mark.

N is limited by size of core storage.

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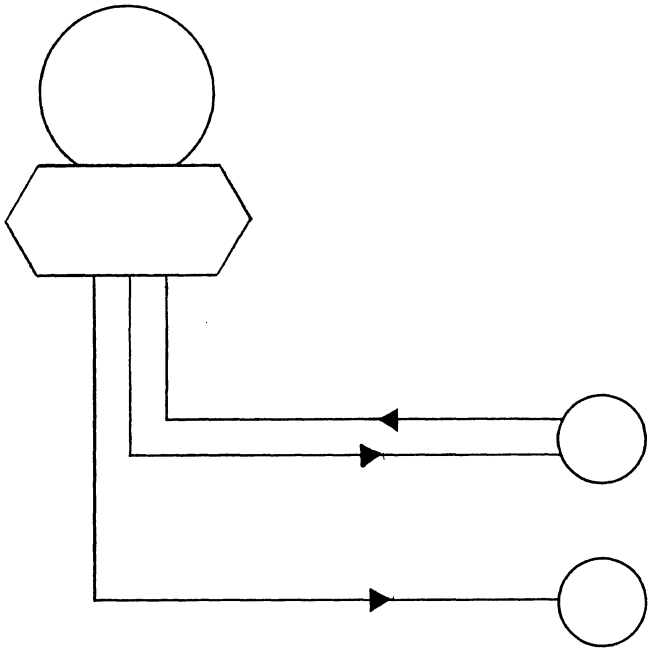
SYSTEM CONFIGURATION

§ 031.

I. TYPICAL CARD SYSTEM (CONFIGURATION I)

Deviations from standard configuration: . . . . . Printer slower by 400 lines/minute.
Card reader slower by 200 cards/minute.

Rental: . . . . . $4,330 per month.



Equipment	Rental
Core Storage: additional 4,000 positions	$ 575
Processing Unit: 1401 Model B4 (with 4,000 positions core storage)	1,630
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	775

Optional Features Included: . . . . .

Advanced Programming.	105
Multiply-Divide.	325
Processing Overlap.	250
Early Card Read.	10
High-Low-Equal Compare.	75
Sense Switches.	15
Expanded Print Edit.	20
TOTAL	$4,330

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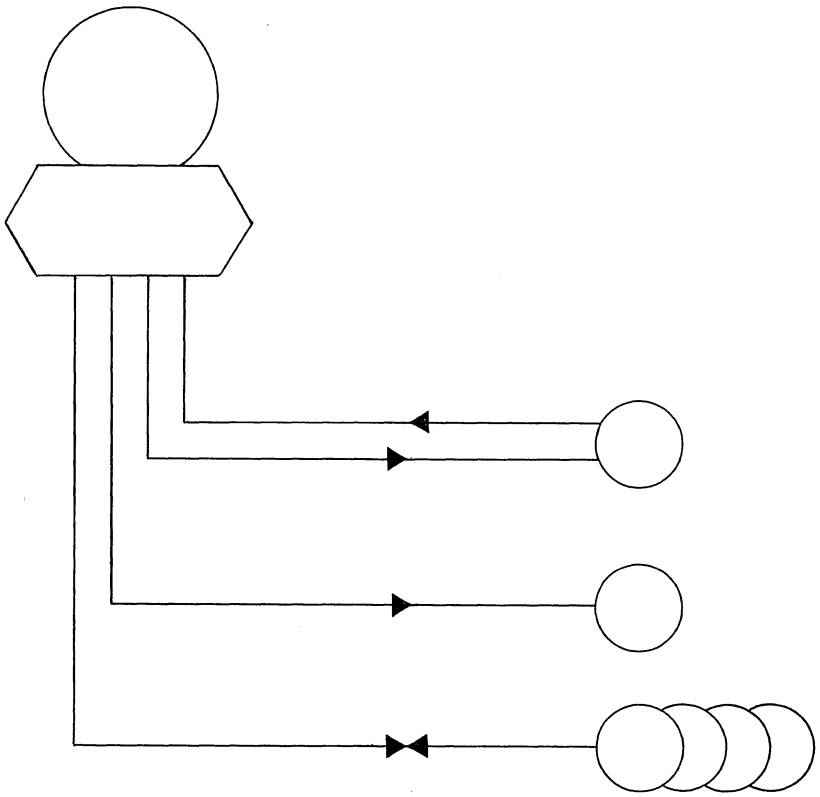
§ 031.

II. 4-TAPE BUSINESS SYSTEM (CONFIGURATION II)

Deviations from Standard configuration: . . . . . Card Reader faster by 300 cards/minute.
Card Punch faster by 150 cards/minute.
3 index registers.

Rental: . . . . . $5,920.



Equipment	Rental
Core Storage: additional 4,000 positions	$ 575
Processing Unit: 1401 Model E4. (with 4,000 positions core storage)	2,130
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	775
Magnetic Tape Units (4) 7,200 or 20,016 char/sec.	1,800
Optional Features Included: . . . . . High-Low-Equal Compare.	75
Sense Switches.	15
TOTAL	$5,920

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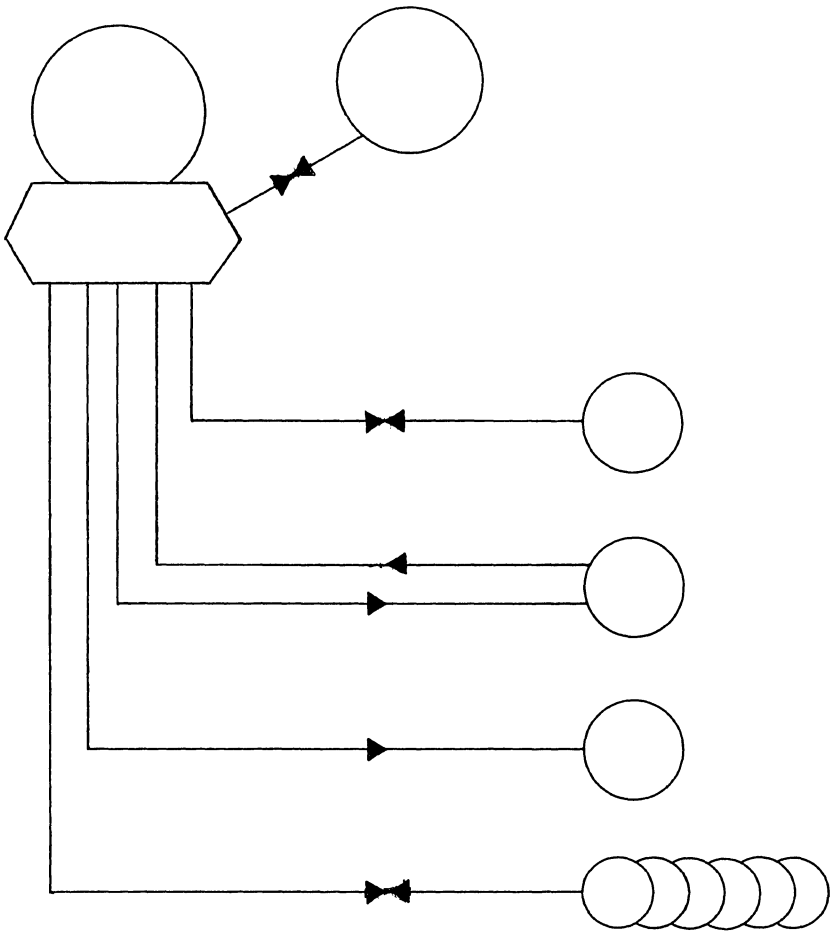
§ 031.

III. 6-TAPE BUSINESS SYSTEM (CONFIGURATION III)

Deviations from standard configuration: . . . . . Magnetic tape faster by 11,000 char/sec.
Card Reader faster by 300 cards/minute.
Card Punch faster by 150 cards/minute.

Rental: . . . . . $10,830 per month.



Equipment	Rental
Core Storage: additional 12,000 positions	$1,575
Processing Unit: 1401 Model C6 (with 4,000 positions core storage)	2,755
Console Inquiry Station (including Adapter)	175
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	775
Magnetic Tape Units (6): 15,000 or 41,667 char/sec.	4,200

Optional Features Included: . . . . . Advanced Programming. 105
Multiply-Divide. 325
Processing Overlap. 250
Early Card Read. 10
High-Low-Equal Compare. 75
Sense Switches. 15
Expanded Print Edit. 20

TOTAL: $10,830

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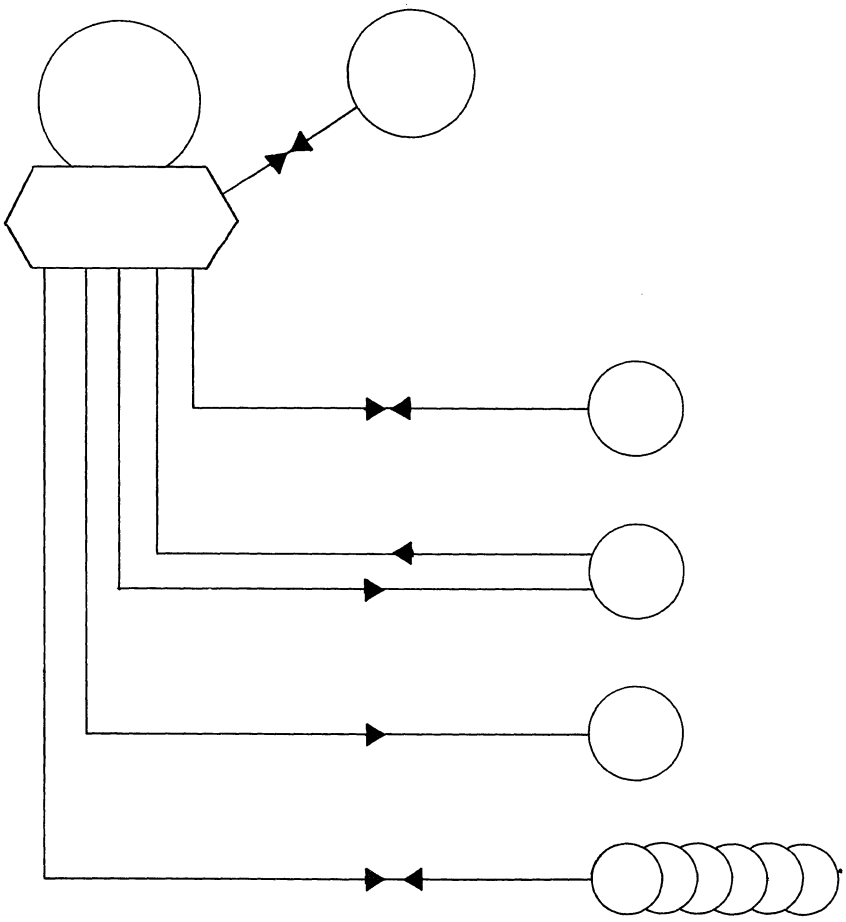
§ 031.

IV. EXPANDED TAPE SYSTEM (CONFIGURATION IV)

Deviations from standard configuration: . . . . . Simultaneous reading and writing on magnetic tape is not possible.
Maximum number of tape units available is 6 rather than the 12 specified.
Core storage is smaller by 40,000 positions.
Card Reader is 300 cards/minute faster.
Card Punch is 150 cards/minute faster.

Rental: . . . . . $11,540 per month.



Equipment	Rental
Core storage: additional 12,000 positions	$1,575
Processing Unit: 1401 Model C6. (with 4,000 positions core storage)	2,755
Console Inquiry Station. (including Adapter)	175
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	775
Magnetic Tape Units (6): 15,000, 41,667 or 60,000 char/sec.	4,535

Optional Features Included: . . . . .

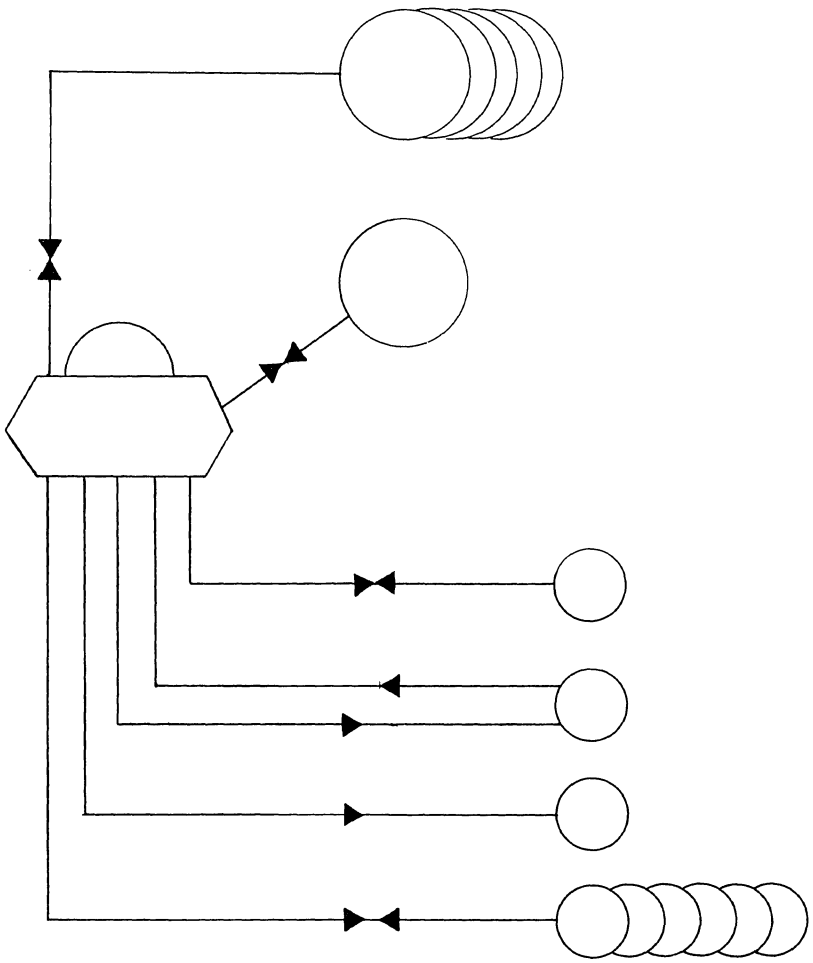
Advanced Programming.	105
Multiply-Divide.	325
Processing Overlap.	250
Print Storage.	375
Early Card Read.	10
High-Low-Equal Compare.	75
Sense Switches.	15
Expanded Print Edit.	20
TOTAL	$11,540

§ 031.

V. 6-TAPE AUXILIARY STORAGE SYSTEM WITH 1311 DISK STORAGE (CONFIGURATION V)

Deviations from standard configuration: . . . . . Card Reader faster by 300 cards/minute.
Card Print faster by 150 cards/minute.
Disk Storage is smaller by 5,100,000 characters.

Rental: $13,330



Equipment	Rental
1311 Disk Storage Drives (5): 14,900,000 positions total	$2,500
Core Storage: additional 12,000 positions	1,575
Processing Unit: 1401 Model F16 (with 4,000 positions core storage)	2,665
Console Inquiry Station (including Adapter)	175
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	775
Magnetic Tape Units (6): 15,000 or 41,667 char/sec.	4,200

Optional Features Included: . . . . .

Advanced Programming.	105
Multiply-Divide.	325
Processing Overlap.	250
Early Card Read.	10
High-Low-Equal Compare.	75
Sense Switches.	15
Expanded Print Edit.	20
Track Record.	40
Direct Seek.	50
TOTAL	$13,330

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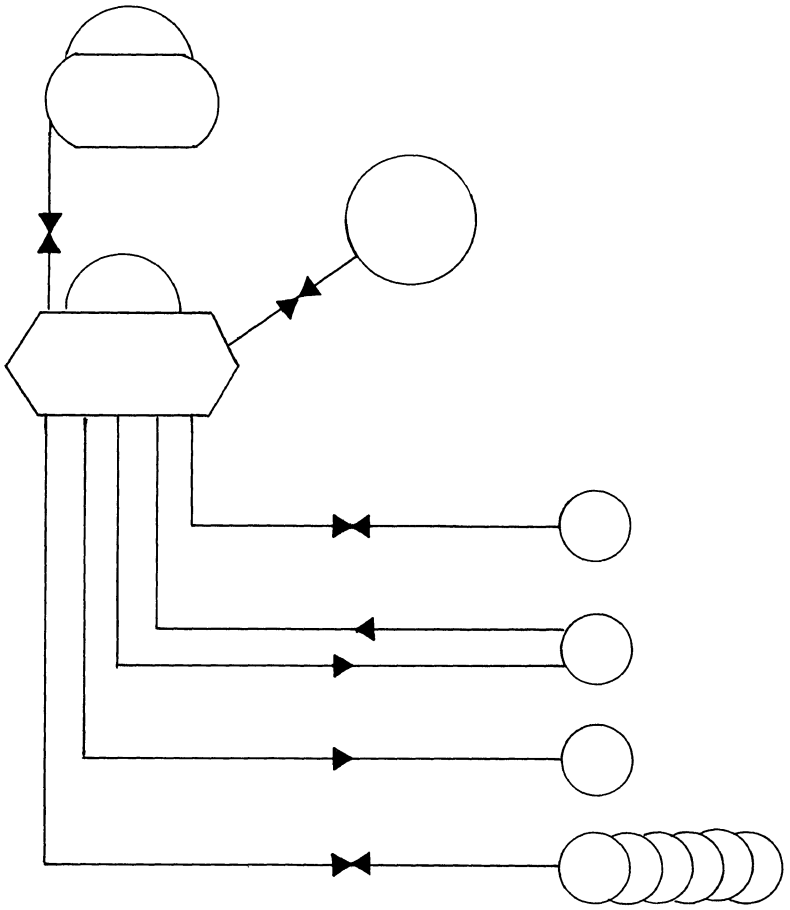
§ 031.

V. 6-TAPE AUXILIARY STORAGE SYSTEM WITH 1405 DISK STORAGE (CONFIGURATION V)

Deviations from standard configuration: . . . . . Card Reader faster by 300 cards/minute.
Card Punch faster by 150 cards/minute.

Rental: . . . . . $12,255 per month.



Equipment	Rental
1405 Disk Storage and Controller: 20,000,000 characters	$1,515
Core Storage: additional 12,000 positions	1,575
Processing Unit: 1401 Model F16. (with 4,000 positions core storage)	2,665
Console Inquiry Station (including Adapter)	175
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	775
Magnetic Tape Units (6) 15,000 or 41,667 char/sec.	4,200

Optional Features Included: . . . . . Advanced Programming. 105
Multiply-Divide. 325
Processing Overlap. 250
Early Card Read. 10
High-Low-Equal Compare. 75
Sense Switches. 15
Expanded Print Edit. 20

TOTAL $12,255

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SYSTEM CONFIGURATIONS - IBM 1401

	CARD ORIENTED SYSTEMS		TAPE ORIENTED SYSTEMS				SYSTEMS		
1401 Processing Unit Model No., with core storage positions indicated:									
1,400	A1	B1	C1	D1	D11	E1		none	
2,000	A2	B2	C2	D2	D12	E2		none	
4,000	A3	B3	C3	D3	D13	E3	F3	F13	F23
8,000 (with 1406 Model 1)	A4	B4	C4	D4	D14	E4	F4	F14	F24
12,000 (with 1406 Model 2)	A5	B5	C5	D5	D15	E5	F5	F15	F25
16,000 (with 1406 Model 3)	A6	B6	C6	D6	D16	E6	F6	F16	F26
Maximum number of peripheral units:									
1402 Card Read Punch	1	1	1	0	0	1	1	1	1
1403 Printer, Model 1*	1	1	0	0	0	1	1	1	1
1403 Printer, Model 2*	1	1	1	1	1	1	1	1	1
1404 Printer*	0	1	1	0	0	1	1	1	1
1405 Disk Storage	0	0	0	0	0	0	1	1	1
1311 Disk Storage	0	5	5	0	0	5	0	0	0
1406 Core Storage	1	1	1	1	1	1	1	1	1
1407 Console Inquiry	0	1	1	1	1	1	1	1	1
729 Tape Unit	0	0	6	6	0	0	0	6	0
7330 Tape Unit	0	0	6 †	6 †	6	6	0	6 †	6
1412 Magnetic Reader, or 1418 Optical Reader, or 1419 Magnetic Reader, or 1428 Alphameric Optical Reader, or 1009 Data Trans. Unit, or 1011 Paper Tape Reader, or 7710 Data Communication Unit or 3271 Direct Data Channel	0	1	1	1	1	1	1	1	1
Availability of Special Features:									
Processing Overlap	no	yes	yes	yes		yes	yes		
Expanded Print Edit	yes	yes	std.	std.		yes	yes		
Read Punch Release	yes	yes	std.	no		yes	yes		
6 Sense Switches	yes	yes	std.	std.		yes	yes		
Multiply-Divide	no	yes	yes	no		yes	yes		
Print Storage	no	yes	yes	yes		yes	yes		
Column Binary	no	yes	yes	no		yes	yes		
High - Low - Equal Compare	no	yes	yes	yes		yes	yes		
Advanced Programming	no	yes	yes	yes		yes	yes		
Compressed Tape	no	no	yes	yes		yes	yes		
Punch Feed Read	no	yes	yes	no		yes	yes		
51-Column Feed	yes	yes	yes	no		yes	yes		
Early Card Read	yes	yes	yes	no		yes	yes		
Numerical Print	yes	yes	yes	yes		yes	yes		
Interchangeable Chain	yes	yes	yes	yes		yes	yes		
Selective Tape Listing	no	yes	yes	no		yes	yes		
Space Suppression	yes	yes	yes	yes		yes	yes		
Additional Access Arm	no	no	no	no		no	yes		
Direct Seek	no	yes	yes	no		yes	no		
Scan Disc	no	yes	yes	no		yes	no		
Seek Overlap	no	yes	yes	no		yes	no		
Track Record	no	yes	yes	no		yes	no		

* Only one printer may be attached to a system.
† Tape Intermix Unit required (max. total of 729 and 7330 tape units is 6).

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INTERNAL STORAGE: CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . . Core Storage.
1401 Processing Unit and
1406 Core Storage Unit.
Models 1, 2, and 3.

.12 Basic Use: . . . . . working storage.

.13 Description:

The 1401 Processing Unit may contain 1,400, 2,000, or 4,000 character positions of core storage. When more than 4,000 positions are required, a 1406 Core Storage Unit is added. Models 1, 2, and 3 contain 4,000, 8,000, and 12,000 positions, respectively. Cycle time is 11.5 microseconds for each access of one alphameric character. Each character position consists of 8 bits: 6 data bits, 1 odd parity bit, and 1 word mark bit. Core Storage is used for all input-output areas and index registers, a total of from 260 to 461 positions, depending upon the optional features installed.

.14 Availability: . . . . . 12 months as of April, 1963.

.15 First Delivery: . . . . 1401, September, 1960
1406, March, 1961.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	9 char	none.
Arithmetic registers:	0.	
Logic registers:	0.	
I-O control:	0.	
Card read area:	80 char	none.
Card punch area:	80 char	none.
Printer area:	100 or 132 char	none.
Column binary area:	160 char	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter: . . . . 0.050 inch.
Core bore: . . . . . 0.030 inch.
Array size (4K module): 50 by 80 by 8 bits.
6 by 5.125 by 8.5 inches.

.23 Storage Phenomenon: . . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by program: . . . . . yes.

.242 Data regenerated constantly: . . . . . no.

.243 Data volatile: . . . . . no.

.244 Data permanent: . . . . no.

.245 Storage changeable: . . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.

.283 Type of access: . . . . . uniform.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . . 87,000 cycles/second.

.292 Peak data rates
Unit of data: . . . . . character.
Conversion factor: . . . 8 bits/char.
Data rate: . . . . . 87,000 char/sec.
Compound data rate: . . 87,000 char/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage					Maximum Storage
Identity:						
1401 Model:	1	2	3	4	5	6.
1406 Model:	none	none	none	1	2	3.
Words:	variable.					
Characters:	1,400	2,000	4,000	8,000	12,000	16,000.
Instructions:	variable.					
Modules:	1	1	1	2	2	2.

.32 Rules For Combining Modules: . . . . . all possible configurations are shown above.

.4 CONTROLLER: . . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: . 1 access device.

.52 Simultaneous Operations: . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 6.5 μ sec.
Cycle time: . . . . . 11.5 μ sec.
For data unit of: . . . . 1 character.

.6 CHANGEABLE STORAGE: no.

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§ 041.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . . yes.
With Disc Storage Unit: yes.

.72 Transfer Load Size

With self: . . . . . 1 to N char limited by storage capacity.
With Disc Storage Unit:. 1 record or 1 band.

.73 Effective Transfer Rate

With self: . . . . . 43,500 char/sec.
With Disc Storage Unit:. 8,420 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	limit check	stop.
Receipt of data:	parity check	indicator and alarm.
Dispatch of data:	send parity bit	indicator and alarm.
Conflicting commands:	not possible.	
Invalid character:	validity check	stop and alarm.
Recovery of data:	parity check	indicator and alarm.

INTERNAL STORAGE: DISK STORAGE UNIT

§ 042.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit. 1405 Models 1 and 2. "RAMAC".

.12 Basic Use: . . . . . auxiliary storage.

.13 Description:

This store, often referred to as a RAMAC unit, consists of 25 or 50 thin magnetic discs on a common vertical shaft. Each disc has 200 bands on the top face and 200 on the bottom. Each band is divided into 5 sectors, each capable of holding 1 record with a fixed length of 200 alphameric characters. Model 1 has 25 discs with a total capacity of 50,000 records or 10,000,000 characters. Model 2 has 50 discs with a capacity of 100,000 records or 20,000,000 characters. Only one unit can be connected to a system. Disc storage drive seek time can be fully overlapped with internal processing. No overlapping is possible during disc read or write operations.

Access is by means of a fork-shaped arm with two read-write heads, one head serving each face of the disc. The arm moves vertically to the selected disc, then horizontally to the selected band. A seven-position indelible address on the disc is used to verify automatically that the record accessed is the one called for by the program. The "write disc check" command can be used for a programmed comparison of data in core storage with data previously written on the disc. Access time varies from 0.2 to 860 milliseconds; the average for pure random processing is about 600 milliseconds. The peak transfer rate is 22,500 characters per second; bulk transfer rate with optimum arrangement of data is 8,420 characters per second.

An Additional Access Arm is available as an optional feature. This makes it possible to seek two different records simultaneously, but only one read or write operation can be done at a time.

.14 Availability: . . . . . 12 months as of April, 1963.

.15 First Delivery: . . . . July, 1961.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . multiple discs.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . . 24 inches.
Thickness or length: . thin.
Number on shaft: . . Model 1, 25 discs.
Model 2, 50 discs.

.23 Storage Phenomenon: . . magnetization.

.24 Recording Permanence

.241 Data erasable by program:. . . . . yes
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable:. . . no.

.25 Data Volume Per Band of 1 Track

Words: . . . . . variable.
Characters:. . . . . 1,000.
Digits: . . . . . 1,000.
Instructions: . . . . . variable.
Records: . . . . . 5.

.26 Bands Per Physical Unit: . 400 per disc (200 on each side).

.27 Interleaving Levels: . . none.

.28 Access Techniques

.281 Recording method: . . . moving heads.

.283 Type of access

Description of Stage	Possible starting stage
Remove head from unwanted disc:	if new disc is selected.
Move head to selected disc:	no.
Move head to selected band:	if same disc was previously selected.
Wait for start of selected record:	if same band was previously selected.
Wait for transfer of record:.	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . . 1,200 rpm.
Bit rate per track:. . . 157,500 bits/sec/track.

.292 Peak data rates
Unit of data: . . . . . character.
Conversion factor:. . . 7 bits/char.
Gain factor: . . . . . 1.
Data rate: . . . . . 22,500 char/sec.
Compound data rate:. . 22,500 char/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage	
Identity:		1405 Model 1	1405 Model 2.
Discs:	0	25	50.
Words:	0	variable	variable.
Characters:	0	10,000,000	20,000,000.
Instructions:	0	variable	variable.
Records:	0	50,000	100,000.
Bands:	0	10,000	20,000.
Modules:	0	1	1.

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§ 042.

.32 Rules for Combining Modules:. . . . . only 1 module per system.

.4 CONTROLLER

.41 Identity: . . . . . Disk-Storage Control. #3327.

.42 Connection to System

.421. On-Line: . . . . . 1 max (Built into Disk Storage Unit).
.422 Off-Line:. . . . . none.

.43 Connection to Device

.431 Devices per controller:. 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . one 200-char record or one 1,000-char band.
.442 Input-Output area: . . . core storage.
.443 Input-Output area access: . . . . . each character.
.444 Input-Output area lockout: . . . . . yes, for full block.
.445 Synchronization: . . . . automatic.
.447 Table control:. . . . . none.
.448 Testable conditions:. . . inoperable access arm.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Stacks per system: . . . 2 (4 with Additional Access Arm).
Stacks per module: . . . 2 (4 with Additional Access Arm).
Stacks per yoke: . . . . 2 (4 with Additional Access Arm).
Yokes per module: . . . 1 (2 with Additional Access Arm).
.512 Stack movement: . . . . vertically to selected disc; then horizontally to selected band.
.513 Stacks than can access any particular location: 1 (2 with Additional Access Arm).
.514 Accessible locations, records

	Model 1	Model 2
By single stack		
With no movement:	5	5.
With all movement:	25,000	50,000.
By all stacks		
With no movement:	10	10.

.515 Relationship between stacks and locations: 1 stack serves top faces of all discs; other stack serves bottom faces.

.52 Simultaneous Operations

A: . . . . . Waiting for access to specified location.
B: . . . . . Searching for access by pattern matching.
C: . . . . . Reading.
D: . . . . . Recording.

.52 Simultaneous Operations (Contd.)

Without Additional Access Arm:. . . . . a + c + d = at most 1.
b = 0.
With Additional Access Arm:. . . . . c + d = at most 1.
a + c + d = at most 2.
b = 0.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation msec.	Example msec.
Remove head from unwanted disc:	0 or 90 to 250	200.
Move to selected disc:	0 or 100 to 315	200.
Move to selected band:	0 or 90 to 250	200.
Wait for start of selected record:	0.2 to 50.2	25.
Read one record, or	10	10.
Read one band:	50	--.
Total:	10.2 to 915	635.

.6 CHANGEABLE STORAGE: none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . . no.
With core storage: . . yes.

.72 Transfer Load Size

With core storage: . . . 1 record or 1 band.

.73 Effective Transfer Rate

With core storage: . . . 8,420 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none.	
Receipt of data:	parity check	indicator and alarm.
Dispatch of data:	send parity bit	indicator and alarm.
Conflicting commands:	interlock	wait.
Inoperable access arm:	check	indicator and alarm.
Wrong-length record:	check	indicator and alarm.
Wrong-record selected:	address comparison	try again; if still wrong, set indicator and alarm.
Any DSU error:	check	indicator and alarm.
Recovery of data:	parity check and address comparison	indicator and alarm.

NOTE: "Write disc check" can be programmed for complete verification of write operations.

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INTERNAL STORAGE: 1311 DISK STORAGE DRIVE

§ 043.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Drive. 1311 Models 2 and 4.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

The 1311 Disk Storage Drive is a low cost random access storage, available for the IBM 1410, 1440 and 1620 Data Processing Systems as well as the 1401, which features rapid interchangeability of the "Disk Pack" storage cartridges. The system is suitable for either random or sequential processing methods.

Each Disk Pack consists of six discs on a common vertical axis. Data can be recorded on ten disc surfaces; the top and bottom surfaces of the pack are not used. Each recording surface is divided into 100 concentric tracks, each track is divided into 20 sectors, and each sector holds a 5-character address and up to 100 alphameric characters of data. The data capacity is therefore 2,000 characters per track, 200,000 characters per surface, and 2,000,000 characters per pack. With the optional Track Record feature, the data capacity is 2,980 characters per track, 298,000 characters per surface, and 2,980,000 characters per pack. It should be noted that use of this feature requires reading full tracks of data, thereby increasing the required internal core storage. Up to 5 Disk Storage Drives can be connected to a 1401 system, thus the maximum on-line data capacity is 10,000,000 characters.

Access is by means of a comb-like mechanism containing five arms that move horizontally between the discs. Each arm has one read-write head mounted on the top and one on the bottom, and each head serves one disc surface. The entire access mechanism moves as one unit, so all 10 read-write heads are always positioned at corresponding tracks on their respective surfaces. The term "cylinder" is applied to each group of 10 tracks (1 on each disc surface) that can be read or recorded upon at a single setting of the access mechanism. There are 100 cylinders per Disk Storage Drive, and each cylinder can hold 20,000 characters.

Time for access mechanism movement ranges from zero (for successive references to a previously selected cylinder) to 400 milliseconds; average random access time is 250 milliseconds. Unless the optional Direct Seek feature is installed, the access arms cannot move directly from one cylinder to another. Instead, the arms retract all the way to the "home" position (beyond track 00) and then move back to the selected cylinder. The result is that movements between adjacent cylinders require from 85 milliseconds (track 00 to 01) to 390 milliseconds (track 98 to 99).

.13 Description (Contd.)

Rotational speed of the discs is 1,500 rpm. Maximum rotational delay is 40 milliseconds, and the average is 20 milliseconds. There is also a head select delay of 2 milliseconds. Total reference cycle time to read a randomly-placed 100-character record, up-date it, re-write it, and execute a programmed write check is 354 milliseconds. If no access motion is required, the total reference cycle time is reduced to 104 milliseconds. Peak data transfer rate is 77,000 characters per second, and the effective bulk transfer rate is 33,800 to 38,200 characters per second.

A single read or write instruction can transfer from 1 to 200 consecutive sectors of information; i.e., from 100 characters to the capacity of core storage in multiples of 100 characters. The programmer can elect to read and write sector addresses along with the data records. Handling of variable-length disc records is facilitated by "sector count overlays" in which the first three characters of a record specify the number of sectors (from 2 to 200) comprising that record.

All capacities and transfer rates quoted here are based on operation in the "move" mode, in which six data bits and one parity bit are recorded for each character. In the alternative "load" mode, the word mark bit is also recorded for each character, and sector capacity is reduced from 100 to 90 data characters. All capacities and transfer rates for the load mode are therefore 10 per cent lower than the figures quoted here. Use of the load mode is essential for program storage and for data storage when field lengths vary from record to record.

Checks are made for parity errors, wrong length records, and unequal address comparisons. The "write disc check" instruction causes a character-by-character comparison of data just written on the disc with the data in core storage. This instruction usually follows each write operation. All disc errors cause the setting of testable indicators.

Disk Storage Drive seek time can be fully overlapped with internal processing. A "branch if access mechanism busy" instruction is provided. No overlapping is possible during disc read or write operations. Only one seek operation may go on at a time, regardless of the number of Disk Storage Drives in a system.

The removable Disk Packs are 14 inches in diameter, 4 inches high, and weigh less than 10 pounds, including covers. A Disk Pack can be removed from a Disk Storage Drive and replaced by another Disk Pack in one minute. When a Disk Pack is not mounted on a drive, the pack and its cover combine to form a sealed container that can be conveniently stored and transported. One Disk Pack is supplied with each 1311 Disk Storage Drive. Additional Disk Packs cost $490 each, f.o.b. San Jose.

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.13 Description (Contd.)

Optional Features

Direct Seek: Permits the access mechanism to move directly to the specified cylinder without returning to the "home" position. Access motion time ranges from zero to 250 milliseconds and averages 150 milliseconds.

Track Record: Permits reading and writing a full track as a single 2,980-character record, thereby increasing the capacity of each Disk Pack from 2,000,000 to 2,980,000 characters. The increased capacity is achieved by using the areas that normally contain sector addresses for data storage.

Scan Disk: Permits an automatic search of data recorded in disc storage for a specific identifier or condition.

Seek Overlap: Permits a "Seek" operation on one disc storage drive to be overlapped with one 1311 "Read" or "Write" operation on another disc unit plus any number of other "Seek" operations.

.14 Availability: . . . . . ?

.15 First Delivery: . . . . ?

.16 Reserved Storage: . . . none. (Note that each 100-digit sector is preceded by a 5-digit address, but these address digits are not counted as storage.)

.2 PHYSICAL FORM

.21 Storage Medium: . . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . . 14 inches o.d.
Thickness or length: . thin.
Number or shaft: . . . 6.

.23 Storage Phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . yes.

.25 Data Volume per Band of 1 Track

Words: . . . . . variable.
Characters: . . . . . 2,000.
Digits: . . . . . 2,000.
Instructions: . . . . . variable.
Sectors: . . . . . 20.

.26 Bands per Physical Unit: 100 per disc surface.

.27 Interleaving Levels: . . 1.

.28 Access Techniques

.281 Recording method: . . . by one of the magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to home position † and then to selected band: .	mandatory when new band is selected.
Wait for selected sector for reading or recording: . . .	if same band was previously selected.

† Not necessary with Direct Seek feature.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1,500 rpm.
Bit rate per track: . . 539,000 data bits/sec/track.
.292 Peak data rates
Unit of data: . . . . . character.
Conversion factor: . . 7 bits per character (6 plus parity).
Gain factor: . . . . . 1 track/band.
Data rate: . . . . . 77,000 characters/sec. not counting address digits.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage			Maximum Storage
Identity:	0	1311 Model 4	1311 Model 2	1 1311 Model 4 and 4 1311 Model 2.
Discs:	0	6	6	30.
Words:	0	variable	variable	variable.
Characters:	0	2,000,000	2,000,000	10,000.
Instructions:	0	variable	variable	variable.
Modules:	0	1	1	5.

.4 CONTROLLER

.41 Identity: . . . . . part of 1311 Model 4.

.42 Connection to System

.421 On-line: . . . . . 1 1311 Model 4.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 5 modules.
.432 Restrictions: . . . . . 1 Model 4 and 1 to 4 Model 2; no other restrictions.

.44 Data Transfer Control

.441 Size of load.
Variable length: . . . 1 to 200 sectors of 100 characters per sector; number of sectors set by programmer.
Fixed length: . . . . . 20 sectors of 100 characters per sector (one band).

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.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . none.
.448 Testable conditions: . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
Stacks per system: . . 50 max.
Stacks per module: . . 10.
Stacks per yoke: . . . 10.
Yokes per module: . . 1.
.512 Stack movement: . . . . horizontal.
.513 Stacks that can access any particular location: . . . . . 1.
.514 Accessible locations
By single stack
With no movement: . 20 sectors.
With all movement: . 2,000 sectors.
By all stacks
With no movement: . 200 sectors per module
200 to 1,000 sectors per system.
.515 Relationship between stacks and locations: . three most significant digits of Sector Address denote head and band (cylinder) number.

.52 Simultaneous Operations: . . . . . maximum of 1 1311 Disk Storage operation (reading, recording, or seeking) at a time per 1401 system.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation	Average
Without Direct Seek		
Move head to home position and then to selected band:	75 to 392 msec.	250 msec.
Wait for selected sector for reading or recording:	0 to 40 msec.	20 msec.
Total:	75 to 432 msec.	270 msec.
With Direct Seek		
Move head to selected band:	54 to 248	154 msec.
Wait for selected sector for reading or recording:	0 to 40 msec.	20 msec.
Total:	54 to 288 msec.	174 msec.

.6 CHANGEABLE STORAGE

.61 Cartridges

.611 Cartridge capacity
Without Track Record feature: . . . . . 2,000,000 characters (6 discs).
With Track Record feature: . . . . . 2,980,000 characters (6 discs).
.612 Cartridges per module: 1.
.613 Interchangeable: . . . . yes.

.62 Loading Convenience

.621 Possible loading
While computing system in use: . . . yes.
While storage system in use: . . . . . yes, if the particular module is not addressed.
.622 Method of loading: . . . operator.
.623 Approximate change time: . . . . . 1 minute.
.624 Bulk loading: . . . . . no; 1 cartridge of 6 discs at a time.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage unit possibilities
With self: . . . . . no.
With core storage: . . yes.

.72 Transfer Load Size

With core storage: . . . 1 to 20 sectors; number of sectors selected by program.
1 block of 20 sectors (one band).

.73 Effective Transfer Rate

The times shown are the average for either reading from or recording on disc storage with no checking.

With core storage
With Direct Seek: . . 38,200 char/sec.
Without Direct Seek: . 33,800 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check on matching sector address	indicator.
Invalid code:	none.	
Receipt of data:	parity check	indicator.
Recording of data:	programmed read-back and compare	indicator.
Recovery of data:	parity check	indicator.
Dispatch of data:	parity bit included.	
Timing conflict:	interlock	wait.
Physical record missing:	check on record length	indicator.
Reference to locked area:	check on optional lock	indicator.

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CENTRAL PROCESSOR: PROCESSING UNIT

§ 051.

.1 GENERAL

.11 Identity: . . . . . Processing Unit. 1401 Models A, B, C, D, E, F.

.12 Description:

The 1401 is a two-address, add-to-storage processor. All operations are performed serially by character and terminated when a word mark bit is sensed, so operand size is limited only by the programmer's desires and the available core storage. The basic arithmetic and logical capabilities of the six models are identical; they differ, however, in the configurations of peripheral equipment and optional features that can be attached, as shown in the System Configuration chart. Controllers for the card read-punch, printer, and magnetic tape units are an integral part of the Processing Unit.

The processor is well suited to general data manipulation and has powerful editing capabilities, but multiplication, division, indexing, high-low comparison, and record transfer capabilities are extra-cost options, as described below. Instruction length is variable from one to eight characters. Arithmetic and data transfer instructions are usually seven characters long. Through careful placement of data, instructions can sometimes be "chained" so that a one character instruction does the work of a seven character one, resulting in savings in both storage requirements and execution time. Chaining is possible only when a series of operations is to be performed on items of data stored in consecutive locations.

Data movement is performed in either the MOVE mode or the LOAD mode of operation. In the MOVE mode, data items are moved without field-defining word marks, thereby effectively restricting the data format to fixed item lengths, because instructions must repeatedly operate on the same data addresses. In the LOAD mode, data items are moved with restricting word marks, marking dynamically variable item lengths possible; i.e., the number of characters used to represent a given data item can vary from record to record. The LOAD mode usually results in longer internal processing because it usually requires storing address registers and subsequent indexing to determine the length of each data item in order to ascertain the low order position of the next data item. The LOAD mode usually makes tape input-output operations shorter, even though an extra word mark character is inserted on the tape record for each item, because non-significant zeros or blanks used to fill out items to equal lengths in the MOVE mode can be omitted. Because the basic 1401 system (without optional features) does not possess the ability to index or store address registers, the data format is necessarily restricted to fixed position fields of preset length and, therefore, to the MOVE mode of data manipulation.

.12 Description (Contd.)

The ability to store the contents of either the A-address or the B-address registers (an optional feature) is very helpful when addressing data items; however, the contents of only one of the two address registers can be stored for a given setting, because the instruction that stores one destroys the contents of the other.

The card reader, card punch, and printer input-output areas are preset locations in core storage. These locations are completely usable as regular storage. Before a card punch or printer output operation can be performed, the data to be punched or printed must be moved to the appropriate preset output area. Similarly, care must be exercised so that no data which needs to be preserved is located in the preset card reader input area when a read operation is initiated.

Optional Features

Advanced Programming: Makes three 3-character registers in core storage available as index registers which can index any instruction address; permits storing the contents of the A or B address registers; and permits the transfer of complete records of data within core storage by a single instruction.

Column Binary: Permits processing of column binary coded cards and magnetic tapes, such as those used in the IBM 704, 709, and 7090 systems.

Expanded Print Edit: Adds check protection, floating dollar sign, decimal control, and sign control left to the basic editing capabilities.

High-Low-Equal Compare: Permits testing of indicators for high, low or equal conditions after a comparison. (Without the compare feature, only equal-unequal comparisons can be made.)

Multiply-Divde: Permits direct multiplication and division.

Sense Switches: Provide six console switches and corresponding testable indicators which can be used to control the stored program.

Direct Data Channel: Permits two 1401 systems or a 1401 and 1441 to transfer data from one to another.

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.12 Description (Contd.)

Optional Features (Contd.)

Processing Overlap: Allows the system to compute while input/output is in process. Computing continues while the input-output unit prepares to send or receive data, and between character transfers to and from core storage.

Tape Intermix: Permits mixing 729 tape units with 7330 tape units on the same system.

.13 Availability: . . . . . 12 months as of April, 1963.

.14 First Delivery: . . . . September, 1960

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-Subtract:	automatic	decimal	1 to N char.
Multiply:			
Short:	none.		
Long:	subroutine	decimal	1 to N char.
Divide:	automatic (with Multiply-Divide)	decimal	1 to N char.
No remainder:	none.		
Remainder:	subroutine	decimal	1 to N char.
	automatic (with Multiply-Divide)	decimal	1 to N char.
.212 Floating point			
Add-Subtract:	subroutine	decimal	8 & 2 char.
Multiply:	subroutine	decimal	8 & 2 char.
Divide:	subroutine	decimal	8 & 2 char.
.213 Boolean			
AND:	none.	Binary	
Inclusive OR:	none.		

.214 Comparison: . . . . . only for equality; optional feature for high-low.

Numbers:	automatic	1 to N char.
Absolute:	none.	
Letters:	automatic	1 to N char.
Mixed:	automatic	1 to N char.

Collating sequence: blank, specials, A-Z, 0-9.

.215 Code translation:

Provision	From	To	Size
optional feature	column binary (card image)	binary tape format	1 to 80 columns.

.216 Radix conversion:

Provision	From	To	Size
none.			

.217 Edit format:

	Provision	Comment	Size
Alter size:	automatic	expand but not contract.	1 to N char.
Suppress zero:	automatic.		
Round off:	none.		
Insert point:	automatic.		
Insert spaces:	automatic		
Insert $, CR-:	automatic		
Float $:	optional feature.		
Protection:	optional feature.		

.218 Table look-up: . . . . . none.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value with B zone-bit in units position.

.222 Zero: . . . . . positive, negative, and unsigned zeros and blanks give same result in arithmetic but are unequal in comparisons.

.223 Operand size determination: . . . . . word mark bit in high order digit position.

.23 Instruction Formats

.231 Instruction structure: . . variable; 1 to 8 characters.

.232 Instruction layout:

Part	OP	A or I	B	d
Size (char)	1	3	3	1

Instructions may consist of:

1. OP only
2. OP, d
3. OP, A or I
4. OP, A or I, d
5. OP, A or I, B
6. OP, A or I, B, d

.233 Instruction parts

Name	Purpose
OP:	operation code.
A:	address of an operand in core storage or of a peripheral device.
I:	location of next instruction if a branch occurs.
B:	address of an operand or field in core storage.
d:	modifier for an operation code.

.234 Basic address structure: 2 + 0.

.235 Literals

Arithmetic: . . . . . none.

Comparisons and tests: yes, single character.

Incrementing modifiers: . . . . . none.

.236 Directly addressed operands

.2361 Internal storage type

	Minimum size	Maximum size	Volume accessible
core:	1 char	total capacity	total capacity.
disc:	1 block	1 band of 5 blocks	total capacity (indirect addressing must be used).

.237 Address indexing

.2371 Number of methods: . . 1.

.2372 Names: . . . . . indexing (with optional feature).

.2373 Indexing rule: . . . . . addition, modulo 16,000.

.2374 Index specification: . . zone bits in tens position of presumptive address.

.2375 Number of potential indexers: . . . . . 3.

.2376 Addresses which can be indexed: . . . . . all.

.2377 Cumulative indexing: . none.

§ 051.

.2378 Combined index and step: none.
.238 Indirect addressing:. . none, except for disc storage unit.
.239 Stepping: . . . . . none.

.24 Special Processor Storage

.241

Category of storage	No. of locations	Size in characters	Program usage
Processing Unit:	1	3	sequence counter.
Processing Unit:	2	3	data transfer control.
Core Storage	3 (5 with Column Binary Feature)	80 to 132	input-output areas.

.242

Category of storage	Total no. of locations	Physical form	Access time, sec.	Cycle time, sec.
Processing Unit:	3	transistorized latch	?	11.5
Core Storage:	3 (5 with Column Binary Feature)	core	6.5	11.5

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . 1.
.315 Sequence control step size: . . . . . 1 character.
.316 Accessibility to routine: none.
.317 Permanent or optional modifier: . . . . . no.

.32 Look-Ahead: . . . . . none.

.33 Interruption: . . . . . none.

.34 Multi-running: . . . . . none.

.35 Multisequencing: . . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ secs

.411 Fixed point
Add-subtract: . . . . . 115 + 23D.
Multiply:. . . . . 115 + 104D + 57.5D^2 (with optional feature).
Divide:. . . . . 104 + 92D + 80.5D^2 (with optional feature).

.412 Floating point (8-digit precision)
Add-subtract: . . . . 7,850.
Subtract:. . . . . 8,300.
Multiply:. . . . . 7,600.
Divide: . . . . . 11,700.

.413 Additional allowance for
Indexing:. . . . . 34.5 or 46.0 per modified address.
Re-complementing: . . 34.5D.

.414 Control
Compare: . . . . . 92 + 23D.
Branch: . . . . . 57.5 to 115.

.415 Counter control: . . . . none.

.416 Edit:. . . . . 92 + 34.5C.
.417 Convert:. . . . . none.
.418 Shift: . . . . . none.

.42 Processor Performance in μ sec

.421 For random addresses

	Fixed point	Floating point
c = a + b:	207 + 46D	8,800.
b = a + b:	115 + 23D	8,800.
Sum N items:	115 + 23D	8,200.
c = ab, with MD:	207 + 127D + 57.5D^2	8,600.
c = ab, with subroutines:	466 + 3450D + 140D^2	- - -
c = a/b, with MD:	196 + 115D + 80.5D^2	12,700
c = a/b, with subroutines:	8680 + 2950D + 172D^2	- - -

.422 For arrays of data

	Fixed point	Floating point
$c_i = a_i + b_j$, with AP:	965 + 46D	9,500.
$c_i = a_i + b_j$, without AP:	1173 + 46D	9,600.
$b_j = a_i + b_j$:	713 + 23D	9,600.
Sum N items:	529 + 23D	8,600.
$c = c + a_i b_j$, with MD:	920 + 150D + 58D^2	17,300.
$c = c + a_i b_j$, with subroutines:	765 + 3450D + 140D^2	

.423 Branch based on comparison

	With High-Low-Equal Compare	Without High-Low-Equal Compare
Numeric data: . . .	1012 + 23D	1104 + 46D.
Alphameric data: .	1012 + 23D	impractical.

.424 Switching
Unchecked: . . . . 483.
Compose: . . . . . 943 (with High-Low-Equal Compare).
List search: . . . . 644 + 644N.

.425 Format control per character
Unpack: . . . . . 34.
Compose: . . . . . 62.

.426 Table look up per comparison
For a match:. . . . . 575 + 23C.
For least or greatest:. 775 + 25C.
For interpolation point:. . . . . 575 + 23C.

.427 Bit indicators
Set bit in separate location: . . . . . 115.
Test bit in separate location: . . . . . 184.

.428 Moving: . . . . . 92 + 23D.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	indicator & alarm.
Underflow (float-pt):	none.	
Zero divisor:	overflow check	indicator & alarm.
Invalid data:	char. validity check	stop & alarm.
Invalid operation:	check	stop & alarm.
Arithmetic error:	none.	
Invalid address:	limit check	stop & alarm.
Receipt of data:	parity check	indicator & alarm.
Dispatch of data:	none.	

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CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . contained in 1401 Processing Unit, at upper left corner of front panel.

.12 Associated Units: . . . . none.

.13 Description

The 1401 Console occupies the upper left quarter of the front panel of the Processing Unit cabinet. Display lights are set into a schematic diagram of the processor's data flow paths. Alarm lights across the top indicate errors in the processor or in specific peripheral units. The main operating controls are at the bottom of the console panel. Less frequently used controls are in the Auxiliary Console, which is located just below the main console panel and is covered during normal operation. The Console is designed for operation from a standing position, and no desk space is provided. Typewriter input-output is available only through the inclusion of the optional 1407 Console Inquiry Station.

.2 CONTROLS

.21 Power

Name	Form	Comment
Power on:	button	turns on main power supply.
Power off:	button	turns off main power supply.
Emergency off:	pull switch	disconnects all power.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
Start key:	button	initiates machine operation.
Stop key:	button	halts processing upon completion of current instruction

.24 Stepping: . . . . . Mode switch selects one of nine operation modes: RUN, INSTRUCTION EXECUTION, SINGLE CYCLE PROCESS, SINGLE CYCLE NON-PROCESS, CHARACTER DISPLAY, STORAGE PRINT-OUT, ALTER, STORAGE SCAN, or ADDRESS STOP. Several of these result in stepping each time Start key is depressed.

.25 Resets

Name	Form	Comment
Start reset:	button	turns off all indicators.
Check reset:	button	must be depressed after a processing error.
I/O check stop:	toggle switch	determines whether system will stop on reader, punch, or printer errors.
Check stop:	toggle switch	determines whether processing errors will result in halts.

.28 Special

Name	Form	Comment
Manual address:	4 10-position dials	select address for entry into A-, B-, or I-address register.
Register keylights:	5 buttons	select an address register for display or data entry.

.26 Loading

Name	Form	Comment
Tape load:	button	selects tape unit 1, loads 1 record starting at position 001, and transfers control to 0002.
Bit switches:	8 toggle switches	used to alter characters in storage.
Enter switch:	toggle	enters character selected by bit switches into storage.

.27 Program Branching

Name	Form	Comment
Sense switch A:	toggle switch	controls last-card operations (standard).
Sense switches B-G:	toggle switches (6)	testable by program to control branching (optional feature).

.3 DISPLAY

.31 Alarms

Name	Form	Condition indicated
Process light:	static light	Processing Unit error.
RAMAC light:	static light	Disc Storage Unit error.
Tape light:	static light	tape read or write error.
External I/O light:	static light	error in a serial I/O unit.
Reader light:	static light	operator attention required by card reader.
Punch light:	static light	operator attention required by card punch.
Printer light:	static light	printer error.
Storage light:	static light	parity error in core storage.
Logic light:	static light	arithmetic parity error.
A light:	static light	parity error in A-register.
B light:	static light	parity error in B-register.
Storage-address light:	static light	parity error in address register.
OP-register light:	static light	incorrect operation code.

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.32 Conditions

Name	Form	Comment
Overflow light:	static light	remains ON until overflow indicator is tested by program.
B ≠ A light:	dynamic light	indicates unequal comparison.
B = A light:	dynamic light	indicates equal comparison.
B > A light:	dynamic light	with High-Low-Equal Compare feature only.
B < A light:	dynamic light	with High-Low-Equal Compare feature only.
Instruction length:	static light	indicates which character of an instruction is displayed.

.33 Control Registers

Name	Form	Comment
A-register:	BCD lights.	
B-register:	BCD lights.	
OP-register:	BCD lights.	
Storage address:	BCD lights (4 positions)	A-, B-, or I-address is displayed, depending upon key-light depressed.

.34 Storage

(1) Set Mode switch to CHARACTER DISPLAY.
(2) Set Manual Address switches to location to be displayed.
(3) Press Start key to display storage contents (one character) in the B-register lights.

.4 ENTRY OF DATA

.41 Into Control Registers

(1) Set Mode switch to ALTER.
(2) Set Manual Address switches to the address to be entered.
(3) Press key-light for the desired register.
(4) Press Start key.

.42 Into Storage

(1) Set Mode switch to ALTER.
(2) Set Manual Address switches to storage location to be filled.
(3) Set Bit-switches to the required pattern.
(4) Turn on Enter switch to load one character at a time.

.5 CONVENIENCES

.51 Communication: . . . . . none.

.52 Clock: . . . . . none.

.53 Desk Space: . . . . . none.

.54 View: . . . . . the console is designed for best visibility and operation from a standing position.

AUERBACH / BNA

INPUT-OUTPUT: CARD READ-PUNCH (READER)

§ 071.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch, (Reader only). 1402 Model 1.

.12 Description:

While the 1402 consists of a card reader and punch housed in the same cabinet, the two units are completely independent of one another from the user's viewpoint and are covered in separate sections of this report.

The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Conversion from the card column code to internal BCD code is automatic. A hole-count check is made on each column at a second reading station, and the bit configuration of each character is checked for validity as it is transferred into core storage. A hopper with a 3,000-card capacity and 3 stackers with 1,000-card capacities (one shared with the punch unit) can be loaded and unloaded without stopping the reader.

Optional Features:

Column Binary: Permits true card image to be stored in core positions 401-480 and 501-580. (No character validity checking can be done in this case.)

Early Card Read: Provides a 3-point clutch so card reading can be initiated at 25-millisecond intervals instead of the standard 75-millisecond interval.

Interchangeable Feed: Permits reading of either 80- or 51-column cards by interchanging hardware.

Processing Overlap: Permits computation during reader start time and between character transfers.

Read-Punch Release: Permits computation during reader start time (21 milliseconds per card).

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . . September, 1960

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . . brush.
.223 Common system: . . . . no.

.23 Multiple copies: . . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards (51-column cards with optional Interchangeable Feed).
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80-columns of standard spacing.
.324 Track use
Data: . . . . . 80.
Total: . . . . . 80.
.325 Row use
Data: . . . . . 12.

.33 Coding: . . . . . column code as in Data Code Table No. 3 (401:143.100), or (with Column Binary) binary pattern of holes in each col.

.34 Format Compatibility

Other device or system	Code translation
All devices using std. 80-column cards: . .	not required.

.35 Physical Dimensions: . . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (circuitry is in processing unit).

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.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . . core storage positions 001-080 (also positions 401-480 and 501-580 in Column Binary mode).
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block. (no lockout when Processing Overlap is used.)
.445 Table control: . . . . . none.
.446 Synchronization: . . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation
Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . 1 card forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . . automatic by processor.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . . no.
Offset card: . . . . . no.
Select stacker: . . . . . yes, one of 3.
Select format: . . . . . no.
Select code: . . . . . with Column Binary only.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . with Processing Overlap only.
Output lock: . . . . . no.
Nearly exhausted: . . . . no.
Busy controller: . . . . . no.
End of medium marks: . no.
Exhausted: . . . . . yes.
Full stacker: . . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard unit.
II: . . . . . with Read-Punch Release.
III: . . . . . with Processing Overlap.

.62 Speeds

.621 Nominal or peak speed: . 800 cards/min, all cases.
.622 Important parameters

Name	Value
Clutch cycle:	75 msec.

.623 Overhead: . . . . . 1 clutch point (3 with optional feature).
.624 Effective speeds: . . . . 800 cards/min if processing time per card does not exceed these values:
I: . . . . . 10 msec.
II: . . . . . 31 msec.
III: . . . . . 63 msec.

.63 Demands on System

Component	Condition	msec per card,	or	Percentage
Processing Unit:	I	65	or	86.7.
	II	44	or	58.7.
	III	12	or	16.0.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Card width:	interchange of hardware	with Interchangeable Feed only.

.72 Other Controls

Function	Form	Comment
Load:	key	starts loading of instruction cards.
Check reset:	key	resets read error indicators.
Stop:	key	halts system at end of current program step.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	3,000 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . 0.25 to 0.50 minute.
.733 Adjustment time (80- to 51-column cards): . 10 to 15 minutes.
.734 Optimum reloading period: . . . . . 1.25 minutes.

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.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	indicator and alarm.*
Input area overflow:	cannot occur.	
Invalid code:	check	indicator and alarm.*
Exhausted medium:	check	indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop and alarm.
Stacker full:	check	stop and alarm.

* Stop will occur if I/O Check Stop Switch is on.

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INPUT-OUTPUT: CARD READ-PUNCH (PUNCH)

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch, (Punch only). 1402 Model 1.

.12 Description

Housed in the same cabinet as the card reader, this unit punches standard 80-column cards at a peak speed of 250 cards per minute. Conversion from internal BCD representation to the column card code is automatic. A reading station makes a hole-count check on each column. The 1,200-card feed hopper and three 1,000-card stackers (1 shared with the reader unit) can be loaded and unloaded without stopping the punch.

Optional Features

Column Binary: Permits punching contents of core positions 401-480 and 501-580 into a single card without code conversion.

Punch Feed Read: Adds a reading station ahead of the punching station so that results can be punched into the same card from which data was read. Hole-count and character validity checks are made on the read operation, and the demand on the processing unit is increased by 3 milliseconds per card.

Processing Overlap: Permits computation during punch start time and between character transfers from core store.

Read-Punch Release: Permits computation during punch start time (37 milliseconds per card).

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punches.
.222 Sensing system: . . . . . brush.
.223 Common system: . . . . no.

.23 Multiple Copies: . . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.

.324 Track use
Data: . . . . . 80.
Total: . . . . . 80.
.325 Row use
Data: . . . . . 12.

.33 Coding: . . . . . column code as Data Code Table No. 3 (401:143.100), or (with Column Binary) binary pattern of holes in each column.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (circuitry is in processing unit).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . none.

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.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage positions 101-180 (also positions 001-080 with Punch Feed Read and 401-480 and 501-580 with Column Binary.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block. (no lockout when Processing Overlap is used).
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . with Punch Feed Read, 1 card forward, interlocked with output.
.522 Output: . . . . . 1 card forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . . automatic, by processor.

.54 Format Control: . . . . none.

.55 Control Operations

Disabled: . . . . . no.
Request interrupt: . . . . no.
Offset card: . . . . . no.
Select stacker: . . . . . yes, 1 of 3.
Select format: . . . . . no.
Select code: . . . . . with Column Binary only.
Unload: . . . . . no.

.56 Testable Conditions

Disable: . . . . . no.
Busy device: . . . . . with Processing Overlap only.
Output lock: . . . . . no.
Nearly exhausted: . . . . no.
Busy controller: . . . . . no.
End of medium marks: . no.
Hopper empty: . . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard unit.
II: . . . . . with Read-Punch Release.
III: . . . . . with Processing Overlap.

.62 Speeds

.621 Nominal or peak speed: . 250 cards/min, (all cases).
.622 Important parameters

Name	Value
Clutch cycle:	240 msec.

.623 Overhead: . . . . . 4 clutch points.
.624 Effective speeds: . . . . 250 cards/min if processing time per card does not exceed these values:
I: . . . . . 22 msec.
II: . . . . . 59 msec.
III: . . . . . 212 msec.

.63 Demands on System

Component	Condition	msec. per card,	or	Percentage
Processing Unit:	I	218	or	90.8.
	II	181	or	75.4.
	III	16	or	6.7.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets punch error indicators.
Stop:	key	halts system at end of current program step.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . 0.25 to 0.50 minute. Punch does not need to be stopped.
.734 Optimum reloading period: . . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Errors	Check or Interlock	Action
Recording:	hole count	indicator and alarm.*
Reading:	hole count (with Punch Feed Read)	indicator and alarm.*
Output block size:	fixed.	
Invalid code:	check	indicator and alarm.*
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop and alarm.
Stacker full:	check	stop and alarm.

* Stop will occur if I/O Check Stop Switch is on.

AUERBACH / BNA

INPUT-OUTPUT: PAPER TAPE READER

§ 073.

.1 GENERAL

.11 Identity: . . . . . Paper Tape Reader. 1011 Model 1.

.12 Description:

This unit reads data from punched paper tape into 1401 core storage at a peak speed of 500 rows per second. Five-, six-, seven-, or eight-track tape can be read, and translation of the tape codes to 1401 BCD coding is controlled by plugboard wiring. The tape can be either chad of chadless; 11/16, 7/8, or 1-inch wide; and in the form of strips, conventional reels, or rolls which feed from the center. Parity checks can be applied to tape codes which employ odd-bit parity, but not to five-track telegraphic tape. The optional Processing Overlap feature permits computation to be overlapped with paper tape input.

.13 Availability: . . . . . .12 months, as of April, 1963.

.14 First Delivery: . . . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head:. . . sprocket drive.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . swinging arm.
Capacity: . . . . . about 2 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.222 Sensing system:. . . . . photo-electric.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station:. . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 8.
Method of use:. . . . . reads 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:. . . . . paper tape.
.312 Phenomenon: . . . . . punched holes (chad or chadless type).

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 10 per inch.
.322 Parallel by: . . . . . 5 to 8 tracks at standard spacing.
.324 Track use
Data: . . . . . 6 or 5.
Redundancy check: . . 1 or 0.
Timing: . . . . . 1 (sprocket track).
Control signals: . . . . 1 or 0.
Unused: . . . . . 0.
Total: . . . . . 8 to 5 (plus sprocket track).
.325 Row use
Data: . . . . . variable.
Redundancy check: . . 0.
Timing: . . . . . 0.
Control signals: . . . . 1 (end-of-record; optional).
Unused: . . . . . 0.
Gap: (if calibrated) . . 2.

.33 Coding: . . . . . normally 5-track telegraphic or 8-track BCD coding; most 5, 6, 7, or 8-track codes can be translated by plugboard wiring.

.34 Format Compatibility

Other device or system	Code translation
Most devices using 5, 6, 7, or 8-track paper tape:	plugboard wiring.

.35 Physical Dimensions

.351 Over-all width: . . . . . 11/16, 7/8, or 1 inch.
.352 Length
Strip: . . . . . 20 to 240 inches.
Roll (inside feeding): . 5 to 400 feet.
Reel (outside feeding):. 5 to 1,000 feet.

.4 CONTROLLER

.41 Identity: . . . . . No separate controller. (#7080 Serial Input/Output Adapter required on 1401).

.42 Connection to System

.421 On-line: . . . . . 1.
Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller:. 1.
.432 Restrictions:. . . . . 0 if other units requiring 7080 Adapter or 3271 Direct Data Channel is connected to the 1401.

.44 Data Transfer Control

.441 Size of load:. . . . . 1 to N characters, where N is limited by available core storage.

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.442 Input-output areas: . . .core storage.
.443 Input-output area access: . . . . . .each character.
.444 Input-output area lockout: . . . . . .yes, for full block, (no lockout when Processing Overlap is used).
.445 Table control: . . . . .none.
.446 Synchronization: . . . .automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N characters.
.512 Block demarcation
Input: . . . . . .group mark in core storage, or end-of-record character on tape.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . .none.
.523 Stepping: . . . . . .none.
.524 Skipping: . . . . . .none.
.526 Searching: . . . . . .none.

.53 Code Translation: . . . . plugboard wiring.

.54 Format Control

Control: . . . . . .plugboard.
Format alternatives: . . undefined.
Rearrangement: . . . . . yes.
Suppress zeros: . . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . no.
Omit unwanted characters: . . . . . yes.
Assign several tape codes to 1 character: . yes.

.55 Control Operations

Disable: . . . . . .no.
Request interrupt: . . . . no.
Select format: . . . . . no.
Select code: . . . . . no.
Rewind: . . . . . .no.
Unload: . . . . . .no.

.56 Testable Conditions

Disabled: . . . . . .yes.
Busy device: . . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . . no.
End of medium marks: . no.
Exhausted: . . . . . .no.

.6 PERFORMANCE

.61 Conditions

I: . . . . . without Processing Overlap.
II: . . . . . with Processing Overlap

.62 Speeds

.621 Nominal or peak speed: . 500 char/sec.
.622 Important parameters

Name	Value
Tape speed:	50.0 inches/sec.
Start time (to full speed):	2.5 msec average, 9.0 msec max.
Stop distance:	1.5 rows average, 2.0 rows max.

.623 Overhead: . . . . . 8.5 msec/block.
.624 Effective speeds: . . . . 500 N/(N+4) char/sec., where N = number of char/block.

.63 Demands on System

Component	Condition	msec per char.,	or	Percentage
Processing Unit:	I	2.0000	or	100.00.
Processing Unit:	II	0.0115	or	0.57.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustments	Method
Tape width:	change reels.
Tape code:	change plugboard panels.

.72 Other Controls

Function	Form
Reset alarm circuits: . .	key.
Reel/strip selector: . .	2-position switch.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Supply & take-up reels:	1,000 feet.
Center-roll feed: . . .	400 feet.

.732 Replenishment time: . . 0.3 to 0.5 minute for strips. 1.0 to 2.0 minutes for reels.
.733 Adjustment time: . . . . 2.0 to 3.0 minutes.
.734 Optimum reloading period: . . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check *	set indicator.
Input area overflow:	check for group mark	stop data transmission.
Invalid code:	plugboard wiring	as wired.
Exhausted medium:	check	stop.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Excessive stop distance:	check	set indicator.
Photocell failure:	check	stop; alarm.

* No parity check on 5-track tape.

AUERBACH / BNA

INPUT-OUTPUT: 1012 TAPE PUNCH

§ 074.

.1 GENERAL

.11 Identity: . . . . . Tape Punch. 1012.

.12 Description

The 1012 Tape Punch operates at the rate of 150 tape characters per second using either 5-, 6-, 7-, or 8-track paper tape or Mylar tape. A punched tape character is represented by a bit pattern found in two or three consecutive core store positions. For eight-track tape characters, the three low order bit positions in the two low order characters and the two low order bit positions in the high order character represent the bit structure of a row. For five-track tape characters, the three low order bit positions in the unit character and the two low order bit positions in the second character represent the bit structure of a row. The 1401 BCD data codes are translated by a macro routine, character by character to the required code format for the tape being used. After translation, a write instruction will cause a character to be punched on either 11/16, 7/8, or 1-inch wide chad (holes completely punched) tape.

A read instruction, given approximately 3.2 milliseconds after the punch instruction, will cause the tape character, punched three cycles previously, to be read into the 1401 core storage. The 1401 representation of the tape character can be compared with the representation of the character previously punched for validating the punched character. If an error is found, the tape character in error and those following can be overpunched with code representing an invalid character, and the characters can then be repunched.

.13 Availability: . . . . . 12 months as of April, 1963.

.14 First Delivery: . . . . November, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pin wheel.
.212 Reservoirs
- Number: . . . . . 2.
- Form: . . . . . swinging arm.
- Capacity: . . . . . approximately 2 feet.

.213 Feed drive: . . . . . electric motor.
.214 Take-up drive: . . . . . electric motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . photo-electric (check read).
.223 Common system: . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . . 1.
Heads/stack: . . . . . 8 plus 1 sprocket.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . check reading.
Distance: . . . . . 3 characters.
Stacks: . . . . . 1.
Heads/stack: . . . . . 8.
Method of use: . . . . . 1 row at a time.

.25 Range of Symbols

Numerals: . . . . . 10 0 - 9.
Letters: . . . . . 26 A - Z.
Special: . . . . . 28.
Total: . . . . . 64.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper or Mylar tape.
.312 Phenomenon: . . . . . punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 10 per inch.
.322 Parallel by: . . . . . 5, 6, 7, or 8 tracks at standard spacing.

.324 Track use
- Data: . . . . . 7.
- Redundancy check: . . 0.
- Timing: . . . . . 1 sprocket.
- Control signals: . . . 1; end of line.
- Unused: . . . . . 0.
- Total: . . . . . 8 plus sprocket.

.325 Row use: . . . . . all for data.

.34 Format Compatibility

Other device or system: all devices using standard 5-, 6-, 7-, or 8-track paper tape.
Code translation: . . . programmed.

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16, 7/8, or 1 inch.
.352 Length: . . . . . up to 1,000 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller. (#7080 Serial Input-Output Adapter required on 1401.)

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§ 074.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . 0 if other units requiring 7080 Adapter or 3271 Direct Data Channel is connected to the 1401.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 character.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N characters.
.512 Block demarcation Output: . . . . . End of Line character sensed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 character forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . delete code for error characters.
.526 Searching: . . . . . none.

.53 Code Translation: . . . own coding or macro.

.54 Format Control

Control: . . . . . program; 1 character at a time.
Rearrangement: . . . . yes.
Suppress zeros: . . . . yes.
Insert point: . . . . . yes.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . no.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . no.
Rewind: . . . . . no.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . yes.

.56 Testable Conditions (Contd.)

Busy controller: . . . . yes.
End of medium marks: no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 150 characters/second.
.622 Important parameters
Tape speed: . . . . . 15 inches/second.
Packing density: . . . 10 characters/inch.
.623 Overhead: . . . . . none.
.624 Effective speeds: . . . 150 characters/second. If less than 6.6 milliseconds elapse between initiation of punching instructions.

.63 Demands on System

Component: . . . . . processor.
Msec per character: . . 6.67*
or
Precentage: . . . . . 100%.

* This time based on using a subroutine for code conversion which does not make any attempt to process data between punching operations.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . number of tracks.
Method: . . . . . tape width guide.

.72 Other Controls

Function	Form	Comment
Feed Switch:	push button	punches feed code in 8-track tape.
Rewind Switch:	toggle switch	rewinds punched tape onto the supply reel.
Channel Switch:	2-position switch	conditions read circuit for number of tracks on tape to be punched.

.73 Loading and Unloading

.731 Volumes handled
Storage: . . . . . reel.
Capacity: . . . . . 1,000 feet.
.732 Replenishment time: . . 2.0 to 3.0 minutes. punch needs to be stopped.
.733 Adjustment time: . . . 3.0 to 4.0 minutes.
.734 Optimum reloading period: . . . . . 13.3 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	program read after punch	programmed.
Output block size:	none.	
Invalid code:	check.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	check	indicator.
Nearly exhausted:	check	indicator.

INPUT-OUTPUT: PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer.
1403, Models 1 and 2.

.12 Description:

The IBM 1403 is a line printer with a unique horizontal-chain printing mechanism, a tape-controlled carriage, and a feeding and stacking mechanism for continuous forms. Five identical sets of 48 characters are assembled serially on a chain that resembles a bicycle chain and moves in a horizontal plane at 90 inches per second. The print hammers are timed to strike against the paper individually because each character slug travels across many printing positions during a print cycle. At each printing position, the paper is forced into contact with the ribbon against the chain by a solenoid-activated hammer that is fired as the appropriate character slug passes the printing position.

The horizontal-chain printing method generally produces printing of a high quality and eliminates the problem of vertical character alignment that has plagued designers of high speed drum and wheel printers. Output produced by a 1403 Printer, however, can often be recognized by the presence of "framing" (i.e., light boxes which frame some of the printed characters).

The 1403 Model 1 has 100 printing positions and the Model 2 has 132; the two models are identical in all other respects. Peak speed is 600 lines per minute with single spacing and 480 lines per minute with an average line spacing of 1 inch. Printers used with 1401 Model A Processing Units have a single skipping speed of 33 inches per second. In all other 1401 models (B, C, D, E, and F), the printer has a dual-speed carriage which executes all skips of more than eight lines at a speed of 75 inches per second. Skipping is controlled by a 12-channel punched tape loop.

Optional Features

Numerical Print: Permits changing from the standard 48-character chain to a chain with only 16 characters; speeds up to 1, 285 lines per minute can then be obtained on all-numeric output.

Print Storage: Reduces time demands on the processing unit from 84 to 2 milliseconds per line printed by means of a special buffer register,

.12 Description (Contd.)

Optional Features (Contd.)

leaving 98 milliseconds for processing during each print cycle.

Selective Tape Listing Feature: Permits printing paper "adding machine" tapes as an alternative to the regular width forms. When utilizing this feature, as many as eight 1.5 inch-wide tapes or four 3.1 inch-wide tapes or a combination of the two widths can be used. Up to 13 characters per 1.5-inch tape, or up to 29 characters per 3.1 inch tape can be printed. Tapes are individually spaced under program control; however, no form skipping is possible with this feature. Primary use of this feature has been with magnetic ink character recognition equipment in providing batch control over checks.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . sprocket drive push and pull, paper punched on both sides.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnet-driven hammer presses form against moving horizontal chain.
.222 Sensing system: . . . . echo check on hammer magnet.
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . . . 6.
.232 Types of master
Multilith: . . . . . yes, with special ribbon.
Xerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 100 or 132.
Method of use: . . . . . 1 line at a time.

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.25 Range of Symbols

	Standard Set	
Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	12	&, □ - $ * / % # @ ‡.
Alternatives:		by special request.
FORTRAN set:		alternative Print Set F.
Basic COBOL set:		no.
Total:	48	and blank.
	Numeric Set	
Numerals:	10	0-9.
Letters:	0	
Special:	6	$. , * - □.
FORTRAN set:		no.
Req. COBOL set:		no.
Total:	16	and blank.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:	continuous fanfold sprocket punched stationery.
.312 Phenomenon:	printing.

.32 Positional Arrangement

.321 Serial by:	1 line at 6 or 8 per inch.
.322 Parallel by:	100 or 132 characters at 10 per inch.
.324 Track use	
Data:	100 or 132.
Total:	100 or 132.
.325 Row use	
Data:	all.

.33 Coding: engraved character font (Internal coding as in Data Code Table No. 2, 401:142.100).

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Over-all width:	3.50 to 18.75 inches by vernier.
.352 Length:	
Forms:	1 to 22.0 by 1/6 inch at 6 lines/inch. 1 to 16.5 by 1/8 inch at 8 lines/inch. 1 to 17.0 inches (recommended maximum for proper stacking).
.353 Maximum margins:	
Left:	3.0 inches.
Right, Model 1:	6.2 inches.
Model 2:	3.0 inches.

.4 CONTROLLER

.41 Identity: No separate controller (circuitry is in Processing Unit).

.42 Connection to System

.421 On-line:	1.
.422 Off-line:	none.

.43 Connection to Device

.431 Devices per controller:	1.
.432 Restrictions:	0 if 1404 Printer is attached.

.44 Data Transfer Control

.441 Size of load:	1 line of 100 or 132 characters.
.442 Input-output areas	core storage positions 201-300 (201-332 on Model 2).
.443 Input-output area access:	each character.
.444 Input-output area lockout:	yes, for full block.
.445 Table control:	none.
.446 Synchronization:	automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:	100 or 132 char per line.
.512 Block demarcation Output:	fixed.

.52 Input-Output Operations

.521 Input:	none.
.522 Output:	1 line forward with single step.
.523 Stepping:	step 1, 2, or 3 lines as separate operation, or as combined "print then step".
.524 Skipping:	skip to 1 of 12 channels on paper tape loop; can be combined in "print then skip."
.525 Marking:	none.
.526 Searching:	none.

.53 Code Translation: automatic, by processor.

.54 Format Control

Control:	program.
Format alternatives:	unlimited.
Rearrangement:	no.
Suppress zeros:	yes.
Insert point:	yes.
Insert spaces:	yes.
Section sizes:	no.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Select format:	no.
Select code:	no.

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.56 Testable Conditions

Disabled:	no.
Busy device:	with Print Storage only.
Output lock:	no.
Nearly exhausted:	no.
Busy controller:	no.
End of medium marks:	no.
Exhausted:	no.

.6 PERFORMANCE

.61 Conditions

I:	standard character set, without Print Storage.
II:	standard character set, with Print Storage.
III:	numeric set, without Print Storage.
IV:	numeric set, with Print Storage.

.62 Speeds

.621 Nominal or peak speed: I & II, 600 lines/minute.
III & IV, 1285 lines/minute.

.622 Important parameters

Name	Value
Print 1 line, I & II:	100.0 msec.
Print 1 line, III & IV:	46.7 msec.
Skipping speed:	33.0 in/sec for skips of 8 lines or less. 75.0 in/sec for skips of more than 8 lines (not Model A).

.623 Overhead

Step 1 line:	20 msec.
Step 2 lines:	25 msec.
Step 3 lines:	30 msec.
Independent skip N lines:	15 + 5N msec. (N < 9). 15 + 5N msec. (N ≥ 9, Model A). 37.4 + 2.2N msec. (N ≥ 9, all others).
Print & skip N lines, I & II:	as above + 80.0 msec.
Print & skip N lines, III & IV:	as above + 26.7 msec.

.624 Effective speeds:

Average line feed, inches	Lines/min., I & II	Lines/min., III & IV
1/6:	600	1,285
2/6:	572	1,160
3/6:	545	1,059
1:	480	838
2:	418	664
4:	353	514

(See graph)

.63 Demands on System

Component	Condition	msec per line,	or	Percentage*
Processing Unit:	I	84.0	or	84.0.
	II	2.0	or	2.0.
	III	30.7	or	65.8.
	IV	2.0	or	4.3.

* At single spacing

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knobs.	
Horizontal alignment:	knobs.	
Form width:	sliding forms tractors.	
Printing quality:	graduated dial.	
Form thickness:	graduated lever.	
Line pitch:	switch	6 or 8 lines/in.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets printer error indications.
Carriage restore:	key	positions carriage at channel 1 on tape loop.
Single cycle:	key	initiates one print cycle

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity:
Hopper:	20 inch stack.
Stacker:	20 inch stack.

.732 Replenishment time: 1 to 2 minutes. printer needs to be stopped.

.733 Adjustment time: 2 to 3 minutes. printer needs to be stopped.

.734 Optimum reloading period

I & II:	56 minutes.
III & IV:	35 minutes.

Basis: 2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	indicator and alarm.*
Input area overflow:	none	
Output block size:	fixed.	
Invalid code:	check	indicator and alarm.*
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop and alarm.

* Stop will occur if I/O Check Stop Switch is on.

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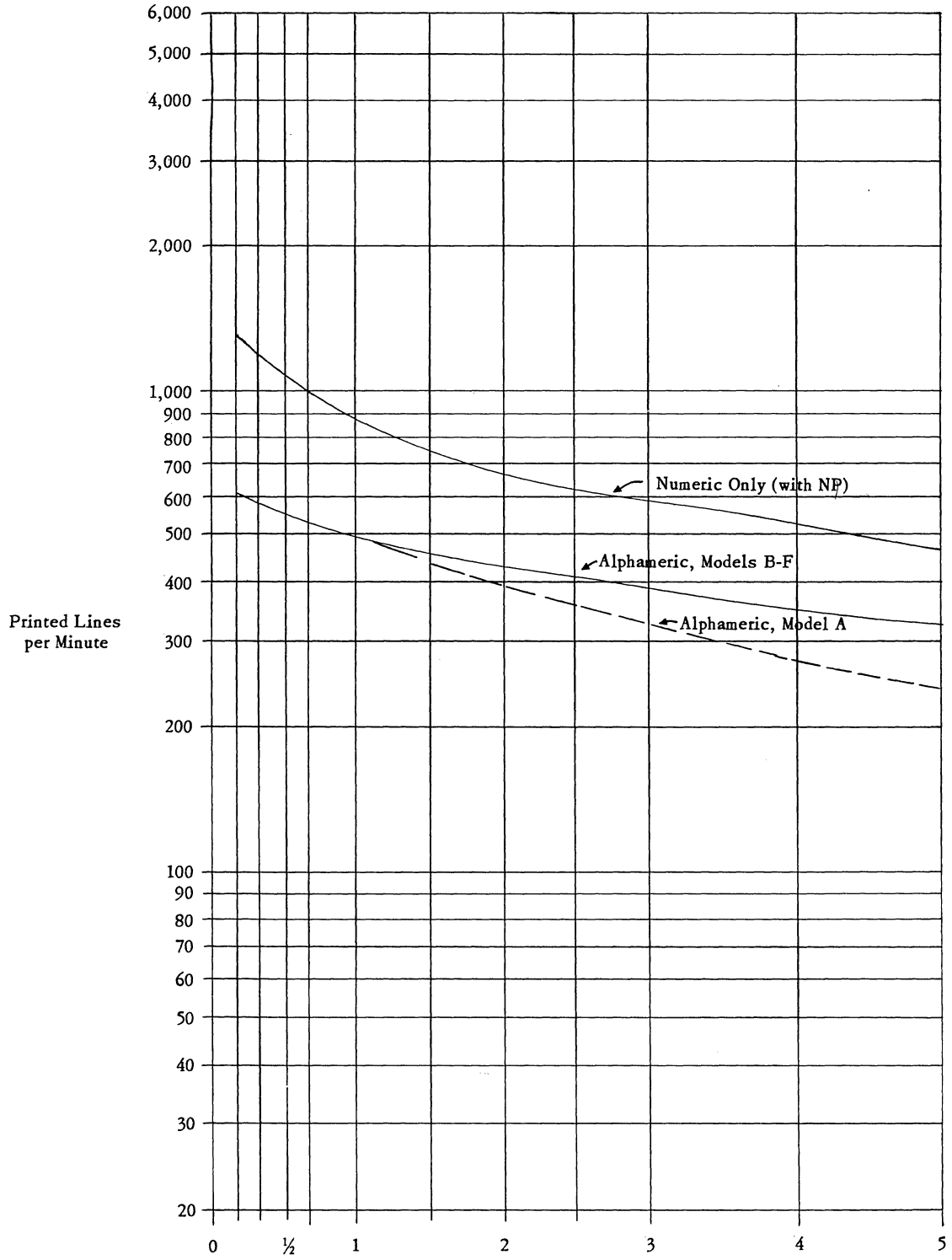
Effective Speed
IBM 1403



NP = Numerical Print feature.

AUERBACH / BNA

INPUT-OUTPUT: PRINTER

§ 082.

.1 GENERAL

.11 Identity: . . . . . Printer. 1404, Model 2.

.12 Description:

This unit has the same horizontal-chain printing mechanism, tape-controlled carriage, and continuous-form feeding and stacking system as the 1403 Printer. Like the 1403, it has 132 printing positions and a peak speed of 600 lines per minute. In addition, the 1404 has a feeding and stacking system for card forms. By unlocking a single knob, the entire printing assembly can be moved laterally to print on either continuous forms or cards (but not on both during the same run). The card transport mechanism can handle single 51- or 80-column cards or two 51- or 80-column cards fed side by side. Peak speed when feeding single cards and printing one line per card is 400 cards per minute. Up to 25 lines can be printed on a standard IBM card.

Cards can be printed on either side depending on how they are loaded into the hopper; however, cards are stacked in reverse of the order in which they are loaded into the hopper. This condition will present file sequence problems if additional processing is required.

Optional Features

Read-Compare: Permits reading any 30-columns of data (specified by plugboard wiring) into core storage positions 334-363 from the punched cards passing through the printer feed channel. Processing is inhibited for 75 milliseconds while each card is read.

Print Storage: Reduces time demands on the processing unit from 84 to 2 milliseconds per line printed by means of a special buffer register, thus allowing 98 milliseconds for processing.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . September, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive push and pull for continuous forms; pinch roller friction for cards.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnet-driven hammer presses form against moving chain.

.222 Sensing system: . . . . echo check on hammer magnets.

.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . . 6.

.232 Types of master
Multilith: . . . . . yes, with special ribbon.
Xerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 132.
Method of use: . . . . . prints 1 line at a time, on cards or continuous forms.

Use of station: . . . . reading (optional Read Compare).
Distance: . . . . . 1 card before print station.
Stacks: . . . . . 1.
Heads/stack: . . . . . 160.
Method of use: . . . . reads any 30 card columns, 1 row at a time.

.25 Range of Symbols

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	12	&, . □ - $ * / % # @ ±
Alternatives:		by special request.
FORTRAN set:		alternative Print Set F.
Basic COBOL set: . . .		no.
Total:	48 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery or punch cards.

.312 Phenomenon: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 per inch.

.322 Parallel by: . . . . . 132 char at 10 per inch.

.324 Track use
Data: . . . . . 132.
Total: . . . . . 132.

.325 Row use
Data: . . . . . all.

.33 Coding: . . . . . engraved character font (Internal coding as in Data Code Table No. 2, 401:142.100).

.35 Physical Dimensions

.351 Overall width: . . . . . 3.50 to 18.75 by inches (continuous forms).
single 51-column to double 80-column cards.

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.352 Length
Forms at 6 lines/inch: 1.0 to 22.0 by 1/6 inch at 6 lines/inch.
Forms at 8 lines/inch: 1.0 to 16.5 by 1/8 inch at 8 lines/inch.
Cards: . . . . . standard.

.353 Maximum margins (continuous forms):
Left: . . . . . 3.0 inches.
Right: . . . . . 3.0 inches.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (circuitry is in Processing Unit).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none if 1403 Printer is connected.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 line of 132 characters.
.442 Input-output areas: . . core storage positions 201-332.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 132 char per line.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 line forward with single step, on cards or continuous forms but not both at the same time.
.523 Stepping: . . . . . step 1, 2, or 3 lines as separate operations, or as combined "print then step".
.524 Skipping: . . . . . skip to 1 of 12 channels on paper tape loop or position new card at first printing line; may be combined in "print then skip."
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control

Control: . . . . . program.
Format alternatives: . unlimited.
Rearrangement: . . . . no.
Suppress zeros: . . . . yes.
Insert point: . . . . . yes.
Insert spaces: . . . . . yes.
Section sizes: . . . . . no.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . with Print Storage only.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: . no.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . . printing on continuous forms, without Print Storage.
II: . . . . . printing on continuous forms, with Print Storage.
III: . . . . . printing on 80-column cards, without Print Storage.
IV: . . . . . printing on 80-column cards, with Print Storage.

.62 Speeds

.621 Nominal or peak speed: I and II, 600 lines/minute. III and IV, 400 cards/minute. (for 1 line of print on each card; 800 cards/minute if 2 cards are fed side by side.)

.622 Important parameters

Name	Value
Print & step 1 line:	100 msec.
Skipping speed: . . .	38 inches/sec for skips of 8 lines or less.
Skipping speed: . . .	85 inches/sec for skips of more than 8 lines.
Cards feed clutch cycle:	150 msec (12-tooth clutch).

§ 082.

.623 Overhead:

Step 1 line:	20 msec.
Step 2 lines:	25 msec.
Step 3 lines:	30 msec.
Independent skip N lines:	15.0 + 4.4N msec (N < 9).
Independent skip N lines:	34.2 + 2.0N msec (N ≥ 9).
Print and skip N lines:	as above + 80.0 msec.
Position next card at first line:	70 msec.

.624 Effective speeds (at 6 lines/inch)

Continuous forms (I & II)

Average line feed, inches	Speed, lines/minute
1/6:	600.
2/6:	572.
3/6:	545.
1:	494.
2:	434.
4:	372.

Punched Cards (III & IV)

Lines printed/card	Speed, cards/minute
1:	400 or 800.
2:	240 or 480.
4:	136 or 272.
8:	72 or 144.
16:	37 or 74.

.63 Demands on System

Component	Condition	msec per line	or	Percentage*
Processing Unit:	I & III	84	or	84.
Processing Unit:	II & IV	2	or	2.

* At single spacing.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Cards or continuous forms:	move print unit literally	involves unlocking and relocking 1 knob.
Throat openings:	calibrated screw	handles standard or post-card stock.
Card width:	move hopper side plates.	
Other adjustments:	same as 1403 Printer.	

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets error alarms.
Carriage restore:	key	positions carriage at channel 1 on tape loop.
Single cycle:	key	initiates 1 print cycle.
Channel select:	rotary switch	selects 1 or both card feed channels.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Card hopper & stacker:	1,200 cards.
Forms hopper & stacker:	20-inch stack.

.732 Replenishment time: . . 1 to 2 minutes, printer needs to be stopped.

.733 Adjustment time: . . . . 2 to 5 minutes, printer needs to be stopped.

.734 Optimum reloading period

Cards:	3 minutes.
I & II:	56 minutes.
Basis:	2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	indicator & alarm.
Reading:	char validity	indicator & alarm.
Input area overflow:	none.	
Output block size:	fixed.	
Invalid code:	check	indicator & alarm.
Exhausted medium:	check	stop & alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop & alarm.

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INPUT-OUTPUT: CONSOLE INQUIRY STATION

§ 083.

.1 GENERAL

.11 Identity: . . . . . Console Inquiry Station. 1407 Model 1.

.12 Description:

The 1407 Console Inquiry Station is a modified IBM Model B electric typewriter with control circuits and work table. Information can be typed into core storage from the keyboard and out of core storage on continuous fan-fold forms. The 1407 is primarily an inquiry unit for 1401 RAMAC systems using 1405 Disk Storage, but it will be found useful for console control, monitor printing, and program testing functions in any 1401 system. It cannot be connected to a 1401 Model A Processing Unit.

Interruption is not provided in the 1401, so console inquiries must be handled by the inclusion of "branch on inquiry request indicator" instructions in the stored program. The indicator is turned on by depressing a key on the 1407 when an inquiry is to be made. Output format is controlled by the stored data. Characters with word marks can be printed in red as an aid in debugging.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . . October, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pin-feed platen; paper punched both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording System

.221 Recording system: . . . engraved hammers.
.222 Sensing system: . . . . typewriter keyboard.
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . . depends on stationery.
Carbon creep: . . . . . none.

.232 Types of master
Multilith: . . . . . no.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . 1 character at a time.

Use of station: . . . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . . 44 keys.
Method of use: . . . . . 1 character at a time.

.25 Range of Symbols

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	28	as in Data Code Table No. 1.
Alternatives:		none.
FORTRAN set:		yes.
Basic COBOL set:		yes.
Total:	64.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fan-fold stationery or roll paper.
.312 Phenomenon: . . . . . printing (output). key depression (input).

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N characters at 10 per inch (N limited by core storage).

.324 Track use
Data: . . . . . 120 print positions.
Total: . . . . . 120.

.325 Row use
Data: . . . . . all.

.33 Coding: . . . . . engraved character font; (Internal coding as in Data Code Table No. 1, See 401:141.100).

.34 Format Compatibility: . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 9.75 inches for sprocket-punched stationery.
.352 Length: . . . . . up to 11 inches per sheet, or continuous rolls.
.353 Maximum margins: . . . no limitations.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (#2272 adapter required on 1401 Processing Unit).

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.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller:. 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load:. . . . . 1 to N characters.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block.
.445 Table control:. . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N characters.
.512 Block demarcation
Input: . . . . . typed group mark or Clear Key.
Output: . . . . . group mark in core storage or Clear Key.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward from keyboard, with printed record.
.522 Output: . . . . . 1 block forward, printed.
.523 Stepping: . . . . . step 1 line upon 1401 instruction or console key depression.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation:. . . . automatic, by processor.

.54 Format Control: . . . . contained in data.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Select format: . . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: . no.
Inquiry request:. . . . . yes.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed:. 10 characters/second (output).
manual typing speed (input).
.624 Effective speeds: . . . . same as peak speeds, plus allowance for carriage returns.

.63 Demands on System

Component: . . . . . Processing Unit.
Msec per block: . . . 0.092.
plus
Percentage of typing time: . . . . 100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Line spacing:	lever	step 1, 2, or 3 lines.
Multiple copy control:	lever	compensates for form thickness.
Set tab stops:	key.	
Set margin stops:	key.	

.72 Other Controls

Function	Form	Comment
Request enter:	key-light	sets inquiry request indicator.
Clear:	key-light	sets inquiry clear indicator.
Respond:	key-light	inserts group mark in core storage, returns carriage, and releases processor interlock.
Word mark:	key	enters word mark with next character typed.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	none.	
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	all codes valid.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.

INPUT-OUTPUT: MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape unit. 729 Models II, IV, V, & VI.

.12 Description:

These tape units are used in IBM's more powerful 1410, 7070, 7080, and 7090 series systems as well as in the 1401. In tape width, density and format, they are compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are summarized in the following table.

Model	Tape speed, inches/sec.	Density, char/inch	Transfer rate, char/sec.
II	75.0	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75.0	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000 (not with 1401)

Up to six tape units can be connected to a 1401 system, but only one can read or write at a time. No computing can be done during a tape input or output operation unless the Processing Overlap feature is added. Lateral and longitudinal parity checks are made on both reading and recording. Different models of the 729 can be intermixed with each other and with 7330 tape units through the use of Tape Intermix Units. Model VI cannot be used at the 800 characters an inch density in a 1401 system.

Optional Features

Column Binary: Permits the processing of binary tapes such as those used in the IBM 704, 709, and 7090 systems.

Compressed Tape Operations: Permits reading of compressed tape (with high-order zeros eliminated) prepared by IBM 7070 systems.

Processing Overlap: Permits computation during tape start time and (at 200 characters per inch only) between character transfers.

.13 Availability: . . . . . with 1401 system, 12 months, as of April, 1963.

.14 First Delivery: . . . with 1401, September, 1960 for Models II & IV; May, 1962 for Models V & VI.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . 2-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or (Models V & VI) 800 rows/inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.

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§ 091.

.325 Row use
- Data: . . . . . 1 to N.
- Redundancy check: . . 1.
- Timing: . . . . . 0.
- Control signals: . . . 0.
- Unused: . . . . . 0.
- Gap: . . . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 1 (See 401:141 100)

.34 Format Compatibility

Other device or system	Code translation
IBM 7330, 727 tape units:	not required.
IBM 7070 series compressed tapes: . . .	optional Compressed Tape.
IBM 704, 709, 7090 binary tapes:	optional Column Binary.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Tape Adapter Unit (built into 1401 Processing Unit).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 6.
.432 Restrictions: . . . . . total number of 729 and 7330 Tape Units is 6.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N char., limited by available core storage.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block, (no lockout when Processing Overlap is used).
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N char., limited by available core storage
.512 Block demarcation
- Input: . . . . . gap on tape or limiting mark in core storage.
- Output: . . . . . limiting mark.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1 block backward (backspace). erase 3.5 inches forward (to skip defective tape areas).
.525 Marking: . . . . . inter-block gap, 0.75 inch long.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations
- Disable: . . . . . disabled after unloading.
- Request interrupt: . . no.
- Select format: . . . . . no.
- Select code: . . . . . with optional Compressed Tape or Column Binary.
- Rewind: . . . . . yes.
- Unload: . . . . . yes.

.56 Testable Conditions
- Disabled: . . . . . no.
- Busy device: . . . . . with Processing Overlap only.
- Output lock: . . . . . no.
- Nearly exhausted: . . . yes.
- Busy controller: . . . . no.
- End of medium marks: yes.

.6 PERFORMANCE

.61 Conditions
- I: . . . . . without Processing Overlap
- II: . . . . . with Processing Overlap.

.62 Speeds

.621 Nominal or peak speed
- Model II: . . . . . 15,000 or 41,667 char/sec.
- Model IV: . . . . . 22,500 or 62,500 char/sec.
- Model V: . . . . . 15,000, 41,667, or 60,000 char/sec.
- Model VI: . . . . . 22,500 or 62,500 char/sec.

.622 Important parameters

Name	Value
Density	
Models II & IV: . .	200 or 556 char/inch.
Models V & VI: . .	200, 556, or 800 char/inch.
Tape speed	
Models II & V: . .	75.0 inches/sec.
Models IV & VI: .	112.5 inches/sec.
Start time	
Models II & V	
Read:	10.5 msec.
Write:	7.5 msec.
Models IV & VI	
Read:	6.7 msec.
Write:	5.0 msec.
Stop time	
Models II & V	
Read:	2.1 msec.
Write:	5.1 msec.
Models IV & VI	
Read:	2.1 msec.
Write:	3.8 msec.
Full rewind time	
Models II & V: . .	1.2 minutes.
Models IV & VI . .	0.9 minutes.
Inter-block gap: . .	0.75 inch.

§ 091.

.623 Overhead
Models II & V: . . . . 12.6 msec/block.
Models IV & VI: . . . 8.8 msec/block.

.624 Effective speeds
Models II & V
200 char/inch: . . . 15,000 N/(N+189) char/sec.
556 char/inch: . . . 41,667 N/(N+525) char/sec.
Models IV & VI
200 char/inch: . . . 22,500 N/(N+198) char/sec.
556 char/inch: . . . 62,500 N/(N+550) char/sec.
Model V
800 char/inch: . . . 60,000 N/(N+756) char/sec.
where N = char/block (See graphs.)

.63 Demands on System

Component	Condition	msec. per block	or	Percentage of transfer time
Processing Unit	I; without Processing Overlap			
	Models II & V			
	Read			
	200 char/inch:	10.5 + 0.0667C		100.0
	556 char/inch:	10.5 + 0.0240C		100.0
	800 char/inch:	10.5 + 0.0167C		100.0
	Write			
	200 char/inch:	7.5 + 0.0667C		100.0
	556 char/inch:	7.5 + 0.0240C		100.0
	800 char/inch:	7.5 + 0.0167C		100.0
	Models IV & VI			
	Read			
	200 char/inch:	6.7 + 0.0444C		100.0
	556 char/inch:	6.7 + 0.0160C		100.0
	Write			
	200 char/inch:	5.0 + 0.0444C		100.0
	556 char/inch:	5.0 + 0.0160C		100.0
Processing Unit	II; with Processing Overlap			
	Models II & V			
	Read			
	200 char/inch:	0.0 + 0.0115C		17.3
	556 char/inch:	3.9 + 0.0240C		100.0
	800 char/inch:	3.9 + 0.0167C		100.0
	Write			
	200 char/inch:	0.0 + 0.0115C		17.3
	556 char/inch:	0.2 + 0.0240C		100.0
	800 char/inch:	0.2 + 0.0167C		100.0
	Models IV & VI			
	Read			
	200 char/inch:	0.0 + 0.0115C		25.9
	556 char/inch:	2.3 + 0.0160C		100.0
	Write			
	200 char/inch:	0.0 + 0.0115C		25.9
	556 char/inch:	0.1 + 0.0160C		100.0

where C is number of characters per block.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (Models V & VI only).

.72 Other Controls

Function	Form	Comment
Address selection:	dial.	
Load rewind:	key.	lowers tape into reservoirs.
Unload	key.	
File protection:	ring on spool	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	2,400 feet; for 1,000-char blocks, 5,000,000 char at 200 char/inch, 11,300,000 char at 556 char/inch, or 14,400,000 char at 800 char/inch.

.732 Replenishment time: . . 1.0 to 1.5 minutes. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . . 6 minutes.
Models IV & VI: . . . 4 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Checks or Interlock	Action
Recording:	read-back; lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Recording level:	signal strength check	indicator & alarm.

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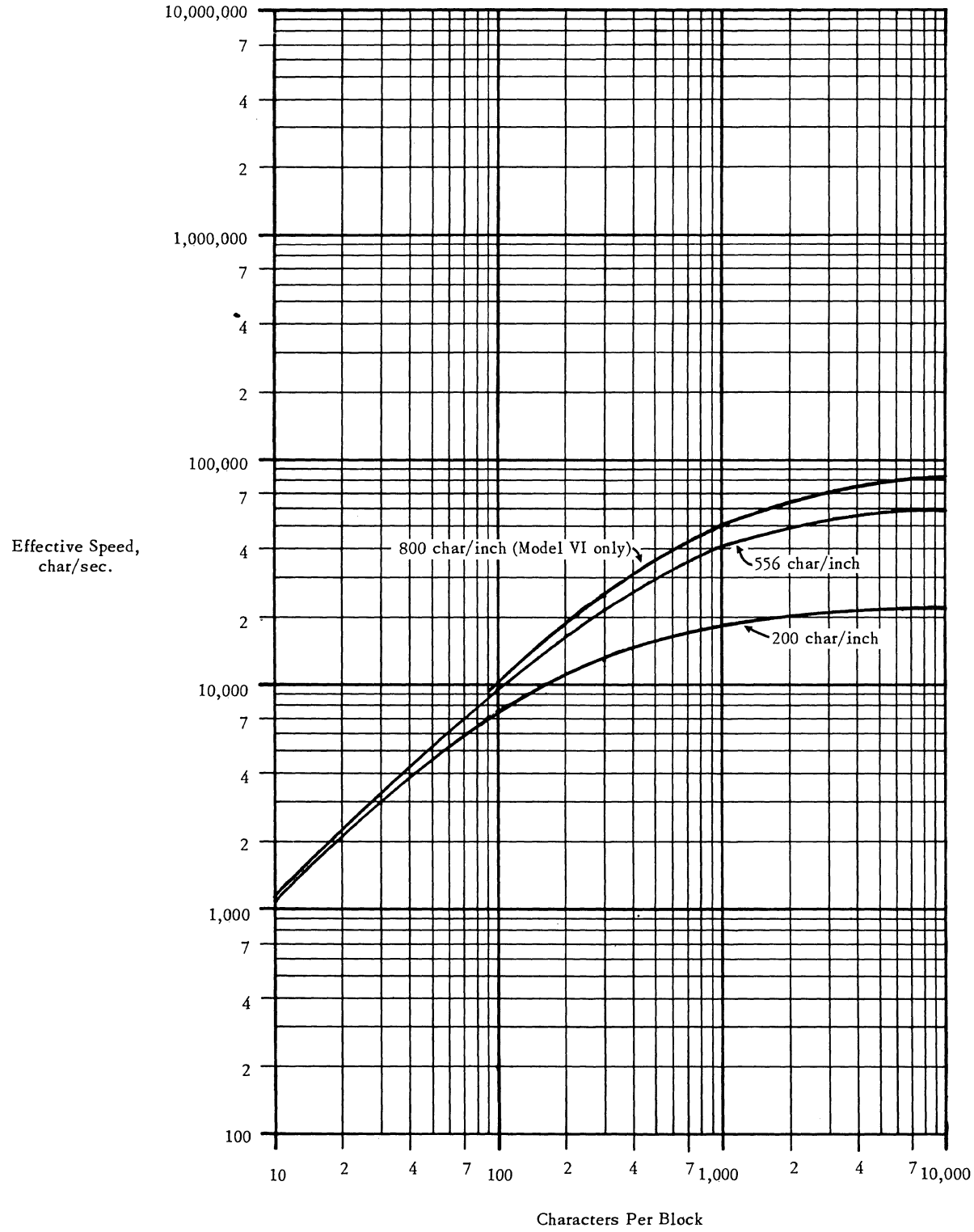
Effective Speed
IBM 729-IV & 729-VI



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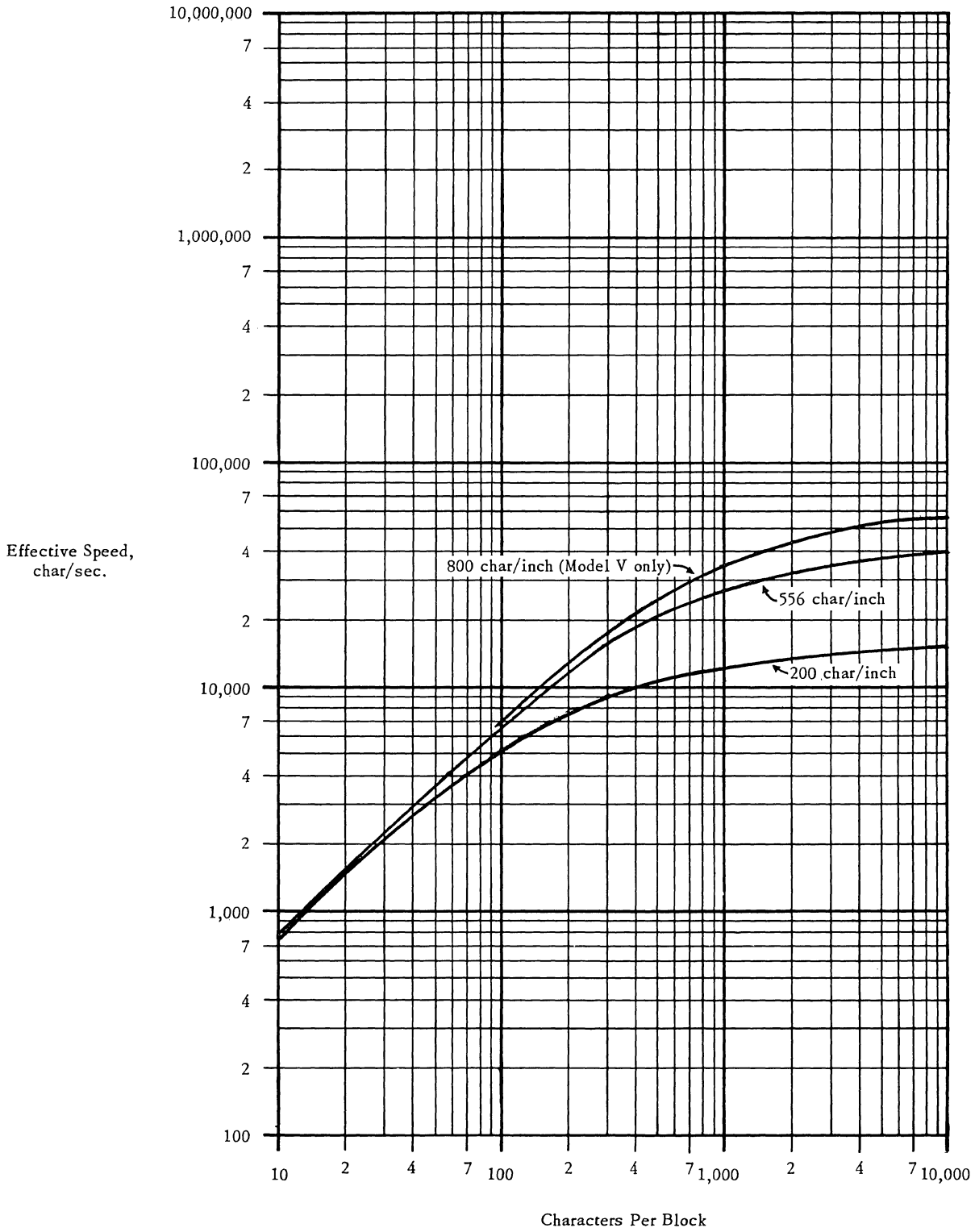
Effective Speed
IBM 729-II & 729-V



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INPUT-OUTPUT: 7330 MAGNETIC TAPE UNIT

§ 092.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit. 7330 Model 1.

.12 Description:

The 7330 Magnetic Tape Unit is slower, simpler, and less expensive than the 729 Tape Unit, but the two are completely compatible. Tape speed is 36 inches per second, and peak transfer rate is either 7,200 or 20,016 characters per second, depending upon the recording density selected. Lateral and longitudinal parity checks are made on both reading and recording.

The basic speed of the 7330 should be adequate for most 1401 system applications, but its throughput can be limited by two restrictions that must be considered:

(1) High speed rewind, which requires 2.2 minutes per full reel, is always terminated by unloading of the tape from the vacuum columns and read-record head. Rewinding without unloading requires 13.3 minutes.
(2) To switch the unit from read to write status, it must be programmed to backspace over the last record read and then rewrite it; such switching between reading and recording will be infrequent in normal applications.

Optional Features

Column Binary: Permits the processing of binary tapes such as those used in the IBM 704, 709 and 7090 systems.

Compressed Tape Operations: Permits reading of compressed tape (with high-order zeros eliminated) prepared by IBM 7070 systems.

Processing Overlap: Permits computation during tape start time and between character transfers.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . . October, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 1.5 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . 2-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200 or 556 char/inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Track Use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.

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§ 092.

.325 Row use

Data	1 to N.
Redundancy check	1.
Timing	0.
Control signals	0.
Unused	0.
Gap	0.75 inch.

.33 Coding: as in Data Code Table No. 1 (See 401:141.100).

.34 Format Compatibility

Other device or system	Code translation
IBM 729, 727 tape units	not required.
IBM 7070 series compressed tapes	optional Compressed Tape.
IBM 704, 709, 7090 binary tapes	optional Column Binary.

.35 Physical Dimensions

.351 Overall width: 0.50 inch.
.352 Length: 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: Tape Adapter Unit. (built into 1401 Processing Unit).

.42 Connection to System

.421 On-line: 1.
.422 Off-line: none.

.43 Connection to Device

.431 Devices per controller: 6.
.432 Restrictions: total number of 7330 and 729 Tape Units is 6.

.44 Data Transfer Control

.441 Size of load: 1 to N char, limited by available core storage.
.442 Input-output areas: core storage.
.443 Input-output area access: each character.
.444 Input-output area lockout: yes, for full block. (no lockout when Processing Overlap is used).
.445 Table control: none.
.446 Synchronization: automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: 1 to N char, limited by available core storage.
.512 Block demarcation
Input: gap on tape or limiting mark in core storage.
Output: limiting mark.

.52 Input-Output Operations

.521 Input: 1 block forward.
.522 Output: 1 block forward.
.523 Stepping: none.
.524 Skipping: 1 block backward (backspace). 3.5 inches forward (to skip defective tape areas).
.525 Marking: inter-block gap, 0.75 inch long.
.526 Searching: none.

.53 Code Translation: matched codes.

.54 Format Control: none.

.55 Control Operations

Disable	disabled after unloading.
Request interrupt	no.
Select format	no.
Select code	with optional Column Binary or Compressed Tape.
Rewind	yes.
Unload	yes.

.56 Testable Conditions

Disabled	no.
Busy device	with Processing Overlap only.
Output lock	no.
Nearly exhausted	yes.
Busy controller	no.
End of medium marks	yes.

.6 PERFORMANCE

.61 Conditions

I	without Processing Overlap
II	with Processing Overlap.

.62 Speeds

.621 Nominal or peak speed: 7,200 or 20,016 char/sec.
.622 Important parameters

Name	Value
Density	200 or 556 char/inch.
Tape speed	36.0 inches/sec.
Inter-block gap	0.75 inch.
Start time	
Read	7.6 msec.
Write	5.0 msec.
Stop time	
Read	12.9 msec.
Write	15.3 msec.

§ 092.

.623 Overhead: . . . . . 20.4 msec/block.

.624 Effective speeds
At 200 char/inch: . . 7,200 N/(N + 147) char/sec.
At 556 char/inch: . . 20,016 N/(N + 408)char/sec.
where N = char/block (see graph).

.63 Demands on System

Component	Condition	msec. per block	or	Percentage of transfer time
Processing Unit:	I; without Processing Overlap			
	Read			
	200 char/inch:	7.7 + 0.139N		100.0
	556 char/inch:	7.7 + 0.050N		100.0
	Write			
	200 char/inch:	5.0 + 0.139N		100.0
	556 char/inch:	5.0 + 0.050N		100.0
Processing Unit:	II; with Processing Overlap			
	Read or write			
	200 char/inch:	0 + 0.0115N		8.3
	556 char/inch:	0 + 0.0115N		23.0

where N is number of characters per block.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	200 or 556 char/in.

.72 Other Controls

Function	Form	Comment
Address selection:	dial.	
Load rewind:	key	loads tape into reservoirs.
Unload:	key.	
File protection:	ring on spool	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Spool:	2,400 feet; for 1,000-char blocks, 5,000,000 char at 200 char/inch, 11,300,000 char at 556 char/inch.

.732 Replenishment time: . . 1.0 to 1.5 minutes. tape unit needs to be stopped.

.734 Optimum reloading period: . . . . . 13 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording	read back; lateral parity	indicator & alarm.
Reading	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing Conflicts:	interlock	wait.
Recording level:	signal strength check	indicator & alarm.

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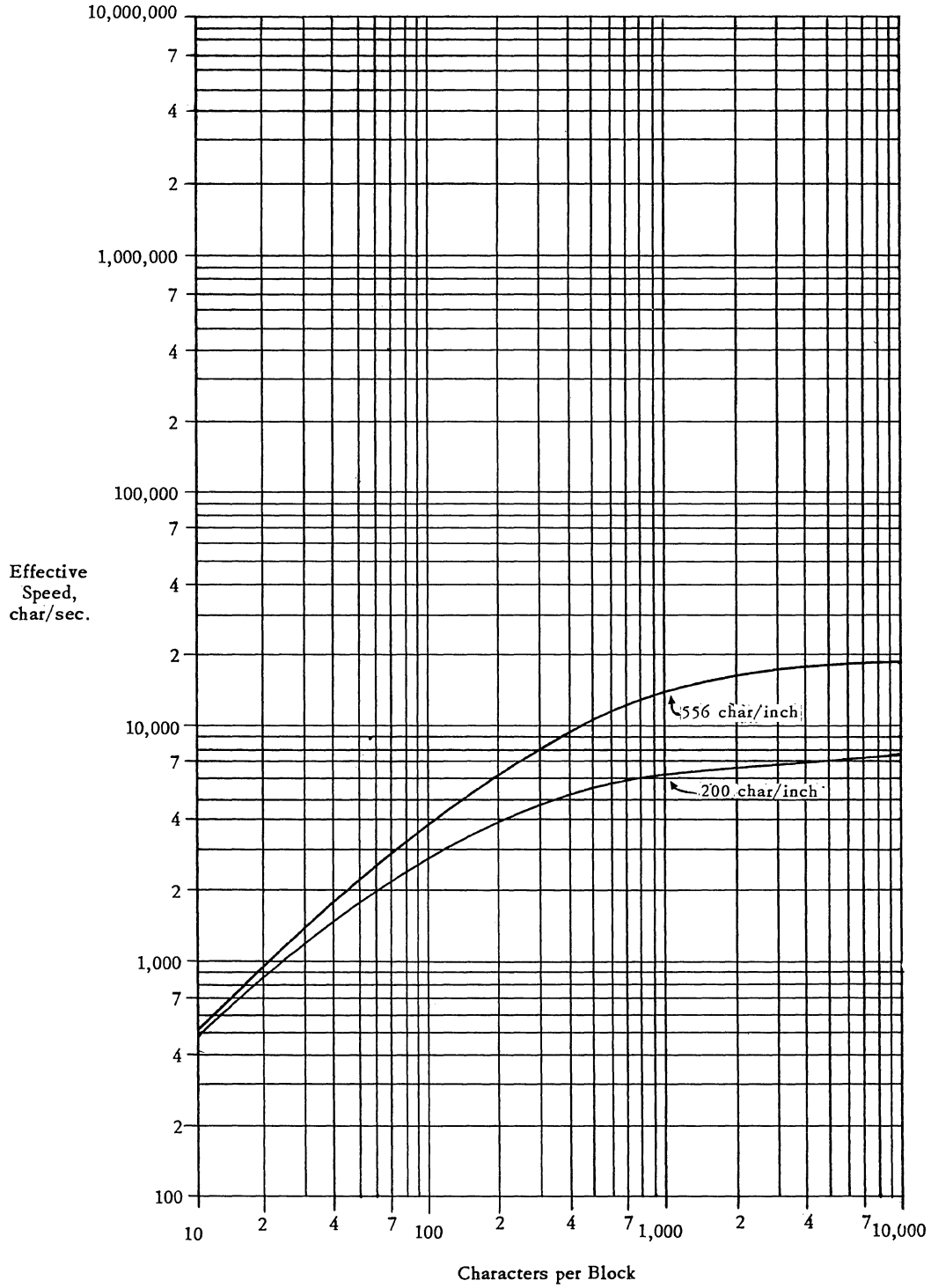
Effective Speed
IBM 7330



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INPUT-OUTPUT: HYPERTAPE DRIVE

§ 093.

.1 GENERAL

.11 Identity: . . . . . Hypertape Drive.
7340 Model 2.

.12 Description

The 7340 Model 2 Hypertape Drive was announced in April, 1963. It fulfills the need for a tape unit for IBM 1401, 1410, and 1460 systems that is compatible with the high-performance, cartridge-loaded 7340 Model 1 Hypertape Drive for the IBM 7074, 7080, 7090, and 7094 systems. First deliveries are scheduled for the third quarter of 1963.

Up to four 7340 Model 2 Hypertape Drives can be connected to a 1401 (or 1460) system via a 7641 Hypertape Control and a Serial Input-Output Adapter. Either the Bit Test or Column Binary feature is a prerequisite. In addition to the four Hypertape Drives, a 1401 (or 1460) can control up to six 729 and/or 7330 Magnetic Tape Units connected in the standard manner.

Recording density is 1,511 rows per inch, and tape speed is 22.5 inches per second. The peak data transfer rate is 34,000 characters per second. In the optional "packed" format, two decimal digits are recorded in each tape row, and transfer rates of up to 68,000 digits per second are possible. Unlike other IBM tape equipment, the Hypertape Drive can read backward as well as forward. Average access time to the next sequential tape block is 18.5 milliseconds. Inter-block gap length is 0.45 inch.

Ten tracks are recorded on 1-inch-wide tape; there is no tape compatibility with non-Hypertape IBM magnetic tape units such as the 729 and 7330. Two tracks are used for double odd parity checking, and bit detection is based on signal phase rather than signal strength. The manufacturer states that these factors make possible detection of all errors and

.12 Description (Contd.)

correction of all single-bit and most double-bit errors. The eight data bits in each tape row can hold either one 6-bit alphameric character (in which case two bits are unused) or two 4-bit decimal digits.

An important feature of the Hypertape Drive is its cartridge loading technique. Supply and take-up reels holding 1,800 feet of tape are enclosed in a sealed cartridge that measures about 17 by 10 by 2 inches and weighs about 8 pounds. The operator loads a reel of tape by raising the top cover of the tape drive, sliding the cartridge into place, lowering the top cover, and pressing the Load-Unload button. Then the tape reels move back to engage the hubs, the tape is lowered into the vacuum columns, and the read-write head moves into position. Unloading is accomplished by reversing this procedure. It is not necessary to rewind the tape before unloading a cartridge.

The differences between the 7340 Model 1 and Model 2 Hypertape Drives can be summarized as follows:

	7340 Model 1	7340 Model 2
Tape speed, inches/sec:	112.5	22.5
Peak transfer rates		
Character/sec:	170,000	34,000
Decimal digits/sec:	340,000	68,000
Average access time, msec:	4.2	18.5
Full rewind time, minutes:	1.5	3.75
Available for:	IBM 7074, 7080, 7090, 7094	IBM 1401, 1410, 1460

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INPUT-OUTPUT: DATA TRANSMISSION UNIT

§ 101.

.1 GENERAL

.11 Identity: . . . . . Data Transmission Unit. 1009.

.12 Description

This unit enables the 1401 Processing Unit to transmit and receive data at speeds up to 300 characters per second over public or private telephone or telegraph lines. The unit at the other end of the line may be a similarly equipped 1401 or 1410 system or an IBM 7701 or 7702 Magnetic Tape Transmission Terminal. A specially-equipped telephone and a serial data set, supplied by the communications company, are also required at each terminal.

Data from the transmitting 1401 in serial-by-character, parallel-by-bit, BCD form is converted by the 1009 into a special serial-by-bit, 4-of-8 transmission code in which each character code consists of four "1" bits and four "0" bits. The 1009 at the receiving terminal handles the reconversion to BCD form. Validity checks insure that each character received contains exactly four out of eight bits, and most errors resulting from switched bits are detected by a longitudinal parity check.

The available transmission speeds are 75, 150, and 300 characters per second. Maximum usable speed and reliability of data transmission are dependent upon the quality of the available communications circuits; at present the 300 characters per second speed cannot be used on toll lines. Unless a 4 wire, full-duplex line is available, a turn-around time of 250 milliseconds is required at the beginning and end of each message. Maximum effective transfer rates, according to IBM, are generally obtained with messages ranging from 300 to 1,000 characters in length. Special 1401 instructions control the transmission of data, and sub-routines are required to handle synchronization, checking, and retransmissions due to errors.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . . October, 1961.

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INPUT-OUTPUT: OPTICAL CHARACTER READER

§ 102.

.1 GENERAL

.11 Identity: . . . . . Optical Character Reader. 1418 Models 1 & 2.

.12 Description:

This unit reads numerical characters printed in IBM 407 type style into 1401 core storage at the rate of 420 5-7/8 inch documents per minute. The standard model reads one line of data, which may be positioned anywhere on the document. Acceptable input data for the reader can be produced by an IBM 407, 408, or 409 Accounting Machine, a 1403 or 1404 Printer, or a typewriter equipped with the 407 type font.

Documents are fed from the hopper, through document separation and alignment stations, to a vacuum drum, which holds them flat as they pass the optical reading station. They are then removed from the drum by a continuous belt mechanism and sent to the selected stacker pocket. Model 1 has 3 stackers and is designed for on-line use only. Model 2 is equipped with 13 stackers and can be used off-line for single-digit sorting on any digit position. Both models have an "overflow stacking" mode that permits unloading the stackers without stopping the reader when no sorting is required.

The optical character reading is accomplished by scanning. Light reflected from the surface of the moving document is positioned by a lens system on a rotating scanning disk, which produces an image of the character sensed. The light image passes through a fixed aperture plate to the surface of a photomultiplier tube, which converts it into a matrix pattern of electrical impulses. A character recognition network determines either that the character is a valid one, in which case it is transmitted to 1401 core storage, or that it is unreadable, in which case the symbol @ is sent to core storage in its place. Each programmed "read" instruction causes only one character to be transmitted from the 1418 to core storage, and indicators must be tested before each character transfer to guard against timing conflicts.

Optional Features

Additional Read Station: Permits reading data from two lines on the document in a single pass. Switching between the two read stations, which are 4.25 inches apart, is under program control.

Mark Reading Station: Permits the reading of up to 37 columns of numerical data marked on a standard IBM card with an ordinary black pencil or ink; cannot be used when the Additional Read Station is installed.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . October, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum drum and moving belt friction.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . none.
.222 Sensing system: . . . . reflected light on photomultiplier tube.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . 1 character at a time.

Use of station: . . . . reading (optional).
Distance: . . . . . 4.25 inches.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . 1 character at a time.

Use of station: . . . . . mark reading (optional; alternative to Additional Read Station).
Distance: . . . . . 4.25 inches.
Stacks: . . . . . 1.
Heads/stack: . . . . . 13.
Method of use: . . . . . 1 column at a time.

.25 Range of Symbols

Numerals:	10	0-9.
Letters:	none.	
Special:	3	□ - ! .
Alternatives:	none.	
Total:	13 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper or card documents.
.312 Phenomenon: . . . . . printing.

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.32 Positional Arrangement

.321	Serial by:	1 to 80 char/document at 10 or 7 char/in., from right to left.
.322	Parallel by:	1 track.
.323	Bands:	2 if optional features are installed; each band is served by a separate read station, but only 1 band can be read at a time.
.324	Track use	
	Data:	all.
	Redundancy check: . .	0.
	Timing:	0.
	Control signals: . . .	0.
	Unused:	0.
	Total:	1 per band.
.325	Row use	
	Data:	all.

.33 Coding: . . . . . printed numerals 0.093 inch high by 10 char/in. (IBM 407 font) or 0.114 inch high by 7 char/in.' (407-E font).

.34 Format Compatibility

Other device or system	Code translation
All equipment using IBM 407 or 407-E fonts:	none required.

.35 Physical Dimensions

.351	Overall width:	2.75 to 3.67 inches.
.352	Length:	5.875 to 8.750 inches.
.353	Minimum margins:	
	Left:	0.375 inch.
	Right:	0.375 inch.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (Serial Input-Output adapter 7080 required on 1401 Processing Unit).

.42 Connection to System

.421	On-line:	1.
.422	Off-line	
	Use	Associated equipment
	Document sorting (Model 2 only): . .	none.

.43 Connection to Device

.431	Devices per controller:	
.432	Restrictions:	none if other units requiring a 7080 Adapter or a 3271 Direct Data Channel are connected to the 1401.

.44 Data Transfer Control

.441	Size of load:	1 character.
.442	Input-output areas: . .	core storage.
.443	Input-output area access:	each character.
.444	Input-output area lockout:	none.
.445	Table control:	none.
.446	Synchronization:	by program.
.447	Synchronizing aids: . .	tests: document under read station 1 or 2; document end reached; character available to 1401; late transfer.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511	Size of block:	1 to 80 char/document.
.512	Block demarcation	
	Input:	trailing edge of document.
	Output:	none.

.52 Input-Output Operations

.521	Input:	documents are fed continuously after unit is engaged; 1401 must be programmed to read each character.
.522	Output:	none.
.523	Stepping:	none.
.524	Skipping:	none.
.525	Marking:	none.
.526	Searching:	none.

.53 Code Translation: . . . automatic.

.54 Format Control: . . . . none.

.55 Control Operations

Disable:	no.
Request interrupt: . . .	no.
Select stacker:	yes.
Select format:	no.
Select code:	no.
Start feeding documents continuously:	yes.
Stop feeding documents:	yes.
Select reading station: .	yes (with optional features).

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Nearly exhausted: . . .	no.
Busy controller:	no.
End of medium marks:	no.
Character ready to be transferred:	yes.
Exhausted:	yes.

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.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 420 documents/minute (5-7/8 inches long).

.622 Important parameters

Name	Value
Read station switch time:	4 msec.
Reader transport rate:	48 inches/sec.
Space between documents:	1.25 inches average.

.624 Effective speeds: . . . . $S = \frac{3,000}{L + 1.25}$ for continuous feeding, where:
S = speed, documents/minute;
L = document length, inches.

.63 Demands on System

Component: . . . . . Processing Unit.
msec per character: . 0.195*.

*Includes time required to test ready, interpret read instruction, and transfer 1 character.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Read station positioning:	levers.

.72 Other Controls

Function	Form	Comment
Manual feed:	knob.	permits registration check.
Start document feeding:	key.	
Reset alarm circuits:	key.	
Overflow stacking mode:	key.	permits continuous operation.
Off-line sort mode:	key.	
Start document counter:	key.	has automatic reset.
Select sort position:	rotary switch.	
Document end switch:	4-pos. switch.	determines point at which "document end" indicator shall be set.
Select display character:	rotary switch.	controls CRT display unit.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	12.0 inch stack (600-1,200 documents).
Stackers (3 or 13): .	4.5 inch stack each.

.732 Replenishment time: . . 0.5 to 1.0 minutes. Reader needs to be stopped unless in alternate-pocket mode.

.733 Adjustment time: . . . 5 to 10 minutes.

.734 Optimum reloading period: . . . . . 1.5 to 3.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	see "Invalid code".	
Input area overflow:	none.	
Invalid code:	validity logic	transmit @ to core storage.
Exhausted medium:	check	stop reader; alarm & indicator.
Imperfect medium:	none.	
Timing conflicts:	check	set indicator.
Full stacker:	check	stop reader; alarm.
Improper feeding:	checks	stop reader; alarm.
Improper registration:	check	alarm.

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INPUT-OUTPUT: MAGNETIC CHARACTER READER

§ 103.

.1 GENERAL

.11 Identity: . . . . . Magnetic Character Reader. 1419 Model 1.

.12 Description:

This magnetic character reader-sorter reads 1,600 six-inch documents per minute. Documents up to 8-3/4 inches long can be handled at proportionately lower rates. The 1419 is functionally similar to the earlier 1412 Magnetic Character Reader, whose peak speed is 950 documents per minute. Characters printed in magnetic ink in Font E-13B (adopted as standard by the American Bankers' Association) are recognized in a character matrix 7 positions wide by 10 positions high. Only the 10 numerical characters and 4 special symbols can be read, and all magnetic ink imprinting must be on a single line within 5/8 inch of the bottom edge of the document. Invalid or unrecognizable characters cause an indicator to be set and an asterisk to be transmitted to core storage. Missing fields, incorrect field lengths, document spacing errors, and missing or out-of-sequence special symbols also cause error indications.

Four basic modes of operation are possible:
1. Off-line sorting on any one digit position.
2. On-line use (reading data into 1401 core storage) with single-digit sort as above.
3. On-line use with programmed selection of any of the 13 stacker pockets.
4. On-line use in "alternate pocket" mode. This permits unloading the stackers without stopping the reader, but no sorting can be done.

When reading 6-inch documents, 32.2 milliseconds are available for processing each document with the Processing Overlap feature and 9.5 milliseconds without it. The 1419 has only one operating speed. If, therefore, the required processing time exceeds these values, it will be necessary to transcribe the magnetic ink data to magnetic tape and then process the tape in a separate operation.

Optional Features

Multiple Column Control: Permits the routing to stacker A of documents with specified digit values in up to four selected digit positions.

Electronic Accumulator and Sequence Checking: Permits accumulated totals of the amounts read from documents to be printed on paper tape, and checks selected positions for correct document sequencing. (Multiple Column Control is a prerequisite.)

Split Field: Permits the division of standard A.B.A. check fields into two elements, each of variable length.

Self-Checking Number: Provides verification of account numbers. Available in either Modulus 10 or Modulus 11; the latter is more effective and more expensive.

.13 Availability: . . . . . 12 months, as of April, 1963.

.14 First Delivery: . . . . November, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . moving belt friction.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . none.
.222 Sensing system: . . . . magnetic heads.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 30.
Method of use: . . . . . scans characters horizontally from right to left.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	none.	
Special:	4	amount, dash, transit, on-us.
Alternatives:	none.	
Total:	14.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper or card documents.
.312 Phenomenon: . . . . . magnetic ink imprinting.

.32 Positional Arrangement

.321 Serial by: . . . . . 7 segments per character; 1 to 42 characters per document.
.322 Parallel by: . . . . . 30 tracks (3 groups of 10 each; allows for variations in vertical position of magnetic characters on document).
.323 Bands: . . . . . 1.

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.324 Track use
Data: . . . . . 10 of 30.
Redundancy check: . . 0.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 20.
Total: . . . . . 10 of 30.

.325 Row use
Data: . . . . . all.

.33 Coding: . . . . . font E-13B magnetic ink characters.

.34 Format Compatibility

Other device or system	Code translation
All equipment using Font E-13B characters in standard A.B.A. format:	none required.

.35 Physical Dimensions

.351 Overall width: . . . . . 2.75 to 3.67 inches.
.352 Length: . . . . . 6.00 to 8.75 inches.
.353 Maximum margins:
Distance of leading edge of first symbol from reference edge of document: . . . . 0.3125 inch $\pm$ 0.0625.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (Serial Input-Output Adapter #7080 required on 1401 Processing Unit).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line

Use	Associated equipment
Document sorting: . .	none.

.43 Connection to device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none if other units requiring a 7080 Adapter or a 3271 Direct Data Channel are connected to the 1401.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 document.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . for full block (no lockout when Processing Overlap is used).
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic within a document; by program for successive documents.
.447 Synchronizing aids: . . tests: document ready to be read; document under read head.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . up to 42 characters per document in standard A.B.A. fields.
.512 Block demarcation
Input: . . . . . trailing edge of document or group mark in core storage.
Output: . . . . . none.

.52 Input-Output Operations

.521 Input: . . . . . documents are fed continuously after unit is engaged; 1401 must be programmed to read each document.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . control panel and program.
Format alternatives: . undefined.
Rearrangement: . . . . by program.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Section sizes: . . . . . limited.
Select fields: . . . . . control panel.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Select stacker: . . . . yes.
Select format: . . . . . no.
Select code: . . . . . no.
Start feeding documents continuously: . . . . . yes.
Stop feeding documents: yes.

.56 Testable Conditions

Disabled: . . . . . indirectly.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: no.
Exhausted: . . . . . indirectly.

.6 PERFORMANCE

.61 Conditions

I: . . . . . without Processing Overlap.
II: . . . . . with Processing Overlap.

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.62 Speeds

.621 Nominal or peak speed: 1,600 6-inch documents/minute. (1,960 51-column documents can be read per minute, but cannot be sorted).

.622 Important parameters

Name	Value
Space between documents:	2.5 inches minimum.
Reader transport rate:	263 inches/sec.

.623 Overhead: 50 msec minimum interval from "engage" instruction until first document reaches read head.

.624 Effective speeds: S = 9,600/L for continuous feeding, where:
S = speed, documents/minute.
L = document length, inches.

.63 Demands on System

BASIS: 6-inch documents at minimum spacing.

Component	Condition	msec per document	or	Percentage
Processing Unit:	I	28.0		74.7
Processing Unit:	II	5.3		14.1

.7 EXTERNAL FACILITIES

.71 Adjustments: none required (feeds intermixed documents of varying sizes).

.72 Other Controls

Function	Form	Comment
Document counter on-off-reset:	switch.	
Unload pocket/restart	foot switch	halts & restarts feeding.
Single document feed:	key	reads & processes 1 document.
Field selection:	5 keys	select fields to be read.
Off-line mode:	key.	
Program-sort mode:	key	permits programmed stacker selection.
Sort field	5 keys	select field for sorting.
Sort position:	10 keys	select position for sorting.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Feed hopper:	12.0 inch stack (600-1200 documents).
Stackers (13):	4.5 inch stack each.

.732 Replenishment time: 0.5 to 1.0 minutes. Reader needs to be stopped, unless operating in alternate pocket mode.

.733 Adjustment time: no adjustments required.

.734 Optimum reloading period: 0.4 to 0.8 minute.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	see "Invalid code".	
Input area overflow:	check for group mark,	stop data transmission.
Invalid code:	validity logic	transmit * to storage & set indicator.
Exhausted medium:	check	stop reader; alarm.
Imperfect medium:	none.	
Timing conflicts:	6 photocells	set indicators.
Full stacker:	check	stop reader; alarm.
Field length error:	character count	set indicator.
Document spacing:	2 photocells	set indicator.
Feed jam:	2 photocells	stop reader; alarm.
Pocket selection:	check	stop reader; alarm.

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INPUT-OUTPUT: 1412 MAGNETIC CHARACTER READER

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.1 GENERAL

.11 Identity: . . . . . Magnetic Character Reader. 1412 Model 1.

.12 Description

The 1412 Magnetic Character Reader-Sorter reads and sorts into any 1 of 13 pockets 950 documents (6 inches long) per minute. Documents up to 8-3/4 inches long can be handled at proportionately lower rates. The 1412 is functionally similar to the later Model 1419 Magnetic Character Reader, whose peak speed is 1,600 documents per minute, (see Section 401:103.100). Characters printed in magnetic ink character Font E-13B (adopted as standard by the American Bankers' Association) are recognized through a reader head matrix 7 scan-time units wide by 10 units high. Only the 10 numerical characters and 4 special symbols can be read, and all magnetic ink imprinting must be on a single line within five-eighths of an inch of the bottom edge of the document. Invalid characters or characters not included in the group of stored logical patterns cause an indicator to be set and an asterisk to be transmitted to core storage. Missing fields, incorrect field length, document spacing errors, and missing or out-of-sequence special symbols also cause error indications.

Pocket selection is determined by the digit read from the column being sorted (one column at a time in the normal mode) which activates the correspondingly numbered chute blade, thus directing documents into specified pockets (A, B, 0 to 9, and reject).

Three basic modes of operation are possible:

Off-line sorting on any individual digit position.

On-line use; 1410 controls document feeding and reading, 1412 controls document sorting.

On-line use; 1410 controls document feeding and reading, and selects distribution stacker.

When reading 6-inch documents, the minimum time available for processing each document is 15.0 milliseconds. The processing overlap feature cannot be utilized on a system having a 1412; therefore, if the processing time exceeds these values, it is necessary to program the start-stop and reading as required.

One 1412 Magnetic Character Reader can be connected to a 1401 system through the 7080 Serial Input-Output Adapter.

.12 Description (Contd.)

A field length verification check and odd-bit parity checks are performed on each character transmitted from the 1412 to core storage.

Optional Features

Multiple Column Select-Sort Suppress:

Permits the sorting to pocket A or B of documents with specific digit values in up to four selected digit positions.

Permits the routing to pocket A or B of documents that do not have specified numbers in designated column positions of a predetermined field.

Permits the routing to pocket A or B of documents that contain a specific code in a predetermined field while sorting all other documents.

Auxiliary Document Counter: counts all documents passing photocell 4.

Self-Checking Number Verification: provides verification of account numbers. Available in either Modulo 10 or Modulo 11; the latter is more effective and more expensive.

Electronic Accumulator and Sequence Checking: permits accumulated totals of the amounts read from documents to be printed as lists, and checks selected positions for correct document sequencing. (Multiple Column Select-Sort Suppress is a prerequisite.)

.13 Availability: . . . . . 12 months as of April, 1963.

.14 First Delivery: . . . . ?

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . moving belt friction.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . magnetic heads.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 30.
Method of use: . . . . . scans characters horizontally.

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.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	none.	
Special:	4	amount, dash, transit, on-us.
Alternatives:		none.
Total:	14.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:	paper or card documents.
.312 Phenomenon:	magnetic ink imprinting.

.32 Positional Arrangement

.321 Serial by:	7 segments per character; 1 to 40 characters per document.
.322 Parallel by:	30 tracks (3 groups of 10 each, allows for variations in vertical position of magnetic characters on documents).
.323 Bands:	1.
.324 Track use	
Data:	10 of 30.
Redundancy check:	0.
Timing:	0.
Control signals:	0.
Unused:	20.
Total:	10 of 30.
.325 Row use:	all for data.

.33 Coding: Font E-13B magnetic ink characters.

.34 Format Compatibility

Other device or system:	all equipment using Font E-13B characters in standard A.B.A. Format.
Code translation:	none required.

.35 Physical Dimensions

.351 Overall width:	2.75 to 3.67 inches.
.352 Length:	6.00 to 8.75 inches.

.4 CONTROLLER

.41 Identity: 7080 Serial I/O Adapter.

.42 Connection to System

.421 On-line:	1.
.422 Off-line	
Use:	document sorting.
Associated equipment:	none.

.43 Connection to Device

.431 Devices per controller:	1 per adapter.
.432 Restrictions:	none.

.44 Data Transfer Control

.441 Size of load:	1 document.
.442 Input-output areas:	core storage.
.443 Input-output area access:	each character.
.444 Input-output area lockout:	for full block (no lockout when Processing Overlap is used).
.445 Table control:	none.
.446 Synchronization:	automatic within a document; by program for successive documents.
.447 Synchronizing aids:	tests; document ready to be read; document under read head.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:	up to 40 characters per document in standard A.B.A. fields.
.512 Block demarcation Input:	trailing edge of document or group mark in core storage.

.52 Input-Output Operations

.521 Input:	documents are fed continuously until a stop feed command is given; 1401 must be programmed to read each document.
.522 Output:	none.
.523 Stepping:	none.
.524 Skipping:	none.
.525 Marking:	none.
.526 Searching:	none.

.53 Code Translation: automatic.

.54 Format Control

Control:	control panel and program.
Format alternatives:	undefined.
Rearrangement:	by program.
Suppress zeros:	no.
Insert point:	no.
Insert spaces:	no.
Section sizes:	limited.
Select fields:	control panel.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Select stacker:	yes.
Select format:	no.
Select code:	no.
Start feeding documents continuously:	yes.
Stop feeding documents:	yes.

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.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Nearly exhausted:	no.
Busy controller:	yes.
End of medium marks:	no.
Exhausted:	yes.

.6 PERFORMANCE

.61 Conditions: none.

.62 Speeds

.621 Nominal or peak speed: 950 6-inch documents/minute.

.622 Important parameters

Space between documents:	3.0 inches minimum; average is approximately equal to document length.
Reader transport rate:	200 inches/second.
Minimum processing time:	15.0 msec/document.
Minimum stacker selection time:	7.5 msec/document.

.623 Overhead: 50 msec minimum interval from "engage" instruction until first document reaches read head.

.624 Effective speed: S = 6,000/L for continuous feeding, where: S = speed, document/minute, L = document length, inches.

.63 Demands on System

Basis: 6 inch documents at minimum spacing.

Component	msec per document	Percentage
Processing Unit:	48.0	76.4

.7 EXTERNAL FACILITIES

.71 Adjustments: none required (feeds intermixed documents of varying sizes).

.72 Other Controls

Function	Form	Comment
Document counter on-off-reset:	switch.	
Reset plunge:	plunges	resets document counter to yes.
Stop-restore:	key	stops machine and resets sort-compare circuits.
Sort key:	key	permits sorting.
Alternate pocket select:	key	for alternating input pockets.
Central processor on-line:	key	puts unit on line.
Reader off-line:	key	permits off-line operation.
Sort column:	key	determines which sort column will be used for sort operation.
Sort field:	key	selects field to be sorted.
Read field:	key	selects field(s) for transmission to the central processor.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Feed hopper:	12.0-inch stack (600 to 1,200 documents).
Stackers (13):	4.5-inch stack each.

.732 Replenishment time: 0.5 to 1.0 minute.

.733 Adjustment time: no adjustment necessary.

.734 Optimum reloading period: 0.6 to 1.3 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	see "Invalid code".	
Input area overflow:	check for group mark	stop data transmission.
Invalid code:	validity logic	transmit * to storage and set indicator.
Exhausted medium:	check	stop reader, set indicator.
Imperfect medium:	none.	
Timing conflict:	5 photocells	set indicator.
Fill stackers:	interlock	stop reader.
Field length error:	character cost	set indicator.
Document spacing:	2 photocells	set indicator.
Feed jam:	check	stop reader, set indicator.
Transfer of data:	parity check	halt computer.

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INPUT-OUTPUT: 1428 ALPHAMERIC OPTICAL READER

§ 105.

.1 GENERAL

.11 Identity: . . . . . Alphameric Optical Reader 1428 Model 1 and 2.

.12 Description

The 1428 unit reads alphameric characters printed in 1428 tape font (available on IBM 1403 Printers and IBM Electric typewriters) into 1401 core storage at the rate of 400 5-7/8 inch documents per minute. The standard model reads one line of data, which may be positioned anywhere on the document within marginal limitations.

Documents are fed from the hopper, through document separation and alignment stations, to a vacuum drum, which holds them flat as they pass the optical reading station. They are then removed from the drum by a revolving belt mechanism and sent to the selected stacker pocket. Model 1 has 3 stackers and is designed for on-line use only. The 3 stackers can be utilized for alternate pocket selection only. Model 2 is equipped with 13 stackers and can be used off-line (when the off-line switch is depressed) for single character sorting on any position. Both models have an "overflow stacking" mode that permits unloading the stackers without stopping the stackers and without stopping the reader when no sorting is required.

The optical character reading is accomplished by scanning. Light reflected from the surface of the moving document is positioned by a lens system on a rotating scanning disk, which produces an image of the character sensed. The light image passes through a fixed aperture plate to the surface of a photomultiplier tube, which converts it into a matrix pattern of electrical impulses. A character recognition network determines either that the character is a valid one, in which case it is transmitted to 1401 core storage, or that it is unreadable, in which case the symbol @ is sent to core storage in its place. Each programmed "read" instruction causes only one character to be transmitted from the 1428 to core storage, and indicators must be tested before each character transfer to guard against timing conflicts, and possible loss of characters.

Optional Features

Additional Read Station: Permits reading data from two lines on the document in a single pass. Switching between the two read stations, which are 4.25 inches apart, is under program control.

Mark Reading Station: Permits the reading of up to 37 columns of alphameric data marked on a standard IBM card with an ordinary black pencil or ink; cannot be used when an Additional Read Station is installed.

.13 Availability: . . . . . 12 months as of April, 1963.

.14 First Delivery: . . . . ?

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . vacuum drum and moving belt friction.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . reflected light on photomultiplier tube.
.223 Common system: . . . none.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . 1 character at a time.

Use of station: . . . . . reading (optional).
Distance: . . . . . 4.25 inches.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . 1 character at a time.

Use of station: . . . . . mark reading (optional; alternative to additional Read Station).
Distance: . . . . . 4.25 inches.
Stacks: . . . . . 1.
Heads/stack: . . . . . 13.
Method of use: . . . . . 1 column at a time.

.25 Range of Symbols

Numerals:	10	0 through 9.
Letters:	26	A through Z.
Special:	6	$ / * - (decimal and comma as one) and a preprinted vertical field mark (1).
Alternatives:	none.	
FORTRAN set:	none.	
Req. COBOL set: . . .	none.	
Total:	42.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper documents.
.312 Phenomenon: . . . . . printing.

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.32 Positional Arrangement

.321	Serial by:	1 to N rows at most, 10 per inch where N is size of document.
.322	Parallel by:	1 track only.
.323	Bands:	2 if optional second Read Station installed; each band is served by a separate read station but only 1 band may be read at a time.
.324	Track use	
	Data:	all.
	Redundancy check:	inherent in system.
	Timing:	character to character.
	Control signals:	special characters.
	Total:	1.
.325	Row use:	same as track use.

.33 Coding: printed characters, 1428 type font, .090-inch high and spaced 10 characters or fewer per inch.

.34 Format Compatibility

Other device or system:	all equipment using IBM 1428 type font.
Code translation:	none required.

.35 Physical Dimensions

.351	Overall width:	2.75 to 3.67 inches.
.352	Length:	5.875 to 8.75 inches.
.353	Maximum margins	
	Left:	0.375 inch.
	Right:	0.375 inch.

.4 CONTROLLER

.41 Identity: no separate controller (Serial Input-Output adapter 7080 required on 1401 Processing unit).

.42 Connection to System

.421	On-line:	1.
422	Off-line	
	Use:	Document Sorting (Model 2 only).
	Associated Equipment:	none.

.43 Connection to Device

.431	Devices per controller:	1.
.432	Restrictions:	none if other units requiring a 7080 Adapter or a 3271 Direct Data Channel are connected to the 1401.

.44 Data Transfer Control

.441	Size of load:	1 character.
.442	Input-output areas:	core storage.
.443	Input-output area access:	each character.
.444	Input-output area lockout:	none.
.445	Table control:	none.
.446	Synchronization:	by program.
.447	Synchronizing aids:	tests; document under read station 1 or 2; document end reached; character available to 1401; late transfer.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511	Size of block:	1 to 80 characters per document.
.512	Block demarcation	
	Input:	trailing edge of document.
	Output:	none.

.52 Input-Output Operations

.521	Input:	documents are fed continuously after unit is engaged; 1401 must be programmed to read each character.
.522	Output:	none.
.523	Stepping:	none.
.524	Skipping:	none.
.525	Marking:	none.
.526	Searching:	none.

.53 Code Translation: automatic.

.54 Format Control

Control:	program.
Format alternatives:	no.
Rearrangement:	no.
Suppress zeros:	no.
Insert point:	no.
Insert spaces:	no.
Zero insertion:	yes.
Reading selection:	yes.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Select stacker:	yes.
Select format:	no.
Select code:	no.
Start feeding documents continuously:	yes.
Stop feeding documents:	yes.
Select reading station:	yes (with optional features).

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Nearly exhausted:	no.
Busy controller:	no.
End of medium marks:	no.
Character ready to be transferred:	yes.
Exhausted:	yes.

§ 105.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 400 documents/minute (5-7/8 inches long).

.622 Important parameters

Name	Value
Read station switch time:	4 msec.
Reader transport rate:	48 inches/sec.
Space between documents:	1.25 inches.

.623 Overhead: . . . . . 4 msec when second read station is used.

.624 Effective speeds: . . . $S = \frac{2,880}{L + 1.25}$ for continuous feeding, where:
S = speed, documents/minute
L = document length, inches.

.63 Demands on System

Component: . . . . . Processing Unit.
Msec per character: . . 0.195*

* Includes time required to test ready, interpret read instruction, and transfer 1 character.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . read station positioning.
Method: . . . . . levers.
Comment: . . . . . positions for reading from any specified location on the face of the document.

.72 Other Controls

Function	Form	Comment
Manual feed:	knob	permits registration check.
Reset:	key	resets electronic circuitry.
Register Run Key:	key	used to feed documents without operating system.
Alternate Pocket select:	key	makes alternate pocket selection operative.
Start document counter:	key	has automatic reset.
Off-line sort mode:	key.	
Document End switch:	4-position switch	determines point at which "document and" indicator shall be set.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	15.0 inch stack (800 - 1,500 documents).
Stacker (3 or 13): . .	4.5-inch stack each.

.732 Replenishment time: . . 0.5 to 1.0 minute. Reader needs to be stopped unless in alternate pocket mode.

.733 Adjustment time: . . . 5 to 10 minutes.

.734 Optimum reloading period: . . . . . 2.0 to 3.75 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	see "Invalid code".	
Input area overflow:	none.	
Invalid code:	validity logic	transmits @ to core storage.
Exhausted medium:	check	stops reader; alarm and indicator.
Imperfect medium:	none.	
Timing conflicts:	check	sets indicator.
Full stack:	check	stops reader; alarm.
Improper feeding:	check	stops reader; alarm.
Improper registration:	check	alarm.

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DATA COMMUNICATION UNIT

§ 106.

.1 GENERAL

.11 Identity: . . . . . 7710 Data Communication Unit.

.12 Description

The 7710 Data Communication Unit enables the 1401 Data Processing System to transmit and receive data at speeds up to 5,100 characters per second from remote equipment. This unit can use both public and private line communication facilities. The equipment at the other end of the network can be: a similarly equipped 1401; 7701 or 7702 Magnetic Tape Transmission Terminal; a 1009 Data Transmission Unit; or a 1013 Card Transmission Terminal. A specially equipped telephone and serial data set, supplied by the communication company, are also required at each terminal. The 7710 must be operated at a speed compatible with the equipment it is communicating with. This compatibility is achieved by setting a Speed Select Switch located on the Customer Engineer's Panel to a speed of 4,800, 2,400, 2,000, or 1,200 bits per second. The 7710 allows high speed data transfer and remote area communication between two 1401 installations or centralized data processing facilities.

Data are transferred between 1401 core storage and the 7710 via the Serial I/O Adapter (7080) serially by character and parallel by bit. The 1401 controls the

.12 Description (Contd.)

movement of data, while the 7710 controls the transmission of data. The transmitting 7710 converts each character from six-bit code plus parity bit into a fixed-count four-of-eight code. It is possible to transmit intermixed binary and BCD alphameric records. Transmission through communication facilities is serial by character and serial by bit. The receiving 7710 reverses the code translation procedure. Validity checks ensure that each character received contains exactly four out of eight bits, and a longitudinal parity check detects most errors resulting from switched bits.

Input messages can be of any length and are terminated by an end-of-message signal. Output messages can also be any length and are terminated by a group mark with a word mark in core storage.

Optional Features

A high speed communication interface or provision for high speed and low speed communication interfaces: Permits multipoint communication for low speed data gathering and point-to-point communication for volume transfer of data at high speed.

.13 Availability: . . . . . 14 months as of April1963.

.14 First Delivery: . . . . ?

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INPUT-OUTPUT: 1231 OPTICAL MARK PAGE READER

§ 107.

.1 GENERAL

.11 Identity: . . . . . Optical Mark Page Reader. 1231.

.12 Description

The Optical Mark Page Reader reads ordinary pencil marks (not printed characters) from 8-1/2" x 11" data sheets directly into a 1401, 1440, or 1460 Data Processing System. A #7080 Serial Input/Output Adapter is required on the 1401 or 1441 Processing Unit.

The 1231 (or its off-line counterpart, the 1232) will be useful in organizations that use standardized forms for such functions as surveys, orders, applications, medical records, payroll time records, inventory listings, and sales analyses. The 1231's chief advantage is the elimination of much of the key punching and verifying normally associated with the preparation of input for automatic data processing. In a single pass of the pencil-marked data sheets through the 1231, the marks are read and the data is transferred to the computer. (The 1232, working off-line, converts the marked information into punched cards.)

Documents are read at varying rates of speed, depending upon the mode switch settings. When set to "continuous", feeding is at a constant speed of 2,000 documents per hour. When set to "demand", feeding is controlled by the computer program with speeds varying up to 1600 documents per hour. The feeding mode selected depends upon the computer program control method used.

.12 Description (Contd.)

Data sheets are fed from a pneumatically-controlled hopper (600-sheet capacity) through the reading area and directed to one of two stackers. The main stacker holds 600 sheets. Sheets with detected errors are directed to a separate stacker (50-sheet capacity). Documents are stacked in reverse sequence in both stackers.

All marks read from a data sheet are stored as bits in a sonic delay line storage unit until they are transferred to the computer by execution of a Read instruction. Less than 10 milliseconds are required to transfer data from the sonic delay line to the computer storage.

The user may have up to 1,000 mark positions on one side of a sheet (2,000 on both sides). Mark positions are pre-printed in rows of 20 positions. Each row is divided into two 10-position groups. Each 10-position group is called a "word" for the purpose of defining a marking area. Each word can be divided into two 5-position segments. Data words and segments can be grouped in various combinations to form fields.

First deliveries are scheduled for the third quarter of 1964.

Optional Feature

Master Mark: A master data sheet, containing up to 10 words of marked data, can be read and stored in the delay line for transfer to the computer. The master sheet is identified by a special preprinted mark and contains data that is to be associated with all subsequent data sheets until a new master sheet is read. Thus, data common to a series of data sheets need be recorded and read only once.

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INPUT–OUTPUT: 7770 AUDIO RESPONSE UNIT

§ 108.

.1 GENERAL

.11 Identity: . . . . . Audio Response Unit. 7770, Model 1.

.12 Description

The IBM 7770 Audio Response Unit is a buffered communications unit that accepts telephoned requests and relays them to a central processing unit which processes the data and returns a coded reply to the 7770. The 7770 interprets the reply, selects the proper words from its stored vocabulary, and transmits these words as a voice response back to the inquirer.

The Audio Response Unit is composed of three sections: inquiry, control, and audio output.

The inquiry section accepts digital inquiries from the connected inquiry terminals through a common carrier receiver, in message lengths up to 40 digits. Transmission of the inquiry between the receiver and the 7770 is accomplished in a 3-out-of-14 or 2-out-of-8 inquiry code. The 7770 receives the inquiry from the receiver terminal in serial-by-character, parallel-by-bit form. The inquiry is then translated into BCD form, stored in a buffer, and transferred to the computer when the total inquiry has been received. An inquiry is assumed to be complete when the 7770 receives no data for five consecutive seconds.

The digital control section controls the data flow between the CPU (central processing unit) and the 7770 through the 1311 Disk Storage control unit. A Read File command from the CPU causes the inquiry to be transferred from the 7770 to the CPU. When the CPU completes its interpretation of the inquiry, it composes a coded response message. The CPU then issues a Write File command, and the response message is transferred to the buffer of the 7770. The response message is composed of vocabulary word locations (located on the 7770's magnetic drum), and is sent one word at a time. The maximum length of this response message is 38 words. Positions 1 through 38 may contain the drum addresses of the appropriate audio response words. A group mark in any position from 2 through 39 will signify the end of the message. The last position of the 40-character area is always a blank.

The audio output section provides the actual audio response to the inquirer. These words, recorded on the magnetic drum in analog form as an audio signal, are amplified and transmitted to the terminal originating the inquiry.

.12 Description (Contd.)

The vocabulary is recorded on the magnetic sleeve of a drum 4 inches in diameter and 10 inches long. There are 128 tracks on the drum, addressable by a seven-bit BCD address field associated with each track. Two tracks are prerecorded; one having an address of zeros (blank) and the other with ones (group mark). The "blank" track indicates 500 milliseconds of silence (500 milliseconds per revolution), and the "group mark" track is used for end-of-message control.

The prerecorded drum vocabulary is flexible in three ways:

(1) The number of drum words can be 32, 48, or 64, and can be increased to 80, 96, 112, or 128 by a special feature.

(2) A master vocabulary provided by IBM is a list of frequently used industry words, numbers from 0-9, and letters of the alphabet.

(3) The vocabulary can be changed, by exchanging the analog recorded cylinder, at any time by the customer.

A 7770 Model 1 can be used with a 1401, 1440, or 1460, and a 7770 Model 2 with a 1410 or 7010 System. Only one 7770 can be attached to a system, in lieu of a 1311 Disk Storage Drive Model 2, thereby reducing by one the maximum number of 1311 Model 2's. For a 1401, a 7149 Adapter on the 1311 Model 4 is needed; for a 1440/1460, a 7150 Adapter on the 1311 Model 1 is needed.

The 7770 operates in a half-duplex mode over toll, leased, or privately-owned voice-grade lines. The basic 7770 handles up to four lines. The line capacity can be expanded, in 4-line increments, to a maximum of 64 lines. Random inquiries on any or all input-output lines can be serviced simultaneously.

The 7770 operates with the following inquiry terminal devices, provided the proper arrangements have been made by the customer with the common carrier: 1001 Data Transmission Terminal, rotary dial telephone with associated pushbutton manual dialing device, rotary dial telephone with pushbutton card dialer device, pushbutton manual dialing telephone, and pushbutton type card dialer telephone.

First 7770 deliveries are scheduled for the first quarter of 1965.

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . Processing Overlap Feature. #5730.

Print Storage Feature. #5585.

Read Punch Release Feature. #6040.

Seek Overlap Feature.

Serial Input/Output Adapter.

Early Card Read.

.12 Description

The basic 1401 system has a very limited capability for simultaneous operations. These operations are limited to advancing forms on the printer, rewinding magnetic tape, or performing a seek on a disc storage unit while processing. The processing unit is inhibited during all input-output operations except for a short period at the end of each card cycle, print cycle, or tape block movement. Combination instructions are available which initiate sequential card read, punch, or printing operations in any combination. Some time can thereby be saved through partial overlapping of the Read-Punch start and stop times and the printer-forms advance times. These instructions are "print and read," "read and punch," "print and punch," and "print, read, and punch". In a 1401 system without the optional features described below, combination printing, card reading, and card punching operations can occur at the rate of 200 full card and print cycles per minute, using the 1-character combination instruction. If the print, read, and punch operations are initiated by separate instructions, the maximum rate is about 150 card and print cycles per minute.

Optional Features:

Processing Overlap: Permits computation while a peripheral unit prepares to send or receive data and between character transfers. Whenever the peripheral unit is ready to transfer or receive a character, it signals the Processing Unit, and computation is inhibited for one 11.5-microsecond cycle. Processing Overlap is most effective on high-volume card reading and punching and on low-speed magnetic tape operations. Transfer rates of the 729 Model II and IV Tape Units at high density are too high to permit any computing to be done.

Automatic protection of the input-output areas is sacrificed when Processing Overlap is used, but indicators are provided which permit branching if the

.12 Description (Contd.)

Optional Features (Contd.)

punch, reader, or tape units are busy. This feature increases the power and flexibility of the system at the expense of increased programming complexity.

Print Storage: Provides a buffer register which holds a full line of information to be printed. It reduces the demand upon the Processing Unit from 84 microseconds to 2 microseconds per line. An indicator permits branching if the printer is busy.

Read Punch Release: Permits computation to continue during the initial phase of each card read or punch cycle. The resulting increase in available processing time is 21 microseconds per read cycle and 37 microseconds per punch cycle. If a read or punch instruction is not given within the required interval after feeding the card, an error halt will occur. Read Punch Release cannot be used in the Processing Overlap mode.

Early Card Read: Provides two additional clutch points where the card feeding mechanism can engage. This feature makes it possible to engage the card feeding mechanism at 25-millisecond intervals instead of the normally required 75-millisecond interval.

For card systems, the Early Card Read and the Read Punch Release features provide valuable extensions to processing time available during card cycles. The optional features required to achieve the optimum throughput capabilities of the card reader can be determined by calculating the total processing time required. The following table shows the optional features required and the resulting card reading speeds.

Total Processing Time Required (msec)	Optional Features Required	Cards Per Minute
less than 10	none	800
10 to 31	Read Punch Release	800
31 to 35	Early Card Read	600
35 to 56	Read Punch Release Early Card Read	600
56 to 60	Early Card Read	500
60 to 81	Early Card Read Read Punch Release	500
81 to 85	Early Card Read	400
85 to 106	Read Punch Release Early Card Read	400

As the foregoing table shows, careful consideration should be given to the application before determining what optional features should be included. The above table only deals with one input device and processing. The addition of an output device would make the calculations even more complex. These factors should

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§ 111.

.12 Description (Contd.)

Optional Features (Contd.)

all be considered for the specific application in determining the optional features required for a system.

Seek Overlap: Permits a 1311 Disk Storage "Seek" operation to be overlapped with one 1311 "Read" or "Write" operation plus as many other "Seek" operations as there are available Disk Storage Drives in the system (a maximum of five). Without this feature, only one seek operation at a time is possible. To be effective, the feature must be installed on every 1311 drive in the system.

Serial Input/Output Adapter: Permits connection of any one of the following devices to a 1401 system:

1009 Data Transmission Unit
1011 Paper Tape Reader
1012 Tape Punch
1412 Magnetic Character Reader
1419 Magnetic Character Reader
1418 Optical Character Reader
1428 Alphameric Optical Reader
3271 Direct Data Channel
7710 Data Communication Unit

The Processing Unit is interlocked whenever data is being transferred to or from the device connected to the Serial I/O Adapter, except in the case of the 1011 or 1419 or 7710 if the Processing Overlap feature is in use.

.2 CONFIGURATION CONDITIONS

I: . . . . . basic system; no special features.
II: . . . . . system with Print Storage and Read Punch Release special features.
III: . . . . . system with Print Storage and Processing Overlap special features.
IV: . . . . . system same as III with Seek Overlap added.

.4 RULES

Condition I

Any or all of the following:

Rewind magnetic tapes
Advance forms on printer
Seek record in one Disk Storage unit

And either one of the following:

Internal processing
Any input-output operation.

.4 RULES (Contd.)

Condition II

Any or all of the following:

Rewind magnetic tapes
Seek record in one Disk Storage unit
Print a line or advance forms
Start card read cycle
Start card punch cycle

And either one of the following:

Internal processing
Any input-output operation (other than printing).

Condition III

Any or all of the following:

Rewind magnetic tapes
Seek record in one Disk Storage unit
Print a line or advance forms

And either one of the following:

Internal processing with any one overlapped input-output operation †
Any non-overlapped input-output operation (other than printing).

Condition IV

Any or all of the following:

Rewind magnetic tapes
Seek record in each 1311 Disk Storage Drive
Print a line or advance forms

And either one of the following:

Internal processing with any one overlapped input-output operation †
Any non-overlapped input-output operation (other than printing).

Note: Part of each card cycle, print cycle, and magnetic tape start-stop time is available for internal processing under all conditions. Furthermore, card reader, card punch, and printer operations can be partially overlapped with one another through use of the combination instructions described in Paragraph .12 above.

† The following operations can be overlapped:

Card reader input
Card punch output
Magnetic tape start-stop times
Magnetic tape data transfers at 20,016 char/sec and below
1011 Paper Tape Reader input
1419 Magnetic Character Reader input
7710 Data Communication Unit input or output.

INSTRUCTION LIST

§ 121.

INSTRUCTION					OPERATION
OP.	A or I	B	d	MNEM. OP.	
					Arithmetic
A	A	B	-	A	(A) + (B) → B.
A	A	-	-	A	(A) + (A) → A.
S	A	B	-	S	(B) - (A) → B.
S	A	-	-	S	(A) - (A) → A; result is 0 with sign of (A).
@	A	B	-	M*	(A) x (B) → B.
%	A	B	-	D*	(B) ÷ (A) → B.
?	A	B	-	ZA	0's → B, then (A) + (B) → B.
!	A	B	-	ZS	0's → B, then (B) - (A) → B.
!	A	-	-	ZS	Changes sign of (A).
					Logic
B	I	-	-	B	Jump unconditionally to I.
B	I	-	9	B	Jump to I if printer tape channel #9 is sensed.
B	I	-	A	B	Jump to I if "last card" switch on.
B	I	-	i*	B	Jump to I if sense switch "i" is on (i = B, C, D, E, F, or G).
B	I	-	K	B	Jump to I if end of reel.
B	I	-	L	B	Jump to I if tape error.
B	I	-	P*	B	Jump to I if printer busy.
B	I	-	Q	B	Jump to I if console inquiry request.
B	I	-	R*	B	Jump to I if carriage busy.
B	I	-	S	B	Jump to I if (B) = (A).
B	I	-	T*	B	Jump to I if (B) < (A) (low comparison).
B	I	-	U*	B	Jump to I if (B) > (A) (high comparison).
B	I	-	Z	B	Jump to I on overflow.
B	I	-	?	B	Jump to I if reader error.
B	I	-	!	B	Jump to I if punch error.
B	I	-	+	B	Jump to I if printer error.
B	I	-	@	B	Jump to I if printer tape channel #12 is sensed.
B	I	-	%	B	Jump to I on processing error.
B	I	-	/	B	Jump to I if (B) ≠ (A) (unequal comparison).
B	I	-	*	B	Jump to I if console inquiry clear key pressed.
B	I	B	d	B	Jump to I if (B) = d (d = any char.).
V	I	B	d	BWE	Jump to I if (B) has certain zone bit configuration, specified by d value.
					Data Transfer
D	A	B	-	MN	(A) → B; 1 char., numerical portion only.
L	A	B	-	LCA	(A) → B; including word mark.
M	A	B	-	MCW	(A) → B; word marks undisturbed.
Y	A	B	-	MZ	(A) → B; 1 char., zone portion only.
Z	A	B	-	MCS	(A) → B; with zero suppression.
,	A	B	-	SW	Set word marks at A & B.
□	A	B	-	CW	Clear word marks at A & B.
					Miscellaneous Internal Operations
C	A	B	-	C	Compare (A) to (B) & set indicator.
E	A	B	-	MCE	(A) → B, modified by edit-control word at B.
H	A	-	-	SBR*	Contents of B Address Register → A.
Q	A	-	-	SAR*	Contents of A Address Register → A.
N	-	-	-	NOP	No operation.
/	A	-	-	CS	Clear storage from A to next lower 100's position
.	-	-	-	H	Halt.
#	A	B	-	MA*	(A) + (B) → B, for address modification.
P	A	B	-	MCM*	(A) → B; moves entire record to record mark.

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§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
OP.	A or I	B	d	MNEM. OP.	
					Internal Storage: Disc Storage Units
M	%Fo	B	R	MCW	Seek disc storage record whose address is in B.
M	%Fx	B	R	MCW	Read from disc storage into B; no word-marks.
M	%Fx	B	W	MCW	Write into disc storage from B; no word-marks.
L	%Fx	B	R	LCA	Read from disc storage into B with word-marks.
L	%Fx	B	W	LCA	Write into disc storage from B with word-marks.
					For disc storage instructions:
					x = 1: single record.
					x = 2: full track.
					x = 3: write disc check operation.
					Input-Output: Punched Card & Printer
1	-	-	-	R	Read 1 card into Core Storage positions 001-080.
2	-	-	-	W	Print 1 line from Core Storage positions 201-332.
2	-	-	□	W	Print word marks from Core Storage positions 201-332 as 1's
3	-	-	-	WR	Print 1 line & read 1 card, overlapped.
4	-	-	-	P	Punch 1 card from Core Storage positions 101-180.
4	-	-	R	P*	Read 1 card at punch feed & punch 1 card.
5	-	-	-	RP	Read 1 card and punch 1 card, overlapped.
6	-	-	-	WP	Print 1 line & punch 1 card, overlapped.
6	-	-	R	WP*	Read at punch feed, punch, & print.
7	-	-	-	WRP	Print, read, & punch, overlapped.
8	-	-	-	SRF*	Start card-read feed, without interlock.
9	-	-	-	SPF*	Start card-punch feed, without interlock.
F	-	-	d	CC	Space or skip printer, as indicated by d.
K	-	-	d	SS	Select reader or punch stacker indicated by d.
K	-	-	$	SS*	Enter Processing Overlap mode.
K	-	-	.	SS*	Exit from Processing Overlap mode.
					Input-Output: Magnetic Tape
L	%Ux	B	R	LCA	Read 1 block from Magnetic Tape x into B with word-marks.
L	%Ux	B	W	LCA	Write 1 block on Magnetic Tape x from B with word-marks.
M	%Ux	B	R	MCW	Read 1 block from Magnetic Tape x into B; no word-marks.
M	%Ux	B	W	MCW	Write 1 block on Magnetic Tape x from B; no word-marks.
M	%Cx	B	R	MCW*	Read 1 block from Magnetic Tape x into B; compressed tape.
U	%Ux	-	B	CU	Backspace 1 block on Magnetic Tape x.
U	%Ux	-	E	CU	Skip & erase 3.5 inches on Magnetic Tape x.
U	%Ux	-	M	CU	Record end-of tape mark on Magnetic Tape x.
U	%Ux	-	R	CU	Rewind Magnetic Tape x.
U	%Ux	-	U	CU	Rewind and unload Magnetic Tape x.
					Input-Output: Console Inquiry
M	%To	B	R	MCW	Data from keyboard B; no word-marks.
M	%To	B	W	MCW	(B) console printer; no word-marks.
L	%To	B	R	LCA	Data from keyboard B; with word-marks.
L	%To	B	W	LCA	(B) console printer; with word-marks.
					Input-Out: Paper Tape Reader
L	%P1	B	R	LCA	Read 1 block into B with word-marks.
M	%P1	B	R	MCW	Read 1 block into B; no word-marks.
					Input-Out: Tape Punch
M	%P1	B	W	MCW	Punch 1 tape character.
M	%P1	B	R	MCW	Read 1 tape character (for read-back check).
K	-	-	A		Backspace 1 tape character.
K	I	-	A		Backspace 1 tape character and jump to I.
					Input-Output: Magnetic Character Readers
U	%S1	-	E	CU	Start feeding documents continuously.
U	%S1	-	D	CU	Stop feeding documents.
L	%S1	B	R	LCA	Transfer data from 1 document into B with word-marks.
M	%S1	B	R	MCW	Transfer data from 1 document into B; no word-marks.
K	-	-	d	SS	Select stacker pocket indicated by d.

* Optional features required.

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§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
OP.	A or I	B	d	MNEM. OP.	
					Input-Out: Data Communication Unit
U	%D1	-	E	CU	Informs Receiving computer that the transmitting computer has data to transmit.
M	%D1	B	W	MCW	Moves 1 record from core storage to the Communication Unit.
K	-	-	G	SSG	Informs transmitting computer it must retransmit last message.
K	-	-	C	SSC	Signals end of job on transmit.
K	-	-	E	SSE	Signals end of job on receive.
M	%D1	B	R	MCW	Moves 1 record from Communication Unit to Core Storage.
U	%D1	-	D	CW	Informs transmitting computer that Receiving computer has received the last record that was transmitted.
					Input-Output: Optical Character Readers
U	%S2	-	E	CU	Start feeding documents continuously.
U	%S2	-	D	CU	Stop feeding documents.
L	%S2	B	R	LCA	Transfer 2 character into B; convert vertical field marks to word-marks (1418 only).
M	%S2	B	R	MCW	Transfer 1 character into B; no word-marks (1418 only).
K	-	-	d	SS	Select stacker pocket indicated by d.
K	-	-	d	SS	The d-modifier C, E, or F, permits the 1428 to read only those characters included in the corresponding alphabetic, numeric, or alphanumeric character sets respectively.
M	%S2	B	R	MU	Transfer 1 character into B (1428 only).

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CODING SPECIMEN: SYMBOLIC PROGRAMMING SYSTEM

§ 131.

.1 TRANSLATOR LISTING

PAGE 2

REC TYPE	PG	LIN	CT	LABEL	OP	A OPERAND	B OPERAND	D	LOCN	INSTRUCTION	COMMENT/LITERAL	SFX	ERRORS	INITL
	1	510	8		B	BLANTO	0019		0354	B 691 019	TAPE OUTPUT			
	1	520	7		A	0019	LOTAPE		0362	A 019 H64				
	1	530	8	MMACHS	B	* +008	0006		0369	B 384 006				
	1	540	7		MCW	0006	MACHSZ		0377	M 006 G01				
	1	550	8		B	* +008	0007	1	0384	B 399 007 1				
	1	560	7		MCW	C0C	SENSSW		0392	M J08 209				
	1	570	8		B	* +008	0008	2	0399	B 414 008 2				
	1	580	7		MCW	C00C	PRNTSZ		0407	M J16 G03				
	1	590	7		MCW	PRNTSZ	ORG2		0414	M G03 G05				
	1	600	7		A	C1C	ORG2		0421	A J09 G05				
	1	610	8		B	RAMTST	0012		0428	B 533 012				
	1	620	7		A	C2C	ORG2		0436	A J10 G05	TAPE INPUT			
	1	630	7		MCW	C1C	TAPESW		0443	M J09 H58				
	1	640	7		MCW	C1C	TAPE		0450	M J09 202				
	1	650	1		MCW				0457	M				
	1	660	8		B	* +008	0015		0458	B 473 015				
	1	670	7		MCW	C1C	HEADER		0466	M J09 207				
	1	680	8		B	* +015	0016		0473	B 495 016				
	1	690	7		MCW	C1C	MULTIF		0481	M J09 208				
	1	700	7		MCW	0016	NTFILE		0488	M 016 G11				
	1	710	8		BWZ	FIXEDT	0012	2	0495	V 610 012 2				
	1	720	8		B	VARUNB	0012	V	0503	B 663 012 V				
	1	730	8		B	* +008	0012	B	0511	B 526 012 B				
	1	740	7		MCW	C1C	VARBEX		0519	M J09 205				
	1	750	7	BLOCKT	MCW	C1C	BLKTP		0526	M J09 204				
	1	760	7	RAMTST	MCW	IDENT	0180		0533	M H69 180				
	1	770	8		B	NORAM	0026		0540	B 702 026				
	1	780	7		MCW	C1C	RAMAC		0548	M J09 210	RAMAC IS SPECIF			
	1	790	8		B	M1ROUT	0075	1	0555	B 783 075 1				
	1	800	8		B	M2ROUT	0075	2	0563	B 794 075 2				
	1	810	8		B	M3ROUT	0075	3	0571	B 805 075 3				
	1	820	8		B	M4ROUT	0075	4	0579	B 900 075 4				
	1	830	8		B	M5ROUT	0075	5	0587	B ‡10 075 5				
	1	840	8		B	M6ROUT	0075	6	0595	B ‡21 075 6				
	1	850	7		H	* -006	0102		0603	. 603 102	NO MODE			
	1	860	7	FIXEDT	MCW	C1C	FIXED		0610	M J09 203	TAPE			
	1	870	8		B	RAMTST	0014		0617	B 533 014				
	1	880	7		C	0012	C000C		0625	C 012 J19				
	1	890	5		B	* +015		/	0632	B 651 /				
	1	900	7		MCW	C999C	0012		0637	M J22 012				
	1	910	7		MCW	C1C	T1000R		0644	M J09 206				
	1	920	7		A	0014	TBLKFA		0651	A 014 G10				
	1	930	1		A				0658	A				
	1	940	4		B	BLOCKT			0659	B 526				
	1	950	7	VARUNB	MCW	C200C	0012		0663	M J25 012				
	1	960	4		B	RAMTST			0670	B 533				
	1	970	8	ERROR1	B	* +003	0001	*	0674	B 684 001 *				
	1	980	2		SS			1	0682	K 1				

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IBM

1401 Symbolic Programming System
Coding Sheet

Program _____

Programmed by _____

Date _____

Page No. [1 2] of _____

Identification [76 80]

LINE (3 5)	COUNT (6 7)	LABEL (8 13)	OPERATION (14 16)	(A) OPERAND ADDRESS (17)	(A) OPERAND ± (23)	(A) OPERAND CHAR. ADJ.	(A) OPERAND IND. (27)	(B) OPERAND ADDRESS (28)	(B) OPERAND ± (34)	(B) OPERAND CHAR. ADJ.	(B) OPERAND IND. (38)	d (39)	COMMENTS (40 55)
010													
020													
030													
040													
050													
060													
070													
080													
090													
100													
110													
120													
130													
140													
150													
160													
170													
180													
190													
200													

X29-1152-2

CODING SPECIMEN: AUTOCODER

§ 132.

.1 TRANSLATOR LISTING

ILLUSTRATE TYPICAL ORGANIZATION OF PROGRAM WITH IOCS PAGE 4

SEQ	PG	LIN	LABEL	OP	OPERANDS	SEX	CT	LOCN	INSTRUCTION	TYPE	CARD
248				SW	IOCSLB+36		4	0845	, U72	GENIO	20
249				A	IOCSLB+38,IOCSV6-1		7	0849	A U74 K59	GENIO	20
250				CW	IOCSLB+36		4	0856	) U72	GENIO	20
251			)3R001	C	IOCSV6-1,=0365-		7	0860	C K59 K64	GENIO	20
252				BL	)4M001		5	0867	B 904 T	GENIO	20
253				A	IOCSLB+31,IOCSV6-4		7	0872	A U67 K56	GENIO	20
254				C	IOCSV6-1,IOCTDY		7	0879	C K59 199	GENIO	21
255				BE	)4J001		5	0886	B 930 S	GENIO	21
256				BL	)4J001		5	0891	B 930 T	GENIO	21
257				H	)4J001		4	0896	. 930	GENIO	21
258				B	)20001		4	0900	B 755	GENIO	21
259			)4M001	SW	IOCSLB+30		4	0904	, U66	GENIO	21
260				S	-3650-,IOCSV6		7	0908	S K68 K60	GENIO	21
261				A	+1,IOCSLB+31		7	0915	A K51 U67	GENIO	22
262				CW	IOCSLB+30		4	0922	) U66	GENIO	22
263				B	)3R001		4	0926	B 860	GENIO	22
264			)4J001	B	)8P001		4	0930	B /56	GENIO	22
265				MCW	- -,IOCSLB+39		7	0934	M K69 U75	GENIO	22
266				MCW	IOCRCY		4	0941	M T98	GENIO	22
267				MCW	---		4	0945	M K70	GENIO	22
268				MCW	IOCTDY		4	0949	M 199	GENIO	23
269				MCW	IOCIDT		4	0953	M U16	GENIO	23
270				MCW	- -		4	0957	M K69	GENIO	23
271				MCW	IOCSEQ		4	0961	M U01	GENIO	23
272				MCW	---		4	0965	M K70	GENIO	23
273				BW	)4N001,IOCOPS		8	0969	V +13 K28 1	GENIO	23
274			)4K001	MCW	IOCSER,IOCSLB+14		7	0977	M U06 U50	GENIO	23
275				MCW	-1HDR -,IOCSLB+4		7	0984	M K75 U40	GENIO	24
276				MCW	-W-,IOCTDF+13		7	0991	M K76 T90	GENIO	24
277				MCW	-M-,IOCTDF+6		7	0998	M K77 T83	GENIO	24
278				B	IOCRWR		4	1005	B T47	GENIO	24
279				B	IOCLVE		4	1009	B S05	GENIO	24
280			)4N001	BW	)4K001,IOCFSW		8	1013	V 977 K45 1	GENIO	24
281				MCW	IOCSLB+9,IOCSER		7	1021	M U45 U06	GENIO	25
282				B	)4K001		4	1028	B 977	GENIO	25
283			* PROCESS TAPE OUTPUT - END OF REEL			$				GENIO	
284			)4P001	EQU	*+1			1032		GENIO	
285				MN	IOCTAP,*+4		7	1032	D U30 +42	GENIO	25
286				WTM	0		5	1039	U (U0 M	GENIO	25
287				B	)8P001		4	1044	B /56	GENIO	25
288				MCW	)8Q001=10,IOCSLB+29		7	1048	M K87 U65	GENIO	25
289				MCW	)8Q001		4	1055	M K87	GENIO	25
290				MCW	IOCBLK-1		4	1059	M U21	GENIO	26
291				MCW	-1EOR -		4	1063	M K92	GENIO	26
292				BW	*+5,IOCLOS		8	1067	V +79 K30 1	GENIO	26
293				B	*+8		4	1075	B +86	GENIO	26
294				MCW	-F-,IOCSLB+3		7	1079	M K93 U39	GENIO	26
295				MCW	-W-,IOCTDF+13		7	1086	M K76 T90	GENIO	26
296				MCW	-M-,IOCTDF+6		7	1093	M K77 T83	GENIO	27
297				B	IOCRWR		4	1100	B T47	GENIO	27

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§ 132.

.2 CODING SHEET

IBM

Program _____

Programmed by _____

Date _____

Form X24-1350-1
Printed in U.S.A.

INTERNATIONAL BUSINESS MACHINES CORPORATION

IBM 1401 AND 1410 DATA PROCESSING SYSTEMS

AUTOCODER CODING SHEET

Identification ____ 76 80

Page No. __ 1 2 of ____

Line 3 5	Label 6 15	Operation 16 20	OPERAND 21 25 30 35 40 45 50 55 60 65 70
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13			
14			
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16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

(1/62:40M-S)

AUERBACH / BNA

DATA CODE TABLE NO. 1

§141.

.1 USE OF CODE: . . . . . internal, magnetic tape, and disc storage.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 8 bits: 6 data, 1 parity, 1 word mark.
Odd parity is used internally, and on disc storage; even parity is used on magnetic tape.
Word mark bit is not used on magnetic tape or disc storage; it is replaced by the word separator character, = .

.22 Character Structure

.221 More significant pattern: . . . . . 2 zone bits: B, A = 32, 16

.222 Less significant pattern: . . . . . 4 numeric bits: 8, 4, 2, 1

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	blank	¢	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W		F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	‡	:	?
11	#	,	$	.
12	@	%	*	□
13	:	=	)	(
14	>	'	;	<
15	√	"	△	≠

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . . 1403 and 1404 Printers.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 8 bits: 6 data, 1 odd parity, 1 word mark.

.22 Character Structure

.221 More significant pattern: . . . . . 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: . . . . . 4 numeric bits: 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	blank	±	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	‡	-	&
11	#	,	$	.
12	@	%	*	□
13				
14				
15				

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . . punched card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	blank	&	-	
12				
11				
0	0	?	:	
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2				≠
8-3	#	.	$	,
8-4	@	□	*	%
8-5	:	(	)	=
8-6	>	<	;	'
8-7	√	±	△	"

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DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . internal collating sequence.

.2 STRUCTURE OF CODE

In ascending sequence:

blank	G
.	H
□	I
(	¦
<	J
ǂ (group mark)	K
&	L
$	M
*	N
)	O
;	P
Δ	Q
-	R
/	ǂ (record mark)
,	S
%	T
= (word separator)	U
'	V
"	W
¢	X
#	Y
@	Z
:	0
>	1
√‾ (tape mark)	2
?	3
A	4
B	5
C	6
D	7
E	8
F	9

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PROBLEM-ORIENTED FACILITIES

§ 151.

.1 UTILITY

.11 Simulators of Other Computers: . . . . . none.

.12 Simulation by Other Computers: . . . . . none.

.13 Data Sorting and Merging

1401 SORT 1
Reference: . . . . . 1401 Program Library File No. 1.2.002.
Record size: . . . . . 10 to 800 characters, preset.
Block size: . . . . . 10 to 800 characters, preset.
Key size: . . . . . up to 5 fields, each of any preset length.
File size: . . . . . final output must fit on one reel.
Number of tapes: . . 4 minimum.
Date available: . . . . October, 1960.
Description
SORT 1 is a generalized program to perform basic tape sorting functions on a 1401 system with a minimum of 4,000 positions of core storage, 4 magnetic tape units, card reader-punch, printer, and the High-Low-Equal Compare feature. A fifth tape unit may be used as a dump tape for unreadable records. Blocked or unblocked records with a preset block length of up to 800 characters may be sorted. A checkpoint routine permits restarts at the beginning of any merge pass. Parameters for the particular sort to be performed are punched into a control card and used to initialize the generalized program. File size is limited to a single output reel, or about 125,000 blocked 80-character records at the 556 characters an inch tape density.

1402 SORT 2 & MERGE 2
Reference: . . . . . 1401 Program Library File No. 1.2.003.
Record size: . . . . . } preset; maximum depends
Block size: . . . . . } upon core storage capacity and order of merge.
Key size: . . . . . up to 100 chars. total in up to 10 fields.
File size: . . . . . 1 reel max. for 2-way merge; 2 reels max. for 3-way merge.
Number of tapes: . . . 4 or 6.
Date available: . . . . May, 1961.

Description
SORT 2 takes advantage of expanded 1401 system capabilities to reduce the time required for general sorting. It will operate on a system with a minimum of 8,000 core storage positions, 4 magnetic tape units, card reader-punch, printer, High-Low-Equal Compare, and Advanced Programming. Two-way or three-way merge passes can be performed, depending upon whether four or six tape units are available. Maximum block and record sizes vary from 1,100 characters for a 3-way merge with the 8K core storage size to 3,900 characters for a 2-way merge with 16K. As in SORT 1, parameters from a control card are used to tailor the generalized program for the specific job, and a checkpoint routine permits restarts at the beginning of any merge pass.

MERGE 2 is a related routine that can be used to merge sequenced records from up to five different input files into a single output file. It can operate as a two-, three-, four-, or five-way merge depending upon the number of tape units available. Minimum configuration is the same as for SORT 2 except that only three tape units are required for a two-way merge. Up to nine reels of input data can be handled successively by each input tape unit during a single merge. Extremely long files can be sequenced by means of a series of partial sorts followed by one or more MERGE 2 passes.

SORT 6 is a set of generalized sorting routines that can be incorporated into the Autocoder library. The sort generator is supplied with a description of the sort required and then generates a sort program which complies with the specifications. File formats are then described by control cards which are interpreted prior to execution. The generated program will sort fixed length, blocked records contained in a punched card file, magnetic tape file, or disc storage. The minimum configuration requirements are 4,000 core storage positions, 1402 Card Reader Punch, 1403 Printer, 1311 Disk Storage Drive, and the High-Low-Equal Compare feature.

.14 Report Writing

1401 Card Report Program Generator
Reference: . . . . . IBM 1401 Program Library File No. 1.3.002.
Date available: . . . Version 2 - July, 1961.
Description:

This generator facilitates the preparation of report programs which will process an input card file to produce a printed report and/or a punched card deck. Four distinct phases are involved in its use:

1. Writing the report specifications in a problem-oriented language on four different types of specification forms: Input, Data, Calculation, and Format.

2. Translating the report specifications into a symbolic object program through the use of the Card Report Program Generator Processor Deck.

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§ 151.

.14 Report Writing (Contd.)

3. Translating the symbolic program into 1401 machine language by means of either the SPS or Autocoder translator.

4. Executing the object program to produce the desired report.

A minimum of 4,000 positions of core storage is required to generate a report program. The object program can be run on any 1401 system whose storage capacity will accommodate it, and no special features are required. Primary emphasis has been placed on the generation of efficient object programs for a wide variety of report formats and computational requirements. The generation process is lengthy and involves considerable card handling unless the translating 1401 system is large enough to permit use of the Autocoder translator, in which case card-handling can be eliminated. The problem-oriented language, while not as easy to master as one might hope, should result in significant savings in programming time and effort as compared with the use of a machine-oriented language for report program preparation.

1401 Tape Report Program Generator
Reference: . . . . . IBM 1401 Program Library File No. 1.3.002.
Date available: . . . . Version 2 - July, 1961.
Description:

The Tape Report Program Generator utilizes the same language and performs the same basic function as the card version described above. Object programs produced by the tape version, however, process an input tape file to produce a printed report, a punched card deck, an output tape file, or any combination of the three. The object computer must have at least 4,000 positions of core storage and 1 magnetic tape unit, or 2 tape units if tape output is specified. Either block fixed-length records or unblocked variable-length records can be processed as input data, but tape output is limited to unblocked fixed-length records no longer than 132 characters.

FARGO (1401 Automatic Report Generating Operation)
Reference: . . . . . IBM 1401 Program Library File No. 1.3.001.
Date available: . . . . July, 1961.
Description:
FARGO is a report generator of the load-and-run type that was designed to simplify the conversion of report preparation from punched card tabulating equipment to the 1401 system. Input is from punched cards, and printed listings or tabulations are produced, with or without summary punching. At least 4,000 positions of core storage are required. The Print Storage and Early Card Read features are recommended for maximum operating speeds. Multiplication and division can be done only if the Multiply-Divide feature is available or if the appropriate subroutines are incorporated by means of an intricate patching procedure.

FARGO's main feature is the elimination of the separate translation runs that are usually required in report generation. Control cards giving the specifications for the particular report to be produced are inserted at four specified points in the FARGO program deck. Each of the four phases of the FARGO program is loaded in turn, and the appropriate program steps are generated from the control card parameters. Then the input data cards are read and the report is produced without pause. While FARGO may be useful for some "one-shot" reports or for applications where the report specifications change frequently, its capabilities are far more limited and its object programs less efficient than those of the Card Report Program Generator. There is no language compatibility between the FARGO and Card Report Program Generator systems.

.15 Data Transcription

Multiple Utility Program for IBM 1401 Tape Systems.
Reference: . . . . . IBM 1401 Program Library File No. 1.4.008.
Date available: . . . . Version 2 - August, 1961.
Description:

Designed primarily for 1401 systems serving as input-output processors for IBM 700 or 7000 series systems, this routine controls card-to-tape, tape-to-card, and tape-to-printer operations. One, two, or all three operations may be performed concurrently. The following equipment is required: 1401 with at least 4,000 core storage positions, card read-punch, printer, one magnetic tape unit for each concurrent operation, High-Low-Equal Compare, Advanced Programming, Read Punch Release, and 6 additional sense switches. The Column Binary feature is required if binary information is to be handled. The Print Storage feature is recommended for maximum speed in tape-to-printer operations.

The program's functions are determined by the operator's sense switch settings. The routine may be interrupted at any time to begin another run of a completed operation; it may then be restarted without disturbing the continuity of other concurrent operations. In card-to-tape operations each BCD or column-binary coded card becomes a single, unblocked tape record. Tape-to-card operations require the tape records to be unblocked and no more than 80 characters in length. The tape-to-printer function is more versatile: tapes may contain records up to 1,001 characters long. One record is printed per line in exact tape image, except that the first character of each record may serve as a control character for forms movement.

In addition to the Multiple Utility Program, individual Card-to-Tape, Tape-to-Card, and Tape-to-Printer Utility Programs are available. Each of these routines can handle blocked, variable-length records, perform sequence checks, select specified fields for transcription, and treat certain records differently from the standard routine through exception procedures. The Tape-to-Printer Utility Program permits editing and zero suppression on up to 16 fields per record. When the individual data transcription routines are used, only one operation can be performed at a time.

§ 151.

.15 Data Transcription (Contd.)

Programs for Card Systems
Reference: . . . . . IBM 1401 Program Library.
Date Available: . . . . all programs currently available.
Description:
The following programs are designed for 1401 Card Systems and perform ordinary tasks that are necessary for all installations:

Print Storage: This program prints the contents of portions of core storage as specified in a control card at 600 lines per minute.

Punch Storage: This program punches the contents of portions of core storage as specified in a control card at 250 cards per minute.

Punch-List-Sequence Check: This program punches lists, or sequence checks, or performs any combination of these operations using input from any card deck.

Disc Storage Utility Programs
Reference: . . . . . IBM 1401 Program Library.
Date Available: . . . all programs currently available.
Description:
There are six data transcription programs available for RAMAC IBM 1401 systems: Disc to Printer, Clear Disc Storage, Disc to Tape, Tape to Disc, Disc to Card, and Card to Disc.

The 1311 Disk Storage 1401 system utility program portion of the Library contains eight data transcription programs: Clear Disc Storage, Disc to Card, Card to Disc, Copy Disc, Disc to Printer, Disc Record Load, Disc to Tape, and Tape to Disc. The minimum 1401 configuration required for these programs is 4,000 core storage positions, 1401 Card Read Punch, 1403 Printer, 1311 Disk Storage Drive. In addition, the Copy Disc program requires two disc drives.

1009 Utility Programs
Reference: . . . . . IBM 1401 Program Library.
Date Available: . . . all programs currently available.
Description:
Data from cards or tape is transmitted over a long distance line by the following programs: card to line, tape to line, line to card, and line to tape. The tape to line and line to tape combination of programs accepts messages up to 1,000 characters for transmission. The card programs in any combination accept messages varying from 80 to 640 characters in multiples of 80. The minimum configuration required for these programs is 4,000 core storage positions, sense switches, either an IBM Tape Drive or a 1402 Card Read Punch, and a 1009 Data Transmission Unit.

7710 Utility Programs
Reference: . . . . . IBM 1401 Program Library.
Date Available: . . . all programs currently available.
Description:
Three Utility Programs are available for controlling the movement of data between the 7710 Data Communications Unit connected to a 1401 system and a remote terminal. The remote terminal can be: another 7710 connected to a 1401 system, a 1009 Data Transmission Unit connected to a 1401 system, an IBM 7701 or 7702 Magnetic Tape Transmission Terminal, or an IBM 1013 Card Transmission Terminal.

The 1401-7710 Tape Transmit Utility Program is a self-loading program which employs a control card to specify the format required for a given data transmission operation. The data records to be transmitted are read into core storage from magnetic tape. Input tape reading and data transmission are controlled by the utility program. The 1401-7710 Tape Receive Utility program performs in reverse order the same tasks described above. This program controls input from the 7710 Data Communications Unit into the 1401 system, and then writes the data onto magnetic tape.

The 1401-7710 Transmit-Receive Utility Program is a combination of the two preceding programs. This program controls the input and/or output of Data Transmission messages and Magnetic Tape blocks, and can be interleaved with operational programs through program exits. A priority loop is also incorporated to control branches for entry into a receive data routine, a transmit data routine, or to the user's operating programs when there is no call for the first two operations.

.16 File Maintenance

While no comprehensive file maintenance program has been published for the 1401, there are utility programs which aid in file organization. These programs are designed to assist in establishing and maintaining data files in disc storage.

Programs available for the RAMAC disc storage unit using the chaining method of file organization are: Chain Load of Master Records, Trailer Load Program RAMAC-to-Tape, Chain Additions of Master Records, Chain Deletions of Master Records, RAMAC-to-Card.

Programs available for the 1311 Disk Storage Unit are designed to support either a random file organization using the chaining address method of file organization or a sequential file using a purely sequential file organization. Programs for the random file include: Pass One Random Load, Pass Two Random Load, Additions Program for Master Records, Loading and Additions Program for Trailer Records, Delete or Tag Program for Master and Trailer Records, Delete Program for Tagged Master and Trailer Records, Delete Program for Single Trailer, Unload Program for Reorganization. Programs for the sequential file include: Load Program, Additions Program, Delete or Tag Program, Deletion of Tagged Records, Unload Program for Reorganization.

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.17 Other

A variety of specialized operating routines are available for the 1401, and the number is growing steadily. Descriptions of all the available routines can be found in "IBM 1401 Program Library Abstracts." Descriptions of a few of the more widely used programs follow:

Clear Storage: This routine clears the entire storage to blanks and leaves a word mark set in location 001.

Multiply I: This subroutine multiplies up to two 10-digit numbers, using a minimum of storage space.

Multiply II: This subroutine multiplies two numbers having a maximum of nine digits, in a minimum amount of time. Multiply II should be used when time is the important factor whereas Multiply I should be used when conserving core storage requirements is the important factor.

Divide: This subroutine uses repetitive subtraction to perform division. The length of the divisor, dividend, and quotient may range from 1 to 20 digits, with certain restrictions.

Dozens to Units Conversion: This subroutine converts dozens and fractions of dozens to units.

Units to Dozens Conversion: This subroutine converts units to dozens and fractions of dozens.

.2 PROBLEM ORIENTED LANGUAGE: . . . . . none.

PROCESS ORIENTED LANGUAGE: COBOL-61

§ 161.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 COBOL (4K and 12K-16K Versions).

.12 Origin: . . . . . General Products Division, IBM Corporation.

.13 Reference: . . . . . IBM Publications F28-8053-1, C24-1492-0, J24-1474-1.

.14 Description

The 1401 COBOL language is a subset of COBOL-61, the most widely implemented pseudo-English common language for business applications. Although a number of electives have been incorporated, 1401 COBOL has several significant deficiencies with respect to Required COBOL-61. These deficiencies result from the manufacturer's decision to "defer" several important but not easily implemented language facilities. The deficiencies of 1401 COBOL relative to Required COBOL-61, as well as the facilities of Elective COBOL-61 that have and have not been implemented, are tabulated at the end of this description.

The 1401 COBOL Processor is available in two different versions, for 1401 systems with a minimum of either 4,000 or 12,000 positions of core storage. The two versions are described in Sections 401:183 and 401:184, respectively. Both versions of the Processor use the 1401 COBOL language described in this Section, but certain language facilities incorporated in the 4K version are not available in the 12K-16K version (probably because the 12K-16K version was released 5 months earlier). The EXAMINE verb of Required COBOL-61 (which facilitates a variety of character manipulation operations) and the elective ENTER verb (which permits the inclusion of 1401 Autocoder statements into a COBOL source program) fall into this category. These and other language differences between the two versions are indicated in the lists of deficiencies and electives that follow.

The library facilities of COBOL-61 are not available in the 1401 COBOL system. The COBOL library is a collection of prewritten entries for the Environment, Data, and Procedure Divisions that can reduce the amount of writing involved in coding programs and encourage standardization of coding techniques. The other deviations from Required COBOL-61 are relatively minor when COBOL source programs are written specifically for the 1401, but are likely to cause serious problems when COBOL programs written for other systems must be compiled and run on a 1401.

.14 Description (Contd.)

The language facilities of the IBM 1401 and 1410 COBOL systems are quite similar, so few difficulties should be encountered in transferring COBOL-coded programs from a 1401 to a 1410 by recompiling them on the 1410. (The IBM 1410 COBOL language is described in Section 402:162.) Furthermore, the 1401 and the new, faster IBM 1460 will be program-compatible and will use the same COBOL language and translators.

Among the electives that have been incorporated into 1401 COBOL, the COMPUTE verb is probably the most valuable. COMPUTE permits arithmetic operations to be expressed in a concise formula notation similar to that of FORTRAN. For example, the COBOL operations:

```
SUBTRACT B FROM A GIVING T
DIVIDE C INTO T GIVING X
```

can alternatively be expressed as:

```
COMPUTE X = (A - B) / C.
```

IBM 1401 COBOL object programs can read and write information on magnetic tape only in the move mode with even parity (RECORDING MODE 1), whereas 1410 COBOL permits reading and writing in either the load or move mode and with either odd or even parity. When the move mode is used work mark bits in core storage are neither recorded on the tape during a write operation nor disturbed during a read operation. Thus, the 1401 COBOL system is geared toward use of fixed field operands.

Magnetic tape files can be organized in any of the following record formats:

- Fixed length records, unblocked; with or without record marks.
- Fixed length records, blocked; with record marks and padding of short blocks.
- Variable length records, blocked; with a record mark and Record Character Count field in each record and a Block Character Count field in each block.

Tape record lengths may not exceed 999 characters, but block sizes are limited only by the storage capacity of the target computer. Card and printer files must be unblocked and have fixed record lengths of 80 characters for the 1402 Card Read-Punch, 100 characters for the 1403 Model 1 Printer, and 132 characters for the 1403 Model 2 Printer.

Although the 1401 is a variable word length computer, the COBOL provisions for item lengths which vary from run to run have not been implemented.

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.14 Description (Contd.)

Arithmetic operand sizes can be preset to any value up to 18 digits. The data description clauses USAGE, SIGNED, and SYNCHRONIZED have no significance in the 1401 system because of its variable word length capability and its use of the same representation for both numeric and alphameric data. These three clauses should not be used in 1401 COBOL source programs.

Availability

Language: . . . . . 1961.

Translator
12K-16K Version: . . June, 1962.
4K Version: . . . . . November, 1962.

Deficiencies with respect to Required COBOL-61

Environment Division:

- The OPTIONAL option in the FILE-CONTROL paragraph, which provides for files that will not necessarily be present each time the object program is run, is deferred.
- The MULTIPLE REEL option in the FILE-CONTROL paragraph and all other features that provide for automatic assignment of tape units are deferred.
- The COPY options that enable SOURCE-COMPUTER, OBJECT-COMPUTER, and SPECIAL-NAMES paragraphs to be taken from the library are deferred.
- The RENAMING clause in the FILE-CONTROL paragraph, which enables more than one file to utilize the same File Description without the need to rewrite the description, is deferred.
- One ALTERNATE AREA may be specified in the FILE-CONTROL paragraph if the object computer has the Processing Overlap feature; otherwise, none may be specified.
- No RERUN option is provided.

Data Division:

- The COPY options that enable File and Record descriptions to be taken from the library are deferred.
- No nesting of REDEFINES clauses (which allow the same storage area to contain different data items) is permitted except in cases where one of two redefinitions is at the 01 level. †
- The PICTURE clause characters "0" and "B" are implemented as replacement characters rather than as insertion characters, so non-standard results may be obtained in editing operations.

Procedure Division:

- The REEL option of the CLOSE verb, which provides for the closing of a reel prior to its normal end, is deferred.
- The EXAMINE verb and TALLY register, which make it possible to replace and/or count the number of occurrences of a specified character in a data item, are deferred. †
- A given file cannot be processed both as an input file and as an output file in the same Program.
- A literal used after the STOP verb must be numerical and less than four digits in length. †

† Deficiency applies only to the 12K-16K version of 1401 COBOL.

Extensions to COBOL 61: . . . . . , none. (The SORT verb and Report Writer facility of Extended COBOL-61 are not provided.)

§ 161.

.14 Description (Contd.)

COBOL-61 Electives Implemented (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
1	Formula characters	+, -, *, /, **, =.
6	Figurative constants	HIGH-VALUE(S), LOW-VALUE(S).
	File Description	
8	BLOCK size	allows an upper limit to be specified, but not in the standard way.
	Record Description	
19	SIZE clause option	can be used only to specify size of a variable length record.
20	Conditional range	allows a conditional value to be a range.
	Verbs	
22	COMPUTE	permits algebraic formulas.
24 ‡	ENTER ‡	permits use of 1401 Autocoder language within a COBOL program.
	Verb Options	
27	LOCK	locks rewound tapes.
30	ADVANCING	specifies paper advance of 1, 2, or 3 lines, or to any channel on carriage tape.
32	Formulas	algebraic formulas can be used.
33	Operand size	up to 18 digits.
35	Tests	IF { } IS NOT ZERO form is provided.
37	Compound conditionals	ANDs and ORs can be intermixed.
38	Complex conditionals	permits conditional statements within conditional statements.
	Environment Division	
40	SOURCE-COMPUTER	specifies differences from the "standard" configuration.
41	OBJECT-COMPUTER	specifies differences from the "standard" configuration.
42	SPECIAL-NAMES	specifies hardware for ACCEPT, DISPLAY, and WRITE verbs.

‡ Elective is implemented in the 4K version, but not in the 12K-16K version.

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§ 161.

.14 Description (Contd.)

COBOL-61 Electives Not Implemented (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
2	Relationship characters	> and < not available.
3	Semicolon	always ignored by translator.
4	Long literals	literals may not exceed 120 characters.
5	Figurative constants	HIGH BOUND(S), LOW BOUND(S) not available.
7	Computer-name	no alternative computer names.
	File Description	
9	FILE CONTAINS	approximate file size cannot be shown.
10	Label formats	labels must be standard or omitted.
11	SEQUENCED ON	no list of keys can be given.
12	HASHED	hash totals cannot be created.
	Record Description	
13	Table length	lengths of tables and arrays may not vary.
14	Item length	variable item lengths cannot be specified in a PICTURE.
15	BITS option	items cannot be specified in binary.
16	RANGE IS	value ranges of items cannot be shown.
17	RENAMES	alternative groupings of elementary items cannot be specified.
18	SIGN IS	no separate signs allowed.
21	Label handling	only standard labels (or none) may be used.
	Verbs	
23	DEFINE	new verbs cannot be defined.
25	INCLUDE	no library routines can be called.
26	USE	no non-standard I/O error and label handling routines.
	Verb Options	
28	MOVE CORRESPONDING	each item must be individually moved.
29	OPEN REVERSED	tapes cannot be read backward.
34	Relationships	IS UNEQUAL TO, EQUALS, and EXCEEDS are not provided.
36	Conditionals	no implied objects with implied subjects.
39	Conditional statements	only AT END or ON SIZE ERROR may follow imperative statements.
	Environment Division	
43	FILE-CONTROL	cannot be taken from library.
44	PRIORITY IS	no priorities can be specified for multi-running purposes.
45	I/O-CONTROL	cannot be taken from library.
46	I/O-CONTROL	rerun methods and multi-file tapes cannot be specified.
	Identification Division	
47	DATE-COMPILED	current date will not be inserted automatically.
	Special Features	
48	Library	library routines cannot be called.
49	Segmentation	no provision for segmentation of object programs.

PROCESS ORIENTED LANGUAGE: FORTRAN

§ 162.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 FORTRAN.

.12 Origin: . . . . . General Products Division, IBM Corporation.

.13 Reference: . . . . . IBM Publication J24-1455-1.

.14 Description

The IBM 1401 FORTRAN language is basically FORTRAN I and is considerably less powerful than the IBM 709/7090 FORTRAN II language described in Section 408:161. Probably the most significant language limitations are the inability to define and use FORTRAN-coded subroutines and functions, the restriction of arrays to one or two dimensions rather than three, the inability to perform Boolean operations and complex arithmetic (i.e., arithmetic using numbers composed of a real part and an imaginary part), and the inability to incorporate symbolic coding. Other restrictions relative to 709/7090 FORTRAN II are summarized at the end of this description.

The most significant positive feature of IBM 1401 FORTRAN is its ability to take advantage of the variable word length capabilities of the 1401 Processing Unit. The programmer can specify any desired degree of precision up to 20 decimal digits for the internal representation of numeric data. The precision (f) to be used for all floating point values within a single program is preset by a control card. If no specification is made, f is set at eight digits. The number of core storage positions required for each floating point variable of f digits precision is f + 2, because two additional digits are required to specify the exponent. Fixed point precision (k), which is also specified by a control card, is set at five digits if no other specification is made and applies to all fixed point values within a program. Object program execution times and storage requirements will naturally increase when increased precision is demanded.

The ranges of numeric magnitudes that can be represented in 1401 FORTRAN and in 709/7090 FORTRAN II are compared in the following table:

System	Floating Point	Fixed Point
1401 FORTRAN:	10^{-100} to $(1 \times 10^{-f}) \times 10^{99}$	1 to $10^{k} - 1$.
709/7090 FORTRAN:	10^{-38} to 10^{38}	1 to 131,071.

where f and k are floating and fixed point precisions, respectively, in decimal digits.

As in 709/7090 FORTRAN II, a single READ, PRINT, PUNCH, READ INPUT TAPE, or WRITE OUTPUT TAPE statement can cause input or output of any number of blocks whose lengths can be a maximum of 80 characters for the card reader or punch or 133 characters (including 1 printer control character) for the printer or magnetic tape units. A READ TAPE or WRITE TAPE statement, however, will produce a transfer of a single block of data whose length may not exceed 233 characters unless the input-output "list" names a single, non-subscripted array. Shorter blocks are blank-filled to produce a fixed tape block length of 233 characters. Tape records produced by the READ TAPE statement are in internal format. Despite these limitations, the READ TAPE and WRITE TAPE statements will be found useful for temporary magnetic tape storage of the "scratch-pad" variety because of the relatively limited internal storage capacity of 1401 systems.

.14 Description (Contd.)

The restrictions and extensions of the IBM 1401 FORTRAN language relative to IBM 709/7090 FORTRAN II follow.

Restrictions

(1) The following statements are not permitted:

SUBROUTINE
FUNCTION
CALL
RETURN
COMMON
FREQUENCY
ASSIGN
Assigned GO TO
IF ACCUMULATOR OVERFLOW
IF QUOTIENT OVERFLOW
IF DIVIDE CHECK
READ DRUM
WRITE DRUM

(2) Arrays are limited to two dimensions (709/7090 FORTRAN II permits three).

(3) Double precision, complex, and logical operations are not permitted (but note that precision can be preset at up to 20 digits).

(4) Alphameric information can be handled only in the form of Hollerith items (FORMAT specification wH), which cannot be named or manipulated in storage; the Aw specification is not available.

(5) Arithmetic function statements are not permitted.

(6) Symbolic coding cannot be incorporated into the FORTRAN source program.

(7) Input-Output in octal form (O-type conversion) is not permitted.

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.14 Description (Contd.)

Restrictions (Contd.)

(8) A list of compiler output options following the END statement will be ignored.

(9) Floating point and fixed point variables can be assigned to the same storage locations by an EQUIVALENCE statement only if f + 2 = k.

(10) Separately compiled programs cannot be combined at execution time.

(11) Object programs cannot be segmented (as in 709/7090 CHAIN operations).

(12) The number of branch points in the list of a computed GO TO statement cannot exceed 10.

(13) Exponentiation of a negative floating point base to an integral floating point power (e.g., A**3.0) always produces a positive result; i.e., the result is incorrectly signed for odd integral powers.

.14 Description (Contd.)

Restrictions (Contd.)

(14) Only nine of the standard FORTRAN functions are provided:

SINF:	sine.
COSF:	cosine.
LOGF:	natural logarithm.
EXPF:	exponentiation.
SQRTF:	square root.
ABSF:	absolute value of floating point argument.
XABSF:	absolute value of fixed point argument.
FLOATF:	convert fixed point argument to floating point.
XFIXF:	convert floating point argument to fixed point.

Extensions

(1) Data items can be represented internally with any desired degree of precision between 2 and 20 digits for floating point items and between 1 and 20 digits for fixed point items, as preset by control cards.

(2) A wider range of numeric magnitudes can be represented in 1401 FORTRAN than in the 709/7090 system, as shown in the table above.

(3) Variable names can be up to 14 characters in length.

MACHINE ORIENTED LANGUAGE: SYMBOLIC PROGRAMMING SYSTEM

§171.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 Symbolic Programming Systems. SPS-1 & SPS-2. SPS.

.12 Origin: . . . . . IBM General Products Division, 1401 Applied Programming.

.13 Reference: . . . . . IBM publications: J24-0200-2 & J24-1412-1; 1401 Program Library File No. S1401-SP-021 and 1401-SP-030.

.14 Description:

SPS is the basic machine-oriented language for the 1401 system. Its powers are necessarily very limited because its translator was designed to operate on a 1401 with no tapes and only 1,400 positions of core storage. Literals and macro-instructions cannot be used. Except for eight pseudo-operations which define constants and labels and provide limited translator control, there is a strict one-to-one correspondence between SPS statements and 1401 machine language instructions. There are no significant language differences between SPS-1 and SPS-2; the latter was developed to facilitate the full use of expanded 1401 systems, and its translator requires at least 4,000 core storage positions.

The use of the SPS language provides understandable mnemonic operation codes as well as the ability to use the actual instruction codes if desired. Several useful subroutines are available from the 1401 Program Library which can be manually inserted into the program deck. These subroutines offer error control, file labeling, special math functions, multiplication and division facilities, and several other commonly used routines. For complete details refer to the 1401 Program Library Abstracts.

.15 Publication Date:

SPS-1: . . . . . October, 1960.
SPS-2: . . . . . August, 1961.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . refer to SPS coding sheet, 401:171.820.

.22 Legend

Line: . . . . . sequences entries on coding sheet.
Count: . . . . . denotes number of characters a defined area or constant will contain.

.22 Legend (Contd.)

Label: . . . . . names an area or instruction.
Operation: . . . . . mnemonic or machine code, for operation to be performed.
A & B Operands: . . . . actual or symbolic addresses of data to be operated upon, including specification of relative addresing and/or indexing.
d: . . . . . single-character modifier for certain operation codes.
Comments: . . . . . explanatory information to be listed but not assembled.

.23 Corrections: . . . . . spare lines on coding sheet and gaps in sequence numbers.

.24 Special Conventions

.241 Compound addresses: . . BASE ± ADJUSTMENT, where BASE is any label and ADJUSTMENT is a decimal integer.
.242 Multi-addresses: . . . . none.
.243 Literals: . . . . . not available.
.244 Special coded addresses: * refers to low-order position of instruction in which it appears.
.245 Other
Actual core storage addresses: . . . . . 4-digit decimal numbers, left-justified in operand fields.

.3 LABELS

.31 General

.311 Maximum number of labels per translator interation:

Core Storage Positions	Translator	Maximum Labels
1,400:	SPS-1	40
2,000:	SPS-1	100
4,000:	SPS-1	300
4,000:	SPS-2	260
8,000:	SPS-2	660
12,000:	SPS-2	1,060
16,000:	SPS-2	1,460

.312 Common label formation rule: . . . . . yes
.313 Reserved labels: . . . . none.
.314 Other restrictions: . . . none.
.315 Designators: . . . . . none.
.316 Synonyms permitted: . . no.

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.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . mandatory if referenced by other instructions.
Formation rule
First character: . . . alphabetic.
Others: . . . . . alphabetic or numeric (no special characters).
Number of chars: . . 1 to 6.
.322 Labels for library routines: . . . . . none.
.323 Labels for constants: . . same as Procedures.
.324 Labels for files: . . . . none.
.325 Labels for records: . . . same as Procedures.
.326 Labels for variables: . . same as Procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constant: 32 characters per card; may be split into two or more entries.
.412 Maximum size literals: . none available.

.42 Working Areas

.421 Data layout
Implied by use: . . . . no.
Specified in program: yes.
.422 Data type: . . . . . not required.
.423 Redefinition: . . . . . no.

.43 Input-Output Areas

.431 Data layout: . . . . . explicit.
.432 Data type: . . . . . not required.
.433 Copy layout: . . . . . no.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . alternative.
Number: . . . . . 37.
Example: . . . . . R = read a card.
Comment: . . . . . must be left-justified.
.512 Absolute
Existence: . . . . . alternative.
Number: . . . . . 38 (many variations through "d" modifier.
Example: . . . . . 1 = read a card.
Comment: . . . . . must be right-justified.
.52 Macro Codes: . . . . . none.
.53 Interludes: . . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . pseudo operations.
Label adjustment: . . none.
Annotation: . . . . . "comment card" with* in column 8.
.542 Allocation counter
Set to absolute: . . . . .ORG pseudo.
Set to label: . . . . . .no.
Step forward: . . . . .DS pseudo with * as operand.
Step backward: . . . . .no.
Reserve area: . . . . . .no.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . . multiplication, division, floating point arithmetic.
.612 Method of call: . . . . . manual insertion of cards.

.62 Special Functions

.621 Facilities: . . . . . square root, sin-cos.
.622 Method of call: . . . . . manual insertion of cards.

.63 Overlay Control

.631 Facilities: . . . . . none.

.64 Data Editing

.641 Radix conversion: . . . . none.
Code translation: . . . . none.
.642 Format control: . . . . not required due to hardware editing capability.

.65 Input-Output Control

.651 File labels: . . . . . yes.
.652 Reel labels: . . . . . yes.
.653 Blocking: . . . . . no.
.654 Error control: . . . . . yes.
.655 Method of call: . . . . . manual insertion of cards.

.66 Sorting

.661 Facilities: . . . . . none (all sort routines are independent programs).

.67 Diagnostics

.671 Dumps: . . . . . linkages to fixed or selective core storage printout routines may be inserted and removed by special routines.
.672 Tracers: . . . . . none.
.673 Snapshots: . . . . . see .671

.7 LIBRARY FACILITIES

.71 Identity: . . . . . IBM 1401 Program Library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . . yes.
.723 Private: . . . . . yes.

.73 Storage Form: . . . . . cards.

.74 Varieties of Contents: . . wide variety of subroutines and independent programs available; reference: "IBM 1401 Program Library Abstracts."

.75 Mechanism

.751 Insertion of new item: . . . file in card library.
.752 Language of new item: . generally SPS.
.753 Method of call: . . . . . insert in deck.

§171.

.76 Insertion in Program

.761 Open routines exist:. . . yes.
.762 Closed routines exist:. . yes.
.763 Open-closed is optional:. in some cases.
.764 Closed routines appear once:. . . . . yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . . none.

.82 Pseudos

Code	Description
CTL:	specifies core storage sizes of translating and target systems.
ORG:	sets address allocation counter.

.82 Pseudos (Contd.)

Code	Description
EX:	causes a temporary halt in loading of the object program, and execution of the portion just loaded.
END:	indicates end of source program; can initiate execution of object program immediately after loading.
DCW:	loads a constant and sets work mark in high-order position.
DC:	loads a constant without word mark.
DS:	assigns a machine address to a label.
DSA:	stores a constant equivalent to the machine address assigned to a specific label.

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5/63 Revised

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

IBM 1401 SYMBOLIC PROGRAMMING SYSTEM

CODING SHEET

FORM X24-1152-2
PRINTED IN U.S.A.

Program _____

Page No. [1 2] of _____

Programmed by _____ Date _____

Identification [76 80]

LINE (3 5)	COUNT (6 7)	LABEL (8 13)	OPERATION (14 16)	(A) OPERAND ADDRESS (17)	(A) OPERAND ± (23)	(A) OPERAND CHAR. ADJ.	(A) OPERAND IND. (27)	(B) OPERAND ADDRESS (28)	(B) OPERAND ± (34)	(B) OPERAND CHAR. ADJ.	(B) OPERAND IND. (38)	d (39)	COMMENTS (40 55)
010													
020													
030													
040													
050													
060													
070													
080													
090													
100													
110													
120													
130													
140													
150													
160													
170													
180													
190													
200													

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MACHINE ORIENTED LANGUAGE: AUTOCODER

§ 172.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 Autocoder, Version 3.

.12 Origin: . . . . . IBM General Products Division, Applied Programming.

.13 Reference: . . . . . IBM Publication J24-1434; 1401 Program Library File No. 1401-AU-037.

.14 Description:

Autocoder is a more powerful machine-oriented language than the basic Symbolic Programming System. It provides macro-instructions, literals, library routines, and a free-form coding sheet that simplifies programming, but requires at least 4 magnetic tape units and 4,000 positions of core storage on the translating 1401 system. As in SPS, there is a general one-to-one correspondence between source statements and machine language instructions. Through the use of macros, however, the programmer can call and cue open or closed library routines at will, thereby greatly reducing coding time and effort. User-defined macros can easily be inserted into the library.

The Autocoder language is not directly compatible with SPS, but the Autocoder translator can translate source programs coded in either language or in a combination of the two. Compatibility between IBM 1401 and 1410 systems is provided by the fact that the 1401 Autocoder language is essentially a subset of the 1410 Autocoder language. This means that programs coded in 1401 Autocoder can be translated and run on a 1410 system after relatively minor modifications, mainly to the input-output operations.

The 1401 Input/Output Control System is a supplement to Autocoder. It consists of additional control and macro operations that handle reading and writing, tape blocking and unblocking, file labeling, and error checking. Characteristics of the overall program, the object system, and each record file must be included in the source program in the form of a series of descriptive cards preceded by a header card.

Additional input-output control and macro operations are available for the following:

- Direct Data Channel routines for: Program detection of read request or write requests, error detection and corrections, system to system read-write, output scheduling, coordination with other Input-Output Control System programs in either system, and scheduling Direct Data Channel routines for each system.
- 1311 Disk Storage Drive routines for: Input-output operations associated with punched cards, magnetic tape, printer and 1311 Disk Storage. These routines provide facilities for blocking and unblocking, together with the associated macro instructions, GET, PUT, OPEN, and CLOSE, as well as standardized routines for input-output error correction, end-of-file and labeling.

.14 Description (Contd.)

.15 Publication Date: . . . Version 3, October, 1961.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . Refer to Autocoder coding sheet, 401:172.081.

.22 Legend

Line:	sequences entries on coding sheet.
Label:	names an area or instruction.
Operation:	defines operation to be performed, in either mnemonic or machine code.
Operand:	actual or symbolic addresses of data to be operated upon with specification of indexing or relative addressing, address constants, literals and/ or comments.

.23 Corrections: . . . . . spare lines on coding sheet and gaps in sequence numbers.

.24 Special Conventions

.241 Compound addresses: .	BASE + ADJUSTMENT, where BASE is any label and ADJUSTMENT is a decimal integer.
.242 Multi-addresses: . . .	in pseudos & macros only.
.243 Literals	
Numeric:	preceded by +or - sign.
Alphameric:	preceded and followed by @.
All:	total operand length may not exceed 52 characters.
.244 Special coded addresses:	* refers to low-order position of instruction in which it appears.

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.245 Other
Actual core storage address: . . . . . 1 to 5 decimal digits.
Address constants: . . + or - preceding label of item whose address is to be used as an operand.

.3 LABELS

.31 General

.311 Maximum number of labels per translator iteration

Core storage positions	Maximum labels
4,000	150
8,000	510
12,000	870
16,000	1,270

.312 Common label formation rule: . . . . . yes.
.313 Reserved labels
For basic macros: . . CHA, MAD, TOV, OVL, CAL, INC, DIO, DTF, GET, PUT, OPE, CLO, DCL, FEO, RDL, REL, SPA, STA.
.314 Other restrictions: . . none.
.315 Designators: . . . . . none.
.316 Synonyms permitted: . yes; EQU pseudo.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . mandatory if referenced by other instructions.
Formation rule
First character: . . alphabetic.
Others: . . . . . alphabetic or numeric (no special characters).
Number of characters: 1 to 6.
.322 Labels for library routines
Existence: . . . . . mandatory.
Formation rule
First character: alphabetic.
Others: . . . . . alphameric (no special characters).
Number of characters: . . . . . 5 (no two routines may have the same first 3 characters.
.323 Labels for constants: . same as Procedures.
.324 Labels for files: . . . . same as Procedures (with IOCS only).
.325 Labels for records: . . same as Procedures.
.326 Labels for variable: . . same as Procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants
Numeric: . . . . . 52 char.
Alphabetic: . . . . . 50 char, preceded & followed by @ .
Alphameric: . . . . . 50 char, preceded & followed by @ .
.412 Maximum size literals: 52 char total operand length.

.42 Working Areas

.421 Data layout
Implied by use: . . . no.
Specified in program: yes.
.422 Data type: . . . . . not required.
.423 Redefinition: . . . . . yes; EQU pseudo.

.43 Input-Output Areas

.431 Data layout: . . . . . explicit layout.
.432 Data type: . . . . . not required.
.433 Copy layout: . . . . . yes.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . alternative to absolute.
Number: . . . . . 95.
Example: . . . . . R = read a card.
.512 Absolute
Existence: . . . . . alternative to mnemonic.
Number: . . . . . 38 (many variations through "d" modifier).
Example: . . . . . 1 = read a card.
Comment: . . . . . punch op. code in column 19 & d modifier in column 20.

.52 Macro-Codes

.521 Number available
Input-output: . . . . . 8.
Arithmetic: . . . . . none.
Math functions: . . . none.
Error control: . . . . none.
Restarts: . . . . . none.
Subroutine call and cue: . . . . . 2.
Overlay control: . . . 2.
Chaining of instructions: . . . . . 1.
Address modification: 1.
.522 Examples
Simple: . . . . . CALL SQRO1.
Elaborate: . . . . . CALL SUBO1, DATA1, DATA2, DATA3.
.523 New macros: . . . . . inserted into library in separate run.

.53 Interludes: . . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . pseudo operations.
Label adjustment: . . pseudo operations.
Annotation: . . . . . special cards.

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.542 Allocation counter
- Set to absolute: . . . ORG, LTORG pseudos.
- Set to label: . . . . . ORG pseudo.
- Step forward: . . . . ORG pseudo.
- Step backward: . . . ORG pseudo.
- Reserve area: . . . . DS pseudo.

.543 Label adjustment
- Set labels equal: . . . EQU pseudo.
- Set absolute value: . . EQU pseudo.
- Clear label table: . . no.

.544 Annotation
- Comment phrase: . . COMMENT card (* in column 6).
- Title phrase: . . . . JOB card.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic

.611 Facilities: . . . . . multiply.
divide.
floating point arithmetic.

.612 Method of call: . . . . macros.

.62 Special Functions

.621 Facilities: . . . . . square root.
sin-cos.

.622 Method of call: . . . . macros.

.63 Overlay Control

.631 Facilities: . . . . . OVLAY & TOVLY macros clear storage and load next program section from cards or tape.

.632 Method of call: . . . . . macros.

.64 Data Editing

.641 Radix conversion: . . none.
Code translation: . . . none.

.642 Format control: . . . . not required due to hardware editing capability.

.65 Input-Output Control

.651 File labels: . . . . . }
.652 Reel labels: . . . . . } Input-Output Control
.653 Blocking: . . . . . } System.
.654 Error control: . . . . . }

.655 Method of call: . . . . macros.

.66 Sorting

.661 Facilities: . . . . . none.

.67 Diagnostics

.671 Dumps: . . . . . linkages to fixed or selective core storage printout routines may be inserted and removed by special routines.

.672 Tracers: . . . . . none.

.673 Snapshots: . . . . . see .671.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . 1401 Autocoder Library, included in system tape.

.72 Kinds of Libraries

.721 Fixed master: . . . . no.
.722 Expandable master: . . yes.
.723 Private: . . . . . private facilities may be added to master library.

.73 Storage Form: . . . . . tape (supplied on cards for transcription to tape).

.74 Varieties of Contents: supplied with 6 basic macros; Input-Output Control System and other facilities desired by user may be added.

.75 Mechanism

.751 Insertion of new item: special library run.
.752 Language of new item: 1401 Autocoder.
.753 Method of call: . . . . . CALL or INCLD macro.

.76 Insertion in Program

.761 Open routines exist: . . yes; user-defined macros.
.762 Closed routines exist: . yes; CALL or INCLD macros.
.763 Open-closed is optional: no.
.764 Closed routines appear once: . . . . . yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
CALL:	sets up linkage to a closed library routine and (once only) inserts it in program.
INCLD:	inserts an inflexible library routine without linkage.
CHAIN:	facilitates coding of chained instructions.
OVLAY:	prepares storage and loads an overlay from cards.
IOVLY:	prepares storage and loads an overlay from tape.
MA:	facilitates coding of address modifications without indexing.
User-defined macro:	causes an open library routine to be inserted directly into the program.
OPEN:	initializes a tape or card file.
CLOSE:	deactivates a file, with rewind if desired.
GET:	locates a single record for processing, from either a blocked or unblocked file.
PUT:	inserts a processed record into an output file.

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.81 Macros (Contd.)

Code	Description
RELSE:	causes next GET or PUT to refer to next block in the file.
FEORL:	initiates end-of-reel routine.
DCLOS:	deactivates the tape used for dumping uncorrectable blocks.
RDLIN:	causes cards to be read at object time to modify tape labels.

.82 Pseudos

Code	Description
JOB:	identifies program deck or tape & prints headings on listing.
CTL:	specifies storage sizes of translating & target systems and type of translator output desired.
ORG:	sets address allocation counter.
LTORG:	assigns storage locations to previously encountered literals & closed library routines.
EX:	causes a temporary halt in loading of the object program, and execution of the portion just loaded.
XFR:	same as EX, except that literals & closed library routines are not stored.
END:	indicates end of source program; can initiate execution of object program immediately after loading.

.82 Pseudos (Contd.)

Code	Description
ALTER:	permits additions, deletions, & substitutions in the object program after original assembly.
DELET:	deletes all or part of a routine from the library tape.
INSER:	inserts a whole or partial routine into the library tape.
PRINT:	provides listing of a specified library routine.
PUNCH:	provides listing and punched deck for a specified library routine.
REPET:	copies library portion of the system tape.
DA:	defines an area of core storage and the lengths, names, and relative positions of the fields within it.
DCW:	loads a constant and sets word mark in high-order position.
DC:	loads a constant without word mark.
DS:	by-passes and labels an area of storage.
DSA:	stores a constant equivalent to the machine address assigned to a specific label.
EQU:	assigns a label to an actual or symbolic address.
DIOCS:	precedes a series of cards describing characteristics of the program and the target computer.
DTF:	precedes a series of cards describing a specific file.

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FORM X24-1350-1
PRINTED IN U.S.A.

Program _____

Programmed by _____

Date _____

1401/1410 AUTOCODER CODING SHEET

Identification ____ (76–80)

Page No. __ (1–2) of ____

Line (3–5)	Label (6–15)	Operation (16–20)	OPERAND (21–70)
0,1			
0,2			
0,3			
0,4			
0,5			
0,6			
0,7			
0,8			
0,9			
1,0			
1,1			
1,2			
1,3			
1,4			
1,5			
1,6			
1,7			
1,8			
1,9			
2,0			
2,1			
2,2			
2,3			
2,4			
2,5			

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PROGRAM TRANSLATOR: SYMBOLIC PROGRAMMING SYSTEMS

§ 181.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 Symbolic Programming Systems. SPS-1 & SPS-2.

.12 Description:

Both of the SPS translators are designed for punched card input-output, and both normally require 4 card passes (or 5 if a condensed object program deck is desired). SPS-1 will operate on a 1401 card system with the minimum 1,400 positions of core storage. The object programs it assembles cannot be run on 1401 systems with more than 4,000 storage positions. SPS-2 requires at least 4,000 storage positions in the translating system and can assemble programs for any 1401 system configuration. The number of labels that can be processed per translator iteration depends upon the translating system's core storage capacity. Because of the strict one-to-one correspondence of SPS statements to 1401 machine language instructions, the object program will require the same storage space and operating time as a hand-coded program.

The 1401 Program Library contains several user-developed revisions of the SPS-2 translator utilizing tape passes rather than card passes. These programs will effectively speed up the time required for translation; however, they require from one to three magnetic tape units (depending on the program used) in addition to the minimum configuration requirements. For additional information about these programs refer to the 1401 Program Library Abstracts. Since these programs require expanded 1401 systems to operate, the remainder of this report is devoted to the card system translators.

.13 Originator: . . . . . IBM General Products Division, 1401 Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability:

Dates of general issue for current versions:
SPS-1: . . . . . October, 1960.
SPS-2: . . . . . August, 1961.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 1401 SPS Language.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards.
.222 Obligatory ordering: . . must be in correct sequence according to coding sheet page and line numbers.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage size.
.232 Maximum size source statements: . . . . . 55 characters per card.
.233 Maximum number of data items: . . . . . see next entry.
.234 Others
Maximum number of labels per translator iteration:

Core storage positions	Translator	Maximum labels
1,400	SPS-1	40
2,000	SPS-1	100
4,000	SPS-1	300
4,000	SPS-2	260
8,000	SPS-2	660
12,000	SPS-2	1,060
16,000	SPS-2	1,460

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . . IBM 1401 machine language.
.312 Language style: . . . . . machine.
.313 Output media: . . . . . punched cards; 1 instruction per card. Condensing Program prepares condensed deck containing up to 7 instructions or 38 characters per card, whichever is reached first; its input is the SPS object deck.

.32 Conventions

.321 Standard inclusions: . . none.

.33 Documentation

Subject	Provision
Source program: . . .	pre-process listing routine.
Object program:	post-process listing routine.
Storage map:	post-process listing routine.
Restart point list: . . .	none.
Language errors: . . .	pre-process listing routine.

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.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Pre-process listing: . . lists source program & checks it for errors.
Pass 1: . . . . . prepares table of labels & assigns addresses to them.
Pass 2: . . . . . processes operands & punches object deck.
Post-process listing: . . lists source & object programs & notes undefined symbols.

.42 Optional Modes

.421 Translate:. . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . yes (pre-process listing).
.424 Patching: . . . . . no (must re-assemble).
.425 Up-dating:. . . . . no (must re-assemble).

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . no.
.433 Short translate on restricted program: . . . no.

.44 Bulk Translating: . . . . no.

.45 Program Diagnostics:. . none.

.46 Translator Library: . . none (required routines must be manually inserted into program deck).

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead:. . . . . none.
.512 Space required for each input-output file: . . . variable.
.513 Approximate expansion of procedures:. 1.0

.52 Translation Time

.521 Normal translating:. . . 4.0 + 0.015S min.
.522 Checking only: . . . . . 1.0 + 0.003S min. (for pre-process listing).

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . unaffected.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration
SPS-1: . . . . . 1401 Processing Unit with 1,400 core storage positions; 1402 Card Read-Punch; 1403 Printer; no optional features.
SPS-2: . . . . . As above, except 4K minimum core storage.

.612 Larger configuration advantages: . . . . . larger core storage handles more labels per iteration (see .234).

.62 Target Computer

.621 Minimum configuration:. no limitations.
.622 Usable extra facilities
SPS-1: . . . . . 4K is maximum core storage size; otherwise all facilities are usable.
SPS-2: . . . . . all facilities are usable.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	sequence check	noted in listing.
Duplicate names:	none.	
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	none.	
Inconsistent program:	none.	
Undefined names:	check	### inserted as address.
Illegal operation code:	check	noted in listing.

.8 ALTERNATIVE TRANSLATORS

Computer	Identity	Date	Comment
IBM 704:	704 Assembly of 1401 SPS Programs	available now	1401 Program Library File No. 13.2.001.

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PROGRAM TRANSLATOR: AUTOCODER

§ 182.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 Autocoder, Version 3. Autocoder.

.12 Description:

Operation of the Autocoder translator requires at least 4,000 core storage positions, 4 magnetic tape units, card reader-punch, printer, and the Advanced Programming and High-Low-Equal Compare features. Larger core storage sizes speed up the translation by permitting longer tape blocks and the processing of more labels per translator iteration. Input may be from either punched cards or tape, and the object program may be in the form of a condensed card deck and/or a loadable tape. The translator will accommodate source programs in either the Autocoder or SPS languages or a combination of the two.

The Input-Output Control System is a supplement to Autocoder that effectively eliminates the need for detailed programming of standardized input and output routines. By using a few macro instructions, routines for reading and writing blocked and unblocked records, packing and unpacking blocked records, file labeling, and checking and preparing magnetic tape (including record count checking, error checking, and correction) are available. Autocoder will generate only the Control System routines necessary to service the requirements of the job according to the detailed information supplied from the control card entries. The manufacturer has estimated that the generated input-output routines require approximately 5 percent more core storage than programmer-created machine oriented language coding.

Input-Output Control System macro instructions provide linkages to two basic procedures: the OPEN-CLOSE subroutine and the GET-PUT subroutine. The OPEN-CLOSE routines check and write IBM 1401 standard front and end of label records; for multi-reel files, they automatically process end-of-reel records, provide for automatically alternating tape units, and enter the label-record at the beginning of the new reel.

The GET-PUT routine reads or writes, blocks or unblocks files, and provides error checking routines.

The routines generate for the Input-Output Control System appear only once for a file regardless of the number of different places in a program they are referred to. The housekeeping subroutine (i.e., GET, PUT, OPEN, or CLOSE) which performs the same functions for different data files appears only once for each file. Some of the error routines may be shared by more than one data file.

.12 Description (Contd.)

.13 Originator: . . . . . IBM General Products Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . Version 3 released in October, 1961.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 1401 Autocoder or SPS language or a combination of the two.

.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards or card images on magnetic tape.

.222 Obligatory ordering: . must be in correct sequence according to coding sheet page and line numbers.

.223 Obligatory grouping: . none.

.23 Size Limitations

.231 Maximum number of source statements: . limited by target computer storage capacity.

.232 Maximum size source statements: . . . . . 72 characters per card.

.233 Maximum number of data items: . . . . . see next entry.

.234 Others

Maximum number of labels per translator iteration

Core storage positions	Maximum labels
4,000:	150
8,000:	510
12,000:	870
16,000:	1,270

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 1401 machine language.

.312 Language style: . . . . machine.

.313 Output media: . . . . . punched cards and/or magnetic tape.

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.32 Conventions

.321 Standard inclusions: . . Input/Output Control System is generally included.
.322 Compatible with: . . . 1401 Autocoder Library.

.33 Documentation

Subject	Provision
Source program:	. . . listing.
Object program:	. . . listing.
Storage map:	. . . . . none.
Restart point list:	. . none.
Language errors:	. . listing & messages during assembly.
Label table:	. . . . . listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Pass 1:	. . . . . handles additions, deletions, or alterations to the library if required.
Pass 2:	. . . . . reads source program; processes macros and pseudos.
Pass 3:	. . . . . converts mnemonic operation codes to machine language and fixed form (SPS) statements to Autocoder format.
Pass 4:	. . . . . converts literals to constants and assigns relative addresses to all data.
Pass 5:	. . . . . assigns actual addresses to as many labels as can be handled.
Pass 6:	. . . . . processes all operands, lists symbol table on the printer, and transfers control back to pass 5 if more labels must be processed.
Pass 7:	. . . . . prints combined listing of source and object programs with error messages; punches condensed, self-loading deck if desired.
Pass 8:	. . . . . produces loadable object program tape and/or re-sequenced source program deck.

.42 Optional Modes

.421 Translate: . . . . . yes.
.422 Translate and run: . . no.
.423 Check only: . . . . . no.
.424 Patching: . . . . . begin with pass 4.
.425 Up-dating: . . . . . begin with pass 4.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . no.
.433 Short translate on restricted program: . . no.

.44 Bulk Translating: . . . no.

.45 Program Diagnostics: . none in basic system; can be inserted into library.

.46 Translator Library

.461 Identity: . . . . . 1401 Autocoder Library.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . tape (on Autocoder system tape).
Organization: . . . . card images, in alphabetical order by routine name.
.464 Contents
Routines: . . . . . open and closed.
Functions: . . . . . yes.
Data Descriptions: . in IOCS entries.
.465 Librarianship
Insertion: . . . . . during special library run.
Amendment: . . . . . during special library run.
Open routines: . . . . inserted whenever cued by specific macro instructions.
Closed routines: . . . CALL or INCLD macro with name of routine as operand; CALL also generates subroutine linkages.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
IOCS	variable	depends upon facilities used; 1900 positions exclusive of input-output areas for typical program with card input and blocked tape output.

.512 Space required for each input-output file: . . . same as block length.
.513 Approximate expansion of procedures: . . . . . 1.0, exclusive of macros.

.52 Translation Time

.521 Normal translating: . . . 0.009S minutes for 10,000-statement program on 16K translating computer with 729IV tapes. Smaller core store or slower tapes will increase translation time.

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . unaffected.

§ 182.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration:. 1401 Processing Unit with 4,000 core storage positions.
4 Magnetic Tape Units, model 729II, 729IV, 729V, or 7330.
1402 Card Read-Punch.
1403 Printer, Model 2.
Advanced Programming feature.
High-Low-Equal Compare feature.

.612 Larger configuration advantages: . . . . . larger core storage handles longer blocks and more labels per iteration; fifth tape unit permits stacked program output.

.62 Target Computer

.621 Minimum configuration:. no limitations.
.622 Usable extra facilities: . all facilities.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	none.	
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	check	noted in listing.
Inconsistent program:	none.	
Undefined names:	check	noted in listing.

.8 ALTERNATIVE TRANSLATORS: . . . none available.

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PROGRAM TRANSLATOR: COBOL (4K)

§ 183.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 COBOL (4K). Program 1401-CB-070.

.12 Description

The 1401 COBOL 4K Processor converts source programs written in IBM 1401 COBOL (Section 401:161) into 1401 Autocoder programs. The Autocoder programs are, in turn, converted to 1401 machine language object programs in a separate run by the 1401 Autocoder translator, described in Section 401:182.

The translating 1401 must have a minimum of 4,000 core storage positions, 4 magnetic tape units, a 1402 Card Read-Punch, a 1403 Model 2 Printer, and the Advanced Programming, High-Low-Equal Compare, and Sense Switches features. The Print Storage and Read Punch Release features can be utilized to speed up compilation if available. A fifth magnetic tape unit is required if a listing of the COBOL source statements followed by their Autocoder expansions is desired.

The 1401 used to run COBOL-coded object programs must have the Advanced Programming, High-Low-Equal Compare, and Sense Switches features. The Multiply-Divide feature is required if the source program contains any multiplication, division, or exponentiation. The Print Storage and Processing Overlap features are not required, but can be utilized if available.

In addition to the IOCS (Input-Output Control System) macro instructions, 17 COBOL Subroutines must be inserted into the 1401 Autocoder Library before the Autocoder system is used to process the COBOL translator's output. The closed COBOL subroutines range from 137 to 1,800 characters in length, and each is called when a particular language facility is used in the source program. As an example, use of the DISPLAY verb necessitates the inclusion of a 526-character subroutine in the object program. Because even the largest 1401 has only 16,000 positions of core storage, and because 1401 COBOL object programs cannot be segmented, the programmer should try to avoid particularly the use of those language facilities that require the inclusion of the larger COBOL subroutines. The subroutines, their lengths, and the reasons they are called are listed in Paragraph 401:183.511.

The COBOL Processor checks for a variety of source program errors and prints a diagnostic message whenever one is found. Compilation is halted upon

.12 Description (Contd.)

detection of a "critical" error (i.e., one that makes further attempts at compilation impractical). Critical errors will usually be detected during the first few minutes of the compilation process. A printed "Cobol Dictionary" lists each COBOL data-name, procedure-name, and special-name; the sequence number of the card on which it first appears; and the condensed Autocoder name by which it can be identified in the symbolic program listing.

.13 Originator: . . . . . General Products Division, IBM Corporation.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . released for general use November 30, 1962; modification letters 1 and 2 dated January 22 and February 26, 1963.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 1401 COBOL.
.212 Exemptions: . . . . . see "Deficiencies with respect to Required COBOL 61" in Paragraph 401:161.14.

.22 Form

.221 Input media: . . . . . punched cards.
.222 Obligatory ordering: . . COBOL RUN card.
Identification Division.
Environment Division.
Data Division.
Procedure Division.
.223 Obligatory grouping: . . by division, section, and paragraph.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage.
.232 Maximum size source statements: . . . . . not specified.
.233 Maximum number of data items: . . . . . practically unlimited.
.234 Others
Maximum record length (tape): . . . . 999 characters.
Maximum block length (tape): . . . . limited by target computer storage.
Maximum computational item size: . . 18 digits.
Maximum alphameric literal size: . . . . . 120 characters.

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§ 183.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 1401 Autocoder.
.312 Language style: . . . . symbolic (converted to final machine language program by the 1401 Autocoder translator; see Section 401:182).
.313 Output media: . . . . . magnetic tape and/or punched cards.

.32 Conventions

.321 Standard inclusions: . . none.
.322 Compatible with: . . . . IBM 1401 Input-Output Control System (IOCS) and 4K COBOL Subroutines; both must be included as part of the 1401 Autocoder system tape used.

.33 Documentation

Subject	Provision
Source program:	listing.
Object program:	optional listing. †
Storage map:	none.
Restart point list: . . .	none.
Language errors: . . .	messages in listing.
Dictionary:	listing (shows COBOL-name to Autocoder-name relationships).

† Optional listing of the COBOL source statements followed by their Autocoder expansions can be produced, but requires a fifth magnetic tape unit. A symbolic object program listing is also produced by the Autocoder translator.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

The 1401 COBOL 4K Processor consists of 10 logical segments, and each segment contains from 3 to 20 separate phases. The main functions of each segment can be summarized as follows:

Segment A: Reads source deck, assigns sequence numbers, lists card-images on the printer, processes the Identification Division, compresses key words, and eliminates "noise" (non-required) words.

Segment B: Prints syntax diagnostics and suspends compilation if necessary, compresses data and procedure names, and produces dictionary of COBOL names and their corresponding Autocoder counter parts.

Segment C: Processes SPECIAL-NAMES paragraph and condition-names (level 88 data entries).

Segment D: Analyzes PICTURE clauses, builds an internal description for each data entity, prints data description diagnostics, generates edit masks, and outputs storage reservation entries.

.41 Phases and Passes (Contd.)

Segment E: Analyzes input-output entries, generates IOCS descriptions, and prints input-output diagnostics.

Segment F: Processes portions of the Procedure Division.

Segment G: Converts the COBOL arithmetic, MOVE, PERFORM and READ procedural statements to macro form; processes arithmetic and comparison operators, and optimizes arithmetic statements by eliminating unnecessary temporary storage locations.

Segment H: Converts data, equipment, program switch, and literal descriptions to table entries; processes subscripts; and merges data descriptions after Procedure Division names.

Segment I: Generates procedural macros, selects appropriate library routines, and prints arithmetic and relational diagnostics.

Segment J: Substitutes proper parameters into model statements from library, sets up subroutine linkages, arranges Autocoder program in proper sequence and outputs it, and (if requested) merges source and Autocoder statements for optional source-symbolic listing.

.42 Optional Mode

.421 Translate: . . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . no; but translation halts upon detection of a "critical" error.
.424 Patching: . . . . . no.
.425 Up-dating: . . . . . no.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . no.
.433 Short translate on restricted program: . no.

.44 Bulk Translating: . . . possible for the COBOL-to-Autocoder phase, but not for the entire translation process.

.45 Program Diagnostics: . none.

.46 Translator Library: . . none in COBOL-to-Autocoder phase; but see 1401 Autocoder Library, Paragraph 401:182.46.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . required COBOL subroutines may occupy up to 6,770 core storage positions depending upon language facilities used in the source program; see table.

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COBOL SUBROUTINES

Name	Approximate Length (chars)	Reason Subroutine is Called
Accept	265	Use of ACCEPT verb.
Display	526	Use of DISPLAY verb.
Go To Depending	137	Use of GO TO . . . DEPENDING.
Subscript 1	185	Use of one-level subscripting.
Subscript 2	230	Use of two-level subscripting.
Subscript 3	276	Use of three-level subscripting.
Alpha Compare	663	Comparison involving alphabetic group item.
Compare FIGCON	445	Comparison of group item to figurative constant with $SIZE greater than 1.
If Numeric	148	Use of IF NUMERIC on item with SIZE greater than 1.
If Alphabetic	176	Use of IF ALPHABETIC on item with SIZE greater than 1.
Move ALL	289	Filling a group item with a figurative constant.
Editing	347	Use of COBOL zeros, floating + or - sign, or DB.
Move Field to Record	324	Moving group item to a record of unequal length.
Exponentiation	500	Use of an integer exponent.
Exponentiation	1,800	Use of a non-integer exponent.
Examine	375	Use of EXAMINE verb.
Index	86	Use of any other COBOL Subroutine except DISPLAY.

.512 Space required for each input-output file: . . . same as maximum block length, except doubled when "1 ALTERNATE AREA" is specified.

.513 Approximate expansion of procedures: . . . . ?

.52 Translation Time: . . . ?

.53 Optimizing Data

Explicit:

- Storage sizes and optional features of both the translating and target computers are specified in the SOURCE-COMPUTER and OBJECT-COMPUTER paragraphs of the environment division.
- One alternate input-output area can be specified for magnetic tape files only if the Processing Overlap feature is available.
- Magnetic tape records may be of variable length.

Implicit:

- Avoid use of the source language facilities that require the presence of the larger COBOL Subroutines (see 401:183.511).
- Do not compute anything within each pass through a PERFORM loop that can just as well be computed only once, before entering the loop.
- Do not compute the same sub-expression within two or more different COMPUTE statements if the practice can be avoided by evaluating the sub-expression in a separate statement.
- Check input data for reasonability.

.53 Optimizing Data (Contd.)

Automatic:

- Arithmetic statements are optimized by eliminating unnecessary temporary storage locations.
- Because of the 1401's alphameric, variable word length mode of operation, conversions between the DISPLAY and COMPUTATIONAL modes are not required.

.54 Object Program Performance: . . . . . ?

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 1401 Processing Unit with 4,000 core storage positions.
1402 Card Read-Punch.
1403 Model 2 Printer.
4 Magnetic Tape Units.
Advanced Programming feature.
High-Low-Equal Compare feature.
Sense Switches feature.

.612 Larger configuration advantages: . . . . . larger core store speeds compilation.
fifth tape unit permits listing of source and symbolic statements.
Read Punch Release and/or Print Storage features speed compilation.

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.62 Target Computer

.621 Minimum configuration: 1401 Processing Unit with sufficient storage to hold object program, data, and subroutines.
Advanced Programming feature.
High-Low-Equal Compare feature.
Sense Switches feature.
Multiply-Divide feature (if source program calls for multiplication, division, or exponentiation.)

.622 Usable extra facilities: up to 16,000 core storage positions.
1402 Card Read-Punch.
1403 Printer.
up to 6 Magnetic Tape Units.
Print Storage feature.
Processing Overlap feature.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	checks	print message.
Unsequenced entries:	checks	print message.
Improper format:	checks	print message.
Incomplete entries:	checks	print message.
Target computer overflow:	check by Autocoder translator.	
Inconsistent program:	checks	print message.
Excessive item size:	checks	print message.
Data description conflict:	checks	print message.
Invalid editing:	checks	print message.
Invalid subscripting:	checks	print message.
Class contradiction:	checks	print message.

Note: When a "critical" error is detected, compilation is halted.

.8 ALTERNATIVE TRANSLATOR: . . . . IBM 1401 COBOL (12K-16K); see Section 401:184.

PROGRAM TRANSLATOR: FORTRAN

§ 185.

.1 GENERAL

.11 Identity: . . . . . IBM 1401 FORTRAN. Program 1401-FO-050, Version 2.

.12 Description

This translator permits utilization of all the facilities of the IBM 1401 FORTRAN language, which is basically FORTRAN I and is described in Section 401:162. No magnetic tape units are required for translation or for object program execution, but tape units can be utilized in either phase when available. The minimum facilities required in both the translating and target 1401 systems are 8,000 core storage positions, a card read-punch and printer, plus the Advanced Programming, High-Low-Equal Compare, and Multiply-Divide features. Core stores consisting of 12,000 or 16,000 positions can be fully utilized, and are virtually mandatory when FORTRAN programs of any appreciable size or complexity are contemplated.

Translation of the FORTRAN source program to a machine language object program is performed in a single pass of the compiler program, which may be stored on either punched cards or magnetic tape. The source program is loaded into core storage from punched cards. Then the 63 logical phases of the compiler are loaded and executed, one at a time, causing a gradual transformation within core storage of the source statements to an object program that consists of generated 1401 instructions, list and format strings, and constants. Arithmetic statements are translated into strings of operand addresses and operation codes which are to be executed interpretively. At the end of the translation process, the object program and all necessary subroutines are present in core storage, ready for immediate execution. A condensed object program deck and its listing will be punched and printed if requested.

All floating point arithmetic, input-output operations, and format conversions are performed by standard subroutines, which occupy a total of 3,500 character positions of storage in the object program. Input-output and arithmetic work areas and a "snapshot" routine that permits core storage dumps occupy an additional 700 storage positions. Nine standard library functions and six "processing" routines, which are included only when required by specific source program operations, occupy a total of up to 2,526 storage positions. The obvious conclusion is that, in an 8K 1401, very little storage space is likely to be available for the generated object program and the data it is to process. The manufacturer states that the total number of generated object program characters (exclusive of subroutines) will, in general, be less than twice the number of characters in the source program. Emphasis is placed on efficient use of storage rather than on minimizing object program execution speed.

.12 Description (Contd.)

Checks are made for source program errors, and a diagnostic message is printed whenever an error is detected. Translation will then continue when possible. Errors at execution time result either in system halts with error code displays (for input-output, data format, or subscript errors) or in printed messages and continuation of program execution with incorrect but predictable results (for arithmetic errors).

.13 Originator: . . . . . General Products Division, IBM Corporation.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . Version 1 - December 1961. Version 2 - December 1962.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 1401 FORTRAN.
.212 Exemptions: . . . . . none, but note language limitations in Section 401:162.14.

.22 Form

.221 Input media: . . . . . punched cards.
.222 Obligatory ordering: . . all statements in correct logical sequence, preceded by a control card.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by core storage capacity.
.232 Maximum size source statements: . . . . . 660 characters.
.233 Maximum number of data items: . . . . . limited by core storage capacity.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 1401 machine language.
.312 Language style: . . . . condensed, non-relocatable card deck.
.313 Output media: . . . . . punched cards; program is also retained in core storage for immediate execution.

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§ 185.

.32 Conventions

.321 Standard inclusions: . . arithmetic, input-output, format, and snapshot routines.

.33 Documentation

Subject	Provision
Source program:	listing.
Object program:	optional listing in form of core storage dump.
Storage map:	listing.
Restart point list: . . .	none.
Language errors: . . .	listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

The 1401 FORTRAN system is a one-pass compiler. First the source program is read into core storage. Then the compiler (on either punched cards or magnetic tape) is loaded and executed, one phase at a time, gradually transforming the source statements into a 1401 machine language object program. When the end of the compiler deck (or tape) is reached, the compilation is complete. The compiler consists of 63 logical phases, beginning with a system monitor that initiates loading and execution of each succeeding phase, and ending with insertion of the standard closed arithmetic subroutines that are always included in the object program.

.42 Optional Mode

.421	Translate:	yes.
.422	Translate and run: . . .	yes.
.423	Check only:	no.
.424	Patching:	no.
.425	Up-dating:	no.

.43 Special Features

.431	Alter to check only: . .	no.
.432	Fast unoptimized translate:	no.
.433	Short translate on restricted program: .	no.

.44 Bulk Translating: . . . no.

.45 Program Diagnostics

.451	Tracers:	none.
.452	Snapshots:	none.
.453	Dumps:	a printout of the contents of core storage can be produced at any halt encountered during object program execution by transferring control to the "snapshot" program, which is always present in core storage.

.46 Translator Library

.461	Identity:	1401 FORTRAN function library.
.462	User restriction: . . .	none.

.463 Form

Storage medium: . . .	punched cards or magnetic tape.
Organization:	relocatable machine language, assembled from 1401 Autocoder language.

.464 Contents

Routines:	standard arithmetic, input-output, format, and snapshot routines.
Functions:	9 standard plus up to 12 user-defined.
Data descriptions: . .	none.

.465 Librarianship

Insertion:	must be manually inserted into system deck, which can then be transcribed to tape.
Amendment:	same as insertion.
Call procedure: . . .	use of a function name in an arithmetic statement causes inclusion of the appropriate closed subroutine.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space
Input-output and arithmetic work area:	333 characters.
Snapshot program: .	367 characters.
Arithmetic, input-output, and format routines:	3,500 characters.

Note: The 9 standard library functions and 6 "processing" routines, which are included only when required, occupy a maximum of 2,526 additional character positions.

.512 Space required for each input-output file: . . . single input-output area serves all files.

.513 Approximate expansion of procedures: . . . . total number of generated object program characters (in-line procedures, list and format strings, constants, and subscripting parameters) will not exceed twice the number of characters in the source program (**).

§ 185.

.52 Translation Time

.521 Normal translating (exclusive of object program punchout and listing)

Card version: . . . . approximately 3 minutes; time is essentially independent of program size (**).

Tape version: . . . . 0.25 + 0.012S minutes, where S is number of source program cards, using a 729 IV tape unit (**).

(**) Estimate by the manufacturer.

.53 Optimizing Data

.531 Explicit:

EQUIVALENCE statement reduces data storage requirements by causing locations to be shared by two or more variables within a program.

Floating and fixed point data representation can be preset to the minimum required precision, thereby minimizing both storage requirements and execution time.

.532 Implicit:

Keep subscript expressions as simple as possible.

Do not compute anything within a DO loop that can just as well be computed before entering the loop.

Do not compute the same sub-expression more than once if the practice can be avoided by evaluating the sub-expression in a separate arithmetic statement.

Check input data for reasonability.

Use successive multiplications rather than exponentiation to develop squares and cubes.

.533 Automatic:

Generated strings of arithmetic operations are reorganized to minimize the required number of temporary storage areas.

Duplicate lists appearing in input-output statements are eliminated to minimize object program space requirements.

.54 Object Program Performance: . . . . . no conclusive data available.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 1401 Processing Unit with 8,000 core storage positions.
1402 Card Read-Punch.
1403 Printer (Model 1 or 2).
Advanced Programming feature.
High-Low-Equal Compare feature.
Multiply-Divide feature.

.612 Larger configuration advantages: . . . . . 1 Magnetic Tape Unit can speed compilation by replacing the card reader in containing the FORTRAN compiler.
More core storage can be utilized when available.
Sense Switches can control compiler output options.

.62 Target Computer

.621 Minimum configuration: 1401 Processing Unit with 8,000 core storage positions.
1402 Card Read-Punch.
1403 Printer (Model 1 or 2).
Advanced Programming feature.
High-Low-Equal Compare feature.
Multiply-Divide feature.

.622 Usable extra facilities: 729 or 7330 Magnetic Tape Units.
More core storage.
Sense Switches feature.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	checks	print message.
Unsequenced entries:	none.	
Duplicate names:	checks	print message.
Improper format:	checks	print message.
Incomplete entries:	checks	print message.
Target computer overflow:	check	print message.
Mixed arithmetic:	check	print message.
Undefined names:	checks	print message.
Unreferenced names:	checks	print message.
Illegal subscripts:	checks	print message.

Note: Upon detection of a source program error, compilation will continue whenever possible after the diagnostic message has been printed.

.8 ALTERNATIVE TRANSLATORS: . . . none.

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OPERATING ENVIRONMENT

§ 191.

.1 GENERAL

.11 Identity: . . . . . no integrated supervisor available.

.12 Description

No comprehensive supervisor routine for production running has been published or announced to date for the 1401 systems. The facilities covered in this section, therefore, must be provided by incorporating in each program specific routines, either special library routines or individually written routines to perform loading, tracing, dumping, run to run locators, etc.

All routines used in a program are called in through standard or specially created macro codes and are incorporated into the program at translation time.

There is, however, a comprehensive supervisor routine for testing called Auto-Test, which is described in section 401:52. This routine provides the facilities for stacking programs to be tested and automatically produces the necessary documentation to evaluate the tested programs.

.13 Availability: . . . . . library routines described are currently available.

.14 Originator: . . . . . IBM Corporation and individual users.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Programs from on-line libraries: . . . . . Card Library for standard routines is supplied by IBM; cards for desired program must be loaded manually. Tape Libraries: several library control routines in 1401 Program Library.

.212 Independent programs: self-loading card decks or magnetic tapes, as produced by SPS and Autocoder translators.

.214 Master routines: . . . . Input-Output Control System (IOCS) is called by macros at translation time. The subroutines called in are a combination of open and closed routines. (See 401:172.14 and 401:172.81).

.22 Library Subroutines: . may be inserted at translation time in forms of cards (SPS) or tape (Autocoder Library), or at execution time as independents. Open subroutine card decks.

.23 Loading Sequence

Method	Description
Manual:	sequencing of card decks or program tapes.
1401 Tape Executive Program:	1401 Program Library File No. 01.4.015 permits placing programs on an executive tape and loading these programs based on sense switch setting.
1401 Monitor System for tape:	1401 Program Library File No. 01.4.039, permits addition or deletion of programs on an executive tape and loading these programs into core storage for execution.
1401 Program Tape Execution Routine: . .	1401 Program Library File No. 01.4.052, permits writing and maintaining a 1401 Program tape from condensed card decks and loading these programs into core storage for execution. The loading conditions are based on sense switch settings.

.3 HARDWARE ALLOCATION: . . . . as incorporated in user's program.

.4 RUNNING SUPERVISION: . . . . as incorporated in user's program.

.45 Restarts

.451 Establishing restart points: . . . . . 1401 Check-Point Card Program. 1401 Program Library No. 01.4.030 provides facility for recording memory contents and I/O unit positions to enable restart under program control.

.452 Restarting process: . . same series of routines as above enable restart under program control.

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§ 191.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . . 1401 Trap Subroutine Card Program.
1401 Program Library Program No. 01.4.032 generates a tape record containing necessary information for tracing.
Trace Card Program, 1401 Program Library file No. 01.4.026, provides facility for tracing a program to the error.

.512 Snapshots: . . . . . the following programs are available in the 1401 Program Library: Insert Linkage to fixed Print Storage, this program inserts in the desired section of an object program linkage to a routine which prints out the contents of storage between specified limits.
Insert Linkages to Selective Print Storage performs same function as preceding routine but the specified limits may vary with each print mode.

.52 Post Mortem: . . . . . Memory Annotation, Post Test Program, 1401 Program Library Program No. 01.4.050. Produces a print-out of all or any position of core storage. Prints program locations and instructions in machine language and converts addresses to 5 decimal-digit form, with index register identification. If they are tagged, program distinguishes between numeric-constant fields and alphabetic fields. Several other storage dump routines are available in the 1401 Program Library.

Note: Auto-Test for the IBM 1401 System is a comprehensive test control operating system. This system provides the ability to stack Autocoder, SPS, and FARGO programs and automatically produce the necessary documentation to evaluate the tested programs.

The Auto-Test routines provide the ability to:

- Generate either tape or RAMAC File records required as input test data for the program to be tested.

.52 Post Mortem (Contd.)

Note (Contd.):

- Automatically correct the object program (in source language) without reassembling or manually calculating patching addresses.
- Trace RAMAC File references by listing: the disc address used in the execution of RAMAC instructions, an indication of a read (R) or write (W) instruction, and in the LOAD mode the actual data read or written transferred to or from the disc.
- obtain a printout of core storage between specified limits during run execution at specified points in the object program.
- At the end of a program test, obtain a memory printout and a tape print of all specified tapes.
- Produce an 80-80 card listing of all input-output cards with individual identification of the stacker pockets the cards came from.
- If a program stalls, a restart procedure is available that will provide the memory printouts and tape printouts specified; bypass the program with the error, and begin automatically to test the next program.

The Auto-Test routines can be used in any desired combination for obtaining efficient testing of 1401 programs. If used properly, these routines can be a very useful testing tool.

.6 OPERATOR CONTROL: as incorporated in user's program.

.7 LOGGING: . . . . . as incorporated in user's program.

.8 PERFORMANCE

.81 Program Loading Time: condensed card decks; approximately 2,800 instructions per minute.
program tapes; approximately 2,400 to 6,000 instructions per minute using card images with 1 instruction per card.

.82 Reserved Equipment: . none.

.83 Running Overhead: . . . depends upon facilities incorporated in program.

SYSTEM PERFORMANCE

§ 201.

GENERALIZED FILE PROCESSING (401:201.1)

These problems involve updating a master file from information in a detail file and producing a printed record of each transaction. This application is one of the most typical of commercial data processing jobs and is fully described in Section 4:200.1 of the Users' Guide.

Standard Configuration I has no magnetic tape units. Therefore, it is assumed that both the master and detail files are on punched cards, and that the two files have been collated off-line so that each detail card follows its associated master record cards. Since master records with no activity (i.e., no corresponding detail cards) would, in most cases, be removed from the file before the computer run, only the times at an activity factor of 1.0 are really significant for Standard Configuration I. The relatively low speed of the card punch (250 cards per minute) in producing the updated Master File makes the over-all processing time for Configuration I much higher than for Configurations II, III, and IV, which utilize magnetic tape for the master file. It should be noted that the master record length for Standard File Problem A is 108 characters, which necessitated the use of two 80-column cards for each master record. Although there are well-known methods for packing more than 80 characters of information onto a card, their use was not deemed appropriate in these standardized performance calculations.

In Standard Configurations II, III, and IV, the master file is on magnetic tape, the detail file is read by the 1402 Card Read-Punch, and the report file is produced by the 1403 Printer. The combination "print and read" instruction is used wherever it results in improved performance.

Standard Configuration II is a "stripped-down" magnetic tape system that includes none of the optional features that improve the 1401's capabilities for simultaneous operations. Furthermore, the lack of the Automatic Programming and Multiply-Divide features makes internal processing time for Configuration II over three times as long as for Configurations III and IV. Because of this inefficient processing and the high penalties imposed by each input-output operation, central processor time is the limiting factor on throughput in Configuration II.

Standard Configuration III has a significantly higher throughput than Configuration II as a result of the following major configuration additions: doubled core storage; more and faster magnetic tape units; and the Processing Overlap, Advanced Programming, and Multiply-Divide features. The facilities of Configuration III are more than adequate for use of the 1401 Autocoder, IOCS, COBOL, and FORTRAN systems. The Processing Overlap feature permits card reading and magnetic tape start-stop times to be overlapped with internal processing. The Advanced Programming feature provides three index registers, instructions to store the A and B address register contents, and a full-record internal transfer instruction. These facilities add up to a highly significant increase in processing capabilities, as the system performance graphs clearly show.

Standard Configuration IV adds still faster magnetic tape units (729V) and the Print Storage feature to the facilities of Configuration III. Print Storage permits 98 per cent of each 1403 Printer cycle to be overlapped with internal processing and with the input or output operation (card reading in this case) that is being performed in the Processing Overlap mode. With this increased capability for simultaneous operations, the speed of the 1403 Printer becomes the limiting factor on total time required over most of the plotted activity range. (In comparing the price of the 1401 in Standard Configuration IV with other systems, it should be kept in mind that a 1401 system can have only half as much core storage and half as many magnetic tape units as the configuration rules on page 4:030.120 specify.)

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SYSTEM PERFORMANCE (Contd.)

§ 201.

SORTING (401:201.2)

The standard estimate for sorting 80-character records by straightforward merging on magnetic tape was developed from the time for Standard File Problem A by the method explained in Paragraph 4:200.213 of the Users' Guide. A two-way merge was used in Configuration II (which has only four magnetic tape units) and a three-way merge in Configurations III and IV. The results are shown in Graph 401:201.214.

Graph 401:201.224 is based on published timing data for the manufacturer-developed sort routines: SORT 1 for Configuration II and SORT 2 for Configurations III and IV. The two graphs show close agreement between the estimated and published sorting times.

MATRIX INVERSION (401:201.3)

In matrix inversion, the object is to measure central processor speed on the straightforward inversion of a non-symmetric, non-singular matrix. No input-output operations are involved. The standard estimate is based on the time to perform cumulative multiplication ($c = c + a_i b_j$) in eight-digit precision floating point using standard subroutines (see Paragraph 401:051.422). The results are shown in Graph 401:201.313. Speeds are relatively low because of the 1401's lack of floating point arithmetic hardware.

Graph 401:201.323 shows the times for a matrix inversion routine coded in 1401 FORTRAN by the manufacturer and timed on a 1401. The FORTRAN-coded routine takes about three times as long as the matrix inversion times derived by the standard estimating technique. According to the manufacturer, this 1-to-3 relationship between the speeds of 1401 FORTRAN-coded and symbolic-coded object programs is fairly typical.

GENERALIZED MATHEMATICAL PROCESSING (401:201.4)

This problem measures over-all system performance on a simple mathematical application with widely varying ratios of input-to-computation-to-output volume, as described in Section 4:200.4 of the Users' Guide. The time requirements shown in Graph 401:201.414 apply to Standard Configurations I and III. In both configurations, input is via the 1402 Card Read-Punch, output is via the 1403 printer, and the calculations are performed in eight-digit precision floating point, using standard subroutines.

GENERALIZED STATISTICAL PROCESSING (401:201.5)

Here the object is to compile a number of cross-tabulation tables, using input records consisting of thirty 2-digit items that have been pre-edited and blocked for efficient input. The procedure is described in Section 4:200.5 of the Users' Guide. Graph 401:201.514 shows the times required when from 1 to 1,000 table elements are augmented for each input record. Configuration I uses the 1402 Card Read-Punch as an input device, with one record per card. In Configuration III and IV, input is via magnetic tape, with 18 records per block. Configuration II lacks the Advanced Programming and Multiply-Divide features, and was therefore found unsuitable for this type of statistical processing.

IBM 1401
SYSTEM PERFORMANCE

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Revised 5/63

IBM 1401 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration I		Configuration II		Configuration III		Configuration IV		Reference
1 Input-Output Times	Char/block	(File 1)	54 per card		1,080		1,080		1,080		
	Records/block	K (File 1)	0.5		10		10		10		
	msec/block	File 1/File 2	150/480		74.4/74.4		38.6/38.6		30.3/30.3		
		File 3	75		75		75		75		
		File 4	120		120		120		120		
	msec/switch	File 1/File 2									4:200.112
		File 3									
		File 4									
	msec penalty	File 1/File 2	24/32		61.7/59.0		29.9/26.0		21.6/17.9		
		File 3	12		65		12		12		
		File 4	84		84		84		2		
2 Central Processor Times	msec/block	a1	4.1		2.1		2.1		2.1		
	msec/record	a2	5.0		9.4		8.3		8.3		
	msec/detail	b6									4:200.1132
	msec/work	b5 + b9	28.0		92.6		21.1		21.1		
	msec/report	b7 + b8									
3 Standard Problem A F = 1.0	msec/block for C. P. and dominant column.	a1	4.1		2.1		2.1		2.1		
		a2 K	2.5		94.0		83.0		83.0		
		a3 K	14.0		926.0		211.0		211.0		
		File 1 Master In	12.0		61.7	74.4	29.9	38.6	21.6		
		File 2 Master Out	16.0	240.0	59.0	74.4	26.0	38.6	17.9		4:200.114
		File 3 Details	6.0				120.0		120.0		
		File 4 Reports	42.0	60.0	1,320.0	1,500.0*	840.0	1,500.0*	20.0	1,200.0	
		Total	96.6	300.0	2,462.8	1,648.8	1,312.0	1,577.2	475.6	1,200.0	
4 Standard Problem A Space	Unit of measure	(character)									
		Std. routines	100		1,850		3,150		3,150		
		Fixed	9		0		9		9		
		3 (Blocks 1 to 23)	387		672		654		654		
		6 (Blocks 24 to 48)	2,676		2,628		2,676		2,676		4:200.1151
		Files	744		2,584		2,584		2,584		
		Working	---		108		108		108		
		Total	3,916		7,842		9,181		9,181		

* Total time for Files 3 and 4, using combination "read and print" instruction.

IBM 1401 SYSTEM PERFORMANCE (Contd.)

WORKSHEET DATA TABLE 2							
Worksheet	Item			Configuration I	Configuration III	Configuration IV	Reference
5	Fixed/Floating point			Floating Point	Floating Point		
	Unit name	input		Card Reader	Card Reader		
		output		Printer	Printer		
	Size of record	input		80 characters	80 characters		
		output		132 characters	132 characters		
Standard Mathematical Problem A	msec/block	input	T1	75	75		4:200.413
		output	T2	120	120		
	msec penalty	input	T3	12	12		
		output	T4	84	84		
	msec/record		T5	0.161	0.161		
	msec/5 loops		T6	499.088	499.088		
	msec/report		T7	7.050	7.050		
7	Unit name			Card Reader	729 II Tape Unit	729 V Tape Unit	
	Size of block			80 characters	7,080 characters	1,080 characters	
	Records/block		B	1	18	18	
Standard Statistical Problem A	msec/block		T1	75	38.6	30.3	4:200.512
	msec penalty		T3	12	29.9	21.6	
	C.P.	msec/block	T5	0.161	0.380	0.380	
		msec/record	T6	---	1.852	1.852	
		msec/table	T7	3.423	3.423	3.423	

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SYSTEM PERFORMANCE

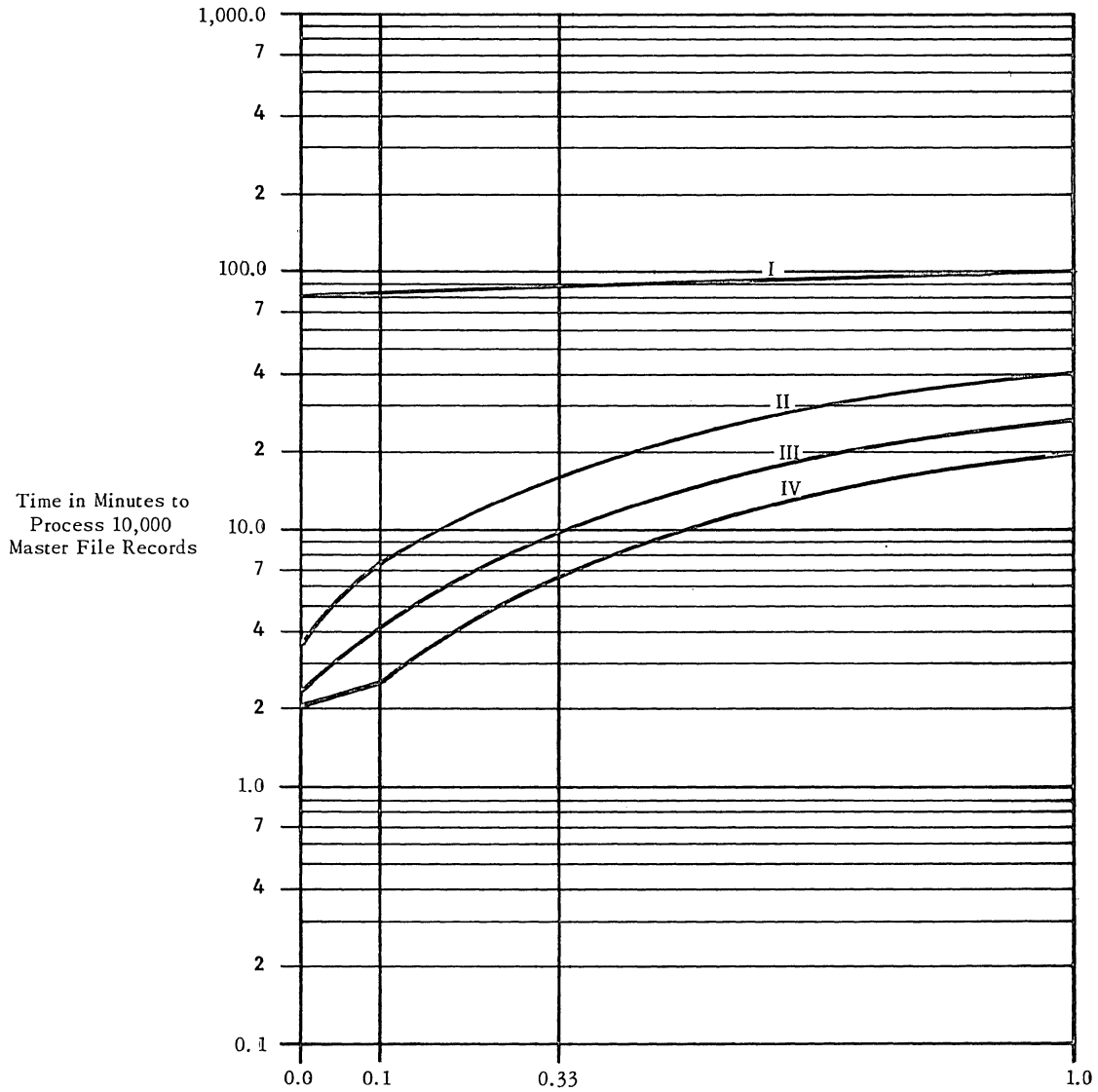
§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.
.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.
.114 Graph: . . . . . see graph below.
.115 Storage space required
Configuration I: . . . 3,900 characters.
Configuration II: . . . 7,800 characters.
Configuration III: . . . 9,200 characters.
Configuration IV: . . . 9,200 characters.



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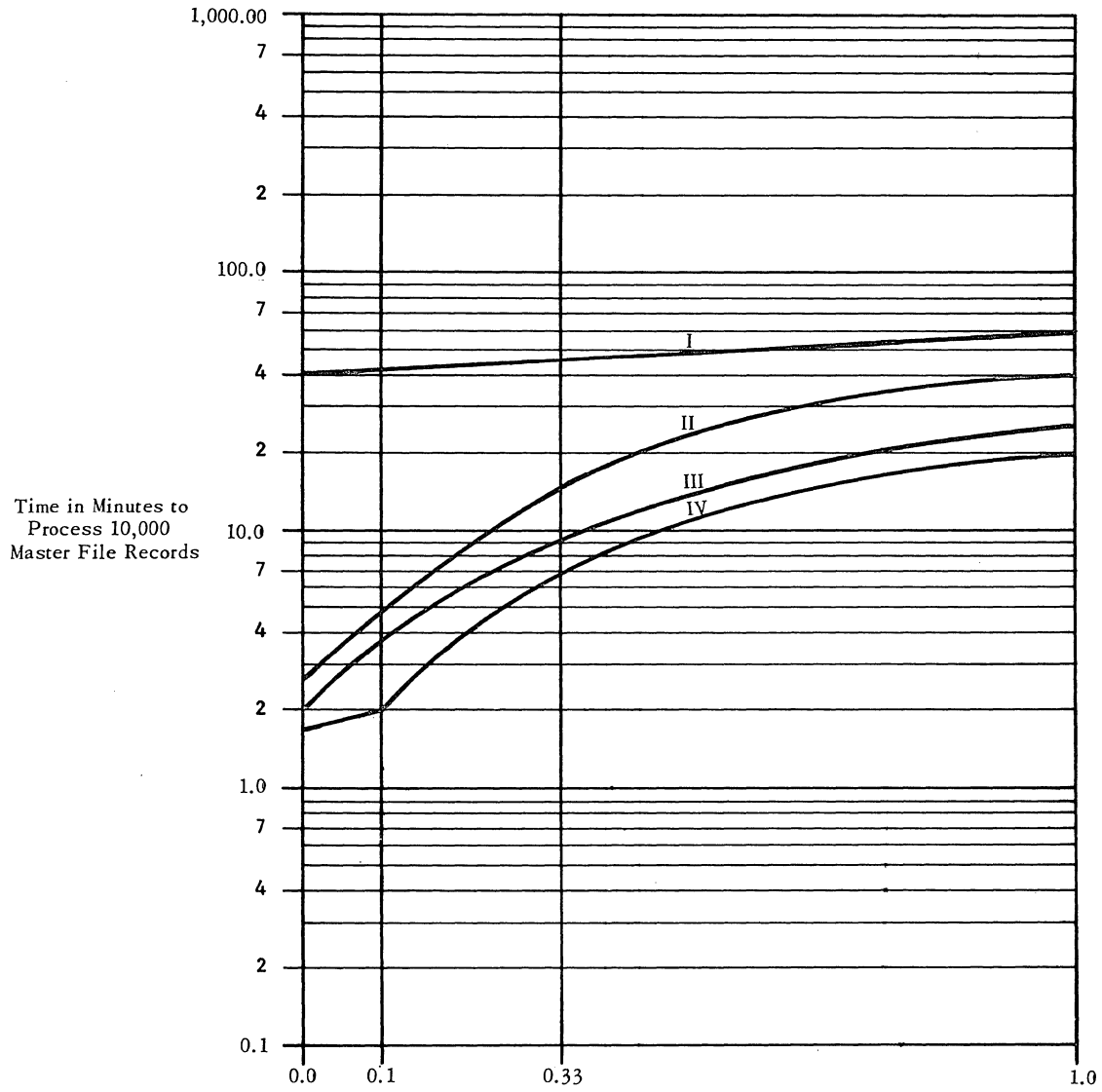
§ 201.

.12 Standard File Problem B

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



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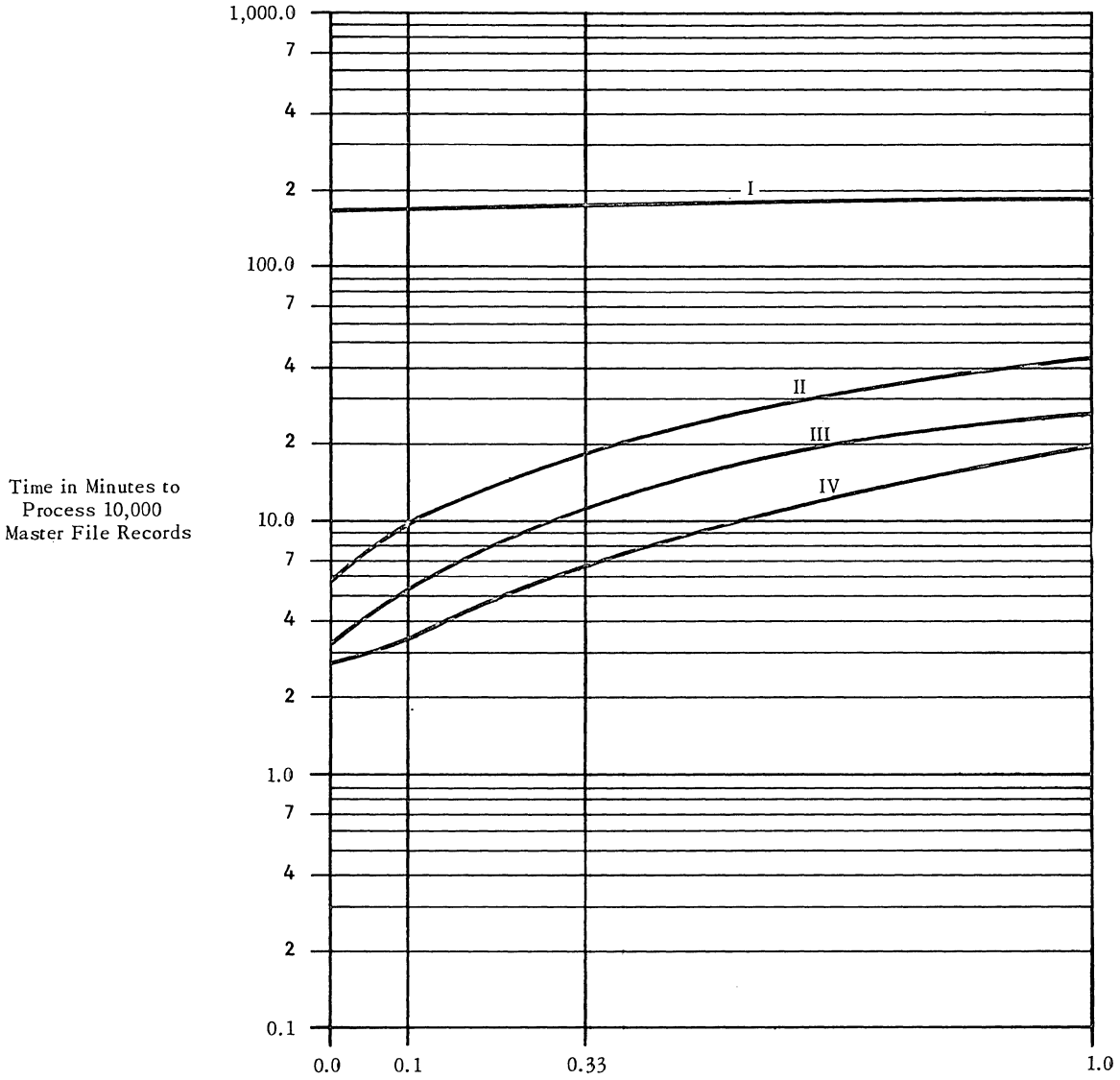
§ 201.

.13 Standard File Problem C

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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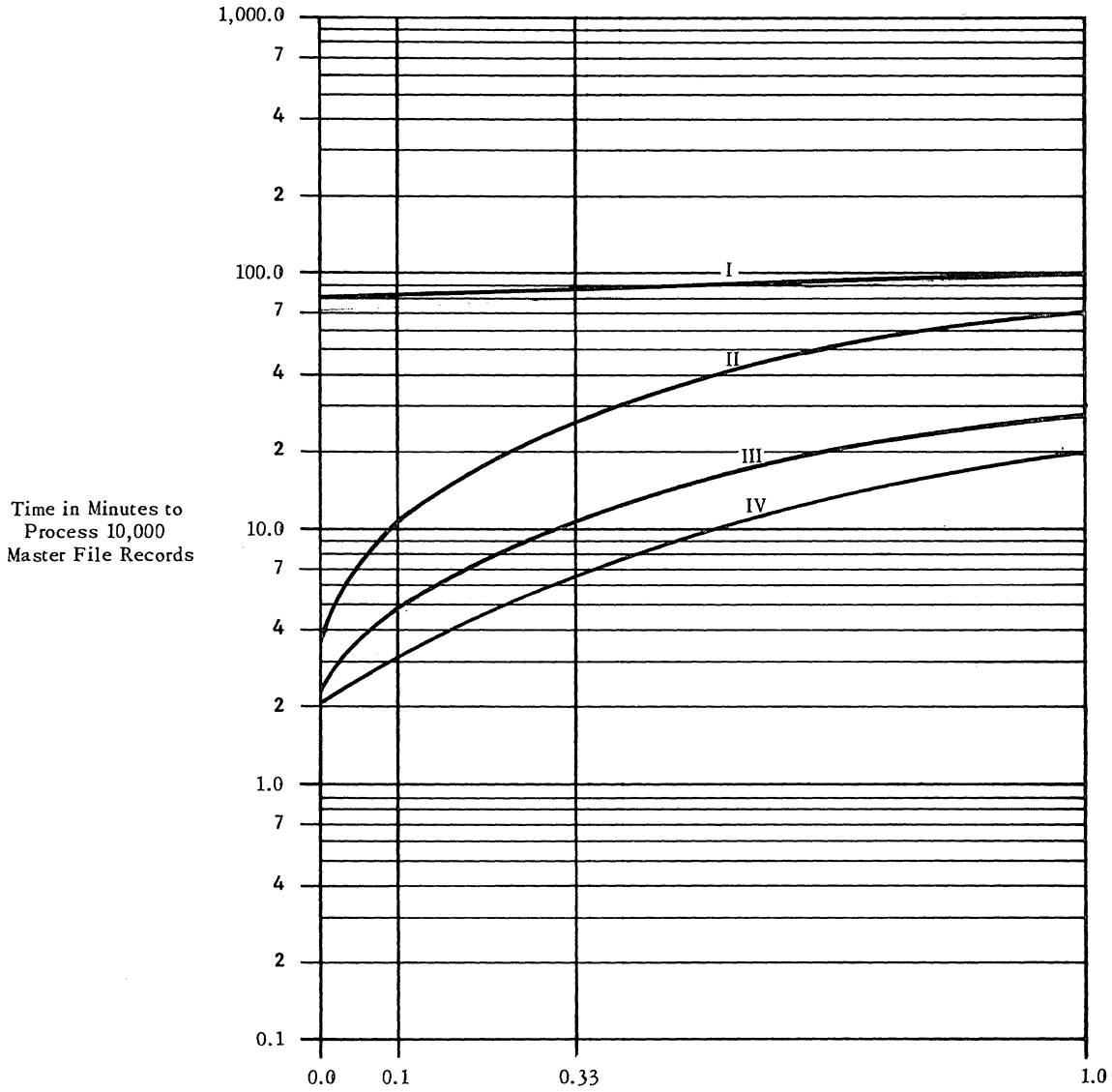
§ 201.

.14 Standard File Problem D

.141 Record sizes
Master file:. . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line,

.142 Computation:. . . . . trebled.
.143 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



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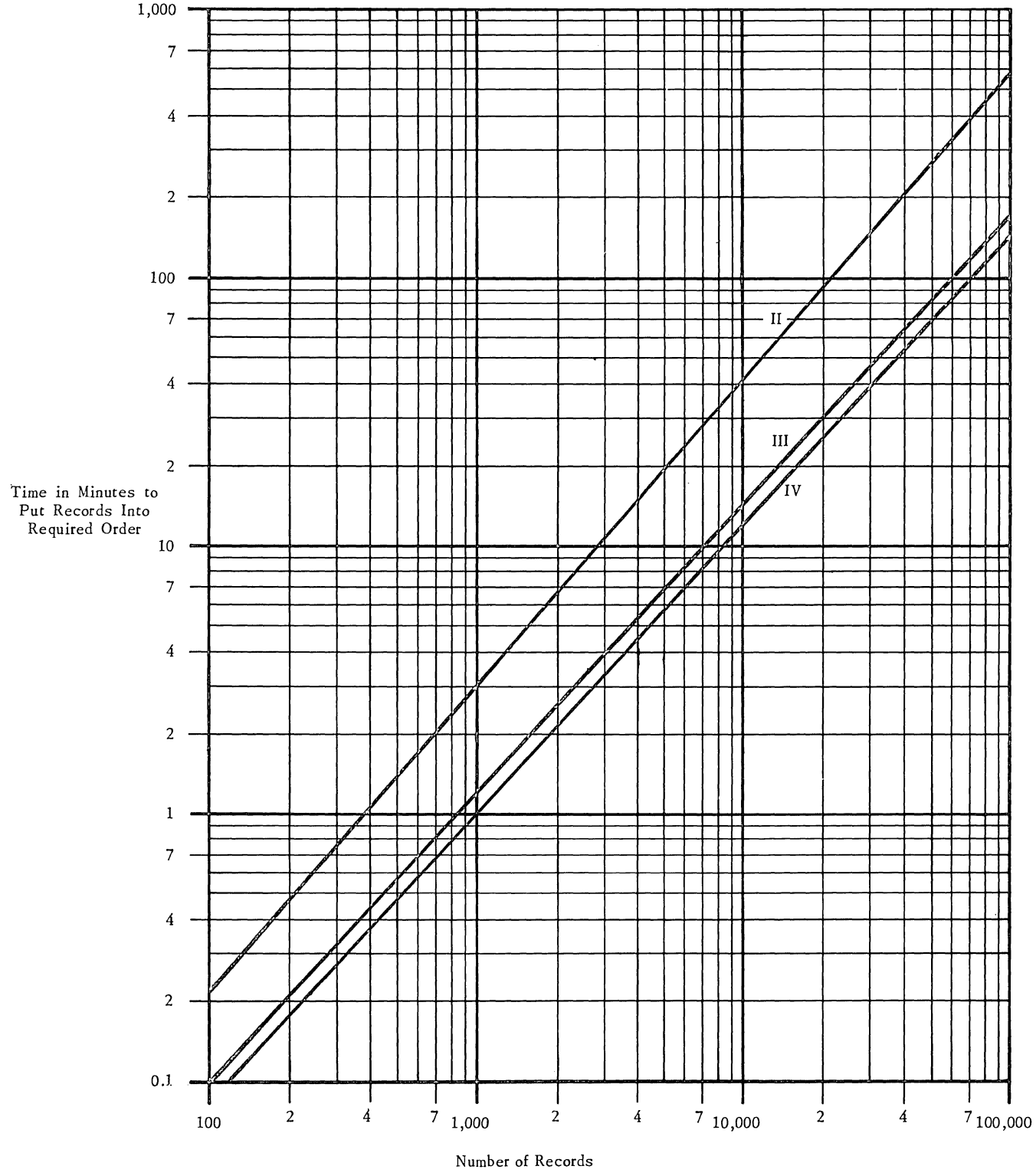
§ 201.

.2 SORTING

.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.
.212 Key size: . . . . . 8 characters.
.213 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.
.214 Graph: . . . . . see graph below.
.215 Capacity of one reel (ten 80-char records per block)
200 char/inch: . . . . 57,000 records.
556 char/inch: . . . . 125,000 records.



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§ 201.

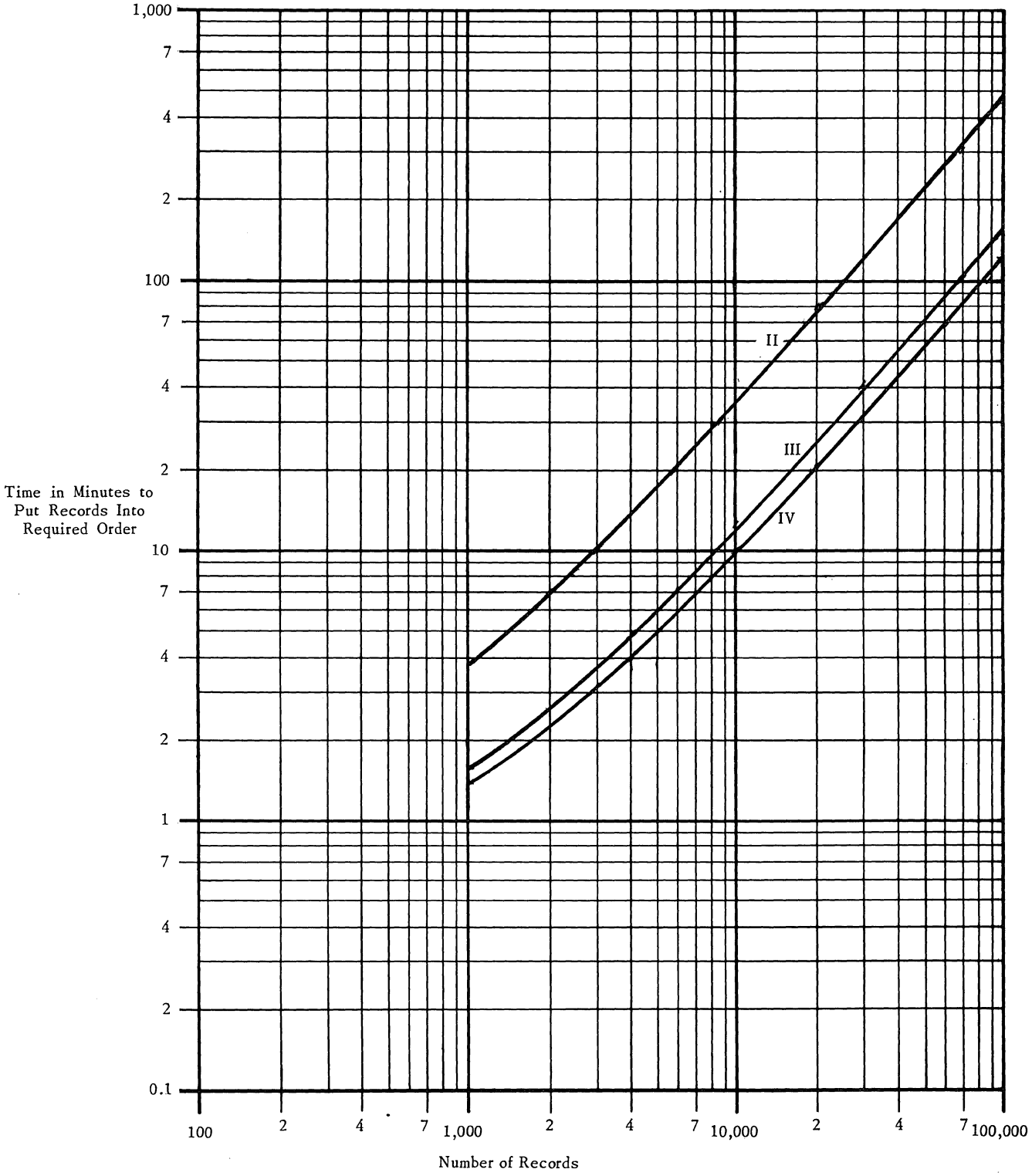
.22 IBM 1401 SORT 1 and SORT 2 Times

.221 Record size: . . . . . 80 characters.

.222 Key size: . . . . . 8 characters.

.223 Timing basis: . . . . . IBM 1401 SORT 1 for configuration II; IBM 1401 SORT 2 for configurations III and IV.

.224 Graph: . . . . . See graph below.



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§ 201.

.3 MATRIX INVERSION

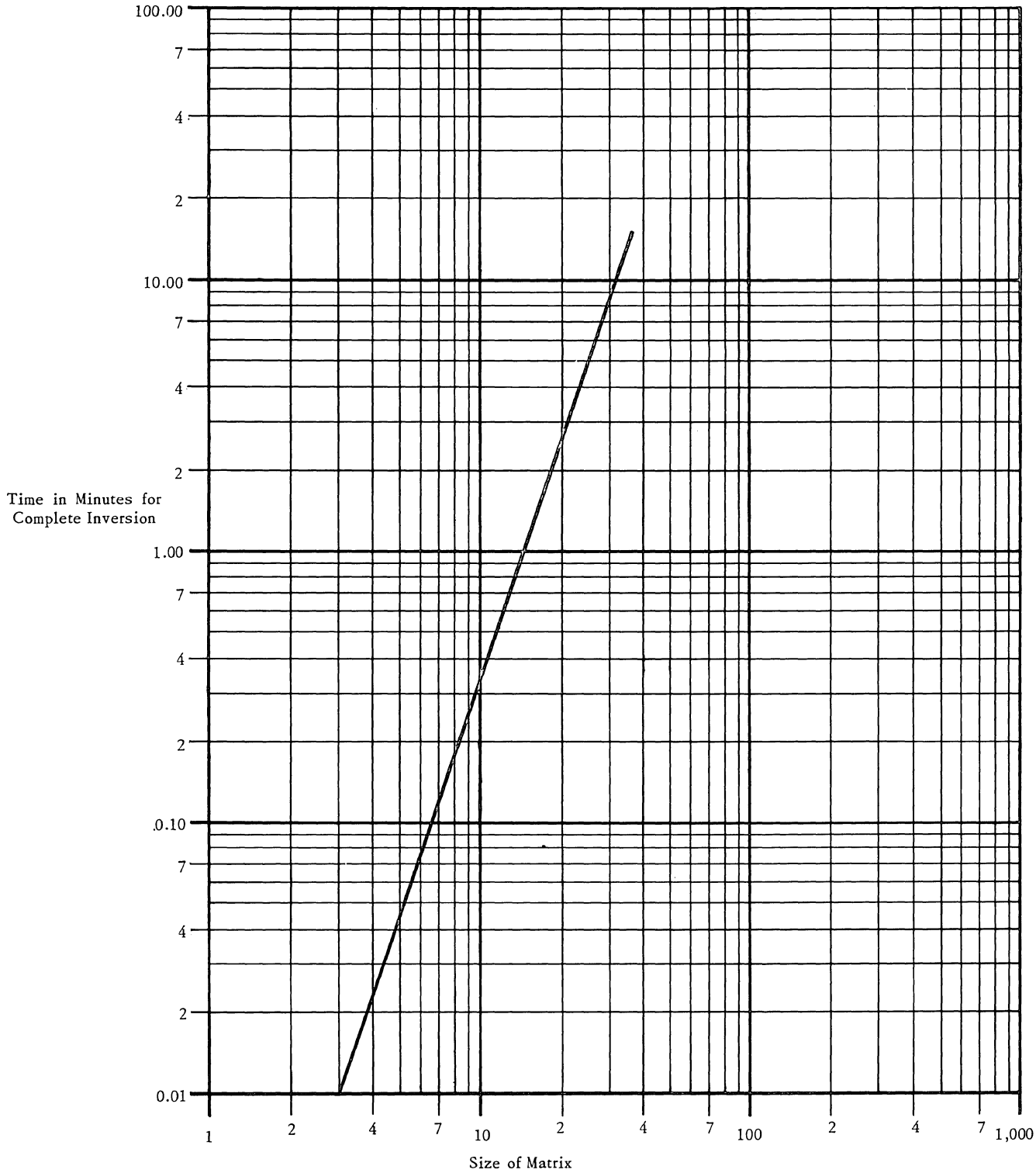
.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . . see graph below.

.314 Maximum matrix size
4K core storage: . . 14.
8K core storage: . . 25.
16K core storage: . . 37.



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§ 201.

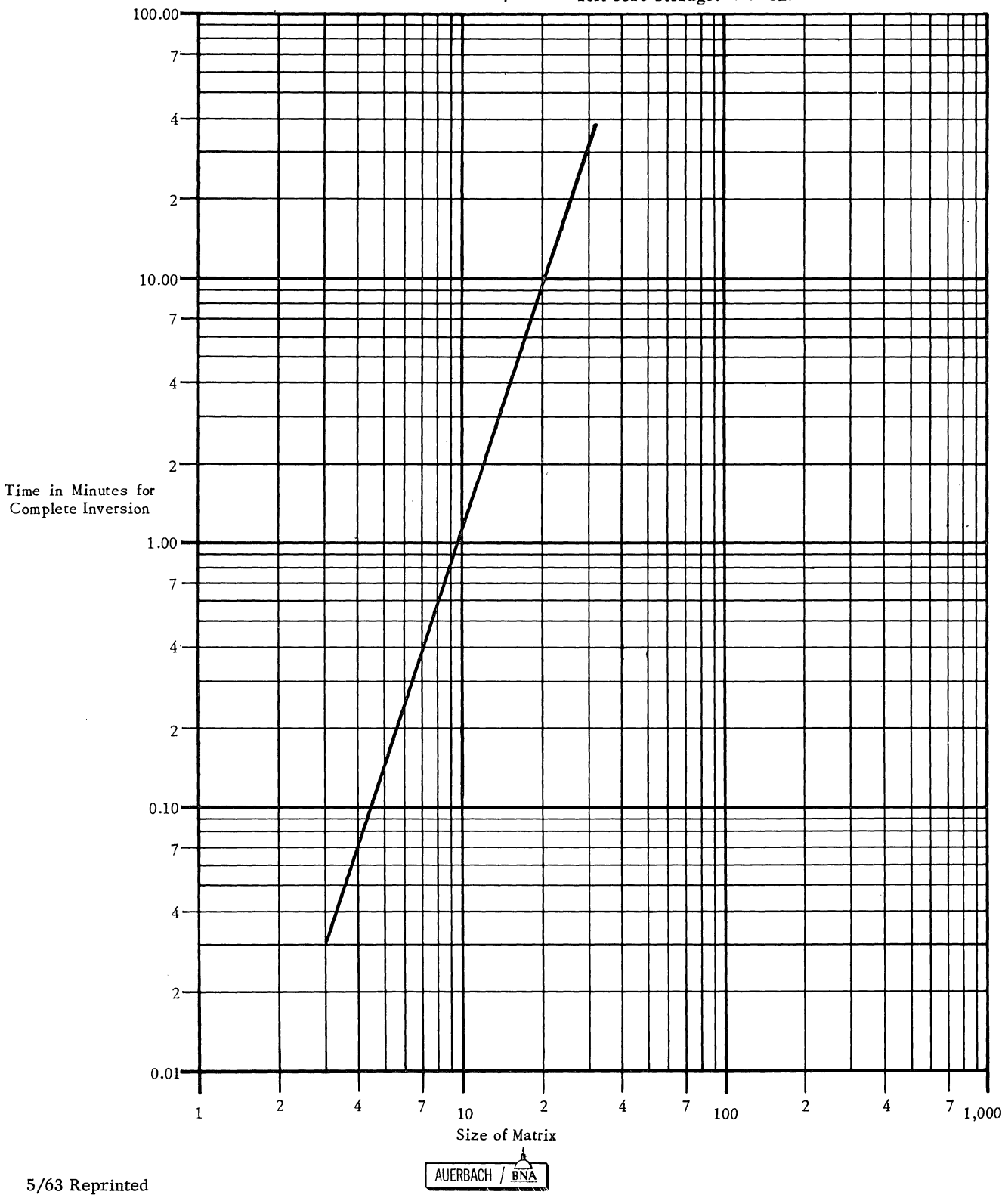
.32 FORTRAN-Coded Routine Times

.321 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.322 Timing basis: . . . . . FORTRAN-coded matrix inversion routine timed by manufacturer (IBM estimates same routine coded in machine oriented language would be 3 times as fast).

.323 Graph: . . . . . see graph below.

.324 Maximum matrix size
8K core storage: . . 15.
16K core storage: . . 32.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

.411 Record sizes:. . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

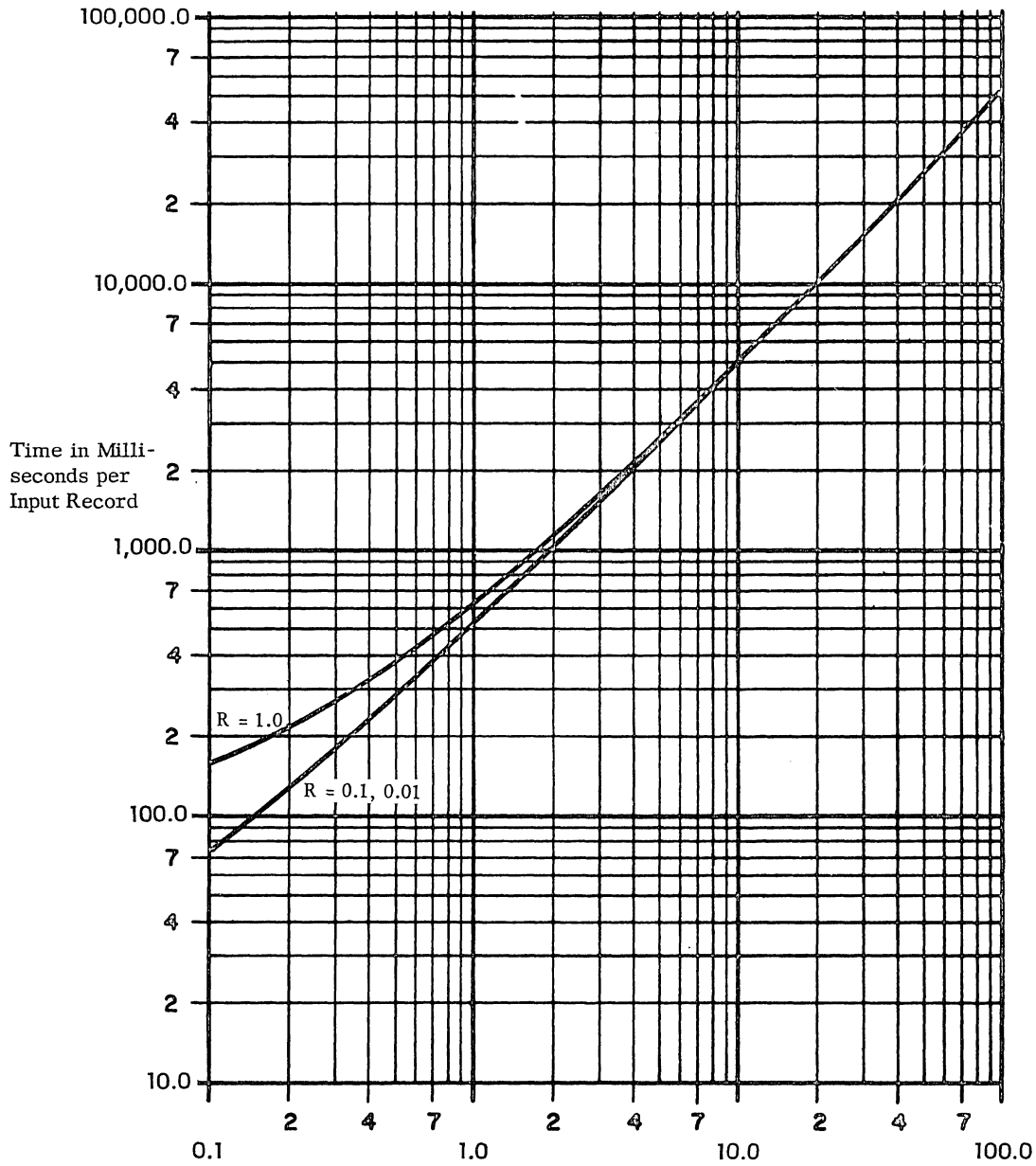
.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.413

.414 Graph: . . . . . see graph below.

CONFIGURATIONS I AND III; SINGLE LENGTH (8 DIGIT PRECISION) FLOATING POINT

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



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§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

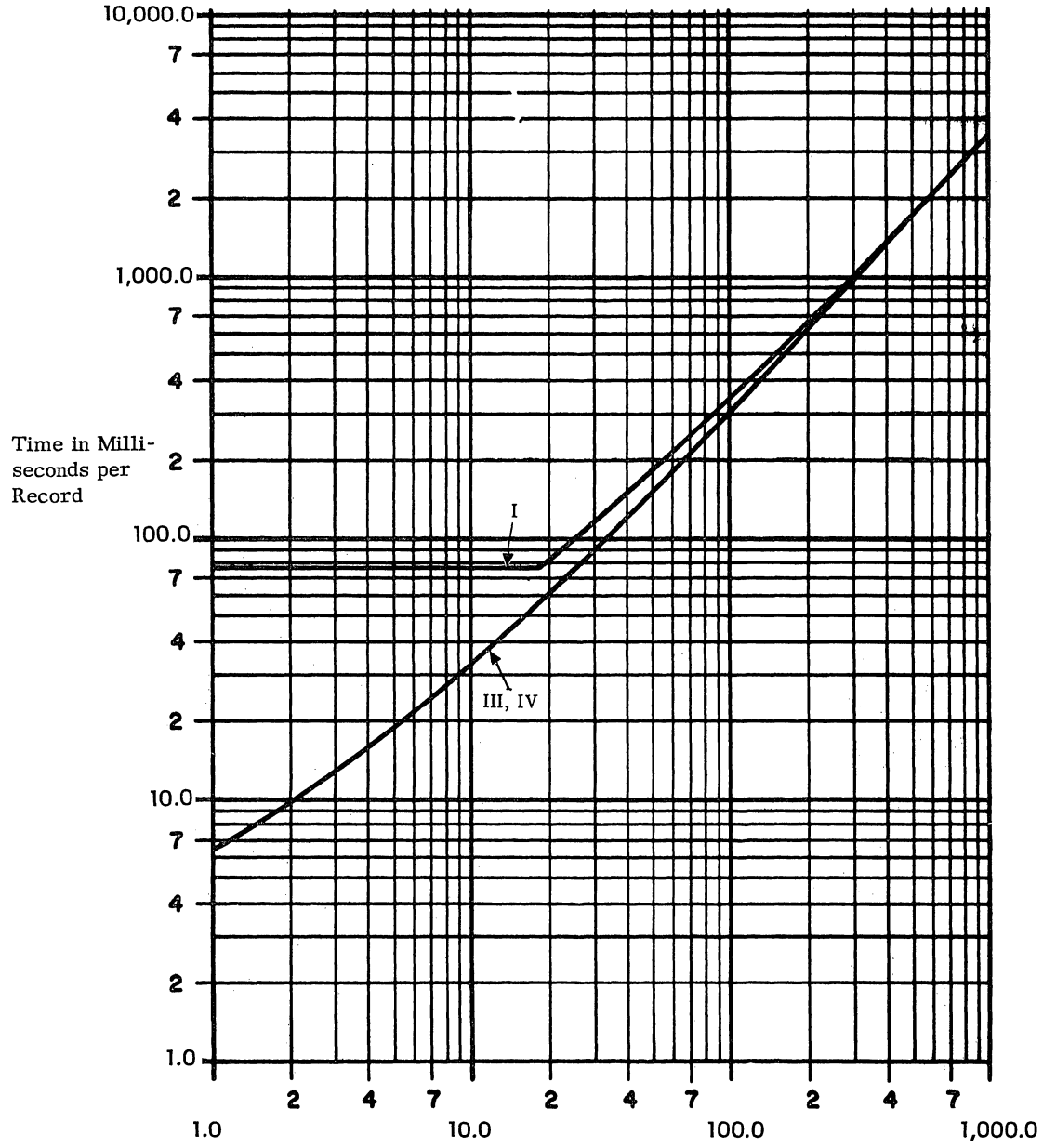
.51 Standard Statistical Problem A Estimates

.511 Record size:. . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . . see below.



Roman numerals denote Standard Configurations

IBM 1401
PHYSICAL CHARACTERISTICS

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IBM 1401 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Processing Unit	Processing Unit	Processing Unit	Processing Unit	Processing Unit	Processing Unit	Card Read-Punch
	Model Number		1401 Model A	1401 Model B	1401 Model C	1401 Model D	1401 Model E	1401 Model F	1402 Model 1
PHYSICAL	Height × width × depth, in.		60 × 29 × 31	60 × 58 × 31	60 × 58 × 31	60 × 58 × 31	60 × 58 × 31	60 × 58 × 31	45 × 58 × 30
	Weight, pounds		1015	1840	2025	2170	2025	2025	1300
	Maximum cable lengths, ft.								
	To Processing Unit		---	---	---	---	---	---	18
	To Power Receptacle		---	---	---	14	---	---	14
	To Indicated Unit		18 (1402)	18 (1402)	18 (1402)	---	18 (1402)	18 (1402)	---
ATMOSPHERE †	Storage Ranges	Temperature, °F.	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110
		Humidity, %	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80
	Working Ranges	Temperature, °F.	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90
		Humidity, %	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80
	Heat dissipated, BTU/hr.		4200	6700	8100	9100	8100	8500	3500
	Air flow, cfm.		400	660	810	840	810	830	90
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance	±10%	±10%	±10, −8%	+10, −8%	+10, −8%	+10, −8%	±10%
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle
	Phases and lines		3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line
	Load KVA		3.2	4.0	4.5	3.7	4.5	4.6	Included in 1401 load
NOTES	† All units have internal filters.								

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IBM 1401 PHYSICAL CHARACTERISTICS (Contd.)

IDENTITY	Unit Name		Printer	Printer	Disk Storage Drive	Disk Storage Drive	Disc Storage Unit	Core Storage Unit	Core Storage Unit	Core Storage Unit	Console Inquiry Station	Magnetic Character Reader	Optical Character Reader	Optical Character Reader	Magnetic Character Reader	Alphameric Optical Reader	Alphameric Optical Reader	Magnetic Tape Unit	Magnetic Tape Unit	Data Transmission Unit	Paper Tape Reader	Paper Tape Punch	Compressor	Accumulator Unit	Data Communication Unit
	Model Number		1404	1403 Models 1, 2	1311 Model 2	1311 Model 4	1405 Models 1, 2	1406 Model 1	1406 Model 2	1406 Model 3	1407	1412 Model 1	1418 Model 1	1418 Model 2	1419 Model 1	1428 Model 1	1428 Model 2	729, all models	7330	1009	1011	1012	Part of 1405	Accessory to 1412 or 1419	7710
PHYSICAL	Height × width × depth, in.		54×67×32	53×48×29	38×30×24	38×43×24	70×61×31	40×29×31	40×29×31	40×29×31	39×60×29	61×112×41	68×112×41	68×112×41	61×112×42	61×112×41	61×112×41	69×29×34	58×29×31	40×29×31	60×32×37	60×32×37	29×40×33	39×17×21	32×70×38
	Weight, pounds		1600	750	390	650	2115	350	350	350	300	2400	1950	2300	2600	1950	2300	1200	640	350	530	570	700	100	500
	Maximum cable lengths																								
	To Processing Unit		21 (1401)	21			40	10	10	10	10	40	25	25	40	25 (1401)	25 (1401)	100 total	100 total	15	80	80 (1401)	---	---	14 (Power Cord)
	To Power Receptacle			---			14	---	---	---	---	10	15	15	6	15 (Power Receptacle)	15 (Power Receptacle)	---	---	15	14	14 (Power Receptacle)	---	---	25 (1401)
	To Indicated Unit			---			---	---	---	---	---	---	---	---	---			---	---	15 (subset)	---		40 (1405)	5 (1412 & 1419)	.25 (Dataset)
ATMOSPHERE	Storage Ranges	Temperature, °F.	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110	50 – 110
		Humidity, %	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80	0 – 80
	Working Ranges	Temperature, °F.	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	65 – 80	65 – 80	65 – 80	65 – 80	65 – 80	65 – 80	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	60 – 90	50 – 90
		Humidity, %	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 65	20 – 65	20 – 65	20 – 65	20 – 65	20 – 65	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80	20 – 80
	Heat dissipated, BTU/hr.		5100	3000	2000	4000	7240	450	650	850	425	6300	8300	8300	8500	8300	8300	3900	3415	1000	4100	4100	10,800	---	2000
	Air flow, cfm.		280	310			500	90	90	120	60	320	575	575	?	575	575	550	150	120	150	65	300	0	500
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	115	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance		±10%			±10%	±10%	±10%	±10%	±10%	±10%	±10%	±10%	±10%			+10, −8%	+10, −8%	±10%	±10%		±10%	±10%	
	Cycles	Nominal	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
		Tolerance		±½ cycle			±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle	±½ cycle			±½ cycle	±½ cycle	±½ cycle	±½ cycle		±½ cycle	±½ cycle	
	Phases and lines		3φ, 4-line	3φ, 4-line	1φ	1φ	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	1φ, 3-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	3φ, 4-line	1φ, 3-line	1φ, 3-line	1φ	3φ, 4-line	1φ, 3-line	1φ, 3-line
	Load KVA		---	Included in 1401 load	0.75	1.4	5.0	0.4	0.4	0.4	0.2	2.7	4.6	4.6	3.3	4.6	4.6	1.6	1.1	0.3	1.8	1.8	4.0	---	0.6
NOTES																									

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchases $
CENTRAL PROCESSOR	1401	Processing Unit (All prices include 4,000 positions of core storage).			
	Model A3	Card System	1,430	49.00	87,700
	Model B3	Expanded Card System	1,580	53.25	97,600
	Model C3	729 Tape/Card System	2,680	81.50	131,100
	Model D13	7330 Tape System	2,175	70.50	130,000
	Model D3	729 Tape System	2,655	72.75	130,000
	Model E3	7330 Tape/Card System	2,080	71.25	126,400
	Model F3	RAMAC/Card System	1,610	55.25	98,950
	Model F23	RAMAC/Card/7330 Tape	2,110	73.25	127,750
	Model F13	RAMAC/Card/729 Tape	2,590	75.50	127,750
		Corrections to above prices for other core storage sizes:			
		1,400 positions	-230	-1.50	-4,000
		2,000 positions	-130	-1.50	-3,200
		4,000 positions	0	0	0
		8,000 positions *	+50	+2.00	+2,150
		12,000 positions *	+75	+3.00	+2,550
		16,000 positions *	+75	+3.00	+2,550
		* Add appropriate 1406 Core Storage Unit.			
		Optional Features			
	1060	Advanced Programming	105	1.00	3,935
	4575	High-Low-Equal Compare	75	1.75	2,800
	5730	Processing Overlap	250	13.75	15,000
	1490	Bit Test	20	0.50	800
	1990	Column Binary	100	2.50	3,600
	5275	Multiply-Divide	325	9.50	11,700
	7600	Sense Switches	15	0.50	550
	2210	Compressed Tape (#1060 required)	35	3.25	1,300
	3580	800 char./inch Tape Adapter	35	0	1,575
STORAGE	1405	Disk Storage Unit			
	Model 1	10,000,000 characters	965	88.00	36,000
	Model 2	20,000,000 characters (#3327 controller req'd.)	1,515	96.00	48,500
		Optional Features			
		Additional Access Arms			
	1008	For 1405 Model 1	400	64.00	14,750
	1009	For 1405 Model 2	425	64.00	15,500
	1406	Core Storage			
	Model 1	4,000 positions	575	13.50	24,500
	Model 2	8,000 positions	1,075	15.50	45,800
	Model 3	12,000 positions	1,575	20.75	67,100

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PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchases $
STORAGE (CONTD.)	1311	Disk Storage Drive			
	Model 2	Additional on System	375	29.00	17,000
	Model 4	First on System (3339 Adapter included)	1,000	74.25	46,650
		Optional Features			
	3281	Direct Seek (Model 4 only)	50	3.25	2,400
	6396	Scan Disk (Model 4 only; 4575 req'd on 1401)	35	.50	1,680
	6400	Seek Overlap	40	1.75	1,950
	8011	Track Record (Model 4 only)	40	.50	1,920
INPUT-OUTPUT	1402	Card Read-Punch	550	45.00	30,000
		Optional Features			
	3550	Early Card Read	10	0	215
	4150, 1013	51-Column Feed	60	28.25	3,810
	5890, 5895	Punch Feed Read	80	5.75	2,985
	6040	Read Punch Release	25	0.50	950
	1011	Paper Tape Reader (#7080 adapter req'd.)	500	42.50	22,400
	1012	Tape Punch	465	35.50	20,850
	1403	Printer			
	Model 1	100 print positions	725	172.00	32,900
	Model 2	132 print positions (#5540 control included)	835	187.75	36,450
		Optional Features			
	4740	Interchangeable Chain	75	0	3,125
	5380, 5381	Numerical Print (#4740 req'd.)	275	8.75	11,050
	3835	Expanded Print Edit	20	0.50	750
	5585	Print Storage	375	34.50	12,600
	6411, 6412	Sel Tape Listing Feature	275	10.75	12,400
	7246	Space Suppression	75	0	60
	1404	Printer (#5539 and #5563 controls included)	1,635	249.00	89,330
		Optional Features			
	4740	Interchangeable Chain	75	0	3,125
	3835	Expanded Print Edit	20	0.50	750
	5585	Print Storage	375	34.50	12,600
	5990, 5991	Read-Compare	250	21.75	14,000
	7246	Space Suppression	75	0	60
	1407	Console Inquiry Station (#2272 adapter included)	175	14.75	8,800
	729	Magnetic Tape Unit			
		Model II	700	116.00	36,000
		Model IV	900	128.00	41,250
		Model V	750	122.00	37,200
	7330	Magnetic Tape Unit	450	52.25	22,000
	7340 Model 2	Hypertape Drive	1,050	?	68,700

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchases $
INPUT-OUTPUT (CONTD.)	1412	Magnetic Character Reader	2,000	183.00	91,400
		Optional Features			
	2385	Document Counter	15	2.25	600
	3610	Electronic Accumulation (#5215 required)	250	19.00	9,750
	5215	Multiple Column Select	50	2.00	2,250
		Self-Checking Numbers:			
	7061	Modulus 10	40	1.75	1,950
	7062	Modulus 11	65	2.75	3,000
	1419	Magnetic Character Reader	2,275	240.00	110,500
		Optional Features			
	3610	Electronic Accumulation (#5201 required)	250	19.00	9,750
	5201	Multiple Column Control	50	2.00	2,250
	7440	Split Field	20	0.75	1,225
		Self-Checking Numbers:			
	7061	Modulus 10	40	1.75	1,950
	7062	Modulus 11	65	2.75	3,000
	3791	Endorser			
		for 1412	350	31.50	17,150
		for 1419	375	32.00	18,350
	1418	Optical Character Reader			
	Model 1	3 stackers	2,600	160.00	120,300
	Model 3	13 stackers	2,900	190.00	133,800
		Optional Features			
	4950	Mark Reading Station	125	5.00	5,950
		Additional Read Station			
	6045	.093-inch characters	125	16.00	5,450
	6046	.130-inch characters	125	16.00	5,450
	1428	Alphameric Optical Reader			
	Model 1	3 stackers	3,000	190.00	138,600
	Model 2	13 stackers	3,300	220.00	152,100
		Optional Features			
	4950	Mark Reading Station (not with 6044)	125	5.00	5,950
	6044	Read Station (not with 4950)	125	16.00	5,450
	1009	Data Transmission Unit	500	11.50	26,400
	7710	Data Communication Unit	1,575	75.00	83,000
		Optional Features			
	3460	Dual Communications Interface	15	0	600
	4703	Internal Clock	145	1.25	5,000
CONTROLLERS	3327	Disc Storage Control	355	45.50	10,850
	7080	Serial I/O Adapter (Required for 1009, 1011, 1412, 1418, 1419, or 7641, only one of which may be connected to a system.)	100	1.50	3,750

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PRICE DATA (Contd.)

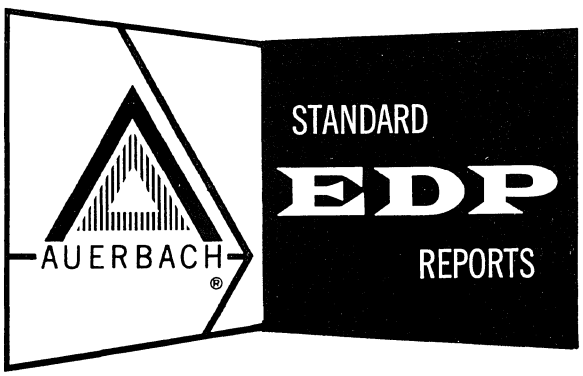
§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchases $
CONTROLLERS (CONTD.)	7641	Hypertape Control Unit	2,500	?	160,000
		Tape Intermix Units			
	7804	729 IVs with 729 II/Vs	0	0	0
	7805	729 II/Vs with 729 IVs	0	0	0
	7806	7330s with 729 II/Vs	45	0	2,250
	7807	7330s with 729 IVs	45	0	2,250
	7808	7330s with 729 IIs/IVs/Vs (Require 7804 or 7805)	45	0	2,250

Note: Monthly maintenance charges apply to purchased equipment only; they are based on a graduated scale, and the charges listed here are for the first 3 years after installation.

IBM 1410

International Business Machines Corp.



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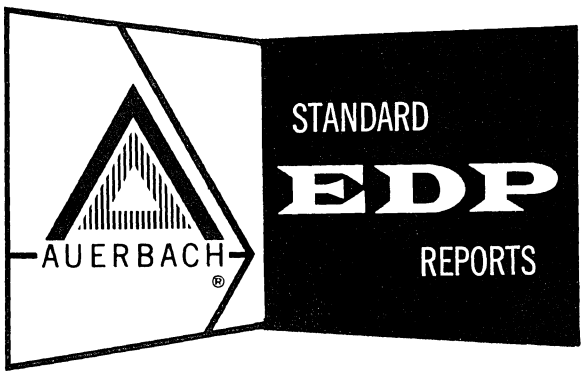
IBM 1410

International Business Machines Corp.



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INTRODUCTION

§ 011.

The IBM 1410 is a small to medium scale, solid-state computer system oriented toward solving business data processing problems. System rentals range from approximately $7,000 to $40,000 per month, and most installations will probably fall within the $12,000 to $20,000 range.

The 1410 is compatible with the IBM 1401 to the extent that built-in 1401 compatibility circuits enable many 1401 machine language programs to be run directly on a 1410. The increased speed and power of the 1410 cannot be fully utilized in this mode of operation, however, and 1401 programs that use the Processing Overlap, Column Binary, Compressed Tape, Punch Feed Read, or Serial Input-Output features cannot be run on the 1410. The buffers for card read and card punch operations for the 1410 are significantly different from those for the 1401.

Programs written for the 1410 can be operated unaltered on the more powerful 7010 with an identical configuration of input-output devices. Programs for the 1410 which use IBM 1405 Disk Storage, 1412/1419 Magnetic Ink Character Readers, or the Program Addressable Clock will not operate on the 7010 because these 1410 input-output devices are not available for connection to the 7010.

The core storage of the 1410 can consist of 10,000, 20,000, 40,000, 60,000, or 80,000 character positions, with each position containing 6 data bits, a parity bit, and word mark bit. The core storage cycle time is 4.5 microseconds and can be reduced to 4.0 microseconds by using the optional Accelerator feature. In addition, up to 5 disc storage units with a total capacity of up to 280,000,000 characters can be connected. The 1301 Disk Storage Unit and the 1311 Disk Storage Drive each utilize a comb-like access mechanism which makes it possible to access corresponding bands on all discs simultaneously. The 1405 is the familiar RAMAC unit which utilizes one read-write mechanism to search all disc surfaces (i.e., its operation is similar to that of a juke box).

The central processor is a variable word-length, alphameric processor with add-to-store logic, which utilizes a five-character address structure. Instructions contain from 1 to 12 characters. Input-output, arithmetic, and data transfer instructions are usually 10, 11, and 12 characters in length, respectively. Although 15 index registers are provided, their usefulness is limited because no special instructions are available for incrementing or testing them. Floating point arithmetic is available on an RPQ (Request for Price Quotation) basis only.

The application of variable length field definitions to a data processing problem should be given very serious consideration. The main advantage of variable length fields is that the required input-output time is reduced. This advantage is a very valid consideration if the input-output time is the limiting factor for the total time required. However, in reducing the input-output time by using variable length fields, the additional data manipulation required to utilize these fields increases the required central processor time.

An alternative method to reduce to a minimum the total time requirements for a problem is to use a variable length record technique employing combinations of variable and fixed fields. That is, any fields (usually numeric) that require a great deal of manipulation are assigned fixed field length in fixed locations in the record, and any fields (usually alphabetic) that require very little manipulation form the variable portion of the record. Using this method effectively reduces the total time requirements for the majority of applications.

The 1410 instruction repertoire is characterized by: 64 data move instructions; versatile editing capabilities; table look-up capability; basic arithmetic instructions, including multiply and divide; comparison instructions; and logical branching. The variable

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INTRODUCTION (Contd.)

§ 011.

length operand fields are defined by word marks, enabling the program to be designed for the data rather than the machine.

The 1410 can operate with a variety of peripheral units, including magnetic ink character readers, telegraphic equipment, and remote inquiry units, in addition to magnetic tape, paper tape, and unit record equipment.

Punched card input-output and printer output are buffered; thus internal processing can be overlapped with card reading, punching, and printing. Unless the Processing Overlap feature is installed, however, magnetic tape reading and writing cannot occur simultaneously, either with each other or with internal processing. Additional facilities for expanding the degree of simultaneity available in a 1410 system include priority interrupt and a second input-output channel. With two channels and Processing Overlap, simultaneous read, compute, and write operations are possible.

The 1402 combination Card Read-Punch unit provides the 1410 system with a peak reading capability of 800 cards per minute and a peak punching capability of 250 cards per minute. A 1442 card reader, which can read 400 cards per minute, can also be connected to the 1410 system (see 414:071). The 1011 Paper Tape Reader has a peak speed of 500 characters per second.

The 1403 Model 1 and 2 Printers have 100 and 132 print positions, respectively. Each uses a 48-character print set and operates at a peak speed of 600 alphameric, single-spaced lines per minute. The 1403 Model 3 Printer has 132 print positions with a 48-character print set and operates at a peak speed of 1,100 alphameric lines per minute.

The IBM 729 series and 7330 Magnetic Tape Units can be used in the 1410 system. Peak transfer rates can range from 7,200 to 90,000 characters per second. The effective transfer rates can range from 6,100 to 50,000 characters per second using 1,000-character blocks. Since the effective transfer rate of core storage is 111,000 characters per second, very little data manipulation during tape read or write time is possible when using the higher speed tape units. Up to 20 tape units (10 per channel) can be connected, and no more than 2 tape read or write operations can occur simultaneously with internal processing.

The IBM 1412 or IBM 1419 Magnetic Ink Character Readers can be connected to a 1410 system to provide input from paper or card documents inscribed with magnetic ink.

A wide range of telegraphic equipment is available for connection to the 1410, including the powerful 7750 Program Transmission Control, the 7864 Telegraph Input-Output, the 1009 Data Transmission Unit, and the 1014 Remote Inquiry Unit.

Autocoder, the basic machine oriented coding system for the 1410, is available in two versions: Basic Autocoder and Autocoder. Autocoder is more powerful than Basic Autocoder in that it provides macro-instructions, longer literals, and the means to call on library routines. However, a minimum of 4 magnetic tape units and 20,000 positions of core storage are required for the assembly of Autocoder programs. The Autocoder library includes the Input-Output Control System (IOCS), which provides control and macro-instructions that handle reading and writing, tape blocking and unblocking, file labeling, and magnetic tape error detection.

The Autocoder library also includes the following programs:

- Simulation of the IBM 650; Enables the 1410 to assume the characteristics of the 650.
- 1410 Sort 10: Generalized program for ordering records of an unordered file on either magnetic tape or a RAMAC disk file.
- 1410 Sort/Merge 11: Generalized program for ordering and merging tape records; does not use Processing Overlap or the Priority Feature.

INTRODUCTION (Contd.)

§ 011.

- 1410 Sort/Merge 12: Generalized program for ordering and merging tape records; uses Processing Overlap and Priority Features.
- 1410 Card Report Program Generator: Facilitates the preparation of report programs.
- 1410 Tape Report Program Generator: Facilitates the preparation of report programs for tape files.
- Seven 1405 and six 1301 Disk Storage utility programs which provide the basic facilities for program testing, and service functions for production runs.

The library also contains a Procedure for Automatic Testing (PAT) which can include any or all of the following:

- Tracing routine: Traces each instruction within a specified area.
- Snapshot routine: Prints out the contents of selected areas of core storage following the execution of any instruction in the program being tested.
- Post Mortem: Prints out the entire contents of 1410 core storage.
- Clear Storage: Sets all of core storage to blank.
- Tape Duplicate: Duplicates data on one tape upon another.

Both COBOL-61 and FORTRAN II have been implemented for the 1410. Both the COBOL and FORTRAN compilers are on the Processor Operating System Tape, both produce Autocoder programs which must be translated to 1410 machine language by the Autocoder translator, and both require at least 20,000 positions of core storage and 4 magnetic tape units in the translating 1410 system. IBM 1410 COBOL includes a number of useful electives, such as the COMPUTE and ENTER verbs; but several significant features of Required COBOL-61, including the EXAMINE verb and the COBOL library, have not been implemented for the 1410. FORTRAN II for the 1410 is distinguished by the fact that the programmer can specify any desired degree of precision for the internal representation of both fixed and floating point data items.

The 1410 FORTRAN language includes complete facilities for defining and using subroutines and functions, but does not allow Boolean operations, complex arithmetic, or symbolic coding.

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DATA STRUCTURE

§021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Character:	8 bits	alphamerics.
Sector:	200 char.	1405 DSU record location.
Band:	5 sectors	1405 DSU.
Disc:	400 bands	1405 DSU.
Band:	2,800 char.	1301 DSU.
Disc:	500 bands	1301 DSU.
Band:	2,000 char.	1311 DSU.
Disc:	500 bands	1311 DSU.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	1 char.
Alphabetic:	1 char.
Instruction:	1 to 12 char.
Number:	1 to N char, ended by word mark.
Block:	1 to N char, ended by record mark or group mark with word mark.

Note: N is limited by size of core storage.

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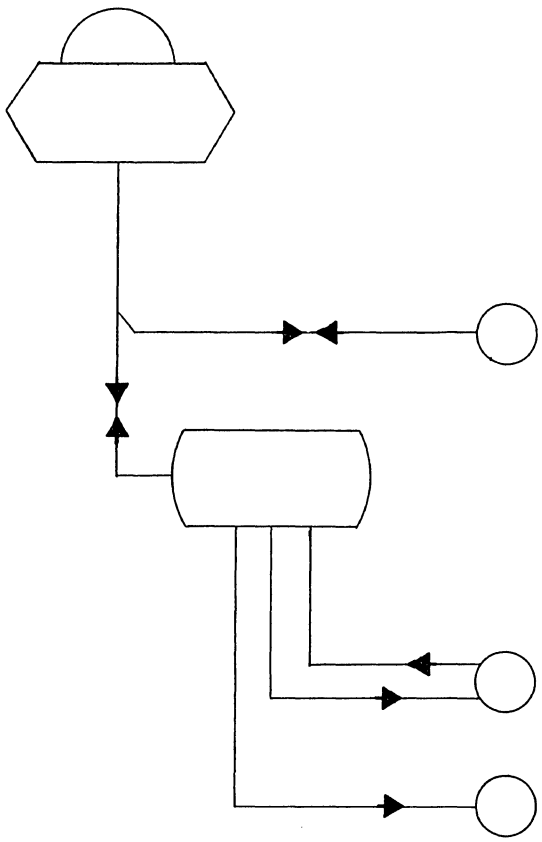
SYSTEM CONFIGURATION

§ 031.

I. TYPICAL CARD SYSTEM

Deviations: . . . . . none.

Rental: . . . . . $6,115 per month.



Equipment	Rental
Core Storage: 10,000 positions Processing Unit: 1411 Model 1	$3,800
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Printer: 600 lines/min.	775

Optional Features Included:. . . . . none.

Total $6,115

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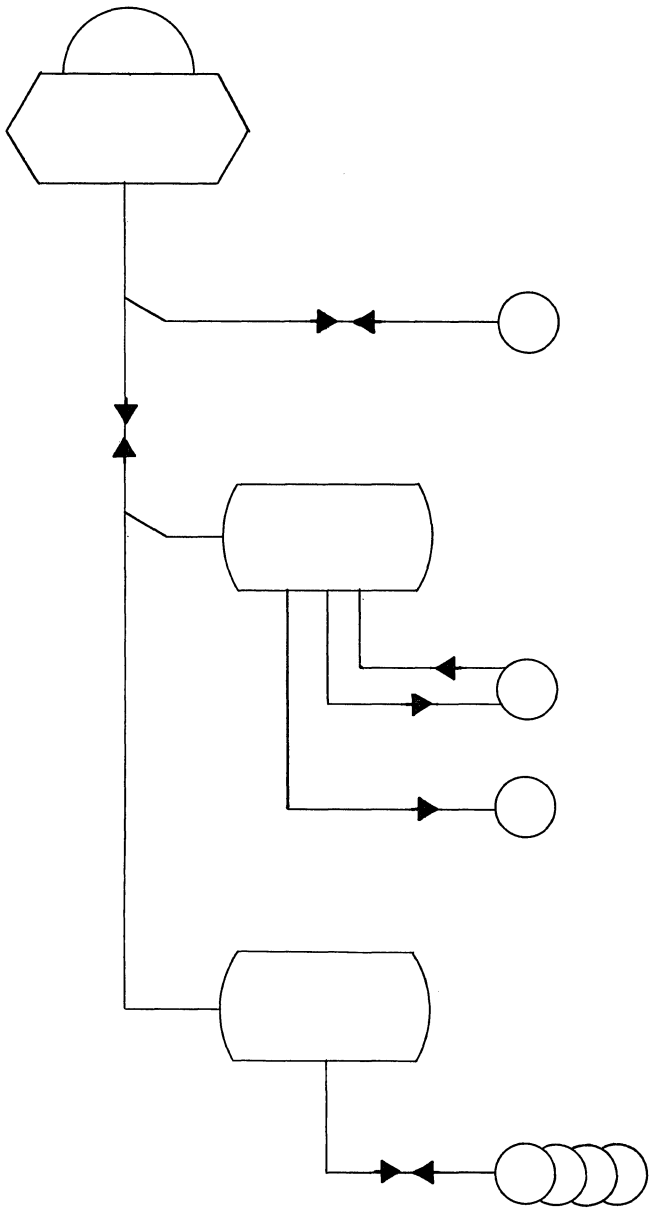
§ 031.

II. MINIMUM TAPE SYSTEM

Deviations: . . . . . none.

Rental: . . . . . $8,415 per month.



Equipment	Rental
Core Storage: 10,000 positions Processing Unit: 1411 Model 1	$3,800
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Printer: 600 lines/min.	775
Synchronizer: 1414 Model 2	500
Magnetic Tape Units (4): 7,200 or 20,016 char/sec.	1,800
Total	$8,415

Optional Features Included: . . . . . none.

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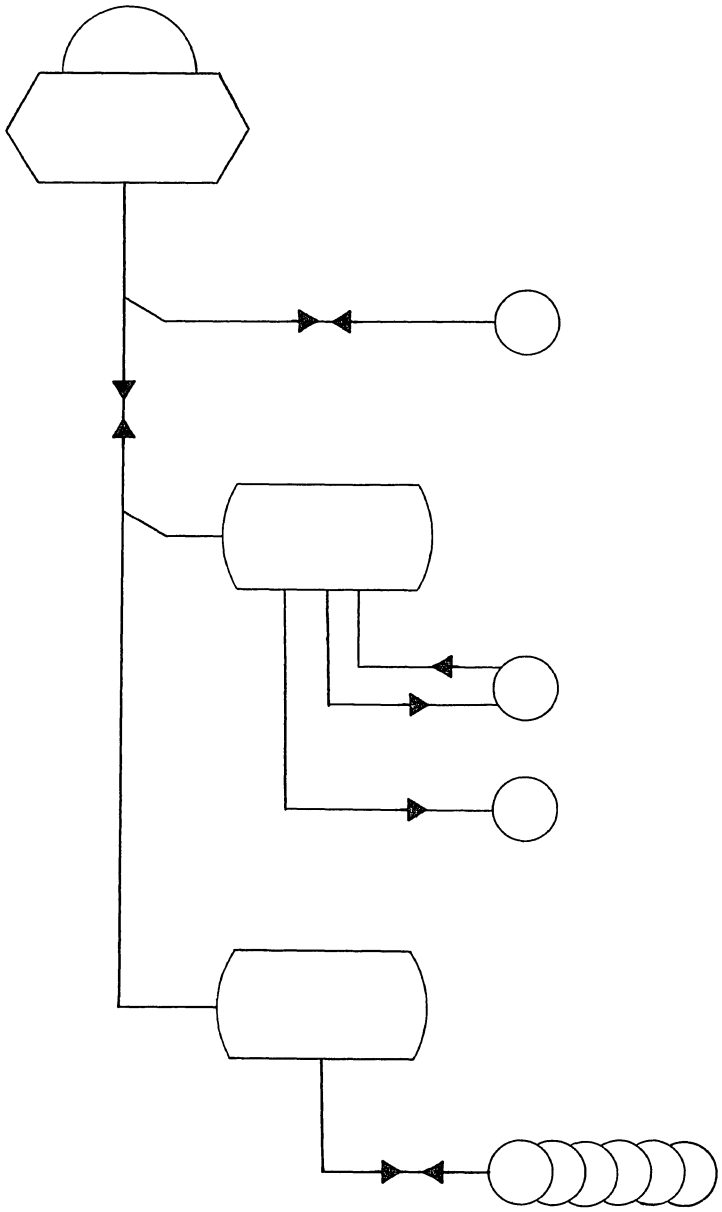
§ 031.

III. AVERAGE TAPE SYSTEM

Deviations: . . . . . none.

Rental: . . . . . $12,240 per month.



Equipment	Rental
Core Storage: 20,000 positions Processing Unit: 1411 Model 2	$4,550
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Printer: 600 lines/min.	775
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (6): 15,000 or 41,667 char/sec.	4,200
Optional Features Included: . . . . . Processing Overlap	200
Total	$12,240

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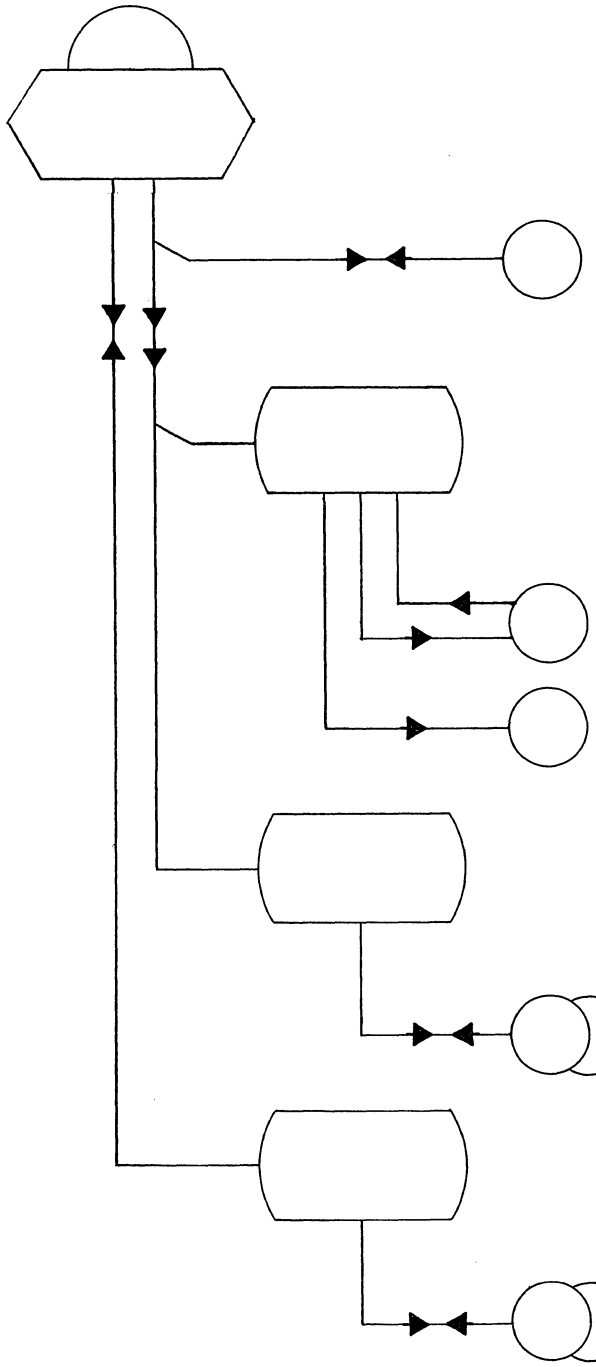
§ 031.

IV. EXPANDED TAPE SYSTEM

Deviations: . . . . . none.

Rental: . . . . . $19,060 per month.



Equipment	Rental
Core Storage: 40,000 positions Processing Unit: 1411 Model 3	$5,400
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Printer: 600 lines/min.	775
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (6): 15,000, 41,667, or 60,000 char/sec.	4,500
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (6): 15,000, 41,667 or 60,000 char/sec.	4,500

Optional Features Included: . . . . .

Processing Overlap	200
Priority Feature	125
800 CPI Feature on 729 Model IV (2)	70
Total	$19,060

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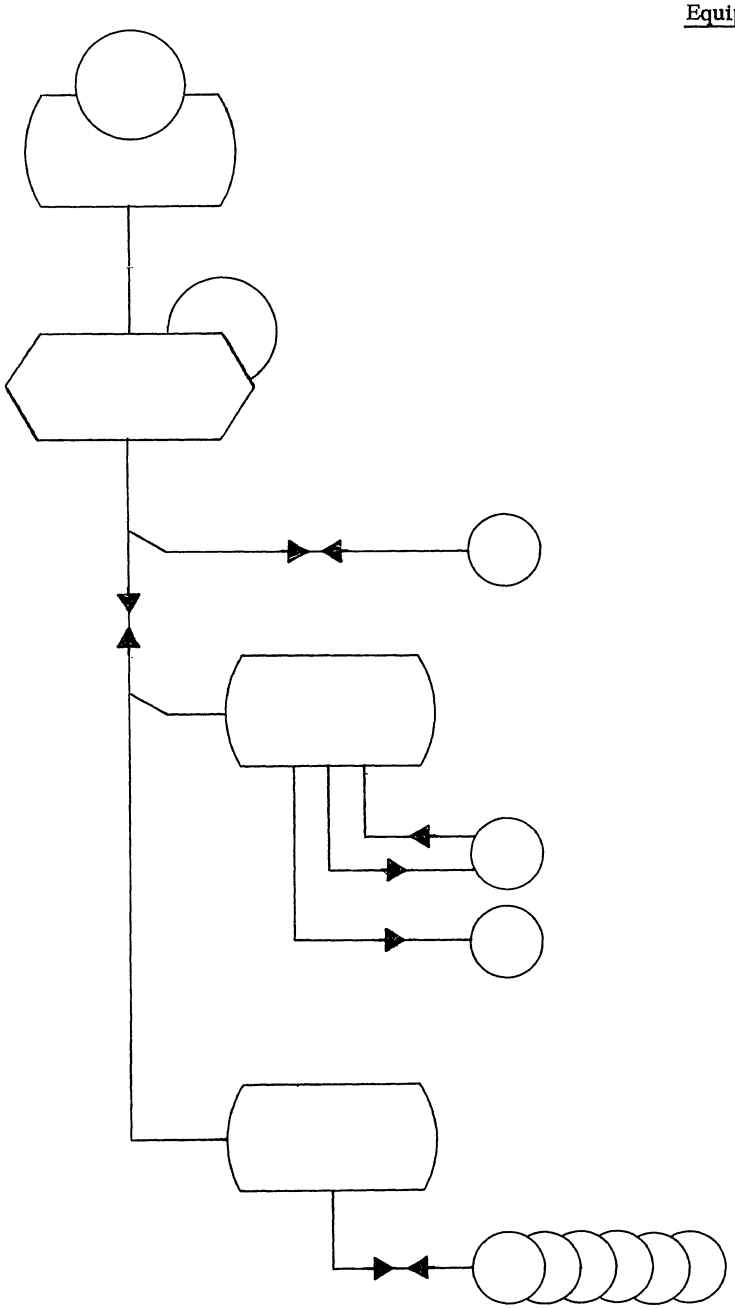
§ 031.

V. AUXILIARY STORAGE SYSTEM

Deviations: . . . . . none.

Rental: . . . . . $15,365 per month.



Equipment	Rental
Disk Storage and Controller: 1301 Model 1; 28,000,000 characters	$3,000
Core Storage: 20,000 Positions Processing Unit: 1411 Model 2	4,550
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Printer: 600 lines/min.	775
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (6): 729 II 15,000 or 41,667 char/sec.	4,200
Optional Features Included: . . . . . Processing Overlap	200
Priority Feature	125
Total	$15,365

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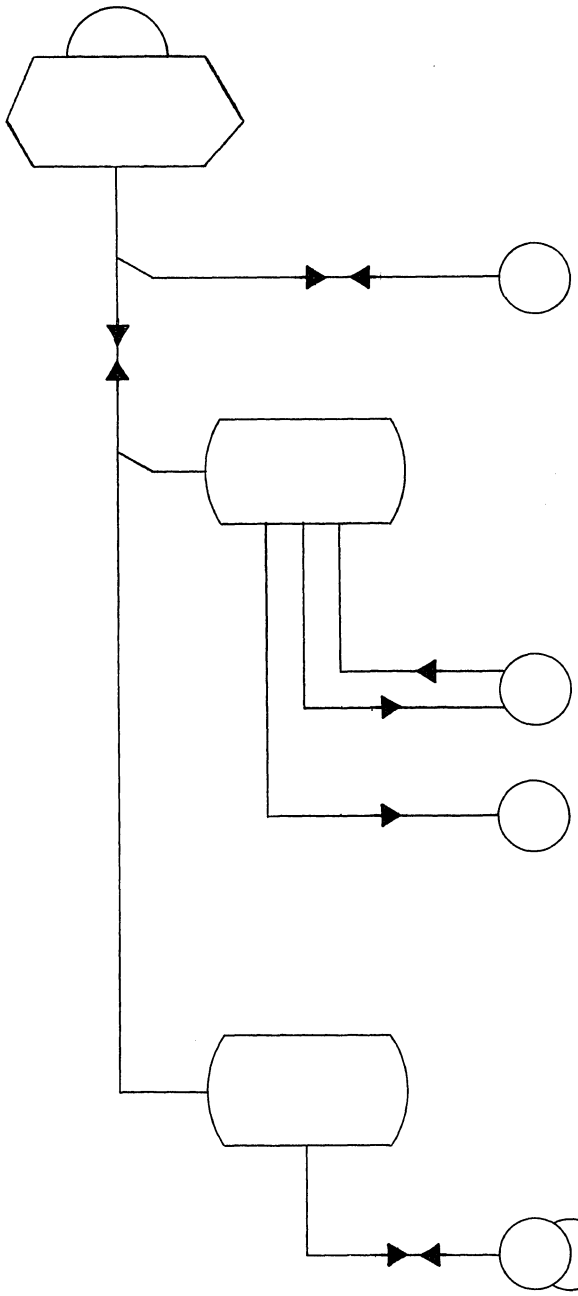
§031.

VI. SCIENTIFIC SYSTEM

Deviations: . . . . . floating point hardware available on RPQ basis only; not included here.

Rental: . . . . . $15,790 per month.



Equipment	Rental
Core Storage: 80,000 positions Processing Unit: 1411 Model 5	$8,100
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Printer: 600 lines/min.	775
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (6): 729 II 15,000 or 41,667 char/sec.	4,200
Optional Features Included: . . . . . Processing Overlap.	200
Total	$15,790

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§ 031.

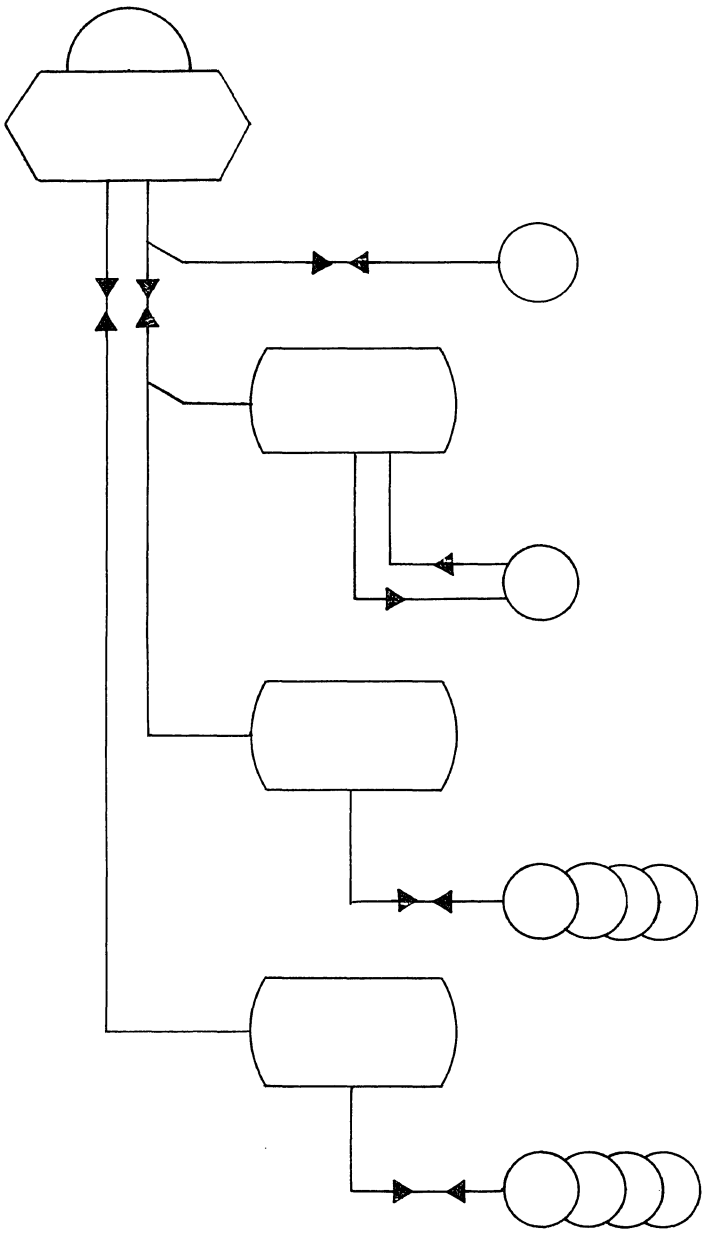
VIIB 10-TAPE GENERAL, PAIRED CONFIGURATION

Deviations from Standard Configuration

On-line: . . . . . card reader 700 cards/min. faster.
on-line Card Punch.
floating point hardware available
on RPQ basis only; not included here.
9 more index registers.

Rental: . . . . . $23,560 per month.

On-Line Equipment



Equipment	Rental
Core Storage: 80,000 positions Processing Unit: 1411 Model 5	$8,100
Console Typewriter	250
Synchronizer: 1414 Model 3	675
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	615
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (4) 22,500 or 62,500 char/sec.	3,600
Synchronizer: 1414 Model 1	975
Magnetic Tape Units (4) 22,500 or 62,500 char/sec.	3,600
Optional Features Included: . . . . . Processing Overlap	200
Priority Feature	125
TOTAL On-Line	$19,115
TOTAL Off-Line	4,445
GRAND TOTAL	$23,560

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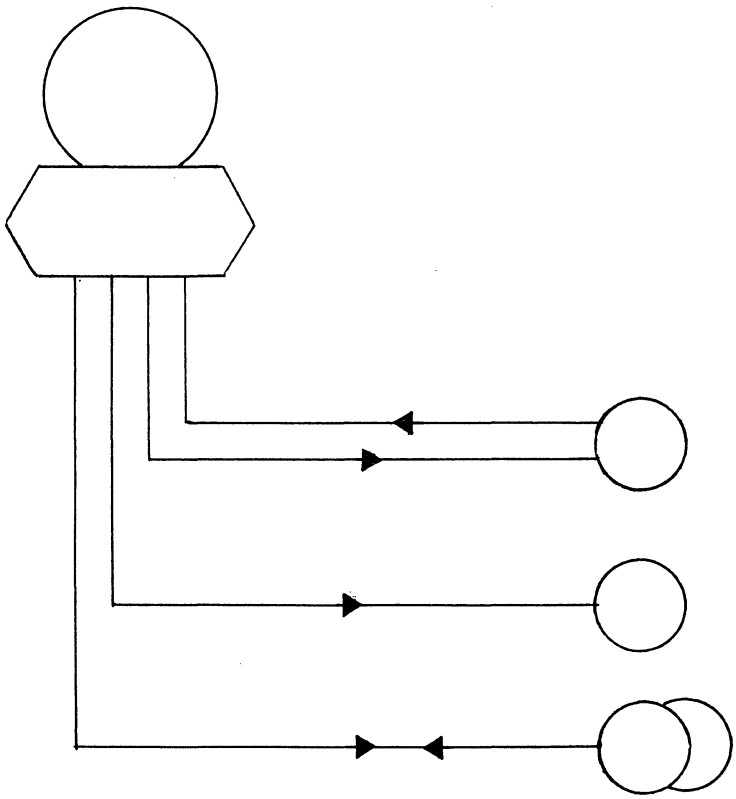
VIIB 10-TAPE GENERAL, PAIRED CONFIGURATION (Contd.)

Deviations from Standard Configuration

Off-line: . . . . . magnetic tape 10,000 char/sec. slower.
printer 100 lines/min. faster.
Card Reader 300 cards/min. faster.
Card Punch 150 cards/min. faster.
no Console typewriter output.

Off-line Equipment	Equipment	Rental
	Core Storage: 8,000 positions. Processing Unit: 1401 Model E4.	$2,130
	Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
	Printer: 600 lines/min.	775
	7330 Magnetic Tape Units (2) 7,200 or 20,016 char/sec.	900
Optional Features Included:	High-Low-Equal Compare.	75
	Sense Switches.	15
	TOTAL	$4,445

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INTERNAL STORAGE: CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . . Core Storage.
1411 Processing Unit Models 1, 2, 3, 4, 5.

.12 Basic Use: . . . . . working storage.

.13 Description

The 1411 Processing Unit can include from 10,000 to 80,000 character positions of core storage. Models 1, 2, 3, 4, and 5 contain 10,000, 20,000, 40,000, 60,000, and 80,000 positions, respectively. Cycle time is 4.5 microseconds for each access of one alphameric character. Each character position consists of eight bits: Six data bits, one odd parity bit, and one word mark bit.

Optional Features

Accelerator Feature: Reduces the cycle time from 4.5 microseconds to 4.0 microseconds for each access of one alphameric character and reduces the number of word cycles for some data operations. This feature produces an internal speed-up of approximately 23 per cent, with a resulting increase of 15 per cent to 23 per cent in the data throughput, by improving the timing of 39 instructions.

.14 Availability: . . . . . 14 months as of February, 1962.

.15 First Delivery: . . . . December, 1961.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	75 (can also be used as working storage)	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by program: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . coincident current.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Unit of data: . . . . 1 character.
Cycling rate: . . . . . 222,222 cycles/sec.
Conversion factor: . . 8 bits/character.
Data rate: . . . . . 222,222 char/sec.
Compound data rate: . 222,222 char/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	Minimum Storage Model 1	Model 2	Model 3	Model 4	Maximum Storage Model 5
Words:	variable	(1 to N characters, limited by storage capacity)			
Characters:	10,000	20,000	40,000	60,000	80,000
Instructions:	variable	(1 to 12 characters).			
Modules:	1	1	1	1	1

.32 Rules for combining modules: . . . . . all possible configurations are shown above.

.4 CONTROLLER: . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: 1 access device.

.52 Simultaneous Operations: . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . ? μsec.
Cycle time: . . . . 4.5 μsec.
For data unit of: . . . 1 character.

.6 CHANGEABLE STORAGE: . . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possible.
With self: . . . . . yes.

.72 Transfer Load Size

With self: . . . . . 1 to N characters, limited by storage capacity.

.73 Effective Transfer Rate

With self: . . . . . 111,000 char/sec.

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.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	limit check	stop & alarm.
Receipt of data:	parity check	stop & alarm.
Dispatch of data:	send parity bit.	
Conflicting commands:	not possible.	
Improper commands:	check	stop & alarm.
Recording of data:	record parity bit.	
Recovery of data:	parity check	stop & alarm.

INTERNAL STORAGE: 1405 DISK STORAGE UNIT

§ 042.

.1 GENERAL

.11 Identity: . . . . . 1405 Disk Storage Unit. Models 1 & 2. DSU.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

This store, often referred to as a RAMAC unit, consists of 25 or 50 thin magnetic discs on a common vertical shaft. Each disc has 200 bands on the top face and 200 on the bottom. Each band is divided into 5 sectors, each capable of holding 1 record with a fixed length of 200 alphameric characters. The Model 1 has 25 discs with a total capacity of 50,000 records or 10,000,000 characters. The Model 2 has 50 discs with a capacity of 100,000 records or 20,000,000 characters. Up to five units can be connected to a system.

Access is by means of a fork-shaped arm with two read-write heads, one head serving each face of the disc. The arm moves vertically to the selected disc, then horizontally to the selected band. A seven-position indelible address on the disc is used to verify automatically that the record accessed is the one called for by the program. The "write disc check" command may be used for a programmed comparison of data in core storage with data previously written on the disc. Access time varies from 0.2 to 800 milliseconds; the average for pure random processing is approximately 600 milliseconds. The peak transfer rate is 22,500 characters per second; the bulk transfer rate with optimum arrangement of data is 8,400 characters per second.

Two Additional Access Arms per unit are available as optional features. These arms make it possible to seek three different records on one unit simultaneously, but only one read or write operation at a time can be performed on one channel. The maximum total number of access arms which a 1410 system can have is twelve.

.14 Availability: . . . . . 14 months, as of February, 1962.

.15 First Delivery: . . . . with 1410 system, February, 1962.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . multiple disc.

.22 Physical Dimensions

.222 Drum or disc
- Diameter: . . . . . 24 inches.
- Thickness or length: . thin.
- Number on shaft: . . . Model 1, 25 discs. Model 2, 50 discs.

.23 Storage phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by program: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data volume per band of 1 track

- Words: . . . . . variable.
- Characters: . . . . . 1,000.
- Digits: . . . . . 1,000.
- Instructions: . . . . . variable.
- Records: . . . . . 5.

.26 Bands per physical unit: 400 per disc (200 each side).

.27 Interleaving Levels: . . none.

.28 Access Techniques

.281 Recording method: . . . two magnetic heads on moving access arm.

.283 Type of access

Description of stage	Possible starting stage
Remove head from unwanted disc:	if new disc is selected.
Move head to selected disc:	no.
Move head to selected band:	if same disc was previously selected.
Wait for start of selected record: . . .	if same band was previously selected.
Wait for transfer of record:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
- Cycling rates: . . . . 1,200 rpm.
- Bit rate per track: . . 157,500 bits/sec/track.

.292 Peak data rates
- Unit of data: . . . . . character.
- Conversion factor: . . 7 bits/char.
- Gain factor: . . . . . 1.
- Data rate: . . . . . 22,500 char/sec.

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.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	-	1405, Model 1	1405, Model 2.
Discs:	0	25	50.
Words:	0	variable	variable.
Characters:	0	10,000,000	20,000,000.
Instructions:	0	variable	variable.
Records:	0	50,000	100,000.
Bands:	0	10,000	20,000.
Modules:	0	1	1.

.32 Rules for Combining Modules: . . . . . 5 modules max; Model 1 or 2.

.4 CONTROLLER

.41 Identity: . . . . . Disk Storage Control. #3326.

.42 Connection to System

.421 On-Line: . . . . . No more than 1 per I/O channel.
.422 Off-Line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: up to 5.
.432 Restrictions: . . . . . maximum of 5 Disk Storage Units per system; 1405's cannot be included in the same 1410 system with 1301's.

.44 Data Transfer Control

.441 Size of load: . . . . . one 200-char record or one 1,000-char band.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . none.
.448 Testable conditions: . . not ready; access arm busy; invalid character; wrong length record; no transfer.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of heads
Stacks per system: . 24 max.
Stacks per module: . 6 max.
Stacks per yoke: . . . 2.
Yokes per module: . . 1 standard; 3 max.
.512 Stack movement: . . . . vertically to selected disc, then horizontally to selected band.
.513 Stacks that can access any particular location: . . . . . 3 max.
.514 Accessible locations, records

	Model 1	Model 2
By single stack		
With no movement:	5	5.
With all movement:	25,000	50,000.
By all stacks, with no movement		
Per module, standard:	10	10.
Per module, with 3 access arms:	30	30.
Per system, max:	120	120.

.515 Relationship between stacks and locations: . one stack serves top faces of all discs; other stack serves bottom faces.

.52 Simultaneous Operations

A: . . . . . waiting for access to specified location.
B: . . . . . searching for access by pattern matching.
C: . . . . . reading.
D: . . . . . recording.

b = 0.
c + d = at most 1 per channel.
a + c + d = at most n, where n is the number of access arms in the system (maximum of 12).

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation (msec)	Example (msec)
Remove head from unwanted disc: . . .	0 or 90 to 250	200.
Move to selected disc:	0 or 100 to 315	200.
Move to selected band:	0 or 90 to 250	200.
Wait for start of selected record: . . .	0.2 to 50.2	25.
Read one record, or:	10	10.
Read one band:	50	- .
Total	10.2 to 915	635.

.6 CHANGEABLE STORAGE: . . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities

With self: . . . . . no.
With core storage: . . yes.

.72 Transfer Load Size

With core storage: . . in units of 1 record or 1 band.

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.73 Effective Transfer Rate

With core storage: . . 8,400 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	none.	
Receipt of data:	parity check*	indicator & alarm.
Dispatch of data:	send parity bit.	
Conflicting commands:	interlock	wait.
Inoperable access arm:	check	indicator & alarm.
Wrong-length record:	check	indicator & alarm.
Wrong record selected:	address comparison	try again; if still wrong, set indicator & alarm.
Any disc unit error:	check	indicator & alarm.
Recovery of data:	parity check and address comparison	indicator & alarm.

* "Write disc check" can be programmed for complete checking of write operations.

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INTERNAL STORAGE: 1301 DISK STORAGE UNIT

§ 043.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit. 1301 Models 1 and 2.

.13 Description

The 1301 Model 1 Disk Storage Unit can store up to 28,000,000 alphameric characters. The Model 2 has 2 modules on a single vertical shaft and can store up to 56,000,000 characters. Each module contains 25 discs; 40 of the 50 disc surfaces are used for data storage. Each module is served by a comb-like access mechanism. Forty data read-write heads, one for each data surface, move horizontally between the discs. The entire access mechanism moves as one unit, so the horizontal position of all the heads serving a given module is always the same. The 40 bands, 1 on each disc surface, that can be read or recorded upon when the access mechanism is in any given position are referred to as a "cylinder".

There are 250 bands on each disc surface. The size and number of records stored in each band are variable. Their formats are controlled by a format surface that can be written upon only by a special instruction after manually releasing a write lock. Each of the 250 bands on the format surface controls the record format of the entire cylinder in the corresponding position. A different record format can be used in each of the 250 cylinders in each module.

Data can be recorded in either of two modes. In the move mode, only the six data bits and one space bit are recorded for each character. In the load mode, word mark bits are also recorded, and a total of nine bits is used for each character. All storage capacities and transfer rates quoted in this report are based on the move mode; they will be about seven-ninths as high when the load mode is used.

Each band contains one six-character home address plus one six-character record address for each record stored in it. The storage capacity of each band is 2,838 - 38R characters, where R is the number of records in the band. Twenty-four 80-character records, for example, could be stored in one band. Instructions are provided to read or record a single record, a full band with or without record addresses, or, with the optional Read/Write Cylinder feature a full cylinder of up to 112,000 characters.

Time for access mechanism movement ranges from zero (for a record in a previously-selected cylinder) to 180 milliseconds. Maximum rotational delay time is 34 milliseconds. Total reference cycle time to read a randomly-placed record of 270 characters, up-date it, re-write it, and execute a programmed write check is 248 milliseconds. If no access motion is required, the total reference cycle time is reduced to 88 milliseconds. Using the Read/Write Cylinder feature, an effective bulk transfer rate of 82,300 characters per second can be achieved.

Checking features include a parity check upon data received by the File Control, a comparison of the record address on the disc with the address in the stored program, and a wrong-length record indicator. Three check characters are generated and recorded during each write operation. When the record is read, the check characters are automatically generated again and compared with the ones read from the disc. As in the 1405 RAMAC unit, a programmed comparison of data recorded on a disc with data in core storage can be carried out by means of the "write disc check" instruction.

1301 Disk Storage Units can be connected to one or both of the 1410's I/O channels; the total number of 1301 units is limited to five in either case. Model 1301, 1311, and 1405 Disk Storage Units cannot be used in the same 1410 system. The 1301 has larger capacities, faster access, higher transfer rates, more flexible formats, and more checking features than the earlier 1405 RAMAC unit.

.14 Availability: . . . . . 14 months as of February, 1962.

.15 First Delivery: . . . . July, 1962.

.16 Reserved Storage

Purpose	Number of locations	Locks
Clocking:	1 disc surface	not addressable.
Spares:	8 disc surfaces	not addressable.
Format:	1 disc surface	manual lock.
Addresses:	42 + 38R char/track, for R records/ track	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . . 24 inches.
Thickness or length: . thin.
Number on shaft: . . . Model 1, 25 discs.
Model 2, 50 discs.

.23 Storage Phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.

.242 Data regenerated constantly: . . . . . no.

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.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data Volume per Band of 1 Track

Words: . . . . . variable.
Characters: . . . . . 2,838 - 38R, for R records/track.
Digits: . . . . . 2,838 - 38R.
Instructions: . . . . . variable.
Records: . . . . . variable.

.26 Bands per Physical Unit: 250 per disc surface.

.27 Interleaving Levels: . . 1.

.28 Access Techniques

.281 Recording method: . . . magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to selected band:	if new band is selected.
Wait for selected record:	if same band was previously selected.
Read one record or one band:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1,790 rpm.
Bit rate per track: . . 630,000 bits/sec.

.292 Peak data rates
Unit of data: . . . . . character.
Conversion factor (bits per unit): . . . . . 7 (9 in load mode).
Gain factor (tracks per band): . . . . . 1.
Data rate: . . . . . 90,000 char/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage			Maximum Storage
Identity:		1301 Model 1	1301 Model 2	5 1301s, Model 2
Discs:	0	20 data	40 data	200 data
Words:	0	variable		
Characters (max):	0	28,000,000	56,000,000	280,000,000
Instructions:	0	variable		
Records:	0	variable		
Bands:	0	10,000	20,000	100,000
Modules:	0	1	2	10

.32 Rules for Combining Modules: . . . . . up to 5 1301s, Model 1 and/or Model 2, in any combination.

.4 CONTROLLER

.41 Identity: . . . . . File Control. #7631 Models 1 and 3.

.42 Connection to System

.421 On-line: . . . . . 2; 1 per I/O channel.
.422 Off-line: . . . . . #7631 Model 3 permits shared use of 1301s with an IBM 7000 series system (except 7072).

.43 Connection to Device

.431 Devices per controller: 5.
.432 Restrictions: . . . . . maximum of 5 Disk Storage Units per system; 1301 and 1405 Disk Storage Units cannot be used in same system.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 record of 1 to 2,800 chars, 1 band of up to 2,800 chars, or (with optional Read/Write Cylinder) 1 cylinder of up to 112,000 characters.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block (no lockout in overlap mode).
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . none.
.448 Testable conditions: . . not ready; access in motion; data check; wrong record selected; no transfer; wrong length record.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
Stacks per system: . . 40 to 400.
Stacks per module: . . 40.
Stacks per yoke: . . . 40.
Yokes per module: . . 1.
.512 Stack movement: . . . . horizontal.
.513 Stacks that can access any particular location: . . . . . 1.
.514 Accessible locations
By single stack
With no movement: . 1 band.
With all movement: . 250 bands.
By all stacks
With no movement: . 40 bands per module. 40 to 400 bands per system.
.515 Relationship between stacks and locations: . first 4 digits of 6-digit home address for each band denote head and band number.

.52 Simultaneous Operations

A: . . . . . seeking a specified location.
B: . . . . . reading.
C: . . . . . recording.
a + b + c = at most 1 per Disk Storage Unit module.
b + c = at most 1 per File Control.

§ 043.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, (msec)	Example, (msec)
Move head to selected band:	0 or 50 to 180	160.
Wait for selected record:	0 to 34	17.
Read one record:	0.4 to 34	4.
Read one band:	34.	
Total:	0.4 to 248	181.

.6 CHANGEABLE STORAGE: no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

With self: no.
With core storage: yes.

.72 Transfer Load Size

With core storage: 1 record of 1 to 2,800 chars, 1 band, or (with optional Read/Write Cylinder) 1 cylinder.

.73 Effective Transfer Rate

With core storage (using optional Read/Write cylinder): 82,300 char/sec.
With core storage (without Read/Write Cylinder): 42,000 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	indicator & alarm.
Invalid code:	parity check	indicator & alarm.
Receipt of data:	parity check	indicator & alarm.
Recording of data:	programmed write check; generate check characters	indicator & alarm.
Recovery of data:	regenerate and compare check characters	indicator & alarm.
Dispatch of data:	send parity bit.	
Timing conflicts:	check	indicator & alarm.
Physical record missing:	check	indicator & alarm.
Reference to locked area:	none.	
Circuit failure:	check	indicator & alarm.
Wrong length record:	check	indicator & alarm.

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INTERNAL STORAGE: 1311 DISK STORAGE DRIVE

§ 044.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Drive. 1311 Models 1 and 2.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

The 1311 Disk Storage Drive is a low cost random access storage, available for the IBM 1401, 1440, and 1620 Data Processing Systems as well as the 1410, which features rapid interchangeability of the "Disk Pack" storage cartridges. The system is suitable for either random or sequential processing methods.

Each Disk Pack consists of six discs on a common vertical axis. Data can be recorded on ten disc surfaces; the top and bottom surfaces of the pack are not used. Each recording surface is divided into 100 concentric tracks, each track is divided into 20 sectors, and each sector holds a 5-character address and up to 100 alphameric characters of data. The data capacity is therefore 2,000 characters per track, 200,000 characters per surface, and 2,000,000 characters per pack. With the optional Track Record feature, the data capacity is 2,980 characters per track, 298,000 characters per surface, and 2,980,000 characters per pack. It should be noted that use of this feature requires reading full tracks of data, thereby increasing the required internal core storage. Up to 5 Disk Storage Drives per channel can be connected to a 1410 system; thus the maximum on-line data capacity is 20,000,000 characters.

Access is by means of a comb-like mechanism containing five arms that move horizontally between the discs. Each arm has one read-write head mounted on the top and one on the bottom, and each head serves one disc surface. The entire access mechanism moves as one unit, so all 10 read-write heads are always positioned at corresponding tracks on their respective surfaces. The term "cylinder" is applied to each group of 10 tracks (1 on each disc surface) that can be read or recorded upon at a single setting of the access mechanism. There are 100 cylinders per Disk Storage Drive, and each cylinder can hold 20,000 data characters.

Time for access mechanism movement ranges from zero (for successive references to a previously-selected cylinder) to 400 milliseconds; average random access time is 250 milliseconds. Unless the optional Direct Seek feature is installed, the access arms cannot move directly from one cylinder to another. Instead, the arms retract all the way to the "home" position (beyond track 00) and then move back to the selected cylinder. The result is that movements between adjacent cylinders require from 85 milliseconds (track 00 to 01) to 390 milliseconds (track 98 to 99).

.13 Description (Contd.)

Rotational speed of the discs is 1,500 rpm. Maximum rotational delay is 40 milliseconds, and the average is 20 milliseconds. There is also a head select delay of 2 milliseconds. Total reference cycle time to read a randomly-placed 100-character record, up-date it, re-write it, and execute a programmed write check is 354 milliseconds. If no access motion is required, the total reference cycle time is reduced to 104 milliseconds. Peak data transfer rate is 77,000 characters per second, and the effective bulk transfer rate is 33,800 to 38,200 characters per second.

A single read or write instruction can transfer from 1 to 200 consecutive sectors of information; i.e., from 100 characters to the capacity of core storage, in multiples of 100 characters. The programmer can elect to read and write sector addresses along with the data records. Handling of variable-length disc records is facilitated by "sector count overlays" in which the first three characters of a record specify the number of sectors (from 2 to 200) comprising that record.

All capacities and transfer rates quoted here are based on operation in the "move" mode, in which six data bits and one parity bit are recorded for each character. In the alternative "load" mode, the word mark bit is also recorded for each character, and sector capacity is reduced from 100 to 90 data characters. All capacities and transfer rates for the load mode are therefore 10 per cent lower than the figures quoted here. Use of the load mode is essential for program storage and for data storage when field lengths vary from record to record.

Checks are made for parity errors, wrong length records, and unequal address comparisons. The "write disc check" instruction causes a character-by-character comparison of data just written on the disc with the data in core storage. This instruction usually follows each write operation. All disc errors cause the setting of testable indicators.

Disk Storage Drive seek time can be fully overlapped with internal processing. A "branch if access mechanism busy" instruction is provided. No overlapping is possible during disc read or write operations. Only one seek operation may go on at a time, regardless of the number of Disk Storage Drives in a system.

The removable Disk Packs are 14 inches in diameter, 4 inches high, and weigh less than 10 pounds, including covers. A Disk Pack can be removed from a Disk Storage Drive and replaced by another Disk

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.13 Description (Contd.)

Pack in one minute. When a Disk Pack is not mounted on a drive, the pack and its cover combine to form a sealed container that can be conveniently stored and transported. One Disk Pack is supplied with each 1311 Disk Storage Drive. Additional Disk Packs cost $490 each, f.o.b. San Jose.

Optional Features

Direct Seek: Permits the access mechanism to move directly to the specified cylinder without returning to the "home" position. Access motion time ranges from zero to 250 milliseconds and averages 150 milliseconds.

Track Record: Permits reading and writing a full track as a single 2,980-character record, thereby increasing the capacity of each Disk Pack from 2,000,000 to 2,980,000 characters. The increased capacity is achieved by using the areas that normally contain sector addresses for data storage.

Scan Disk: Permits an automatic search of data recorded in disc storage for a specific identifier or condition.

.14 Availability: . . . . . ?

.15 First Delivery: . . . . ?

.16 Reserved Storage: . . . none. (Note that each 100-digit sector is preceded by a 5-digit address, but these address digits are not counted as storage.)

.2 PHYSICAL FORM

.21 Storage Medium: . . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . . 14 inches o.d.
Thickness or length: . thin.
Number on shaft: . . . 6.

.23 Storage Phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . yes.

.25 Data Volume Per Band of 1 Track

Words: . . . . . variable.
Characters: . . . . . 2,000.
Digits: . . . . . 2,000.
Instructions: . . . . . variable.
Sectors: . . . . . 20.

.26 Bands per physical unit: 100 per disc surface.

.27 Interleaving Levels: . . 1.

.28 Access Techniques

.281 Recording method: . . . by one of the magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to home position † and then to selected band: .	mandatory when new band is selected.
Wait for selected sector for reading or recording: . . .	if same band was previously selected.

† Not necessary with Direct Seek feature.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1,500 rpm.
Bit rate per track: . . 539,000 data bits/sec/track.

.292 Peak data rates
Unit of data: . . . . . character.
Conversion factor: . . 7 bits per character (6 plus parity).
Gain factor: . . . . . 1 track/band.
Data rate: . . . . . 77,000 characters/sec not counting address digits.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage			Maximum Storage
Identity:	0	1311 Model 1	1311 Model 2	2 1311's Model 1 & 8 1311's Model 2.
Discs:	0	6	6	60.
Words:	0	variable	variable	variable.
Characters:	0	2,000,000	2,000,000	20,000,000.
Instructions:	0	variable	variable	variable.
Modules:	0	1	1	10.

.4 CONTROLLER

.41 Identity: . . . . . part of 1311 Model 1.

.42 Connection to System

.421 On-line: . . . . . 2 1311's Model 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 5 modules.
.432 Restrictions: . . . . . 1 Model 1 and 1 to 4 Model 2; no other restrictions.

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.44 Data Transfer Control

.441 Size of load
- Variable length: . . . 1 to 200 sectors of 100 characters per sector; number of sectors set by programmer.
- Fixed length: . . . . . 20 sectors of 100 characters per sector (1 band).

.442 Input-output area: . . . core storage.

.443 Input-output area access: . . . . . each character.

.444 Input-output area lockout: . . . . . yes.

.445 Synchronization: . . . . automatic.

.447 Table control: . . . . . none.

.448 Testable conditions: . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks
- Stacks per system: . . 100 max.
- Stacks per module: . . 10.
- Stacks per yoke: . . . 10.
- Yokes per module: . . 1.

.512 Stack movement: . . . . horizontal.

.513 Stacks that can access any particular location: . . . . . 1.

.514 Accessible locations
- By single stack
  - With no movement: . 20 sectors.
  - With all movement: . 2,000 sectors.
- By all stacks
  - With no movement: . 200 sectors per module 200 to 1,000 sectors per system.

.515 Relationship between stacks and locations: . 3 most significant digits of Sector Address denote head and band (cylinder) number.

.52 Simultaneous Operations: . . . . . no more than 1 1311 Disk Storage operation (reading, recording, or seeking) at a time per 1410 system.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation	Average
Without Direct Seek		
Move head to home position and then to selected band:	75 to 392 msec	250 msec.
Wait for selected sector for reading or recording: . .	0 to 40 msec	20 msec.
Total:	75 to 432 msec	270 msec.
With Direct Seek		
Move head to selected band: . .	54 to 248 msec	154 msec.
Wait for selected sector for reading or recording: . .	0 to 40 msec	20 msec.
Total:	54 to 288 msec	174 msec.

.6 CHANGEABLE STORAGE

.61 Cartridges

.611 Cartridge capacity
- Without track record feature: . . . . . 2,000,000 characters (6 discs).
- With track record feature: . . . . . 2,980,000 characters (6 discs).

.612 Cartridges per module: 1.

.613 Interchangeable: . . . . yes.

.62 Loading Convenience

.621 Possible loading
- While computing system in use: . . . yes.
- While storage system in use: . . . yes, if the particular module is not addressed.

.622 Method of loading: . . . operator.

.623 Approximate change time: . . . . . 1 minute.

.624 Bulk loading: . . . . . no; 1 cartridge of 6 discs at a time.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage unit possibilities
- With self: . . . . . no.
- With core storage: . . yes.

.72 Transfer Load Size

With core storage: . . . 1 to 200 sectors; number of sectors selected by program.
1 block of 20 sectors (1 band).

.73 Effective Transfer Rate

The times shown are the average for either reading from or recording on disc storage with no checking.

With core storage
- With Direct Seek: . . 38,200 char/sec.
- Without Direct Seek: . 33,800 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check on matching sector address	indicator.
Invalid code:	none.	
Receipt of data:	parity check	indicator.
Recording of data:	programmed read-back and compare	indicator.
Recovery of data:	parity check	indicator.
Dispatch of data:	parity bit included.	
Timing conflict:	interlock	wait.
Physical record missing:	check on record length	indicator.
Reference to locked area:	check on optional lock	indicator.

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CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . 1411.
Processing Unit.
Models 1, 2, 3, 4, and 5.

.12 Description

The 1411 is a two-address, add-to-storage processor. The five models differ only in the number of core storage positions they contain. The standard instruction repertoire includes multiplication, division, table look-up, comparison, a wide variety of internal data transfers, and a powerful editing capability. Operations are performed serially by character and are usually terminated when a word mark bit is sensed. Operand sizes may vary from one character to the capacity of core storage. Instruction length is variable from 1 to 12 characters, but most arithmetic and data transfer instructions are 11 characters long. When a series of operations is to be performed on data stored in sequential locations, it is possible to "chain" some of the instruction addresses so that 1-character instructions do the work of 11-character instructions. Fifteen 5-position index registers are provided in core storage, but no specific commands exist for initializing, stepping, or testing the index registers.

Data movement is performed in either the MOVE mode or the LOAD mode of operation. In the MOVE mode, data are moved without field-defining word marks, thereby effectively restricting the data format to fixed word length, because instructions must repeatedly operate on the same data addresses. In the LOAD mode, data are moved with restricting word marks making variable field length possible. The LOAD mode usually results in longer internal processing because it usually requires storing address registers, and subsequent indexing to determine the length of the data field in order to ascertain the low-order position of the next data field. The LOAD mode usually makes tape input-output operations shorter, even though an extra word mark character is inserted on the tape record for each field, because the total length of the record is usually shorter and because non-significant zeros used to fill out fields to equal lengths in the MOVE mode can be omitted.

The ability to store the contents of either the A-address or the B-address registers is very helpful when addressing fields; however, the contents of only one of the registers can be stored for a given setting because the instruction that stores the contents of one register will destroy the contents of the other.

The 1411 core storage cycle time of 4.5 microseconds is 2.56 times as fast as that of the closely related IBM 1401 Processing Unit, but the instruction addresses for the 1411 are two characters longer and it requires more storage cycles for certain operations. In most applications, the overall internal speed ratio of the 1411 over the 1401 with Multiply-Divide, Advanced Programming, and High-Low-Equal Compare options is very close to 2.0.

.12 Description (Contd.)

Optional Features

Program Addressable Clock: Permits storing real time values, in hours and hundredths, in core storage by program interrogation of the clock. The unit is mounted on the 1415 Console and provides a visual display of time.

Priority Feature: Permits automatic interruption of the stored program upon completion of selected input-output or seek operations or upon console request, allowing more efficient use of the system's overlap and inquiry capabilities.

Process Overlap Feature: Allows processing to continue during storage cycles not required for data transfer by input-output operations.

Accelerator Feature: Reduces the cycle time from 4.5 microseconds to 4.0 microseconds for each access of one alphameric character and reduce the number of word cycles for some data operations. This feature produces an internal speed-up of approximately 23 per cent, with a resulting increase of 15 per cent to 23 per cent in the data throughput, by improving the timing of 39 instructions.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . December, 1961.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-Subtract:	automatic	decimal	1 to N char. (N limited by available store).
Multiply			
Short:	none.		
Long:	automatic	decimal	1 to N char.
Divide			
No remainder:	none.		
Remainder:	automatic	decimal	1 to N char.

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.21 Operations and Operands (Contd.)

Operation and Variation	Provision	Radix	Size
.212 Floating point*			
Add-Subtract:	subroutine	decimal	8 & 2 char.
Multiply:	subroutine	decimal	8 & 2 char.
Divide:	subroutine	decimal	8 & 2 char.
.213 Boolean			
AND:	none.		
Inclusive OR:	none.		
.214 Comparison			
Numbers:	automatic	1 to N	char.
Absolute:	none.		
Letters:	automatic	1 to N	char.
Mixed:	automatic	1 to N	char.
Collating sequence:	blank, special characters, A-Z, 0-9.		

* Hardware available on a "Request Price Quotation" basis.

.215 Code translation: . . . none.

.216 Radix conversion: . . . none.

.217 Edit format:

	Provision	Comment	Size
Alter size:	automatic	expand but not contract	2 to N char.
Suppress zero:	automatic		
Round off:	none.		
Insert point:	automatic		
Insert spaces:	automatic		
Insert $, CR-*:	automatic		
Float $:	automatic		
Protection:	automatic	asterisk protection, sign and decimal control	
Equality:	automatic	d modifier (see instruction format) determines type of look-up	1 to N char.
Greater than:	automatic		
Greatest:	none		
Least:	none		
Stop on any:	automatic		
Lookup to end:	automatic		
Less than:	automatic		
Greater than or equal to:	automatic		
Less than or equal to:	automatic		

.22 Special Cases of Operands

.221 Negative numbers: . . absolute value with B zone-bit in units position.

.222 Zero: . . . . . positive, negative and unsigned zeros and blanks give same result in arithmetic, but are unequal in comparisons.

.223 Operand size determination: . . . . . word-mark bit in high-order digit position.

.23 Instruction Formats

.231 Instruction structure: . variable: 1 to 12 characters.

.232 Instruction layout:

Part	OP	A or I	B	d
Size (char)	1	5	5	1

or

Part	OP	X	B	d
Size (char)	1	3	5	1

Instruction formats may contain:

1. OP only
2. OP, d
3. OP, X, d
4. OP, A
5. OP, A, d
6. OP, X, B, d
7. OP, A, B
8. OP, A, B, d

.233 Instruction parts

Name	Purpose
OP:	operation code-specifies operation to be performed.
I:	address indicating the destination of a jump.
A:	address of a field in core storage.
X:	channel and I/O unit involved in an I/O operation.
B:	address of a field in core storage.
d:	modifier for an operation code.

.234 Basic address structure: 2 + 0.

.235 Literals

Arithmetic:	none.
Comparisons and tests:	yes, single character.
Incrementing modifiers:	none.

.236 Directly addressed operands

.2361 Internal storage type

	Minimum size	Maximum size	Volume accessible
Core:	1 char	total capacity	total capacity.
Disc (1405):	1 block (200 char)	1 band (5 blocks)	total capacity, but must use indirect addressing.
Disc (1301):	1 char	80,000 char	

.237 Address indexing

.2371 Number of methods: .	1.
.2372 Names:	indexing.
.2373 Indexing rule:	addition, modulo 80,000.
.2374 Index specification: .	zone bits in the 10's and/or 100's position of presumptive address.
.2375 Number of potential indexers:	15.
.2376 Addresses which can be indexed:	A, B. I.
.2377 Cumulative indexing:	none.
.2378 Combined index and step:	none.

.238 Indirect addressing: . . none, except for Disk Storage Unit operations.

.239 Stepping: . . . . . none.

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.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in char.	Program usage
Core:	15	5	index registers.
Processing Unit:	7	5	address registers.

.242 Category of storage	Total number locations	Physical form	Access time, μ sec	Cycle time, μ sec
Core:	15	core	?	4.5
Processing Unit:	7	?	?	4.5

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.
.314 Special sub-sequence counters: . . . . . none.
.315 Sequence control step size: . . . . . 1 character.
.316 Accessibility to routine: . . . . . indirectly, by storing B-address after Branch.
.317 Permanent or optional modifier: . . . . . no.

.32 Look-Ahead: . . . . . none.

.33 Interruption: . . . . . available as an optional feature.

.331 Possible causes
In-out units: . . . . free (unit specified by Priority Select switch).
In-out controllers: . . free (applicable for overlapped I/O instructions only).
Storage access: . . . 1. seek operation completed by access arm.
2. free controller.
Processor errors: . . none.
Other: . . . . . 1. Moving Priority Select switch, from OFF to ON position.
2. console request.
3. Teleprocessing buffer requesting service.
Program control
Individual control: . 1. disc storage, console, I/O channel, or Teleprocessing buffer.
2. I/O unit designated by Priority Select Switch.
Method: . . . . . set Priority Latch.
Restriction: . . . . . system must be operating in PRIORITY ALERT mode.

.333 Operator control: . . . 1. select 1 of 4 I/O units using Priority Select switch.
2. Priority Select On-Off switch permits or prohibits interruption by unit designated by Priority Select switch.
.334 Interruption conditions: 1. interruptible instruction in main routine.
2. system operating in PRIORITY ALERT mode.
3. a priority request has been set.
4. channel associated with latch not busy.
.335 Interruption process
Disabling interruption: . . . . . automatic (priority alert latch is set OFF).
Registers saved: . . own coding.
Destination: . . . . . fixed location (automatic jump).
.336 Control methods
Determine cause: . . own coding (test indicators).
Enable interruption: . own coding (one instruction).

.34 Multi-running: . . . . possible on a limited basis, using Priority Feature.

.341 Method of control: . . own coding.
.342 Maximum number of programs:. . . . . 2 is practical limit.
.343 Precedence rules: . . . own coding.
.344 Program protection: . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec

.411 Fixed point	Without Accelerator Feature	With Accelerator Feature
Add-subtract:	54.0 + 11.3D	48 + 8D
Multiply:	78.8 + 61.9D + 28.1D^2	60 + 36D + 20D^2
Divide:	58.5 + 87.8D + 73.1D^2	52 + 52D + 52D^2

.412 Floating point (subroutines, 8-digit precision)

	Without Accelerator Feature
Add:	3,360
Subtract:	3,840
Multiply:	4,800
Divide:	8,160

.413 Additional allowance for

	Without Accelerator Feature	With Accelerator Feature
Indexing:	34.5 per modified address.	30.67 per modified address.
Re-complementing:	6.8D	4.0D

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.414 Control

	Without Accelerator Feature	With Accelerator Feature
Compare:	54.0 + 9D	48 + 8D.
Branch:	40.5	36.0
Compare and Branch:	69.8 (comparing 1 bit or character)	62.0 (comparing 1 bit or character).

.415 Counter Control: . . . none.

.416 Edit

Without Accelerator feature: . . . . . 54.0 + 13.5C.

With Accelerator feature: . . . . . 48.0 + 12.0C.

.417 Convert: . . . . . none.

.418 Shift:. . . . . none.

.42 Processor Performance in μ secs

.421 For random addresses

	Fixed point	Floating point
c = a + b:	113.0 + 22.5D	3,990.
b = a + b:	54.5 + 11.3D	3,990.
Sum N items:	54.5 + 11.3D	3,360.
c = ab:	137.3 + 73.2D + 28.1D^2	5,430.
c = a/b:	117.0 + 99.1D + 73.1D^2	8,790.

.422 For arrays of data

	Fixed Point	Floating point
$c_i = a_i + b_j$:	567.0 + 31.5D	4,453.
$b_j = a_i + b_j$:	385.0 + 9.0D	4,453.
Sum N items:	338.0 + 11.3D	3,644.
$c = c + a_i b_j$:	616.0 + 84.4D + 28.1D^2	8,930.

.423 Branch based on comparison

Numeric data: . . . . 605 + 9D.

Alphabetic data: . . . 605 + 9C.

.424 Switching

Unchecked: . . . . . 302.

Checked: . . . . . 581.

List search: . . . . . 412 + 389N.

.425 Format control per character

Unpack: . . . . . 18.

Compose: . . . . . 34.

.426 Table look-up per comparison

For a match: . . . . 23 + 9C.

For least or greatest: 392 + 10C (Look-up instructions not usable).

For interpolation point: . . . . . 23 + 9C.

.427 Bit indicators

Set bit in separate location: . . . . . 65.

Set bit in pattern: . . impractical.

Test bit in separate location: . . . . . 65.

Test bit in pattern: . . 65.

Test AND for B bits: . impractical.

Test OR for B bits: . . impractical

.428 Moving data: . . . . . 58.5 + 11.3D.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	indicator & alarm.
Underflow:	none.	
Zero divisor:	overflow check	indicator & alarm.
Invalid data:	char. validity check	stop & alarm.
Invalid operation:	check	stop & alarm.
Arithmetic error:	none.	
Invalid address:	check	stop & alarm.
Receipt of data:	parity check	indicator & alarm.
Dispatch of data:	parity check	indicator & alarm.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . Console.
1415 Model 1.

.12 Associated Units: . . . Console Input-Output Printer stands on console desk.

.13 Description

The 1415 Console, which is a required part of every 1410 system, consists of a desk holding the console I/O printer, control unit, and indicator-light panel. (The console I/O printer is described in the Input-Output section.) The control unit contains the main operating controls for the system and the power status lights. The indicator-light panel, mounted just above the console printer, contains a variety of error alarms, processor status indicators, and I/O channel status indicators. The only display of control register contents is provided by printouts via the console printer, which occur whenever the system stops. The 11 compatibility switches on the 1401 make it possible to run many IBM 1401 routines using the 1410 without reprogramming.

.2 CONTROLS

.21 Power

Name	Form	Function
Power on:	button.	
Power off:	button.	
Emergency off:	button	disconnects all power.
DC off:	button	disconnects DC power during short idle periods.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Function
Start key:	button	initiates machine operation.
Stop key:	button	stops program upon completion of current instruction and prints register contents via the Console Typewriter.

.24 Stepping: . . . . . Mode switch selects 1 of 6 operation modes: C.E. (storage scan), I/E CYCLE, ADDRESS SET, RUN, DISPLAY, or ALTER. The I/E CYCLE mode permits stepping through the program, with typewriter printout of all registers for each step if desired.

.25 Resets

Name	Form	Function
Program reset:	button	resets check circuits and registers; sets sequence counter to 00001.
Computer reset:	button	as above, but all indicators are also reset.

.26 Loading: . . . . . none.

.27 Sense Switches: . . . . none, except when operating in 1401 mode.

.28 Special

Name	Form	Function
Printout control:	on-off switch	inhibits stop printouts by typewriter.
Check control:	3-position switch	determines whether error printouts will be followed by automatic restarts.
Asterisk-insert:	on-off switch	causes input characters of invalid parity to be replaced by asterisks in storage.
Address entry:	7-position switch	selects an address register for entry of an address from typewriter.
1401 Compatibility:	11 toggle switches	permits running most IBM 1401 programs on the 1410. The toggles represent the 1401 I/O check stop, I/O check reset, bit entry, and sense switches.

.3 DISPLAY

.31 Alarms: . . . . . 15 System Check lights indicate error conditions such as parity errors, invalid characters, I/O timing errors, invalid addresses, and improper instructions.
5 Power Indicator lights indicate overheating, tripped circuit breakers, etc.

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.32 Conditions:. . . . . 6 Status lights show when the overflow, zero balance, and high, low, and equal compare indicators are turned on.
6 I/O Channel Control lights on each I/O channel installed indicate the following conditions: interlock, write disc check interlock, reading, writing, overlapped operation in process, non-overlapped operation in process.
6 I/O Channel Status lights on each I/O channel indicate: unit not ready, unit busy, I/O parity error, wrong length record, end-of-file condition, no data transfer.
4 System Controls lights indicate: 1401 compatibility mode, priority alert mode system stopped, console switches not in normal positions.

.33 Control Registers:. . . no dynamic display; setting Mode switch to I/E CYCLE and pressing Start key causes typewriter to print contents of I-, A-, and B-address registers, OP register, d register, and 7 other 1-character registers. (The same printout occurs whenever an error stop, programmed stop, or manual stop is encountered.)

.34 Storage: . . . . . printed on typewriter by setting Mode switch to DISPLAY, pressing Start key, and typing high-order address of field to be printed. Printout is terminated by a word mark, but continues if Start key is held down.

.4 ENTRY OF DATA

.41 Into Control Registers

1. Set Mode switch to ADDRESS SET.
2. Set Address entry switch to desired register.
3. Press Start key.
4. Type data on typewriter keyboard.

.42 Into Storage

1. Display contents of desired field on typewriter, as described in .34.
2. Set Mode switch to ALTER.
3. Press Start key.
4. Type correct data on typewriter keyboard.

.5 CONVENIENCES

.51 Communication: . . . . none.

.52 Clock: . . . . . optional Program Addressable Clock provides visual display of time and can be interrogated by the stored program.

.53 Desk Space: . . . . . console desk top is 70 by 29 inches; ample free space is provided for operating convenience.

.54 View:. . . . . the 1410 is designed for operation by person seated at console desk; unobstructed view in all directions.

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INPUT-OUTPUT: PAPER TAPE READER

§071

.1 GENERAL

.11 Identity: . . . . . Paper Tape Reader. 1011 Model 1.

.12 Description:

This unit reads data from punched paper tape into 1410 core storage at a peak speed of 500 rows per second. Five-, six-, seven-, or eight-track tape can be read, and translation of the tape codes to 1410 BCD coding is controlled by plugboard wiring. The tape can be either chad or chadless; 11/16, 7/8, or 1-inch wide; and in the form of strips, conventional reels, or rolls which feed from the center. Parity checks can be applied to tape codes which employ odd-bit parity, but not to five-track telegraphic tape. Paper tape input is buffered; however, a maximum of 80 characters can be read from the tape on 1 read instruction.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.

.212 Reservoirs
- Number: . . . . . 2.
- Form: . . . . . swinging arm.
- Capacity: . . . . . about 2 feet.

.213 Feed drive: . . . . . motor.

.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . none.

.222 Sensing system: . . . . photoelectric.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

- Use of station: . . . . . reading.
- Stacks: . . . . . 1.
- Heads/stack: . . . . . 8.
- Method of use: . . . . . reads 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper tape.

.312 Phenomenon: . . . . . punched holes (chad or chadless type).

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to 80 rows at 10 per inch.

.322 Parallel by: . . . . . 5 to 8 tracks at standard spacing.

.324 Track use
- Data: . . . . . 6 or 5.
- Redundancy check: . . 1 or 0.
- Timing: . . . . . 1 (sprocket track).
- Control signals: . . . 1 or 0.
- Total: . . . . . 8 to 5 (plus sprocket track).

.325 Row use
- Data: . . . . . 1 to 80.
- Redundancy check: . . 0.
- Timing: . . . . . 0.
- Control signals: . . . 1 (end-of-record; optional).
- Unused: . . . . . 0.
- Gap: . . . . . 2.

.33 Coding: . . . . . normally 5-track telegraphic or 8-track IBM coding; most 5-, 6-, 7-, or 8-track codes can be translated by plugboard wiring.

.34 Format Compatibility

Other device or system	Code translation
Most devices using 5-, 6-, 7-, or 8-track paper tape:	plugboard wiring

.35 Physical Dimensions

.351 Overall width: . . . . . 11/16, 7/8, or 1 inch.

.352 Length
- Strip . . . . . 20 to 240 inches.
- Roll (inside feeding): 5 to 400 feet.
- Reel (outside feeding): . . . . . 5 to 1,000 feet.

.4 CONTROLLER

.41 Identity: . . . . . Input-Output Synchronizer. 1414 Model 4 or Model 5 (with Paper Tape Read Adapter #5514).

.42 Connection to System

.421 On-line: . . . . . 1.

.422 Off-line: . . . . . none.

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.43 Connection to Device

.431 Devices per controller: . . . . . A 1414 Model 4 can control a Card Read-Punch, a Printer, and various combinations of the following devices: Data Transmission Unit, Remote Inquiry Unit, Telegraph I/O Features, and Paper Tape Reader; Model 5 is identical except that it cannot control a Card Read-Punch or Printer.

.432 Restrictions: . . . . . A 1414 Model 4 or 5 can control any configuration which does not exceed 6 buffers. A Paper Tape Reader requires 1 buffer.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 80 characters.
.512 Block demarcation Input: . . . . . group mark in 81st position of core storage, or end-of-record character on tape, whichever occurs first.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . plugboard wiring.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . undefined.
Rearrangement: . . . . yes.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . no.
Omit unwanted characters: . . . . . yes.
Assign several tape codes to 1 character: yes.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt . . . yes (with optional feature).
Select format: . . . . . no.
Select code: . . . . . no.
Rewind: . . . . . no.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: no.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 500 char/sec.
.622 Important parameters
Tape speed: . . . . . 50.0 inches/sec.
Start time (to full speed) . . . . . 2.5 msec average, 9.0 msec max.
Stop distance: . . . . 1.5 rows average, 2.0 rows max.
.623 Overhead . . . . . 8.5 msec/block.
.624 Effective speeds: . . . 500 N/(N + 4) char/sec, where N = no. of char/block.

.63 Demands on System

Component: . . . . . Processing unit.
Msec per block: . . . 0.880.
or
Percentage: . . . . . 0.52 minimum.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Tape width:	change reels.
Tape code:	change plugboard panels.

.72 Other Controls

Function	Form
Reset alarm circuits:	key.
Reel/strip selector:	2-position switch.

§ 071.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Supply & take-up reels:	1,000 feet.
Center-roll feed:	400 feet.

.732 Replenishment time: . 1.0 to 2.0 minutes for reels. 0.3 to 0.5 minute for strips. Reader needs to be stopped.

.733 Adjustment time: . . . 2.0 to 3.0 minutes.

.734 Optimum reloading period: . . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading	parity check*	set indicator.
Input area overflow:	check for end-of-record	set indicator.
Invalid code:	plugboard wiring	as wired.
Exhausted medium:	check	set indicator; alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Excessive stop distance:	check	set indicator.

* No parity check on 5-track tape.

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INPUT-OUTPUT: CARD READ-PUNCH (READER)

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch (Reader only).
1402 Model 2.

.12 Description

While the 1402 consists of a card reader and punch housed in the same cabinet, the two units are independent of one another from the user's viewpoint and are covered in separate sections of this report.

The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Conversion from the card column code to internal BCD code is automatic. A hole-count check is made on each column at a second reading station, and the bit configuration of each character is checked for validity as it is transferred into the read synchronizer for later transmission into core storage. A hopper with a 3,000-card capacity and 3 stackers with 1,000-card capacities (1 shared with the punch unit) can be loaded and unloaded without stopping the reader.

A 1442 Card Reader can also be connected to the 1410 system (see 414:071).

Optional Features

Interchangeable Feed: Permits reading of either 80- or 51-column cards by interchanging hardware.

Priority Feature: Permits interruption of the main routine upon the completion of a cycle by the card reader.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 12 rows of each card, 1 at a time.

Use of station: . . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 12 rows of each card, 1 at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards (51-column cards with optional feature).
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use
Data: . . . . . 80.
Total: . . . . . 80.
.325 Row use
Data: . . . . . 12.

.33 Coding: . . . . . column code as in table 3.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Input-Output Synchronizer.
1414 Model 3 or 4.

.42 Connection to System

.421 On-line: . . . . . 1 Model 3 or Model 4.
.422 Off-Line: . . . . . none.

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§ 072.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . 1 card forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . with optional priority feature.
Offset card: . . . . . no.
Select stacker: . . . . . yes, 1 of 3.
Select format: . . . . . no.
Select code: . . . . . no.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: . no.
Controller not ready: . yes.
Hopper empty: . . . . . yes.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 800 cards/min.
.622 Important parameters
Clutch cycle: . . . . . 75 msec.
.623 Overhead: . . . . . 1 clutch point.
.624 Effective speeds: . . . 800 cards/min. if processing time per card does not exceed 74.12 msec.

.63 Demands on System

Component: . . . . . Processing Unit.
Msec per card: . . . . 0.88.
Percentage: . . . . . 1.2.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . card width.
Method: . . . . . interchange of hardware.
Comment: . . . . . with interchangeable feed only.

.72 Other Controls

Function: . . . . . end of file.
Form: . . . . . key.
Comment: . . . . . activates circuits that signal last-card condition in central processing unit.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	3,000 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . 0.25 to 0.50 minute. reader does not need to be stopped.
.733 Adjustment time: . . . 10 to 15 minutes.
.734 Optimum reloading period: . . . . . 1.25 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	indicator & alarm.
Input area overflow:	none.	
Invalid code:	validity check	indicator & alarm.
Exhausted medium:	check	stop & alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop & alarm.
Stacker full:	check	stop & alarm.
Wrong length record:	check	indicator.
No transfer:	check	indicator.

INPUT-OUTPUT: CARD READ-PUNCH (PUNCH)

§073.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch (Punch only).
1402 Model 2.

.12 Description

Housed in the same cabinet as the card reader, this unit punches standard 80-column cards at a peak speed of 250 cards per minute. Conversion from internal BCD representation to the column card code is automatic. A reading station makes a hole-count check on each column. The 1,200-card feed hopper and three 1,000-card stackers (one shared with the reader unit) can be loaded and unloaded without stopping the punch. A punch buffer register in the Input-Output Synchronizer permits the overlapping of punching with other operations.

Optional Feature

Priority feature: Permits interruption of the main routine upon the completion of a cycle by the card punch.

.13 Availability: . . . . . 14 months as of March, 1962.

.14 First Delivery: . . . . September, 1960

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punch.
.222 Sensing system: . . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . . 1.
Heads/stack: 80
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use
Data: . . . . . 80.
Total: . . . . . 80.
.325 Row use
Data: . . . . . 12.

.33 Coding: . . . . . column code as in table 3.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Input-Output Synchronizer.
1414 Model 3 or 4.

.42 Connection to System

.421 On-line: . . . . . 1; Model 3 or Model 4.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

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§ 073.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation
Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 card forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . with optional Priority Feature.
Offset card: . . . . . no.
Select stacker: . . . . yes, 1 of 3.
Select format: . . . . no.
Select code: . . . . . no.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: . . . . . no.
Controller not ready: . yes.
Hopper empty: . . . . . yes.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 250 cards/min.

.622 Important parameters
clutch cycle: . . . . . 240 msec.
.623 Overhead: . . . . . 4 clutch points.
.624 Effective speeds: . . . 250 cards/min if processing time per card does not exceed 216.62 msec.

.63 Demands on System

Component: . . . . . Processing Unit.
Msec per block: . . . 0.88.
or
Percentage: . . . . . 0.4.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls: . . . . start and stop only.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . . 0.25 to 0.50 minute, punch does not need to be stopped.
.733 Adjustment time: . . . none.
.734 Optimum reloading period: . . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	hole count	indicator & alarm.
Output block size:	fixed.	
Invalid code:	parity check	indicator & alarm.
Exhausted medium:	check	stoppage & alarm.
Imperfect medium:	none	
Timing conflicts:	interlock	wait.
Feed jam:	check	stoppage & alarm.
Stacker full:	check	stoppage & alarm.
Wrong length record:	check	indicator.

AUERBACH / BNA

INPUT-OUTPUT: PRINTER (1403)

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer. 1403, Models 1 and 2.

.12 Description

The 1403 Models 1 and 2 printers are line printers with horizontal-chain printing mechanism, dual-speed tape-controlled carriage, and feeding and stacking system for continuous forms. Each character is printed as it is positioned opposite a magnet-driven hammer that presses the form against the moving chain at the correct printing position. Peak speed is 600 lines per minute with single spacing and 480 lines per minute at an average spacing of 1 inch. The Model 1 has 100 printing positions and the Model 2 has 132; they are identical in all other respects. A print buffer register in the Input-Output Synchronizer holds a full line of data and permits the overlapping of printing with other operations.

Optional Features

Numerical Print: Permits changing from the standard 48-character set chain to a chain with only a 16-character set; speeds up to 1,285 lines per minute can then be obtained on all-numeric output.

Priority feature: Permits interruption of the main routine upon the completion of a cycle by the printer.

Smaller type: Desirable for printing eight lines per inch on continuous forms.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive push and pull, paper punched on both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . magnet-driven hammer presses form against moving horizontal chain.

.222 Sensing system: . . . . echo check on hammer magnets.

.223 Common system: . . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . 6.

.233 Types of master
- Multilith: . . . . . yes, with special ribbon.
- Xerox: . . . . . yes.
- Spirit: . . . . . yes.

.24 Arrangement of Heads

- Use of station: . . . . . printing.
- Stacks: . . . . . 1.
- Heads/stack: . . . . . 100 or 132.
- Method of use: . . . . . 1 line at a time.

.25 Range of Symbols

Standard Set

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	12	&,. - / % # @ ‡ □ * $
Alternatives:		special request.
FORTRAN set:		alternative Print Set F.
Req. COBOL set: . . .		no.
Total:	48 and blank.	

Numeric Print Set

Numerals:	10	0-9.
Letters:	0.	
Special:	6	$. , * - □
FORTRAN set:		no.
Req. COBOL set: . . .		no.
Total:	16 and blank	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold sprocket punched stationery.

.312 Phenomenon: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 per inch.

.322 Parallel by: . . . . . 100 or 132 char. at 10 per inch.

.324 Track use
- Data: . . . . . 100 or 132.
- Total: . . . . . 100 or 132.

.325 Row use
- Data: . . . . . all.

.33 Coding: . . . . . engraved character font (Internal coding as in Data Code Table No. 2).

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§ 081.

.34 Format Compatibility

Other device or system: 1403 Model 3.
Code translation: . . . none.

.35 Physical Dimensions

.351 Overall width: . . . . 3.50 to 18.75 inches by vernier.
.352 Length forms: . . . . 1 to 22.0 inches by 1/6 inch at 6 lines/in.
1 to 16.5 inches by 1/8 inch at 8 lines/in.
1 to 17.0 inches (recommended maximum for proper stacking).
.353 Maximum margins
Left: . . . . . 3.0 inches.
Right; Model 1: . . 6.2 inches.
Model 2: . . 3.0 inches.

.4 CONTROLLER

.41 Identity: . . . . . Input-Output Synchronizer. 1414 Model 3, 4, or 8.

.42 Connection to System

.421 On-line: . . . . . 1 Model 3, Model 4, or Model 8 per channel.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 line of 100 or 132 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 100 or 132 characters per line.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 line forward with single step.
.523 Stepping: . . . . . step 1, 2, or 3 lines as separate operation, or as combined "print then step".
.524 Skipping: . . . . . skip to one of 12 channels on paper tape loop; may be combined in "print then skip".
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control

Control: . . . . . program.
Format alternatives: . unlimited.
Rearrangement: . . . . no.
Suppress zeros: . . . . yes.
Insert point: . . . . . yes.
Insert spaces: . . . . . yes.
Section sizes: . . . . . no.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . with optional Priority Feature.
Select format: . . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: no.
Controller not ready: . yes.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard character set, 100 print positions.
II: . . . . . numeric set, 100 print positions.
III: . . . . . standard character set, 132 print positions.
IV: . . . . . numeric set, 132 print positions.

.62 Speeds

.621 Nominal or peak speed
I and III: . . . . . 600 lines/min.
II and IV: . . . . . 1,285 lines/min.

.622 Important parameters
Print 1 line, I and III: 100.0 msec.
Print 1 line, II and IV: 46.7 msec.
Skipping speed: . . . . 33.0 in/sec for skips of 8 lines or fewer.
Skipping speed: . . . . 75.0 in/sec for skips of more than 8 lines.

.623 Overhead
Step 1 line: . . . . . 20 msec.
Step 2 lines: . . . . . 25 msec.
Step 3 lines: . . . . . 30 msec.
Independent skip of N lines: . . . . . 15 + 5N msec. ($N < 9$).
37.4 + 2.2N msec.. ($N \geq 9$).

§ 081.

.624 Effective speeds

Average line feed, inches	Lines/min., I & III	Lines/min., II & IV
1/6:	600	1,285
2/6:	572	1,160
3/6:	545	1,059
1:	480	838
2:	418	664
3:	382	580
4:	353	514
5:	327	461

(See graph)

.63 Demands on System

Component	Condition	Msec per line		Percentage*
Processing Unit:	I	1.10	or	1.10
	II	1.10	or	2.35
	III	1.45	or	1.45
	IV	1.45	or	3.10

* at single spacing.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knobs.	
Horizontal alignment:	knobs.	
Form width:	sliding forms tractors.	
Printing quality:	graduated dial.	
Form thickness:	graduated lever.	
Line pitch:	switch	6 or 8 lines/inch.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets printer error indications.
Carriage restore:	key	positions carriage at channel 1 on tape loop.
Single cycle:	key	initiates 1 printer cycle.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	20-inch stack.
Stacker:	20-inch stack.

.732 Replenishment time: 2 to 3 minutes.

.733 Adjustment time: 3 to 5 minutes. printer needs to be stopped.

.734 Optimum reloading period

I & III:	56 minutes.
II & IV:	35 minutes.
Basis:	2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	indicator & alarm.
Input area overflow:	none.	
Output block size:	fixed.	
Invalid code:	check	indicator & alarm.
Exhausted medium:	check	stop & alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop & alarm.
Wrong length record:	check	indicator.

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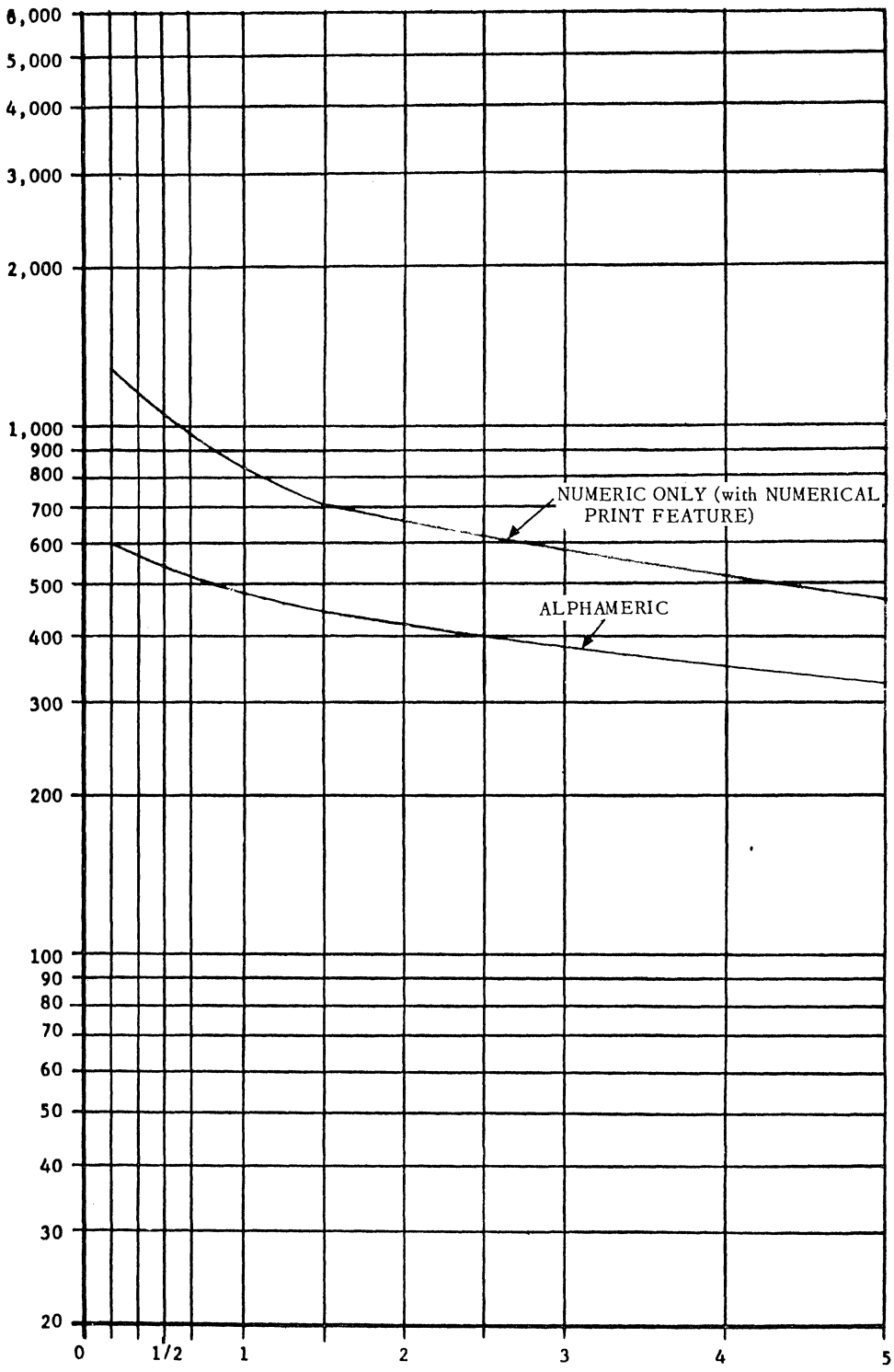
EFFECTIVE SPEED
IBM 1403



AUERBACH / BNA

INPUT-OUTPUT: PRINTER (1403 MODEL 3)

§ 082.

.1 GENERAL

.11 Identity: . . . . . Printer. 1403 Model 3.

.12 Description

The IBM 1403 Printer, Model 3, has the same general physical characteristics as the Models 1 and 2. The basic difference between the Model 3 and the other models is in design of the device which rotates the type elements.

In the earlier models, the individual slugs of type formed a closed-loop oval chain which was mounted in a horizontal plane. In the Model 3, a train of type slugs (with three characters per slug) moves through a similarly shaped channel, resulting in greater printing accuracy at higher speeds. The relative increase in rotational speed from 90 inches to 206 inches per second results in peak printing speed of 1,100 single-spaced lines per minute, and 755 lines per minute with an average spacing of 1 inch.

The Model 3 uses the same dual-speed, tape-controlled carriage as the Model 2, permitting skipping at 33 inches per second for skips of eight or fewer lines, and 75 inches per second for skips of more than eight lines.

Use of the same instruction and core storage areas as the Model 2, precludes the need to change programs in order to use the Model 3. However, the reduction from 100 milliseconds to 54.5 milliseconds in the print cycle time results in a corresponding reduction in available processing time. Programs may therefore need to be rewritten in order to complete all necessary processing in the reduced time available without sacrificing the increase in printing speed.

No more than two Model 3 printers can be connected to a 1410 system. Each Model 3 in a 1410 system requires a 1414 Input-Output Synchronizer (Model 3, 4, or 8).

Optional Features

Priority Feature: Permits interruption of the main routine upon completion of a cycle by the printer.

.13 Availability: . . . . . 18 months.

.14 First Delivery: . . . . August, 1964.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive, paper punched on both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnet-driven hammer passes from against horizontal moving line of tape slugs.

.333 Sensing system: . . . . none.

.223 Common system: . . . none.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . 6.
Carbon creep: . . . . no.

.233 Types of master
Multilith: . . . . . yes, with special ribbon.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 132.
Method of use: . . . . . 1 line at a time.

.25 Range of Symbols

	Standard Set	
Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	12	&, . - / % # @ ≠ □ * $
Alternatives:		special request.
FORTRAN set:		alternative Print Set F.
Basic COBOL set: . . .		no.
Total:	48 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold sprocket-punched stationery.

.312 Phenomenon: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 per inch.

.322 Parallel by: . . . . . 132 char at 10 per inch.

.324 Track use
Data: . . . . . 132.
Total: . . . . . 132.

.325 Row use
Data: . . . . . all.

.33 Coding: . . . . . engraved character font (Internal coding as in Data Code Table No. 2).

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§ 082.

.34 Format Compatibility

Other device or system: 1403 Models 1 and 2.
Code translation: . . . none.

.35 Physical Dimensions

.315 Overall width: . . . . . 3.50 to 18.75 inches by vernier.

.352 Length
Forms: . . . . . 1.0 to 22.0 by 1/6 inch at 6 lines/in.
1.0 to 16.5 by 1/8 inch at 8 lines/in.
1.0 to 17.0 inches (recommended maximum for paper stacking).

.353 Maximum margins
Left: . . . . . 3.0 inches.
Right: . . . . . 3.0 inches.

.4 CONTROLLER

.41 Identity: . . . . . Input-Output Synchronizer 1414 Model 3, 4, or 8.

.42 Connection to System

.421 On-line: . . . . . 1 Model 3, Model 4, or Model 8 per channel.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 line of 132 characters.
.442 Input-Output areas: . . core storage.
.443 Input-Output area access: . . . . . each character.
.444 Input-Output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 132 char per line.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 line forward with single step.
.523 Stepping: . . . . . step 1, 2, or 3 lines as separate operation, as combined "print, then step."
.524 Skipping: . . . . . skip to 1 of 12 channels on paper tape loop; may be combined in "print, then skip."
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . program.
Format alternatives: . unlimited.
Rearrangement: . . . . no.
Suppress zeros: . . . . yes.
Insert point: . . . . . yes.
Insert spaces: . . . . . yes.
Section sizes: . . . . . no.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . with optional Priority feature.
Select format: . . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: no.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 1,100 lines/minute.
.622 Important parameters
Print 1 line: . . . . . 54.5 msec.
Skipping speed: . . . . 33.0 in/sec for skips of 8 lines or less.
Skipping speed: . . . . 75.0 in/sec for skips of more than 8 lines.
.623 Overhead
Step 1 line: . . . . . 20 msec.
Step 2 lines: . . . . . 25 msec.
Step 3 lines: . . . . . 30 msec.
Independent skip of N lines: . . . . . $15 + 5N$ msec ($N < 9$).
$37.4 + 2.2N$ msec ($N \geq 9$).

.624 Effective speeds

Average line feed, inches	Lines/minute
1/6:	1,100.
2/6:	1,005.
3/6:	930.
1:	755.
2:	610.
3:	538.
4:	481.
5:	435.

(see graph)

.63 Demands on System

Component: . . . . . processing unit.
Msec per line: . . . . . 1.4.
Percentage*: . . . . . 2.57.

* at single spacing.

§ 082.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knobs.	
Horizontal alignment:	knobs.	
Form Width:	sliding forms tractor.	
Print density control:	knob.	
Form thickness:	graduated lever.	
Line Pitch:	switch	6 or 8 lines/in.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets printer error indications.
Carriage restart:	key	positions carriage at position 1 on tape loop.
Single cycle:	key	initiates 1 printer cycle.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	20-inch stack.
Stacker:	20-inch stack.

.732 Replenishment time: . . 2 to 3 minutes. printer needs to be stopped.

.733 Adjustment time: . . . 3 to 5 minutes.

.734 Optimum reloading period: . . . . . 38 minutes.

Basis: 2-part sets, 17 inches long at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	indicator and alarm.
Output block size:	fixed.	
Invalid code:	check	indicator.
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Feed jam:	check	stop and alarm.
Wrong length record:	check	indicator.

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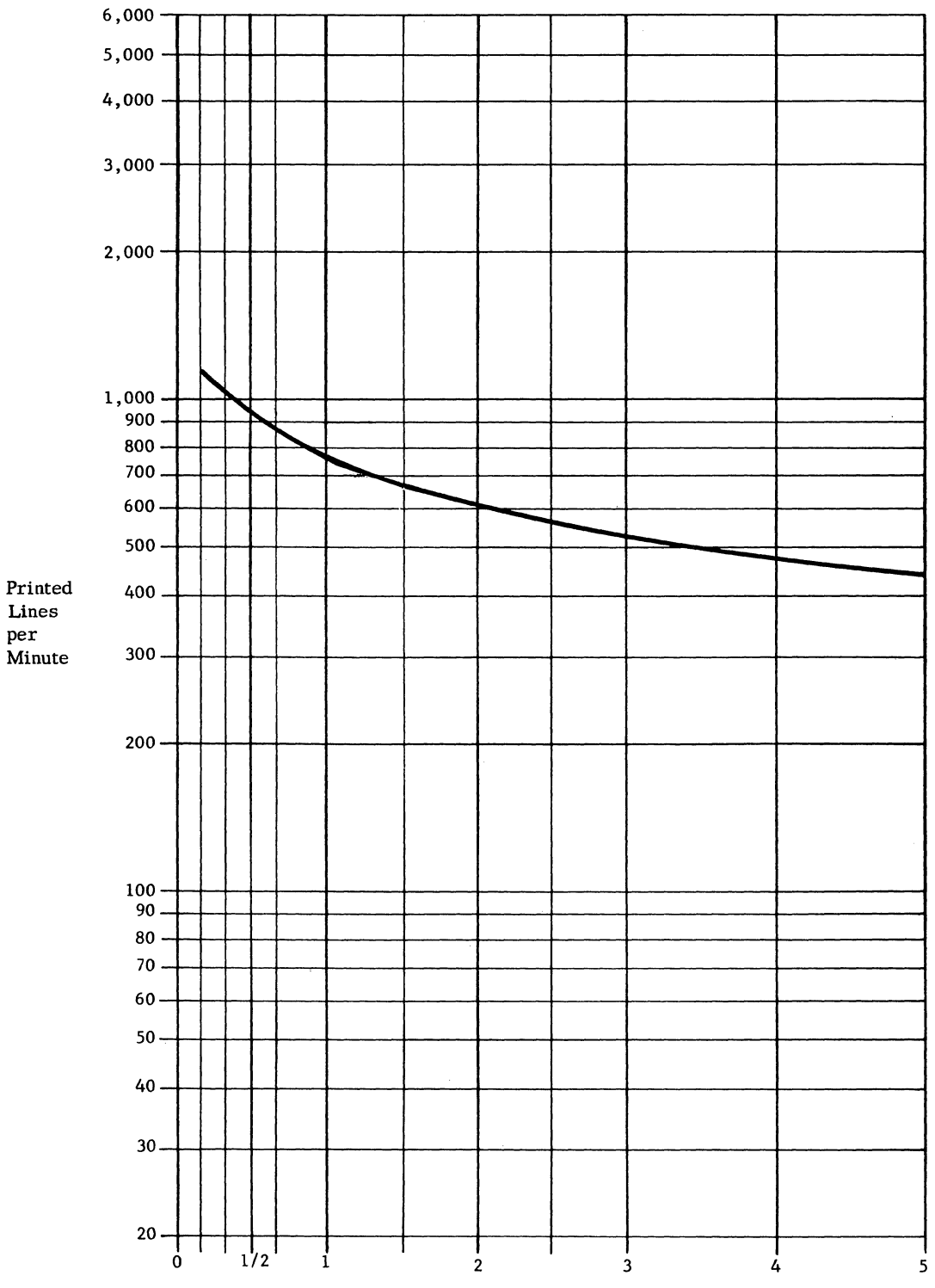
EFFECTIVE SPEED
IBM 1403 PRINTER, MODEL 3



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INPUT-OUTPUT: CONSOLE I/O PRINTER

§083

.1 GENERAL

.11 Identity: . . . . . Console I/O Printer. Part of 1415 Model 1 Console.

.12 Description:

The Console I/O Printer is a modified IBM electric typewriter that stands on the console desk. The printer handles console inquiries, prints messages under program control, provides a log of console operations, and displays and permits alteration of the contents of control registers and core storage. The display function is particularly important because no other visual display of control register or storage status is provided in the 1410 system. Whenever a system stop occurs (whether it is programmed, operator-controlled, or caused by an error) the contents of the 12 primary control registers are automatically printed in a fixed format. The same information can be printed after each cycle when manually stepping through a program in the I/E CYCLE mode. In the DISPLAY mode, the starting address is typed manually; then the contents of successive core storage positions are printed until a word mark is sensed.

Console inquiries are initiated by pressing the Request key. This sets an indicator which must be tested by the stored program to transfer control to the inquiry routine. If the optional Priority Feature is installed, pressing the Request key causes the priority routine to be executed as soon as input-output channel 1 is not busy. Inquiries are limited to a preset length specified by the programmer; longer or shorter messages result in wrong-length record indications and incorrect processing of the inquiry. Carriage returns, backspacing, and tabulation cannot be controlled from the keyboard.

.13 Availability: . . . . . 14 months as of February, 1962

.14 First Delivery: . . . . . December, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pin-feed platen; paper punched both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved hammers.
.222 Sensing system: . . . . . typewriter keyboard
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . . depends on stationery.

.232 Types of master
Multilith: . . . . . no.
Zerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . 1 character at a time.

Use of station: . . . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . . 44 keys.
Method of use: . . . . . 1 character at a time.

.25 Range of Symbols

Numerals: . . . . . 10 0 - 9.
Letters . . . . . 26 A - Z.
Special: . . . . . 28 as in Data Code Table No. 1.
Alternatives: . . . . . none.
FORTRAN set: . . . . . yes.
Req. COBOL set: . . . . yes.
Total: . . . . . 64 plus word mark and invalid parity symbols.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon: input--key depression. output--printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use
Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font. (Internal coding as in Data Code Table No. 1).

.34 Format Compatibility: . . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 9.75 inches.
.352 Length: . . . . . no limitations.
.353 Maximum margins: . . . no limitations.

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§083

.4 CONTROLLER

.41 Identity: . . . . . no separate controller.

.42 Connection to System

.421 On-Line:. . . . . 1.
.422 Off-Line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N characters, where N is limited by core storage.
.442 Input-output areas: . . . core storage or control registers.
.443 Input-output area access:. . . . . each character of core storage.
.444 Input-output area lockout:. . . . . yes, for full block (no lockout in overlap mode.)
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N characters, where N is limited by core storage.
.512 Block demarcation
Input: . . . . . Release key; next higher core position must contain a previously-inserted group mark.
Output: . . . . . group mark in core storage or Cancel key.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustments	Method	Comment
Line spacing:	lever	step 1 or 2 lines.
Margin set:	2 levers.	
Copy control:	5-position lever	compensates for form thickness.

.72 Other Controls

Function	Form	Comment
Inquiry request:	key	sets testable indicator
Cancel:	key	terminates inquiry routine.
Release:	key	initiates processing of a typed inquiry.
Word-mark:	key	enters word mark with next character typed.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	none.	
Input area overflow:	check	indicator & carriage lock-up.
Output block size:	none.	
Invalid code:	all codes valid.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Receipt of data:	parity	indicator & alarm.

INPUT-OUTPUT: MAGNETIC TAPE UNIT (729)

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit. 729 Models II, IV, V, VI.

.12 Description

These tape units are used in the IBM 1401, 7070, 7080 and 7090 series systems as well as in the 1410. In tape width, density and format, they are compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are as follows:

Model	Tape speed (inches/sec.)	Density (char/inch)	Transfer rate (char/sec.)
II	75.0	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75.0	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

Up to 20 tape units can be connected to a 1410 system, with a maximum of 10 units on each data transmission channel. In a one-channel system no computing can be done during a tape input or output operation unless the Processing Overlap feature is added. However, overlapped reading, writing and processing are possible in a two-channel system. Lateral and longitudinal parity checks are made on both reading and recording. Different models of the 729 can be intermixed with each other and with 7330 tape units through the use of Tape Intermix Units on a 1414 Model 1 Synchronizer.

Optional Features

Processing Overlap: Permits computation during tape start time and between character transfers.

Priority Feature: Permits interruption of the main routine upon completion of an overlapped read, write, or write check operation that does not result in a busy or not ready condition.

.13 Availability: . . . . . with 1410 system, 14 months as of February, 1962.

.14 First Delivery: . . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . 2-gap head.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or 800 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking)
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 0.
Gap: . . . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 1.

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§ 091.

.34 Format Compatibility

Other device or system	Code translation
IBM 7330, 727 tape units:	not required.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Synchronizer. 1414, Model 1.

.42 Connection to System

.421 On-line: . . . . . maximum of 2 1414s, Model 1 and/or 2.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: up to 10 Model IIs, IVs, Vs and VIs in any combination.
.432 Restrictions: . . . . . 7330s can be mixed with 729s if a tape Intermix Unit is installed on the 1414 Model 1.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N char, limited by available core storage.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block (no lockout when Processing Overlap is used).
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N char, limited by available core storage.
.512 Block demarcation
Input: . . . . . gap on tape, or limiting mark in core storage.
Output: . . . . . limiting mark in core storage.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1 block backward (backspace).
erase 3.5 inches forward (to skip defective tape areas).
.525 Marking: . . . . . inter-block gap, 0.75 inch long.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes (with special features).
Select format: . . . . . no.
Select code: . . . . . no.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard system.
II: . . . . . with Processing Overlap

.62 Speeds

.621 Nominal or peak speed

Model II:	15,000 or 41,667 char/sec.
Model IV:	22,500 or 62,500 char/sec.
Model V:	15,000, 41,667, or 60,000 char/sec.
Model VI:	22,500, 62,500, or 90,000 char/sec.

.622 Important parameters

Name	Value
Density	
Models II & IV:	200 or 556 char/inch.
Models V & VI:	200, 556 or 800 char/inch.
Tape speed	
Models II & V:	75.0 inches/sec.
Models IV & VI:	112.5 inches/sec.
Start time	
Models II & V	
read:	10.5 msec.
write:	7.5 msec.
Models IV & VI	
read:	6.7 msec.
write:	5.0 msec.
Stop time	
Models II & V	
read:	2.1 msec.
write:	5.1 msec.
Models IV & VI	
read:	2.1 msec.
write:	3.8 msec.
Full rewind time	
Models II & V:	1.2 minutes.
Models IV & VI:	0.9 minute.
Interblock gap:	0.75 inch.

§ 091.

.623 Overhead
Models II & V: . . . . 12.6 msec/block.
Models IV & VI: . . . 8.8 msec/block.

.624 Effective speeds:
Models II & V
200 char/inch: . . . 15,000 N/(N + 189) char/sec.
556 char/inch: . . . 41,667 N/(N + 525) char/sec.
Models IV & VI
200 char/inch: . . . 22,500 N/(N + 198) char/sec.
556 char/inch: . . . 62,500 N/(N + 550) char/sec.
Model V
800 char/inch: . . . 60,000 N/(N + 756) char/sec.
Model VI
800 char/inch: . . . 90,000 N/(N + 792) char/sec.

where N = char/block (see graphs).

.63 Demands on System

Component	Condition	Msec per block	or	Percentage of transfer time
Processing Unit	I; without Processing Overlap			
	Models II & V			
	Read			
	200 char/inch:	10.7 + 0.0667C		100.0
	556 char/inch:	10.7 + 0.0240C		100.0
	800 char/inch:	10.7 + 0.0167C		100.0
	Write			
	200 char/inch:	11.7 + 0.0667C		100.0
	556 char/inch:	11.7 + 0.0240C		100.0
	800 char/inch:	11.7 + 0.0167C		100.0
	Models IV & VI			
	Read			
	200 char/inch:	6.8 + 0.0444C		100.0
	556 char/inch:	6.8 + 0.0160C		100.0
	Write			
	200 char/inch:	7.8 + 0.0444C		100.0
	556 char/inch:	7.8 + 0.0160C		100.0
Processing Unit	II; with Processing Overlap			
	Models II & V			
	Read			
	200 char/inch:	0.0 + 0.0045C		7.9
	556 char/inch:	0.0 + 0.0045C		21.9
	800 char/inch:	0.0 + 0.0045C		31.4
	Write			
	200 char/inch:	0.0 + 0.0045C		7.9
	556 char/inch:	0.0 + 0.0045C		21.9
	800 char/inch:	0.0 + 0.0045C		31.4
	Models IV & VI			
	Read			
	200 char/inch:	0.0 + 0.0045C		14.6
	556 char/inch:	0.0 + 0.0045C		32.9
	800 char/inch:	0.0 + 0.0045C		47.3
	Write			
	200 char/inch:	0.0 + 0.0045C		14.6
	556 char/inch:	0.0 + 0.0045C		32.9
	800 char/inch:	0.0 + 0.0045C		47.3

where C is number of characters per block.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (Models V & VI only).

.72 Other Controls

Function	Form	Comment
Address selection:	dial.	
Load rewind:	key	lowers tape into reservoirs.
Unload:	key	
File protection:	ring on spool	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	2,400 feet; for 1,000 char blocks, 5,000,000 char at 200 char/inch, 11,300,000 char at 556 char/inch, or 14,400,000 char at 800 char/inch.

.732 Replenishment time: . 1.0 to 1.5 minutes. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . . 6 minutes.
Models IV & VI: . . . 4 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-back; lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Recording level:	signal strength check	indicator & alarm.

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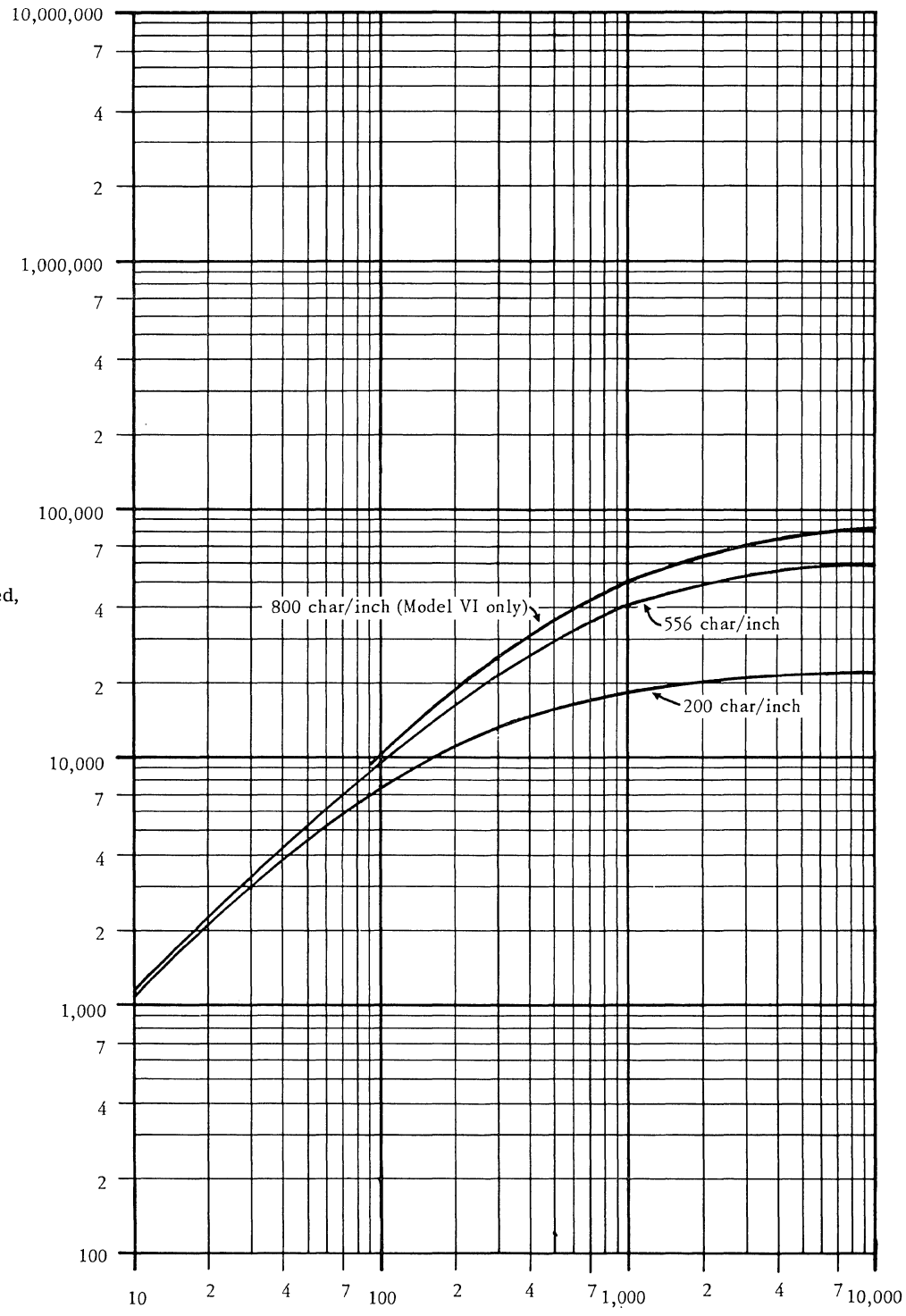
Effective Speed
IBM 729-IV & 729-VI



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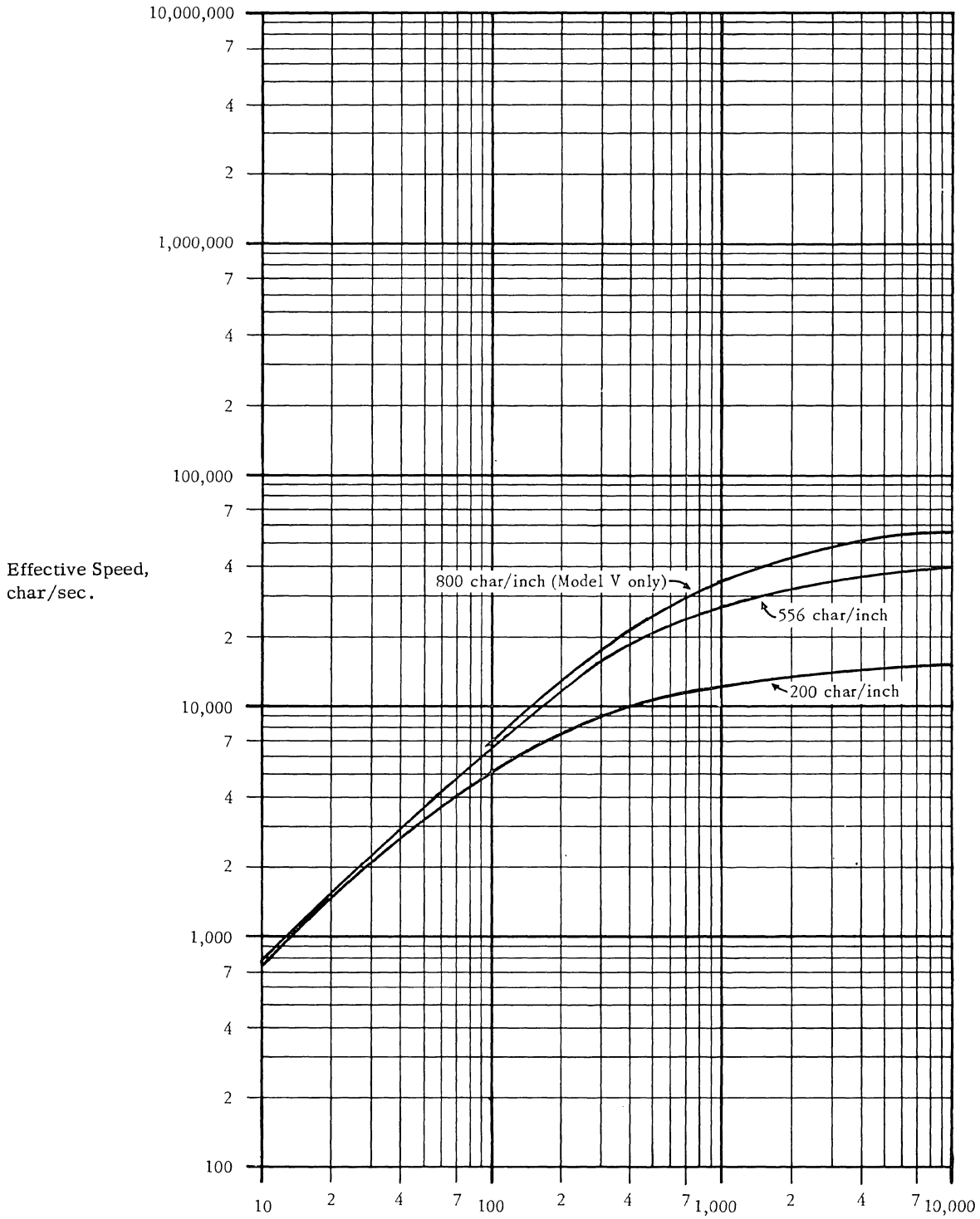
Effective Speed
IBM 729-II & 729-V



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INPUT-OUTPUT: MAGNETIC TAPE UNIT (7330)

§ 092.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit. 7330 Model 1.

.12 Description

The Model 7330 Tape Unit is slower, simpler, and less expensive than the 729, but the two are completely compatible. Tape speed is 36 inches per second, and peak transfer rate is either 7,200 or 20,016 characters per second, depending upon the recording density selected. Lateral and longitudinal parity checks are made on both reading and recording.

The throughput of the 7330 can be limited by two restrictions that must be considered:

High-speed rewind, which requires 2.2 minutes, is always terminated by unloading of the tape from the vacuum columns and read-record head. Rewinding without unloading requires 13.3 minutes per full reel.

To switch the unit from read to write status, it must be programmed to backspace over the last record read and then rewrite it; such switching between reading and recording will be infrequent in normal applications.

Optional Features

Processing Overlap: Permits computation during tape start time and between character transfers.

Priority feature: Permits interruption of the main routine upon completion of an overlapped read or write operation that does not result in a busy or not ready condition.

.13 Availability: . . . . . with 1410 system, 14 months as of February, 1962.

.14 First Delivery: . . . . October, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
- Number: . . . . . 2.
- Form: . . . . . vacuum.
- Capacity: . . . . . about 1.5 feet.

.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . 2-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200 or 556 char/inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
- Data: . . . . . 6.
- Redundancy check: . . 1.
- Timing: . . . . . 0 (self-clocking).
- Control signals: . . . 0.
- Unused: . . . . . 0.
- Total: . . . . . 7.

.325 Row use
- Data: . . . . . 1 to N.
- Redundancy check: . . 1.
- Timing: . . . . . 0.
- Control signals: . . . 0.
- Unused: . . . . . 0.
- Gap: . . . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 1.

.34 Format Compatibility

Other device or system: IBM 729, 727 tape units.
Code translation: . . . not required.

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§ 092.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Input-Output Synchronizer. 1414 Model 2

.42 Connection to System

.421 On-line: . . . . . no more than 2 1414s, Models 1 and/or 2.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: up to 10.
.432 Restrictions: . . . . . 729s cannot be intermixed with 7330s on 1414 Model 2; 7330s can be intermixed with 729s on 1414 Model 1 with addition of #7814 Tape Intermix.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N char, limited by available core storage.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each character.
.444 Input-output area lockout: . . . . . yes, for full block (no lockout when Processing Overlap is used).
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N char, limited by available core storage.
.512 Block demarcation
Input: . . . . . gap on tape or limiting mark in core storage.
Output: . . . . . limiting mark.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1 block backward (backspace); erase 3.5 inches forward (to skip defective tape areas).
.525 Marking: . . . . . inter-block gap, 0.75 inch long.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes (with optional features).
Select format: . . . . . no.
Select code: . . . . . no.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard system.
II: . . . . . with Processing Overlap

.62 Speeds

.621 Nominal or peak speed: 7,200 or 20,016 char/sec.
.622 Important parameters
Density: . . . . . 200 or 556 char/inch.
Tape speed: . . . . . 36.0 inches/sec.
Inter-block gap: . . . 0.75 inch.
Full rewind time
With unloading: . . 2.2 minutes.
Without unloading: . 13.3 minutes.
Start time
Read: . . . . . 7.6 msec.
Write . . . . . 5.0 msec.
Stop time
Read: . . . . . 12.9 msec.
Write: . . . . . 15.3 msec.
.623 Overhead: . . . . . 20.4 msec/block.
.624 Effective speeds
at 200 char/inch: . . 7,200 N/(N + 147) char/sec.
at 556 char/inch: . . . 20,016 N/(N + 408) char/sec.
where N = char/block (see graph).

.63 Demands on System

Component	Condition	Msec per block	or Percentage of transfer time
Processing Unit	I; without Processing Overlap		
	Read		
	200 char/inch:	8.1 + 0.139C	100.0
	556 char/inch:	8.1 + 0.050C	100.0
	Write		
	200 char/inch:	13.8 + 0.139C	100.0
	556 char/inch:	13.8 + 0.050C	100.0
	II; with Processing Overlap		
	Read		
	200 char/inch:	0 + 0.0045C	3.8
	556 char/inch:	0 + 0.0045C	10.5
	Write		
	200 char/inch:	0 + 0.0045C	3.8
	556 char/inch:	0 + 0.0045C	10.5

where C is number of characters per block.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment: . . . . . recording density.
Method: . . . . . switch.
Comment: . . . . . 200 or 556 char/in.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	
Load rewind:	key	loads tape into reservoirs.
Unload:	key	
File protection:	ring on spool	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage: . . . . . reel.
Capacity: . . . . . 2,400 feet; for 1,000-char blocks, 5,000,000 char at 200 char/inch or 11,300,000 char at 556 char/inch.

.732 Replenishment time: . . 1.0 to 1.5 minutes. tape unit needs to be stopped.

.734 Optimum reloading period: . . . . . 13 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral & longitudinal parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Recording level:	signal strength check	indicator & alarm.

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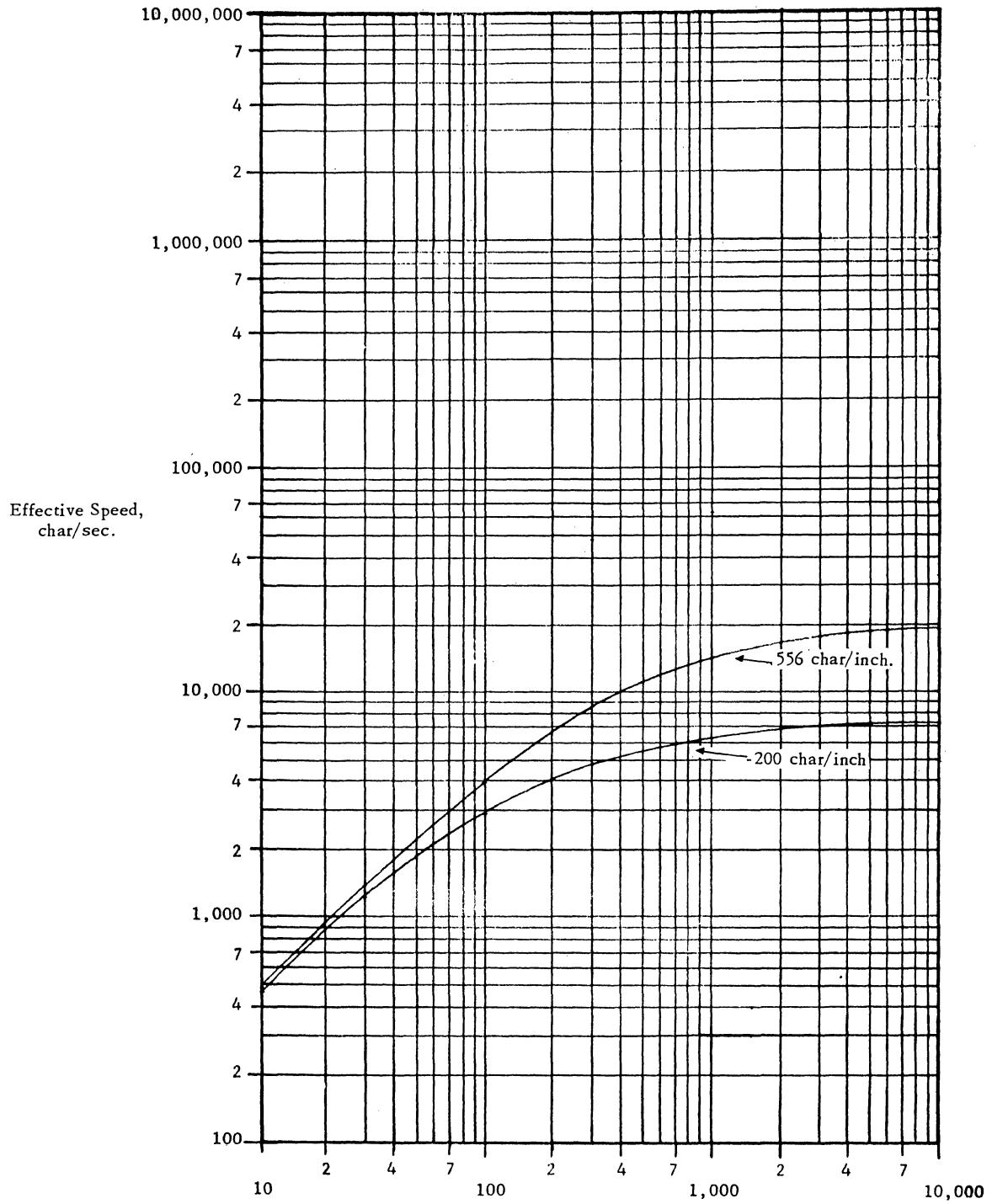
EFFECTIVE SPEED
IBM 7330



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INPUT-OUTPUT: DATA TRANSMISSION UNIT

§ 101.

.1 GENERAL

.11 Identity: . . . . . Data Transmission Unit. 1009 Model 1.

.12 Description

This unit enables the 1410 Data Processing System to transmit and receive data at speeds up to 300 characters per second over public or private telephone or telegraph lines. The unit at the other end of the line may be a similarly equipped 1401 or 1410 system or an IBM 7701 or 7702 Magnetic Tape Transmission Terminal. A specially-equipped telephone and a serial data set, supplied by the communications company, are also required at each terminal.

Data from core storage of the transmitting 1410 is transferred to the output synchronizer in loads with a fixed length of 80 characters. This transfer requires 880 microseconds, after which the Processing Unit is free to perform other operations. From the synchronizer, the data goes to the 1009 Data Transmission Unit. There it is converted from the normal serial-by-character, parallel-by-bit, BCD form to a special serial-by-bit, 4-out-of-8 transmission code in which each character code consists of four "1" bits and four "0" bits, and sent over the communications line.

The 1009 at the receiving terminal reconverts the data to the internal BCD form. Validity checks insure that each character received contains exactly four out of eight bits, and a longitudinal parity check detects most errors resulting from switched bits. Data from the receiving 1009 is transferred to an input synchronizer and from there into 1410 core storage. Input messages may be of any length and are terminated by an end-of-message signal. The two 80-position input synchronizers are filled alternately. Whenever one synchronizer fills up, the 1410 inquiry request indicator is set, and the stored program must initiate the transfer from the synchronizer to the desired core storage positions. The 1410 Priority Feature simplifies programming and increases operating efficiency.

The available transmission speeds are 75, 150, and 300 characters per second. Maximum usable speed and reliability of the data transmission are dependent upon the quality of the available communications circuits. At present, the 300 character per second speed cannot be used on toll lines.

The 1414 Model 4 Input/Output Synchronizer and the #3238 Data Transmission Unit Adapter are required to attach the 1009 to a 1410 system, and only one Data Transmission Unit may be connected to a system.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . October, 1961.

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INPUT-OUTPUT: REMOTE INQUIRY UNIT

§ 102.

.1 GENERAL

.11 Identity: . . . . . Remote Inquiry Unit. 1014 Model 1.

.12 Description:

The Remote Inquiry Unit is a modified electric typewriter with control circuits and indicator lights, mounted on a 29- by 24-inch work table. This unit is used for interrogating and printing replies from a 1410 system, and is connected to the system by a four-wire cable up to 8 miles long. The user is responsible for the installation and maintenance of cable runs over 50 feet in length. Up to 20 Remote Inquiry Units can be connected to a 1410 system. An automatic sequencing device controls the order of acceptance of inquiry requests when more than one unit is connected.

When an inquiry is to be made, the Request key on the Remote Inquiry Unit is depressed. This signals the Remote Inquiry Unit Adapter on the 1414 Model 4 or 5 Input/Output Synchronizer. As soon as the adapter is not busy with another inquiry operation, the Proceed light on the Remote Inquiry Unit is turned on. The inquiry unit address (0-9) is automatically loaded into the input synchronizer; followed by the typed inquiry message of up to 78 characters. After typing of the inquiry is completed, the Release key is depressed. This action sets the Inquiry Request indicator in the 1410 and the message can be transferred to core storage and processed by the stored program. With the optional Priority Feature, control can be transferred to the inquiry routine as soon as the synchronizer is filled.

The reply message is set up in core storage with the address of the receiving inquiry unit in the first position. It is transferred to the output synchronizer at internal speeds, and from there to the inquiry typewriter at 15.5 characters per second. Each reply message is limited to 78 characters, terminated by a group mark, and followed by an automatic carriage return.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . July, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . sprocket drive - paper punched both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved hammers.
.222 Sensing system: . . . . . typewriter keyboard.
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . . depends on stationery.

.233 Types of master
Multilith: . . . . . no.
Zerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . 1 character at a time.

Use of station: . . . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . . 44 keys.
Method of use: . . . . . 1 character at a time.

.25 Range of Symbols

Numerals:	10 0-9.
Letters:	26 A-Z.
Special:	8 &. -$*, #/ (All other special characters print as #).
Alternatives:	none.
FORTRAN set:	no.
Req. COBOL set:	no.
Total:	44 plus space.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon: . . . . . input - key depression. output - printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font. (Internal coding as in Data Code Table No. 1, except that only 8 of the 28 special characters are available.)

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§ 102.

.34 Format Compatibility: . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 9.75 inches.
.352 Length: . . . . . up to 11 inches per sheet.
.353 Maximum margins: . . . no limitations

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Synchronizer. 1414 Model 4 or 5.

Remote Inquiry Unit Adapter. #6136

(Both units are required.)

.42 Connection to System

.421 On-line: . . . . . 1 1414 Model 4 or 5 and 1 or 2 #6136 adapters per system.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . 10 per #6136 adapter.
.432 Restrictions: . . . . . maximum of 6 buffers in 1414 Model 4 or 5; each #6136 adapter requires 2 buffers.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to 78 characters.
.442 Input-output areas: . . . core storage.
.443 Input-output area access:. . . . . each character.
.444 Input-output area lockout: . . . . . yes.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:. . . . . 1 to 78 characters per inquiry (input) or reply (output).
.512 Block demarcation
Input: . . . . . Release key.
Output: . . . . . group mark in core storage.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . step 1 or 2 lines upon key depressions or control character □ in output data.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control: . . . . contained in data.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . with Priority feature only.
Select format: . . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . . no.
Busy controller: . . . . yes.
End of medium marks: . no.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: input - manual typing speed.
output - 15.5 char/sec.
.624 Effective speeds: . . . same as peak speeds, less allowance for carriage returns.

.63 Demands on System

Component Processing Unit
Msec per block: . . . 0.88.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . typical typewriter adjustments.

.72 Other Controls

Function	Form	Comment
Inquiry request:	key	signals adapter that an inquiry is to be made.
Inquiry release:	key	signals end of message and sets Inquiry Request indicator.
Inquiry cancel:	key	terminates inquiry without a reply.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Recording:	parity	indicator & alarm.
Reading	parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	check	indicator & alarm.
Invalid code:	none.	
Exhausted medium:	check	alarm.
Imperfect medium:	none.	
Timing conflicts:	checks	alarm if input typing speed exceeds 12.5 char/sec.; wait for Proceed light if adapter is serving another Inquiry Unit.

INPUT-OUTPUT: MAGNETIC CHARACTER READER

§ 103.

.1 GENERAL

.11 Identity: . . . . . Magnetic Character Reader.
1419 Model 1.

.12 Description:

This magnetic character reader-sorter reads 1,600 6-inch documents per minute. Documents up to 8-3/4 inches long can be handled at proportionately lower rates. The 1419 is functionally similar to the earlier 1412 Magnetic Character Reader, whose peak speed is 950 documents per minute. Characters printed in magnetic ink in Font E-13B (adopted as standard by the American Bankers' Association) are recognized in a character matrix 7 positions wide by 10 positions high. Only the 10 numerical characters and 4 special symbols can be read, and all magnetic ink imprinting must be on a single line within 5/8-inch of the bottom edge of the document. Invalid or unrecognizable characters cause an indicator to be set and an asterisk to be transmitted to core storage. Missing fields, incorrect field lengths, document spacing errors, and missing or out-of-sequence special symbols also cause error indications.

Four basic modes of operation are possible:

1. Off-line sorting on any one digit position.
2. On-line use (reading data into 1410 core storage) with single-digit sort as above.
3. On-line use with programmed selection of any of the 13 stacker pockets.
4. On-line use in "alternate pocket" mode. This permits unloading the stackers without stopping the reader, but no sorting can be done.

When reading 6-inch documents, 32.2 milliseconds are available for processing each document with the Processing Overlap feature and 9.5 milliseconds without it. The 1419 has only one operating speed. If, therefore, the required processing time exceeds those values, it will be necessary to transcribe the magnetic ink data to magnetic tape and then process the tape in a separate operation.

Optional Features

Multiple Column Control: permits the routing to stacker A of documents with specified digit values in up to four selected digit positions.

.12 Description (Contd.)

Electronic Accumulator and Sequence Checking: permits accumulated totals of the amounts read from documents to be printed on paper tape, and checks selected positions for correct document sequencing. (Multiple Column Control is a prerequisite.)

Split Field: permits the division of standard A.B.A. check fields into two elements, each of variable length.

Self-Checking Number: provides verification of account numbers. Available in either Modulus 10 or Modulus 11; the latter is more effective and more expensive.

.13 Availability: . . . . . 14 months as of February, 1962.

.14 First Delivery: . . . . October, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . moving belt friction.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . magnetic heads.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 30.
Method of use: . . . . . scans characters horizontally from right to left.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	none.	
Special:	4	amount, dash, transit, on-us.
Alternatives:	none.	
Total:	14.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper or card documents.
.312 Phenomenon: . . . . . magnetic ink imprinting.

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.32 Positional Arrangement

.321 Serial by: . . . . . 7 segments per character; 1 to 40 characters per document.

.322 Parallel by: . . . . . 30 tracks (3 groups of 10 each; allows for variations in vertical position of magnetic characters on document).

.323 Bands: . . . . . 1.

.324 Track use

Data:	10 of 30.
Redundancy check:	0.
Timing:	0.
Control signals:	0.
Unused:	20.
Total:	10 of 30.

.325 Row use

Data:	all.

.33 Coding: . . . . . Font E-13B magnetic ink characters.

.34 Format Compatibility

Other device or system	Code translation
All equipment using Font E-13B characters in standard A.B.A. format:	none required.

.35 Physical Dimensions

.351 Overall width: . . . . . 2.75 to 3.67 inches.

.352 Length: . . . . . 6.00 to 8.75 inches.

.353 Maximum margins: Distance of leading edge of first symbol from reference edge of document: . . . . . 0.3125 ± 0.0625 inch.

.4 CONTROLLER

.41 Identity: . . . . . no separate controller (Magnetic Character Reader Adapter on 1411: #4900 for channel 1, #4901 for channel 2).

.42 Connection to System

.421 On-line: . . . . . 1 per I/O Channel.

.422 Off-line:

Use	Associated Equipment
Document sorting:	none.

.43 Connection to Device

.431 Devices per controller: 1 per Adapter.

.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 document.

.442 Input-output areas: . . core storage.

.443 Input-output area access: . . . . . each character.

.444 Input-output area lockout: . . . . . for full block (no lockout when PO is used).

.445 Table control: . . . . . none.

.446 Synchronization: . . . . automatic within a document; by program for successive documents.

.447 Synchronizing aids: . . tests: document ready to be read; document under read head.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . up to 42 characters per document in standard A.B.A. fields.

.512 Block demarcation Input: . . . . . trailing edge of document or group mark in core storage.

.52 Input-Output Operations

.521 Input: . . . . . documents are fed continuously after unit is engaged; 1410 must be programmed to read each document.

.522 Output: . . . . . none.

.523 Stepping: . . . . . none.

.524 Skipping: . . . . . none.

.525 Marking: . . . . . none.

.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by Magnetic Character Reader.

.54 Format Control

Control:	control panel and program.
Format alternatives:	undefined.
Rearrangement:	by program.
Suppress zeros:	no.
Insert point:	no.
Insert spaces:	no.
Section sizes:	limited.
Select fields:	control panel.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Select stacker:	yes.
Select format:	no.
Select code:	no.
Start feeding documents continuously:	yes.
Stop feeding documents:	yes.

.56 Testable Conditions

Disabled:	indirectly.
Busy device:	yes.
Nearly exhausted:	no.
Busy controller:	yes.
End of medium marks:	no.
Exhausted:	indirectly.

§ 103.

.6 PERFORMANCE

.61 Conditions

I: . . . . . without Processing Overlap
II: . . . . . with Processing Overlap

.62 Speeds

.621 Nominal or peak speed: 1,600 6-inch documents/minute. (1,960 51-column documents can be read per minute, but cannot be sorted).

.622 Important parameters

Name	Value
Space between documents:	2.5 inches minimum.
Reader transport rate:	263 inches/sec.

.623 Overhead: . . . . . 50 msec minimum interval from "engage" instruction until first document reaches read head.

.624 Effective speeds: . . . $S = 9,600/L$ for continuous feeding, where:
S = speed, documents/minute
L = document length, inches.

.63 Demands on System

Basis: . . . . . 6-inch documents at minimum spacing.

Component	Condition	m.sec per document	or	Percentage
Processing Unit:	I	28.0	or	74.7
Processing Unit:	II	5.3	or	14.1

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none required (feeds intermixed documents of varying sizes).

.72 Other Controls

Function	Form	Comment
Document counter on-off-reset:	switch	
Unload pocket/restart:	foot switch	halts & restarts feeding.
Single document feed:	key	reads & processes 1 document.
Field selection:	5 keys	selects fields to be read.
Off-line mode:	key.	
1419 sort mode:	key	
Program-sort mode:	key	programmed stacker selection.
Sort fields:	5 keys	selects field for sorting.
Sort position:	10 keys	selects position for sorting.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Feed hopper:	12.0-inch stack (600-1, 200 documents).
Stackers (13):	4.5-inch stack each.

.732 Replenishment time: . 0.5 to 1.0 minute. Reader needs to be stopped, unless operating in alternate pocket mode.

.733 Adjustment time: . . . no adjustments required.

.734 Optimum reloading period: . . . . . 0.4 to 0.8 minute.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	see "Invalid code".	
Input area overflow:	check for group mark	stop data transmission.
Invalid code:	validity logic	transmit * to storage & set indicator.
Exhausted medium:	check	stop reader; alarm.
Imperfect medium:	none	
Timing conflicts:	6 photocells	set indicators.
Full stacker:	check	stop reader; alarm.
Field length error:	character count	set indicator.
Document spacing:	2 photocells	set indicator.
Feed jam:	2 photocells	stop reader; alarm.
Pocket selection:	check	stop reader; alarm.

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INPUT-OUTPUT: 1412 MAGNETIC CHARACTER READER

§ 104.

.1 GENERAL

.11 Identity: . . . . . Magnetic Character Reader. 1412 Model 1.

.12 Description

The 1412 Magnetic Character Reader-Sorter reads and sorts 950 documents (6 inches long) per minute into any 1 of 13 pockets. Documents up to 8 3/4 inches long can be handled at proportionately lower rates. The 1412 is functionally similar to the later Model 1419 Magnetic Character Reader, whose peak speed is 1,600 documents per minute (see 402:103.100). Characters printed in magnetic ink character Font E-13B (adopted as standard by the American Bankers' Association) are recognized through a reader head matrix 7 scan-time units wide by 10 units high. Only the 10 numerical characters and 4 special symbols can be read, and all magnetic ink imprinting must be on a single line within five-eighths of an inch of the bottom edge of the document. Invalid characters or characters not included in the group of stored logic patterns cause an indicator to be set and an asterisk to be transmitted to core storage. Missing fields, incorrect field length, document spacing errors, and missing or out-of-sequence special symbols also cause error indications.

Pocket selection is determined by the digit read from the column being sorted (one column at a time in the normal mode) which activates the correspondingly numbered chute blade, thus directing documents into specified pockets (A, B, 0 to 9, and reject).

Three basic modes of operation are possible:

Off-line sorting on any individual digit position.

On-line use; 1410 controls document feeding and reading, 1412 controls document sorting.

On-line use; 1410 controls document feeding and reading, and selects distribution stacker.

When reading 6-inch documents, 57.7 milliseconds are available for processing each document with the processing overlap feature and 15.0 milliseconds without it. If the processing time exceeds these values, it is necessary to program the start-stop and reading as required.

Either one or two 1412 Magnetic Character Readers can be connected to a 1410 system. If only one 1412 is required, it can be connected to either data channel. If two 1412's are required, one must be connected to each data channel. One Model 4900, 4902, or 4903 Magnetic Character Reader Adapter is required for each 1412.

.12 Description (Contd.)

A field length verification check and odd-bit parity checks are performed on each character transmitted from the 1412 to core storage.

Optional Features

Multiple Column Select-Sort Suppress:

- Permits the routing to pocket A or B of documents with specific digit values in up to four selected digit positions.
- Permits the routing to pocket A or B of documents that do not have specified numbers in designated column positions of a predetermined field.
- Permits the routing to pocket A or B of documents that contain a specific code in a predetermined field while sorting all other documents.

Auxiliary Document Counter: counts all documents passing photocell 4.

Self-Checking Number Verification: provides verification of account numbers. Available in either Modulo 10 or Modulo 11; the latter is more effective and more expensive.

Electronic Accumulator and Sequence Checking: permits accumulated totals of the amounts read from documents to be printed as lists, and checks selected positions for correct document sequencing. (Multiple Column Select-Sort Suppress is a prerequisite.)

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . moving belt friction.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . magnetic heads.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 30.
Method of use: . . . . . scans characters horizontally.

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§ 104.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	none.	
Special:	4	amount, dash, transit, on-us.
Alternatives:		none.
Total:	14.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:	paper or card documents.
.312 Phenomenon:	magnetic ink imprinting.

.32 Positional Arrangement

.321 Serial by:	7 segments per character; 1 to 40 characters per document.
.322 Parallel by:	30 tracks (3 groups of 10 each; allows for variations in vertical position of magnetic characters on documents).
.323 Bands:	1.
.324 Track use	
Data:	10 of 30.
Redundancy check:	0.
Timing:	0.
Control signals:	0.
Unused:	20.
Total:	10 of 30.
.325 Row use:	all for data.

.33 Coding:	Font E-13B magnetic ink characters.

.34 Format Compatibility

Other device or system:	all equipment using Font E-13B characters in standard A. B. A. Format.
Code translation:	none required.

.35 Physical Dimensions

.351 Overall width:	2.75 to 3.67 inches.
.352 Length:	6.00 to 8.75 inches.

.4 CONTROLLER

.41 Identity:	no special controller (Magnetic Character Reader Adapter on 1411: #4900 or 4903 for channel 1, #4902 or 4903 for channel 2.)

.42 Connection to System

.421 On-line:	1 per I/O channel.
.422 Off-line	
Use:	document sorting.
Associated equipment:	none.

.43 Connection to Device

.431 Devices per controller:	1 per adapter.
.432 Restrictions:	none.

.44 Data Transfer Control

.441 Size of load:	1 document.
.442 Input-output areas:	core storage.
.443 Input-output area access:	each character.
.444 Input-output area lockout:	for full block (no lockout when Processing Overlap is used).
.445 Table control:	none.
.446 Synchronization:	automatic within a document; by program for successive documents.
.447 Synchronizing aids:	tests; document ready to be read; document under read head.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:	up to 40 characters per document in standard A. B. A. fields.
.512 Block demarcation Input:	trailing edge of document or group mark in core storage.

.52 Input-Output Operations

.521 Input:	documents are fed continuously until a stop feed command is given; 1410 must be programmed to read each document.
.522 Output:	none.
.523 Stepping:	none.
.524 Skipping:	none.
.525 Marking:	none.
.526 Searching:	none.

.53 Code Translation:	automatic.

.54 Format Control

Control:	control panel and program.
Format alternatives:	undefined.
Rearrangement:	by program.
Suppress zeros:	no.
Insert point:	no.
Insert spaces:	no.
Section sizes:	limited.
Select fields:	control panel.

.55 Control Operations

Disable:	no.
Request interrupt:	no.
Select stacker:	yes.
Select format:	no.
Select code:	no.
Start feeding documents continuously:	yes.
Stop feeding documents:	yes.

§ 104.

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Nearly exhausted:	no.
Busy controller:	yes.
End of medium marks:	no.
Exhausted:	yes.

.6 PERFORMANCE

.61 Conditions

I:	without Processing Overlap.
II:	with Processing Overlap.

.62 Speeds

.621 Nominal or peak speed:	950 6-inch documents/minute.
.622 Important parameters	
Space between documents:	3.0 inches minimum; average is approximately equal to document length.
Reader transport rate:	200 inches/second.
Minimum processing time:	15.0 msec/document.
Minimum stacker selection time:	7.5 msec/document.
.623 Overhead:	50 msec minimum interval from "engage" instruction until first document reaches read head.
.624 Effective speed:	S = 6,000/L for continuous feeding, where: S = speed, documents/minute; L = document length, inches.

.63 Demands on System

Basis: . . . . . 6 inch documents at minimum spacing.

Component	Condition	Msec per document	Percentage
Processing Unit:	I	48.0	76.4.
Processing Unit:	II	5.3	8.4.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none required (feeds intermixed documents of varying sizes).

.72 Other Controls

Function	Form	Comment
Document counter on-off-reset:	switch.	
Reset plunge:	plunger	resets document counter to zero.
Stop-restore:	key	stops machine and resets sort-compare circuits.
Sort Key:	key	permits sorting.
Alternate pocket select:	key	for alternating input pockets.
Central processor on-line:	key	puts unit on line.
Reader off-line:	key	permits off-line operation.
Sort column:	key	determines which sort column will be used for sort operation.
Sort field:	key	selects field to be sorted.
Read field:	key	selects field(s) for transmission to the central processor.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Feed hopper:	12.0-inch stack (600 to 1,200 documents).
Stackers (13):	4.5-inch stack each. Reader must be stopped unless operating in alternate pocket mode.

.732 Replenishment time:	0.5 to 1.0 minute.
.733 Adjustment time:	no adjustment necessary.
.734 Optimum reloading period:	0.6 to 1.3 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	see "Invalid code".	
Input area overflow:	check for group mark	stop data transmission.
Invalid code:	validity logic	transmit * to storage . and set indicator.
Exhausted medium:	check	stop reader, set indicator.
Imperfect medium:	none.	
Timing conflicts:	5 photocells	set indicator.
Fill stackers:	interlock	stop reader.
Field length error:	character cost	set indicator.
Document spacing:	2 photocells	set indicator.
Feed jam:	check	stop reader, set indicator.
Transfer of data:	parity check	halt computer.

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INPUT-OUTPUT: PROGRAMMED TRANSMISSION CONTROL

§ 105.

.1 GENERAL

.11 Identity: . . . . . 7750 Programmed Transmission Control.

.12 Description

General

The 7750 Programmed Transmission Control links telecommunication terminals to the IBM 1410, permitting the 1410 to deal with a single input-output device instead of treating each terminal individually. The 7750 has 16 scan points that can be connected to adapters to permit use of varied types of transmission services. From 4 to 112 low speed lines (45 to 200 bits per second) or 1 to 16 high speed lines (voice quality, 1,200 bits per second) or a combination of the 2 types can be connected.

Telecommunication equipment such as the IBM 65/66 Data Transceiver (with IBM 67 Telegraph Signal Unit), the IBM 1009 Data Transmission Unit, the IBM 7701 Magnetic Tape Transmission Terminal, and teletype machines can be connected via communication lines to the 7750.

Function

The 7750 is an electronic computer available in 3 models having 4,096, 8, 192, and 16,384 words (48 bits each) of core storage for processing and 128 words (also 48 bits) of control storage for directing the receive and transmit operations for each scan point or communication channel. Data originating in outlying transmission terminals are transmitted to the 7750, then:

(1) assembled into messages on a character-by-character basis, checked for validity of transmission, and edited to remove functional characters used in transmission.

(2) sent to the 1410 for processing. After the data processing operations are performed in the 1410, the steps are reversed.

The stored program of the 7750 performs the editing and controls the sequence of input-output operations to and from the communication lines.

Logical Operation

Simultaneous servicing of the Communication Channels is achieved through the use of the Process Control Scanner. The 7750 processes data character by character. Each input channel has an exclusive input area, set by a Limit Word. The program goes from area to area in a predetermined sequence and processes the input characters in each. Consequently, as the program proceeds from character to character by area, different routines may be required. Since it is impossible to predict when particular subroutines will be required, all necessary routines must be available at all times. Therefore, the more varied the message format, the more process storage required.

.12 Description (Contd.)

The six possible modes of operation are assigned priority in the following sequence: Service, Channel Service, Copy, Out, In, and Normal. A separate program must be written to service each mode. Operation mode indicators are set either automatically or by programming. When an indicator of a higher priority mode is set, control is automatically transferred to the program that will service that mode. Control is transferred back to the original point of interruption only after all of the modes of higher priority have been serviced.

The 7750 can initiate a request for data transfer between it and the 1410 by setting an indicator in the 1410. When the 1410 recognizes the request, programming must be available in the 1410 to service the input-output operation. When the 1410 initiates or services a request for data transfer between it and the 7750, the 7750 must be in a suitable mode of operation to perform the required operation.

Equipment

The 7750 Programmed Transmission Control can be connected to either channel of the IBM 1411 Central Processor through an optional control adapter. Prerequisites for such connection include the 1410 Priority and Process Overlap special features with any of the Models A1 through A5 of the 1411. The same prerequisites permit the connection of the 1440 computer with a special adapter. With the 1448 Transmission Control Unit (see 414:102) connected to the 1440, 1062 Teller Terminals can transmit via the 1440 to the 1410.

With the connection of the 7750 to the 1411, the instruction set has been expanded to include an input-output assignment, K, for the 7750.

Core Storage

The 7750 has two core stores: Control Storage, and Process Storage. Each store has 48-bit words.

Control storage contains 128 words which are used for controlling the mode operation and input-output operations, and for indicating automatically detected channel errors.

Process storage words can be used for program instructions, constants, tables, area (chain) controlling limit words, and data.

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§ 105.

.12 Description (Contd.)

Programming

The 12 basic instruction types for the 7750 are increased to 77 actual instructions by modifying microcodes. Each instruction is contained in 1 word of core storage and is executed in either 28 microseconds or 56 microseconds depending on the instruction.

The instruction repertoire includes logical AND, inclusive OR, exclusive OR, comparison, data movement, and editing; however, no provision is made for arithmetic computation.

Indirect addressing is permissible. Direct addressing of any part of Control core storage is possible through the seven-bit binary address used in the instruction word. Direct addressing of any part of Process core storage is possible through the 16-bit binary address used in the instruction word.

.12 Description (Contd.)

Programming (Contd.)

Process core storage is divided into blocks, each consisting of eight consecutive words. Blocks can be linked together by putting the address of one into the block control character of the other. In this way, variable length records can be processed while fully utilizing Process core storage.

A symbolic assembly program using mnemonic operation codes and symbolic addresses is available for the 1410 for assembling 7750 programs. This assembly program includes a Data Control Package and an Input-Output Control System. After assembly, programs are loaded into the 7750 via the 1410.

INPUT-OUTPUT: TELEGRAPH INPUT-OUTPUT

§ 106.

.1 GENERAL

.11 Identity: . . . . . Telegraph Input-Output. Models 7864, 7871, 7875.

.12 Description

The 7864 telegraph input-output feature provides for the connection of a telegraph line to the IBM 1410 System. A Model 7864 unit consists of one input line connection and one output line connection. A maximum of four telegraph lines can be connected to a system in any combination as long as at least one input line and one output line are included.

The input unit (either 7864 or 7871) consists of an input adapter that is connected to an input synchronizer (either 1414-4 or 1414-5) which contains a buffer storage with a capacity of 80 characters. The output unit (either 7864 or 7875) consists of an output adapter that is connected to an output synchronizer (either 1414-4 or 1414-5) which also contains a buffer storage for 80 characters.

The input operation is performed in two steps: first, transfer of data from the telegraph line into the input synchronizer; then, transfer of data from the input synchronizer into core storage.

The input synchronizer receives data through the 7864 Telegraph input-output unit which converts 5-bit telegraphic code to 7-bit BCD code, 1 character at a time, until either 80 characters are transmitted or an end parenthesis,), is encountered or the line is disconnected because of failure. Either of the foregoing conditions sets the inquiry status latch, whose setting is program testable and can be used to initiate the routine which transfers 80 characters from the synchronizer to core storage.

.12 Description (Contd.)

Characters representing each of the following are always deleted from incoming messages prior to being entered into the synchronizer: letters, figures, line feed, and blank. Characters representing the following can optionally be deleted from incoming messages: carriage return, beginning of record, and end of record.

The output operation is performed in two steps: first the transfer of data from core storage to the output synchronizer; then the transfer of the data from the output synchronizer to the telegraph line. Messages or message segments must be 80 characters in length and in the proper format for the telegraph line. Transfer of data from core storage to the output synchronizer is initiated by a move or load instruction. The entire 80 characters of the message are then transferred to the output synchronizer.

After the output synchronizer is filled, the output unit tests the telegraph line. As soon as the line is free, the data are translated from seven-bit BCD to five-bit telegraphic code and transmitted via the line one character at a time until the synchronizer is empty. Any characters which translate into an invalid five-bit telegraphic code are sent out via the line as valid blanks; then an error indicator is set in the central processor.

The 1414-4 or 1414-5 I/O Synchronizer to which the telegraph feature is connected requires either a 4659 or 4661 I/O Adapter to be connected to the 1411 processing unit.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . Input/Output Synchronizers. 1414 Models 1, 2, 3, 4, 5, 7, and 8.

Processing Overlap Feature. #5730.

Dual Synchronizer Adapter. #3470.

Priority Feature. #5620.

.12 Description

Input-Output Synchronizers: These units contain the circuitry to control data transfers between the Processing Unit and most of the input-output devices. The Model 1 can control up to ten 729 Model II, IV, or V Magnetic Tape Units in any combination, while the Model 2 performs the same function for up to ten 7330 Magnetic Tape Units. One Model 1, 2, or 7 Synchronizer can be connected to each I/O channel, for a maximum of two per 1410 system. Each Synchronizer handles one tape read or write operation at a time, and the Processing Unit is interlocked during the entire tape operation (including start and stop times) unless the Processing Overlap Feature is installed.

The 1414 Model 3 Input-Output Synchronizer is connected to I/O channel 1 when printed reports or punched cards are to be handled by the system. It provides and controls input-output buffers for the 1402 Card Read Punch and the 1403 Printer. Data to be punched or printed is transferred at internal speeds from core storage to the synchronizer in blocks of a full card or line when the output instruction is given; thus the Processing Unit is free to perform other duties during most of the operating cycle of the output device. When a "read a card" instruction is given, the contents of the 80-character card input buffer are immediately transferred to the designated area of core storage. Then, with the Processing Unit free, the buffer is refilled with the data read from the next card.

The Model 4 Synchronizer controls and buffers the 1009 Data Transmission Unit, the 1011 Paper Tape Reader, the 1014 Remote Inquiry Unit, and/or the 7864 Telegraph Input-Output Feature, as well as the Card Read-Punch and Printer. Like the 1414 Model 3, which it replaces in expanded systems, the Model 4 is always connected to I/O channel 1 and reduces demands on the Processing Unit to a small fraction of each input-output device's operating cycle.

.12 Description (Contd.)

The Model 5 Synchronizer is similar to the Model 4 except that it cannot control the Card Read-Punch or Printer.

The Model 7 Synchronizer can control up to 10 IBM 729 II, IV, V, VI Magnetic Tape Units in any combination, and with the 7814 Tape Intermix "Special Feature" 7330 Magnetic Tape Units can be intermixed.

The Model 8 Synchronizer controls only a 1403 Printer Model 1, 2, or 3. Only one Model 3, 4, 5, or 8 Synchronizer can be connected to channel 1.

Processing Overlap Feature: Permits the overlapping of Processing Unit operations with input-output operations on Magnetic Tape Units, Disk Storage Units, Magnetic Character Readers, or the Console I/O Printer. Internal processing continues while the input-output device prepares to send or receive data and is interrupted for 4.5 microseconds for each character transmitted to or from core storage. Only one overlapped operation at a time can be done on each I/O channel. No other input-output operation can be initiated while an overlapped operation is in progress on the same channel, but an overlapped operation can be started while buffered operations (such as reading a card and printing a line) are in progress.

Dual Synchronizer Adapter: Provides a second I/O channel to which up to 10 Magnetic Tape Units, 5 Disk Storage Units, and 1 Magnetic Character Reader can be connected. This adapter and two 1414 Model 1 or 2 Input-Output Synchronizers permit simultaneous tape reading, writing, and internal processing. The Processing Overlap Feature is a prerequisite for two-channel operation.

Priority Feature: Permits automatic interruption of the stored program upon completion of selected input-output or seek operations or upon console request. This feature is required for maximum utilization of the system overlap and inquiry capabilities. It makes multi-running possible on a limited basis, although the associated programming is complex. The Priority Feature is described in detail in the 1411 Processing Unit section.

.2 CONFIGURATION CONDITIONS

I: . . . . . without Processing Overlap.
II: . . . . . with Processing Overlap and 1 channel.
III: . . . . . with Processing Overlap and 2 channels.

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§ 111.

.4 RULES

General

The card reader, card punch, printer, and teleprocessing units operate through separate buffers in order that internal processing can continue as soon as the buffers for these units become either filled or emptied.

Only one overlapped operation (e.g., read tape operation) can be performed on each input-output channel. No other input-output operation can be initiated on the same channel while an overlapped operation is in progress; however, an overlapped operation can be started while buffered operations (such as reading a card and printing a line) are in progress.

Condition I

All of the following operations:

Card read/Card punch/Print one line/Data Transmission Unit inpur or output/Remote Inquiry input or output/Paper Tape Reader input or output/and

any one of the following operations:

Process
Magnetic tape read or write
Disc storage read or write
Console I/O Printer output
Magnetic Ink Character Reader input
Programmed Transmission Control read or write.

.4 RULES (Contd.)

Condition II

All of the following operations:

Card read/Card punch/Print one line/Data Transmission Unit input or output/Remote Inquiry input or output/Paper Tape Reader input/Process/ and

any one of the following operations:

Magnetic tape read or write
Disc storage read or write
Console I/O Printer output
Magnetic Character Reader input
Programmed Transmission Control read or write.

Condition III

All of the following operations:

Card read/Card punch/Print one line/Data Transmission Unit input or output/Paper Tape Reader input/Process/ and

no more than two of the following operations in any combination (including two identical operations) with the exception of those denoted by asterisks:

Magnetic tape read or write
Disc storage read or write
Console I/O Printer output*
Magnetic Ink Character Reader input
Programmed Transmission Control input or output*

* Only one such device can be in the system.

INSTRUCTION LIST

§ 121.

INSTRUCTION					OPERATION
OP.	A, I or X	B	d	mnemonic OP. code	
					Arithmetic
A	A	B	-	A	(A) + (B) ⟶ B.
A	A	-	-	A	(A) + (A) ⟶ A.
S	A	B	-	S	(B) - (A) ⟶ B.
S	A	-	-	S	(A) - (A) ⟶ A; result is 0 with sign of (A).
?	A	B	-	ZA	(A) ⟶ B.
?	A	-	-	ZA	(A) ⟶ A; strips zone bits (except for sign position).
:	A	B	-	ZS	-(A) ⟶ B.
:	A	-	-	ZS	-(A) ⟶ A; strips zone bits and changes sign.
@	A	B	-	M	(A) x (B) ⟶ B.
%	A	B	-	D	(B) ÷ (A) ⟶ B.
					Logic
J	I	-	-	B	jump unconditionally to I.
J	I	-	9	BC9	jump to I if printer tape channel #9 is sensed.
J	I	-	@	BCV	jump to I if carriage overflow (channel 12).
J	I	-	1	BU	jump to I if unequal compare.
J	I	-	S	BE	jump to I if equal compare (B = A).
J	I	-	T	BL	jump to I if low compare (B < A).
J	I	-	U	BH	jump to I if high compare (B > A).
J	I	-	V	BZ	jump to I if zero balance.
J	I	-	W	BDV	jump to I if divide overflow.
J	I	-	Z	BAV	jump to I if arithmetic overflow.
J	I	-	Q	BNQ	jump to I if inquiry.
J	I	-	1	BOL 1	jump to I if overlap in process on channel 1.
J	I	-	2	BOL 2	jump to I if overlap in process on channel 2.
J	I	-	R	BPB	jump to I if printer carriage busy.
R or X	I	-	1	BNR 1 or 2	jump to I if Not Ready Indicator is ON (channel 1 or 2).
R or X	I	-	2	BCB 1 or 2	jump to I if Busy Indicator is ON
R or X	I	-	4	BER 1 or 2	jump to I if Data Check Indicator is ON
R or X	I	-	8	BEF 1 or 2	jump to I if Condition Indicator is ON
R or X	I	-	A	BNT 1 or 2	jump to I if No Transfer Indicator is ON
R or X	I	-	B	BWL 1 or 2	jump to I if Wrong Length Indicator is ON
B	I	B	d	BCE	jump to I if (B) = d (d = any character).
W	I	B	d	BBE	jump to I if any bit in (B) = any bit in d (not wm or c).
V	I	B	1	BW	jump to I if word mark in (B).
V	I	B	2, B, K, S	BZN	jump to I if zone in (B).
V	I	B	3, C, L, T	BWZ	jump to I if word mark or zone in (B)
					Data Transfer
D	A	B	1	MLx MRx	numerical portion of (A) ⟶ B.
D	A	B	2	MLx MRx	zone portion of (A) ⟶ B.
D	A	B	4	MLx MRx	word mark portion of (A) ⟶ B.
D	A	B	-	SCNLx SCNRx	scan for word marks, record marks, or group-marks with word marks. Note: 8-bit in d indicates a left-to-right move; no 8-bit indicates a right-to-left move; the four different A and B bit configurations determine what stops transfer or scan. X portion of mnemonic is used to specify portion of data moved and terminal point of move.

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INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
OP.	A, I or X	B	d	mnemonic OP. code	
Z	A	B	-	MCS	(A)⟶B; suppress high order zeros and commas and remove units position zone bits.
,	A	B	-	SW	set word marks at A and B.
□	A	B	-	CW	clear word marks at A and B.
					Miscellaneous Internal Operations
C	A	B	-	C	compare (A) to (B) and set indicator.
T	A	B	-	--	table look-up to end*.
T	A	B	7	--	table look-up to any*.
T	A	B	d	xxx	table look-up* -- d character determines whether look-up is for higher, lower, or equal to search argument; appropriate compare indicator is turned on.
					* A is address of search argument. B is address of low order character of table.
E	A	B	-	MCE	(A)⟶B, modified by edit-control word at B.
G	A	-	A	SAR	contents of A address register⟶A.
G	A	-	B	SBR	contents of B address register⟶A.
G	A	-	E	SER	contents of E address register⟶A.
G	A	-	F	SFR	contents of F address register⟶A.
1	-	B	-	CS	clear storage from B down through nearest hundreds position.
1	I	B	-	CS	clear storage and jump to I.
.	-	-	-	H	halt (pressing start key restarts system with the next sequential operation).
.	I	-	-	H	halt (pressing start key restarts system with instruction located at I address).
N	-	-	-	NOP	no operation.
					1405 Disc Storage
M or L	xF0	B	R or W	SD	seek disc storage record whose address is in B.
M or L	xF1	B	W	WD	write into disc storage from B - one record.
M or L	xF2	B	W	WDT	write into disc storage from B - full track.
M or L	xF3	B	W	WDC	check data recorded by previous write disc operation.
M or L	xF1	B	R	RD	read from disc storage into B - one record.
M or L	xF2	B	R	RDT	read from disc storage into B - full track.
M	xF4	-	W	-	write indelible address for a single specified sector on disc unit.
					1301 Disc Storage
M or L	xF0	B	R or W	SD	seek disc storage record whose address is in B.
M or L	xF1	B	W	WD	write into disc storage from B - one record.
M or L	xF2	B	W	WCY	write into disc storage from B in the cylinder mode, stopping either at the end of the cylinder or upon sensing a group mark in core storage, whichever comes first.
M or L	xF2	B	W	WDT	write into disc storage from B, stopping either at the end of the track or upon sensing a group mark in core storage, whichever comes first.
M or L	xF6	B	W	WFT	write into disc storage from B - one track.
M or L	xF5	B	W	WHA	write into disc storage from B, beginning at home address area and continuing through record addresses and record areas as defined by the format track, to the end of track.
M or L	xF7	B	W	WFO	write into disc storage from B - one format track.
M or L	xF3	B	W	WDC	check data recorded by previous write disc operation.

§ 121.

INSTRUCTION LIST–Contd.

INSTRUCTION					OPERATION
OP.	A, I or X	B	d	mnemonic OP. code	
M or L	xF1	B	R	RD	read from disc storage into B - one record.
M or L	xF2	B	R	RCY	read from disc storage into B in the cylinder mode, stopping either at the end of the cylinder or upon sensing a group mark in core storage, whichever comes first.
M or L	xF2	B	R	RDT	read from disc storage into B, stopping when a group mark is sensed.
M or L	xF6	B	R	RDT	read from disc storage into B - one track.
M or L	xF5	B	R	RHA	read from disc storage into B, beginning at home address area and continuing through record addresses and record areas as defined by the format track to the end of track.
M or L	xF4	B	-	NOP	no operation.
M or L	xF8	B	-	SAI	disconnect access unit.
					Input-Output: Console Inquiry:
M	%T0	B	R	MCW	data from keyboard ⟶ B; no word-marks.
M	%T0	B	W	MCW	(B) ⟶ console printer; no word-marks.
L	%T0	B	R	MCW	data from keyboard ⟶ B; with word-marks.
L	%T0	B	W	MCW	(B) ⟶ console printer; with word-marks.
					Input-Output: Card and Printer:
M	%1n	B	R	R	80 characters in read synchronizer ⟶ B; refill synchronizer from next card. *
L	%1n	B	R	RW	80 characters in read synchronizer ⟶ B; refill synchronizer from next card; read word separator characters into storage as word marks. *
K	-	-	d	SSF	select read stacker indicated by d.
M	%4n	B	W	P	80 characters in B ⟶ punch synchronizer, then punch 1 card. *
L	%4n	B	W	PW	80 characters in B ⟶ punch synchronizer, then punch; word marks are translated into word separator chars. *
M	%20	B	W	W	100 (or 132) characters in B ⟶ print synchronizer, then print.
L	%20	B	W	W	100 (or 132) characters in B ⟶ print synchronizer, then print; translate word marks to word separator characters for printing.
F	-	-	d	CC	space or skip printer, as indicated by d.
					* n determines card pocket.
					Input-Output: Magnetic Tape
U	%Un	-	B	BSP	backspace one block on MTn.
U	%Un	-	E	SKP	skip and erase 3.5 inches on MTn.
U	%Un	-	M	WTM	record end-of-tape mark on MTn.
U	%Un	-	R	RWD	rewind MTn.
U	%Un	-	U	RWU	rewind and unload MTn.
M	%Un	B	R	RT	read one block from MTn into B.
M	%Un	B	W	WT	write one block on MTn from B.
L	%Un	B	R	RTW	read one block from MTn with word marks into B.
L	%Un	B	W	WTW	write one block on MTn with word marks from B.
L	%Un	B	$	RTG	read from MTn into B; stop when inter-record gap is sensed or last core-storage position is encountered.
L	%Un	B	$	WTE	write from B onto MTn; stop when last core storage position is encountered (ignores group mark with word mark).

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INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
OP.	A, I or X	B	d	mnemonic OP. code	
					Input-Output: Paper Tape Reader
L	%P1	B	R	LCA	read 1 block into B with word marks.
M	%P1	B	R	MCW	read 1 block into B; no word marks.
					Input-Output: Magnetic Character Reader
U	%S1	-	E	CU	start feeding documents continuously.
U	%S1	-	D	CU	stop feeding documents continuously.
L	%S1	B	R	LCA	transfer data from 1 document into B, with word marks.
M	%S1	B	R	MCW	transfer data from 1 document into B; no word marks.
U	-	-	d	SS	select stacker pocket indicated by d.
					Input-Output: Data Transmission Unit
L	%D0	B	W	LCA	write 1 block from B with word marks.
M	%D0	B	W	MCW	write 1 block from B; no word marks.
L	%D0	B	R	LCA	read 1 block into B with word marks.
M	%D0	B	R	MCW	read 1 block into B; no word marks.
					Input-Output: Remote Inquiry Unit
L	%Qn	B	R	LCA	read message into B, erasing word marks. *
M	%Qn	B	R	MCW	read message into B. *
L	%Qn	B	W	LCA	write message from B. **
M	% Qn	B	W	MCW	write message from B.
					* No word marks transmitted. ** Causes a pound sign (#) to be printed on inquiry unit I/O printer for every word mark transmitted.

AUERBACH / BNA

CODING SPECIMEN: BASIC AUTOCODER

§ 131.

.1 TRANSLATOR LISTING

```
BASIC                          SAMPLE PROGRAM FOR BASIC AUTOCODER  1410-AU-102                    PAGE    1
  PGLIN    LABEL     OPCOD  OPERAND                                          CT  ADDRS  INSTRUCTION    CARD    FLAG

S                    CTL    3
                     PST
                     ORG    500                                                  00500
                     DA     1X100,X1,G                                           00500                  1
           PAUL             1,1                                                  00500                  2
                     DA     1X50,X15,0,G                                         00601                  3
           I                7,17                                                 00617                  4
           J                23,24                                                00624                  4
           K                35,35                                                00635                  4
           MIXUP            15,20                                                00620                  4
           EXCESS           53,55                                                00655                  4
                     ZA     I,J                                              11  00652  +00+A600+B3      5
                     S      J,K                                              11  00663  S00+B300+C4      5
                     AZ     I,J                                              12  00674  N00+A600+B3      5     O
           XREG1     EQU    6,X
                     A      1+XREG1,J                                        11  00686  A00‡J600+B3      5
           JOE       B      I,J,3      FORMAT ERROR                           7  00697  J00+A63 +B3      5       F
           PAUL      BE     I,J,3          MULT DEF AND FORMAT ERROR          7  00704  J00+A63 +B3      6       F
                     B      PAUL                                              7  00711  J005‡0           6    M
           ANN       BE     A,J,3          UNDEFINED AND FORMAT  ERROR        7  00718  J.....3 +B3      6      UF
           REAXX     DC     -LOW ORDER LABEL ASSIGNMENT-                     26  00750                  6
            JOHN     DC     -HIGH ORDER LABLEL ASSIGNMENT-                   28  00751                  7
                     ORG    *+X00          ORG NEXT HUNDRED                      00800
           CDAREA    DA     1X80,G                                               00800                  8
           LDADR            5                                                    00804
           SUBOP            3                                                    00802
           RLG              8                                                    00807
           CHCT             10                                                   00809
           DATA             10                                                   00809
           UPORG            21                                                   00820
           NODRG            16                                                   00815
           FLAG             22                                                   00821
           ORGHLD    DA     1X5                                                  00881
           RLCON     DA     1X5                                                  00886
           HOLD      DA     1X11                                                 00891
           CK1              11                                                   00901
           MAX       DA     1X5,G                                                00902                  9
           CLSTOR    DC     -00000-                                           5  00912                 10
            EOFMSG   DCW    -SYSTEM TAPE MADE ON CH 1 UNIT 1-,G              31  00913                 10
                     BCB1   GO                                                7  00945  R022092          10
                                                                                                G
                     BA1    *+1                                               7  00952  R00959M          10
           INPUT     RW     1,CDAREA                                         10  00959  L(1100800R       11
                                                                                                G
                     BA1    ERRRX                                             7  00969  R01650M          11
```

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IBM

FORM X24-1350-1
PRINTED IN U.S.A.

Program _____

Programmed by _____

Date _____

1401/1410 AUTOCODER CODING SHEET

Identification 76 80

Page No. 1 2 of _____

Line 3 5	Label 6 15	Operation 16 20	OPERAND 21 25 30 35 40 45 50 55 60 65 70
0 1			
0 2			
0 3			
0 4			
0 5			
0 6			
0 7			
0 8			
0 9			
1 0			
1 1			
1 2			
1 3			
1 4			
1 5			
1 6			
1 7			
1 8			
1 9			
2 0			
2 1			
2 2			
2 3			
2 4			
2 5			

AUERBACH / BNA

CODING SPECIMEN: AUTOCODER

§ 132

.1 TRANSLATOR LISTING

```
1                                SAMPLE PROGRAM IBM 1410 TAPE AUTOCODER WITH IOCS                PAGE    3
 SEQNC  PGLIN  LABEL       OPCOD  OPERAND                                  CT  ADDRS  INSTRUCTION    CARD    FLAG

  154    1353              B      IOCSEREFWL                                7  00789  J00865           7
  155    1356 IOCSERPUL2   MLCWA  0,IOCSBUCKET&9                           12  00796  D0000001026X      7
  156    1357              B      IOCSERREP2                                7  00808  J00624           7
  157    1358 IOCSERWCPR   SBR    *&30                                      7  00815  G00851B          7
  158    1359              WCP    IOCSERMES1-12                            10  00822  M%T001133W       7
  159    1360              BCB1   *-16                                      7  00832  R008222          7
                                                                                                G
  160    1361              BA1    *&1                                       7  00839  R00846M          8
  161    1362              B      0                                         7  00846  J00000           8
  162    1363 IOCSERNRRO   MLCP   IOCSERNRMS,IOCSERMES1-1                  12  00853  D0112001144L     8
  163    1364 IOCSEREFWL   B      IOCSERWCPR                                7  00865  J00815           8
  164    1365              H      IOCSBUCKET                                6  00872  .01019           8
                                                                                                Q
  165    1402 IOCSERFRWL   MRCWR  IOCSBUCKET,IOCSERSBUC                    12  00878  D0101900957T      8
  166    1403              MLNB   IOCSEREXIT&5,*&13                         12  00890  D0105800914J     9
  167    1404 IOCSEREOFX   B      0                                         7  00902  J00000           9
  168    1405 IOCSEREXI2   B      0                                         7  00909  J00000           9
  169    1406              S      &17,IOCSEREXI2&5                          11  00916  S0156900914      9
  170    1407              BCE    IOCSEREXI2,IOCSERSBUC&10,N                12  00927  B0090900967N     9
  171    1408              S      &7,IOCSEREXI2&5                           11  00939  S0157000914     10
  172    1409              B      IOCSEREXI2                                7  00950  J00909          10
  173    1410 IOCSERSBUC   DA     1X20                                          00957
  174    1411                     1,1                                           00957                 11
  175    1413              ORG    00977                                         00977
  176    1414 IOCSCRDEOF   DS     5                                             00981
  177    1423 IOCSERPERO   BCE    IOCSERFTCD,IOCSBUCKET&2,1                 12  00982  B01060010211    12
  178    1448              BCE    IOCSERFATL,IOCSERCNT1,1                   12  00994  B0106001169I    12
  179    1488 IOCSERBRC1   A      *-10,IOCSERCNT1                           11  01006  A0100601169     12
```

.2 CODING SHEET: . . . same as 402:131.2.

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CODING SPECIMEN: FORTRAN

§ 133.

.1 SOURCE PROGRAM LISTING

0250971 PAGE

```
SEQ  STMNT    FORTRAN STATEMENT
     C        APPENDIX E   SAMPLE PROBLEM 1
     C        MATRIX ARITHMETIC
 1            DIMENSION A(7,7),VECTOR(7),B(7,7)
 2            SENSE LIGHT 1
 3            DO 1 I=1,7
 4            DO 1 J=1,7
 5            B(I,J)=1./FLOATF(I+J-1)
 6   1        A(I,J)=B(I,J)
 7            PRINT 13
 8   13       FORMAT(25H1GENERATED HILBERT MATRIX//)
 9            PRINT 2,A
10   2        FORMAT(1X,7E14.7)
11            PRINT 15
12   15       FORMAT(8HOINVERSE//)
13   10       DO 6 K=1,7
14            VECTOR=1.
15            DO 3 I=2,7
16   3        VECTOR(I)=0.
17            DO 4 J=2,8
18   4        A(I,J)=A(I,J)/A
19            DO 5 I=1,55
20   5        A(I)  =A(I+1)
21            DO 6 I=1,6
22            A(56) =A(I,1)
23            DO 6 J=1,7
24   6        A(I,J)=A(I,J+1)-A(56)*A(7,J)
25            PRINT 2,A
26            IF(SENSE LIGHT 1)11,12
27   11       PRINT 16
28   16       FORMAT(15HOMATRIX PRODUCT//)
29            DO 9 K=1,7
30            DO 8 I=1,7
31            VECTOR(I)=0.
32            DO 8 J=1,7
33   8        VECTOR(I)=VECTOR(I)+A(I,J)*B(J,K)
34   9        PRINT 18,VECTOR
35   18       FORMAT(1X,7F14.8)
36            PRINT 17
37   17       FORMAT(15HOTWICE INVERTED//)
38            GO TO 10
39   12       PRINT 7
40   7        FORMAT(1H1)
41            STOP 111
42            END
```

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IBM

FORTRAN CODING FORM

Form X28-7327-3
Printed in U.S.A.

Program _____
Coded By _____
Checked By _____

Identification
73 80

Date _____
Page _____ of _____

C FOR COMMENT

STATEMENT NUMBER 1 5	Cont. 6	FORTRAN STATEMENT 7 10 15 20 25 30 35 40 45 50 55 60 65 70 72

AUERBACH / BNA

CODING SPECIMEN: COBOL

§ 134.

.1 SOURCE PROGRAM LISTING

```
004130 PROCEDURE DIVISION.                                              PROB 13
004140 HOUSEKEEPING SECTION.                                            PROB 13
004150 HK. OPEN INPUT MASTER-FILE TRANSACTION-FILE OUTPUT OUTPUT-FILE    PROB 13
004160      ORDERS-CANCELLED-FILE ERROR-OUT.                            PROB 13
004170 BEGIN. READ MASTER-FILE AT END GO TO CLOSEM. GO TO SWITCH-OFF     PROB 13
004180      DEPENDING ON SKIPIT. READ TRANSACTION-FILE AT END GO TO      PROB 13
004190      CLOSET.                                                     PROB 13
004191 PRE-TEST. IF CANCEL-ORDER GO TO TEST-AGAIN.                       PROB 13
005010 CMP. IF ADDITIONAL-QTY AND MOD-ORD-NO EQUAL TO TMOD-ORD-NO NEXT   PROB 13
005020      SENTENCE ELSE GO TO TEST. ADD NEW-QTY TO QUANTITY.          PROB 13
005030 OUT. WRITE MASTER-OUTPUT FROM MASTER. GO TO BEGIN.                PROB 13
005040 TEST. IF QTY-CANCELLED AND MOD-ORD-NO EQUAL TO TMOD-ORD-NO NEX    PROB 13
005050-     T SENTENCE ELSE GO TO TEST-AGAIN. SUBTRACT NEW-QTY FROM     PROB 13
005060      QUANTITY. IF QUANTITY IS NEGATIVE NEXT SENTENCE ELSE GO TO   PROB 13
005070      OUT.                                                        PROB 13
005080 CANCEL-IT. WRITE CANCEL-RECORD FROM MASTER GO TO BEGIN.           PROB 13
005090 TEST-AGAIN. IF CANCEL-ORDER AND MOD-ORD-NO EQUAL TO TMOD-ORD-NO2  PROB 13
005100      GO TO CANCEL-IT. IF TMOD-ORD-NO2 IS GREATER THAN MOD-ORD-    PROB 13
005110-     NO MOVE 1 TO SKIPIT GO TO OUT ELSE WRITE ER-OR FROM MASTER   PROB 13
005120      GO TO BEGIN.                                                PROB 13
005130 SWITCH-OFF. MOVE ZERO TO SKIPIT GO TO CMP.                        PROB 13
005140 WR. WRITE MASTER-OUTPUT FROM MASTER READ MASTER-FILE GO TO WR.    PROB 13
005150 CLOSET. CLOSE TRANSACTION-FILE ORDERS-CANCELLED-FILE ERROR-OUT.   PROB 13
005160      GO TO WR.                                                   PROB 13
005170 CLOSEM. CLOSE MASTER-FILE OUTPUT-FILE. STOP RUN.                  PROB 13
```

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IBM

COBOL PROGRAM SHEET

Form No. X28-1464
Printed in U.S.A.

PAGE 1 3	PROGRAM	SYSTEM	SHEET OF
	PROGRAMMER	DATE	IDENT. 73 80

SERIAL 4 6	CONT. 7	A 8	B 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72

AUERBACH / BNA

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . internal, magnetic tape, and disc storage.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 8 bits: 6 data, 1 parity, 1 word mark.

(Word mark bit is not used on magnetic tape or disc storage; it is replaced by the word separator character, = .)

.22 Character Structure

.221 More significant pattern: 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits: 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	Blank	¢	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	ϕ	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	#	:	?
11	#	,	$	.
12	@	%	*	□
13	:	=	)	(
14	>	'	;	<
15	√	"	Δ	≠

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DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . internal, magnetic tape, and disc storage.

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.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	Blank	¢	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	ϕ	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	#	:	?
11	#	,	$	.
12	@	%	*	□
13	:	=	)	(
14	>	'	;	<
15	√	"	Δ	≠

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . 1403 Printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 8 bits: 6 data, 1 odd parity, 1 word mark.

.22 Character Structure

.221 More significant pattern: 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits: 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	Blank	‡	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	B
5	5	V	N	E
6	6	W	∅	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	‡	-	&
11	#	,	$	.
12	@	%	*	□
13				
14				
15				

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . punched card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH None	12	11	0
None	blank	&	-	
12				
11				
0	0		!	
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	Ø	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2				‡
8-3	#	.	$	,
8-4	@	□	*	%
8-5	:	(	)	=
8-6	>	<	;	'
8-7	√	ǂ	Δ	"

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DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE . . . . internal collating sequence.

.2 STRUCTURE OF CODE

In ascending sequence:

blank	G
.	H
□	I
(	¦
<	J
ǂ (group mark)	K
&	L
$	M
*	N
)	O
;	P
Δ	Q
-	R
/	ǂ (record mark)
,	S
%	T
= (word separator)	U
'	V
"	W
¢	X
#	Y
@	Z
:	0
>	1
√ (tape mark)	2
?	3
A	4
B	5
C	6
D	7
E	8
F	9

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PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY

.11 Simulators of Other Computers

IBM 650
Reference: . . . . . IBM Publication J24-1453-0.
Date available: . . . . released.
Description:

Using this simulator, the 1410 assumes the characteristics of a 650. It can simulate all models of the 650, except Model IV. The simulated 650 system can have any or all of these features:

2,000 words of core storage
index registers
core storage
disc storage
magnetic tape

The 1410 System must have 40,000 positions of core storage. The 1410 usually has the same configuration of input and output units as the 650 system being simulated; however, the simulation program can substitute tape units for card and 407 input and output. Control panel wiring is simulated by editing routines. These editing routines, plus the configurations of both computers, are specified by control cards.

.12 Simulation by Other Computers

IBM 704, 709, and 7090
Reference: . . . . . IBM Publication J29-1427-0.
Date available: . . . . released.
Description:

This program enables the user to simulate a 1410 system with 20,000 core storage positions on a 704, 709, or 7090. One version operates with the 704; another with the 709 or 7090.

The simulating computer must have the following minimum configuration:

32,678 words of core storage, an on-line card punch, and an off-line printer. In addition, the 704 must have four magnetic tape units plus one for each 1410 tape unit to be simulated, as well as an on-line card reader. The 709 and 7090 must have five tape units plus one for each simulated tape unit, as well as off-line card-to-tape equipment. Input to the 704 must be on punched cards; input to the 709 and 7090 must be on magnetic tape.

The 709 and 7090 can simulate up to ten 1410 tape units; the 704 can handle up to five. No more than one disc of a 1405 disc storage unit can be

.12 Simulation by Other Computers (Contd.)

Description (Contd):

simulated; the 1301 cannot be simulated. A maximum of 120 print positions can be simulated.

The simulator contains the Basic Autocoder translator. It is possible to run several programs without interruption (assembly and/or production runs). A 1410 program run on the 704 takes about 20 times as long as on the 1410.

.13 Data Sorting and Merging

1410 Sort 10
Reference: . . . . . IBM Publication J29-1414-0.
Record size: . . . . . 13 to 2,000 characters.
Block size: . . . . . 1,000 or 2,000 characters.
Key size: . . . . . up to 10 fields of up to 10 characters each.
File size: . . . . . limited by Disk Storage Unit capacity.
Number of tapes: . . minimum of 1 (plus one 1405 Disk Storage Unit).
Date available: . . . . released.
Description: . . . . . Sort 10 is a generalized program for ordering records of an unordered file stored on tape or in disc storage, using a RAMAC 1410 System. Control information is supplied by the user. Checkpoints and restarts are provided, as well as the ability to print error messages on-line.

1410 Sort/Merge 11
Reference: . . . . . IBM Publication J28-0237-0.
Record size: . . . . . 13 char to maximum allowable block length.
Block size: . . . . . maximum of 1,330 to 9,999 characters, depending on order of merge and system configuration.
Key size: . . . . . up to 10 fields of up to 10 characters each.
File size: . . . . . up to 4 reels (using 10 tapes).
Number of tapes: . . . 4 to 10.
Data available: . . . . released.
Description: . . . . . Sort/Merge 11 is a generalized program for ordering and merging tape records. It does not utilize Processing Overlap or the Priority Feature. It requires a minimum of 20,000 positions of core storage. Any order of merge up to 5-way may be employed.

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§ 151.

.13 Data Sorting and Merging (Contd.)

1410 Sort/Merge 12
Reference: . . . . . IBM Publication J28-0253.
Record size: . . . . . 13 characters to maximum allowable block length.
Block size: . . . . . maximum of 298 to 9,999 characters, depending on order of merge and storage capacity.
Key size: . . . . . up to 10 fields of up to 999 characters each.
File size: . . . . . up to 4 reels (using 10 tapes).
Number of tapes: . . . 4 to 10.
Date available: . . . . released.
Description: . . . . . Sort/Merge 12 is a generalized program for ordering and merging tape records. Unlike Sort/Merge 11, it utilizes the Processing Overlap and Priority Features. Any order of merge up to 5-way may be employed.

.14 Report Writing

1410 Card Report Program Generator
Reference: . . . . . IBM Publication J24-1443-0.
Date available: . . . . released.
Description:

This generator facilitates the preparation of report programs which will process an input card file to produce a printed report and/or a punched card deck. Four distinct phases are involved in its use:

1. Writing the report specifications in a problem-oriented language.

2. Translating the report specifications into a symbolic (Basic Autocoder) object program through the use of the Card Report Program Generator Processor Deck.

3. Translating the symbolic program into 1410 machine language by means of either the Basic Autocoder or Autocoder translator.

4. Executing the object program to produce the desired report.

A minimum of 10,000 positions of core storage is required to generate a report program. The object program can be run on any 1410 system whose storage capacity will accommodate it, and no special features are required. Primary emphasis has been placed on the generation of efficient object programs for a wide variety of report formats and computational requirements. The generation process is lengthy and involves considerable card handling unless the translating 1410 system is large enough to permit use of the Autocoder translator. The problem-oriented language, while not as easy to master as one might hope, should result in significant savings in programming time and effort as compared with the use of a machine-oriented language for program preparation.

.14 Report Writing (Contd.)

1410 Tape Report Program Generator
Reference: . . . . . IBM Publication J24-1443-0.
Date available: . . . . released.

Description:

The Tape Report Program Generator utilizes the same language and performs the same basic function as the card version described above. An object program produced by the tape version, however, processes an input file which may be on tape, card or disc storage to produce a printed report, a punched card deck, an output tape file, or any combination of the three. The output tape file will contain unblocked 132 character records in the move mode, with even parity.

The object computer must have 10,000 core storage positions and a card read-punch. If the specifications indicate tape input and tape, card, and printer output, the target system will require two magnetic tape units and a printer, as well as a card read-punch. The generated program utilizes IOCS for input-output control.

.15 Data Transcription

Tape File Generators (A & B)
Reference: . . . . . IBM Publication J24-1435-0.
Date available: . . . . released.
Description: . . . . . These 2 programs (which differ only in the card formats they handle) prepare tape files from card records. With one of the programs the record can be either fixed or variable length. With the other program, fixed-length records can be written in blocked or unblocked form.

Tape Print Program
Reference: . . . . . IBM Publication J24-1435-0.
Date available: . . . . released.
Description: . . . . . This program produces a listing of the data contained on any magnetic tape written by the IBM 1410. Tape records can be either fixed or variable length and written in either the move or load mode.

.16 File Maintenance

1405 Disk Storage Utility Programs
Reference: . . . . . IBM Publication J28-0248.
Date available: . . . . released.
Description:

Seven 1405 Disk Storage utility programs provide the following facilities for program testing and basic service functions operating on full tracks of selected areas of disc storage:

- Erase and fill areas with any valid 1410 character specified by user.

- Load areas with data contained on cards.

§ 151.

.16 File Maintenance (Contd.)

1405 Disk Storage Utility Programs (Contd.)

- Write contents of areas on magnetic tape (with or without Processing Overlap and Priority special features).
- Reload areas from magnetic tape (with or without Processing Overlap and Priority special features).
- Produce on the printer data recorded on selected tracks.

1301 Disk Storage Utility Routines
Reference: . . . . . IBM Publication J28-0252.
Date available: . . . . released.
Description:

Six 1301 Disk Storage utility routines provide the following facilities for both test and production runs:

- Generate characters for the format track and write them on one or more format tracks.

.16 File Maintenance (Contd.)

1301 Disk Storage Utility Routines (Contd.)

- Generate home address identifier and addresses of records, and write them on one or more disc tracks.
- Load data from magnetic tape records into a designated track of disc storage.
- Write all the data from one or more tracks and the disc location identifier onto magnetic tape.
- Read data from magnetic tape into its original disc storage location.
- Fill record areas of specified tracks with a character specified by the user.

.17 Other: . . . . . none to date.

.2 PROBLEM ORIENTED LANGUAGES: . . . . none.

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PROGRESS ORIENTED LANGUAGE: FORTRAN

§ 161.

.1 GENERAL

.11 Identity: . . . . . IBM 1410 FORTRAN.

.12 Origin: . . . . . Data Processing Division, IBM Corporation.

.13 Reference: . . . . . IBM Publication J24-1468-0.

.14 Description

The IBM 1410 FORTRAN language is a reasonably complete and useful version of FORTRAN II, the most widely accepted process oriented language for scientific applications. The 1410 version differs from the 709/7090 FORTRAN II language (Section 408:161) primarily in that Boolean and complex arithmetic cannot be performed. The other language restrictions are minor. On the other hand, 1410 FORTRAN takes advantage of the variable word length capabilities of the 1411 Processing Unit by permitting the programmer to specify any desired degree of precision for the internal representation of numeric data. The only limitation on item size is the capacity of core storage. The precision (f) to be used for all floating point values within a single program is preset by a control card. If no specification is made, f is set at eight decimal digits. The number of storage positions required for each floating point data value of f digits precision is f + 2, because two additional digits are required to specify the exponent. Fixed point precision (k), which is also preset by a control card, applies to all fixed point values within a program, and is set at five decimal digits if no explicit specification is made. Object program execution times and storage requirements will naturally increase when increased precision is demanded.

The ranges of numeric magnitudes that can be represented in 1410 and 709/7090 FORTRAN II are compared in the following table:

System	Floating Point	Fixed Point
1410 FORTRAN:	10^{-100} to $(1-10^{-f}) \times 10^{+99}$	1 to 10^{k}.
709/7090 FORTRAN:	10^{-38} to 10^{+38}	1 to 131,071.

Where f and k are floating and fixed point precisions, respectively, in decimal digits.

The 1410 FORTRAN language includes complete facilities for defining and using subroutines and functions. Conversion of FORTRAN-coded programs and subroutines written for other systems (e.g., SHARE library routines) should be fairly straightforward so long as the routines include no symbolic coding and no Boolean or complex arithmetic statements. All the standard built-in and library functions of 709/7090 FORTRAN II except hyperbolic tangent are provided. Virtually all the input-output and format features of 709/7090 FORTRAN are available, except that input-output in octal form is not possible.

.14 Description (Contd.)

The 1410 FORTRAN Compiler is designed to operate on a 1410 system with 20,000 or more positions of core storage, a 1402 Card Read Punch, a 1403 Printer, and a minimum of 4 magnetic tape units. The compiler translates the FORTRAN source program into a 1410 Autocoder program, which is in turn converted into a machine language object program by the Autocoder translator.

The restrictions and extensions of the IBM 1410 FORTRAN language relative to IBM 709/7090 FORTRAN II follow:

Restrictions

(1) The following statements are not permitted:

FREQUENCY
READ DRUM
WRITE DRUM

(2) Boolean, complex, and double precision operations are not permitted (but note that precision can be preset to any desired value).

(3) Input-output in octal form (O-type conversion) is not permitted.

(4) A list of compiler output options can follow the END statement, but will be ignored by the compiler.

(5) IF ACCUMULATOR OVERFLOW, IF QUOTIENT OVERFLOW, and IF DIVIDE CHECK all test the setting of the same pseudo overflow indicator, which is turned on only by floating point arithmetic operations.

(6) IF SENSE SWITCH tests one of six pseudo sense switches whose settings must be specified by a control card.

(7) Symbolic coding cannot be incorporated into the FORTRAN source program.

(8) Floating point and fixed point variables must not be assigned to the same storage location in an EQUIVALENCE statement.

(9) The hyperbolic tangent (TANHF) function is not provided.

(10) Object programs cannot be segmented as in 709/7090 CHAIN operations.

Extensions

(1) Fixed point and floating point data items can be represented internally with any desired degree of precision, as preset by control cards (see Description above).

(2) The TYPE statement provides typed output on the on-line 1415 Console I/O Printer.

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PROCESS ORIENTED LANGUAGE: COBOL 61

§ 162.

.1 GENERAL

.11 Identity: . . . . . IBM 1410 COBOL.

.12 Origin: . . . . . IBM Corporation.

.13 Reference: . . . . . IBM Publications. F28-8053-1, J28-0232, N28-1007, and N28-1012.

.14 Description

IBM 1410 COBOL is a subset of COBOL-61, the most widely implemented pseudo-English common language for business applications. Although a number of electives have been incorporated, 1410 COBOL has several significant deficiencies with respect to Required COBOL-61. These deficiencies result from the manufacturer's decision to "defer" several important but not easily implemented language facilities in order to produce the first operative COBOL-61 compiler. The deficiencies of 1410 COBOL relative to Required COBOL-61, as well as the facilities of Elective COBOL-61 that have and have not been implemented, are tabulated at the end of this description.

Probably the most significant language facilities of Required COBOL-61 that have not been implemented for the IBM 1410 are the EXAMINE verb and the COBOL library. The EXAMINE verb and associated TALLY register are used to replace a given character and/or to count the number of times the character occurs in a data item. Thus, a variety of character manipulation operations that cannot otherwise be coded in the COBOL language are possible. The COBOL library is a collection of prewritten entries for the Environment, Data, and Procedure Divisions that can reduce the amount of writing involved in coding programs and encourage standardization of coding techniques.

Among the electives that have been incorporated into 1410 COBOL, the COMPUTE and ENTER verbs are especially useful. COMPUTE permits arithmetic operations to be expressed in a convenient formula notation similar to that of FORTRAN. The statement "ENTER AUTOCODER" enables the programmer to use the 1410 Autocoder language (subject to certain restrictions) within a COBOL program. Autocoder statements can reference non-hyphenated COBOL data and procedure names. The ENTER AUTOCODER facility can be used to develop object programs that utilize IBM 1301 Disk Storage.

IBM 1410 COBOL object programs can read and record information on magnetic tape with either even parity or odd parity, and in either the load or move

.14 Description (Contd.)

data mode. In the load mode, each word mark bit in core storage corresponds to a word-separator character on tape. In the move mode, word marks in core storage are neither recorded on the tape during a write operation nor disturbed during a read operation. Magnetic tape files can be organized in any of the following record formats:

- Fixed length records, unblocked; with or without record marks.
- Fixed length records blocked; with record marks and padding of short blocks.
- Variable length records, blocked; with a record mark and Record Character Count field in each record and a Block Character Count field in each block.

Files assigned to the Card Read-Punch or Printer must be in the move mode, have even parity, and must contain only fixed length, unblocked records.

Although the 1410 is a variable word length computer, the COBOL provisions for dynamically variable item lengths have not been implemented. Arithmetic operand sizes can be preset to any value up to 18 digits. The data description clauses USAGE, SIGNED, and SYNCHRONIZED have no significance in the 1410 system because of its variable word length and its use of the same representation for both numeric and alphameric data. Therefore, these three clauses are ignored by the compiler.

The 1410 COBOL Processor accepts a COBOL source program and converts it into a 1410 Autocoder program. The 1410 Autocoder Processor then produces the machine language object program and listing. The 1410 Processor Operating System Tape contains both the COBOL and Autocoder Processors, and the entire translation process can be performed without operator intervention if the translating computer has at least five magnetic tape units and if no serious source program errors are encountered. The minimum configuration for use of the 1410 COBOL Processor is:

- 20,000 positions of core storage.
- 4 IBM 729 or 7330 Magnetic Tape Units.
- 1 IBM 1402 Card-Punch, Model 2.
- 1 IBM 1403 Printer, Model 2 or 3.

One or two additional tape units can be substituted for the Card Read-Punch and/or Printer if the source program input, object program output, and/or translator listing are to be on magnetic tape.

Availability

Language: . . . . . 1961.

Translator: . . . . . January, 1962.

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14 Description (Contd.)

Deficiencies with respect to Required COBOL-61

Environment Division:

- The OPTIONAL option in the FILE-CONTROL paragraph, which provides for files that will not necessarily be present each time the object program is run, is deferred.
- The MULTIPLE REEL option in the FILE-CONTROL paragraph and all other features that provide for automatic assignment of tape units are deferred.
- The COPY options that enable SOURCE-COMPUTER, OBJECT-COMPUTER, and SPECIAL-NAMES paragraphs to be taken from the library are deferred.
- The RENAMING clause in the FILE-CONTROL paragraph, which enables more than one file to utilize the same File Description without the need to rewrite the description, is deferred.
- One ALTERNATE AREA may be specified in the FILE-CONTROL paragraph if the object computer has the Processing Overlap feature; otherwise, none may be specified.

.14 Description (Contd.)

Deficiencies with respect to Required COBOL-61 (Contd.)

Data Division:

- The COPY options that enable File and Record descriptions to be taken from the library are deferred.
- The REDEFINES clause, which allows the same storage area to contain different data items, can only be used for tables of constants of level 01 that are referred to by subscripted names.

Procedure Division:

- The REEL option of the CLOSE verb, which provides for the closing of a reel prior to its normal end, is deferred.
- The EXAMINE verb and TALLY register, which make it possible to replace and/or count the number of occurrences of a specified character in a data item, are deferred.
- A given file cannot be processed both as an input file and as an output file in the same Program.

Extensions to COBOL-61: none. (The SORT verb and Report Writer facility of Extended COBOL-61 are not provided.)

§ 162. COBOL-61 Electives Impletedted (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
1	Formula characters	+, -, *, /, **, =.
6	Figurative constants	HIGH-VALUE(S), LOW-VALUE(S).
	File Description	
8	BLOCK size	allows a range to be specified.
	Record Description	
19	SIZE clause option	can be used only to specify size of a variable length record.
20	Conditional range	allows a conditional value to be a range.
	Verbs	
22	COMPUTE	permits algebraic formulas.
24	ENTER	permits use of 1410 Autocoder language within a COBOL program.
	Verb Options	
27	LOCK	locks rewound tapes.
30	ADVANCING	specifies paper advance of 1, 2, or 3 lines, or to any channel on carriage tape.
32	Formulas	algebraic formulas can be used.
33	Operand size	up to 18 digits.
35	Tests	IF { } IS NOT ZERO form is provided.
37	Compound conditionals	ANDs and ORs can be intermixed.
	Environment Division	
40	SOURCE-COMPUTER	MEMORY SIZE clause only.
41	OBJECT-COMPUTER	specifies differences from the "standard" configuration.
42	SPECIAL-NAMES	specifies hardware for ACCEPT, DISPLAY, and WRITE verbs.
44	PRIORITY IS	specifies priorities for overlap processing.

COBOL-61 Electives Not Implemented (see 4:161.3)

Key No.	Elective	Comments
	Characters and Words	
2	Relationship characters	> and < not available.
3	Semicolon	always ignored by translator.
4	Long literals	literals may not exceed 120 characters.
5	Figurative constants	HIGH BOUND(S), LOW BOUND(S) not available.
7	Computer-name	no alternative computer names.
	File Description	
9	FILE CONTAINS	approximate file size cannot be shown.
10	Label formats	labels must be standard or omitted.
11	SEQUENCED ON	no list of keys can be given.
12	HASHED	hash totals cannot be created.
	Record Description	
13	Table length	lengths of tables and arrays may not vary.
14	Item length	variable item lengths cannot be specified in a PICTURE.
15	BITS option	items cannot be specified in binary.
16	RANGE IS	value ranges of items cannot be shown.
17	RENAMES	alternative groupings of elementary items cannot be specified.
18	SIGN IS	no separate signs allowed.
21	Label handling	only standard labels (or none) may be used.

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§ 162. COBOL-61 Electives Not Implemented (see 4:161.3) (Contd.)

Key No.	Elective	Comments
	Verbs	
23	DEFINE	new verbs cannot be defined.
25	INCLUDE	no library routines can be called.
26	USE	no non-standard I/O error and label handling routines.
	Verb Options	
28	MOVE CORRESPONDING	each item must be individually moved.
29	OPEN REVERSED	tapes cannot be read backward.
34	Relationships	IS UNEQUAL TO, EQUALS, and EXCEEDS are not provided.
36	Conditionals	no implied objects with implied subjects.
38	Complex conditionals	not permitted.
39	Conditional statements	only AT END or ON SIZE ERROR may follow imperative statements.
	Environment Division	
43	FILE-CONTROL	cannot be taken from library.
45	I/O-CONTROL	cannot be taken from library.
46	I/O-CONTROL	rerun methods cannot be specified.
	Identification Division	
47	DATE-COMPILED	current date will not be inserted automatically.
	Special Features	
48	Library	library routines cannot be called.
49	Segmentation	no provision for segmentation of object programs.

MACHINE ORIENTED LANGUAGE: BASIC AUTOCODER

§ 171.

.1 GENERAL

.11 Identity: . . . . . IBM 1410 Basic Autocoder. Basic Autocoder.

.12 Origin: . . . . . IBM Data Processing Division, Applied Programming.

.13 Reference: . . . . . IBM Publication J24-1413-1. 1410 Program Library 1410-AU-102.

.14 Description

Basic Autocoder is the basic machine oriented language for 1410 systems. There is essentially a one-to-one correspondence between Basic Autocoder statements and 1410 machine language instructions; however, there are eleven pseudo operations which define constants and labels and provide limited translator control. Basic Autocoder utilizes a free-form coding sheet. Literals are permissible but are limited to five characters. Macro-instructions cannot be utilized.

.15 Publication Date: . . . released.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . refer to Autocoder Coding Sheet (402:171.820).

.22 Legend

Line:	sequences entries on coding sheet.
Label:	names an area or instruction.
Operation:	defines operation to be performed, in either mnemonic or machine code.
Operand:	actual or symbolic addresses of data to be operated upon, with specification of indexing or relative addressing, address constants, literals, and/or comments.

.23 Corrections: . . . . . spare lines on coding sheet and gaps in sequence numbers.

.24 Special Conventions

.241 Compound addresses: .	BASE ± ADJUSTMENT, where BASE is any label and ADJUSTMENT is a decimal integer.
.242 Multi-addresses: . . .	none.
.243 Literals	
Numerical:	1 to 5 digits preceded by + or - sign; no blanks.
Alphamerical:	1 to 5 characters preceded and followed by @; can contain blanks and @ symbol; no more than 1 alphamerical literal can appear in a single coding sheet entry.
.244 Special coded addresses:	* refers to low-order position of instruction in which it appears.
.245 Other	
Actual core storage addresses:	1 to 5 decimal digits; leading zeros omitted.
Address constants: . .	+ or - preceding label of item whose address is to be used as an operand (limited to 5 characters).

.3 LABELS

.31 General

.311 Maximum number of labels:	600 per translator iteration.
.312 Common label formation rule:	yes.
.313 Reserved labels:	none.
.314 Other restrictions: . .	none.
.315 Designators:	none.
.316 Synonyms permitted: .	yes.

.32 Universal Labels

.321 Labels for procedures	
Existence:	mandatory if referenced by other instructions.
Region:	universal.
Formation rule	
First character: . .	alphabetic.
Others:	letters or numerals; no special characters.
Number of characters:	1 to 6.
.322 Labels for library routines:	none.
.323 Labels for constants: .	same as procedures.
.324 Labels for files:	none.
.325 Labels for records: . .	same as procedures.
.326 Labels for variables: .	same as procedures.

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.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size
constants: . . . . . limited only by available core storage.

.412 Maximum size literals
Alphameric: . . . . . one to five characters preceded and and followed by @.
Numeric: . . . . . one to five digits preceded by sign; no blanks.

.42 Working Areas

.421 Data layout
Implied by use: . . . . no.
Specified in program: yes.
.422 Data type: . . . . . not required.
.423 Redefinition: . . . . . yes; EQU pseudo.

.43 Input-Output Areas

.431 Data layout: . . . . . explicit.
.432 Data type: . . . . . not required.
.433 Copy layout: . . . . . yes; DA pseudo.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . alternative.
Number: . . . . . 151.
Example: . . . . . M = multiply.
.512 Absolute
Existence: . . . . . alternative.
Number: . . . . . 38 (many variations through "d" modifier).
Example: . . . . . @ = multiply.

.52 Macro-Codes: . . . . . none.

.53 Interludes: . . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . pseudo operations.
Label adjustment: . . pseudo operations.
Annotation: . . . . . special cards.
.542 Allocation counter
Set to absolute: . . . . ORG, LTORG pseudo.
Set to label: . . . . . no.
Step forward: . . . . . DS pseudo.
Step backward: . . . . no.
Reserve area: . . . . DA pseudo.
.543 Label adjustment
Set labels equal: . . . EQU pseudo.
Set absolute value: . . EQU pseudo.
Clear label table: . . no.

.544 Annotation
Comment phrase: . . comment card, with * in column 6.
Title phrase: . . . . . JOB card.

.6 SPECIAL ROUTINES
AVAILABLE: . . . . . none.

.7 LIBRARY FACILITIES: none.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . . none.

.82 Pseudos

Code	Description
DA:	defines an area of core storage and the lengths, names, and relative positions of the fields within it.
DCW:	loads a constant and sets word mark in high-order position.
DC:	loads a constant without word mark.
DS:	by-passes and labels an area of storage.
EQU:	assigns a label to an actual or symbolic address.
CTL:	specifies storage sizes of translating & target systems and type of translator output desired.
ORG:	sets address allocation counter.
LTORG:	assigns storage locations to previously encountered literals & closed library routines.
EX:	causes a temporary halt in loading of the object program, and execution of the portion just loaded.
END:	indicates end of source deck; causes execution of object program immediately after loading if starting address is specified in operand.
PST:	prints a listing of all source program labels together with assigned actual addresses.

IBM

FORM X24-1350-1
PRINTED IN U.S.A.

Program _____

Programmed by _____

Date _____

1401/1410 AUTOCODER CODING SHEET

Identification (76–80)

Page No. (1–2) of _____

Line (3–5)	Label (6–15)	Operation (16–20)	OPERAND (21–70)
0,1			
0,2			
0,3			
0,4			
0,5			
0,6			
0,7			
0,8			
0,9			
1,0			
1,1			
1,2			
1,3			
1,4			
1,5			
1,6			
1,7			
1,8			
1,9			
2,0			
2,1			
2,2			
2,3			
2,4			
2,5			

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MACHINE ORIENTED LANGUAGE: AUTOCODER

§ 172.

.1 GENERAL

.11 Identity: . . . . . IBM 1410 Autocoder. Autocoder.

.12 Origin: . . . . . IBM Data Processing Division, Applied Programming.

.13 Reference: . . . . . IBM Publication J24-1433-0.

.14 Description:

Autocoder is a more powerful machine oriented language than Basic Autocoder. It provides macro-instructions, longer literals, and library routines, but requires at least 4 magnetic tape units and 20,000 positions of core storage on the translating 1410 system. As in Basic Autocoder, there is a general one-to-one correspondence between source statements and machine language instructions. Through the use of macros, however, the programmer can call and cue open or closed library routines at will, thereby reducing coding time and effort. User-defined macros can be inserted into the library.

Since the Autocoder language is an extension of Basic Autocoder, the Autocoder translator can translate source programs coded in either language or in a combination of the two. Compatibility between IBM 1401 and 1410 systems is provided by the fact that the 1401 Autocoder language is essentially a subset of the 1410 Autocoder language. This means that programs coded in 1401 Autocoder can be translated and run on a 1410 system after relatively minor modifications, mainly to the input-output operations.

The 1410 Input/Output Control System is a supplement to Autocoder. It consists of additional control and macro operations that handle reading and writing, tape blocking and unblocking, file labeling, and error checking. Characteristics of the overall program, the object system, and each record file must be included in the source program in the form of a series of descriptive cards preceded by a header card.

.15 Publication Date: . . . . released December, 1961.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . refer to Autocoder Coding Sheet.

.22 Legend

Line: . . . . . sequences entries on coding sheet.
Label: names an area or instruction.
Operation: . . . . . defines operation to be performed, in either mnemonic or machine code.
Operand: . . . . . actual or symbolic addresses of data to be operated upon, with specification of indexing or relative addressing, address constants, literals, and/or comments.

.23 Corrections: . . . . . spare lines on coding sheet and gaps in sequence numbers.

.24 Special Conventions

.241 Compound addresses: . . BASE ± ADJUSTMENT, where BASE is any label and ADJUSTMENT is a decimal integer.
.242 Multi-addresses: . . . . macros only.
.243 Literals: . . . . . any number of characters, provided total operand length does not exceed 52 characters.
Numeric: . . . . . preceded by + or - sign; no blanks.
Alphameric: . . . . . preceded and followed by @
.244 Special coded addresses: . . . . . * refers to low-order position of instruction in which it appears.
.245 Other
Actual core storage addresses: . . . . . 1 to 5 decimal digits (leading zeros omitted).
Address constants: . . + or - preceding label of item whose address is to be used as an operand (up to 10 characters).

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . . 600 per translator iteration.
.312 Common label formation rule: . . . . yes.

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.313 Reserved labels
For basic macros:. . OPEN, CLOSE, CLOSD, GET, PUT, STACK, SKIP, CONSL, RTLBL, WTLBL, RELSE, FEORL, CHKPT, RDLIN, IOBSP, IORWD, IORWU, IOWTM, PSTAC, RTAPE, WTAPE, CALL, INCLD.
For "pseudo macros"*:MATH, BOOL, COMP, NOTE, MEND.

*These macros never appear in source programs; they are used in writing library routines.

.314 Other restrictions: . . . none.
.315 Designators: . . . . . none.
.316 Synonyms permitted: . . yes.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . mandatory if referenced by other instructions.
Formation rule
First character: . . . alphabetic.
Others: . . . . . alphameric; no special characters.
Number of characters: . . . . . 1 to 10.
.322 Labels for library routines
Existence: . . . . . mandatory for entry points.
Formation rule
First character: . . . alphabetic.
Others: . . . . . labels for each entry point in a subroutine must have the same first three characters; last two characters can be any alphamerics; first three characters of subroutine symbols should not be used as the first three characters of any symbols in the source program.
Number of characters:. . . . . 5.
323 Labels for constants: . . same as procedures.
324 Labels for files: . . . same as procedures, with Input/Output Control System only.
.325 Labels for records: . . same as procedures.
.326 Labels for variables: . . same as procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants:limited only by available core storage.
.412 Maximum size literals: total operand length may not exceed 52 characters.
Alphameric: . . . . . preceded and followed by @
Numeric:. . . . . preceded by sign.

.42 Working Areas

.421 Data layout
Implied by use: . . . . no.
Specified in program: . yes.
.422 Data type: . . . . . not required.
.423 Redefinition: . . . . . yes; EQU pseudo.

.43 Input-Output Areas

.431 Data layout: . . . . . explicit.
.432 Data type: . . . . . not required.
.433 Copy layout: . . . . . yes; DA pseudo.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . alternative.
Number: . . . . . 151.
Example:. . . . . M = multiply.
.512 Absolute
Existence: . . . . . alternative.
Number: . . . . . 38 (many variations through "d" modifier).
Example: . . . . . @ = multiply.

.52 Macro-Codes

.521 Number available
Input-output: . . . . . 21.
Subroutine calls:. . . . 2.
Writing of new macros: 5 ("pseudo-macros").
.522 Examples
Simple: . . . . . CALL SQRO1.
Elaborate: . . . . . CALL SUBO1, DATA1, DATA2, DATA3.
.523 New macros: . . . . . inserted into library in separate run.

.53 Interludes: . . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter:. . . pseudo operations.
Label adjustment: . . . pseudo operations.
Annotation:. . . . . special cards.
.542 Allocation counter
Set to absolute: . . . . ORG, LTORG pseudos.
Set to label: . . . . . ORG, LTORG pseudos.
Step forward: . . . . . ORG, DS pseudos.
Step backward: . . . . ORG pseudo.
Reserve area: . . . . DA pseudo.
.543 Label adjustment
Set labels equal: . . . . EQU pseudo.
Set absolute value:. . . EQU pseudo.
Clear label table: . . . no.
.544 Annotation
Comment phrase: . . . comment card, with * in column 6.
Title phrase:. . . . . JOB card.

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.545 Other
Delete routine from library tape: . . . . . pseudo operation.
Insert routine into library tape: . . . . . pseudo operation.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic: . . . none.

.62 Special Functions:. . . none.

.63 Overlay Control: . . . . none.

.64 Data Editing

.641 Radix conversion: . . . . none.
.642 Format control: . . . . . not required because of hardware editing capability.

.65 Input-Output Control

.651 File labels: . . . . . } Input/Output Control System
.652 Reel labels: . . . . . }
.653 Blocking: . . . . . }
.654 Error Control: . . . . . }
.655 Method of call: . . . . . macros.

.66 Sorting: . . . . . none.

.67 Diagnostics: . . . . . none.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . 1410 Autocoder Library, included in system tape.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . . yes.
.723 Private: . . . . . private facilities may be added to master library.

.73 Storage Form: . . . . . routines supplied on cards for transcription to tape.

.74 Varieties of Contents: . . supplied with 7 basic macros; Input/Output Control System and other facilities desired by user may be added.

.75 Mechanism

.751 Insertion of new item: . . special library run.
.752 Language of new item: . . 1410 Autocoder.
.753 Method of call: . . . . . CALL or INCLD macro.

.76 Insertion in Program

.761 Open routines exist: . . . yes; cued by name in operation column.
.762 Closed routines exist: . . yes; cued by CALL or INCLD macros.
.763 Open-closed is optional: no.
.764 Closed routines appear once: . . . . . yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
CALL:	sets up linkage to a closed library routine and (once only) inserts it in program.
INCLD:	inserts an inflexible library routine without linkage.
OPEN:	initializes a tape or card file.
CLOSE:	deactivates a file, with rewind if desired.
GET:	locates a single record for processing, from either a blocked or unblocked file.
PUT:	inserts a processed record into an output file.
RELSE:	causes next GET or PUT to refer to next block in the file.
FEORL:	initiates end-of-reel routine.
RDLIN:	causes cards to be read at object time to modify tape labels.
CLOSD:	deactivates a dump tape.
STACK:	selects cards read into the specified pocket.
SKIP:	skip to specified tape channel.
CONSL:	performs specified console operation.
RTLBL:	reads non-standard tape labels.
WTLBL:	writes non-standard tape labels.
CHKPT:	causes branch to check point routine.
IOBSP:	backspaces one tape record on specified unit.
IORWD:	rewinds specified tape unit.
IORWU:	rewinds and unloads specified tape unit.
IOWTM:	writes a tape mark on specified tape.
PSTAC:	selects cards punched into specified pocket.
RTAPE:	reads a record from specified tape unit.
WTAPE:	writes a record on specified tape unit.

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.82 Pseudos

Code	Description
CTL:	specifies storage sizes of translating & target systems and type of translator output desired.
DELET:	deletes all or part of a routine from the library tape.
EJECT:	causes carriage to restore.
END:	indicates end of source program; can initiate execution of object program immediately after loading.
EX:	causes a temporary halt in loading of the object program, and execution of the portion just loaded.
INSER:	inserts a whole or partial routine into the library tape.
JOB:	identifies program deck or tape and prints headings on listing.
LOAD:	signals processor that a load program should precede object deck.
LTORG:	assigns storage locations to previously encountered literals & closed library routines.
ORG:	sets address allocation counter.
PST:	prints a listing of all source program labels together with assigned actual addresses.
RESEQ:	resets card sequence count.
RUN:	specifies type of run: Autocoder, FORTRAN, COBOL RPG, System.
SFX:	adds a specified sixth character to all labels with 5 or fewer characters.
XFR:	same as EX, except that literals & closed library routines are not stored.
DIOCS:	precedes a series of cards describing characteristics of the program and the target computer.
DTF:	precedes a series of cards describing a specific file.

PROGRAM TRANSLATOR: BASIC AUTOCODER

§ 181.

.1 GENERAL

.11 Identity: . . . . . IBM 1410 Basic Autocoder.

.12 Description

The Basic Autocoder translator is designed for punched card input and output. Translation will normally require two passes; however, additional passes will be required for a program which contains more labels than can be accomodated in the label table of the translating computer. The translator is designed to operate on a 1410 with 10,000 positions of core storage, a card read-punch, and a printer; there is no provision for tape input or output. The object computer, however, may be a tape or disc storage system. In addition to producing a machine language deck in condensed form, the translator prints a listing of both the symbolic and machine language instructions. Because of the one-to-one correspondence of Basic Autocoder statements to 1410 machine language instructions, the object program will require the same storage space and operating time as a hand-coded program.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above

.15 Availability: . . . . . released.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 1410 Basic Autocoder.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards.
.222 Obligatory ordering: . . must be in correct sequence according to coding sheet page and line numbers.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage capacity.
.232 Maximum size source statements: . . . . . 72 characters per card.
.233 Maximum number of data items: . . . . . 600 labels per translator iteration.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . . IBM 1410 machine language.
.313 Output media: . . . . . punched cards.

.32 Conventions

.321 Standard inclusions: . . none.
.322 Compatible with: . . . . IBM 1410 Autocoder.

.33 Documentation

Subject	Provision
Source program:	listing.
Object program:	listing.
Storage map (symbol table): . . .	listing.
Restart point list: . . .	none.
Language errors: . . .	listing & messages during assembly.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Pass I: . . . . . control operations implemented; addresses assigned to labels; multiple labels flagged; operation codes checked for validity.

Pass II: . . . . . machine operation codes and d modifiers furnished in place of mnemonics; declarative operations (DC, DCW, etc.) performed; listing, object deck and load program produced; symbol table printed if requested.

Note: Additional passes may be required if the number of labels and literals used exceeds the storage capacity of the symbol table.

.42 Optional Modes

.421 Translate: . . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . no.
.424 Patching: . . . . . no.
.425 Up-dating: . . . . . no.

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§181.

.43 Special Features

.431 Alter to check only: . . . no.
.432 Fast unoptimized translate: . . . . . no.
.433 Short translate on restricted program: . . no.

.44 Bulk Translating: . . . . no.

.45 Program Diagnostics: . . none.

.46 Translator Library: . . . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . . none.
.512 Space required for each input-output file: . . . . . variable.
.513 Approximate expansion of procedures: . . . . . slightly over 1.0 (because literals are permitted in the source language but not in machine language).

.52 Translation Time

.521 Normal translating: . . . ?

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . unaffected; i.e., same as hand coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 10,000 core storage locations.
1402 Card Read-Punch.
1403 Printer.
.612 Larger configuration advantages: . . . . . more labels can be processed per iteration.

.62 Target Computer

.621 Minimum configuration: any 1410 system.
.622 Usable extra facilities: all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	check	noted in listing.
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	none.	
Inconsistent program:	none.	
Undefined names:	check	noted in listing.

.8 ALTERNATIVE TRANSLATORS

Computer	Identity	Date	Comment
1410	Autocoder	released	Basic Autocoder is a subset of 1410 Autocoder language.

PROGRAM TRANSLATOR: AUTOCODER

§ 182.

.1 GENERAL

.11 Identity: . . . . . IBM 1410 Autocoder. Autocoder.

.12 Description

Operation of the Autocoder translator requires at least 20,000 core storage positions, 4 magnetic tape units, card read-punch, and printer. Larger core storage sizes speed up the translation by permitting longer tape blocks and the processing of more labels per translator iteration. Input may be from either punched cards or tape, and the object program may be in the form of a condensed card deck and/or a loadable tape. The translator will accommodate source programs in either the Autocoder or Basic Autocoder languages or a combination of the two. The translation process is fully automatic. Only those facilities of the Input/Output Control System that are required by the object program are generated and included.

The Autocoder translator and Input/Output Control System are included in the 1410 Compiler System Tape, along with the Report Program Generator, COBOL, and FORTRAN. A system supervisor picks up information from control cards and, acting upon this information, positions the system tape, calls in the required phase or program, and then turns control over to the program called.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . released December, 1961.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 1410 Autocoder.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards or magnetic tape.
.222 Obligatory ordering: . . must be in correct sequence according to coding sheet page and line numbers.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage capacity.
.232 Maximum size source statements: . . . . . 72 characters per card.
.233 Maximum number of data names: . . . . . 600 per translator iteration.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 1410 machine language.
.313 Output media: . . . . . punched cards and/or magnetic tape.

.32 Conventions

.321 Standard inclusions: . . Input/Output Control System.

.33 Documentation

Subject	Provision
Source program: . . .	listing.
Object program: . . .	listing.
Storage map (symbol table):	listing.
Restart point list: . .	listing.
Language errors: . .	messages during assembly and listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes: . . ?

.42 Optional Modes

.421 Translate: . . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . no.
.424 Patching: . . . . . no.
.425 Up-dating: . . . . . no.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . no.
.433 Short translate on restricted program: . . no.

.44 Bulk Translating: . . . yes; "END" control card must follow each program.

.45 Program Diagnostics: . none in basic system; can be inserted into library.

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§ 182.

.46 Translator Library

.461 Identity: . . . . . 1410 Autocoder Library.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . . tape (on Compiler System Tape).
Organization: . . . . alphabetical order by routine name.
.464 Contents
Routines: . . . . . open and closed.
Functions: . . . . . yes.
Data descriptions: . . in IOCS entries.
.465 Librarianship
Insertion: . . . . . yes, during special library run.
Amendment: . . . . . yes, during special library run.
Call procedure
Open routines: . . . inserted whenever cued by specific macro instructions.
Closed routines: . . CALL or INCLD macro with name of routine as operand; CALL also generates subroutine linkages.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space
IOCS:	varies greatly with facilities used.

.512 Space required for each input-output file: . . . variable.
.513 Approximate expansion of procedures: . . . . slightly over 1.0 (exclusive of macros).

.52 Translation Time

.521 Normal translating: . . ?

.53 Optimizing Data: . . . none.

.54 Object Program Performance: . . . . . unaffected; i.e., same as hand coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 20,000 core storage locations, four 729 or 7330 Magnetic Tape Units, 1402 Card Read-Punch, and 1403 Printer.
.612 Larger configuration advantages: . . . . . additional tape unit permits tape input of source program; larger core storage handles more labels per iteration.

.62 Target Computer

.621 Minimum configuration: 10,000 core-storage positions and 1402 Card Read-Punch.
.622 Usable extra facilities: all facilities.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	noted in listing.
Unsequenced entries:	check on new macros being inserted	noted in listing.
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	check	noted in listing.
Inconsistent program:	none.	

.8 ALTERNATIVE TRANSLATORS: . . . none.

OPERATING ENVIRONMENT

§ 191.

.1 GENERAL

.11 Identity: . . . . . no integrated supervisor available.

.12 Description

No comprehensive supervisor routine has been published or announced to date for the 1410 system; therefore, the facilities covered in this section must be provided by the incorporation in each program of specific routines, where available, or by individual coding.

.13 Availability: . . . . . supervisor routine not presently committed; library routines described here are available now.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Libraries: . . . . . card library for standard routines supplied by IBM; cards for desired program must be loaded manually.

.212 Independents: . . . . . self-loading card decks or magnetic tapes, as produced by Basic Autocoder or Autocoder translator.

.22 Library Subroutines: . . may be inserted at translation time in form of cards (Basic Autocoder) or tapes (Autocoder) or at run time as independents.

.23 Loading Sequence: . . . . manual sequencing of card decks or program tapes.

.3 HARDWARE ALLOCATION: . . . . . as incorporated in user's program.

.4 RUNNING SUPERVISION: as incorporated in user's program.

.5 PROGRAM DIAGNOSTICS: . . . . . called in as needed from program library; control cards used to set up linkages.

511 Tracing: . . . . . 1) Trace Program traces each instruction within a specified area of a 1410 program.
2) Branch Trace Program traces each branch instruction in a specified area.

.512 Snapshots: . . . . . Snapshot Program prints out the contents of a selected area of core storage following the execution of any instruction in the program being tested.

.52 Post Mortem: . . . . . Storage Print Program prints out the entire contents of 1410 core storage except the area normally occupied by the 1410 load program. Execution of the print program destroys the contents of certain areas of core storage.

Note: The PAT (Procedure for Automatic Testing) System incorporates the above-mentioned programs plus Clear Storage and Tape Duplicate. This package is used to facilitate program testing. Except for Storage Print, which is included automatically, each of the programs can be used at the discretion of the operator by submitting the appropriate control cards. The PAT System is available only for tape 1410 systems, with or without disc storage. The individual programs described above are available for card systems.

.6 OPERATOR CONTROL: as incorporated in user's program.

.7 LOGGING: . . . . . as incorporated in user's program.

.8 PERFORMANCE: . . . . ?

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IBM 1410
SYSTEM PERFORMANCE

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IBM 1410 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration										Reference
			I		II		III		IV		VII B		
1	Char/block	(File 1)	80		1080		1080		1080		1080		
	Records/block	K (File 1)	0.5		10		10		10		10		
	msec/block	File 1 = File 2	1=150; 2=480		74.4		38.6		30.3		38.6		
		File 3	75		75		75		75		14.5		
		File 4	120		120		120		120		15.8		
Input-Output Times	msec/switch	File 1 = File 2	0		0		0		0		0		
		File 3	0		0		0		0		0		4:200.112
		File 4	0		0		0		0		0		
	msec penalty	File 1 = File 2	1.76		1=62.1; 2=67.8		4.9		4.9		4.9		
		File 3	0.88		0.88		0.88		0.88		0.36		
		File 4	1.452		1.452		1.452		1.452		0.594		
2	msec/block	a1	0.9		1.2		1.2		1.2		1.2		
	msec/record	a2	0.8		3.9		3.9		3.9		3.9		
Central Processor Times	msec/detail	b6	0.8		0.8		0.8		0.8		0.8		4:200.1132
	msec/work	b5 + b9	9.5		9.5		9.5		9.5		9.5		
	msec/report	b7 + b8	3.8		3.8		3.8		3.8		3.8		
3	msec for C.P. and dominant column.	a1	C. P. 0.9	I/O	C. P. 1.2	I/O	C. P. 1.2	I/O	C. P. 1.2	I/O	C. P. 1.2	I/O	
		a2 K	0.4		39.0		39.0		39.0		39.0		
		a3 K	7.0		141.0		141.0		141.0		141.0		
Standard Problem A F = 1.0		File 1 Master In	1.8		62.1		4.9		4.9		4.9	38.6	
		File 2 Master Out	1.8	240.0	67.8		4.9		4.9		4.9		4:200.114
		File 3 Details	0.5		8.8		8.8		8.8		3.6		
		File 4 Reports	0.7		14.5	1200.0	14.5	1200.00	14.5	1200.0	5.9	158.0	
		Total		240.0		1200.0		1200.00		1200.0	200.5		
4	Unit of measure	(character)											
		Std. routines	100		1,500		1,500		1,500		1,500		
		Fixed	75		75		75		75		75		
Standard Problem A Space		3 (Blocks 1 to 23)	600		900		900		900		900		
		6 (Blocks 24 to 48)	4,500		4,500		4,500		4,500		4,500		4:200.1151
		Files	600		2,440		2,440		2,440		2,440		
		Working			108		108		108		108		
		Total	5,875		9,523		9,523		9,523		9,523		

SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A Estimates

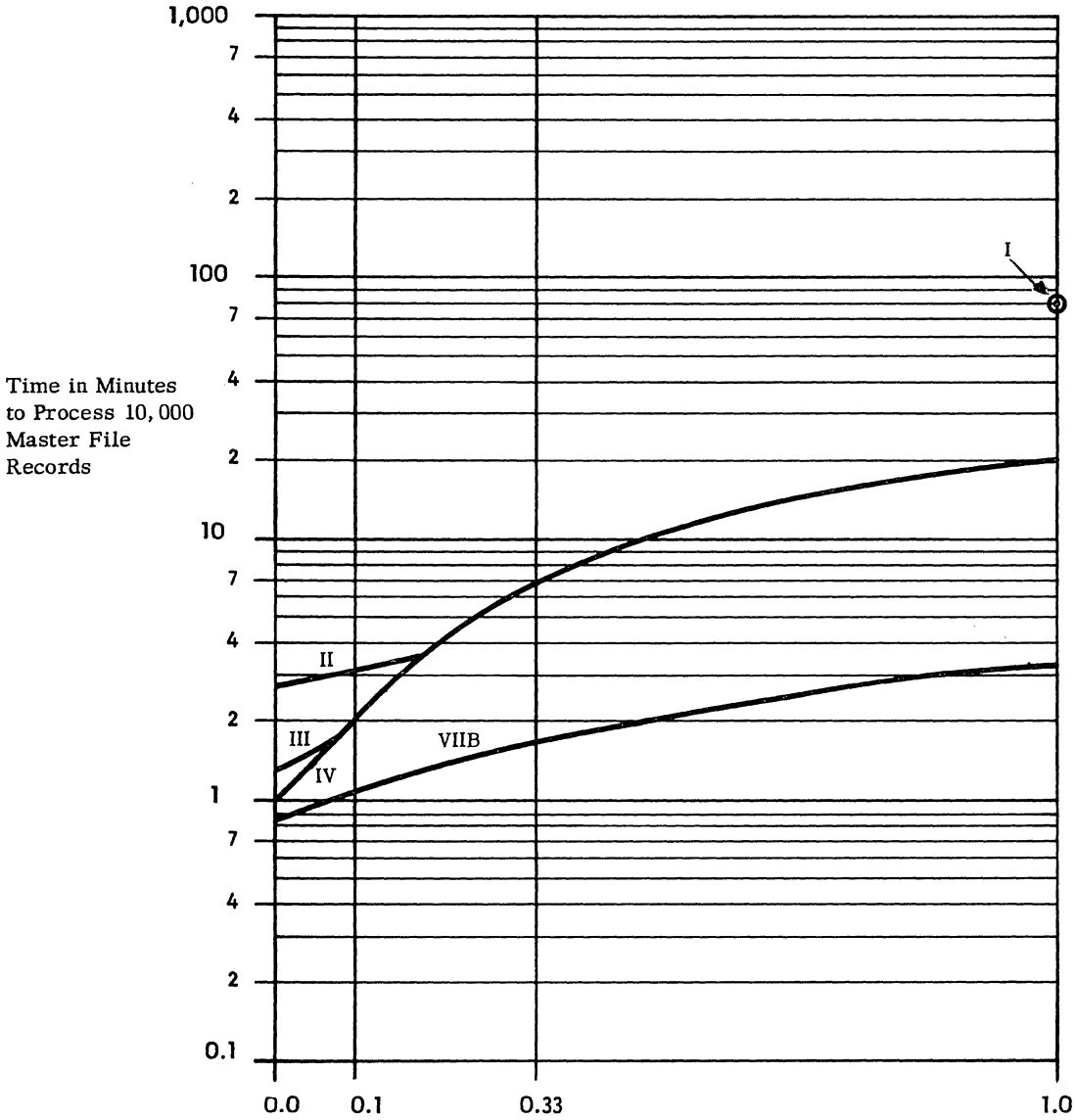
.111 Record Sizes
Master File: . . . . . 108 characters.
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.112 Computation: . . . . . standard.

.113 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . . see graph below.

.115 Storage Space Required
Configuration I: . . . 5,900 characters.
Configuration II: . . . 9,500 characters.
Configuration III: . . . 12,000 characters.
Configuration IV: . . . 12,000 characters.
Configuration VIIB: . . 12,000 characters.



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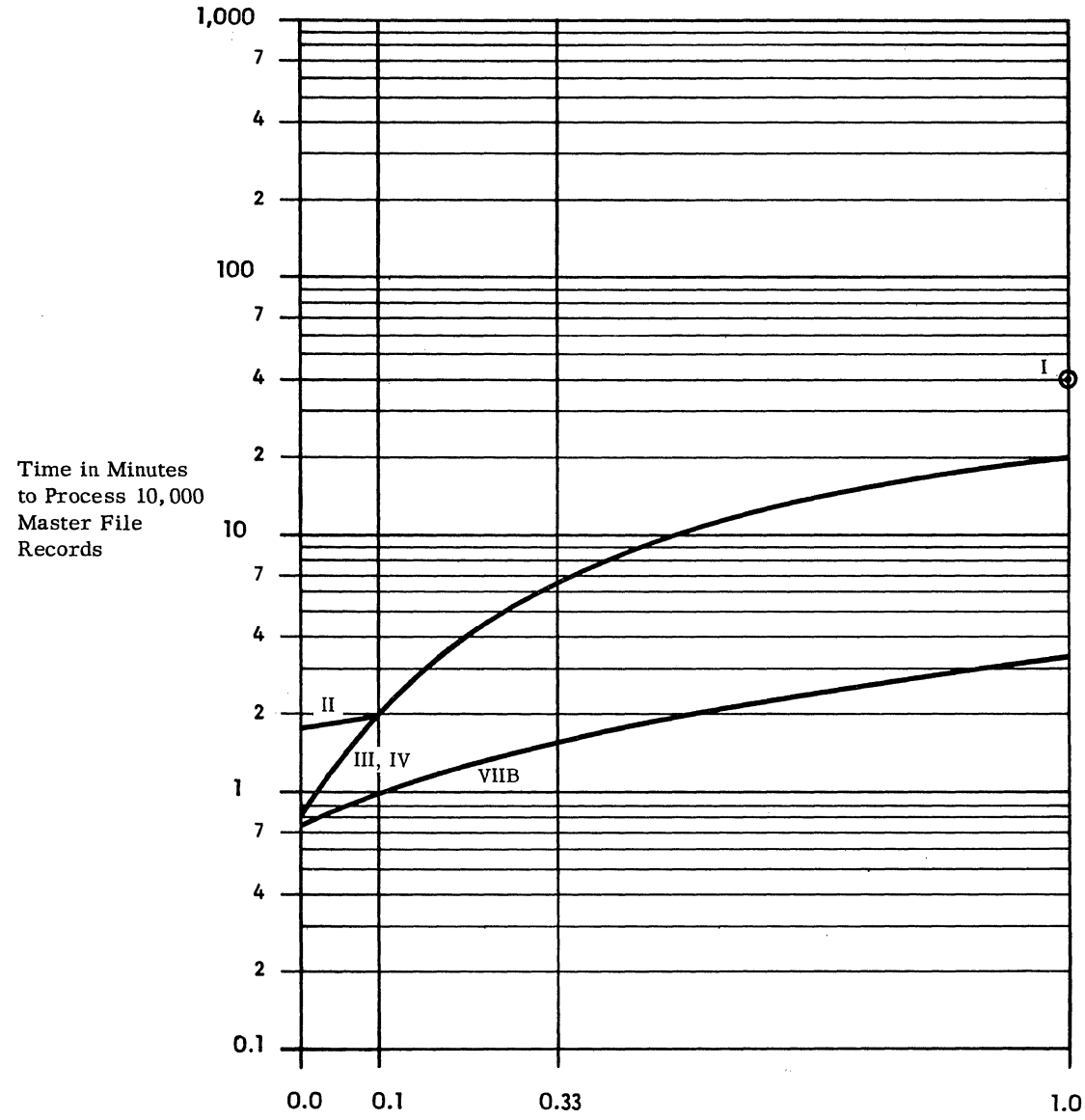
.12 Standard File Problem B Estimates

.121 Record Sizes
Master File: . . . . . 54 characters.
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



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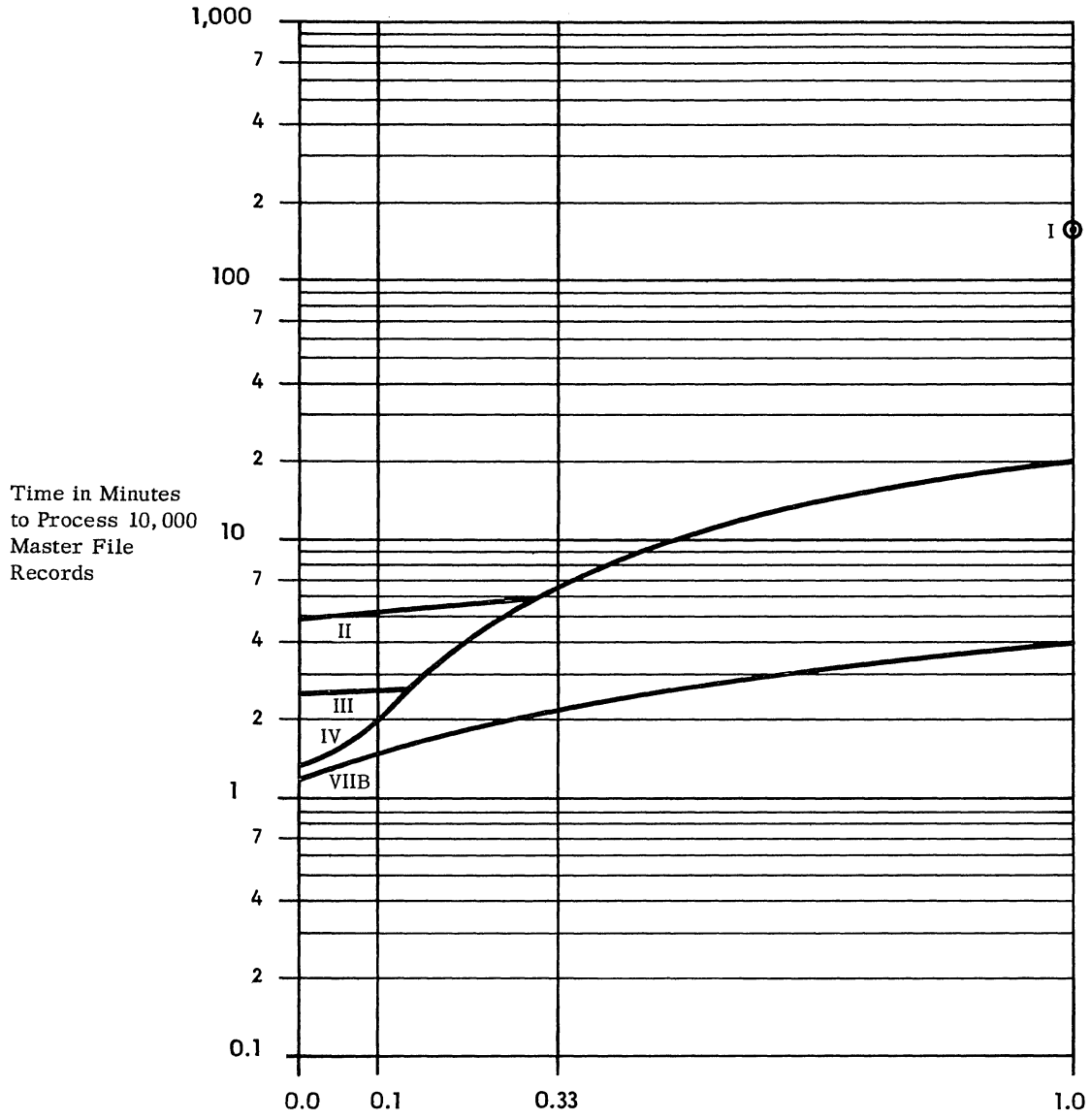
.13 Standard File Problem C Estimates

.131 Record Sizes
Master File: . . . . . 216 characters.
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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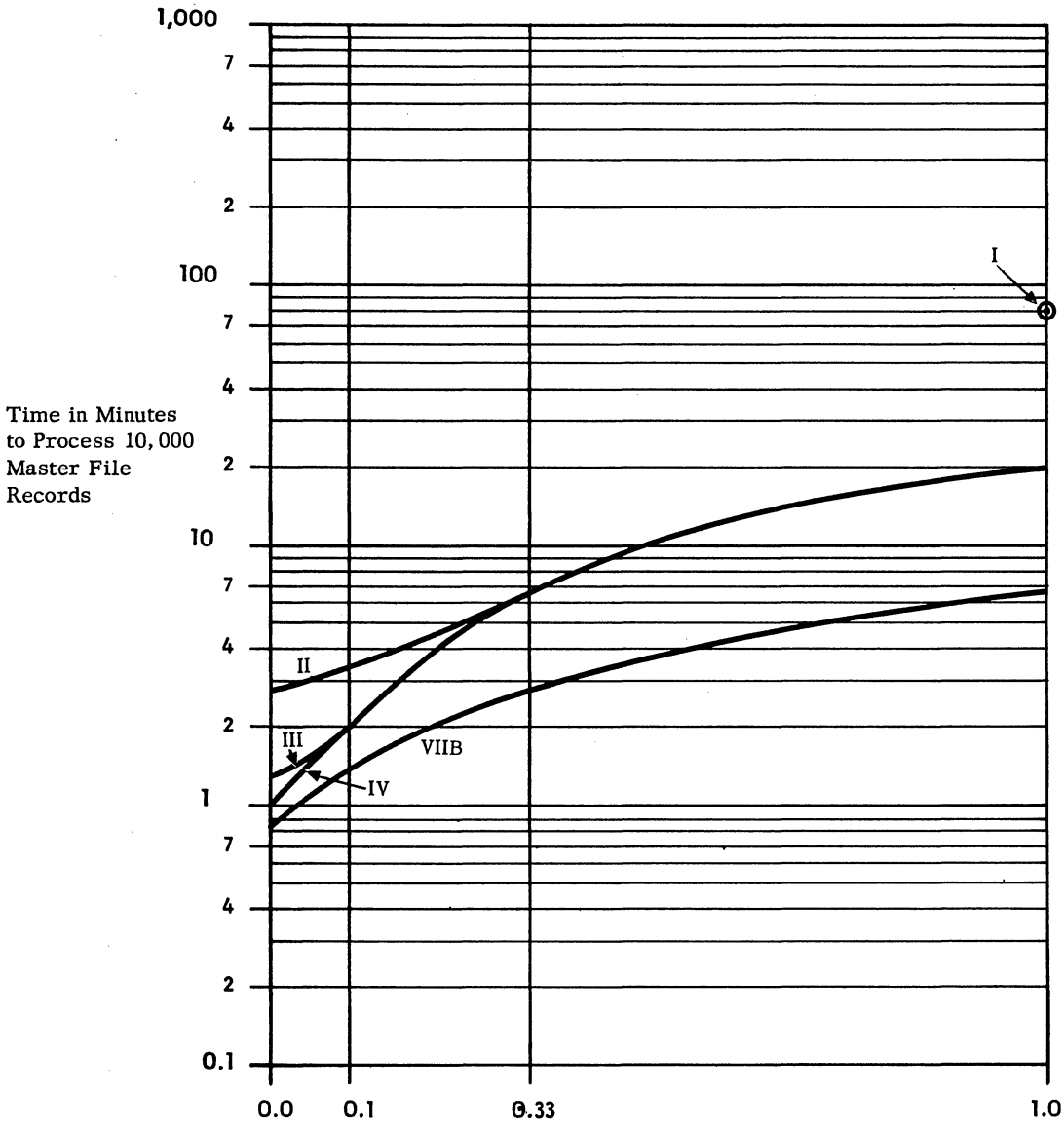
§ 201.

.14 Standard File Problem D Estimates

.141 Record Sizes
Master File: . . . . . 108 characters.
Detail File: . . . . . 1 card.
Report File: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing Basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



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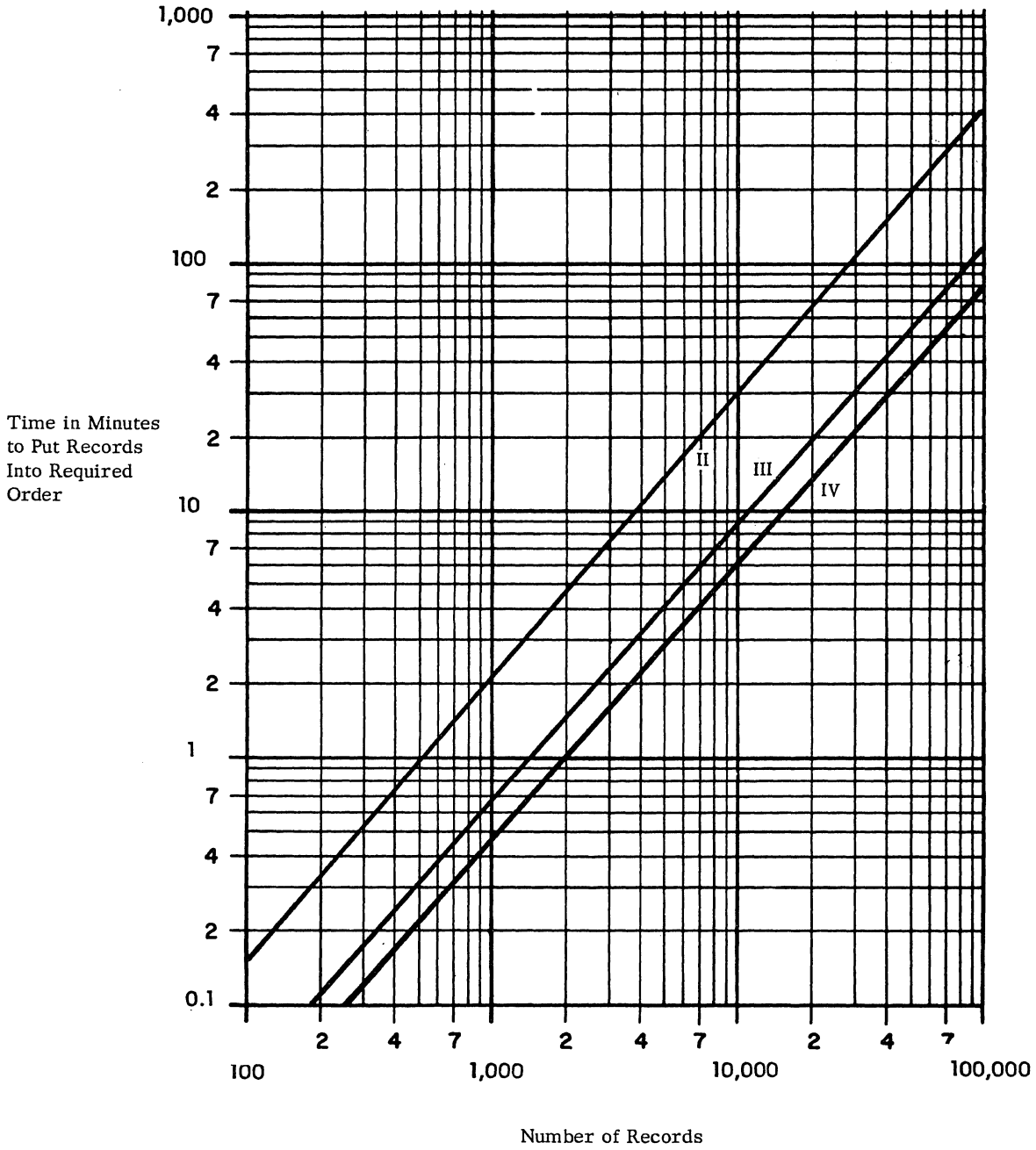
'§ 201.

.2 SORTING

.21 Standard Problem

.211 Record size: . . . . . 80 characters

.212 Key Size: . . . . . 8 characters.
.213 Timing Basis: . . . . . as in 4:200.213.
.214 Graph: . . . . . see graph below.



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§ 201.

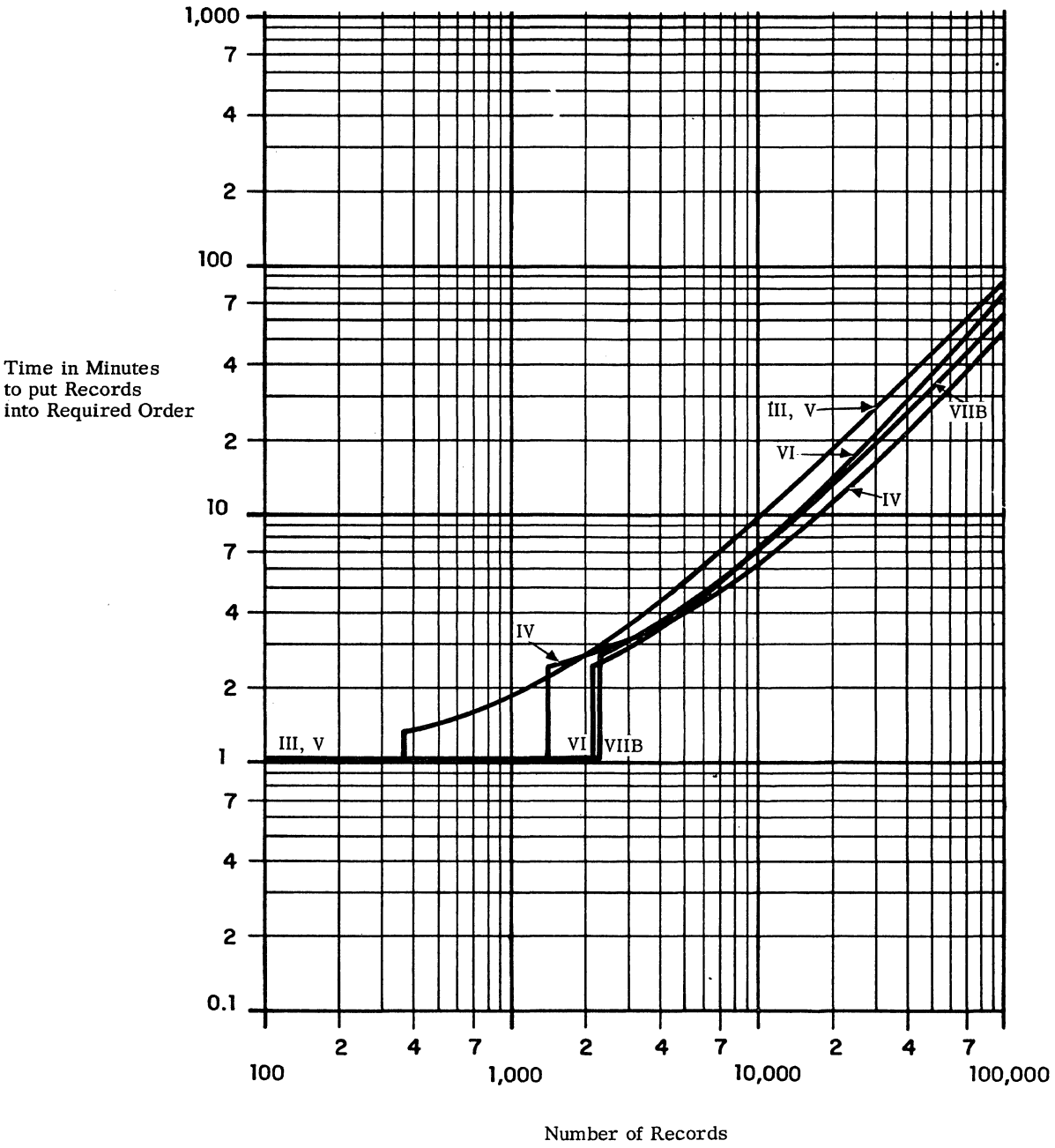
.22 SORT/MERGE 12 Times

.221 Record Size: . . . . . 80 characters.

.222 Key Size: . . . . . 8 characters.

.223 Timing Basis: . . . . IBM Publication C28-0293 Timing For SORT/MERGE 12.

.224 Graph: . . . . . see graph below.



§ 201.

.3 MATRIX INVERSION

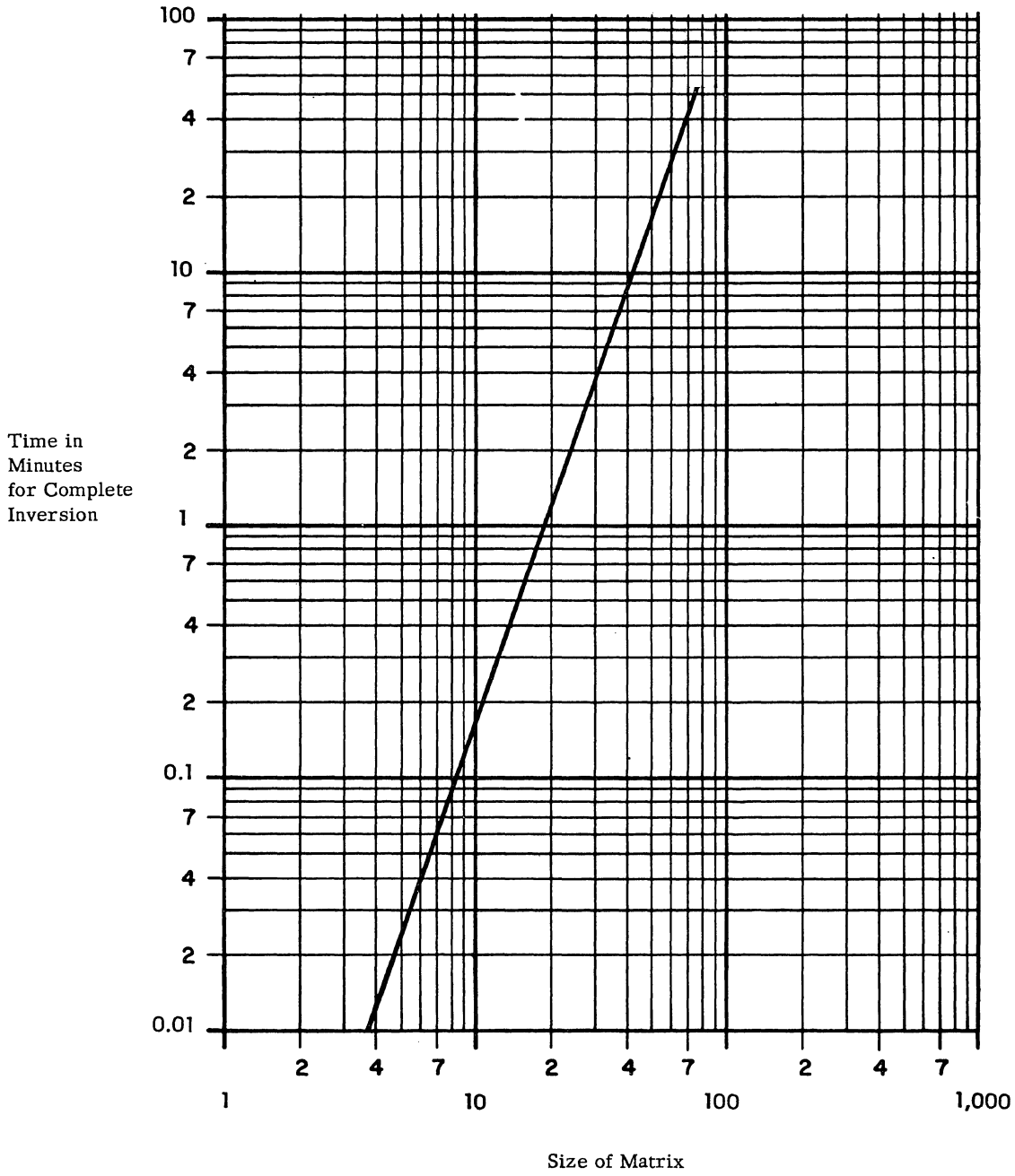
.31 Standard Problem

.311 Basic Parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing Basis: . . . . . as in 4:200.312, using floating point subroutines.

.313 Graph: . . . . . see graph below.

.314 Maximum Matrix Size . 80 by 80.



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IBM 1410
PHYSICAL CHARACTERISTICS

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IBM 1410 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Processing Unit	Processing Unit	Processing Unit	Processing Unit	Input-Output Synchronizer	Input-Output Synchronizer	Input-Output Synchronizer	Input-Output Synchronizer	Input-Output Synchronizer
	Model Number		1411 Models 1, 2, 3	1411 Models A1, A2, A3	1411 Models A4 & A5	1411 Models 4, 5	1414 Models 1, 2 & 7	1414 Model 3	1414 Model 4	1414 Model 5	1414 Model 8
PHYSICAL	Height × Width × Depth, in.		70×146×32	70×182×32	70×218×32	70×182×32	70×38×32	70×38×32	70×74×32	70×74×32	70×38×32
	Weight, lbs.		2,600	3,000	3,700	3,300	500	500	1,000	1,100	750
	Maximum Cable Lengths, ft.										
	To Processing Unit		---	---	---	---	40-50	40-50	40-50	50	50
	To Power Receptacle		14	---	---	14	---	---	---		
	To Designated Unit		40-50 (1414)	---	---	40-50 (1414)	---	---	---		
ATMOSPHERE	Storage Ranges	Temperature, °F.	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110
		Humidity, %	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80
	Working Ranges	Temperature, °F.	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90
		Humidity, %	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80
	Heat Dissipated, BTU/hr.		16,700	17,100	21,900	21,500	1,400	2,120	5,000	4,050	6,050
	Air Flow, cfm.		2,000	2,500	3,000	2,000	500	500	1,000	500	1,000
	Internal Filters		---	Yes	Yes	---	---	---	---	Yes	Yes
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	Power from 1411	Power from 1411	Power from 1411	Power from 1411	Power from 1411
		Tolerance	±10%	±10%	±10%	±10%					
	Cycles	Nominal	60	60	60	60				60	60
		Tolerance	±½	±½	±½	±½					
	Phases and Lines		3 phase, 4 line	3 phase, 4 line	3 phase, 4 line	3 phase, 4 line				3 phase, 4 line	3 phase, 4 line
	Load KVA		6.1	6.6	7.5	7.0	0.5	0.8	1.8	1.2	1.9
NOTES				For I/O Adapter 1412/ 1419s, 7750 attachment	On channel 2, on 1440-1448						

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IBM 1410 PHYSICAL CHARACTERISTICS (Contd.)

IDENTITY	Unit Name		Card Read-Punch	Card Reader	Printer	Console	Disk Storage Unit	Disk Storage Unit	Disk Storage Unit	Disk Storage Unit	Disk Storage Unit	Magnetic Tape Unit	Magnetic Tape Unit	Paper Tape Reader	Data Transmission Unit	Magnetic Character Reader	Magnetic Character Reader	Remote Inquiry Unit	Compressor	Accumulator Unit	Disk Control Unit – 1405	Switch Control Console	File Control	Programmed Transmission Control	Telegraph Converter Base
	Model Number		1402 Model 2	1442 Model 3	1403 Models 1, 2	1415	1405 Models 1, 2	1301 Model 1	1301 Model 2	1311 Model 2	1311 Model 5	729 Models II,IV,V,VI	7330	1011	1009	1412	1419	1014	Part of 1405	Accessory to 1419	3326	7155	7631	7750	7890
PHYSICAL	Height × Width × Depth, in.		45×58×30	49×43×24	53×48×29	29×70×44	70×61×31	69×33×86	69×33×86	38×30×24	38×43×24	69×29×34	58×29×31	60×32×37	40×29×31	61×112×41	61×112×42	35×29×24	29×40×33	39×17×21	In first 1405 DSU	12×9×7	70×38×32	70×81×31	70×36×31
	Weight, lbs.		1,400	450	750	300	2,115	3,625	3,825	390	650	1,160	640	530	500	2,400	2,600	175	700	100	?	10	500	2,700	400
	Maximum Cable Lengths, ft.																								
	To Processing Unit		50		---	50	40	100	100			Maximum total length of a power leg* is 100 ft.	Maximum total length of a power leg* is 80 ft.	---	---	To 1411—25' To Accumulator—5'	25	---	---	---	---				
	To Power Receptacle		---		---	---	---	---	---					14	15 From 1414-60		10	14	---	---	14				
	To Designated Unit		25 (1414)		25 (1414)	---	40 (compressor & other 1405's)	---	---					80 (1414)			---	---	125 (1405)	5 (1412)	---				
ATMOSPHERE	Storage Ranges	Temperature, °F.	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110		65-80	50-110	50-110	65-80	50-110	50-110	50-110	50-110	50-110
		Humidity, %	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80		20-65	0-80	0-80	20-65	0-80	0-80	0-80	0-80	0-80
	Working Ranges	Temperature, °F.	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	60-90	65-80	65-80	60-90	60-90	65-80	60-90	60-90	60-90	60-90	60-90
		Humidity, %	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-65	20-65	20-80	20-80	20-65	20-80	20-80	20-80	20-80	20-80
	Heat Dissipated, BTU/hr.		4,400	3,000	3,000	490	3,240	16,700	20,000	2,000	4,000	3,900	3,415	4,100	1,000	6,300	8,500	500	10,800	0	7,240	---	4,800	26,000*	See 7750
	Air Flow, cfm.		290		310	0	300	?	?			550	150	150	120	320	320	?	300	0	500				
	Internal Filters		---	Yes	---	---	---	---	---	Yes	Yes	---	---	---	---	Yes	---	---	---	---	---	Yes	Yes	Yes	Yes
ELECTRICAL	Voltage	Nominal	Power from 1411	208 or 230	Power from 1411	Power from 1411	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	Power from 1411	208 or 230	115	208 or 230	208 or 230	115	Power from 1405	Power from 1412	Power from 1405	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance					±10%	±10%	±10%			+10%, -8%		±10%	±10%		±10%	±10%							
	Cycles	Nominal		60			60	60	60	60	60	60		60	60	60	60	60				60	60	60	60
		Tolerance					±½	±½	±½			±½		±½	±½		±½	±½							
	Phases and Lines			1 phase			3 phase, 4 lines	3 phase, 4 lines	3 phase, 4 lines	1 phase	1 phase	3 phase, 4 lines			1 phase, 3 lines	1 phase	1 phase, 3 lines	1 phase, 3 lines				3 phase, 4 line	1 phase, 3 line	3 phase, 4 line	1 phase
	Load KVA		1.6	0.9	1.0		4.4	7.5	9.0	0.75	1.4	1.6	1.1	1.8	0.3	2.7	3.3	0.2	4.0	0	0.3	---	2.7	10.8	
NOTES				Card input only			With Disk Storage Control					*Power cable plus successive tape-to-tape power cables				When 1412 used with 1410 system working ranges of 1412 apply					Add 0.6 KVA for each additional access arm			*27,000 with Telegraph Converter Base	

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT No.	IDENTITY OF UNIT Name	PRICES Monthly Rental $	PRICES Monthly Maintenance $	PRICES Purchase $
CENTRAL PROCESSOR	1411	Processing Unit			
	Model 1	10,000 core storage positions	3,800	66.50	189,400
	Model 2	20,000 core storage positions	4,550	70.75	223,000
	Model 3	40,000 core storage positions	5,400	75.25	262,000
	Model 4	60,000 core storage positions	7,250	117.00	380,000
	Model 5	80,000 core storage positions	8,100	122.00	419,000
		For an I/O Adapter (#4660) on channel 2, 1412/1419s, 7750 or 1440-1448 attachment.			
	Model A1	10,000 core storage positions	3,960	66.50	197,400
	Model A2	20,000 core storage positions	4,710	70.75	231,000
	Model A3	40,000 core storage positions	5,560	75.25	270,000
	Model A4	60,000 core storage positions	7,410	117.00	388,000
	Model A5	80,000 core storage positions	8,260	122.00	427,000
	4660	I/O Adaptor	160	4.00	5,600
		Optional Equipment			
	1007	Accelerator	350	6.00	17,500
	5730	Processing Overlap 1/	200	5.25	8,375
	5620	Priority Feature 2/	125	2.75	5,375
	5621	Priority Feature - Extension (5620 Required)	20	1.75	675
STORAGE		Core Storage: Refer to 1411 Processing Unit			
	1301	Disk Storage 3/			
	Model 1	28,000,000 characters	2,165	139.75	119,100
	Model 2	56,000,000 characters	3,565	239.75	189,100
		Optional Feature			
		Cylinder Mode	25	1.00	1,250
	1311	Disk Storage			
	Model 5	First on channel	1,000	77.00	46,500
	Model 2	Additional on channel	375	29.00	17,000
	3341	Disk Storage Drive Adapter for channel 1	120	2.00	3,000
	3342	Disk Storage Drive Adapter for channel 2	120	2.00	3,000
		Optional Equipment			
	6396	Scan Disk (model 5 only - #6397 or 6398 required)	35	.50	1,680
	6397	Scan Feature for channel 1	30		600
	6398	Scan Feature for channel 2	30		600
	6400	Seek Overlap (model 5 and each model 2)	40	1.75	1,950
	8011	Track Record (model 5 only)	40	.50	1,920
	1405	Disk Storage 3/			
	Model 1	10,000,000 characters	995	90.00	37,350
	Model 2	20,000,000 characters	1,545	98.00	49,850

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§ 221. PRICE DATA (Contd.)

CLASS	IDENTITY OF UNIT No.	Name	PRICES Monthly Rental $	Monthly Maintenance $	Purchase $
STORAGE (CONTD.)		Optional Equipment			
		Priority Feature	40	. 1.25	1,725
	1008	Additional Access Arm (Max. 2) Model 1	400	64.00	14,750
	1009	Additional Access Arm (Max. 2) Model 2	425	64.00	15,500
CONTROL-LERS	1414	Input/Output Synchronizer			
	Model 1	Controls 729 magnetic tape unit 6/	1,030	15.50	45,650
	Model 2	Controls 7330 magnetic tape unit 6/	555	16.75	27,050
	Model 3	Controls card I/O only 7/	700	17.50	31,500
	Model 4	Controls card and "Teleprocessing" I/O 7/	800	20.50	41,025
	Model 5	Controls "Teleprocessing" I/O only 7/	725	12.25	36,825
	Model 7	Controls up to 10 729's	1,180	16.25	51,650
	Model 8	For 1403 only	1,175	22.75	59,625
		Optional Equipment			
	6025	Read, Punch Column Binary (on model 4 only)	175	2.00	8,750
		Disk Storage Control (on first 1405 on each channel)	400	44.25	13,950
	7576	Successive Disk Storage	15	1.00	600
	7631	File Control (for 1301)			
	Model 1	This system only	835	30.00	42,000
	Model 3	This system and 7000 system (not 7010 or 7072)	1,035	35.00	52,000
	Model 5	This system and a 7010 or other 1410	1,035	35.00	52,000
	3470	Dual Synchronizer Adapter 1/	325	8.25	13,000
	7155	Switch Control Console			
	Model 1	For up to 2 tape units	35	5.50	1,775
	Model 2	For up to 4 tape units	55	11.00	2,675
	Model 3	For up to 6 tape units	80	16.50	3,875
	Model 4	For up to 8 tape units	100	22.00	4,775
	7814	Tape Intermix (on 1414 model 1 only, to intermix 729 II's, 729 IV's and 7330's in any combination).	45	0	2,250
INPUT-OUTPUT	1402	Card Read Punch (includes Adapter - 4659)	640	70.00	33,825
		Optional Equipment			
	4150 & 1013	51-Column Read (IF)	65	28.25	4,125
	1442	Card Reader (card input only)	350	23.25	19,350
	Model 3 4661	Input/Output Adapter (for 1414 model 5 or 8)	50	.75	2,750
	1403	Printer			
	Model 1	100 print positions (includes Synchronizer Storage #7680)	1,275	185.50	55,650
	Model 2	132 print positions (includes Synchronizer Storage - #7680 and 7681)	1,385	201.25	59,200
	Model 3	132 print positions (includes Synchronizer Storage - #7680 and 7681)	2,010		95,200

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§ 221. PRICE DATA (Contd.)

CLASS	IDENTITY OF UNIT No.	Name	PRICES Monthly Rental $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT (CONTD.)		Optional Equipment			
	4740	Interchangeable Chain (IC)	75	0	3,125
	5380 & 5381	Numerical Print	275	8.75	11,050
	1415	Console	250	10.25	13,600
	1412 Model 1	Magnetic Character Reader	2,000	183.00	91,400
		Magnetic Character Reader Adapters			
	4900	for channel 1 (not with 4902)	215	18.50	8,875
	4902	for channel 2 (not with 4900)	215	18.50	8,875
	4903	second adapter (4900 or 4902 required)	115	10.06	4,750
		Optional Equipment			
	2385	Document Counter (DC)	15	2.25	600
	3610	Electronic Accumulation (EA) (#5215 required)	250	19.00	9,750
	5215	Multiple Column Select (MCS)			
		Self Checking Numbers:	50	2.00	2,250
	7061	Modulus 10 (M-10)	40	1.75	1,950
	7062	Modulus 11 (M-11)	65	2.75	3,000
	729II	Magnetic Tape Unit	700	116.00	36,000
	729IV	Magnetic Tape Unit	900	128.00	41,250
	729V	Magnetic Tape Unit	750	122.00	37,200
	729VI	Magnetic Tape Unit	950	134.00	42,450
	7330	Magnetic Tape Unit	450	52.25	22,000
	1009	Data Transmission Unit 5/	700	15.00	37,400
	1011	Paper Tape Reader 5/	600	44.00	26,150
	1014	Remote Inquiry Unit 5/	400	18.25	22,500
	7864	Telegraph I/O Feature	500	11.00	30,500
		Additional Telegraph Features			
	7871	Telegraph Input Feature	110	3.25	6,750
	7875	Telegraph Output Feature (Both require #7864)	125	3.25	7,750
	5737	Program Addressable Clock 5/	90	6.25	4,125
		Optional Equipment			
	7830	Tape Switching Feature (on 729's)	85	6.50	4,400
	3585 or 3586	800 CPI Feature (to operate 729 V's or VI's at 800 CPI density)	35		1,575
	7750	Programmed Transmission Control			
	Model 1		7,150		440,000
	Model 2		7,950		490,000
	Model 3		9,550		590,000
		Control Adapters			
	1067	for channel 1	325	4.00	9,000
	1068	for channel 2 on 1411 (models A1-A5 only)	325	4.00	9,000

1/ Required for two-channel operation.
2/ Required when using 1405 Disk Storage.
3/ Prices include required Disk Storage Adapter on 1411 (#3301 or #3302 for 1301 and #3310 or 3311 for 1405)
4/ Maintenance prices apply only to purchased equipment and are based upon a sliding scale; those listed here are for the first 3 years after installation. (continued)

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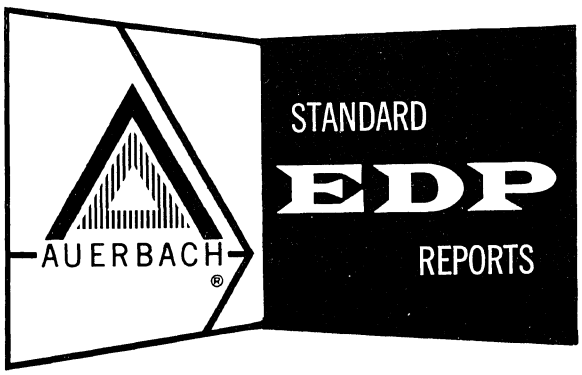
§ 221. PRICE DATA (Contd.)

5/ Price includes Adapter on 1411 (#3238 for 1009, #5514 for 1011, #6136 for 1014, #5738 for 5737).
6/ Price includes Tape I/O Adapter (#7823 for channel 1 and #7824 for channel 2).
7/ Price includes I/O Adapter #4659.

IBM 7070

International Business Machines Corp.

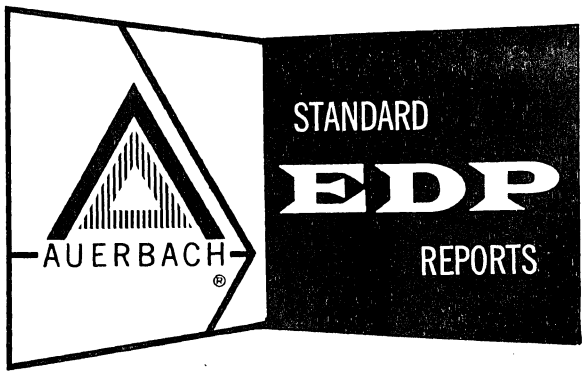


AUERBACH INFO, INC.

PRINTED IN U. S. A.

IBM 7070

International Business Machines Corp.



AUERBACH INFO, INC.

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INTRODUCTION

The solid-state IBM 7070 is most effective as a tape oriented data processing system for high volume business applications.

Core storage may consist of 5,000 or 9,990 word locations, and each location can hold one single-address instruction, five alphameric characters, or a data word of ten decimal digits plus sign. The core storage cycle time is six microseconds.

The instruction repertoire is versatile and effective; the only significant omission is the lack of automatic editing facilities. Three accumulators are provided, and many of the instructions can refer to any one of the three. Ninety-nine core storage locations can be used as index registers. Floating point arithmetic is optional. While the 7070 is basically a fixed word-length system, operand sizes for most internal operations can vary from one to ten digits, and several short fields of like sign can readily be packed into a single core storage location.

A major feature of the 7070 is its ability to transfer several blocks of data to or from different core storage areas in a single operation. This scatter-read and gather-write capability facilitates internal data transfers as well as transfers between core storage and magnetic tape, disc storage, or unit record devices.

Automatic interruption facilitates effective use of the system's capabilities for simultaneous operations. Execution of a priority routine can be initiated automatically whenever an operation is completed by a selected peripheral unit or a manual inquiry request is made.

Overall internal speeds of the 7070 are significantly lower than those of other systems in the same price range. Full-word internal transfers are parallel by word, but transfers of fields less than ten digits in length and all arithmetic operations are performed serially by digit. A 7070 system can, at a rental increase of at least $5,000 per month, be converted to an IBM 7074. The 7074 offers greatly increased internal speeds, up to 30,000 words of core storage, and faster magnetic tape drives, while maintaining program compatibility with the 7070.

The IBM 729 series of magnetic tape units is used in 7070 systems. Peak transfer rates can range from 15,000 to 90,000 characters per second. Up to ten tape units can be connected to each of a maximum of four channels, and up to four tape read/write operations can occur simultaneously with internal processing.

Two different types of magnetic disc storage may be used; the maximum total capacity is 278 million characters. When the faster and more flexible 1301 Disk Storage Units are used, the maximum number of magnetic tape channels is reduced to two.

A line of unit record devices, including a 500 card-per-minute reader, a 250 card-per-minute punch, and a 150 line-per-minute printer, is offered for the 7070 on an "as available" basis. A maximum of three readers and three output devices (printers and/or punches) can be connected. The 7070 has been found to be most effective in tape oriented configurations, and most installations utilize IBM 1401 systems for off-line card-to-tape, tape-to-card, and tape-to-printer operations. As a result, the on-line reader, punch, and printer are no longer in production. A console card reader, rated at 60 cards per minute, is useful in tape systems for direct card input on an exception basis.

Paper tape readers, remote inquiry stations, data transmission terminals, and telegraph transmitters and receivers can be connected to the system through the 1414 Input/Output Synchronizer and the 7907 Data Channel.

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INTRODUCTION – Contd.

Autocoder is the basic machine oriented coding system for the 7070. It is offered in three versions for different translating computer configurations. The full, six-tape version includes powerful macro generation and input-output control facilities.

A FORTRAN II processor is available, and a COBOL 61 processor was delivered in March, 1962. A "compiler systems tape" combines the Autocoder, COBOL, and FORTRAN processors and a Report Program Generator. The manufacturer also offers generalized sort and merge routines, program testing aids, and various utility routines. A wide variety of user-developed routines is available through GUIDE, the 7070 users' organization.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or use
Word:	10 digits plus sign	data or instruction; basic storage location.
Digit:	5 bits	holds 1 decimal digit; addressable by field definition.
Character:	6 bits plus parity	magnetic tape and 1301 Disk Storage Unit.
Band:	2,780 characters max.	1301 DSU.
Band:	60 words	7300 DSU.

INFORMATION FORMATS

Type of Information	Representation
Numeral:	digit (internal) or character (tape).
Letter:	2 digits (internal) or 1 character (tape).
Number:	1 word; 1 to 10 digits by field definition.
Block:	1 to 9,990 words, defined by record definition word or record mark.
Instruction:	1 word.

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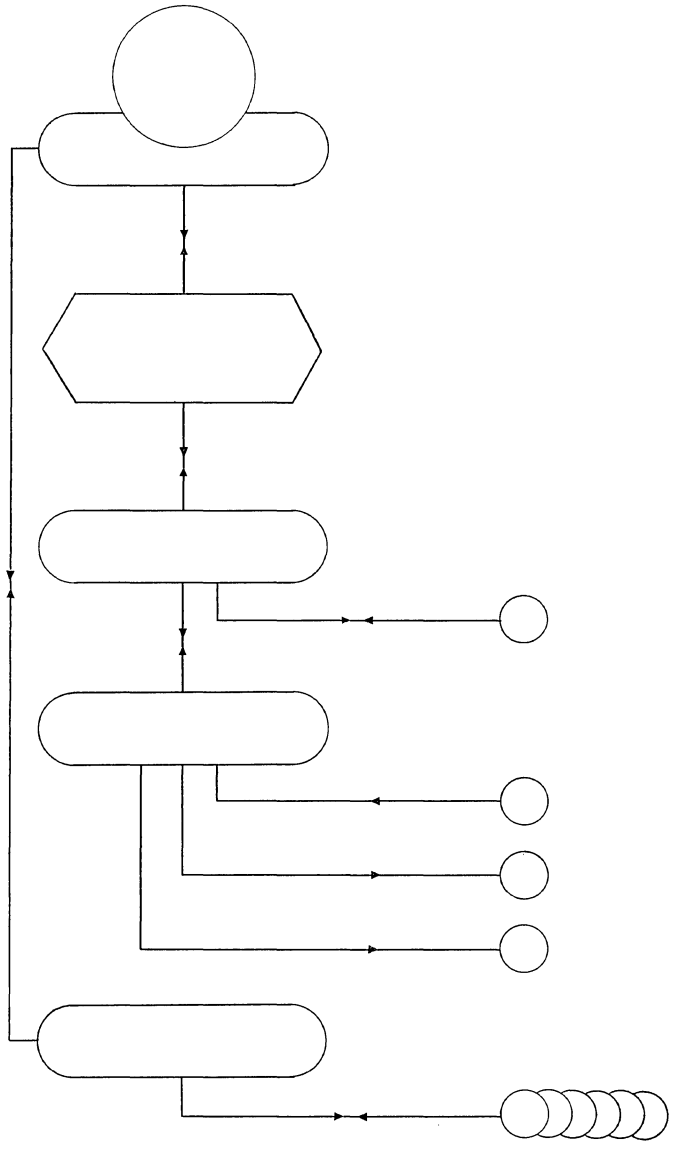
SYSTEM CONFIGURATION

§ 031.

III. 6-TAPE BUSINESS SYSTEM

Deviations from Standard Configuration: . . . . . printer slower by 350 lines/min.

Rental: . . . . . $19,400 per month.



Core Storage: 5,000 words.

Core Storage Control.

Arithmetic & Program Control.

Input/Output Control, Model 1.

Console.

Input/Output Synchronizer, Model 3.

Card Reader: 500 cards/min.

Card Punch: 250 cards/min.

Printer: 150 lines/min.

Tape Control, one channel.

Magnetic Tape Units (6): 15,000 or 41,667 char/sec.

Optional Features Included: . . . . . none.

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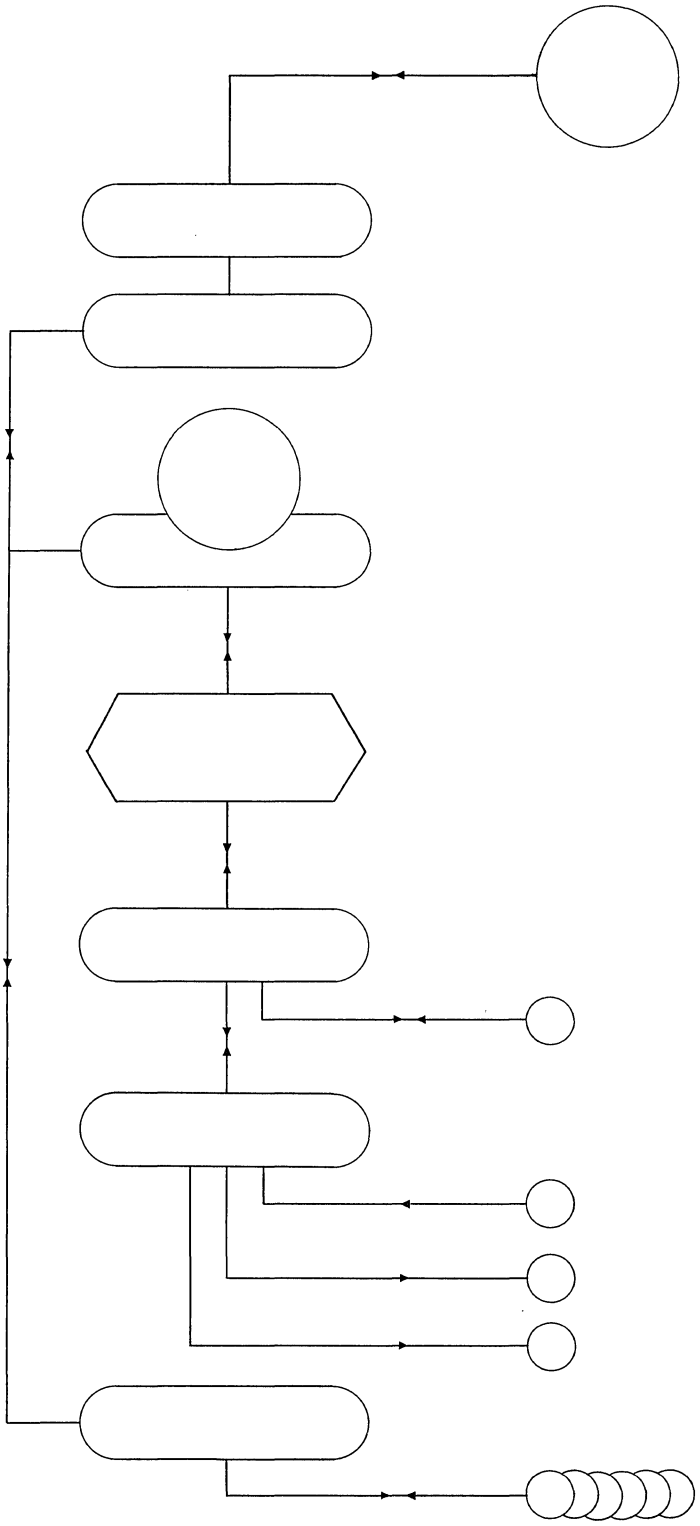
§ 031.

V. 6-TAPE AUXILIARY STORAGE SYSTEM

Deviations from Standard Configuration: . . . . . printer slower by 350 lines/min.

Rental: . . . . . $24,785 per month.



Disc Storage: 1301 Model 1; 27,800,000 characters max.

File Control.

Data Channel, Model 1.

Core Storage: 5,000 words.

Core Storage Control.

Arithmetic & Program Control.

Input/Output Control, Model 1.

Console.

Input/Output Synchronizer, Model 3.

Card Reader: 500 cards/min.

Card Punch: 250 cards/min.

Printer: 150 lines/min.

Tape Control, one channel.

Magnetic Tape Units (6): 15,000 or 41,667 char/sec.

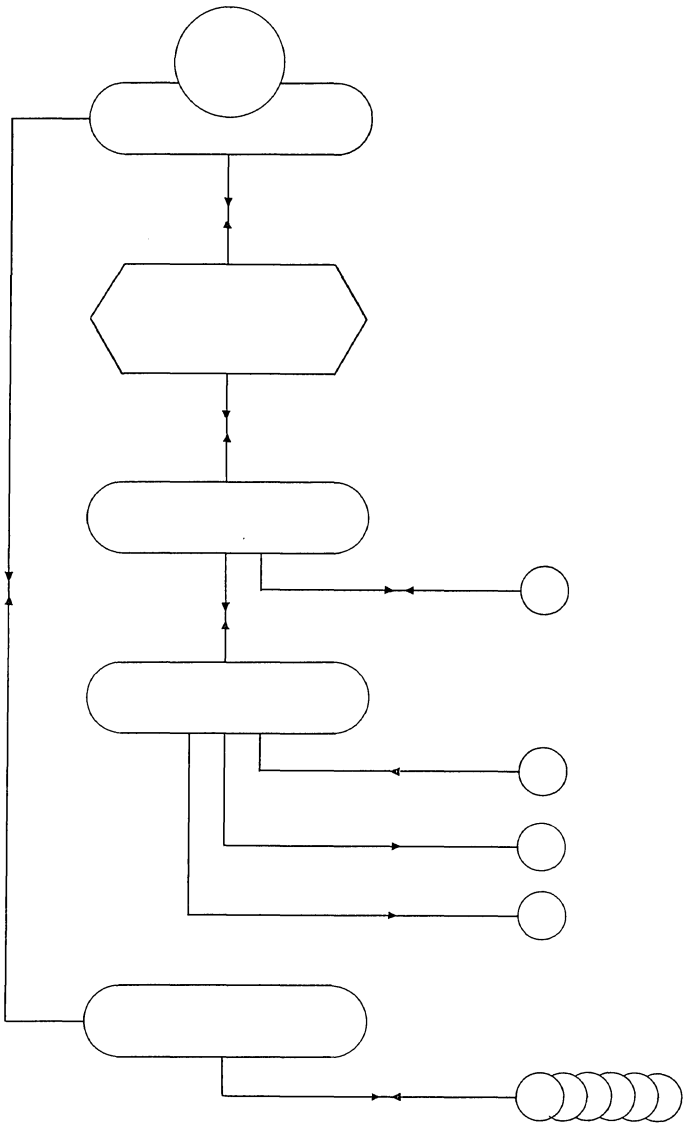
Optional Features Included: . . . . . Cylinder Mode (Disc Storage).

§ 031.

VI. 6-TAPE BUSINESS/SCIENTIFIC SYSTEM

Deviations from Standard Configuration: . . . . . core storage smaller by 4,400 words; printer slower by 350 lines/min.

Rental: . . . . . $23,450 per month.



Core Storage: 9,990 words.

Core Storage Control.

Arithmetic & Program Control.

Input/Output Control, Model 1.

Console.

Input/Output Synchronizer, Model 3.

Card Reader: 500 cards/min.

Card Punch: 250 cards/min.

Printer: 150 lines/min.

Tape Control, one channel.

Magnetic Tape Units (6): 15,000 or 41,667 char/sec.

Optional Features Included: . . . . . Floating Decimal Arithmetic.

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§ 031.

VII. B 10-TAPE GENERAL SYSTEM (PAIRED)

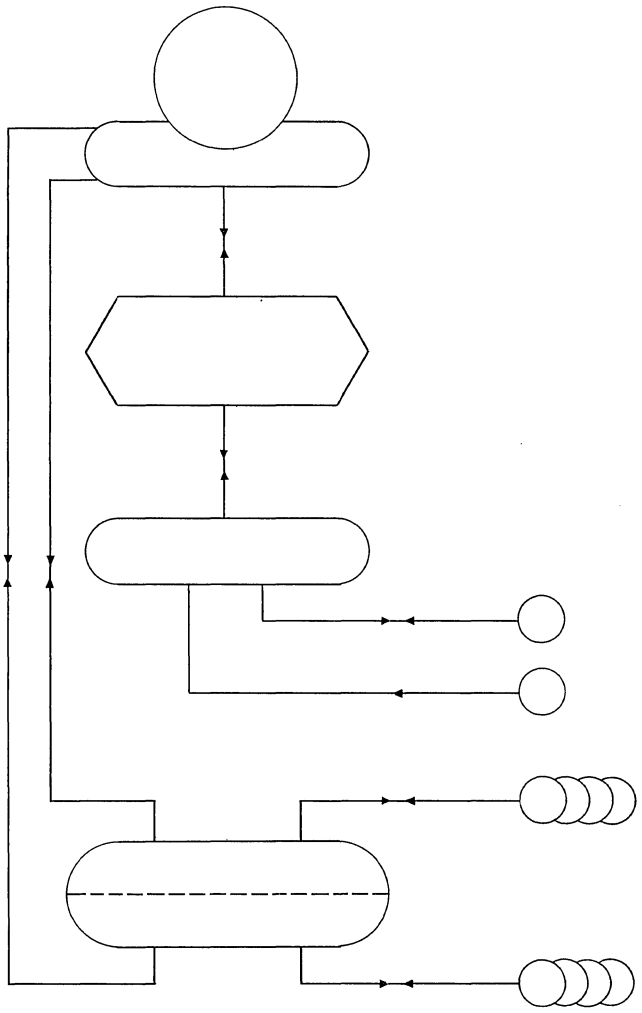
Deviations from Standard Configuration

On-line equipment: . . . . . core storage smaller by 4,400 words.
Off-line equipment: . . . . . none.

Rental

On-line equipment: . . . . . $23,650 per month.
Off-line equipment: . . . . . $ 6,105 per month.
Total: . . . . . $29,755 per month.

On-Line Equipment:



Core Storage: 9,990 words.

Core Storage Control.

Arithmetic & Program Control.

Input/Output Control, Model 2.

Console.

Console Card Reader: 60 cards/min.

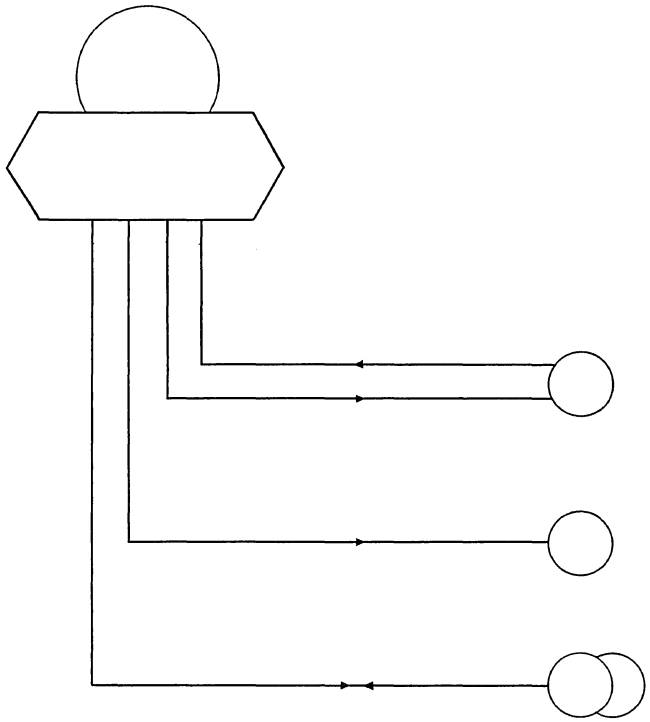
Magnetic Tape Units (4): 22,500 or 62,500 char/sec.

Tape Control, two channels.

Magnetic Tape Units (4): 22,500 or 62,500 char/sec.

§ 031.

Off-Line Equipment (IBM 1401):



Core Storage: 4,000 positions.

Processing Unit: 1401 Model C3.

Card Read-Punch
Reads: 800 cards/min.
Punches: 250 cards/min.

Printer: 600 lines/min.

Magnetic Tape Units (2): 15,000 or 41,667 char/sec.

Optional Features Included

On-line equipment: . . . . . Floating Decimal Arithmetic.

Off-line equipment: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Compressed Tape.
Early Card Read.

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§ 031.

VIII. B 20-TAPE GENERAL SYSTEM (PAIRED)

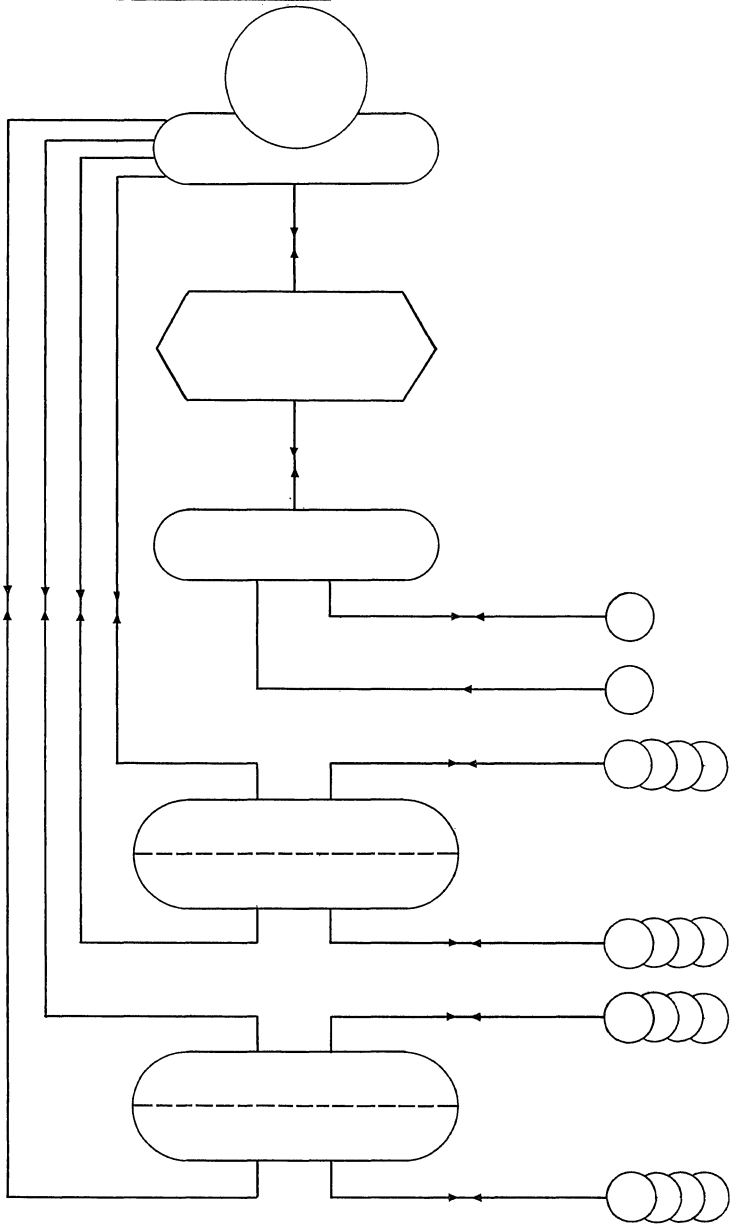
Deviations from Standard Configuration

On-line equipment: . . . . . core storage smaller by 18,800 words.
magnetic tape slower by 30,000 char/sec.
Off-line equipment: . . . . . none.

Rental

On-line equipment: . . . . . $35,850 per month.
Off-line equipment: . . . . . $ 9,180 per month.
Total: . . . . . $45,030 per month.

On-Line Equipment



Core Storage: 9,990 words.

Core Storage Control.

Arithmetic & Program Control.

Input/Output Control, Model 2.

Console.

Console Card Reader: 60 cards/min.

Magnetic Tape Units (4): 22,500, 62,500 or 90,000 char/sec.

Tape Control, two channels.

Magnetic Tape Units (4): 22,500, 62,500 or 90,000 char/sec.

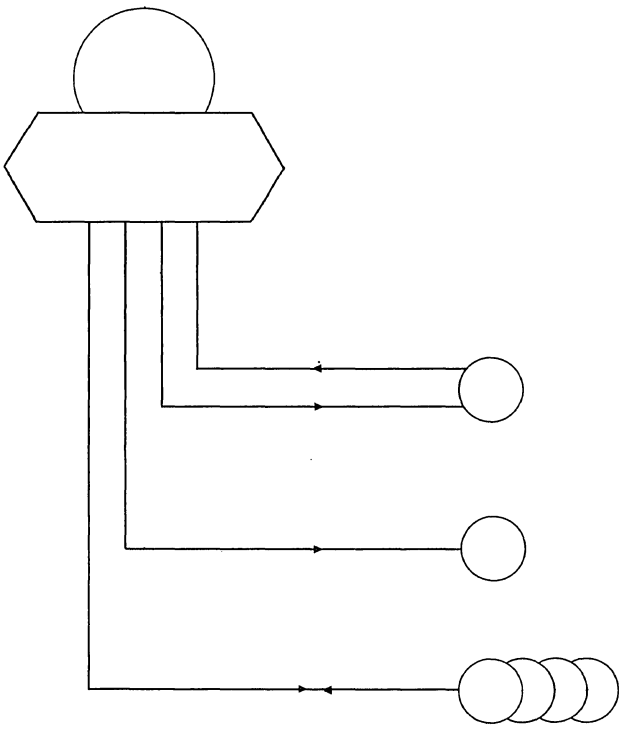
Magnetic Tape Units (4): 22,500, 62,500 or 90,000 char/sec.

Tape Control, two channels.

Magnetic Tape Units (4): 22,500, 62,500 or 90,000 char/sec.

§ 031.

Off-Line Equipment (IBM 1401):



Core Storage: 8,000 positions.

Processing Unit: 1401 Model C4.

Card Read-Punch
Reads: 800 cards/min.
Punches: 250 cards/min.

Printer: 600 lines/min.

Magnetic Tape Units (4): 22,500 or 62,500 char/sec.

Optional Features Included

On-line equipment: . . . . . Floating Decimal Arithmetic.

Off-line equipment: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Compressed Tape.
Print Storage.
Processing Overlap.
Early Card Read.

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INTERNAL STORAGE: CORE STORAGE

§ 041

.1 GENERAL

.11 Identity: . . . . . Core Storage.
7301, Models 1 and 2.
CS.

.12 Basic Use: . . . . . working storage.

.13 Description:

A 7070 system can contain 5,000 or 9,990 word locations of core storage. Each location can hold one numeric word consisting of ten decimal digits and sign, one alphameric word consisting of five characters, or one single-address instruction. Each digit is represented by a two-out-of-five-bit code combination, and validity checks insure that each digit transferred to or from storage contains exactly two bits. Two successive digit positions are required for each alphameric character. Core storage cycle time is six microseconds, and all transfers are parallel by word.

The 7070's scatter-read and gather-write capabilities make it possible to distribute a block of data in core storage into a number of smaller blocks or to assemble several blocks into one larger block. Individual digits or fields within a word can be addressed through the 7070's field definition feature.

.14 Availability: . . . . . 12 to 15 months (**).

.15 First Delivery: . . . . . March, 1960.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	99	none.
Arith registers:	0.	
Logic registers:	0.	
I-O control (including DSU):	144	none.
Table look-up:	1	none.
Electronic switches:	3	none.

Note: All locations can also be used as working storage.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . . magnetic core.

.23 Storage Phenomenon: . . . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.283 Type of access: . . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Unit of data: . . . . . word.
Conversion factor: . . 53 bits/word.
Cycling rate: . . . . . 166,667 cycles/sec.
Data rate: . . . . . 166,667 words/sec.
Compound data rate: . 166,667 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Identity:	Model 1	Model 2.
Words:	5,000	9,990.
Characters:	50,000 numeric 25,000 alphabetic	99,900 numeric. 49,950 alphabetic.
Instructions:	5,000	9,990.
Modules:	1	1.

.32 Rules for Combining Modules: . . . . . one only, Model 1 or Model 2.

.4 CONTROLLER

.41 Identity: . . . . . Core Storage Control.
7602.
Model 1,2,3,4, or 5, depending upon number of tape channels.

.42 Connection to System

.421 On-Line: . . . . . one.
.422 Off-Line: . . . . . none.

.43 Connection to Device

.431 Devices per controller:. 1.
.432 Restrictions: . . . . . none.

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.5 ACCESS TIMING

.51 Arrangement of Heads: . 1 access device.

.52 Simultaneous Operations: . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . ?
Cycle time: . . . . . 6 μ sec.
For data unit of: . . . 1 word.

.6 CHANGEABLE STORAGE: . . . . . No.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

With self: . . . . . yes.

.72 Transfer Load Size

With self: . . . . . 1 digit to several blocks; length and number of blocks are limited only by the capacity of core storage.

.73 Effective Transfer Rate

With self: . . . . . 41,700 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	stop & alarm.
Receipt of data:	validity check	stop & alarm.
Dispatch of data:	none.	
Conflicting commands:	check	stop & alarm.
Recovery of data:	validity check	stop & alarm.
Recording of data:	none.	
Field overflow*:	check	alarm & indicator; optional stop.
Sign change*:	check	alarm & indicator; optional stop.

* When storing field-defined portion of a word.

INTERNAL STORAGE: 7300 DISK STORAGE UNIT

§ 042.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit.
7300 Models 1 and 2.
"RAMAC".
DSU.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

This store, often referred to as a RAMAC unit, consists of 50 thin magnetic discs on a common vertical shaft. Each disc has 100 bands per surface on Model 1 and 200 bands per surface on Model 2. Each band holds a single block of 60 ten-digit 7070 words recorded in the internal two-out-of-five bit code. Total unit capacity is 600,000 words for Model 1 and 1,200,000 words for Model 2. Up to four units may be connected to a 7070. They share tape channels 1 and 2 with the 7604 Tape Control, and up to two disc read or write operations can occur simultaneously with internal processing.

Access is by means of three fork-shaped arms per unit, each with two read-write heads. An arm moves vertically to the selected disc, then horizontally to the selected band. Priority interruption of the stored program occurs upon completion of every seek operation. A seek instruction may be directed either to a specific access arm or to any arm that is not busy. A variety of checking features is incorporated, including an automatic comparison of data recorded on the disc with the data in core storage after every write operation. Errors cause priority interruptions; the initial and final status words, which are generated automatically, can be examined to determine the reason for the interruption.

Access arm positioning requires from 100 to 855 milliseconds. Reading of one band requires from 88 to 113 milliseconds including setup time and rotational delay. An additional 50 milliseconds per band are required for the automatic comparison when writing. Each read or write command transfers exactly one band of 60 words. The data may be gathered from or scattered into different areas of core storage by means of record definition words. The maximum effective bulk transfer rate is 516 words per second.

The 7300 Disk Storage Unit is no longer in production and is currently offered on an "as available" basis. It will be superseded by the larger, faster, and more flexible 1301 Disk Storage Unit.

.14 Availability: . . . . . no longer in production; offered on an "as available" basis.

.15 First Delivery: . . . . March, 1960 (**).

.16 Reserved Storage

Purpose	Number of locations	Locks
Band addresses:	48 positions/band	non-addressable.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Disc
Diameter: . . . . . 24 inches.
Thickness or length: . thin.
Number on shaft: . . . 50.

.23 Storage Phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data Volume per Band of 1 Track

Words: . . . . . 60.
Characters: . . . . . 300.
Digits: . . . . . 600.
Instructions: . . . . . 60.

.26 Bands per Physical Unit

Model 1: . . . . . 200 per disc (100 per surface).
Model 2: . . . . . 400 per disc (200 per surface).

.27 Interleaving Levels: . . none.

.28 Access Techniques

.281 Recording method: . . . moving heads.
.283 Type of access

Description of stage	Possible starting stage
Remove head from unwanted disc: . . .	if new disc is selected.
Move head to selected disc:	no.
Move head to selected band:	if same disc was previously selected.
Set up access register:	if same band was previously selected.
Wait for start of selected record:	no.
Wait for transfer of record:	no.

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.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1,200 rpm.
Bit rate per track: . . 74,200 bits/sec/track.

.292 Peak data rates
Unit of data: . . . . . word.
Conversion factor: . . 53 bits/word.
Gain factor: . . . . . 1.
Data rate: . . . . . 1,400 words/sec/unit.
Compound data rate: . 2,800 words/sec maximum.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage			Maximum Storage
Identity:		Model 1	Model 2	4 Model 2 units.
Discs:	0	50	50	200.
Words:	0	600,000	1,200,000	4,800,000.
Characters:	0	3,000,000	6,000,000	24,000,000.
Instructions:	0	600,000	1,200,000	4,800,000.
Digits:	0	6,000,000	12,000,000	48,000,000.
Modules:	0	1	2	8.

.32 Rules for Combining Units: . . . . . up to 4 units, Model 1 and/or Model 2 in any combination.

.4 CONTROLLER

.41 Identity: . . . . . Disk Storage Control. 7605 Model 1.

Disk Storage Attachment. #3315 (on 7602 Core Storage Control).

.42 Connection to System

.421 On-line: . . . . . one 7605 and one #3315 (both units are required); 7300 DSUs share channels 1 and 2 with magnetic tape units on a 7604 Tape Control.

.43 Connection to Device

.431 Devices per controller: 4 units, Model 1 and/or Model 2.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . one band of 60 words.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . . . automatic.
.447 Table control: . . . . . yes; scatter read and gather write, controlled by record definition words.
.448 Testable conditions: . . priority interruption occurs at end of seek, read, and write operations; digit position 1 of final status word indicates normal condition or specific error.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
Stacks per system: . . 24 maximum.
Stacks per module: . . 6.
Stacks per yoke: . . . 2.
Yokes per module: . . 3.
.512 Stack movement: . . . . vertically to selected disc; then horizontally to selected band.
.513 Stacks that can access any particular location: . . . . . 3.
.514 Accessible locations
By single stack
With no movement: . 1 band of 60 words.
With all movement
Model 1: . . . . . 5,000 bands.
Model 2: . . . . . 10,000 bands.
By all stacks
With no movement: . 6 bands per module. 24 bands per system (maximum).
.515 Relationship between stacks and locations: . 1 stack per yoke serves top surfaces of all discs; other stack serves bottom surfaces.

.52 Simultaneous Operations

A: . . . . . seeking specified band.
B: . . . . . reading.
C: . . . . . recording.
a + b + c = at most 12 (3 per DSU).
b + c = at most 2 (1 if only 1 DSU is installed).

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, m.sec.	Example, m.sec.
Remove head from unwanted disc:	0 or 100 to 225	200.
Move to selected disc: . .	0 or 150 to 405	300.
Move to selected band: . .	0 or 100 to 225	200.
Set up access register: . .	38	38.
Wait for start of band: . .	0 to 50	25.
Read one band:	50	50.
Total:	88 to 993	813.

Note: When recording, an additional 50 m.sec per band is required in all cases for the automatic compare check.

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§ 042.

.6 CHANGEABLE STORAGE: . . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possibilities
With self: . . . . . no.
With core storage: . . yes.

.72 Transfer Load Size

With core storage: . . . 1 band of 60 words.

.73 Effective Transfer Rate

With core storage: . . . 516 words/sec, 5,160 digits/sec, or 2,580 char/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	address comparison	priority signal.
Invalid code:	2-out-of-5 bit check	priority signal.
Receipt of data:	2-out-of-5 bit check	priority signal.
Recording of data:	automatic write compare	priority signal.
Recovery of data:	2-out-of-5 bit check	priority signal.
Dispatch of data:	2-out-of-5 code.	
Timing conflicts:	check	wait or branch.
Reference to locked area:	not possible.	
Wrong length record:	check	priority signal.

Note: "Priority signal" indicates that digit position 1 of the final status word is set to a particular condition code and control is transferred to a disc priority routine which takes the appropriate action.

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INTERNAL STORAGE: 1301 DISK STORAGE UNIT

§ 043.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit.
1301 Models 1 and 2.
DSU.

.13 Description

The 1301 Model 1 Disk Storage Unit can store up to 27, 800, 000 alphameric characters. Model 2 has two modules on a single vertical shaft and can store up to 55, 600, 000 characters. Each module contains 25 discs; 40 of the 50 disc surfaces are used for data storage. Each module is served by a comb-like access mechanism. Forty data read-write heads, one for each data surface, move horizontally between the discs. The entire access mechanism moves as one unit, so the horizontal position of all the heads serving a given module is always the same. The 40 bands, one on each disc surface, that can be read or recorded upon when the access mechanism is in any given position are referred to as a "cylinder".

There are 250 bands on each disc surface. The size and number of records stored in each band are variable. Their formats are controlled by a format surface that can be written upon only by a special instruction after manually releasing a write lock. Each of the 250 bands on the format surface controls the record format of the entire cylinder in the corresponding position. A different record format can be used in each of the 250 cylinders in each module.

Data can be recorded in either the 6-bit or 8-bit mode. In the 6-bit mode each band can store up to 2, 780 characters. In the 8-bit mode, only 2, 160 alphameric characters can be stored in a band, but all-positive numeric data can be "packed" in the form of two 4-bit digits per character position. When more than one record is stored in a band, the data capacity is reduced by 42 characters for each additional record address. Instructions are provided to read or record a single record, a full band, or, with the optional Read/Write Cylinder feature (RC), a full cylinder of up to 111, 200 characters.

Time for access mechanism movement ranges from zero (for a record in a previously-selected cylinder) to 180 milliseconds. Maximum rotation delay time is 34 milliseconds. Total reference cycle time to read a randomly-placed record of 270 characters, update it, re-write it, and execute a programmed write check is 248 milliseconds. If no access motion is required, the total reference cycle time is reduced to 88 milliseconds. Using the Read/Write Cylinder feature, an effective bulk transfer rate of 83, 000 characters per second can be achieved in the 6-bit mode.

Checking features include a validity check upon data received by the File Control, a comparison of the record address on the disc with the address in the stored program, and checks for illegal operation codes or sequences of instructions. Three check characters are generated and recorded during each write operation. When the record is read, the check characters are automatically generated again and compared with the ones read from the disc. As in the 7300 RAMAC unit, a programmed comparison of data recorded on a disc with data in core storage can be made.

A maximum of five 1301 Disk Storage Units can be connected to a 7070 or 7074 system through one or two 7631 File Controls and a 7907 Data Channel. Two read or write operations can occur simultaneously when two File Controls are used. Every disc storage operation is initiated by a "channel select" instruction, which sends the core storage address of the initial channel command word to the specified Data Channel. Internal processing then continues while the Data Channel independently controls the disc operation. A group of 1301 units can be shared by two IBM 7000 series and/or 1410 systems. When 1301 Disk Storage is used in a 7070 system, the maximum number of magnetic tape channels is reduced from four to two.

.14 Availability: . . . . . 12 to 15 months (**).

.15 First Delivery: . . . . July, 1962.

.16 Reserved Storage

Purpose	Number of locations	Locks
Clocking:	1 disc surface	not addressable.
Spares:	8 disc surfaces	not addressable.
Format:	1 disc surface.	manual lock.
Addresses:	29 + 42R char/band, for R records/band	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Disc
Diameter: . . . . . 24 inches.
Thickness: . . . . . thin.
Number on shaft: . . . Model 1, 25 discs.
Model 2, 50 discs.

.23 Storage Phenomenon: magnetization.

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.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.25 Data Volume per Band of 1 Track

	6-bit mode	8-bit mode
Words:	278	216
Characters:	2,780	2,160
Digits:	2,780	2,160
Instructions:	278	216

Note: These are maximum capacities, based upon 1 record per band; each additional record address requires 42 characters. In 8-bit packed mode, up to 4,320 all-positive decimal digits can be stored in a band.

.26 Bands per Physical Unit: 250 per disc surface.

.27 Interleaving Levels: . . 1.

.28 Access Techniques

.281 Recording method: . . . magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to selected band:	if new band is selected.
Wait for selected record:	if same band was previously selected.
Wait for transfer of data:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1,790 rpm.
Bit rate per track: . . 630,000 bits/sec.
.292 Peak data rates
Unit of data: . . . . . character.
Conversion factor: . . 7 or 9 (including space bit).
Gain factor: . . . . . 1 track/band.
Data rate
6-bit mode: . . . . . 90,000 char/sec.
8-bit mode, unpacked: . . . . . 70,000 char/sec.
8-bit mode, packed: 140,000 digits/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	Minimum Storage	1301 Model 1	1301 Model 2	Maximum Storage: 5 1301s, Model 2.
Discs:	0	20 data	40 data	200 data
Words:	0	2,780,000	5,560,000	27,800,000
Characters:	0	27,800,000	55,600,000	278,000,000
Instructions:	0	2,780,000	5,560,000	27,800,000
Modules:	0	1	2	10.
Basis:	6-bit mode, 1 record/band.			

.32 Rules for Combining Modules: . . . . . up to five 1301s, Model 1 and/ or Model 2 in any combination.

.4 CONTROLLER

.41 Identity: . . . . . File Control.
7631 Model 2, 3, or 4.

Data Channel.
7907 Model 1 or 2.

Data Channel Attachment, 3221.
(all three are required).

.42 Connection to System

.421 On-Line: . . . . . one 7631 with one 7907 Model 1, or two 7631s with one 7907 Model 2 (two channels).
.422 Off-Line: . . . . . 7631 Model 3 permits shared use of 1301s with an IBM 1410 system; 7631 Model 4 permits shared use with another 7000 series system (except 7072).

.43 Connection to Device

.431 Devices per controller: 5.
.432 Restrictions: . . . . . maximum of 5 1301s per system, whether 1 or 2 7631s are used.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 record of up to 2,780 chars, 1 band of up to 2,780 chars, or (with RC) 1 cylinder of up to 111,200 characters.
.442 Input-output area: . . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . . . automatic.

§ 043.

.447 Table control: . . . . . yes; scatter-read and gather-write, controlled by channel commands.

.448 Testable conditions: . . access not ready, access inoperable, and various error conditions are signaled by the File Control in response to a "sense" command.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
- Stacks per system: . . 40 to 400.
- Stacks per module: . . 40.
- Stacks per yoke: . . . 40.
- Yokes per module: . . 1.

.512 Stack movement: . . . . horizontal.

.513 Stacks that can access any particular location: . . . . . 1.

.514 Accessible locations
- By single stack
  - With no movement: . 1 band.
  - With all movement: 250 bands.
- By all stacks
  - With no movement: . 40 bands per module. 40 to 400 bands per system.

.515 Relationship between stacks and locations: . first 4 digits of 6-digit home address for each band denote head and band number.

.52 Simultaneous Operations

A: . . . . . seeking a specified location.
B: . . . . . reading.
C: . . . . . recording.
a + b + c = at most 1 per DSU module.
b + c = at most 1 per File Control.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, m. sec.	Example, m. sec.
Move head to selected band:	0 or 50 to 180	160.0.
Wait for selected record:	0 to 34	17.0.
Read one record: . . .	0.4 to 34	4.0.
Read one band:	34.	
Total:	0.4 to 248	181.0.

.6 CHANGEABLE STORAGE: . . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possibilities
- With self: . . . . . no.
- With core storage: . . yes.

.72 Transfer Load Size

With core storage: . . . 1 record, 1 band, or (with RC) 1 cylinder.

.73 Effective Transfer Rate

With core storage, using optional RC
- 6-bit mode: . . . . . 83,000 char/sec.
- 8-bit mode, unpacked: 64,500 char/sec.
- 8-bit mode, packed: . 129,000 digits/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	indicator.
Invalid code:	check	indicator.
Receipt of data:	2-out-of-5 bit check	indicator.
Recording of data:	programmed write check; generate check characters	indicator.
Recovery of data:	regenerate and compare check characters	indicator.
Dispatch of data:	2-out-of-5 code	indicator.
Timing conflicts:	check	indicator.
Physical record missing:	check	indicator.
Reference to locked area:	ignored.	
Access inoperative:	check	indicator.
Circuit failure:	check	indicator.
Illegal instruction sequence:	check	indicator.
Illegal format character:	check	indicator.

Note: These error indications are transmitted from the File Control to the computer in response to a "sense" command.

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CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . Arithmetic and Program Control.
7601.
APC.

.12 Description

The 7601 Arithmetic and Program Control executes the stored program instructions and performs all arithmetic operations in a 7070 system. It contains three accumulators, a one-digit adder, an instruction counter, and the program, arithmetic, auxiliary, and synchronizer registers. Each of the accumulators and registers has a capacity of one word and can hold ten decimal digits plus sign or five alphameric characters. All internal transfers are parallel by word, but arithmetic is performed serially. Although the core storage cycle time is only six microseconds, no instruction can be executed in less than 36 microseconds.

A feature of the 7070 is its versatile instruction repertoire. Full fixed point arithmetic facilities are provided, including addition to and subtraction from a core storage location. Ninety-nine index registers are standard; they occupy core storage locations 0001 through 0099, and a full complement of instructions is provided for loading, incrementing, and testing them. A unique "split-shift" operation permits shifting of only those digits to the right or left of any specified position in the 20-digit register composed of accumulators 1 and 2 coupled together. There are no facilities for bit manipulation, but 30 "electronic switches" (each consisting of one digit position in core storage) can be turned on or off or tested by the program. Table look-up operations can be carried out automatically on tables broken up into any number of core storage blocks. Internal facilities for editing and format control are severely limited. Many load, store, add, subtract, compare, and branch operations can be carried out in any of the three accumulators, and the accumulators can be addressed and used as instruction operands. Multiplication and division require all three accumulators.

The most common operand length is one 10-digit word, but the 7070's field definition feature (FD) permits arithmetic, load, store, compare, and table look-up operations to be carried out on specified portions of a word. The control portion of an instruction specifies the high- and low-order digit positions of the field to be used. Several fields of like sign can therefore be stored in a single core storage location. Store and add-to-storage operations using field definition can result in field overflows (when digit positions beyond the field-defined ones are affected) or sign changes (when the sign of the stored field differs from that of the storage location). Depending upon console switch settings, detection of these errors can result in system halts or the setting of testable indicators.

The 7070's scatter-read and gather-write capabilities can be used in internal transfers as well as input-output operations. A block of data in core storage can be scattered into a number of smaller blocks, or a number of blocks can be gathered into one larger block. The addresses of the several blocks that data is to be gathered from or scattered into are specified in a list of record definition (RD) words; one word for each block to be transferred. The end of a block transfer operation is indicated by a record definition word with a minus sign. Conversions between the numeric and alphameric modes can be made during core-to-core block transfers. Each 10-digit numeric word becomes two five-character alphameric words, and leading zeros can be converted to blanks. Only numeric data should be converted from alphameric to numeric mode; all even-numbered digit positions are lost, so alphabetic or special characters are converted into unrelated numeric codes.

Automatic interruption of the stored program and transfer of control to a priority routine can occur whenever an operation is completed by a magnetic tape unit, disc storage unit, or unit record device, or when an inquiry request is made. This capability is called "Priority Processing". It permits a limited degree of multi-running, but it is not possible for one priority routine to interrupt another.

Optional Features

Floating Decimal Arithmetic (FDA): Provides a full complement of floating point arithmetic operations using an 8-digit fixed point part and a 2-digit exponent. Sixteen-digit results are formed in addition, subtraction, and multiplication.

Interval Timer (IT): Records time in 30-second intervals for up to 8.3 hours, and may be interrogated or reset to zero by the stored program. The Console Card Reader Attachment is a prerequisite.

.13 Availability: . . . . . 12 to 15 months (**).

.14 First Delivery: . . . . March, 1960.

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.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-Subtract:	automatic	decimal	1 word (FD).
Multiply			
Short:	none.		
Long:	automatic	decimal	1 word (FD).
Divide			
No remainder:	none.		
Remainder:	automatic	decimal	1 word (FD).
.212 Floating point			
Add-Subtract:	optional FDA	decimal	8 & 2 digits.
Multiply:	optional FDA	decimal	8 & 2 digits.
Divide:	optional FDA	decimal	8 & 2 digits.
.213 Boolean			
AND:	none.		
Inclusive OR:	none.		
.214 Comparison			
Numbers:	automatic		1 word (FD).
Absolute:	automatic		1 word (FD).
Letters:	automatic		1 word (FD).
Mixed:	automatic		1 word (FD).
Collating sequence:	specials, A to Z, 0 to 9.		

	Provision	From	To	Size
.215 Code translation:	automatic	numeric	alphameric	1 to N words (RD).
	automatic	alphameric	numeric	1 to N words (RD).
.216 Radix conversion:	none.			

	Provision	Comment	Size
.217 Edit format			
Alter size:	automatic	in code translation operations only	1 to N words (RD).
Suppress zero:	automatic		
Round off:	automatic	in right shifts only	1 or 2 words.
Insert point:	none.		
Insert spaces:	none.		
Float:	none.		
Protection:	none.		
.218 Table look-up			
Equality:	automatic		1 word (FD, RD).
Equal or greater:	automatic		1 word (FD, RD).
Greatest:	none.		
Least:	automatic		1 word (FD, RD).
.219 Others			
Add to storage:	automatic		1 word (FD).
Subtract from storage:	automatic		1 word (FD).
Record gather:	automatic		1 to N words (RD).
Record scatter:	automatic		1 to N words (RD).
Electronic switches:	automatic	test, turn on or off	30 switches available.

(FD): Field definition is applicable to this operation (1 to 10 digits).
(RD): Record definition words are used to define blocks of data locations.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value with negative sign.
.222 Zero: . . . . . plus zero is greater than minus zero in comparisons; both give same results in arithmetic.
.223 Operand size determination: . . . . . 1 word or a portion thereof, defined by control portion of instruction.

.23 Instruction Formats

.231 Instruction structure: . 1 word.
.232 Instruction layout:

Part	Operation	Index	Control	Address
Size (digits)	sign + 2	2	2	4

.233 Instruction parts

Name	Purpose
Operation:	specifies operation to be performed.
Index:	specifies indexing word to be added to address part.
Control:	1) specifies high- and low-order digit positions of a field within the addressed core storage location (FD); or 2) augments the operation code.
Address:	1) specifies operand address in core storage; 2) specifies destination of a jump; 3) contains a positive literal; or 4) augments the operation code.

.234 Basic address structure: . . . . . 1 + 0.
.235 Literals
Arithmetic: . . . . . none.
Comparisons and tests: . . . . . 1 digit.
Incrementing modifiers: . . . . . 4 digits.
.236 Directly addressed operands
.2361 Internal

Storage type	Minimum size	Maximum size	Volume accessible
Core:	1 character	1 word	total capacity

.2362 Increased address capacity: . . . . . none.
.237 Address indexing
.2371 Number of methods: 1.
.2372 Name: . . . . . indexing.
.2373 Indexing rule: . . . . addition, modulo 10,000.
.2374 Index specification: . index portion of the modified instruction (2 digits).

§ 051.

.2375 Number of potential indexers: . . . . . 99 (core storage locations 0001-0099).
.2376 Addresses which can be indexed: . . . . address portion of all instructions.
.2377 Cumulative indexing: none.
.2378 Combined index and step: . . . . . yes.
.238 Indirect addressing: . . none.
.239 Stepping
.2391 Specification of increment: . . . . . address portion of stepping instruction.
.2392 Increment sign: . . . always positive, but may be added or subtracted.
.2393 Size of increment: . up to 4 digits.
.2394 End value: . . . . . zero, non-negative, or value specified in indexing word.
.2395 Combined step and test: . . . . . for increment of 1 or decrement of up to 4 digits.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in digits	Program usage
Arithmetic and Program Control:	3	10 + sign	accumulators.
Arithmetic and Program Control:	1	4	instruction counter.
Arithmetic and Program Control:	1	10 + sign	program register.

.242

Category of storage	Total number locations	Physical form	Access time μ sec	Cycle time μ sec
Arithmetic and Program Control:	5	?	?	6.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.
.314 Special sub-sequence counters: . . . . . none.
.315 Sequence control step size: . . . . . 1 word.
.316 Accessibility to routines: . . . . . can be stored in an indexing word.
.317 Permanent or optional modifier: . . . . . no.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes
In-out units: . . . . . completion of an operation by a magnetic tape unit or unit record device; manual inquiry request.
In-out controllers: . . as above.
Storage access: . . . completion of a disc storage seek, read, or write operation.
Processor errors: . . none.
Other: . . . . . none.
.332 Control by routine
Individual control: . . individual unit record devices, tape channels, inquiry controls, disc storage seek, and/or disc storage read/write.
Method: . . . . . stacking latches, set by a mask word in core storage, enable interruption by specific units or groups.
Restriction: . . . . . none.
.333 Operator control: . . . console switches determine which 2 unit record devices can cause interruption.
.334 Interruption conditions: 1) not in priority mode.
2) completion of operation by a unit whose stacking latch is not masked.

Note: Upon completion of magnetic tape or disc storage operations, interruption may occur always or only in the event of an error or unusual condition, depending upon sign of the tape or disc instruction.

.335 Interruption process
Disabling interruption: yes; enters priority mode.
Registers saved: . . . stores instruction counter contents in index word 97 and indicator settings in index word 100.
Destination: . . . . . depends on cause.
.336 Control methods
Determine cause: . . destination usually indicates cause; for tape and disc operations, initial and final status words can be tested.
Enable interruption: . "priority release" instruction.

.34 Multi-running: . . . . . limited capability.

.341 Method of control: . . . own coding, using interruption facilities described above.

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.342 Maximum number of programs: . . . . . 2 is practical limit.
.343 Precedence rules: . . . own coding.
.344 Program protection
Storage: . . . . . none.
In-out units: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ secs

.411 Fixed point
Add-subtract: . . . . 36 + 4D. *
Multiply (average): . . 180 + 82D. *
Divide (average): . . . 672 + 216D.
.412 Floating point (with FDA)
Add: . . . . . 168 to 336.
Subtract: . . . . . 168 to 360.
Multiply (average) . . 1,080.
Divide (average): . . . 2,472.
.413 Additional allowance for
Indexing: . . . . . 36 (24 for branch instructions).
Re-complementing: . 4 + 4D. *

* Round these times to hext higher multiple of 12.

.414 Control
Compare: . . . . . 32 + 4D. *
Branch: . . . . . 36.
Compare and branch: 68 + 4D. *
.415 Counter control
Step: . . . . . 60.
Step and test: . . . . . 60 or 84.
Test: . . . . . 36.
.416 Edit: . . . . . 36 + 120N + 36R, for conversions between alphameric and numeric form, where N is number of data words moved and R is number of record definition words.
.417 Convert: . . . . . none.
.418 Shift: . . . . . 28 + 4D. *

.42 Processor Performance in μ secs

.421 For random addresses	Fixed point (10 digits)	Floating point (with FDA)
c = a + b:	156	324.
b = a + b:	120	324.
Sum N items:	84	252.
c = ab:	1,080	1,152.
c = a/b:	2,904	2,544.

.422 For arrays of data	Fixed point (10 digits)	Floating point (with FDA)
$c_i = a_i + b_j$:	468	636.
$b_j = a_i + b_j$:	396	636.
Sum N items:	204	372.
$c = c + a_i b_j$:	1,404	1,680.

.423 Branch based on comparison
Numeric data (10 digits): . . . . . 450.
Alphabetic data (5 characters): . . . . . 450.
.424 Switching
Unchecked: . . . . . 156.
Checked: . . . . . 300.
List search: . . . . . 144 + 228N.
.425 Format control per character
Unpack: . . . . . 23.
Compose: . . . . . 120 (**).
.426 Table look up per comparison
For a match: . . . . . 108.
For least or greatest: 114.
For interpolation point: . . . . . 108.
.427 Bit indicators
Set bit in separate location: . . . . . 84.
Set bit in pattern: . . impractical.
Test bit in separate location: . . . . . 72.
Test bit in pattern: . . impractical.
Test AND for B bits: . impractical.
Test OR for B bits: . . impractical.
.428 Moving
1 digit: . . . . . 84.
1 word: . . . . . 72.
N words: . . . . . 36 + 24N + 36R, where R is the number of record definition words.

* Round these times to next higher multiple of 12.

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	alarm; stop or set indicator.
Underflow:	check	alarm & indicator.
Zero divisor:	causes overflow.	
Invalid data:	fixed count check	stop & alarm.
Invalid operation:	check	stop & alarm.
Arithmetic error:	none.	
Invalid address:	check	stop & alarm.
Receipt of data:	fixed count check	stop & alarm.
Dispatch of data:	fixed count check	stop & alarm.
Field overflow: ‡	check	alarm; stop or set indicator.
Sign change: ‡	check	alarm; stop or set indicator.

‡ Can occur only when storing a field-defined portion of a word.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . Console.
7150
C.

.12 Associated Units: . . . . Console Typewriter (CT) stands upon console desk.

.13 Description:

The 7150 Console is included in every 7070 series system. It consists of a desk holding an operating panel, an operating keyboard, and a typewriter keyboard. The two keyboards are built into the console typewriter, which stands on the left side of the desk. The typewriter is described in Section 403:082.

The operating panel is mounted vertically to the right of the typewriter. It contains power keys and lights, alteration switches, unit-record priority and address stop controls, and a variety of error and condition lights. The operating keyboard contains the controls most frequently used for program testing and operation. No console lights are provided for the display of register or core storage contents; these displays are provided by the console typewriter. Contents of the program register and instruction counter are typed automatically whenever the stored program stops.

In addition to the 7150 Console, each 7070 series system contains a Customer Engineering Console, which is used primarily by IBM Customer Engineers for diagnostic testing and preventive maintenance. This unit consists of four separate panels: Unit Record, Arithmetic-and-Programming and Storage, Disk Storage and Inquiry, and Magnetic Tape. While the numerous register displays, condition lights, and error alarms in the Customer Engineering Console can be useful in debugging and in determining the exact causes of error halts, only the controls and displays in the main 7150 Console are described in this section.

.2 CONTROLS

.21 Power

Name	Form	Function
Emergency Off:	pull switch	disconnects all power.
Power On:	button	provides full operating power.
Power Off:	button	turns off system.
DC Off:	button	disconnects DC power during short idle periods.

.22 Connections

Name	Form	Function
Priority Controls:	4 dials	assign unit record priorities A and B to specific card readers, punches, or printers.

.23 Stops and Restarts

Name	Form	Function
Start:	button	starts stored program.
Stop:	button	stops program upon completion of current instruction, and types contents of instruction counter and program register.

.24 Stepping

Name	Form	Function
Single Cycle:	button	causes execution of one instruction each time start button is de pressed.
Run:	button	selects normal mode for continuous runing.

.25 Resets

Name	Form	Function
Reset:	button	resets error-detecting circuits.
Program Reset:	button	resets certain program controls and registers.
Computer Reset	button	resets all program controls and registers.
Type Reset:	button	stops typing operation in progress and causes typing of instruction counter and program register contents.

.26 Loading: . . . . . none.

.27 Sense Switches

Name	Form	Function
Alteration:	4 buttons	set indicators which can be tested by stored program.

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.28 Special

Name	Form	Function
Accumulator Overflow:	3 buttons	determine whether accumulator overflows will stop computer.
Exponent Overflow:	button	as above, for floating point operations.
Address Stop:	button and 4 dials	cause stored program to halt whenever the selected address is encountered for either data or an instruction.
Inquiry Only:	button	permits processing of inquiries during periods when the computer is idle.
Display:	button	causes typewriter display of an alphameric word in 10-digit core storage notation.
Alter:	button	permits manual alteration of a word just displayed on typewriter.
Store:	button	stores typed data in core storage.
Log:	button	permits normal typing on the console typewriter.

.3 DISPLAY

.31 Alarms: . . . . . 6 check lights indicate error conditions caused by incorrect programming, operation, control-panel wiring, or machine malfunction.

.32 Conditions: . . . . . 3 mode lights indicate mode in which computer is operating: normal, priority, or inquiry only.
6 status lights show when the accumulator overflow, field overflow, exponent overflow, and sign change indicators are turned on.
7 operating lights indicate which peripheral device, if any, is operating, the status of stored program execution, and, if the stored program has stopped, whether the next instruction is to come from the instruction counter or from the address in the instruction.

.33 Control Registers: . . . contents of instruction counter and program register are typed automatically on console typewriter whenever execution of the stored program stops for routine causes and when certain error conditions occur. The contents of these registers may also be displayed under operator control by the method described in .34.

.34 Storage: . . . . . typing of a 4-digit address causes automatic console typewriter display of contents of the addressed location in the appropriate mode (numeric or alphameric).

.4 ENTRY OF DATA

.41 Into Control Registers

(1) Type 4-digit address on console typewriter, resulting in display of contents of desired register.
(2) Press Alter button.
(3) Type sign and 10 digits (always numeric mode).
(4) Press Store button.

.42 Into Storage: . . . . . same as Control Registers.

.5 CONVENIENCES

.51 Communications: . . . . none.

.52 Clock: . . . . . manual interrogation of optional Interval Timer causes typed display of its contents.

.53 Desk Space: . . . . . adequate free work space in front of operating panel.

.54 View: . . . . . designed for operation by person seated at console desk; unobstructed view in all directions.

INPUT-OUTPUT: CARD READER

§ 071.

.1 GENERAL

.11 Identity: . . . . . Card Reader.
7500.
CR.

.12 Description

The 7500 Card Reader reads standard 80-column cards at a peak speed of 500 cards per minute. Up to three readers may be connected to a system, and all three can operate simultaneously. Input format is controlled by plugboard wiring. Formats may be varied by manual Alteration Switches or by control information punched into the cards. A 16-word input synchronizer serves as a buffer. The scatter-read feature permits data from a single card to be distributed into several different areas of core storage by a single instruction. Translation from card column code to either the numeric or alphameric internal code is automatic; the plugboard wiring determines which internal code will be generated for each card field. Although there are three separate reading stations, read compare checks can be made only on alphameric data. All data is checked for character validity (two-out-of-five bit coding) as it is transferred from the input synchronizer into core storage.

.13 Availability: . . . . . no longer in production; furnished "as available".

.14 First Delivery: . . . . March, 1960 (**).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading (control).
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . reading (control or pre-reading of alphameric data).
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.24 Arrangement of Heads (contd.)

Use of station: . . . . . reading (data entry).
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . column code as in Data Code Table No. 3.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Control.
7600 Model 1.

Input/Output Synchronizer.
7603 Models 1 through 9.

.42 Connection to System

.421 On-line: . . . . . one 7600 and one 7603 (both are required).
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: maximum of 3.
.432 Restrictions: . . . . . appropriate 7603 model must be used.

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§ 071.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . processing is inhibited during data transfer from input synchronizer to core storage.
.445 Table control: . . . . . yes; scatter-read, controlled by record definition words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . one card.
.512 Block demarcation Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . transfer 1 to 16 words from input synchronizer to core storage, then read next card into synchronizer.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . indefinite number; selected by 4 manual Alteration Switches or by control data punched in card.
Rearrangement: . . . . yes.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert zeros: . . . . . yes.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Offset card: . . . . . yes.
Select stacker: . . . . . no.
Select format: . . . . . very limited.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: no.
Hopper empty: . . . . . yes.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 500 cards/minute.
.622 Important parameters
Clutch cycle: . . . . . 120 m. sec.
.623 Overhead: . . . . . 4 clutch points (**).
.624 Effective speeds: . . . 500 cards/min. if processing time per card does not exceed 114 m. sec.

.63 Demands on System

Component	m. sec per card	Percentage
Arithmetic and Program Control:	6.0 max.	5.0 max.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Reset:	button	turns off error alarms.
Alteration:	4 two-way switches	select formats.
End-of-File:	button	permits processing of last cards in file.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,000 cards (**).
Stacker:	1,000 cards (**).

.732 Replenishment time: . . 0.25 to 0.50 mins. reader does not need to be stopped.
.734 Optimum reloading period: . . . . . 2.0 mins (**).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	read compare (alphabetic data only)	alarm; optional stop or offset.
Input area overflow:	none.	
Invalid code:	validity check	alarm; optional stop or offset.
Exhausted medium:	check	branch to end-of-file routine; stop reader.
Imperfect medium:	none.	
Timing conflicts:	clocking check	alarm; stop reader.
Inconsistent plugboard wiring:	ring check	alarm; stop reader.
Misfeed:	card advance check	alarm; stop reader.
Burned out fuse:	check	alarm; stop reader.
Transfer to storage:	validity check	repeat data transfer; if still invalid, branch to error routine.

INPUT-OUTPUT: CARD PUNCH

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Punch.
7550.
CP.

.12 Description

The 7550 Card Punch punches standard 80-column cards at a peak speed of 250 cards per minute. Output format is controlled by plugboard wiring, and formats can be selected by manual Alteration Switches or by control words in the stored program. A 16-word output synchronizer serves as a buffer. The gather-write feature permits data from several different areas of core storage to be punched into one card by a single instruction.

Translation from either numeric or alphameric internal code to the card column code is automatic. Data is checked for character validity (two-out-of-five bit coding) as it is transferred from core storage to the output synchronizer. Under control of the plugboard wiring, numeric data can be checked for double punches and blank columns, and cards can be offset in the stacker.

.13 Availability: . . . . . no longer in production; furnished "as available".

.14 First Delivery: . . . . March, 1960 (**).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punch.
.222 Sensing system: . . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . punching.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . column code as in Data Code Table No. 3.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Control.
7600 Model 1.

Input/Output Synchronizer.
7603 Models 1 through 9.

.42 Connection to System

.421 On-line: . . . . . one 7600 and one 7603 (both are required).
.422 Off-line: . . . . . punch can be used for independent gang punching.

.43 Connection to Device

.431 Devices per controller: maximum of 3.
.432 Restrictions: . . . . . total number of 7400 Printers and 7550 Card Punches may not exceed 3; appropriate 7603 model must be used.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).

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.444 Input-output area lockout: . . . . . processing is inhibited during data transfer from core storage to output synchronizer.
.445 Table control: . . . . . yes; gather-write, controlled by record definition words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . one card.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . transfer 1 to 16 words from core storage to output synchronizer and punch 1 card.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . indefinite number; selected by 4 manual Alteration Switches or by control word (word 1 in output synchronizer).
Rearrangement: . . . . yes.
Suppress zeros: . . . . no.
Insert point: . . . . . yes.
Insert space: . . . . . yes.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Offset card: . . . . . yes.
Select stacker: . . . . . no.
Select format: . . . . . yes.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: no.
Hopper empty: . . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 250 cards/minute.
.622 Important parameters Clutch cycle: . . . . . 240 m.sec.
.623 Overhead: . . . . . 4 clutch points.
.624 Effective speeds: . . . 250 cards/min. if processing time per card does not exceed 234 m.sec.

.63 Demands on System

Component	m.sec per card	Percentage
Arithmetic and Program Control:	6.0 max.	2.5 max.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Method	Comment
Reset:	button	turns off error alarms.
Alteration:	4 two-way switches	select formats.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,000 cards (**).
Stacker:	1,000 cards (**).

.732 Replenishment time: . . 0.25 to 0.50 mins. punch does not need to be stopped.
.734 Optimum reloading period: . . . . . 4.0 mins (**).

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	double-punch and blank column checks	alarm; optional stop or offset.
Output block size:	ring check	alarm; stop punch
Invalid code:	validity check	alarm; optional stop or offset.
Exhausted medium:	check	alarm; stop punch.
Imperfect medium:	none.	
Timing conflicts:	clocking check	alarm; stop punch.
Transfer to synchronizer:	validity check	branch to error routine.
Misfeed:	card advance check	alarm; stop punch.

INPUT-OUTPUT: CONSOLE CARD READER

§ 073.

.1 GENERAL

.11 Identity: . . . . . Console Card Reader. 7501. CCR.

.12 Description

The Console Card Reader is intended for low-cost direct card input, on an exception basis, into a tape-oriented 7070 series system. Using a card feeding, transporting, and stacking mechanism similar to the 24 and 26 Keypunches, the 7501 achieves a peak speed of 60 cards per minute. Data is read from the card one column at a time, converted to internal numeric code, transferred to a one-word synchronizer register in the 7601 Arithmetic and Program Control, and then sent to the designated core storage location. Only the digits 0 through 9 and the plus, minus, and alpha signs are recognized. Each alphameric character must therefore be entered in the form of the appropriate two-digit numeric code as shown in Data Code Table No. 2. Field length is fixed at 10 columns per word, and no columns within a word may be left blank. The sign is represented by a zone punch over the units column of each word. No internal processing can be done while data is being read from a card.

.13 Availability: . . . . . 12 to 15 months (**).

.14 First Delivery: . . . . . ?

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . photo-electric.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 12.
Method of use: . . . . . 1 column at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 80 columns at standard spacing.
.322 Parallel by: . . . . . 12 rows at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . column code as in Data Code Table No. 3; accepts only the numerals 0-9 and special characters +, -, and alpha.

..34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards (numeric data only):	not required.

.35 Physical Dimensions: standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Control. 7600 Model 1 or 2.

.42 Connection to System

.421 On-line: . . . . . one 7600, connected to Arithmetic and Program Control.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card; 1 to 8 fields of 10 digits each.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . processing is inhibited until data transfer from reader is completed.
.445 Table control: . . . . . yes; scatter-read, controlled by record definition words.
.446 Synchronization: . . . . automatic.

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§ 073.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . one card.
.512 Block demarcation
Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . one card forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . . automatic.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Offset card: . . . . . no.
Select stacker: . . . . . no.
Select format: . . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks . no.
Hopper empty: . . . . yes
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 60 cards/minute.
.622 Important parameters
Clutch cycle: . . . . . 1.0 second.
.623 Overhead: . . . . . one clutch point.

.63 Demands on System

Component	m. sec per card	Percentage
Arithmetic and Program Control:	1,000	100

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Feed Reset:	button	feeds or releases a card; turns off error and end-of-file alarms.
End-of-File:	button	allows processing of last cards in file.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	500 cards.
Stacker:	500 cards.

.732 Replenishment time: . . 0.5 to 1.0 mins. reader needs to be stopped.
.734 Optimum reloading period: . . . . . 8.3 mins.

.8 ERRORS, CHECK AND ACTION

Error	Check or Interlock	Action
Reading:	none.	
Input area overflow:	none.	
Invalid code:	double punch and blank column checks	branch to error routine.
Exhausted medium:	check	branch to end-of-file routine; stop reader.
Imperfect medium:	none.	
Timing conflicts:	none.	
Stacker full:	check	alarm; stop reader.
Misfeed:	card advance check	alarm; stop reader.
Incomplete word:	check	branch to error routine.

INPUT-OUTPUT: PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer.
7400.
PR.

.12 Description

The 7400 Printer uses the same basic printing mechanism as the 407 Accounting Machine. The 7400 prints at a peak speed of 150 lines per minute by means of a bank of 120 print wheels mounted side by side. Each print wheel contains 47 different characters, including 11 special symbols which are available in ten different sets. All format control is provided by plugboard wiring. The stored program cannot directly control the output format nor test the printer for busy or error conditions.

Data to be printed is transmitted from core storage to a 16-word output synchronizer. The system's gather-write feature permits data from several areas of core storage to be assembled and printed on one line by a single instruction. The first word transferred to the output synchronizer can be a control word that selects the wired format features to be used on a particular line. A maximum of 80 data characters may be printed on one line. An optional printing technique called "unloading" bypasses the plugboard format and prints the first eight words and their signs from the output synchronizer in print positions 1 through 95.

.13 Availability: . . . . . no longer in production; furnished "as available".

.14 First Delivery: . . . . March, 1960 (**).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive push and pull, paper punched on both sides; or pressure rolls.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . bank of 120 individual print wheels.
.222 Sensing system: . . . . none.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . 6.
.232 Types of master
Multilith: . . . . . no.
Xerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 120.
Method of use: . . . . . one line at a time.

.25 Range of Symbols

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	11	+.□-$*,%/+-
Alternatives:		9 other arrangements of special characters.
FORTRAN set:		character set F.
Req. COBOL set: . . .		no.
Total:	47 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold sprocket punched stationery, single sheets, or roll paper.
.312 Phenomenon: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 per inch.
.322 Parallel by: . . . . . 120 print positions at 10 per inch.
.324 Track use
Data: . . . . . 80 maximum.
Unused: . . . . . 40 minimum.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 4.75 to 16.75 inches by vernier.
.352 Length
at 6 lines/inch: . . . . up to 22.0 inches by 1/6 inch.
at 8 lines/inch: . . . . up to 16.5 inches by 1/8 inch.
.353 Maximum margins
Left: . . . . . 4.375 inch.
Right: . . . . . 4.375 inch.

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Control.
7600 Model 1.

Input/Output Synchronizer.
7603 Models 1 through 9.

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§ 081.

.42 Connection to System

.421 On-line: . . . . . one 7600 and one 7603 (both are required).
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: maximum of 3.
.432 Restrictions: . . . . . total of Printers and Card Punches may not exceed 3; appropriate 7603 model must be used.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 line, containing a maximum of 80 characters from the 16 words in the output synchronizer.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . processing is inhibited during data transfer from core storage to output synchronizer.
.445 Table control: . . . . . yes; gather-write, controlled by record definition words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 120 print positions per line.
.512 Block demarcation Output: . . . . . plugboard wiring.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . transfer 1 to 16 core storage words to output synchronizer, fill remaining synchronizer words with blanks, and print 1 line forward.
.523 Stepping: . . . . . single, double, and triple spacing and space suppression controlled by plugboard wiring.
.524 Skipping: . . . . . skip to one of 10 channels on paper tape loop, before or after printing, controlled by plugboard wiring.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . indefinite number; selected by 4 manual Alteration Switches or by control information in first word in output synchronizer.
Rearrangement: . . . . yes.
Suppress zeros: . . . . yes.
Insert point: . . . . . yes.
Insert spaces: . . . . . yes.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Select format: . . . . . yes.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: no.
Exhausted: . . . . . no.
Punch in carriage control tape: . . . . . yes; channel 9 only.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 150 lines/min.
.622 Important parameters
Print 1 line: . . . . . 400 m.sec.
.624 Effective speeds: . . . 150 lines/minute if processing time does not exceed 394 m.sec; peak speed is maintained for skips between lines of up to 2 inches.

.63 Demands on System

Component	m.sec per line	Percentage
Arithmetic and Program Control:	6.0 max	1.5 max.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	platen and vernier knobs.	
Horizontal alignment:	tractor adjustment wheels.	
Form width:	sliding forms tractors.	
Form thickness:	dial	varies distance between printwheels and platen.
Line spacing:	movable shift cam	6 or 8 lines/inch.

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.72 Other Controls

Function	Form	Comment
Carriage restore:	button	sets carriage at channel 1 position.
Space:	button	advances form 1 space.
Reset:	button	turns off error alarms.
Form stop:	switch	causes stop when forms are exhausted.
Carriage stop:	button	stops undesired skipping.
Platen clutch:	2-position knob	disengages platen for manual adjustment.
Alteration:	4 two-way switches	select formats.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	24-inch stack (**).
Stacker:	6-inch stack (**).

.732 Replenishment time: . . 2 to 3 mins. printer needs to be stopped.

.733 Adjustment time: . . . 3 to 5 mins.

.734 Optimum reloading period: . . . . . 290 minutes (**).
Basis: . . . . . 2-part forms, 22 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Output block size:	ring check	alarm; stop printer.
Invalid code:	validity check	alarm; optional stop.
Exhausted medium:	end-of-form check	optional alarm & stop.
Imperfect medium:	none.	
Timing conflicts:	clocking check	alarm; stop printer.
Burned out fuse:	check	alarm; stop printer.
Transfer to synchronizer:	validity check	branch to error routine; no printing.

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INPUT-OUTPUT: CONSOLE TYPEWRITER

§ 082.

.1 GENERAL

.11 Identity: . . . . . Console Typewriter. Part of 7150 Console. CT.

.12 Description:

The Console Typewriter is a modified IBM electric typewriter which stands upon the console desk. It performs the following functions:

1. Types output data under control of the stored program.
2. Automatically displays the contents of the instruction counter and program register when the stored program stops.
3. Displays and alters content of a core storage word or addressable register under operator control.
4. Performs manual typing independently of the rest of the 7070 system.

.13 Availability: . . . . . 12 to 15 months (**).

.14 First Delivery . . . . . March, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pin feed platen - paper punched both sides.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved hammers.
.222 Sensing system: . . . . typewriter keyboard.
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number: . . . depends on stationery.
.232 Types of master
Multilith: . . . . . no.
Xerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . one character at a time.

Use of station: . . . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . . 44 keys.
Method of use: . . . . . one character at a time.

.25 Range of Symbols

Numerals:	10	0 - 9
Letters:	26	A - Z
Special:	8	+ -) . / * $ #
Alternatives:		none.
FORTRAN set:		no.
Req. COBOL set:		no.
Total:	44 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon
Input: . . . . . key depression.
Output: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use
Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 8.875 inches.
.352 Length: . . . . . no limit.

.4 CONTROLLER

.41 Identity: . . . . . Input/Output Control. 7600 Model 1 or 2.

.42 Connection to System

.421 On-line: one 7600, connected to Arithmetic and Program Control.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load
Input: . . . . . 1 word.
Output: . . . . . limited only by capacity of core storage.

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.442 Input-output areas: . . . core storage or a control register.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . processing is inhibited during data transfers between core storage and synchronizer register.
.445 Table control: . . . . . yes, for output.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block
Input: . . . . . 1 word.
Output: . . . . . 1 word to capacity of core storage, defined by record-definition words.
.512 Block demarcation
Input: . . . . . fixed - 1 word.
Output: . . . . . record-definition word.

.52 Input-Output Operations

.521 Input: . . . . . load 1 manually typed word into selected register or core storage location.
.522 Output: . . . . . type 1 block forward; data is transferred from core storage to typewriter via arithmetic register and synchronizer register.
.523 Stepping: . . . . . steps 1 or 2 lines at end of each printout operation.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic; alphameric input data must be typed as two numeric digits per character.

.54 Format Control: . . . . fixed format; automatic carriage return after each line.

.55 Control Operations

Disable: . . . . . no.
Request interrupt . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: . no.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 10 char/second for output; manual typing speed for input (**).
.624 Effective speeds: . . . same as peak speeds, less allowance for carriage returns.

.63 Demands on System

Component	m.sec per char,	or Percentage
Arithmetic and Program Control:	100	100.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . typical typewriter adjustments.

.72 Other Controls: . . . . . refer to Console section.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	validity check	type bit representation of invalid character.
Input:	validity check	alarm.
Input area overflow:	word length check	print asterisk; data is not stored.
Output block size:	none.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Transfer to synchronizer:	validity check	branch to error routine.
Alphameric input:	check	keyboard locks if non-numeric key is pressed.

INPUT-OUTPUT: 729 MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit.
729 II, IV, V, VI.
MT.

.12 Description:

These tape units are used in the IBM 1401, 1410, 7040, 7080, and 7090 series systems as well as in the 7070 and 7074. In tape width, density and format, they are compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are summarized in the following table:

Model	Tape speed, inches/sec.	Density, char/inch	Transfer rate, char/sec.
II	75.0	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75.0	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

Up to ten tape units can be connected to each of four channels in a 7070 system, and up to four tape operations can be performed simultaneously with internal processing. The maximum number of tape channels is reduced to two if 1301 Disk Storage is installed and/or if the 800 characters-per-inch type density is to be used. Different models of the 729 can be intermixed on the same channel.

The 7070's scatter-read and gather-write capabilities make it possible to distribute sub-blocks of a block of data read from tape into various portions of core storage under the control of record definition words in the stored program. Similarly, data from different sections of core storage can be assembled into one block on tape.

The optional record-mark control mode provides additional flexibility and facilitates the handling of variable-length records. Detection of a record mark in a data word signals the end of a sub-block, and control is transferred to the next sequential record definition word.

.12 Description (Cont'd.)

Since a 7070 word may consist of either ten numeric digits plus sign or five alphameric characters, a mode change character, Δ, is automatically recorded on the tape whenever the data mode changes from alphameric to numeric or vice versa. When the tape is read, the mode change characters insure that each word will be translated back into the proper internal form. When recording in the numeric mode, up to five high-order zeros in each word can be eliminated and not recorded on the tape; they are filled in automatically when the tape is read.

Every tape instruction that might cause a priority signal when it is completed automatically creates an initial status word in a fixed core storage location; a final status word is generated at the end of each read or write operation. The status words are used by the priority routine to determine the specific cause of the priority signal. At the programmer's option, priority interruptions may occur at the end of every tape operation or only when error conditions are detected by the numerous checking circuits.

Because the internal data structures of the IBM 7070 and 1401 systems are different, certain precautions must be observed to insure tape compatibility between the two systems. The 7070 mode change and segment mark characters have no special significance to the 1401; they will be read into its core storage just as any other characters. When preparing tape for the 7070, however, the 1401 must insert the mode change character between alphameric and numeric sections of data. The 1401's word separator character, =, has no significance to the 7070 and should not be used in preparing tapes for it. The optional Compressed Tape Feature enables the 1401 to process tapes written by a 7070 in the zero elimination mode.

Optional Feature

Tape Switching Feature: modifies a tape unit so that it can be logically switched between two tape channels, two computers, or a computer and an off-line auxiliary unit under operator control. The 7155 Switch Control Console is also required.

.13 Availability: . . . . . 12 to 15 months (**).

.14 First Delivery

729 II: . . . . . March, 1960.
729 IV: . . . . . March, 1960
729 V: . . . . . May, 1962
729 VI: . . . . . May, 1962

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.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head:. . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or (Models V and VI) 800 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Trach use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0 (record and segment marks are optional).
Unused: . . . . . 0.
Inter-block gap: . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 4.

.34 Format Compatibility

Other device or system	Code translation
IBM 7330, 727 Tape units:	not required.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Tape Control.
7604 Models 1, 2, 3.
TC.

.42 Connection to System

.421 On-line
Model 1 has two channels and handles 200 and 556 char/inch only.
Model 2 has one channel and handles 200 and 556 char/inch only.
Model 3 has two channels and handles 200, 556, and 800 char/inch.
The following combinations are possible:

	Number of Tape Channels	First 7604 Model No.	Second 7604 Model No.
Without 7907:	1	2	-
	2	1 or 3	-
	3	1	2
	4	1	1
With 7907 Model 1:	1	2	-
	2	1 or 3	-
With 7907 Model 2:	1	2	-
	2	1	-

Note: 7907 Data Channel is required for 1301 Disk Storage Units and/or 1414 Input/Output Synchronizer.

.422 Off-line . . . . . may be switched to another channel, another computer, or an off-line auxiliary unit by means of the optional 7830 Tape Switching Feature and 7155 Switch Control Console.

.43 Connection to Device

.431 Devices per controller: up to six 729 IIs, IVs, Vs, and VIs, in any combination, per tape channel (up to 10 per channel with Additional Tape Attachment, 7835, 7836, 7837 or 7838).
.432 Restrictions: . . . . . 729 Vs and VIs at 800 char/inch can be connected only to 7604 Model 3.

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.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words from (or into) different areas of core storage, as specified by record definition words.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . yes; scatter-read and gather-write, controlled by record definition words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words, limited by available core storage (blocks less than 3 words long are normally treated as noise).
.512 Block demarcation
Input: . . . . . gap on tape or negative record definition word in core storage.
Output: . . . . . negative record definition word.

.52 Input-Output Operations

.521 Input: . . . . . read one block forward into core storage locations specified by record definition word(s); record mark control is optional.
.522 Output: . . . . . write one block forward from core storage locations specified by record definition word(s); record mark control is optional.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1) one block backward (backspace).
2) 4 inches forward (to skip and erase defective tape areas).
3) N segments forward or backward (N is specified in record definition word; a segment is the data between two segment marks on the tape).
.525 Marking: . . . . . inter-block gap, segment mark (SM), tape mark (TM), and mode change (Δ).
.526 Searching: . . . . . none.

.53 Code Translation: . . . . automatic, between tape codes in Data Code Table No. 4 and internal numeric or alphameric modes (Δ on tape signifies mode change).

.54 Format Control

Control: . . . . . program.
Format alternatives: . . undefined.
Rearrangement: . . . . yes; scatter-read and gather-write.
Suppress zeros: . . . . yes; up to 5 per numeric word.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . yes.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes; priority signal.
Select format: . . . . . yes, normal, all alphameric, zero suppression, or record mark control.
Select code: . . . . . no.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . no.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: . yes; 14 feet from physical end.
End of segment: . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

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.621 Nominal or peak speed

Model II: . . . . . 15,000 or 41,667 char/sec.
Model IV: . . . . . 22,500 or 62,500 char/sec.
Model V: . . . . . 15,000, 41,667 or 60,000 char/sec.
Model VI: . . . . . 22,500, 62,500 or 90,000 char/sec.

.622 Important parameters

Name	Value
Density	
Models II & IV:	200 or 556 char/inch.
Models V & VI:	200, 556 or 800 char/inch.
Tape speed	
Models II & V:	75.0 inches/sec.
Models IV & VI:	112.5 inches/sec.
Start time	
Models II & V	
read:	10.5 m.sec.
write:	7.5 m.sec.
Models IV & VI	
read:	6.7 m.sec.
write:	5.0 m.sec.
Stop time	
Models II & V	
read:	2.1 m.sec.
write:	5.1 m.sec.
Models IV & VI	
read:	2.1 m.sec.
write:	3.8 m.sec.
Full rewind time	
Models II & V:	1.2 min.
Models IV & VI:	0.9 min.
Inter-block gap:	0.75 inch.

.623 Overhead

Models II & V: . . . . 12.6 m.sec/block.
Models IV & VI: . . . . 8.8 m.sec/block.

.624 Effective speeds

Models II & V
200 char/inch: . . . . 15,000N/(N + 189) char/sec.
556 char/inch: . . . . 41,667N/(N + 525) char/sec.
Models IV & VI
200 char/inch: . . . . 22,500N/(N + 198) char/sec.
556 char/inch: . . . . 62,500N/(N + 550) char/sec.
Model V
800 char/inch: . . . . 60,000N/(N + 756) char/sec.
Model VI
800 char/inch: . . . . 90,000N/(N + 792) char/sec.
where N = char/block
(See graphs.)

.63 Demands on System

Component	Condition	m.sec per block	or	Percentage of transfer time
Core Storage:	Models II & V			
	200 char/inch	0 + 0.0012N		1.8
	556 char/inch	0 + 0.0012N		5.0
	Models IV & VI			
	200 char/inch	0 + 0.0012N		2.8
	556 char/inch	0 + 0.0012N		7.6
	Model V			
	800 char/inch	0 + 0.0012N		7.2
	Model VI			
	800 char/inch	0 + 0.0012N		10.8

where N = char/block

Note: These demands are based upon alphameric mode; they will be half the size in numeric mode when there is no zero elimination.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (Models V and VI only).

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	button	lowers tape into reservoirs and rewinds tape to load point.
Unload:	button	removes tape from reservoirs and raises upper portion of head assembly.
File protection:	ring on reel	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	2,400 feet; for 1,000-char blocks, 5,000,000 chars at 200-char/inch, 11,300,000 chars at 556-char/inch, or 14,400,000 chars at 800 char/inch.

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.732 Replenishment time: . . 1.0 to 1.5 mins. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . . 6 mins.
Models IV & VI: . . . 4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write with lateral parity check	priority signal.
Reading:	lateral & longitudinal parity	priority signal.
Input block size:	compare working & stop addresses when gap is reached	priority signal.
Output block size:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium	reflective spot or tape mark	priority signal.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Recording level:	signal strength check	priority signal.
Word length:	check	priority signal.
Misplaced Δ character:	check	priority signal.
Code translation:	2-out-of-5 bit check	priority signal.

Note: "Priority signal" indicates that digit position 1 of the final status word is set to a particular condition code, and control is transferred to a tape priority routine which takes the appropriate action.

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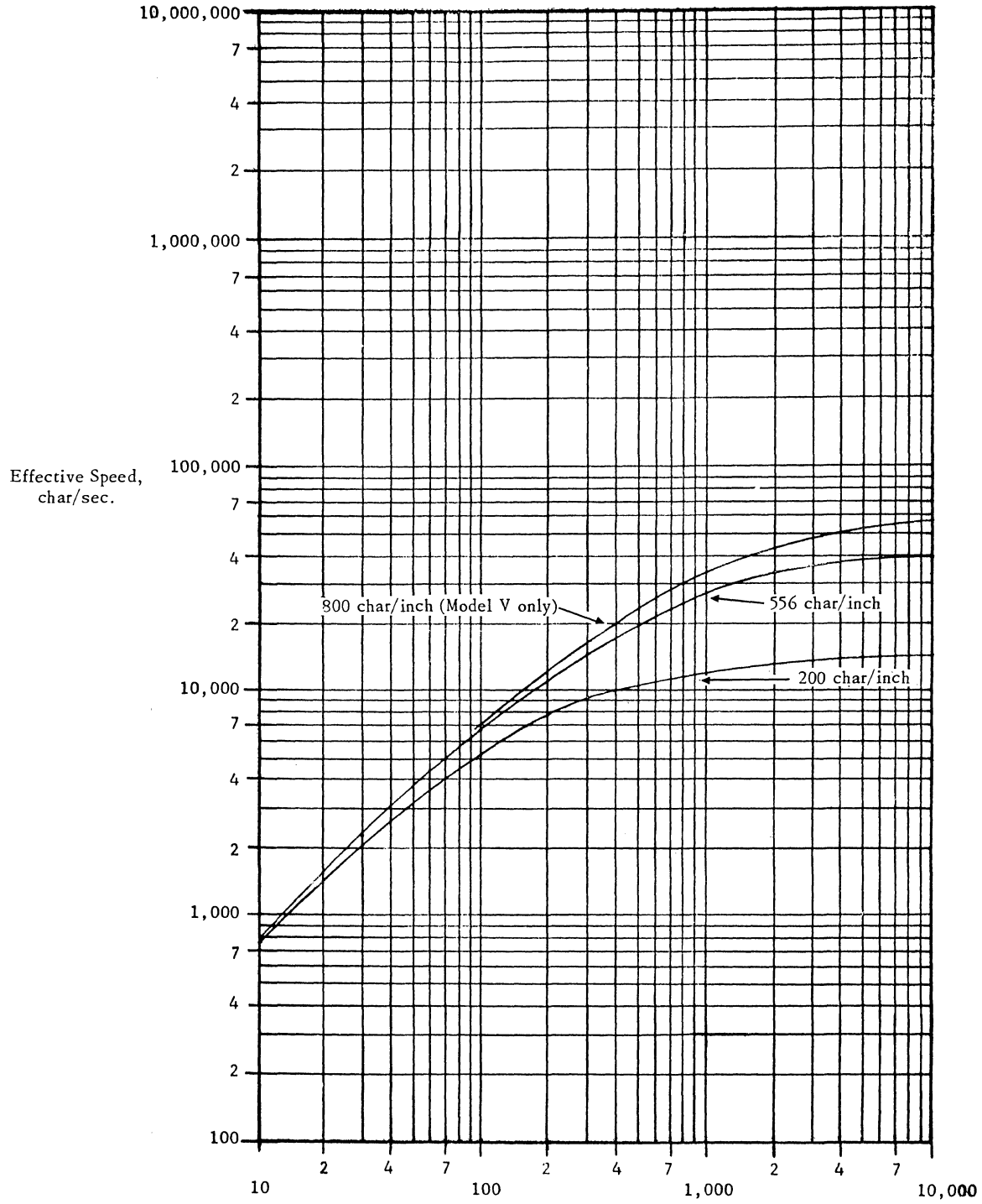
EFFECTIVE SPEED
IBM 729 II & 729 V



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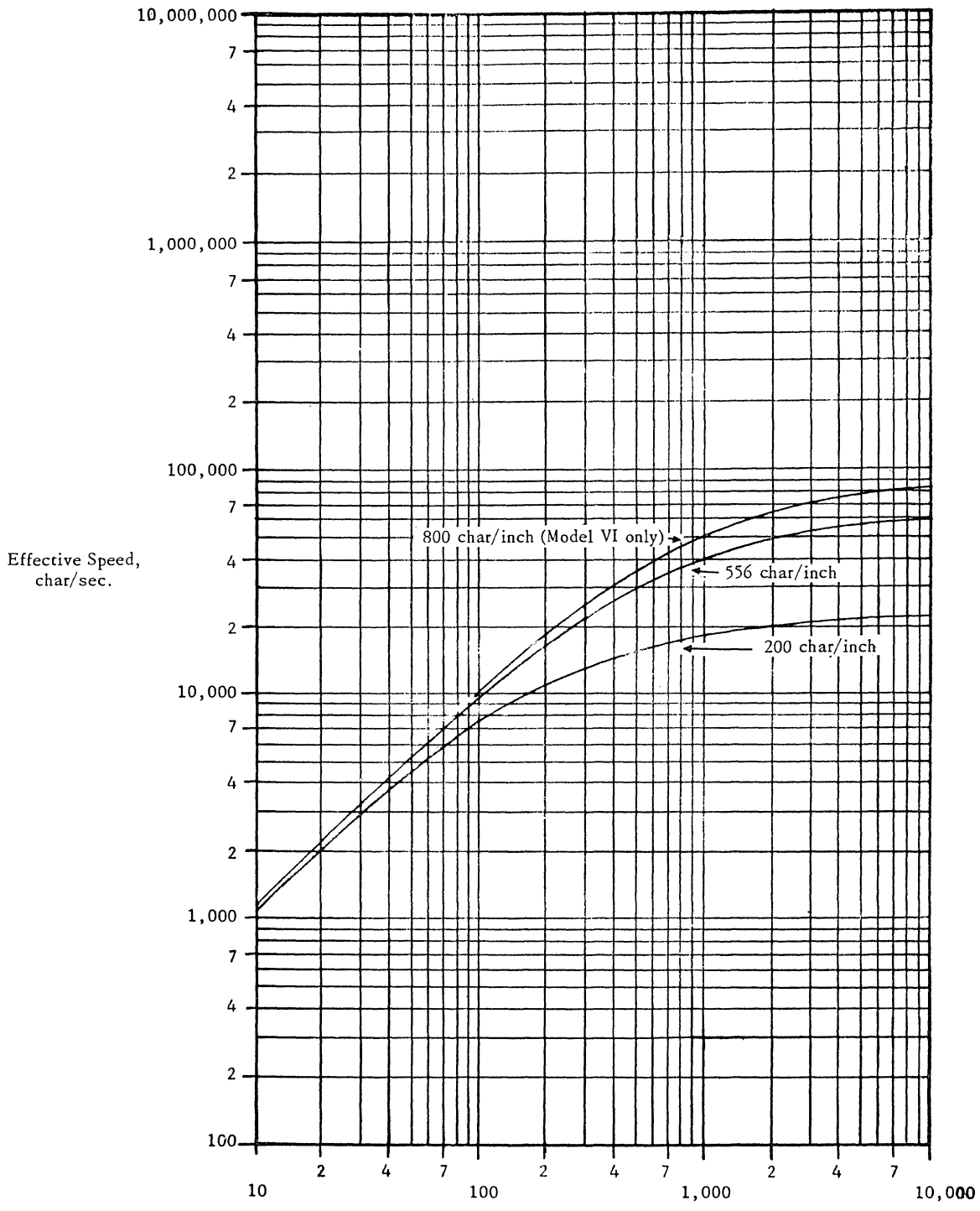
EFFECTIVE SPEED
IBM 729 IV & 729 VI



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INPUT-OUTPUT: INQUIRY STATION

§ 101.

.1 GENERAL

.11 Identity: . . . . . Inquiry Station.
7900 Model 1.
IS.

.12 Description:

The 7900 Inquiry Station is a modified IBM Model B electric typewriter with control circuits and indicator lights mounted on a 48- by 30-inch desk. It is used for interrogating and printing replies from a 7070 system. Up to five Inquiry Stations can be connected to each of two Inquiry Control Synchronizers on the 7600 Input/Output Control. Only one station at a time can be operative on each synchronizer. Maximum cable length is 2,500 feet.

Each synchronizer has a capacity of 10 words. Because the first word in each message must be a control word, maximum data length is 90 digits or 45 alphameric characters per message. The control word designates which of the stations is originating or receiving the message and which of three message formats on a punched tape loop is to be used. Lengths and formats of all inquiries and replies are preset by the tape loop and the stored program. Control words for inquiries are automatically supplied by the tape loop.

An inquiry can be typed whenever no other Inquiry Station on the same synchronizer is in use. Each character enters the synchronizer position designated by the tape loop as it is typed. When the typing is completed and the Release button is pressed, the 7070 receives a priority signal and branches to a subroutine which processes the inquiry. The reply message and its control word are transferred from core storage to the synchronizer, and the reply is typed by the selected Inquiry Station. Then, by means of the "priority release" instruction, the 7070 returns to the main routine at the point where the interruption occurred. Internal processing is inhibited only during the data transfers between the synchronizers and core storage.

.13 Availability: . . . . . 12 to 15 months (**).

.14 First Delivery: . . . . . March, 1960 (**).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . platen friction (pin-feed platen is optional).
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved hammers.
.222 Sensing system: . . . . typewriter keyboard.
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number: . . . depends on stationery.
.232 Types of master
Multilith: . . . . . yes.
Xerox . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . one character at a time.

Use of station: . . . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . . 44 keys.
Method of use: . . . . . one character at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	8	& . - $ * , # /
Alternatives:		none.
FORTRAN set:		no.
Req. COBOL set:		no.
Total:	44 plus space.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon
Input: . . . . . key depression.
Output: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use: . . . . . 104 print positions for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: . none.

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§ 101.

.35 Physical Dimensions

.351 Overall width: . . . . . 11 inches (15 inches with optional carriage).
.352 Length: . . . . . no limit.

.4 CONTROLLER

.41 Identity: . . . . . Inquiry Control Synchronizer. 4671 and 4672. (attached to 7600 Input/Output Control).

.42 Connection to System

.421 On-line: . . . . . 2; first is No. 4671, second is No. 4672.
.422 Off-line: . . . . . manual typing.

.43 Connection to Device

.431 Devices per controller: . 5 per Inquiry Control Synchronizer.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to 9 words plus control word.
.442 Input-output areas: . . . core storage.
.443 Input-Output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . processing is inhibited during data transfers between core storage and synchronizers.
.445 Table control: . . . . . yes; scatter-read and gather-write, controlled by record definition words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . maximum of 90 digits or 45 alphameric characters.
.512 Block demarcation
Input: . . . . . record definition words or limit counter.
Output: . . . . . record definition words or limit counter.

.52 Input-Output Operations

.521 Input: . . . . . transfer one block of manually typed data from synchronizer to core storage.
.522 Output: . . . . . transfer one block from core storage to synchronizer, then to Inquiry Station.
.523 Stepping: . . . . . step variable number of columns, tab stops, or lines, according to punches in control tape.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . punched tape.
Format alternatives: . . 3.
Rearrangement: . . . . yes.
Suppress zeros: . . . . yes.
Insert point: . . . . . no.
Section sizes: . . . . . yes.
Insert spaces: . . . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes; initiate priority signal.
Select format: . . . . . yes, in control word.
Select code: . . . . . no.
Select inquiry unit: . . . yes, in control word.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . . no.
Busy controller: . . . . no.
End of medium marks: . no.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed
Input: . . . . . manual typing speed.
Output: . . . . . 10 char/sec.
.624 Effective speeds: . . . . same as peak speeds, less allowance for carriage returns.

§ 101.

.63 Demands on System

Component	Condition	m. sec per block	or	Percentage
Arithmetic and Program Control:	input	3.0 average		variable.
	output	17.5 average		variable.
Inquiry Control Synchronizer:	input	9,000 maximum		100.
	output	9,000 maximum		100.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . typical typewriter adjustments.

.72 Other Controls

Function	Form	Comment
Format selection:	3 buttons	selects one of the three formats on control tape.
Request:	button	signals synchronizer that a request is to be made.
Release:	button	initiates 7070 priority signal at end of an inquiry.
Cancel:	button	terminates inquiry without a reply.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	none.	
Input area overflow:	check	alarm
Output block size:	automatic cut-off.	
Invalid code:	2-out-of-5 bit check	alarm on input;branch to error routine on output.
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Illegal format or station number:	check	branch to error routine.
Typing error:	check	alarm; depress Cancel key and re-type.

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INPUT-OUTPUT: 1414 SYNCHRONIZER

§ 102.

.1 GENERAL

.11 Identity: . . . . . Input-Output Synchronizer. 1414 Model 6. I-OS.

.12 Description

The 1414 Model 6 Input/Output Synchronizer is used to control a variety of communications devices in a 7070 or 7074 system. It contains six 80-character buffers. Each buffer can be equipped with the appropriate adapter and assigned to the input or output line of a specific device. The 1414 Input/Output Synchronizer is in turn connected to one channel of a 7907 Data Channel on the 7070 or 7074 system. A single data channel can be shared by the 1414 and a 7631 File Control through the use of the #3224 Data Channel Switch. Two 1414s (one per data channel) can be connected to a system.

Delays in executing the stored program are minimized during communications device input-output operations. A "channel select" instruction selects the I/O channel and sends the address of the first of a series of channel commands to the 7907 Data Channel; the 7907 then assumes control of the input-output operation while the central processor continues executing the stored program. Channel commands may be of the read, write, control, or sense type. A read or write command initiates the transfer of a block of up to 80 characters between a buffer in the 1414 and core storage. A control command transmits an order to the 1414 which selects the desired communications device. A sense command transmits a 10-digit word into core storage which indicates the status of the selected device. The powerful priority interrupt facilities of the 7070 series are utilized to service the communications devices.

Data transfer between the 1414 and the 7907 Data Channel requires 11 microseconds per character. Transfer rates between the 1414 and the communications devices connected to it depend upon the individual devices; these are described below.

.121 Data Transmission Unit, 1009 Model 1: This device enables the 7070 or 7074 system to transmit and receive data over telephone or telegraph lines at speeds of 75, 150, 250, or 300 characters per second. The unit at the other end of the line can be a similarly equipped IBM 7000 or 1400 series system, a 7701 or 7702 Magnetic Tape Transmission Terminal, or a 1013 Card Transmission Terminal. The 1009 uses two of the six buffers in a 1414 Synchronizer and requires the #3238 Data Transmission Unit Adapter. One buffer is loaded while the other is unloaded, so messages of variable length can be processed. (See also Section 402:101).

.122 Paper Tape Reader, 1011 Model 1: This unit reads data from punched paper tape at a speed of 500 rows per second. From five to eight tracks can be read. The tape can be either chad or chadless and in the form of strips, reels, or center-feed rolls. The 1011 uses one of the six buffers in a 1414 Synchronizer and requires the #5514 Paper Tape Reader Adapter. Block length is limited to 80 characters. (See also Section 402:071).

.123 Remote Inquiry Unit, 1014 Model 1: This unit consists of a modified electric typewriter with control circuits and indicator lights, mounted on a 29- by 24-inch table. It is used for interrogating and printing replies from a 7070 or 7074 system, and may be located up to eight miles away. Message length is limited to 78 characters. Up to ten Inquiry Units can be connected to a #6136 Remote Inquiry Adapter, and one or two adapters can be connected to a 1414 Synchronizer. Each adapter requires two of the six buffers. (See also Section 402:102.)

.124 Telegraph Input-Output, #7864: This adapter permits direct connection of a telegraph transmitter and receiver to a 7070 or 7074 system. Maximum data transmission rate is about ten characters per second, and the data portion of a message should not exceed 80 characters in length. The #7864 adapter controls one telegraph input unit and one output unit; each unit requires one buffer in the 1414 Synchronizer. A total of up to four telegraph units can be connected to the 1414 through the addition of the #7871 Telegraph Input and/or the #7875 Telegraph Output, which control one unit each.

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS: . . . . none.

.12 Description

A major feature of the 7070 is the flexibility and simultaneity of its input-output operations. Up to four magnetic tape channels can be attached, and a read or write operation on each channel can occur simultaneously with internal processing. (If 1301 Disk Storage and/or the 800 character-per-inch tape density are used, the maximum number of tape channels is reduced to two.) Magnetic tape and disc storage have direct access to core storage through their respective controllers. Execution of the stored program is delayed for one 6-microsecond cycle each time a word is transferred between core storage and the tape or disc storage controller.

In systems using unit record input-output, up to three 7500 Card Readers and three output devices (printers and/or card punches) can operate simultaneously. They are buffered by means of a magnetic drum revolving at 12, 375 revolutions per minute in the 7600 Model 1 Input/Output Control. The stored program is delayed from one to six milliseconds each time a load of data (one card or one line) is transferred between a unit record buffer and core storage.

Console Card Reader and Console Typewriter operations are unbuffered and cannot occur simultaneously with other operations.

Effective utilization of the 7070's capabilities for simultaneous operations is facilitated by the "Priority Processing" feature, which can interrupt the stored program and transfer control to priority routines upon completion of selected input-output or auxiliary storage operations.

.2 CONFIGURATION CONDITIONS: . . . . none.

.3 CLASSES OF OPERATIONS

Class	Member
A:	read card on Console Card Reader.
B:	read card on 7500 Card Reader.
C:	punch card.
D:	print or advance forms on 7400 Printer.
E:	read or write on magnetic tape.
F:	rewind magnetic tape.
G:	read or write in disc storage.
H:	seek record in disc storage.
I:	input or output on Console Typewriter.
J:	input or output on Inquiry Station.
K:	input or output on devices attached to 1414 Input/Output Synchronizer.
P:	internal processing.

.4 RULES

a + i + p = at most 1.
b. = at most 3.
c + d = at most 3.
e = at most T.
e + f = at most 10T.
g = at most 2.
g + h = at most 10 (for 1301 Disk Storage).
g + h = at most 12 (for 7300 Disk Storage).
e + g = at most 4.
j = at most 2.
k = at most 12 (6 per 1414 Synchronizer).

where T = number of magnetic tape channels (T is at most 4; when 1301 Disk Storage is used, T is at most 2).

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§ 121. INSTRUCTION LIST

INSTRUCTION					OPERATION
Op.	Index	Control	Address	Mnemonic Op.	
					Arithmetic
+n4	X	FD	Y	An	(An) + (Y) ⟶ An.
-n4	X	FD	Y	Sn	(An) - (Y) ⟶ An.
+53	X	FD	Y	M	(A3) x (Y) ⟶ A1 & A2
-53	X	FD	Y	D	(A1 & A2) ÷ (Y) ⟶ A2; remainder ⟶ A1.
+17	X	FD	Y	AA	(A1) + | (Y) | ⟶ A1.
-17	X	FD	Y	SA	(A1) - | (Y) | ⟶ A1.
+n8	X	FD	Y	AS	(Y) + (An) ⟶ Y.
-n8	X	FD	Y	SS	(Y) - (An) ⟶ Y.
+n9	X	FD	Y	AAS	| (Y) | + (An) ⟶ Y.
					Floating Point Arithmetic (Optional FDA)‡
+75	X	-	Y	FZA	(Y) ⟶ A1, normalized.
+74	X	-	Y	FA	(A1) + (Y) ⟶ A1 & A2, normalized.
-74	X	-	Y	FS	(A1) - (Y) ⟶ A1 & A2, normalized.
+76	X	-	Y	FAD	(A1 & A2) + (Y) ⟶ A1 & A2, normalized.
-76	X	-	Y	FADS	(A1 & A2) + (Y) ⟶ A1 & A2, not normalized.
+77	X	-	Y	FAA	(A1) + | (Y) | ⟶ A1 & A2, normalized.
-77	X	-	Y	FSA	(A1) - | (Y) | ⟶ A1 & A2, normalized.
+71	-	-	-	FR	Round off (A1).
+73	X	-	Y	FM	(Y) x (A1) ⟶ A1 & A2, normalized.
-73	X	-	Y	FD	(A1) ÷ (Y) ⟶ A1; remainder ⟶ A2.
-75	X	-	Y	FDD	(A1 & A2) ÷ (Y) ⟶ A1; remainder ⟶ A2.
					‡ standard on 7072.
					Logic: Shifting
+50	X	-	nOK	SRn	Shift (An) K places right (K≤10).
+50	X	-	n1K	SRRn	Shift (An) K places right and round.
+50	X	-	n2K	SLn	Shift (An) K places left.
+50	X	J	n300	SLCn	Shift (An) left and count positions shifted; stop on non-zero digit and place count in index word J.
-50	X	-	00K	SR	Shift (A1 & A2) K places right (K≤20).
-50	X	-	01K	SRR	Shift (A1 & A2) K places right and round.
-50	X	-	02K	SL	Shift (A1 & A2) K places left.
-50	X	J	0300	SLC	Shift (A1 & A2) left and count as in SLCn.
-50	X	-	P4K	SRS	Shift (A1 & A2) K places right from position P in A1.
-50	X	-	P5K	SLS	Shift (A1) K places left from position P in A1.
-50	X	-	P6K	SRS	Shift (A2) K places right from position P in A2.
-50	X	-	P7K	SLS	Shift (A1 & A2) K places left from position P in A2.
					Logic: Indexing
+45	X	J	Y	XL	(Y) ⟶ J; J is any of the 99 index words.
-45	X	J	Y	XU	(J) ⟶ Y.
-48	X	J	Y	XLIN	(Y) ⟶ J, with positions 2-5 and 6-9 interchanged.
+46	X	J	L	XZA	L ⟶ J_{2-5}; L is a 4-digit literal.
-46	X	J	L	XZS	L ⟶ J_{2-5}; sign of J is set to minus.
+47	X	J	L	XA	(J_{2-5}) + L ⟶ J_{2-5}.
-47	X	J	L	XS	(J_{2-5}) - L ⟶ J_{2-5}.
+48	X	J	L	XSN	L ⟶ J_{6-9}; loads non-indexing portion.

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§ 121. INSTRUCTION LIST–Contd.

INSTRUCTION					OPERATION
Op.	Index	Control	Address	Mnemonic Op.	
					Logic: Indexing (Cont'd.)
-44	X	J	Y	BXM	Branch to Y if sign of J is minus.
+44	X	J	Y	BXN	Branch to Y if (J_{2-5}) is non-zero.
-43	X	J	Y	BCX	Branch to Y if $(J_{2-5}) \leq (J_{6-9})$.
+49	X	J	Y	BIX	$(J_{2-5}) + 1 \longrightarrow J_{2-5}$; then branch to Y if $(J_{2-5}) \leq (J_{6-9})$.
-49	X	J	Y	BDX	$(J_{2-5}) - (J_{6-9}) \longrightarrow (J_{2-5})$; then branch to Y unless result is 0 or a sign change.
					Logic: Comparisons
+n5	X	FD	Y	Cn	Compare (An) with (Y); turn on high, low, or equal indicator and turn off the other two.
-15	X	FD	Y	CA	Compare | (A1) | With | (Y) |; proceed as above.
+03	X	dp	Y	CD	Compare (digit position p of Y) with the digit d; proceed as in Cn.
-03	X	30	Y	CSA	Compare sign of Y to alpha; proceed as in Cn.
-03	X	60	Y	CSM	Compare sign of Y to minus; proceed as in Cn.
-03	X	90	Y	CSP	Compare sign of Y to plus; proceed as in Cn.
					Logic: Branching
+01	X	-	Y	B	Branch unconditionally to Y.
+02	X	J	Y	BLX	Store (instruction counter) in J_{2-5} and branch to Y.
+n0	X	-	Y	BZn	Branch to Y if (An) = 0.
-n0	X	-	Y	BMn	Branch to Y if sign of An is minus.
+51	X	s0	Y	BAS	Branch to Y if alteration switch s is ON (s = 1, 2, 3, or 4).
+51	X	n1	Y	BCB	Branch to Y if tape/disc channel n is busy (n = 1, 2, 3, or 4).
+6e	X	es	Y	BES	Branch to Y if electronic switch es is ON ($11 \leq$ es ≤ 39).
+40	X	-	Y	BL	Branch to Y if low indicator is ON.
-40	X	-	Y	BH	Branch to Y if high indicator is ON.
-41	X	-	Y	BE	Branch to Y if equal indicator is ON.
+n1	X	-	Y	BVn	Branch to Y if An overflow indicator is ON.
+41	X	00	Y	BFV	Branch to Y if field overflow indicator is ON.
-03	X	04	Y	BSC	Branch to Y if sign change indicator is ON.
+00	X	-	Y	HB	Halt; type (instruction counter) and (program register) and branch to Y when Start Key is pressed.
					Logic: Table Look-up
					Table location is defined by list of RDWs beginning at Y; search argument must be in A3. If search is successful, place found value in A3 and its address in positions 2-5 of index word 98 and skip next instruction.
+66	X	FD	Y	LL	Search for lowest value.
+67	X	FD	Y	LE	Search for table value equal to (A3).
+68	X	FD	Y	LEH	Search for table value equal to or greater than (A3).
					Logic: Priority Processing
+60	X	c	Y	BcL	Branch to Y if stacking latch c is ON.
-61	X	c	Y	cLN	Turn on stacking latch c.
-62	X	c	Y	cLF	Turn off stacking latch c.
+55	X	00	Y	PC	Prevent certain stacking latches from causing interruption, according to mask word in Y.
+64	X	-	Y	PR	Release priority and re-enter main program at Y.
+64	X	-	0097	PR	Release priority and resume main program at point where it was interrupted.

§ 121. INSTRUCTION LIST–Contd.

INSTRUCTION					OPERATION
Op.	Index	Control	Address	Mnemonic Op.	
					Logic: Miscellaneous
-00	X	-	-	HP	Halt; type (instruction counter) and (program register).
-01	X	-	-	NOP	No operation.
+41	X	01	-	SMFV	Set field-overflow sense/stop switch to SENSE.
+41	X	02	-	HMFV	Set field-overflow sense/stop switch to HALT.
-03	X	02	-	SMSC	Set sign-change sense/stop switch to SENSE.
-03	X	03	-	HMSC	Set sign-change sense/stop switch to HALT.
-03	X	31	Y	MSA	Make sign of Y alpha.
-03	X	61	Y	MSM	Make sign of Y minus.
-03	X	91	Y	MSP	Make sign of Y plus.
					Data Transfer
+n3	X	FD	Y	ZAn	0 → An, then (Y) → An.
-n3	X	FD	Y	ZSn	0 → An, then -(Y) → An.
+16	X	FD	Y	ZAA	0 → A1, then | (Y) | → A1.
-16	X	FD	Y	ZSA	0 → A1, then - | (Y) | → A1.
-n1	X	FD	Y	ZSTn	0 → Y, then (An) → Y.
+n2	X	FD	Y	STn	(An) → Y; digits outside field-defined portion are unchanged.
-n2	X	FD	Y	STDn	(An) → Y; same as STn, except sign of An is ignored.
					In the following block transfer operations, a list of record definition words (RDWs) starting at Y defines the initial and final addresses of each of the smaller blocks; starting address of the larger block is in index word J.
+65	X	J	Y	RS	Scatter 1 block of data into several smaller blocks.
-65	X	J	Y	RG	Gather several blocks of data into 1 larger block.
+56	X	J	Y	ENA	Same as RS, except each numeric word is converted to 2 alphameric words during the transfer.
-56	X	J	Y	ENS	Same as ENA, except low-order character of each alpha word indicates sign of the numeric word.
+57	X	J	Y	ENB	Same as ENA, except leading zeros are converted to blanks.
-57	X	J	Y	EAN	Same as RG, except each pair of alphameric words is converted to 1 numeric word.
					Internal Storage: 7300 Disk Storage
±9n	X	00	Y	(P)DR	Read one record on channel n into core storage under control of RDWs starting at Y.*
±9n	X	01	Y	(P)DW	Write one record on channel n from core storage under control of RDWs starting at Y.*
+95	X	-	Y	PDS	Branch to Y if access arm is not available; otherwise seek disc record whose address is in A3, and send priority signal upon completion.
-95	X	-	--nm	DAR	Release access arm nm for another seek operation.
					*Priority signal occurs upon completion if sign of instruction is +.
					Internal Storage: 1301 Disk Storage
±93	X	1F	Y	(P)DCS	Select I/O channel 1 and transmit channel command at Y to file control; F = 1 for packed data or 6 for unpacked data.*
±94	X	1F	Y	(P)DCS	Same as above, except channel 2 is selected.*

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§ 121. INSTRUCTION LIST–Contd.

INSTRUCTION					OPERATION
Op.	Index	Control	Address	Mnemonic Op.	
					Channel commands for the 1301 are as follows (minus sign denotes last command in a series):
±40	U	V	-		Perform control operation defined by word in core storage location UV (seek, set mode, prepare to verify, etc.)
±10	U	V	Y		Read from disc storage into core storage locations UV through Y.
±20	U	V	Y		Write into disc storage from core storage locations UV through Y.
±50	U	V	Y		Transmit "sense" information concerning error and attention conditions from file control to core storage locations UV through Y.
+60	-	-	Y		Branch to next channel command in location Y. * Priority signal occurs upon completion if sign of instruction is +.
					Input-Output: Cards and Printer
+69	-	n0	-	US	Turn on the program switch exit associated with input synchronizer n.
+69	X	n1	Y	UR	Transfer up to 16 words from input synchronizer n to core storage under control of record definition word(s), the first of which is in Y; then read a card.
+69	X	n2	Y	UP, UW	Transfer up to 16 words to output synchronizer n from core storage under control of record definition word(s), the first of which is in Y; perform a punch/write cycle even if transfer is invalid.
+69	X	n4	Y	TYP	Transfer up to 10 words from core storage to output synchronizer under control of record definition word(s), the first of which is in Y; type data from synchronizer; return carriage.
					Input-Output: Magnetic Tape (729 and 7330 only)
					Note: Priority signal occurs upon completion if sign of instruction is + (mnemonic op. code preceded by P).
±8n	X	m1	Y	(P)TR	Read a block from tape unit nm into core storage under control of RDWs, the first of which is in Y.
±8n	X	m2	Y	(P)TRR	Read a block from tape unit nm into core storage under control of RDWs, the first of which is in Y. Record mark on tape causes next RDW to be used if present one is "+" or termination of data movement if "-".
±8n	X	m3	Y	(P)TW	Write a block onto tape unit nm from core storage under control of RDWs, the first of which is in Y.
±8n	X	m4	Y	(P)TWR	Write a block onto tape unit nm from core storage under control of RDWs, the first of which is in Y. The detection of a record mark in storage causes new block definition word to be read if present one is "+" or terminates data movement if "-".
±8n	X	m5	Y	(P)TWZ	Write a block onto tape unit nm from core storage under control of RDWs, the first of which is in Y. High-order insignificant zeroes in numerical words, up to 5 per word, are not written on tape.
±8n	X	m6	Y	(P)TWC	Write a block onto tape unit nm from core storage under control of RDWs, the first of which is in Y. The detection of a record mark in storage causes new block definition word to be read if present one is "+" or terminates data movement if "-". High-order insignificant zeroes in numerical words, up to 5 per word, are not written on tape.

§ 121. INSTRUCTION LIST–Contd.

INSTRUCTION					OPERATION
Op.	Index	Control	Address	Mnemonic Op.	
					Input-Output: Magnetic Tape (729 and 7330 only) (Cont'd.)
±8n	X	m7	Y	(P)TSF	Move tape on unit nm forward a specified number of segments under control of RDW in Y.
±8n	X	m8	Y	(P)TSB	Move tape or unit nm backward a specified number of segments under control of RDW in Y.
±8n	X	m9	Y	(P)TRA	Read a block from tape unit nm into core storage under control of RDWs, the first of which is in Y; all tape characters are read in the alpha mode and become 2 characters in storage.
±8n	X	m0	-0	TSEL	Set up tape unit nm so that a BCB test will determine whether it is available to the stored program.
±8n	X	m0	-1	(P)TM	Write tape mark on tape unit nm.
±8n	X	m0	-2	TRW	Rewind tape unit nm.
±8n	X	m0	-3	TRU	Rewind and unload tape unit nm.
±8n	X	m0	-4	TRB	Backspace tape unit nm one block.
±8n	X	m0	-5	(P)TSM	Write segment mark on tape unit nm.
±8n	X	m0	-6	TSK	Skip forward and erase on tape unit nm.
±8n	X	m0	-7	TEF	Turn off End-of-File indicator for tape unit nm.
±8n	X	m0	-8	TSHD	Set tape unit nm to operate at high density (729 only).
±8n	X	m0	-9	TSLD	Set tape unit nm to operate at low density (729 only).
					Input-Output: Inquiry
+54	X	n0	Y	QR	Transfer 1 block of up to 10 words from inquiry synchronizer n to core storage under control of RDWs starting at Y.
+54	X	n1	Y	QW	Transfer 1 block of up to 10 words under control of RDWs starting at Y from core storage to inquiry synchronizer n, then to Inquiry Station.
					Input-Output: 7907 Data Channel
					NOTE: These instructions apply to Hypertape (7074 only) and all devices connected to the 7907 through the 1414 I/0 Synchronizer.
±9n	X	sF	Y	(P)DCS	Select I/O channel and transmit channel command at Y to 7907; n = 3, 4, 6, 7 for channel 1, 2, 3, 4; s denotes Channel Switch position 1 or 2; F denotes coding format; plus sign causes priority signal upon completion.
					Channel commands are as follows (minus sign denotes last command in a series):
+10	U	V	Y		Read data into core storage location UV through Y.
±20	U	V	Y		Read backward into core storage locations UV through Y, where UV > Y.
+30	U	V	Y		Write from core storage locations UV through Y.
±40	U	V	Y		Transfer order words from core storage locations UV through Y to Hypertape Control or I/0 Synchronizer to initiate control operation(s).
±50	U	V	Y		Transfer status word(s) from Hypertape Control or I/0 Synchronizer to core storage locations UV through Y.
±60	-	-	Y		Branch to next channel command in location Y.

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§ 121. INSTRUCTION LIST NOMENCLATURE

Symbol	Definition
An:	Accumulator n, where n = 1, 2, or 3.
(An):	Contents of Accumulator n.
| (An) |:	Absolute value of contents of Accumulator n.
c:	Stacking latch number.
d:	A digit used as a literal.
es:	Electronic Switch number.
F:	An integer denoting coding format to be used.
FD:	Field Definition may be used; control digits specify high and low-order digit positions of the field to be operated upon.
J:	Indexing Word number.
J_{2-5}:	Digit positions 2 through 5 of Indexing Word J.
K:	Length of a shift, in digit positions.
L:	A four-digit literal.
m:	An integer; usually the unit number of an input-output device.
n:	An integer; usually an I/O channel number.
p:	A specific digit position within a word.
P:	In mnemonic operation code, causes priority signal upon completion of the operation.
RDW:	Record Definition Word; defines the initial and final core storage addresses of a block of data.
s:	Alteration Switch number or Channel Switch position.
UV:	Core storage address specified by the combined Index and Control portions of an instruction.
X:	Number of Indexing Word to be used to modify Address portion; if not indexed, X = 00.
Y:	Address of a core storage location.

CODING SPECIMEN: AUTOCODER

§ 131.

.1 TRANSLATOR LISTING

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PAGE AA   PROGRAM          7070 COMPILER SYSTEM VERSION 00001, CHANGE LEVEL 00000.  PAGE AA

LN CDREF LABEL    OP     OPERAND                          CDNO FD  LOC  INSTRUCTION RI REF

01       ORIGIN   CNTRL  325
02 0001  *                I. B. M.  7070  SNAPSHOT PROGRAM
03 0002  *                 PROVIDE ORIGIN CONTROL CARD
04 0003           DC                                                    0003250325     0325
05 0004  CONST1          &6363657564                      0001 09  0325 &6363657564 00
06 0005  PH1ST    ZA3    10%0,5¤&X1                               0326 &3301050010 CC
07 0006           CSP    9993                                     0327 -0300909993 00
08 0007           BE     *&3                                      0328 -4100090331 01
09 0008           MSM    CCIN                                     0329 -0300610345 01
10 0009           MSM    PH1                              0002    0330 -0300610385 01
11 0010           ST3    PH1%0,5¤                                 0331 &3200050385 01
12 0011           ST3    CCIN%0,5¤                                0332 &3200050345 01
13 0012           ZA3    11%0,5¤&X1                               0333 &3301050011 00
14 0013           ST3    PH1%0,5¤&1                               0334 &3200050386 01
15 0014           ST3    CCIN%0,5¤&1                      0003    0335 &3200050346 01
16 0015           ZA3    *%2¤                                     0336 &3300220336 01      M
17 0016           STD3   PH1%3¤                                   0337 -3200330385 01
18 0017           STD3   CCIN%3¤                                  0338 -3200330345 01
19 0018           STD3   PH1%3¤&1                                 0339 -3200330386 01
20 0019           STD3   CCIN%3¤&1                        0004    0340 -3200330346 01
21 0020           XU     1,99                                     0341 -4500010099 00
22 0021           XZA    1,0                                      0342 &4600010000 CC
23 0022           XSN    1,16&X1                                  0343 &4801010016 00
24 0023           ZA3    CONST1                                   0344 &3300090325 01
25 0024  CCIN     UR     1,CCARD                          0005    0345 &6900110390 01
26 0025           HB     *                                        0346 &0000090346 01      M
27 0026           NOP    0                                        0347 -0100090000 00
28 0027           C3     CCARD&1    CK FOR END                    0348 &3500090391 01
29 0028           BE     PH1          YES                         0349 -4100090385 01
30 0029  ENSW     NOP    HLTA                             0006    0350 -0100090384 01
31 0030           ZA1    DL          SET UP FOR                   0351 &1300030391 01
32 0031           ZST1   2%2,5¤       DELETE                      0352 -1100250002 00
33 0032           ZST1   ENTRY1&X1   RETURN                       0353 -1101690499 01
34 0033           ZA1    0&X2       GET DP                       0354 &1302090000 CC
35 0034           ZST1   DP1&X1     TO TABLE              0007    0355 -1101090496 01
36 0035  ESTBR    ZA1    B1         GET BRANCH                   0356 &1300090399 01
37 0036           ZST1   0&X2       TO DP                        0357 -1102090000 00
38 0037           ZAA    CCARD&2                                 0358 &1600090392 01
39 0038           MSM    9991                                    0359 -0300619991 00
40 0039           CD     CCARD%0¤&2,3                     0008    0360 &0300300392 01
41 0040           BE     *&2                                     0361 -4100090363 01
42 0041           MSP    9991                                    0362 -0300919991 CC
43 0042           ZA2    *%2¤                                    0363 &2300220363 01      M
44 0043           CD     9991%5¤,5                               0364 &0300559991 00
45 0044           BL     *&2                              0009    0365 &4000090367 01
46 0045           ZA2    *%5¤-2                                  0366 &2300550364 01
47 0046           STD2   9991%5¤                                 0367 -2200559991 CC
48 0047           ZST1   M1&1&X1        LIMITS                   0368 -1101090498 01
49 0048           ZA1    MASK                                    0369 &1300090393 01
50 0049           ZST1   M1&X1                            0010    0370 -1101090497 01
51 0050           ZA1    BC                                      0371 &1300670391 01
52 0051           STD1   ACTR1&X1     EST.                       0372 -1201010498 01
53 0052           ZA1    AD          CTRS.FOR                    0373 &1300890391 01
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IBM

Program _____

Programmed by _____

Date _____

7070 AUTOCODER CODING SHEET

FORM X28-6417-2
PRINTED IN U.S.A.

Identification ____ (76 80)

Page No. __ (1 2) of _____

Line (3 5)	Label (6 15)	Operation (16 20)	OPERAND (21 25 30 35 40 45 50 55 60) Basic Autocoder →	Autocoder → (65 70 75)
01				
02				
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AUERBACH / BNA

CODING SPECIMEN: COBOL

§ 132.

.1 SOURCE PROGRAM LISTING

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004130 PROCEDURE DIVISION.                                              PROB 13
004140 HOUSEKEEPING SECTION.                                            PROB 13
004150 HK. OPEN INPUT MASTER-FILE TRANSACTION-FILE OUTPUT OUTPUT-FILE    PROB 13
004160      ORDERS-CANCELLED-FILE ERROR-OUT.                            PROB 13
004170 BEGIN. READ MASTER-FILE AT END GO TO CLOSEM. GO TO SWITCH-OFF     PROB 13
004180      DEPENDING ON SKIPIT. READ TRANSACTION-FILE AT END GO TO      PROB 13
004190      CLOSET.                                                     PROB 13
004191 PRE-TEST. IF CANCEL-ORDER GO TO TEST-AGAIN.                       PROB 13
005010 CMP. IF ADDITIONAL-QTY AND MOD-ORD-NO EQUAL TO TMOD-ORD-NO NEXT   PROB 13
005020      SENTENCE ELSE GO TO TEST. ADD NEW-QTY TO QUANTITY.          PROB 13
005030 OUT. WRITE MASTER-OUTPUT FROM MASTER. GO TO BEGIN.                PROB 13
005040 TEST. IF QTY-CANCELLED AND MOD-ORD-NO EQUAL TO TMOD-ORD-NO NEX    PROB 13
005050-     T SENTENCE ELSE GO TO TEST-AGAIN. SUBTRACT NEW-QTY FROM     PROB 13
005060      QUANTITY. IF QUANTITY IS NEGATIVE NEXT SENTENCE ELSE GO TO   PROB 13
005070      OUT.                                                        PROB 13
005080 CANCEL-IT. WRITE CANCEL-RECORD FROM MASTER GO TO BEGIN.           PROB 13
005090 TEST-AGAIN. IF CANCEL-ORDER AND MOD-ORD-NO EQUAL TO TMOD-ORD-NO2  PROB 13
005100      GO TO CANCEL-IT. IF TMOD-ORD-NO2 IS GREATER THAN MOD-ORD-    PROB 13
005110-     NO MOVE 1 TO SKIPIT GO TO OUT ELSE WRITE ER-OR FROM MASTER   PROB 13
005120      GO TO BEGIN.                                                PROB 13
005130 SWITCH-OFF. MOVE ZERO TO SKIPIT GO TO CMP.                        PROB 13
005140 WR. WRITE MASTER-OUTPUT FROM MASTER READ MASTER-FILE GO TO WR.    PROB 13
005150 CLOSET. CLOSE TRANSACTION-FILE ORDERS-CANCELLED-FILE ERROR-OUT.   PROB 13
005160      GO TO WR.                                                   PROB 13
005170 CLOSEM. CLOSE MASTER-FILE OUTPUT-FILE. STOP RUN.                  PROB 13
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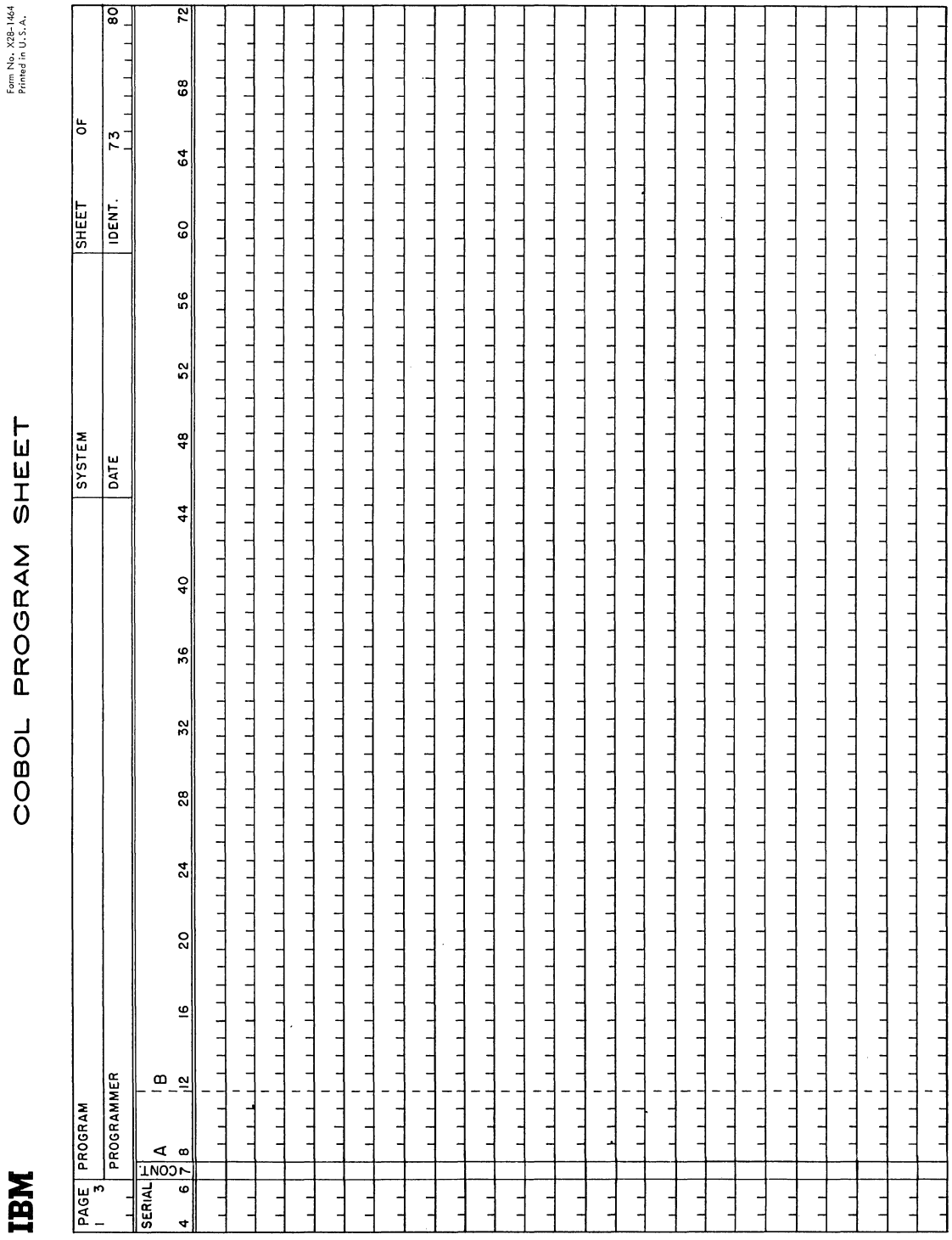
§ 132.

.2 CODING SHEET



AUERBACH / BNA

CODING SPECIMEN: FORTRAN

§ 133.

.1 SOURCE PROGRAM LISTING

0250971 PAGE

SEQ	STMNT	FORTRAN STATEMENT
	C	APPENDIX E SAMPLE PROBLEM 1
	C	MATRIX ARITHMETIC
1		DIMENSION A(7,7),VECTOR(7),B(7,7)
2		SENSE LIGHT 1
3		DO 1 I=1,7
4		DO 1 J=1,7
5		B(I,J)=1./FLOATF(I+J-1)
6	1	A(I,J)=B(I,J)
7		PRINT 13
8	13	FORMAT(25H1GENERATED HILBERT MATRIX//)
9		PRINT 2,A
10	2	FORMAT(1X,7E14.7)
11		PRINT 15
12	15	FORMAT(8HOINVERSE//)
13	10	DO 6 K=1,7
14		VECTOR=1.
15		DO 3 I=2,7
16	3	VECTOR(I)=0.
17		DO 4 J=2,8
18	4	A(I,J)=A(I,J)/A
19		DO 5 I=1,55
20	5	A(I) =A(I+1)
21		DO 6 I=1,6
22		A(56) =A(I,1)
23		DO 6 J=1,7
24	6	A(I,J)=A(I,J+1)-A(56)*A(7,J)
25		PRINT 2,A
26		IF(SENSE LIGHT 1)11,12
27	11	PRINT 16
28	16	FORMAT(15HOMATRIX PRODUCT//)
29		DO 9 K=1,7
30		DO 8 I=1,7
31		VECTOR(I)=0.
32		DO 8 J=1,7
33	8	VECTOR(I)=VECTOR(I)+A(I,J)*B(J,K)
34	9	PRINT 18,VECTOR
35	18	FORMAT(1X,7F14.8)
36		PRINT 17
37	17	FORMAT(15HOTWICE INVERTED//)
38		GO TO 10
39	12	PRINT 7
40	7	FORMAT(1H1)
41		STOP 111
42		END

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IBM

FORTRAN CODING FORM

Form X28-7327-3
Printed in U.S.A.

Program _____
Coded By _____
Checked By _____

Date _____
Page _____ of _____

Identification
73 80

C FOR COMMENT

STATEMENT NUMBER 1 5	Cont. 6	FORTRAN STATEMENT 7 10 15 20 25 30 35 40 45 50 55 60 65 70 72

AUERBACH / BNA

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . internal numeric data and 7300 Disk Storage Unit.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 5 bits per digit.

.22 Character Structure: . two-out-of-five fixed-count code; bit coding as in table below.

.23 Character Codes

DIGIT VALUE	BIT CODE					SIGN VALUE
	0	1	2	3	6	
0	0	1	1	0	0	
1	1	1	0	0	0	
2	1	0	1	0	0	
3	1	0	0	1	0	ALPHA
4	0	1	0	1	0	
5	0	0	1	1	0	
6	1	0	0	0	1	MINUS
7	0	1	0	0	1	
8	0	0	1	0	1	
9	0	0	0	1	1	PLUS

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . internal alphameric data.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 2 digits per character.

.22 Character Structure

.221 More significant pattern: . . . . . 1 digit, coded as in Table No. 1.

.222 Less significant pattern: 1 digit, coded as in Table No. 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN									
	0	1	2	3	4	5	6	7	8	9
0	blank		& or +	-			+ 0	- 0	RM	0
1				/			A	J		1
2							B	K	S	2
3							C	L	T	3
4							D	M	U	4
5		.	$	,	# or =		E	N	V	5
6		¤ or)	*	% or (	@ or '		F	O	W	6
7							G	P	X	7
8							H	Q	Y	8
9		GM		SM	TM		I	R	Z	9

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . punched card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	blank	& or +	-	
12				
11		α		
0	0	$\overset{+}{0}$	$\overset{-}{0}$	
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2				RM ǂ
8-3			$	
8-4	@ or '	⌑ or)	*	% or (
8-5				
8-6				
8-7	TM	GM ǂ	Δ	SM

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DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . magnetic tape and 1301 Disk Storage.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 7 bits; 6 data, 1 even parity.

.22 Character Structure

.221 More significant pattern: . . . . . 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: . . . . . 4 numeric bits; 8, 4, 2, 1.

23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0		blank	-	& or +
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	RM	$\bar{0}$	$\dot{0}$
11	# or =	,	$	.
12	@ or '	% or (	*	⌑ or)
13				
14				
15	TM	SM	Δ	GM

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PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers

IBM 650

Reference: . . . . . IBM Publication C28-6090.
Date available: . . . . October, 1960.
Description:

This routine enables a 7070 (or 7074) system to simulate all standard IBM 650 configurations except those using the 4,000-word drum store or inquiry stations. In general, the configuration of the 7070 system must be the same as the 650 system being simulated. To permit operation of the simulator on a tape oriented 7070, magnetic tape units can be substituted for the unit record input and output devices on the 650. Control panel operations on the 650 can be simulated by control panel wiring on the 7070 unit record devices or by the off-line tape transcription equipment; e.g., by the stored program of an IBM 1401 system. Console controls on the 650 are simulated partly by control cards and partly by the 7070 console switch settings.

The simulation is performed interpretively. Most simulated routines will be executed by the 7070 at from one to three times their speeds on the 650; the major variable is degree of optimization of the original 650 routine.

.12 Simulation by Other Computers

IBM 704

Reference: . . . . . IBM Publication J28-6042.
Date available: . . . . April, 1959.
Description:

This routine was designed for pre-installation testing of IBM 7070 routines on an IBM 704 system. The 704 must have 32,768 words of core storage, card reader, printer, and three magnetic tape units plus one more for each 7070 tape unit to be simulated. Disc storage and inquiry operations are not simulated. Results and debugging data are written on magnetic tape for off-line listing; the on-line printer simulates the 7070 console typewriter.

Execution of a 7070 routine is performed interpretively on the 704 and requires about 40 times as long as on the 7070.

.13 Data Sorting and Merging

IBM 7070/7074 Sort 90

Reference: . . . . . IBM Publication C28-6111.
Record size: . . . . . variable; 999 words maximum.
Block size: . . . . . variable; 999 words maximum.
Key size: . . . . . pre-set; up to 160 digits in up to 10 separate fields.
File size: . . . . . N-1 reels, where N is the merge order.
Number of tapes: . . . 4 to 12 units, on 1 or 2 channels.
Date available: . . . . third quarter, 1960.
Description:

Sort 90 is a generalized routine which modifies itself in accordance with parameters entered on control cards. Phase I reads the input file, performs an internal sort, and generates a series of sequenced strings. Phase II performs a series of two-, three-, four-, or five-way merges. Phase III performs the final merge pass and writes the sorted output file.

Sort 90 can be run on an IBM 7070 or 7074 system with 5,000 or 9,990 words of core storage, and the user can control the amount of storage made available to it. Checkpoints are written at the beginning of each merge pass. Record types, labels, checkpoints, restarts, and error procedures are the same as in the 7070 Input/Output Control System. Provisions have been made for user modifications and additions to Sort 90.

IBM 7070/7074 Merge 91.

Reference: . . . . . IBM Publication C28-6115.
Record size: . . . . . variable; 999 words maximum.
Block size: . . . . . variable; 999 words maximum.
Key size: . . . . . pre-set; up to 160 digits in up to 10 separate fields.
File size: . . . . . unlimited.
Number of tapes: . . . 1 (for sequence checking) to 20, on 1 or 2 channels.
Date available: . . . . third quarter, 1960.
Description:

Merge 91 is a generalized single-pass tape merging program whose specifications are closely related to those of Sort 90. Parameters for a particular merge are entered on control cards. As

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§ 151.

.13 Data Sorting and Merging (Cont'd)

IBM 7070/7074 Merge 91 (Cont'd)

many as eight sequenced input tape files of any length can be merged into a single sequenced output file, or a sequence check may be performed without creating an output.

Merge 91 can be run on an IBM 7070 or 7074 with 5,000 or 9,990 words of core storage. One or two tape units may be assigned to each input file, and the sequenced output can be written on up to eight tape units in rotation. Additional tape units can be used for writing checkpoints, dumping unreadable records, and loading the merge routine. As in Sort 90, provisions have been made for user modifications.

IBM 7074 Generalized Sorting Program Using Hypertape Drives

Reference: . . . . . IBM Publication J28-6154.
Record size: . . . . . variable; 999 words maximum.
Block size: . . . . . variable; 999 words maximum.
Key size: . . . . . preset; up to 160 digits in up to 10 separate fields.
File size
Sorting: . . . . . N-1 reels, where N is the merge order.
Merging: . . . . . 99 reels.
Number of tapes
Sorting: . . . . . at least 2N.
Merging: . . . . . at least N + 1.
Date available: . . . . fourth quarter, 1963.
Description:

This routine is being developed to take advantage of the higher speeds and special features of the 7340 Hypertape Drives. Its specifications and operating procedures are quite similar to those of Sort 90 and Merge 91, and it will perform both sorting and merging operations. Input and output may be on either Hypertape Drives or 729 tape units (for compatibility with other systems). The order of a merge may be as high as five for sorting and eight for merging.

.14 Report Writing

IBM 7070/7074 Report Program Generator (RPG)

Reference: . . . . . IBM Publication C28-6113.
Date available: . . . . second quarter, 1961.
Description:

This generator facilitates the preparation of report writing programs that will process an input tape file to produce a report on an on-line printer and/or magnetic tape for off-line listing. Four phases are involved in its use:

1. Writing the report specifications in an abbreviated format on four different types of forms: Tape File and Printer Specifications, Report Format, Field Dictionary, and Data Selection Requirements.
2. Generating a symbolic routine consisting mainly of Autocoder macro-instructions from the report specifications.
3. Translating the symbolic routine into machine language by means of the Autocoder processor.
4. Executing the object routine to produce the desired report.

The Report Program Generator is contained on the 7070/7074 Compiler System Tape along with the Autocoder Processor, so steps 2 and 3 are accomplished by a single computer run. The translating computer must have a minimum of six magnetic tape units; additional units are required for batched report program generation. Execution of the object program requires at least two tape units or one tape unit and a printer.

Two reports (one printed on-line and one on tape for off-line listing) can be produced simultaneously from the same input file; they can be completely different, or the report printed on-line can be a summary of the full report. If the input file is not in the correct sequence, a pre-sort routine can be generated to set up the input to Sort 90. After the sort, control is transferred to the report writing program proper. Arithmetic capability is limited to the accumulation and listing of totals; multiplication, division, or crossfooting can be performed only through manual insertions into the generated routines.

There is no source language compatibility between the Report Program Generator for the 7070/7074 and those for other IBM systems.

.15 Data Transcription

IBM 7070/7074 Tape File Generator Program

Reference: . . . . . IBM Publication C28-6110, pp. 26-35.
Date available: . . . . third quarter, 1960.
Description:

This routine produces a magnetic tape file from data records on punched cards or another tape unit. Records may be of fixed or variable length and may be blocked or unblocked. A control card precedes the data cards and specifies the parameters for each tape file to be produced.

IBM 7070/7074 Tape Print Program

Reference: . . . . . IBM Publication C28-6110, pp. 62-70.
Date available: . . . . third quarter, 1960.
Description:

Data contained in a magnetic tape file can be listed on an on-line printer or on tape for off-line listing by means of this routine. Records up to 10,000 words in length can be listed. The data is listed in a standardized format, with no provision for editing.

§ 151.

.15 Data Transcription (Cont'd)

IBM 7070 SPOOL System

Reference: . . . . . IBM Publication J28-6047-1 and 7070-IO-076.
Date available: . . . . November, 1960.
Description:

SPOOL is an acronym for "Simultaneous Peripheral Operations On-line". The system enables a 7070 (or 7074) with on-line unit record equipment to perform card-to-tape and tape-to-printer or -punch transcriptions on-line during the execution of another routine. All SPOOL instructions are executed in the 7070's priority mode. When a priority signal is received from a tape unit or unit record device, the main routine is interrupted and the appropriate SPOOL routine is entered. After the necessary input or output operation has been initiated, control is returned to the main routine.

The SPOOL routines occupy the top 400 locations of a 5,000- or 9,990-word core store. In a system with two tape channels, two SPOOL transcription operations and an independent main routine can be performed simultaneously. The SPOOL routines perform straightforward transcriptions upon blocked or unblocked records. No editing is performed, but provisions are made for the addition of special routines coded by the user.

.16 File Maintenance: . . . none.

.17 Other

Storage Print Program

Reference: . . . . . IBM Publication C28-6110, pp. 45-51.
Date available: . . . . third quarter, 1960.
Description:

The contents of one or more core storage areas are listed either on-line or on magnetic tape for off-line printing. The listing also indicates the contents of the accumulators and index words plus the settings of the High-Low-Equal Indicator and all stacking latches.

Procedure for Automatic Testing (PAT)

Reference: . . . . . IBM Publication C28-6110, pp. 100-126.
Date available: . . . . third quarter, 1960.
Description:

This system facilitates program testing by combining various utility routines, the object program, and the test data into a single package. After execution, a listing is produced of the contents of core storage and all input and output tapes. The entire procedure is performed in one continuous operation with a minimum of operator intervention.

.2 PROBLEM ORIENTED LANGUAGES: . . . . none.

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PROCESS ORIENTED LANGUAGE: COBOL 61

§ 161.

.1 GENERAL

.11 Identity: . . . . . IBM 7070/7074 COBOL. COBOL 61.

.12 Origin: . . . . . CODASYL committee; implemented by IBM Data Processing Division.

.13 Reference: . . . . . IBM Publications F28-8053-1 and J28-6182.

.14 Description

The IBM 7070/7074 COBOL language contains virtually all of the facilities of Required COBOL 1961 and parts of Elective COBOL 1961, as described in the Users' Guide, section 4:161. Deficiencies from Required COBOL, electives which have been or will be implemented, and extensions of the language are summarized below. The electives are keyed by number to their descriptions in 4:161.3.

The most significant elective facilities that are provided in the language are the evaluation of algebraic formulae (COMPUTE); the handling of arithmetic operands of up to 18 digits; the movement of data where there are excess source or destination items (MOVE CORRESPONDING); and the insertion of Autocoder coding in a COBOL source program (ENTER).

It should be noted that not all of the language facilities described here have been implemented in the initial 7070/7074 COBOL Processor. The exemptions are listed in item 403:184.212.

Deficiencies: . . . . . none in language (but see item 403:184.212).

Electives (see 4:161)

#1	
#2	= sign only.
#6	
#21	LABEL RECORDS ARE NON-STANDARD permits labels of standard size (80 characters) but non-standard format.
#22	
#24	ENTER AUTOCODER.
#27	
#28	
#32	
#33	handles operands of up to 18 digits.
#35	
#41	SEGMENT-LIMIT clause not implemented.
#42	
#43	
#45	
#46	

.14 Description (Cont'd)

Extensions

1. "PROGRAM-START" clause permits execution of object program to begin at any named point in procedures.

2. "Autocoder-name IS COBOL-name" clause permits procedures coded in Autocoder to refer to COBOL procedure or data names.

.15 Publication Date: . . . . December, 1961.

.2 PROGRAM STRUCTURE

.21 Divisions

IDENTIFICATION: . . .	name of author; name and date of program.
ENVIRONMENT:	describes translating and target computers and relates I/O units to files, names to units.
DATA:	describes the data items and shows the structure of records, files, working storage, and constants.
PROCEDURE:	describes the procedures in an imperative form.

.22 Procedure Entities

PROCEDURE DIVISION:	sections and/or paragraphs.
SECTION:	paragraphs.
PARAGRAPH:	sentences.
SENTENCE:	imperative, conditional, and compiler directing statements.
STATEMENT:	COBOL words.

.23 Data Entities

FILE:	records.
RECORD:	elementary items or group items.
GROUP ITEM:	elementary items or group items; up to 48 levels of group items are possible.
ELEMENTARY ITEM: .	characters.

.24 Names

.241 Simple name formation

Alphabet:	A to Z, 0 to 9, and hyphen.
Size:	30 characters maximum.
Avoid key words: . . .	yes.
Formation rule: . . .	at least one letter; no hyphen as first or last character.

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.242 Designators
- Procedures
  - PROCEDURE DIVISION: . . . . . labeled with name.
  - SECTION: . . . . . SECTION is part of name.
  - PARAGRAPH: . . . . none.
  - SENTENCE: . . . . no name allowed.
- Data: . . . . . none.
- Equipment: . . . . . none.
- Comments: . . . . . begin with key word NOTE.
- Translator control: . none.

.25 Structure of Data Names

.251 Qualified names
- Example: . . . . . TOTAL-IN-MASTER.
- Multiple qualifiers: . yes.
- Complete sequence: . optional.
- Broken sequence: . . . yes.

.252 Subscripts
- Number per item: . . 0 to 3.
- Applicable to: . . . . group item or items.
- Class may be:
  - Special index variable: . . . . . no.
  - Any variable: . . . . yes.
  - Literal: . . . . . yes.
  - Expression: . . . . . no.
- Form may be
  - Integer only: . . . . yes.
  - Signed: . . . . . only positive.

.253 Synonyms
- Preset: . . . . . yes.
- Dynamically set: . . . no.

.27 Region of Meaning of Names

.271 Universal names: . . . all.
.272 Local names: . . . . . none.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . yes.
.312 List by kind: . . . . . no.
.313 Qualify by adjective: . . NUMERIC.
.314 Qualify by phrase: . . . CLASS IS NUMERIC.
.315 Qualify by code: . . . . no.
.316 Hierarchy by list: . . . yes.
.317 Level by indenting: . . optional.
.318 Level by coding: . . . . mandatory.

.32 Files and Reels

.321 File labels
- Variable layout: . . . description, library, or standard.
- Control totals: . . . . none.
- Identity control: . . . description.
- Multi-reel: . . . . . description.

.322 Reel sentinels
- Variable layout: . . . description, library, or standard.
- Block count: . . . . . description.
- Multi-files: . . . . . description.

.33 Records and Blocks

.331 Variable record size: . preset or dynamic.
.332 Variable block size: . . preset or dynamic.
.333 Record size range: . . 3 to N words, limited by core storage capacity.
.334 Block size range: . . . 3 to N words.
.335 Choice of record size: . description or automatic.
.336 Choice of block size: . description or automatic.
.337 Sequence control: . . . none.
.338 In-out error control: . automatic.
.339 Blocking control: . . . . automatic.

Note: Three types of data record organization are permitted in tape files:
1. Fixed number of fixed-length records per block.
2. Fixed number of variable-length records per block.
3. Variable number of variable-length records per block.

.34 Data Items

.341 Designation of class: . description.
.342 Possible classes
- Integer: . . . . . yes.
- Fixed point: . . . . . yes.
- Floating point: . . . . no.
- Alphabetic: . . . . . yes.
- Alphameric: . . . . . yes.

.343 Choice of external radix: none.
.344 Possible radices: . . . only decimal.
.345 Justification: . . . . . description, or automatic left for alpha and point alignment for numeric.
.346 Choice of code: . . . . description.
.347 Possible codes
- Magnetic tape: . . . . BCD, as in Data Code Table No. 4.
- Punched cards: . . . . column code, as in Data Code Table No. 3.

.348 Item size
- Variable size: . . . . preset.
- Designation: . . . . . picture or phrase.
- Range
  - Fixed point numeric: 1 to 18 characters.
  - Alphameric: . . . . 120 characters.

.349 Sign provision: . . . . . optional.

.35 Data Values

.351 Constants
- Possible sizes
  - Integer: . . . . . 1 to 18 characters.
  - Fixed point: . . . . . 1 to 18 characters.
  - Alphabetic: . . . . . 1 to 120 characters.
  - Alphameric: . . . . 1 to 120 characters.
- Subscriptible: . . . . by redefining.
- Sign Provision: . . . . optional.

.352 Literals: . . . . . same as constants.
.353 Figuratives
- Examples: . . . . . ZERO, ZEROES, ZEROS, SPACE, SPACES, QUOTES, ALL "literal".

.354 Conditional variables: . yes.

.36 Special Description Facilities

.361 Duplicate format: . . . COPY.

§ 161.

.362 Re-definition: . . . . . REDEFINES.
.363 Table description
Subscription: . . . . . mandatory, preset size.
Multi-subscripts: . . by hierarchy of levels.
Level of item: . . . . group item or elementary item.
Implied subscript at lower level: . . . . . yes.
.364 Other subscriptable entities: . . . . . none.

.4 OPERATION REPERTOIRE

.41 Formulae: . . . . . COMPUTE verb.

.411 Operator list
+ : . . . . . addition.
- : . . . . . subtraction.
* : . . . . . multiplication.
/ : . . . . . division.
** : . . . . . exponentiation.
= : . . . . . replacement.
.412 Operands allowed
Classes: . . . . . all numeric.
Mixed scaling: . . . . yes.
Mixed classes: . . . . no.
Mixed radices: . . . . no.
Literals: . . . . . yes.
.413 Statement structure
Parentheses
a - b - c means: . . (a-b) - c.
a + b x c means: . . a + (b x c).
a / b / c means: . . (a/b)/c.
a^{bc} means: . . . . . not defined.
Size limit: . . . . . ?
Multi-results: . . . . no.
.414 Rounding of results: . . automatic truncation.
.415 Special cases
x = -x: . . . . . COMPUTE X = - X.
x = x + 1: . . . . . COMPUTE X = X + 1.
x = 4.7 y: . . . . . COMPUTE X = 4.7 * Y.
$x = 5 \times 10^7 + y^2$: . . . COMPUTE X = 5 * 10 ** 7 + Y ** 2.

.42 Operations on Arrays: none.

.43 Other Computation

.431 Operator list
ADD: . . . . . addition, to.
SUBTRACT: . . . . . subtraction, from.
MULTIPLY: . . . . . unrounded multiplication, by.
DIVIDE: . . . . . unrounded division, into.
.432 Operands allowed
Mixed scaling: . . . . yes.
Mixed classes: . . . . no.
Mixed radices: . . . . no.
Literals: . . . . . yes.
Restrictions: . . . . . must be pure numeric; no decimal points allowed in data.

.433 Statement
Mixed verbs: . . . . . no.
Multi-results: . . . . no.
Size limits: . . . . . ?
Multi-operands: . . . yes.
Implied results: . . . last named operand.

.434 Rounding of results: . . optional ROUNDED in procedures, else truncated.
.435 Special cases
x = -x: . . . . . SUBTRACT X FROM 0 GIVING X.
x = x + 1: . . . . . ADD 1 TO X.
x = x + y: . . . . . ADD Y TO X.
x = x ÷ y: . . . . . DIVIDE Y INTO X.
x = xy: . . . . . MULTIPLY Y BY X.
x = remainder x ÷ y: . DIVIDE Y INTO X GIVING Z. MULTIPLY Y BY Z. SUBTRACT Z FROM X.
.436 Typical cases
x = y + z: . . . . . ADD Y, Z GIVING X.

.44 Data Movement and Format

.441 Data copy example: . . MOVE X TO Y.
.442 Levels possible: . . . . group items. elementary items.
.443 Multiple results: . . . . MOVE X TO Y, Z.
.444 Missing operands
Excess sources: . . . MOVE CORRESPONDING.
Excess destinations: . MOVE CORRESPONDING.
.445 Size of operands
Exact match: . . . . . only group items.
Alignment rule
Numbers: . . . . . decimal point.
Alpha: . . . . . left justified.
Filler rule
Numbers: . . . . . zeroes.
Alpha: . . . . . spaces.
Truncating rule
Numbers: . . . . . at each end.
Alpha: . . . . . at right.
Variable size destination: . . . . no.
.446 Editing possible
Change class: . . . . description.
Change radix: . . . . no.
Delete editing symbols: . . . . . no.
Insert editing symbols
Actual point: . . . . description.
Suppress zeroes: . . description.
Insert: . . . . . $, . + - CRDB blank.
Float: . . . . . $.
.447 Special moves: . . . . . none.
.448 Code translation: . . . none.
.449 Character manipulation: EXAMINE; to replace and/or count the number of occurrences of a given character in a data item.

.45 File Manipulation

Open: . . . . . OPEN.
Close: . . . . . CLOSE.
Advance to next record: READ, WRITE.
Step back a record: . . none.
Set restart point: . . . description or library.
Restart: . . . . . none.
Start new reel: . . . . . CLOSE REEL.
Start new block: . . . . none.
Search on key: . . . . . none.
Rewind: . . . . . automatic for CLOSE file.
Unload: . . . . . CLOSE ... WITH LOCK.

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.46 Operating Communication

.461 Log of progress: . . . . DISPLAY; to display low volume data on console typewriter.
.462 Messages to operator: . same as log.
.463 Offer options: . . . . . own COBOL coding using DISPLAY and ACCEPT.
.464 Accept option: . . . . . ACCEPT; to receive low volume data from console card reader.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	ON SIZE ERROR	own COBOL coding.
In-out:	automatic	automatic.
Invalid data:	none	none.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . sections.
paragraphs.
.512 Unconditional jump: . . GO TO X.
.513 Switch: . . . . . separate paragraph, named Y, containing only a GO TO X statement.
.514 Setting a switch: . . . . ALTER Y TO PROCEED TO Z.
.515 Switch on data: . . . . . GO TO X, Y, Z DEPENDING ON W.

.52 Conditional Procedures

.521 Designators
Condition: . . . . . IF.
Procedure: . . . . . implied.
.522 Simple conditions
Expression v expression: . . . no.
Expression v variable: . . . . no.
Expression v literal: . . . . . no.
Expression v figurative: . . . no.
Expression v condition: . . . . no.
Variable v variable: . . . . yes.
Variable v literal: . . . . . yes and reverse.
Variable v figurative: . . . yes and reverse.
Variable v condition: . . . . yes.
Conditional value: . . . . . yes.
.523 Conditional relations
Equal: . . . . . IS (NOT) EQUAL TO, = .
Greater than: . . . . . IS (NOT) GREATER THAN.
Less than: . . . . . IS (NOT) LESS THAN.
Greater than or equal: none.
Less than or equal: . none.
.524 Variable conditions: . . NOT POSITIVE; does include zero.
POSITIVE; does not include zero.
NOT NEGATIVE; does include zero.
NEGATIVE; does not include zero.
NOT NUMERIC.
NUMERIC.
NOT ALPHABETIC.
ALPHABETIC.
ZERO.
NOT ZERO.
.525 Compound Conditionals
IF A AND B: . . . . . many times, not mixed with OR.
IF A OR B: . . . . . many times, not mixed with AND.
IF A DO C AND B DO D: . . . . . yes.
IF A DO C OR B DO D: yes.
.526 Alternative designator: ELSE, or OTHERWISE.
.527 Condition on alternative: . . . . . yes.
.528 Typical examples: . . . IF X IS POSITIVE AND Y IS POSITIVE ADD X TO Y ELSE IF Z IS POSITIVE MOVE Z TO Y.

.53 Sub-routines

.531 Designation
Single statement: . . . name of paragraph or section, in a cue.
Set of statements:
First: . . . . . name of first.
Last: . . . . . name of last.
.532 Possible sub-routines: . series of paragraphs or sections.
.533 Use in-line in program: yes.
.534 Mechanism
Cue with parameters: none.
Cue without parameter: . . . . . PERFORM A THRU B.
Formal return: . . . . implied.
Alternative return: . . EXIT.
.535 Names: . . . . . all universal.
.536 Nesting limit: . . . . . none.
.537 Automatic recursion allowed: . . . . . none.

.54 Function Definition by Procedure: . . . . . none.

.55 Operand Definition by Procedure: . . . . . none.

.56 Loop Control

.561 Designation of loop
Single procedure: . . PERFORM A.
First and last procedures: . . . . . PERFORM A THRU B.
.562 Control by count
Literal: . . . . . yes.
Data: . . . . . yes.
Example: . . . . . PERFORM A AGE TIMES.
.563 Control by step
Parameter
Special index: . . . . none.
Any variable: . . . . VARYING AGE FROM 1 BY 1 UNTIL.
Step: . . . . . any variable.
Criteria: . . . . . any conditional expression.
Multiple parameters: no.
.564 Control by condition
Example: . . . . . UNTIL B IS NEGATIVE.
Combined with step: . optional.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . ?
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . . available always.

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.6 EXTENSION OF THE LANGUAGE: . . . . . none.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . COBOL library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . no.
.723 Private: . . . . . yes.

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . data descriptions; object-computer, special names, file control, and I/O control paragraphs; file and reel labels.

.75 Mechanism

.751 Insertion of new item: . not yet defined.
.752 Language of new item:. COBOL.
.753 Method of call:. . . . . COPY statement.

.76 Types of Routine: . . . see .74.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . yes; ENTER AUTOCODER

.82 Optimizing Information Statements:. . . . . none.

.83 Translator Environment:. . . . . implied.

.84 Target Computer Environment:. . . . . library call or description.

.85 Program Documentation Control: . . . . . none.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: none.

.92 Address Allocation: . . none.

.93 Arrangement of Items in Unpacked Form: . . . SYNCHRONIZED.

.94 Assignment of Input-Output Devices: . . . description or library.

.95 Input-Output Areas: . . description or library.

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PROCESS ORIENTED LANGUAGE: FORTRAN

§162.

.1 GENERAL

.11 Identity: . . . . . .7070/7074 FORTRAN. "Full FORTRAN".

.12 Origin: . . . . . Data Processing Division, IBM Corporation.

.13 Reference: . . . . . IBM Publication C28-6170.

.14 Description:

7070/7074 FORTRAN is, in general, the FORTRAN II language. It differs from 709/7090 FORTRAN principally in that the following statements have not been implemented for the 7070 series: FREQUENCY, READ DRUM, WRITE DRUM. Furthermore, there is no provision in 7070/7074 FORTRAN for Boolean operations or for bit manipulation of any kind, and the object program cannot be segmented.

Complete facilities for defining and using subroutines and functions are provided in 7070/7074 FORTRAN. TYPE provides output on the console typewriter on 7070 series systems; it is not available in 709/7090 FORTRAN. The ranges of numbers that can be handled by the two FORTRAN systems are compared below:

Data Type	7070/7074	709/7090
Integer:	1 to 9,999,999,999	1 to 32,767.
Floating point:	10^{-51} to 10^{+49}	10^{-38} to 10^{+38}.

The FORTRAN Monitor System, which coordinates FORTRAN compilations, symbolic assemblies, and execution of object programs on the 709/7090, has not been made available for the 7070 series (but see section 403:191).

.15 Publication Date: . . . . IBM 7070 Basic FORTRAN, June 1960; Full FORTRAN, February 1962.

.2 PROGRAM STRUCTURE

.21 Divisions

Procedure Statements: algebraic formulae.
comparisons and jumps.
input and output.

.21 Divisions (Cont'd)

Data Statements:. . . . FORMAT: describes the layout, size, scaling and code of input-output data.
EQUIVALENCE: used to cause two variables to have a common location or to specify synonyms.
COMMON: used to cause a name to be common to more than one segment rather than local to each.
DIMENSION: describes the elements in each dimension of an array or set of arrays.

.22 Procedure Entities

Program: . . . . . statements.
functions.
subroutines.
Subroutine: . . . . . statements.
Statement: . . . . . characters; blanks are ignored.
Function: . . . . . statements.

.23 Data Entities

Arrays:. . . . . all variables.
Items:. . . . . floating point variables or constants.
fixed point integer variables or constants.
Hollerith item.
alphameric item.
Hollerith item: . . . . . alphameric item that can only be used for output.
Alphameric item: . . . alphameric item that can only be input during a run; it can be used for output or as a format statement.

.24 Names

.241 Simple name formation

Alphabet:. . . . . .A to Z, 0 to 9.
Size: . . . . . .1 to 6 char.
Avoid key words: . . no.
Formation rule: . . . first char must be a letter;
do not use final F if subscripted and if name is more than 3 char long.

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.242 Designators
- Procedures
  - Statement: . . . . . unsigned integer, 5 digits max.
  - Function: . . . . . same as variable being defined.
  - Subroutine: . . . . . none.
- Data
  - Integer variables: . . initial I, J, K, L, M, N.
  - Floating point variables: . . . . . any other initial letter.
- Equipment
  - Card: . . . . . implied by verbs READ, PUNCH.
  - Magnetic Tape: . . . use key word TAPE.
  - Printer: . . . . . implied by verb PRINT.
- Comments: . . . . . C in column 1.
- Translator control: . . key words EQUIVALENCE, COMMON, DIMENSION.

.25 Structure of Data Names

.251 Qualified names: . . . . none.

.252 Subscripts
- Number per item: . . . 0 to 3.
- Applicable to: . . . . . all variables.
- Class may be
  - Special index variable: . . . . . no.
  - Any variable: . . . . only integers.
  - Literal: . . . . . yes.
  - Expression: . . . . . at most C * N ± C'; where C and C' are literals.
- Form may be
  - Integer only: . . . . C, C', and N.
  - Signed: . . . . . none.
  - Truncated fraction: . . . . . no.
  - Rounded fraction: . . no.

.253 Synonyms
- Preset: . . . . . EQUIVALENCE statement.
- Dynamically set: . . . no.

.26 Number of Names

.261 All entities: . . . . . undefined.

.262 Procedures
- Subroutines and functions: . . . . . 50.
- Statement numbers: . . 400.
- Subroutine arguments: . . . . . 50 per subroutine.

.263 Data
- Files: . . . . . no limit.
- Record formats: . . . no limit.
- Items
  - Nonsubscripted variables: . . . . . 290.
  - Dimensional variables (arrays): . . 290.
  - Three-dimensional arrays: . . . . . 50.

.264 Equipment
- Card readers: . . . . . 1.
- Card punches: . . . . . 1.
- Printers: . . . . . 1.

.27 Region of Meaning of Names: . . . . . all names are local to the subroutines in which they are established unless a COMMON statement is used.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . . FORMAT statement.
.312 List by kind: . . . . . no.
.313 Qualify by adjective: . . no.
.314 Qualify by phrase: . . . no.
.315 Qualify by code: . . . . yes; first letter of name.
.316 Hierarchy by list: . . . no.
.317 Level by indenting: . . no.
.318 Level by coding: . . . . no.
.319 Others
- Array size: . . . . . DIMENSION.
- Four-digit integer: . . FORMAT (I4).
- Four-digit integers, 5: . . . . . FORMAT (5I4).
- Floating point items: FORMAT (F8.3, E10.4) for +999.999 and +.0000E+99

Note: If format of input data differs from FORMAT statement, the data over-rides the FORMAT specifications.

.32 Files and Reels: . . . . own coding.

.33 Records and Blocks

.331 Variable record size: . . implied.
.332 Variable block size: . . . no.
.333 Record size range: . . . no limit.
.334 Block size range: . . . . 120 char. for WRITE OUTPUT TAPE; 240 char. for WRITE TAPE.
.335 Choice of record size: . . . . . READ, WRITE statement.
.336 Choice of block size: . . none.
.337 Sequence control: . . . 1 logical record per tape input-output statement.
.338 In-out error control: . . automatic.
.339 Blocking control: . . . . FORMAT statement.

.34 Data Items

.341 Designation of class: . . by name.

.342 Possible classes
- Integer: . . . . . yes.
- Fixed point: . . . . . no.
- Floating point: . . . . yes.
- Alphabetic: . . . . . yes.
- Alphameric: . . . . . yes.

.343 Choice of external radix: . . . . . none.

.344 Possible radices
- Decimal: . . . . . yes.
- Octal: . . . . . no.

.345 Justification: . . . . . alpha automatic left justified.
.346 Choice of code: . . . . FORMAT statement and READ, WRITE statements.

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.347 Possible codes
- Decimal: . . . . . yes.
- Octal: . . . . . no.
- Hollerith: . . . . . yes.
- Alphameric: . . . . . yes.

.348 Item size (internal)
- Variable size: . . . . fixed.
- Designation: . . . . . none.
- Range
  - Fixed point numeric: fixed; 10 digits.
  - Floating point numeric: . . . . . fixed; 8 & 2 digits.
  - Alphameric: . . . . . fixed; 5 char.

.349 Sign provision: . . . . . optional.

.35 Data Values

.351 Constants
- Possible sizes
  - Integer: . . . . . 1 to 10 digits.
  - Fixed point: . . . . . none.
  - Floating point: . . . 1 to 8 digit fixed point part; 1 or 2 digit exponent.
  - Alphabetic: . . . . . 120 char.
  - Alphameric: . . . . . 120 char.
- Subscriptable: . . . . . yes.
- Sign provision: . . . . . optional.

.352 Literals
- Possible sizes
  - Integer: . . . . . 1 to 10 digits.
  - Fixed point: . . . . . none.
  - Floating point: . . . 1 to 8 digit fixed point part; 1 or 2 digit exponent.
  - Alphabetic: . . . . . none.
  - Alphameric: . . . . . none.
- Designation: . . . . . implied for numerics.
- Sign provision: . . . . optional.

.353 Figuratives: . . . . . own coding.

.354 Conditional variables: . . computed GO TO.

.36 Special Description Facilities

.361 Duplicate format: by multiple references to single FORMAT statement.

.362 Re-definition: . . . . . COMMON statement. EQUIVALENCE statement.

.363 Table description
- Subscription: . . . . . yes.
- Multi-subscripts: . . 1 to 3.
- Level of item: . . . . variables.
- Implied subscript at lower level: . . . no.

.364 Other subscriptible entities: . . . . . tape units.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator List
- + : . . . . . addition, also unary.
- - : . . . . . subtraction, also unary.
- * : . . . . . multiplication.
- / : . . . . . division.
- **: . . . . . exponentiation.
- = : . . . . . is set equal to.
- FLOATF ( ): . . . . . float.
- XFIXF ( ): . . . . . fix.
- ABSF ( ): . . . . . absolute value.
- INTF ( ): . . . . . entire.
- MODF (A,B): . . . . . remainder A ÷ B.
- MAX (A,...): . . . . max value.
- MIN (A,...): . . . . . min value.
- DIMF (A,B): . . . . . diminish A by B.
- LOFG ( ): . . . . . natural log.
- SINF ( ): . . . . . sine.
- COSF ( ): . . . . . cosine.
- EXPF ( ): . . . . . exponential.
- SQRTF ( ): . . . . . square root.
- ATANF ( ): . . . . . arctangent.
- TANHF ( ): . . . . . hyperbolic tangent.

.412 Operands allowed
- Classes: . . . . . numeric only.
- Mixed scaling: . . . . yes.
- Mixed classes: . . . . only in exponentiation and functions.
- Mixed radices: . . . . no.
- Literals: . . . . . yes.

.413 Statement structure
- Parenthesis
  - a - b - c means: . . . (a-b) - c.
  - a + b x c means: . . . a + (b x c).
  - a ÷ b ÷ c means: . . . (a ÷ b) ÷ c.
  - a^{bc} means: . . . . . a**b**c is illegal; parenthesis must be used.
- Size limit: . . . . . 660 char.
- Multi-results: . . . . . no.

.414 Rounding of results: . . . truncation of integers at each step in expression.

.415 Special cases

	Fixed	Floating
x = -x:	K = -K	X = -X
x = x + 1:	K = K + 1	X = X + 1
x = 4.7 y:	K = 47*K/10	X = 4.7*Y
$x = 5x10^7 + y^2$: . .	K = 50000000 + L**2	X = 5.E7 + Y**2
x = y :	K = XABSF(L)	X = ABSF(Y)
x = entire (3.5):	K = XINTF(L)	X = INTF(Y)

.416 Typical examples: X = (-B + SQRTF (B*B-4.0*A*C))/(2.0*A)

.42 Operations on Arrays

.421 Matrix operations: . . . none.

.422 Logical operations: . . none.

.423 Scanning: . . . . . none.

.43 Other Computation: . . none.

.44 Data Movement and Format

.441 Data copy example: . . . Y = X.

.442 Levels possible: . . . . items.

.443 Multiple results: . . . . none.

.444 Missing operands: . . . not possible.

.445 Size of operands
- Exact match: . . . . . implied, except for alpha or input-output.
- Alignment rule
  - Numbers: . . . . . right justified; normalized for floating point.
  - Alpha: . . . . . left justified.
- Filler rule
  - Numbers: . . . . . zeros.
  - Alpha: . . . . . blanks.

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.445 Size of Operands (Cont'd)

Truncating rule
- Numbers: . . . . . truncate at left.
- Alpha: . . . . . truncate at right.
- Variable size destination: . . . . no.

.446 Editing possible
- Change class: . . . . . yes.
- Change radix: . . . . . no.
- Delete editing symbols: . . . . . automatic.
- Insert editing symbols
  - Actual point: . . . . . automatic.
  - Suppress zeroes: . . automatic.
  - Insert: . . . . . automatic point.
  - Float: . . . . . + - signs only.

.447 Special moves: . . . . . none.

.448 Code translation: . . . . automatic.

.449 Character manipulation: . . . . . none.

.45 File Manipulation

- Open: . . . . . .own coding.
- Close: . . . . . own coding.
- Advance to next record: . . . . . READ, WRITE, PUNCH, PRINT.
- Step back a record: . . BACKSPACE.
- Set restart point: . . . . none.
- Restart: . . . . . none.
- Start new reel: . . . . own coding.
- Start new block: . . . . implied in each input-output statement.
- Search on key: . . . . . none.
- Rewind: . . . . . REWIND.
- Unload: . . . . . none.

.46 Operating Communication

.461 Log of progress: . . . . TYPE uses console typewriter; PRINT uses on-line printer.

.462 Messages to operator: . . same as log.

.463 Offer options: . . . . . PAUSE causes halt and type-out of a specified integer.

.464 Accept option . . . . . use Alteration Switch (SENSE SWITCH).

.47 Object Program Errors

Error	Discovery	Special actions
Overflow:	IF clause	own coding.
In-out:	automatic	type message and halt.
Invalid data:	none.	

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . . statement.

.512 Unconditional jump: . . . GO TO N.

.513 Switch: . . . . . GO TO M, (35, 47, 18).

.514 Setting a switch: . . . . ASSIGN 35 TO M.

.515 Switch on data: . . . . . GO TO (35, 47, 18), I.

.52 Conditional Procedures

.521 Designators
- Condition: . . . . . IF.
- Procedure: . . . . . implied.

.522 Simple conditions

Expression	v	expression:	no.
Expression	v	variable:	no.
Expression	v	literal:	no.
Expression	v	figurative:	always zero.
Expression	v	condition:	no.
Variable	v	variable:	no.
Variable	v	literal:	no.
Variable	v	figurative:	always zero.
Variable	v	condition:	no.
Conditional value:			no.

.523 Condition relations
- Equal: . . . . . } jointly in each
- Greater than: . . . . } IF statement against zero.
- Less than: . . . . . }
- Greater than or equal: no.
- Less than or equal: . . no.

.524 Variable conditions: . . always zero.

.525 Compound Conditionals: . . . . . no.

.526 Alternative designator: none.

.528 Typical Example: IF (X**2.0 - 3.0) 29, 37, 18; means go to 29, 37 or 18 if x^2-3 is respectively less than, equal to, or greater than zero. This is the only permitted form of conditional statement.

.53 Subroutines

.531 Designation
- Single statement: . . . same as set.
- Set of statements:
  - First: . . . . . SUBROUTINE.
  - Last: . . . . . END.

.532 Possible subroutines: . . any number of statements.

.533 Use in-line in program: . . . . . no.

.534 Mechanism
- Cue with parameters: CALL XXX (X, Y, Z).
- Number of parameters: 50.
- Formal return: . . . . .RETURN at least once.
- Alternative return: . . none.

.535 Names
- Parameter call by value: . . . . . none.
- Parameter call by name: . . . . . yes.
- Non-local names: . . use COMMON.
- Local names: . . . . . all.
- Preserved own variables: . . . . . all.

.536 Nesting limit: . . . . . unlimited.

.537 Automatic recursion allowed: . . . . . none.

.54 Function Definition by Procedure

.541 Designation
- Single statement: . . . same as set
- Set of statements
  - First: . . . . . FUNCTION.
  - Last: . . . . . END.

.542 Level of procedure: . . any number of statements.

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.543 Mechanism
Cue: . . . . . by name in expression.
Formal return: . . . . RETURN.

.544 Names
Parameter call by value: . . . . . none.
Parameter call by name: . . . . . yes.
Non-local names: . . use COMMON.
Local names: . . . . . all.
Preserved own variables: . . . . . all.

.55 Operand Definition by Procedure: . . . . none.

.56 Loop Control

.561 Designation of loop
Single procedure: . . . none.
First and Last procedure: . . . . . current place to named end; e.g., DO 173 I = 1, N, 2.

.562 Control by count: . . . none.

.563 Control by step
Parameter
Special index: . . . . no.
Any variable: . . . . integer only.
Step: . . . . . positive integers.
Criteria: . . . . . greater than.
Multiple parameters: no.

.564 Control by condition: . . no.

.565 Control by list: . . . . . no.

.566 Nesting limit: . . . . . 50.

.567 Jump out allowed: . . . . yes.

.568 Control variable exit status: . . . . . available.

.6 EXTENSION OF THE LANGUAGE: . . . . . can write new function in library.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . FORTRAN library.

.72 Kinds of libraries

.721 Fixed master: . . . . . no.

.722 Expandable master: . . . yes.

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . . . . . subroutines. functions.

.75 Mechanism

.751 Insertion of new item: . . separate systems run.

.752 Language of new item: . . Autocoder.

.753 Method of call: . . . . . named in procedures.

.76 Types of Routine

.761 Open routines exist: . . yes.

.762 Closed routines exist: . . yes.

.763 Open-closed is variable: . . . . . no.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . no (subroutines may be written in Autocoder).

.82 Optimizing Information Statements

.821 Process usage statements: . . . . . none.

.822 Data usage statements: . . . . . COMMON. EQUIVALENCE.

.83 Translator Environment: . . . . . no.

.84 Target Computer Environment: . . . . no.

.85 Program Documentation Control: . . . . . no.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: . . . . . none.

.92 Address Allocation: . . none.

.93 Arrangement of Items in Word in Unpacked Form: . . . . . none.

.94 Assignment of Input Output Devices: . . . . yes.

.95 Input-Output Areas: . . . automatic; but overlapping operations are not possible.

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MACHINE ORIENTED LANGUAGE: AUTOCODER

§ 171.

.1 GENERAL

.11 Identity: . . . . . IBM 7070/7074 Autocoder.

.12 Origin: . . . . . IBM Data Processing Division, Applied Programming.

.13 Reference: . . . . . IBM Publication C28-6121-0.

.14 Description

Autocoder is the most widely used coding system for the IBM 7070 series. Basically a symbolic machine oriented language, it has been expanded through the addition of powerful macro generators and the Input/Output Control System. The Autocoder language permits utilization of all hardware facilities of a 7070, 7072, or 7074, and there is full program compatibility among the three systems. There is, however, no source language compatibility between Autocoder for the 7070 series and Autocoder for the IBM 1401 and 1410.

Each macro instruction in the source routine is converted by the appropriate macro generator into a series of symbolic instructions which are then converted to machine codes. Parameters in the operand of the macro instruction control the coding that will be produced by the generator. Most powerful of the macros is ARITH, which generates instructions to compute the value of an arithmetic expression written in a manner similar to FORTRAN. Operations may be performed on floating or fixed point variables, constants, or literals; fixed point scaling is handled automatically; and nine floating point arithmetic functions are provided. The LOGIC macro generates instructions to test whether a specified logical expression is true or false, and to set a switch or execute a branch depending upon the result. Other standard macros facilitate loop control and initialization, comparisons, data movement, output editing, and program testing. Additional macro generators can be coded by the user and added to the systems tape. Subroutines are treated as special cases of macro codes.

The IBM 7070 Series Input/Output Control System (IOCS) is a supplement to Autocoder. It provides additional control and macro operations that handle reading, writing, tape blocking and unblocking, file labeling, checkpoints, and error checking. Information pertaining to the system configuration, file characteristics, record layouts, file labels, and checkpoints must be included in the source routine in the form of a series of descriptive entries. The file specification for each tape file must contain 36 separate entries.

.14 Description (Cont'd)

All material in this report section applies to the full Autocoder system, which requires at least six magnetic tape units and is used in most 7070 series installations. Two restricted versions of the language are available for translation on smaller configurations. Basic Autocoder is usable on systems with unit record input-output only, but it is limited to a one-for-one translation of symbolic to machine instructions and cannot process macro instructions of any kind. Four-Tape Autocoder can be used on systems with four or five magnetic tape units; it is restricted to simpler substitution-type macros. Differences among the three versions of Autocoder are emphasized in the Program Translator sections.

.15 Publication Date: . . . . original version, third quarter, 1960.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . refer to 7070 Autocoder Coding Sheet, 403:131.2.

.22 Legend

Line: . . . . . sequences entries on coding sheet.
Label: . . . . . names the location of an instruction or data item.
Operation: . . . . . mnemonic representation of a machine operation, pseudo operation, or macro code.
Operand: . . . . . actual or symbolic address of data to be operated upon, with specification of field definition, relative addressing, indexing, literals and/or comments; or parameters for a macro code.
Identification: . . . . . identifies the routine.

.23 Corrections: . . . . . spare lines on coding sheet and gaps in sequence numbers.

.24 Special Conventions

.241 Compound addresses: . . BASE + ADJUSTMENT where BASE is any label and ADJUSTMENT is a decimal integer.

.242 Multi-addresses: . . . . in pseudos and macros only.

.243 Literals
Fixed numeric: . . . . preceded by + or - sign.
Floating numeric: . . . ± nF ± m, where n is an integer of 1 to 8 digits and m is a 1 or 2-digit exponent.
Alphameric: . . . . . preceded and followed by @

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.244 Special coded addresses: . . . . . * refers to this address.
.245 Actual core storage addresses: . . 1 to 4 decimal digits.

.3 LABELS

.31 General

.311 Maximum number of labels: . . . . . no practical limit.
.312 Common label formation rule: . . . . . yes.
.313 Reserved labels: . . . . labels ABS, AND, E, G, IN, L, LC, LS, NOT, NOZERO, OR, R, RR, RS, TO, WITH, and all function names are forbidden when certain macros are used.
.314 Other restrictions: . . . none.

.32 Universal Labels

.321 Labels for procedures
Existence: . . . . . mandatory if referenced by other instructions.
Formation rule
First character: . . . letter.
Others: . . . . . letters or numerals; no blanks or special characters.
Number of characters: . . . . . 1 to 10.
.322 Labels for library routines: . . . . . same as procedures.
.323 Labels for constants: . . same as procedures.
.324 Labels for files
Existence: . . . . . mandatory when IOCS is used.
Formation rule (recommended form)
First 8 characters: . . TAPEFILE.
Last 2 characters: . . alphameric.
Number of characters: . . . . 10.
.325 Labels for records: . . same as procedures.
.326 Labels for variables: . . same as procedures.

.33 Local Labels: . . . . . none.

.4 DATA

.41 Constants

.411 Maximum size constants
Integer
Decimal
When referenced by symbolic instruction: . . . . . 10 digits.
When referenced by macro-codes only: 20 digits.
Octal: . . . . . none.
Hexadecimal: . . . . none.
Fixed numeric: . . . . same as integers.
Floating numeric
Decimal: . . . . . 8 digit mantissa, 2 digit exponent.
Octal: . . . . . none.
Hexadecimal: . . . . none.
Alphabetic
When referenced by symbolic instruction: . . . . . 5 characters.
When referenced by macro-codes only: . . . . . unlimited.
Alphameric: . . . . . same as alphabetic.
.412 Maximum size literals
Integer
Decimal
When referenced by symbolic instruction: . . . . . 10 digits.
When referenced by macro-codes only: . . . . . 20 digits.
Octal: . . . . . none.
Hexadecimal: . . . . . none.
Fixed numeric: . . . . same as integers.
Floating numeric
Decimal: . . . . . 8 digit fixed point part, 2-digit exponent; usable only with macro-codes.
Octal: . . . . . none.
Hexadecimal: . . . . . none.
Alphabetic
In symbolic machine instructions: . . . . . 5 characters.
In macro-code operands: . . . . . 120 characters.
Alphameric: . . . . . same as alphabetic.

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.42 Working Areas

.421 Data layout: . . . . . specified in program; DA pseudo.
.422 Data type: . . . . . tabulated in program; alphameric, fixed or floating point numeric.
.423 Redefinition: . . . . . yes; EQU pseudo.

.43 Input-Output Areas

.431 Data layout: . . . . . specified in program; DA pseudo.
.432 Data type: . . . . . not required.
.433 Copy layout: . . . . . no.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
Existence: . . . . . mandatory.
Number: . . . . . 152.
Example: . . . . . ASn = add to storage from accumulator n (n = 1, 2, or 3).

.512 Absolute
Existence: . . . . . not permitted.

.52 Macro-Codes

.521 Number available
Input-output: . . . . . 17 (in IOCS system).
Arithmetic: . . . . . 1.
Math functions: . . . . 9 (in ARITH macro only).
Error control: . . . . . none.
Restarts: . . . . . 1 (in IOCS)
Logic: . . . . . .6.
Initialization: . . . . . 3.
Data movement: . . . . 3.
Diagnostics: . . . . . 1.
.522 Examples
Simple: . . . . . MOVE A TO B.
Elaborate: . . . . . ARITH X = A + B * C - D/2, OVERFLOWBR.
.523 New macros: . . . . . inserted into library in separate run.

.53 Interludes: . . . . . none.

.54 Translator Control

.541 Method of control
Allocation counter: . . . pseudo operations.
Label adjustment: . . . pseudo operations.
Annotation: . . . . . see .544.
.542 Allocation counter
Set to absolute: . . . . ORIGIN CNTRL and LITORIGIN CNTRL pseudos.
Set to label: . . . . . ORIGIN CNTRL and LITORIGIN CNTRL pseudos.
Step forward: . . . . ORIGIN CNTRL pseudo.
Step backward: . . . . ORIGIN CNTRL pseudo.
Reserve area: . . . . DA pseudo.
.543 Label adjustment
Set labels equal: . . . EQU pseudo.
Set absolute value: . . EQU pseudo.
Clear label table: . . none.
.544 Annotation
Comment phase: . . . . any card; separated from operand by at least two blanks.
Title phrase: . . . . . comments card, with asterisk in column 6.
.545 Other
Reserve index words or electronic switches: XRESERVE, XRELEASE, SRESERVE, SRELEASE CNTRL pseudos.

.6 SPECIAL ROUTINES AVAILABLE

Note: Only those facilities supplied by the manufacturer on the 7070 Series Compiler Systems Tape are listed here; others may be incorporated as described in paragraph .75.

.61 Special Arithmetic

.611 Facilities: . . . . . operand of ARITH macro may specify addition, subtraction, multiplication, and/or division in fixed or floating point mode.
.612 Method of call: . . . . . ARITH macro.

.62 Special Functions

.621 Facilities: . . . . . square root, log, exponential, sin, cosin, arcsine, and arctangent (all in floating point mode).
.622 Method of call: . . . . . by name in operand of ARITH macro; e.g., ARITH Y = SIN (X).

.63 Overlay Control: . . . . none.

.64 Data Editing

.641 Radix conversion: . . . none.
Code translation: . . . none (machine instructions are available for conversions between alphameric and numeric modes).
.642 Format control
Zero suppression: . . . yes.
Size control: . . . . . yes.
Sign control: . . . . . yes.
Special characters: . . insert $, .
float $
.643 Method of call: . . . . . DLINE pseudo specifies layout and editing for a print-line area; EDMOVE macro edits fields and moves them into the print-line area.

.65 Input-Output Control

.651 File labels: . . . . . IOCS, see .81.
.652 Reel labels: . . . . . IOCS, see .81.
.653 Blocking: . . . . . IOCS, see .81.
.654 Error control: . . . . . IOCS, see .81.
.655 Method of call: . . . . . macros; 15 available.

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.66 Sorting: . . . . . none.

.67 Diagnostics

.671 Dumps: . . . . . SNAP macro may be used.
.672 Tracers: . . . . . none.
.673 Snapshots: . . . . . SNAP macro provides listing of specified portions of core storage on any selected output unit.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . 7070 Series Compiler Systems Tape.

.72 Kind of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . yes.
.723 Private: . . . . . private facilities may be added.

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . . . . . macro generators and functions (subroutines are considered as special cases of macros).

.75 Mechanism

.751 Insertion of new item: . . . . . special generator run compiles new macro generator and inserts it into systems tape.
.752 Language of new item: Autocoder.
.753 Method of call: . . . . . macro code or function name in ARITH macro.

.76 Insertion in Program

.761 Open routines exist: . . . yes; most macros.
.762 Closed routines exist: . . . . . yes; functions and some macros.
.763 Open-closed is optional: . . . . . no.
.764 Closed routines appear once: . . . . . optional.

.8 MACRO AND PSEUDO TABLES

.81 Macros

Code	Description
ARITH:	computes value of an arithmetic expression and stores the result in any desired field.
COMP:	compares two fields and branches according to the results of the comparison.
CYCLE:	branches specified number of times to each of a series of locations.

.81 Macros (Cont'd)

Code	Description
RECYC:	reinitializes one or more CYCLE macros.
DECOD:	analyzes a code field and branches according to the value it contains.
LOGIC:	tests whether a given expression is true or false, sets a switch or branches, or both.
ZSIGN	analyzes a field or area for the presence of zero and, if not zero, for its sign, and branches accordingly.
SETSW:	sets one or more digit, electronic, or program switches to an on or off condition.
ZERO:	replaces contents of fields or areas with zeros or blanks.
FILL:	replaces contents of fields or areas with a specified constant.
EDMOV:	transfers data items between specified fields in storage and edits them to conform to the format of the field to which they are moved.
MOVE:	transmits data from one specified field or area in storage to another.
SHIFT:	places contents of a field into one or more accumulators, shifts it and stores the result.
SNAP:	provides a listing of a specified portion of storage.
OPEN (IOCS):	prepares input and output files for processing.
GET (IOCS):	makes one data record available for processing.
PUT (IOCS):	moves one record from a processing area to the next available space in an output area.
CLOSE (IOCS):	makes input and output files unavailable for processing.
END (IOCS):	removes all tapes from use upon completion of a job.
PUTX (IOCS):	places records in an output file by exchanging RDWs rather than by moving the record.
RLSE (IOCS):	starts a new record block.
WTM (IOCS):	writes one or more tape marks on an output file.
BSP (IOCS):	backspaces over one or more records in a file.
RWD (IOCS):	rewinds either an input or output file.
RDSF (IOCS):	spaces an input tape forward over a specified number of segment marks.

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.81 Macros (Cont'd)

Code	Description
RDSB (IOCS):	spaces an input tape backward over a specified number of segment marks.
RDLIN (IOCS):	reads data from input label Information Cards.
WSM (IOCS):	writes one or more segment marks on an output file.
CHPT (IOCS):	writes checkpoint record defined by DCHPT descriptive entry.
FEORN (IOCS):	force end-of-reel on an input file.
FEOR (IOCS):	force end-of-reel on an output file.
DEOR (IOCS):	delay end-of-reel after reaching end-of-tape mark and continue writing.

NOTE: Macros marked (IOCS) are available in Autocoder and Four-Tape Autocoder; all others in full Autocoder only.

.82 Pseudos

Code	Description
DA	defines and reserves any portion of storage.
DC:	assigns names to constants.
DRDW:	generates a block definition word.
DSW*:	defines digital switches for use by SETSW and LOGIC macros.
DLINE*:	specified layout of printline area and editing to be performed.
EQU:	assigns a label to an actual or symbolic address.
CODE*:	names a field which may contain a code during processing; names and defines code values.
DIOCS (IOCS)	selects major methods of processing to be used.

.82 Pseudos (Cont'd)

Code	Description
DTF (IOCS):	describes any input or output tape file.
DUF (IOCS):	describes type of file and unit record equipment to be used.
DCHPT (IOCS):	descriptive entry associated with the writing of checkpoint records.
XRESERVE*:	prevents assignment of symbolic names to designated index register.
SRESERVE*:	prevents assignment of symbolic names to designated electronic switches.
XRELEASE*:	releases designated index registers for later assignment
SRELEASE*:	releases designated electronic switches for later assignment.
CNTRL:	used in conjunction with ORIGIN, LITORIGIN, END, BRANCH, XRELEASE, SRELEASE, XRESERVE, SRESERVE.
BRANCH:	causes processor to produce an execute card containing an unconditional branch instruction.
END:	indicates to processor that end of source language program has been reached.
ORIGIN:	instructs processor to begin assignment of succeeding entries at specified location.
LITORIGIN:	causes immediate compilation of all remaining material generated "out-of-line" since last LITORIGIN or beginning of program.

NOTE: Pseudos marked (IOCS) are available in Autocoder and Four-Tape Autocoder; those marked * are available in full Autocoder only.

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PROGRAM TRANSLATOR: AUTOCODER

§181.

.1 GENERAL

.11 Identity: . . . . . IBM 7070 Series Compiler System: Autocoder. "Autocoder 76."

.12 Description

This translator permits utilization of all the facilities of the Autocoder language as described in section 403:171.

Its operation requires at least six magnetic tape units. The translator and its library of macro generators and functions are provided in the 7070 Series Compiler Systems Tape, which also contains the COBOL and FORTRAN processors, the Report Program Generator, and the Input/Output Control System. Up to ten magnetic tape units will be found useful for bulk translating, and on-line unit record input-output devices can be utilized if available.

Additions, alterations, and deletions from the Compiler Systems Tape are handled by a systems run which produces an updated systems tape. New macro generators, written in the Autocoder language, are processed and added to the macro library during a special generator run.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . third quarter, 1960.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 7070/7074 Autocoder.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . magnetic tape and/or punched cards (both forms may be used in a single run).
.222 Obligatory ordering: . . correct sequence according to coding sheet page and line numbers.
.223 Obligatory grouping: . . . none.

.23 Size Limitations

.231 Maximum number of source statements: no practical limit if overlays are used in object program.

.232 Maximum size source statements: . . . . . 75 characters per card; continuation cards may be used with certain instructions.

.233 Maximum number of data items: . . . . . no practical limit.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . . IBM 7070 series machine code.
.313 Output media: . . . . . magnetic tape (punched card deck is optional).

.32 Conventions

.321 Standard inclusions: . . . Input/Output Control System (optional).

.33 Documentation

Subject	Provision
Source program:	magnetic tape listing (on-line printer listing is optional).
Object program:	listing.
Storage map (symbol table):	listing.
Restart point list: . .	none.
Language errors: . . .	listing.
Cross reference table:	listing (with symbol table).
Allocation counter limits:	listing.
Available index words:	listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Systems Control: . . . . supervises the translation process and handles house-keeping functions.
Phase I: . . . . . scans and assigns numbers to source program statements, checks for errors, and prepares input files for Phases II and III.

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.41 Phases and Passes (Cont'd)

Phase II:	converts each macro instruction to a series of symbolic machine instructions.
Phase III:	assigns machine locations to statements and machine addresses to operands; prepares listing and condensed program deck.

.42 Optional Modes

.421	Translate:	yes.
.422	Translate and run:	no.
.423	Check only:	no.
.424	Patching:	no; must alter object deck or retranslate.
.425	Up-dating:	no.

.43 Special Features

.431	Alter to check only:	no.
.432	Fast unoptimized translate:	no.
.433	Short translate on restricted program:	no.

.44 Bulk Translating: yes (at least 7 magnetic tape units are required).

.45 Program Diagnostics

.451	Tracers:	none.
.452	Snapshots:	SNAP macro.
.453	Dumps:	SNAP macro.

.46 Translator Library

.461	Identity:	7070 Series Compiler Systems Tape.
.462	User restriction:	none.
.463	Form	
	Storage medium:	magnetic tape.
	Organization:	alphabetical order by macro or function name; each routine preceded by 16-word identification record.
.464	Contents	
	Routines:	open and closed.
	Functions:	yes; used in ARITH macro.
	Data descriptions:	no.
.465	Librarianship	
	Insertion:	systems or generator run.
	Amendment:	systems run.
	Call procedure:	macro code or function name in ARITH macro.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed Overhead

Name	Space	Comment
Input-Output Control System (optional):	approx. 750 to 2,000 words	depends upon facilities used and number of files.

.512	Space required for each input-output file:	1, 2, or 3 times maximum block length, as specified.
.513	Approximate expansion of procedures:	1.0 (exclusive of macros, which vary widely).

.52 Translation Time

.521 Normal translating (* *)

IBM 7070; 729 IV tape units:	0.007S.
IBM 7072; 7330 tape units:	not available.
IBM 7074; 729 IV tape units:	0.004S.

where S is number of source statements.

.53 Optimizing Data: none.

.54 Object Program Performance: essentially unaffected; decreased if macro codes are used extensively.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611	Minimum configuration:	6 magnetic tape units and 5,000 words of core storage.
.612	Larger configuration advantages:	up to 10 magnetic tape units provide greater flexibility and facilitate bulk translating; two magnetic tape channels and 9,990 core storage locations speed up translation; card reader, punch, and/or printer provide on-line card input, object deck, and/or listing.

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.62 Target Computer

.621 Minimum configuration: . . . . . any IBM 7070, 7072, or 7074 system.

.622 Usable extra facilities: . . . . . all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	type message and halt.
Unsequenced entries:	check	noted in listing.
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	check	noted in listing.
Inconsistent program:	checks on some macros	noted in listing.
Input-output errors:	various checks	type message and halt.

.8 ALTERNATIVE TRANSLATORS: . . . . . none.

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PROGRAM TRANSLATOR: FOUR-TAPE AUTOCODER

§182.

.1 GENERAL

.11 Identity: . . . . . IBM 7070/74 Four-Tape Autocoder. "Autocoder 74."

.12 Description

This translator was designed for use in installations having a 7070, 7072, or 7074 system with four or five magnetic tape units. It provides most of the advantages of the full Autocoder system, but its ability to process macro codes is limited to simple substitution-type macros, in contrast to the powerful macro generation capability of full Autocoder. There are also a number of minor limitations on the use of the Input/Output Control System (IOCS), and seven of the Autocoder pseudo instructions have not been implemented.

The Four-Tape Autocoder system includes a library of subroutines and macro instructions. The only macros supplied by the manufacturer (other than those in IOCS) are ZSUM, which sums up to seven items and stores the result, and CALL, which calls a library subroutine and sets up a linkage to it. Additions, corrections, and deletions to the library are handled by special system runs. Changes to a previously assembled routine are facilitated by a special reassembly run which uses as input the edited listing tape from the original assembly and Autocoder statements specifying the changes to be made. Since Four-Tape Autocoder and Full Autocoder use different types of macros, neither translator can process routines written for the other unless no macro codes are used.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . third quarter, 1960.

.2 INPUT

.21 Languages

.211 Name: . . . . . IBM 7070/7074 Autocoder.
.212 Exemptions: . . . . . no macro generators (substitution-type macros are used instead); numeric constants limited to 10 digits; Input/Output Control System is less flexible than in full Autocoder; 7 pseudos are not available.

.22 Form

.221 Input media: . . . . . magnetic tape or punched cards.
.222 Obligatory ordering: . . correct sequence according to coding sheet page and line numbers.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . . . . no practical limit if overlays are used in object program.
.232 Maximum size source statements: . . . . . 75 characters per card.
.233 Maximum number of data items: . . . . . no practical limit.
.234 Maximum number of library items: . . . . 196 macros and/or subroutines.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 7070 machine code.
.313 Output media: . . . . . magnetic tape and/or punched cards.

.32 Conventions

.321 Standard inclusions: . . Input/Output Control System (optional).

.33 Documentation

Subject	Provision
Source program:	listing on magnetic tape and/or on-line printer.
Object program:	listing.
Storage map (symbol table):	listing.
Restart point list: . . .	none.
Language errors: . . .	listing.
Available index words:	listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Systems Control: . . . . supervises the translation process.
Phase I: . . . . . reads source program, checks sequence, inserts skeleton routines in place of macro codes, generates subroutine linkages, and types error messages.

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.41 Phases and Passes (Cont'd)

Phase II:	checks operation codes for validity and converts them to machine codes, generates symbol table, allocates storage locations and processes operands insofar as possible.
Phase III:	checks for duplicate labels, assigns operand addresses, assigns index word and electronic switch numbers. (Phase III is repeated if number of labels exceeds core storage capacity).
Phase IV:	packs literals into storage locations, checks all instructions for completeness, writes object program tape and edited listing tape (plus on-line card deck and listing if elected).

.42 Optional Modes

.421 Translate:	yes.
.422 Translate and run:	no.
.423 Check only:	no.
.424 Patching:	yes; re-assembly run makes corrections, additions or deletions to previously assembled listing tape.
.425 Up-dating:	yes; re-assembly run.

.43 Special Features

.431 Alter to check only:	no.
.432 Fast unoptimized translate:	no.
.433 Short translate on restricted program:	no.
.44 Bulk Translating:	yes; at least 5 magnetic tape units are required.
.45 Program Diagnostics:	none; can be added to library by user.

.46 Translator Library

.461 Identity:	Four-Tape Autocoder Library.
.462 User restriction:	none.
.463 Form	
Storage medium:	magnetic tape.
Organization:	alphabetical order by routine name.
.464 Contents	
Routines:	open and closed.
Functions:	yes.
Data descriptions:	no.
.465 Librarianship	
Insertion:	yes, system run.
Amendment:	yes; system run.
Call procedure:	macros by name; subroutines by name in operand of CALL macro.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name:	Input-Output Control System (optional).
Space:	approx. 750 to 2,000 words.
Comment:	depends upon facilities used.
.512 Space required for each input-output file:	1, 2, or 3 times maximum block length, as specified.
.513 Approximate expansion of procedures:	1.0 (exclusive of macros, which vary widely).

.52 Translation Time

.521 Normal translating:	not available.
.53 Optimizing Data:	none.
.54 Object Program Performance:	essentially unaffected; decreased if macro codes are used extensively.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration:	4 magnetic tape units and 5,000 words of core storage.
.612 Larger configuration advantages:	9,990 words of core storage, two tape channels, and/or fifth magnetic tape unit speed up translation; card reader, punch, and/or printer provide on-line card input, object deck, and/or listing.

.62 Target Computer

.621 Minimum configuration:	any IBM 7070, 7072, or 7074 system.
.622 Usable extra facilities:	all.

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.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	type message and continue.
Unsequenced entries:	check	type message and continue.
Duplicate names:	check	type message and continue.
Improper format:	check	type message and continue.
Incomplete entries:	check	type message and continue.
Target computer overflow:	check	type message and continue.
Inconsistent program:	none.	
Input-output errors:	check	type message and halt.

.8 ALTERNATIVE TRANSLATORS: . . . . . none.

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PROGRAM TRANSLATOR: BASIC AUTOCODER

§ 183.

.1 GENERAL

.11 Identity: . . . . . IBM 7070/74 Basic Autocoder.
"Autocoder 72".

.12 Description

The Basic Autocoder system was designed for card-only 7070 or 7074 systems. It uses a subset of the Autocoder language, but most of the refinements have been eliminated. Neither macro codes nor the Input/Output Control System can be used, and maximum operand length is reduced from 55 to 40 characters. Translator input and output are normally on punched cards, and two card passes are required for an assembly. There is a strict one-to-one correspondence between imperative statements in the source routine and machine instructions in the object routine. Routines written in Basic Autocoder can be processed by any of the three versions of the Autocoder translator and can utilize all hardware facilities of the 7070 series.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . third quarter, 1960

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 7070/7074 Autocoder.
.212 Exemptions: . . . . . no macro codes; maximum operand length is 40 characters; numeric constants limited to 10 digits; Input/Output Control System is not available; 7 pseudos are not available.

.22 Form

.221 Input media: . . . . . punched cards or magnetic tape.
.222 Obligatory ordering: . . correct sequence according to coding sheet page and line numbers.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage capacity.
.232 Maximum size source statements: . . . . . 60 characters per card.
.233 Maximum number of data items: . . . . . limited by core storage capacity of translating computer; 700 to 1,100 symbols with 5K core storage and 2,300 to 3,500 with 10K.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . . IBM 7070 series machine code.
.313 Output media: . . . . . punched cards.

.32 Conventions

.321 Standard inclusions: . . none.

.33 Documentation

Subject	Provision
Source program:	listing or symbolic card deck.
Object program:	listing or symbolic card deck.
Storage map:	none.
Restart point list: . . .	none.
Language errors: . . .	typed messages.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Pass 1: . . . . . performs checks, reserves storage for data and instructions, prepares symbol table and assigns addresses.
Pass 2: . . . . . processes operation codes and operands, types error messages, and prepares the object deck and listing.

.42 Optional Mode

.421 Translate: . . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . no.
.424 Patching: . . . . . no.
.425 Up-dating: . . . . . no.

.43 Special Features

.431 Alter to check only: . . . no.
.432 Fast unoptimized translate: . . . . . no.

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.433 Short translate on restricted program: .. no.

.44 Bulk Translating: . . . . no.

.45 Program Diagnostics: none.

.46 Translator Library: . . . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . . none.
.512 Space required for each input-output file: . . . . . variable.
.513 Approximate expansion of procedures: . . 1.0.

.52 Translation Time

.521 Normal translating: . . . not available.

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . unaffected; i.e., same as hand coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: . . . . . 5,000 words of core storage, card reader, and card punch.

.612 Larger configuration advantages: . . . . . second card punch eliminates need for sorting object and symbolic output decks; printer provides on-line listing; one magnetic tape unit handles symbolic output for off-line listing; second tape unit handles source program input, replacing card reader.

.62 Target Computer

.621 Minimum configuration: . . . . . any IBM 7070, 7072, or 7074 system.
.622 Usable extra facilities: all.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	type message.
Unsequenced entries:	check	type message.
Duplicate names:	check	type message.
Improper format:	check	type message.
Incomplete entries:	check	type message.
Target computer overflow:	check	type message.
Inconsistent program:	none	
Input-output errors:	check	type message and halt.

.8 ALTERNATIVE TRANSLATORS

Computer	Identity	Date	Comment
IBM 650:	"Assembly and Condensing of 7070 Basic Autocoder Programs on the IBM 650", IBM form J28-6041-1	August, 1960	handles Basic Autocoder language only, on card 650 with alphabetic and special character devices.

PROGRAM TRANSLATOR: COBOL 61

§ 184.

.1 GENERAL

.11 Identity: . . . . . IBM 7070/7074 COBOL Processor.

.12 Description

The COBOL Processor accepts source programs written in the IBM 7070/7074 COBOL language, described in section 403:161. A number of the language facilities, however, have not been implemented in this version of the processor; these "deferred features" are listed in item .212. Probably the most significant omissions are the EXAMINE verb and several useful features of the PICTURE clause.

Conversion from COBOL source statements to 7070 series machine language instructions is a two-stage process. The COBOL Processor generates a set of symbolic instructions in Autocoder language; these are converted to the machine language object routine by the Autocoder translator. Since both the COBOL and Autocoder translators are contained in the 7070 series Compiler Systems Tape, the entire translation process is automatic.

Operation of the COBOL Processor requires 9,990 core storage locations and at least seven magnetic tape units. There is no provision for bulk translating. When a source language error is detected, the erroneous entry and a diagnostic message are written on magnetic tape. Whenever possible, an assumption is made about the programmer's intent and processing continues.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . February, 1962

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 7070/7074 COBOL.

.212 Exemptions

Procedure Division

1. The CORRESPONDING option of the MOVE verb.
*2. The EXAMINE verb, including the TALLY register.
*3. Class conditions in conditional statements.
*4. Numeric literals in DISPLAY statements.
*5. The figurative constant ALL.
*6. Truncation of arithmetic results; the ROUNDED option is standard.

.212 Exemptions (Contd)

Data Division

*1. The JUSTIFIED clause.
*2. The BLANK WHEN ZERO clause as applied to output data.
*3. The CHECK PROTECT clause.
*4. The figurative constant ALL.
*5. The COPY option.
*6. The following PICTURE characters:
   a. preceding + and - signs.
   b. floating + and - signs.
   c. asterisk (check protect).
   d. zero and blank as insertion characters.
   e. Z if preceded by another character.
   f. V (implied decimal point) in a report item.

Environment Division

*1. The COPY option.
*2. The OPTIONAL clause of the FILE-CONTROL paragraph.
*3. Automatic allocation of object computer input-output devices.

* Denotes that the exempted facility is part of Required COBOL - 1961.

.22 Form

.221 Input media: . . . . . magnetic tape or punched cards.

.222 Obligatory ordering: . . Identification Division. Environment Division. Data Division. Procedure Division.

.223 Obligatory grouping: . . by division and section.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage capacity.

.232 Maximum size source statements: . . . . . ?

.233 Maximum number of data items: . . . . . ?

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 7070 series machine code.

.313 Output media: . . . . . magnetic tape; optional on-line punched card deck.

.32 Conventions

.321 Standard inclusions: . . Input-Output Control System.

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.33 Documentation

Subject	Provision
Source program:	listing (card images on magnetic tape).
Object program:	listing (in Autocoder form).
Storage map:	listing.
Restart point list:	none.
Language errors:	listing (typed messages explain error halts).

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Part I (COBOL Processor):	source program is converted to Autocoder symbolic form.
Part II (Autocoder Translator):	Autocoder statements are converted to machine code.

.42 Optional Mode

.421	Translate:	yes.
.422	Translate and run:	no.
.423	Check only:	no.
.424	Patching:	no.
.425	Up-dating:	no.

.43 Special Features

.431	Alter to check only:	no.
.432	Fast unoptimized translate:	no.
.433	Short translate on restricted program:	no.

.44 Bulk Translating: . . . no.

.45 Program Diagnostics: . none.

.46 Translator Library: . . none.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
Input-Output Control System:	approx. 750 to 2,000 words	depends upon facilities used and number of files.

.512 Space required for each input-output file: . . . controlled by user; RESERVE ... ALTERNATE AREAS.

.513 Approximate expansion of procedures: . . . . average is 5 to 10 machine instructions per elementary procedural statement (**).

.52 Translation Time

.521 Normal translating (***)
(typical total times per source program line, based upon limited user operating experience)

IBM 7070; 729 IV tape units:	10 seconds.
IBM 7072; 7330 tape units:	not available.
IBM 7074; 729 IV tape units:	5 seconds.

.53 Optimizing Data: . . . . none.

.54 Object Program Performance: . . . . . limited data available; manufacturer estimates that overall time and space requirements will be about 1.4 times the requirements for good hand coding.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611	Minimum configuration:	7 magnetic tape units and 9,990 words of core storage.
.612	Larger configuration advantages:	card reader provides on-line card input; printer lists error messages on-line.

.62 Target Computer

.621	Minimum configuration:	any IBM 7070 series system.
.622	Usable extra facilities:	up to 10,000 core storage locations, magnetic tape units, card readers, punches, printers.

.7 ERRORS, CHECKS AND ACTION

Errors	Check or Interlock	Action
Missing entries:	check	halt; type message.
Unsequenced entries:	check	error message.
Duplicate names:	check	error message.
Improper format:	checks	error message.
Incomplete entries:	checks	error message.
Target computer overflow:	check	error message.
Inconsistent program:	checks	error message.
Use of "deferred" feature:	checks	error message.
Translator storage overflow:	checks	error message.
Input-output error:	checks	halt; type message.

Note: In all above cases except the first and last, assumptions about the data are made automatically and processing continues.

.8 ALTERNATIVE TRANSLATORS: . . . none.

PROGRAM TRANSLATOR: FORTRAN

§ 185.

.1 GENERAL

.11 Identity: . . . . . IBM 7070 Series Compiler System: FORTRAN Processor. "Full FORTRAN".

.12 Description

This translator permits utilization of all the facilities of the 7070/7074 FORTRAN language as described in section 403:162.

The FORTRAN Processor is part of the 7070 Series Compiler Systems Tape, which also contains the Autocoder and COBOL Processors, the Report Program Generator, and the Input/Output Control System. At least six magnetic tape units are required for its operation, and up to ten tape units will be found useful for bulk translating. On-line unit record input-output devices can be utilized if available. The optional Floating Decimal Arithmetic feature will speed up execution of the object routine. There is no provision for overlapping input-output operations and computation in the object routine.

The FORTRAN Processor converts each FORTRAN source program into a set of symbolic machine instructions and macro codes in the Autocoder language, which is then converted by the Autocoder Processor into a machine language object routine. The translation process is fully automatic. At execution time, the object routine can be loaded anywhere in core storage by means of the FORTRAN Relocatable Loader. The relocatability feature permits several routines that have been compiled separately to be loaded at the same time. FORMAT statements are executed interpretively at run time.

.13 Originator: . . . . . IBM Data Systems Division, Programming Systems.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . 1961.

.2 INPUT

.21 Language

.211 Name: . . . . . 7070/7074 FORTRAN.
.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards or magnetic tape.
.222 Obligatory ordering: . . all statements must be in correct sequence.
.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage.
.232 Maximum size source statements: . . . . . 660 char (10 cards).
.233 Maximum number of data items
Nonsubscripted: . . . 290.
Subscripted: . . . . . 290.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 7070 series machine code.
.313 Output media: . . . . . magnetic tape (on-line punched card deck is optional).

.32 Conventions

.321 Standard inclusions: . . FORTRAN Package (includes input-output, floating point arithmetic, float, fix, log, and exponential subroutines).
.322 Compatible with: . . . . PEST monitor routine (see 403:191).

.33 Documentation

Subject	Provision
Source program: . . .	listing on magnetic tape or on-line printer.
Object program: . . .	listing (in Autocoder language).
Storage map:	listing.
Restart point list: . .	none.
Language errors: . .	typed messages and listing.

.4 TRANSLATING PROCEDURES

.41 Phases and Passes

Part I: . . . . . converts FORTRAN source statements into Autocoder statements.
Part II (Autocoder): . . assembles the object program in machine language.

.42 Optional Modes

.421 Translate: . . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . no.
.424 Patching: . . . . . no (but individual segments can be recompiled separately).
.425 Up-dating: . . . . . no.

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.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate:. . . . . no.
.433 Short translate on restricted program: . . no.

.44 Bulk Translating: . . . yes; multi-file run compiles two or more independent programs and writes all output on same tapes.

.45 Program Diagnostics: none (tracers, snapshots, and dumps can be handled by the PEST monitor).

.46 Translator Library

.461 Identity: . . . . . FORTRAN library, on 7070 Series Compiler Systems Tape.
.462 User restriction: . . . general.
.463 Form
Storage medium: . . . magnetic tape.
Organization:. . . . . alphabetical order by internal name.
.464 Contents
Routines: . . . . . closed.
Functions: . . . . . yes.
Data descriptions: . . no.
.465 Librarianship
Insertion:. . . . . systems run.
Amendment: . . . . . systems run.
Call procedure: . . . named in procedural statement.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead

Name	Space	Comment
FORTRAN Package:	960 locations	FORMAT interpreter, I/O, fix, float, log, exponential routines, etc.
Relocatable Loader:	743 locations	area can be used for object program data.
Special hardware functions:	325 locations	indexing and status words, etc.

.512 Space required for each input-output file:. . . . . single I/O area serves all files.
.513 Approximate expansion of procedures: . . . . averages 5 to 6 machine instructions per FORTRAN statement (**).

.52 Translation Time

.521 Normal translating (**)
System overheads
IBM 7070; 729 IV tape units:. . . . . 8 minutes.
IBM 7072; 7330 tape units: . . . . . not available.
IBM 7074; 729 IV tape units:. . . . . 5 minutes.
Approximate total times per source statement, for typical routines of around 100 statements.
IBM 7070; 729 IV tape units: . . . . . 6 seconds.
IBM 7072; 7330 tape units: . . . . . not available.
IBM 7074; 729 IV tape units:. . . . . 3.5 seconds.

.53 Optimizing Data:. . . . none.

.54 Object Program Performance

Type	Time	Space
Elementary algebra:	unaffected	unaffected.
Complex formulae:	unaffected	unaffected.
Deep nesting:	increased	increased.
Heavy branching:	unaffected	unaffected.
Complex subscripts:	increased	increased.
Overlapping operations:	not possible.	
Data editing (FORMAT):	increased greatly	unaffected.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 6 magnetic tape units and 5,000 words of core storage.
.612 Larger configuration advantages:. . . . . up to 10 magnetic tape units provide greater flexibility and facilitate bulk translating; 2 tape channels and more core storage speed up translation; card reader, punch, and/or printer provide on-line card input, object deck, and/or listing.

.62 Target Computer

.621 Minimum configuration: . . . . . any IBM 7070, 7072, or 7074 system.
.622 Usable extra facilities: all magnetic tape units; on line card reader, punch, and printer; additional core storage; Floating Decimal Arithmetic.

§ 185.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	type message and halt.
Unsequenced entries:	none.	
Duplicate names:	check	noted in listing.
Improper format:	check	noted in listing.
Incomplete entries:	check	noted in listing.
Target computer overflow:	check	noted in listing.
Inconsistent program:	checks	noted in listing.
Size limitations exceeded:	checks	noted in listing.

.8 ALTERNATIVE TRANSLATORS: . . . . . none.

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PROGRAM TRANSLATOR: BASIC FORTRAN

§ 186.

.1 GENERAL

.11 Identity: . . . . . IBM 7070 Basic FORTRAN.

.12 Description

Basic FORTRAN was designed for use on systems with fewer magnetic tape units than the six required for full 7070/7074 FORTRAN. Either a card reader or a magnetic tape unit can be used to read in the FORTRAN source program. Conversion to symbolic Basic Autocoder form is accomplished in a single pass. Output of the symbolic routine can be on a card punch, printer, or magnetic tape unit. Any one of the three Autocoder translators may then be used to translate the symbolic routine into machine language form. All FORMAT statements are executed interpretively at run time.

The IBM 7070 Basic FORTRAN language is a proper subset of full 7070/7074 FORTRAN. The principal differences between the two versions are as follows:

1. Subroutines and functions cannot be defined and used in Basic FORTRAN; i.e., the CALL, SUBROUTINE, FUNCTION, RETURN, and COMMON statements are not implemented.

2. Basic FORTRAN allows a maximum of two subscripts per item, versus three for full FORTRAN.

3. Data names are limited to five characters in Basic FORTRAN, versus six in full FORTRAN.

4. Size limitations on the source program are more severe in Basic FORTRAN (see item .23).

.13 Originator: . . . . . IBM Data Systems Division, Programming Systems.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . June, 1960.

.2 INPUT

.21 Language

.211 Name: . . . . . 7070 Basic FORTRAN (a subset of 7070/7074 FORTRAN).

.212 Exemptions: . . . . . subroutines and functions cannot be defined; see also size limitations in item .23.

.22 Form

.221 Input media: . . . . . punched cards or magnetic tape.

.222 Obligatory ordering: . . all statements must be in correct sequence.

.223 Obligatory grouping: . . none.

.23 Size Limitations

.231 Maximum number of source statements: . . limited by target computer storage.

.232 Maximum size source statements: . . . . . 660 characters (10 cards).

.233 Maximum number of data items: . . . . . $2S + N \leq 200$, where S and N are the numbers of subscripted and nonsubscripted variables, respectively.

.234 Others

Pairs of parentheses:	50 per statement.
Constants:	40 per statement.
Subscripts:	64 per statement; 2 per data item.
DO loop nesting limit:	27.
User function subroutines:	20 per source program.
Names:	5 characters max.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . Basic Autocoder.

.312 Language style: . . . . symbolic; translatable to machine code by any of the Autocoder translators.

.313 Output media: . . . . . punched cards or magnetic tape.

.32 Conventions

.321 Standard inclusions: . . none (FORTRAN Package, Relocatable Loader, and all required subroutines must be loaded at execution time).

.33 Documentation

Subject	Provision
Source program: . . .	listing.
Object program: . . .	listing (on-line printer or magnetic tape).
Storage map:	none.
Restart point list: . .	none.
Language errors: . .	typed messages.

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.4 TRANSLATING PROCEDURE

.41 Phases and Passes: . . one-pass compiler.

.42 Optional Modes

.421 Translate: . . . . . yes.
.422 Translate and run: . . . no.
.423 Check only: . . . . . no.
.424 Patching: . . . . . no.
.425 Up-dating: . . . . . no.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . no.
.433 Short translate on restricted program: . no.

.44 Bulk Translating: . . . yes; press Start key to initiate compilation of each successive routine.

.45 Program Diagnostics: . none.

.46 Translator Library

.461 Identity: . . . . . FORTRAN library.
.463 Form
Storage medium: . . . punched cards.
Organization: . . . . . absolute relocatable form.
.464 Contents
Routines: . . . . . no.
Functions: . . . . . yes (closed subroutines).
Data descriptions: . . no.
.465 Librarianship
Insertion: . . . . . yes.
Amendment: . . . . . yes; switch cards.
Call procedure: . . . name in procedural statement sets up linkage; subroutine must be loaded with object deck.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . total of 1,250 core storage locations for FORTRAN package, indexing words, tape status words, etc.

.512 Space required for each input-output file: . . . single I/O area serves all files.

.513 Approximate expansion of procedures: . . . . averages 5 to 6 machine instructions per FORTRAN statement (**).

.52 Translation Time: . . . not available.

.53 Optimizing Data: . . . . none.

.54 Object Program Performance

Type	Time	Space
Elementary algebra	unaffected	unaffected.
Complex formulae	unaffected	unaffected.
Deep nesting	increased	increased.
Heavy branching	unaffected	unaffected.
Complex subscripts	increased	increased.
Data editing (FORMAT)	increased greatly	unaffected.
Overlapping operations	not possible.	

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 5,000 words of core storage; card reader or magnetic tape unit for input; card punch, printer, and/or magnetic tape unit for output.

.612 Larger configuration advantages: . . . . . none.

.62 Target Computer

.621 Minimum configuration: any IBM 7070, 7072, or 7074 system.

.622 Usable extra facilities: all magnetic tape units; on-line card reader, punch, and printer; additional core storage; Floating Decimal Arithmetic.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	typed message.
Unsequenced entries:	none.	
Duplicate names:	none.	
Improper format:	check	typed message.
Incomplete entries:	check	typed message.
Target computer overflow:	none	checked by assembler.
Inconsistent program:	checks	typed message.
Size limitations exceeded:	checks	typed message.

Note: Each typed message includes the first 40 characters of the erroneous statement. Processing continues after the message is typed.

.8 ALTERNATIVE TRANSLATORS: . . . none.

OPERATING ENVIRONMENT: PEST

§ 191.

.1 GENERAL

.11 Identity: . . . . . University of Pittsburgh Executive System for Tapes. PEST.

Originator and maintainer: . . . . . Mr. Russell Ranshaw, University of Pittsburgh.

Source of information: . Mr. Lee Ohringer, University of Pittsburgh.

.12 Description

No comprehensive operating system has been made available for the 7070 series by the manufacturer. The Compiler Systems Tape automates the compilation of programs written in the Autocoder, COBOL, FORTRAN, and Report Program Generator languages, but provides no control over execution of the object routines. The Procedure for Automatic Testing (PAT), described in 403:151.17, facilitates the testing of object routines. Other Operating Environment facilities must, in general, be provided by individual subroutines, by the Input/Output Control System, or by the user's own coding.

The University of Pittsburgh Executive System for Tapes (PEST) is an integrated supervisor routine developed by a 7070 user; the remainder of this report section describes the facilities it provides.

Control cards are read by the PEST routine, and the information from them is stored in "hidden memory" (ten locations which are never available to the user through normal programming). PEST then calls the necessary routines from the system tape and initiates the performance of FORTRAN compilations, Autocoder assemblies, program listings, object program executions, storage dumps, or other operations specified on the control card. In FORTRAN programs compiled by PEST, a STOP statement is translated into a 10-step routine that will return control to the PEST system. A macro instruction is provided to accomplish the same function in routines written in Autocoder.

The PEST system requires at least three magnetic tape units to handle the input, output, and systems tapes. The existence of an IBM 1401 for off-line data transcriptions is assumed. The program translators that have been incorporated into the PEST system are Four-Tape Autocoder (Autocoder 74) and an extended version of Basic FORTRAN that permits the insertion of Autocoder instructions into the FORTRAN source routine. The COBOL Processor has not been incorporated.

.13 Availability: . . . . . first used in April, 1961; all features mentioned here are currently functioning.

.2 PROGRAM LOADING

.21 Source of Programs

.211 Libraries: . . . . . PEST system library (on magnetic tape) contains pre-assembled routines which user can select by preceding his data with the appropriate parameter card.

.212 Independents: . . . . . EXECUTE causes loading and execution of the routine currently in position in the input unit.

.22 Library Subroutines: Autocoder 74 macro library and Basic FORTRAN function library are included in PEST system; a simple up-date process is provided.

.23 Loading Sequence: . . . routines are normally loaded sequentially from magnetic tape; sequence may be altered by entering number of routine to be run into accumulator 1.

.3 HARDWARE ALLOCATION

.31 Storage

.311 Sequencing of program for movement between levels: . . . . . any routine can be segmented by the insertion before assembly of Autocoder BRANCH CONTROL statements.

.312 Occupation of working storage: . . . . . all core storage is available to the user.

.313 Choice of location: . . . relocation codes are punched into object decks; routines can be loaded anywhere in core storage.

.32 Input-Output Units

.321 Initial assignment: . . . specified when program is written.

.322 Alternation: . . . . . tape swapping can be specfied in IOCS entries.

.323 Reassignment: . . . . . operator can at all times choose which physical tape units shall be used.

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.4 RUNNING SUPERVISION

.41 Simultaneous Working: as incorporated in program.

.42 Multiprogramming: . . as incorporated in program.

.43 Multisequencing: . . . . none.

.44 Errors, Checks, and Action

Error	Check or Interlock	Action
Loading input error:	none.	
Allocation impossible:	none.	
In-out error - single:	IOCS checks	repeat operation.
In-out error - persistent:	IOCS checks	halt and type message.
Overflow:	hardware checks	halt or set indicator.
Invalid instructions:	none.	
Program conflicts:	none.	
Control card error:	check	note in listing and bypass program.

.45 Restarts

.451 Establishing restart points: . . . . . DCHPT entry in IOCS causes checkpoint records to be written before processing of each input and/or output reel or when CHPT macro occurs in routine.

.452 Restarting process: . . load restart sequence number into accumulator 1 and transfer control to PEST system.

.5 PROGRAM DIAGNOSTICS

.51 Dynamic

.511 Tracing: . . . . . trace routines have been modified for use within the PEST system.

.512 Snapshots: . . . . . SNAPSHOT, which lists the contents of a specified core storage area when a certain point is reached in the program, has been rewritten for use with PEST.

.52 Post-Mortem: . . . . . dumps of selected portions of core storage are made after execution of a program if specified on control card; the dumps may be made unconditionally or only if an error has occurred.

Note: FORTRAN source programs are run through a pre-scan routine which can detect approximately 80 different types of errors. If any errors are found, they are listed and compilation of the program is bypassed.

.6 OPERATOR CONTROL

.61 Signals to Operator

.611 Decision required by operator: . . . . . not required; necessary information is specified on control cards.

.612 Action required by operator: . . . . . off-line IBM 1401 lists operator actions required as it prepares the input file.

.613 Reporting progress of run: . . . . . console typewriter types log, including time used for each operation.

.62 Operator's Decision: . Alteration Switches.

.63 Operator's Signals

.631 Inquiry: . . . . . none.

.632 Change of normal progress: . . . . . methods are available to abandon a run, to alter the sequence of routines in a queue and to reallocate equipment.

.7 LOGGING

.71 Operator Signals: . . . console typewriter.

.72 Operator Decisions: . . console typewriter.

.73 Run Progress: . . . . . console typewriter, output listing, and punched summary cards.

.74 Errors: . . . . . some recorded on output listing.

.75 Running Times: . . . . console typewriter, user's output, and punched summary cards.

.76 Multi-running Status: . none.

.8 PERFORMANCE

.81 Program Loading Time: . . . . . not available; system is fully automatic and quite efficient.

.82 Reserved Equipment: . 3 magnetic tape units (input, output, and system tapes).

.83 Running Overhead: . . . very low; normal computer performance is essentially unaffected.

IBM 7070
SYSTEM PERFORMANCE

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IBM 7070 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1										
Worksheet	Item		Configuration						Reference
			III		VII B		VIII B		
1 Input-Output Times	Char/block	(File 1)	1,080		1,080		1,080		4:200.112
	Records/block	K (File 1)	10		10		10		
	m.sec/block	File 1 = File 2	38.5		26.1		20.8		
		File 3	120		10.1		9.7		
		File 4	400		10.7		10.1		
	m.sec/switch	File 1 = File 2	0		0		0		
		File 3	0		0		0		
		File 4	0		0		0		
	m.sec penalty	File 1 = File 2	1.2		1.2		1.2		
		File 3	6		0.1		0.1		
		File 4	6		0.1		0.1		
2 Central Processor Times	m.sec/block	a1	0.8		0.8		0.8		4:200.1132
	m.sec/record	a2	1.9		1.9		1.9		
	m.sec/detail	b6	2.5		2.5		2.5		
	m.sec/work	b5 + b9	7.5		7.5		7.5		
	m.sec/report	b7 + b8	14.7		14.7		14.7		
3 Standard Problem A F = 1.0	m.sec for C.P. and dominant column.	a1	0.8		0.8		0.8		4:200.114
		a2 K	18.7		18.7		18.7		
		a3 K	247.8		247.8		247.8		
		File 1 Master In	1.2		1.2		1.2		
		File 2 Master Out	1.2		1.2	26.1	1.2		
		File 3 Details	60.0		1.0		1.0		
		File 4 Reports	60.0	4000	1.0	107.0	1.0	101.0	
		Total	389.7	4000	271.7	133.1	271.7	101.0	
4 Standard Problem A Space	Unit of measure	(words)							4:200.1151
		Std. routines	1,500		1,500		1,500		
		Fixed	247		247		247		
		3 (Blocks 1 to 23)	102		102		102		
		6 (Blocks 24 to 48)	792		792		792		
		Files	864		880		880		
		Working	32		32		32		
		Total	3,537		3,553		3,553		

IBM 7070 SYSTEM PERFORMANCE–Contd.

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration III	Configuration VII B	Configuration VIII B	Reference
5 Standard Mathematical Problem A	Fixed/Floating point				Floating*	Floating*	4:200.413
	Unit name		input		729 IV	729 VI	
			output		729 IV	729 VI	
	Size of record		input		80 char (unblocked)	80 char (unblocked)	
			output		100 char (unblocked)	100 char (unblocked)	
	m.sec/block		input T1		10.1	9.7	
			output T2		10.4	9.9	
	m.sec penalty		input T3		0.1	0.1	
			output T4		0.1	0.1	
	m.sec/record		T5		2.3	2.3	
	m.sec/5 loops		T6		60.1	60.1	
	m.sec/report		T7		5.9	5.9	
7 Standard Statistical Problem A	Unit name				729 IV	729 VI	4:200.512
	Size of block				30 char	30 char	
	Records/block		B		1	1	
	m.sec/block		T1		9.8	9.5	
	m.sec penalty		T3		0.1	0.1	
	C. P.	m.sec block	T5		– –	– –	
		m.sec record	T6		2.9	2.9	
		m.sec table	T7		0.77	0.77	

* Using optional Floating Decimal Arithmetic feature.

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SYSTEM PERFORMANCE

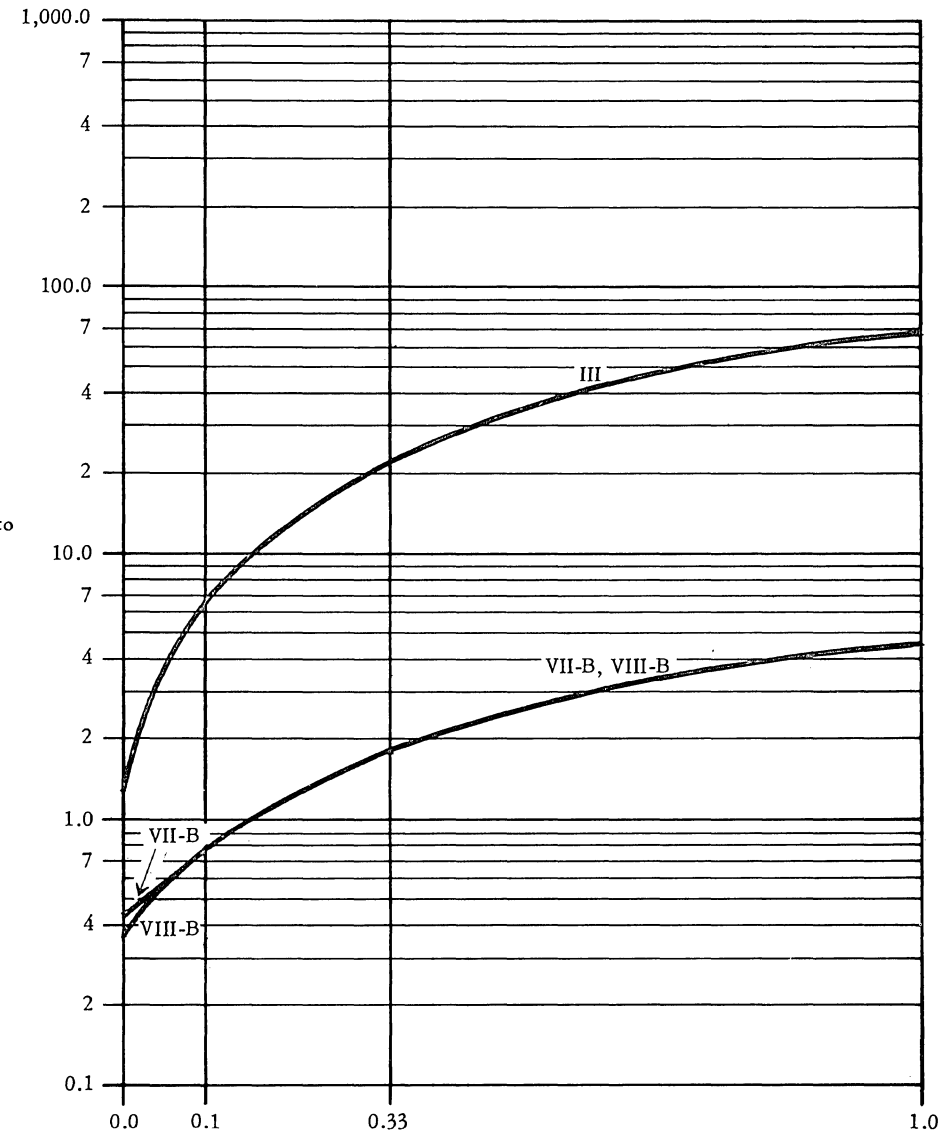
§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A Estimates

.111 Record sizes
Master file: . . . . 108 characters.
Detail file: . . . . 1 card.
Report file: . . . . 1 line.

.112 Computation: . . . . standard.
.113 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.113
.114 Graph: . . . . . see graph below.
.115 Storage space required
Configuration III: . . . 3,500 words.
Configuration VII B: .. 3,500 words.
Configuration VIII B: . 3,500 words.



Time in Minutes to Process 10,000 Master File Records

Activity Factor
Average Number of Detail Records Per Master Record

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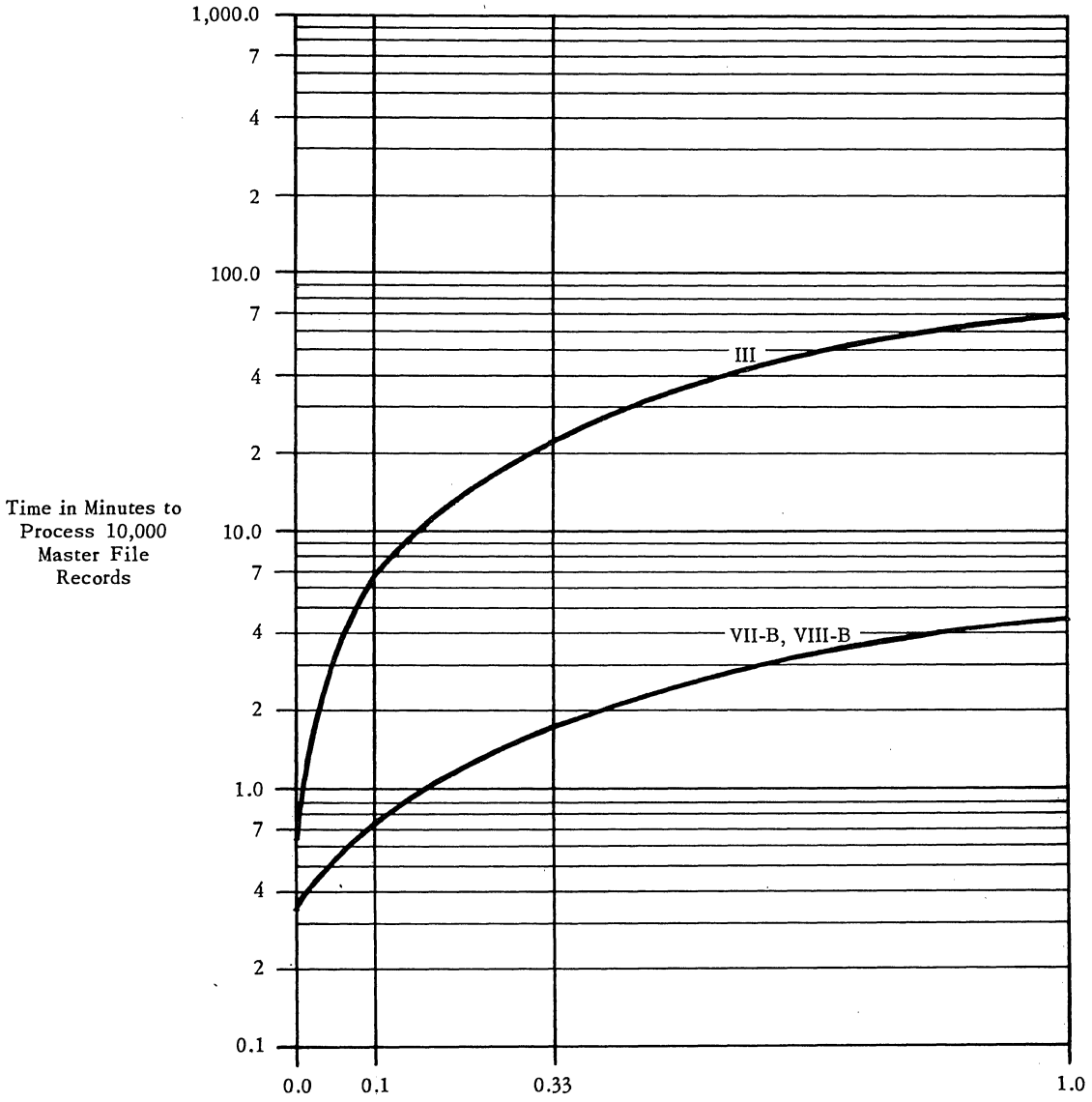
§ 201.
.12 Standard File Problem B Estimates

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in User's Guide, 4:200.12
.124 Graph: . . . . . see graph below.

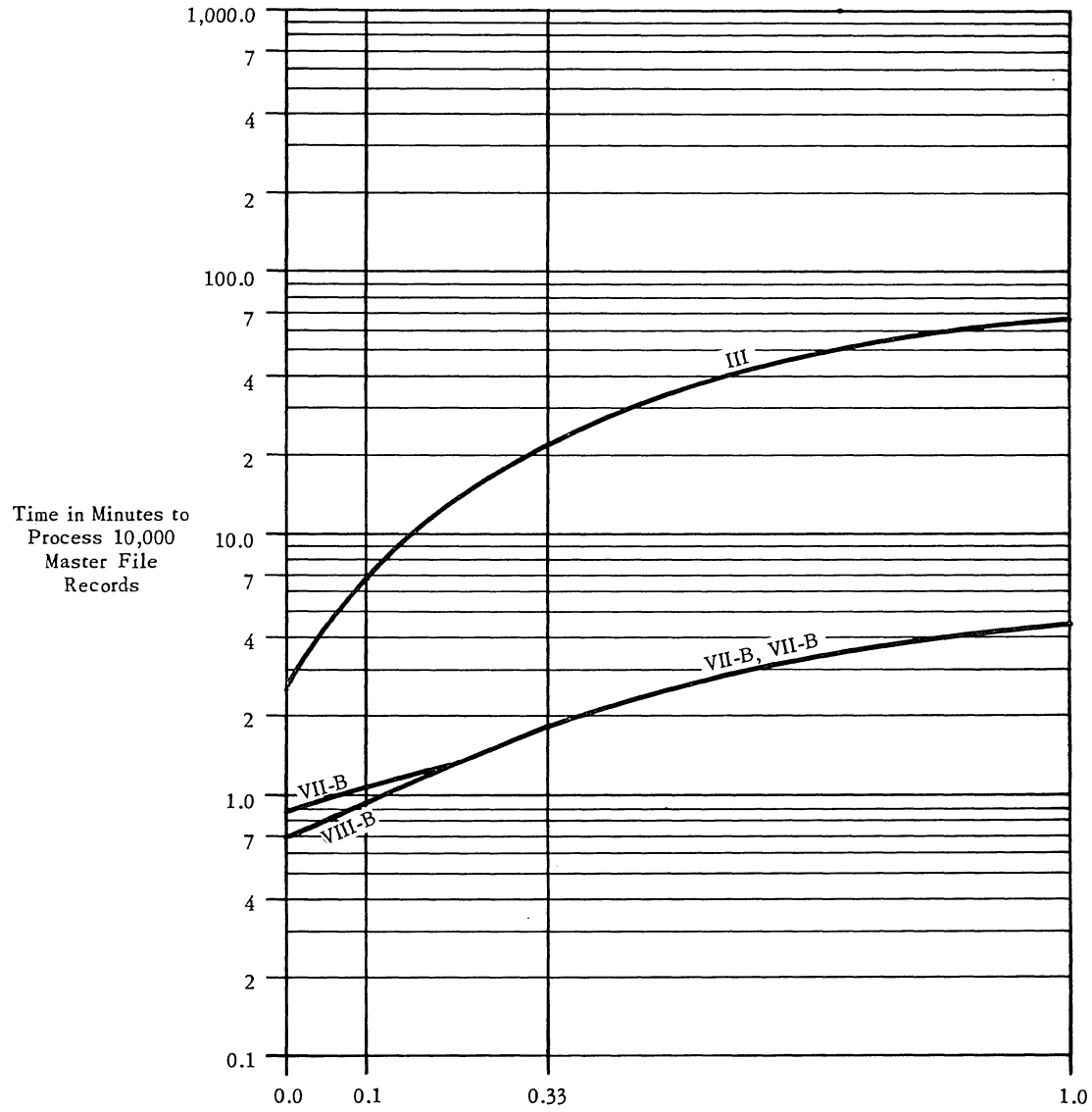


§ 201.

.13 Standard File Problem C Estimates

.131 Record sizes
Master file: . . . . 216 characters.
Detail file: . . . . 1 card.
Report file: . . . . 1 line.

.132 Computation: . . . . standard.
.133 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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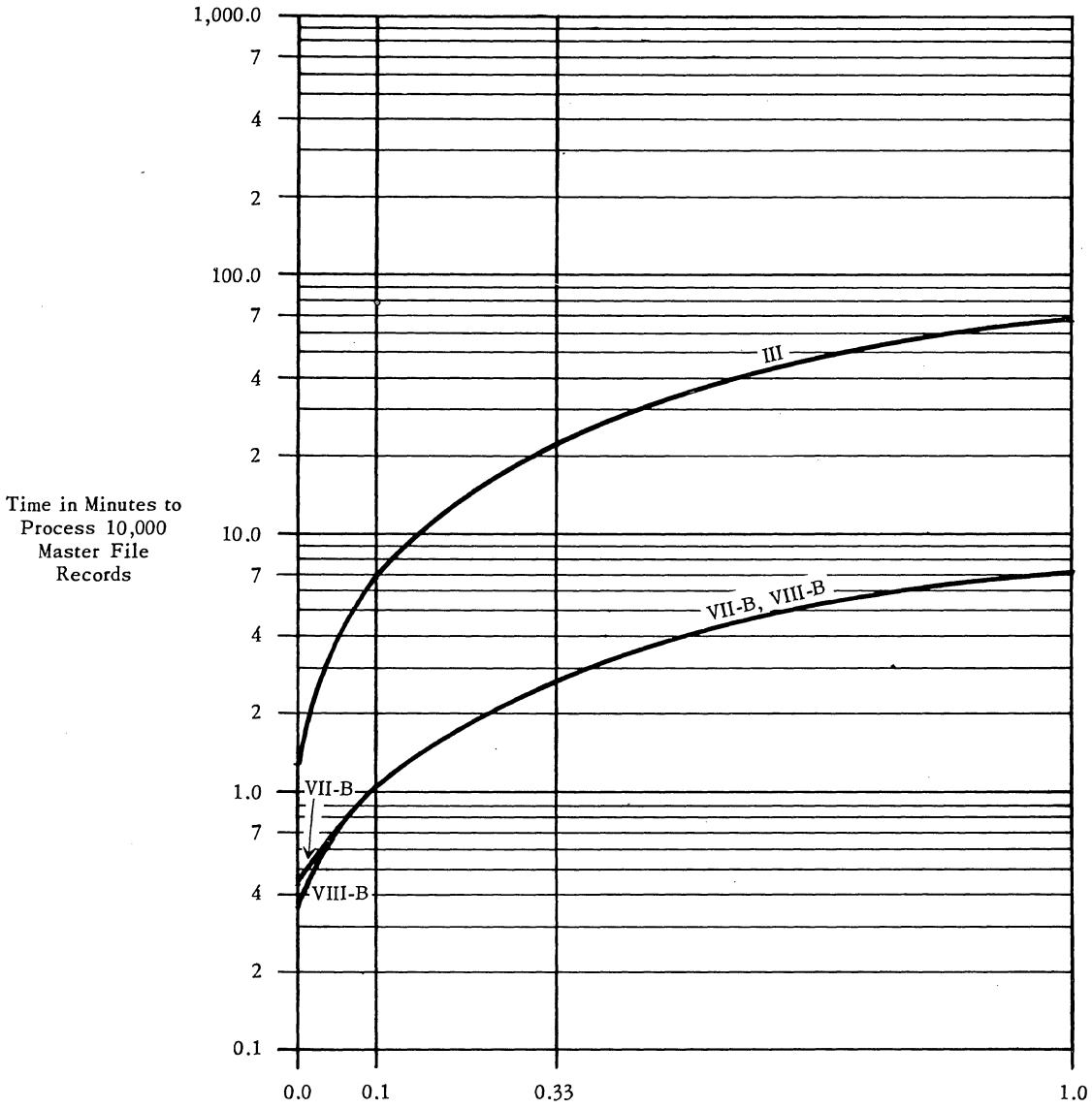
§ 201.

.14 Standard File Problem D Estimates

.141 Record sizes
Master file: . . . . 108 characters.
Detail file: . . . . 1 card.
Report file: . . . . 1 line.

.142 Computation: . . . . trebled.
.143 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



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§ 201.

.2 SORTING

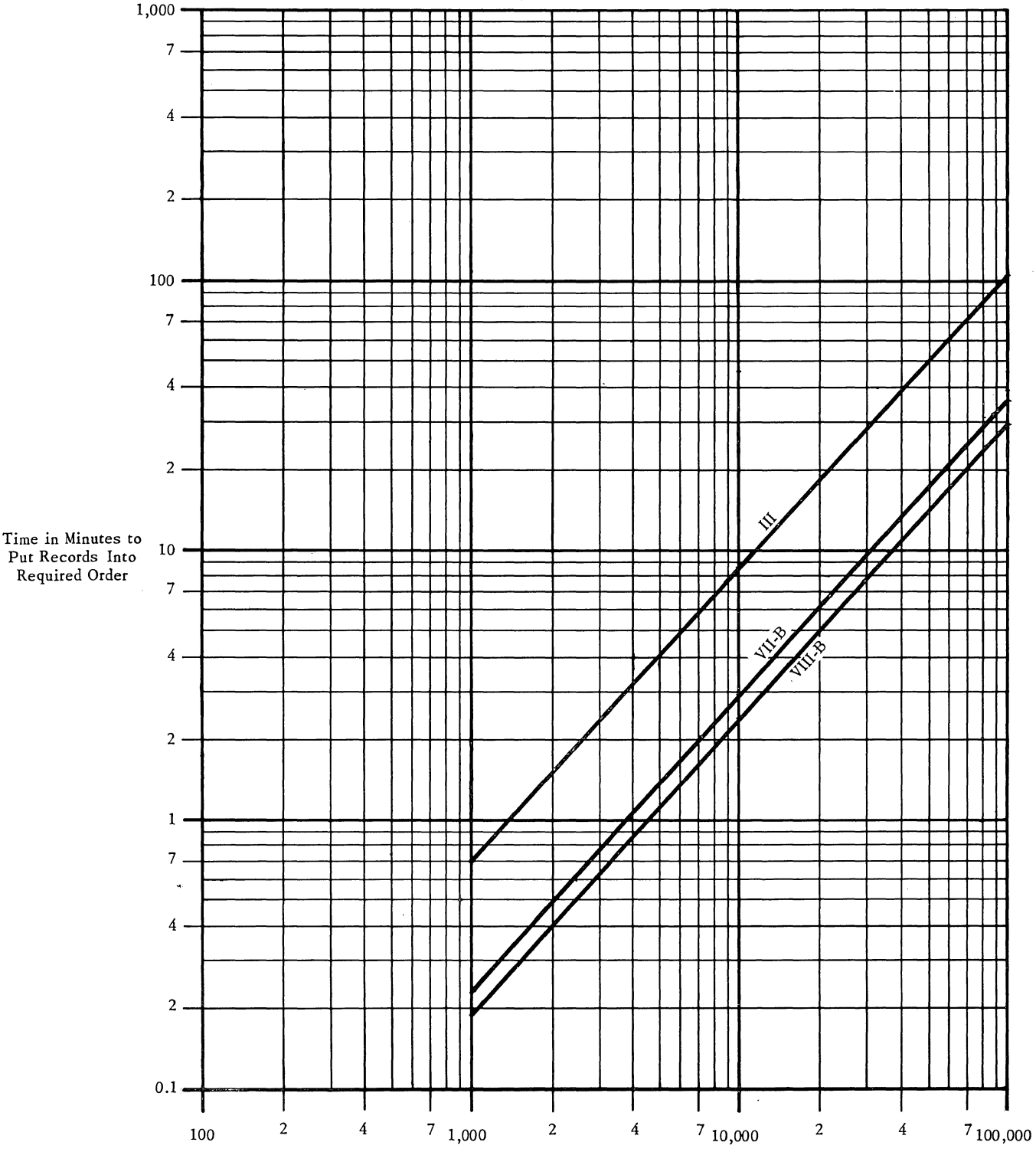
.21 Standard Problem Estimates

.211 Record size: . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



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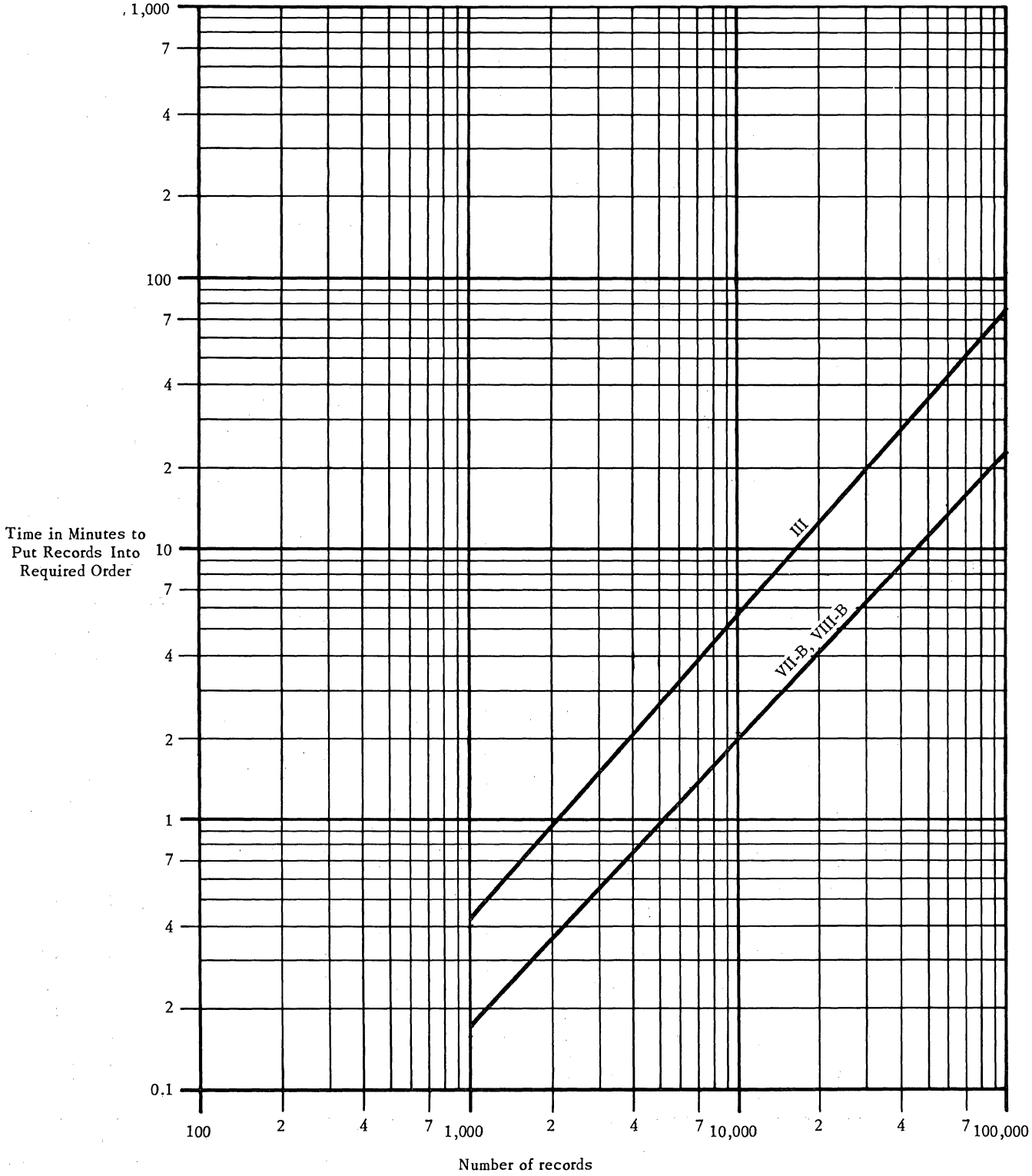
§ 201.

.22 IBM 7070/7074 SORT 90 Times

.221 Record size: . . . . 80 characters.

.222 Key size: . . . . 8 characters.
.223 Timing basis: . . . . IBM Publication C28-6111, pp. 76-84.
.224 Graph: . . . . . see graph below.



NOTE: Times for Configurations VII-B and VIII-B are the same because internal processing speed is the limiting factor.

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§ 201.

.3 MATRIX INVERSION

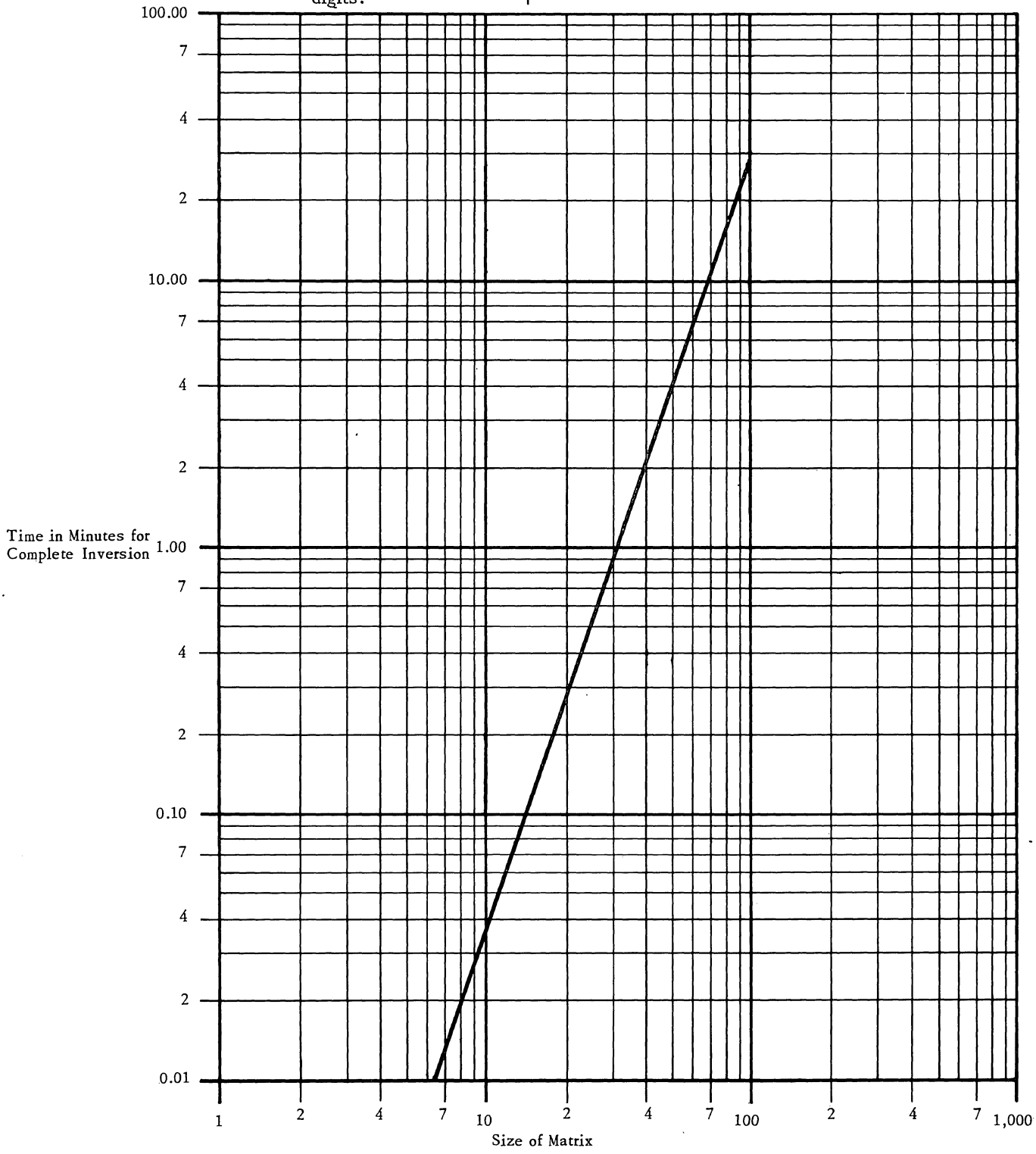
.31 Standard Problem Estimates

.311 Basic parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.312; with Floating Decimal Arithmetic option.

.313 Graph: . . . . . see graph below.

.314 Maximum matrix sizes
5,000 core storage locations: . . 67.
9,990 core storage locations: . . 97.



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§ 201.

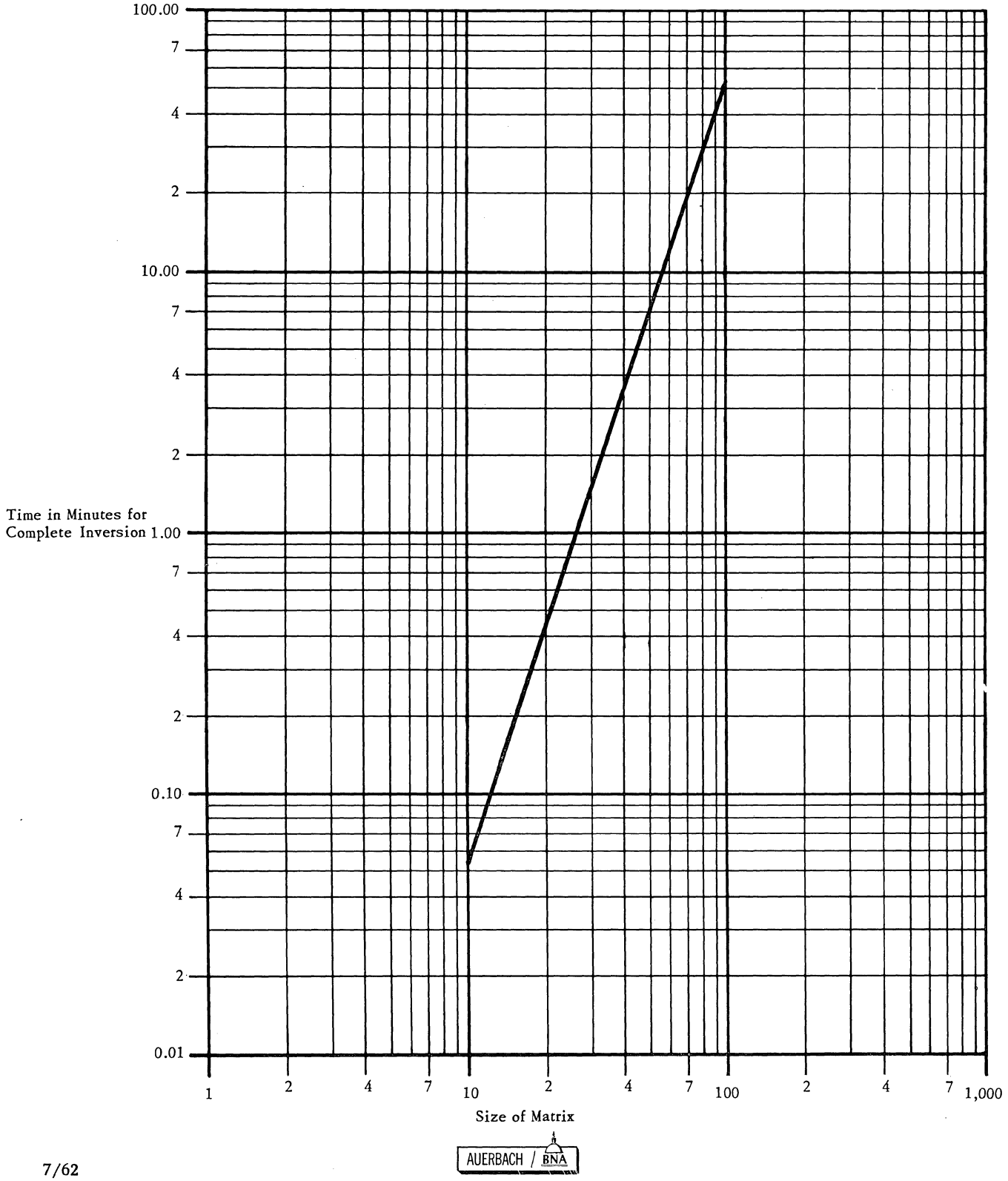
.32 Single Precision Matrix Inversion Times

.321 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.322 Timing basis: . . . . . GUIDE General Program Library, No. 10.1.003; routine does not utilize the optional Floating Decimal Arithmetic hardware.

.323 Graph: . . . . . see graph below.

.324 Maximum matrix sizes
5,000 core storage locations: . . 67.
9,990 core storage locations: . . 97.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

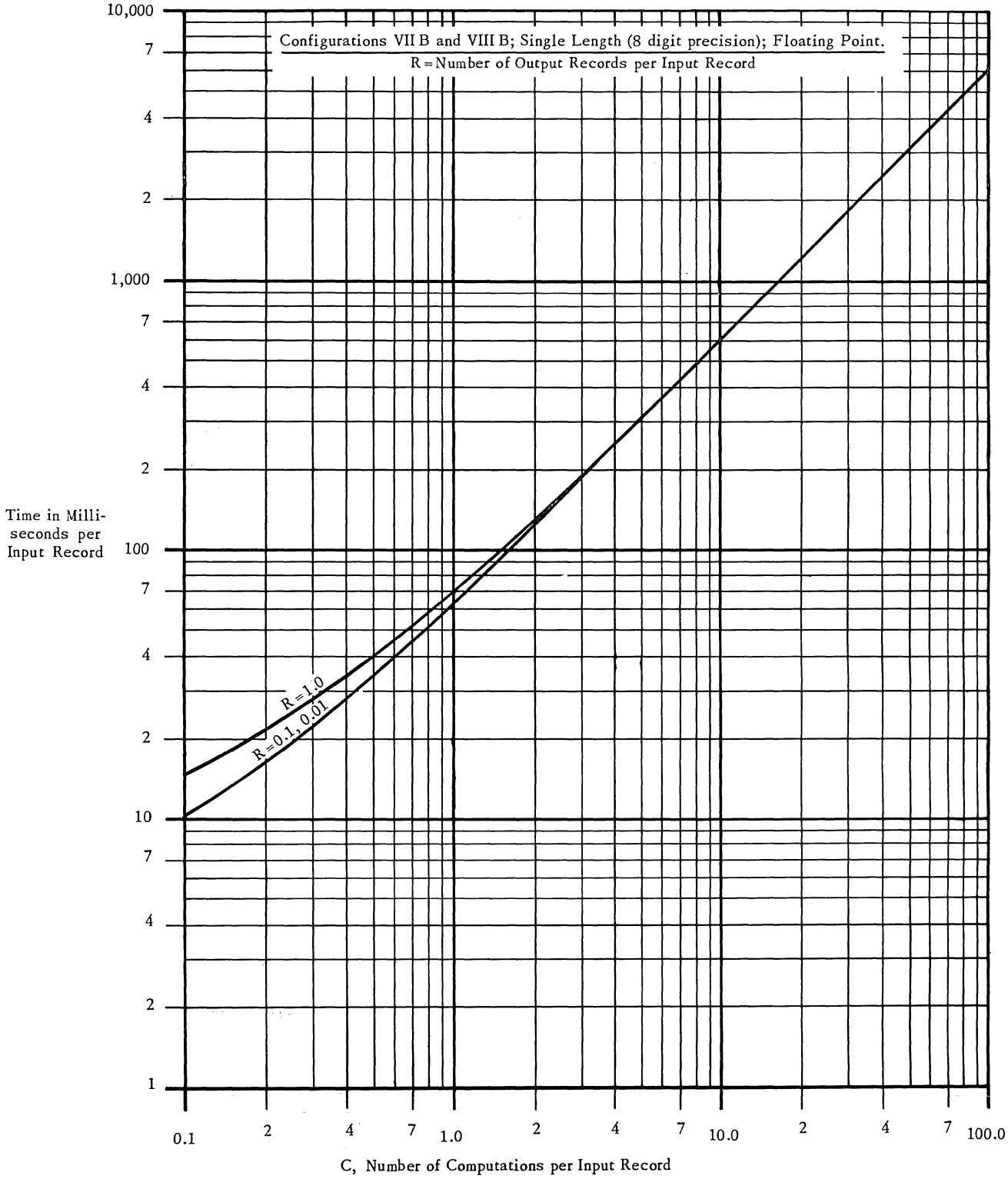
.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . 5 fifth-order polynomials.
5 divisions.
1 square root.

.413 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.413; with optional Floating Decimal Arithmetic.

.414 Graph: . . . . . see graph below.



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§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

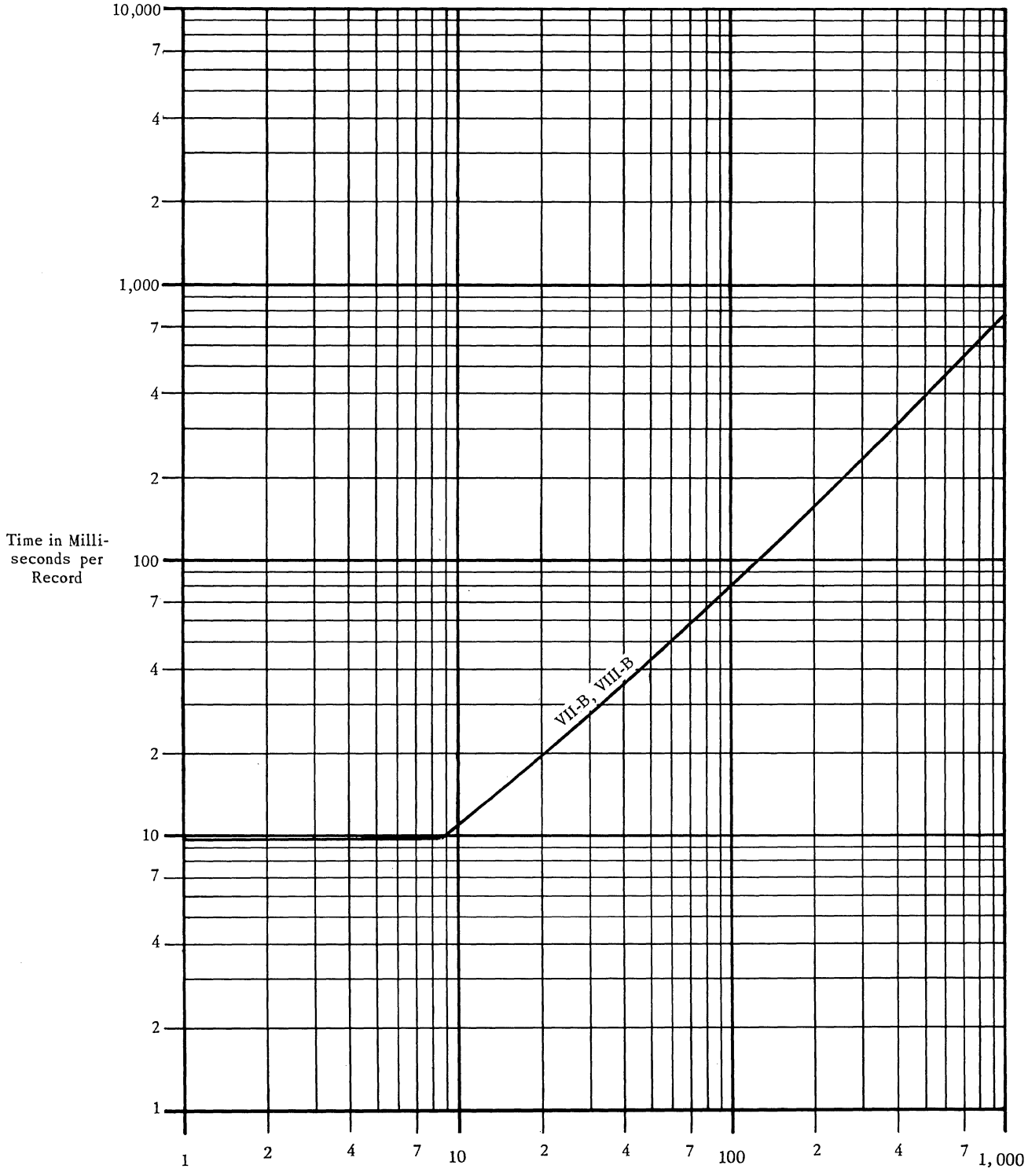
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . using estimating procedure outlined in User's Guide. 4:200.513.

.514 Graph: . . . . . see graph below.



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IBM 7070
PHYSICAL CHARACTERISTICS

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IBM 7070 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Arithmetic and Program Control	Core Storage	Core Storage Control	Console Card Reader	Card Reader	Card Punch	Printer
	Model Number		7601	7301	7602	7501	7500	7550	7400
PHYSICAL	Height × width × depth, in.		69×59×68	69×29.5×68	69×29.5×68	39×33×29	43×29×35	43×29×35	49×60×31
	Weight, lbs.		4,600	1,500	1,800	200	1,000	1,000	1,900
	Maximum Cable Lengths, feet								
	To 7601		----	----	----	----	----	----	----
	To Power Supply		----	----	75	----	----	----	----
	To Designated Unit		51 (7605)	0 (7602)	40 (7150)	35 (7600)	40 (7603)	40 (7603)	40 (7603)
ATMOSPHERE	Storage Ranges	Temperature, °F.	50-110	50-110	50-110	50-110	50-110	50-110	50-110
		Humidity, %	0-80	0-80	0-80	0-80	0-80	0-80	0-80
	Working Ranges	Temperature, °F.	65-90	65-90	65-90	65-90	65-90	65-90	65-90
		Humidity, %	20-80	20-80	20-80	20-80	20-80	20-80	20-80
	Heat Disspitated, BTU/hr.		9,200	6,600	600 (Model 1) 1,900 (other models)	4,800	4,400	4,800	4,800
	Air Flow, cfm.		900	400	220	----	----	----	----
	Internal Filters								
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance	+10%, -8%	+10%, -8%	+10%, -8%	+10%, -8%	+10%, +8%	+10%, -8%	+10%, -8%
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		0.7	1.4	0.1	1.7	1.5	1.5	1.7
NOTES									

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IBM 7070 PHYSICAL CHARACTERISTICS—Contd.

IDENTITY	Unit Name		Magnetic Tape	Console	Disc Storage	Remote Compressor	Disc Control	Disc Storage	Disc Storage	File Control	I/O Control	I/O Synchronizer	Tape Control	Inquiry Station	Power Converter	Data Transmission Unit	Paper Tape Reader	Remote Inquiry Unit	Input/Output Synchronizer	Data Channel
	Model Number		729	7150	7300	Part of 7300 DSU	7605	1301 Model 1	1301 Model 2	7631	7600	7603	7604	7900	7802	1009	1011	1014	1414 Model 6	7907
PHYSICAL	Height × width × depth, in.		69×29×34	40×66×33	71×62×30	29×40×33	69×29.5×68	69×86×33	69×86×33	70×38×32	69×29.5×68	69×29.5×68	69×29.5×68	29×29.5×68	69×29.5×68	40×29×31	60×32×36	35×29×24	70×74×32	69×20×68
	Weight, lbs.		1,200	400	2,300	700	1,200	3,625	3,825	500	2,100	2,300	2,100	400	1,700	500	529	175	1,100	1,500
	Maximum Cable Lengths, feet																			
		To 7601	----	35	----	----	----	----	----	----	24	----	----	----	----	----	----	----	----	----
		To Power Supply	----	----	----	----	----	----	----	----	----	----	----	----	----	15	14	14	----	----
		To Designated Unit	100 (7604)	35 (7600)	45 (7605)	72 (7605)	46 (7602)	100 (7631)	100 (7631)	55 (7907)	46 (7602)	29 (7602)	41 (7605)	50 (7602)	75 (7602)	60 (1414)	90 (1414)	8 miles (1414)	55 (7907)	55 (7631) 55 (1414)
ATMOSPHERE	Storage Ranges	Temperature, °F.	50-90 mylar 40-120 HD	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110	50-110
		Humidity, %	20-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80	0-80
	Working Ranges	Temperature, °F.	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90	65-90
		Humidity, %	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80	20-80
	Heat Dissipated, BTU/hr.		3,900	800	9,100	10,800	1,800	16,700	20,000	4,800	3,600	4,600	4,600	500	15,100	1,000	4,100	1,000	4,450	7,800
	Air Flow, cfm.		550	0	300	300	320	1,800	1,800	400	560	800	400	0	800	120	150	----	1,000	400
	Internal Filters																			
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	115	208 or 230	115	208 or 230	115	208 or 230	208 or 230
		Tolerance	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	±10%	±10%	±10%	±10%	+10%, −8%
	Cycles	Nominal	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
		Tolerance	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5
	Phases and Lines		3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	1φ, 3-wire	3φ, 4-wire	1φ, 3-wire	1φ, 3-wire	1φ, 3-wire	3φ, 4-wire	3φ, 4-wire
	Load KVA		1.6	0.02	3.7	4.0	0.3	7.5	9.0	2.7	0.9	0.9	0.9	0.2	12.8	0.3	1.8	0.35	1.30	2.25
NOTES			Cable length is total for all 729s on a channel.																	

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Central Processor	7601	Arithmetic and Program Control	3,000	87.50	145,500.
		Optional Features			
	4419	Floating Decimal Arithmetic	750	17.25	33,350.
	4760	Interval Timer	70	1.75	3,375.
Storage	7301	Core Storage			
	model 1	5,000 words	3,500	31.25	195,000.
	model 2	9,990 words	6,800	37.50	343,000.
	1301	Disc Storage			
	model 1	55,600,000 BCD characters	2,100	138.00	115,500.
	model 2	111,200,000 BCD characters	3,500	238.00	185,500.
		Optional Features			
		Cylinder Mode	25	1.00	1,250.
	7300	Disc Storage			
	model 1	6,000,000 digits	975	194.00	62,200.
	model 2	12,000,000 digits	1,500	306.00	74,800.
Input - Output	729 II	Magnetic Tape Unit	700	116.00	36,000.
	729 IV	Magnetic Tape Unit	900	128.00	41,250.
	729 V	Magnetic Tape Unit	750	122.00	37,200.
	729 VI	Magnetic Tape Unit	950	134.00	42,450.
		Optional Features			
	7835, 7836, 7837 or 7838	Additional 729 Tape Attachment (on 7602)	100	0.50	4,500.
	7830	Tape Switching Feature (on 729 II/IV/V/VI)	85	6.50	4,400.
	7400	Printer	950	40.50	37,000.
	7500	Card Reader	400	44.75	13,100.
	7550	Card Punch	550	36.75	19,500.
	7501	Console Card Reader (Price includes #2265 Card Reader Attachment on 7600.)	100	6.25	4,300.
	7900	Inquiry Station	250	26.75	10,300.
	7150	Console Control Unit	300	15.50	13,050.
	1414	Input/Output Synchronizer (Model 6)	850	12.00	43,350.
	1009	Data Transmission Unit (requires 3238)	500	11.50	26,400.
	1011	Paper Tape Reader (requires 5514)	500	42.50	22,400.

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§ 221. PRICE DATA – Contd.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Input - Output (Cont'd)	1014	Remote Inquiry Unit (requires 6136)	200	12.50	11,000.
	7864	Telegraph Input/Output	500	11.00	30,500.
	7871	Telegraph Input (requires 7864)	110	3.25	6,750.
	7875	Telegraph Output (requires 7864)	125	3.25	7,750.
	3238	Data Transmission Unit Adapter	200	3.50	11,000.
	5514	Paper Tape Reader Adapter	100	1.50	3,750.
	6136	Remote Inquiry Unit Adapter	200	5.75	11,500.
Controllers	7602	Core Storage Control			
	model 1	For card-only system	1,400	21.25	65,200.
	model 2	Two channels (tape/disc system)	1,600	31.25	73,950.
	model 3	One channel (tape/disc system)	1,500	29.25	69,800.
	model 4	Three channels (tape/disc system)	1,800	36.25	83,800.
	model 5	Four channels (tape/disc system)	1,900	38.25	88,500.
	7600	Input/Output Control			
	model 1	For any card system	1,400	41.00	63,000.
	model 2	For tape/disc systems	800	19.75	33,000.
	7603	Input/Output Synchronizer			
	model 1	One input and one output (unit record)	1,000	22.75	35,900.
	model 2	Two inputs and one output (unit record)	1,300	30.50	46,000.
	model 3	One input and two outputs (unit record)	1,350	31.25	48,300.
	model 4	Two outputs and two inputs (unit record)	1,650	39.00	59,300.
	model 5	Two inputs and three outputs (unit record)	2,000	47.50	72,700.
	model 6	One input and three outputs (unit record)	1,700	39.75	61,600.
	model 7	Three inputs and one output (unit record)	1,600	38.25	57,100.
	model 8	Three inputs and two outputs (unit record)	1,950	46.75	70,400.
	model 9	Three inputs and three outputs (unit record)	2,300	55.25	83,700.
	4671	Inquiry Control - Synchronizer #1 (on 7600)	400	6.50	18,250.
	4672	Inquiry Control - Synchronizer #2 (on 7600)	350	5.00	15,250.
	7605	Disc Storage Control (for 7300 DSU)	3,900	36.75	141,800.
	3315	Disc Storage Attachment (on 7602)	300	0	14,250.
	7604	Tape Control			
	model 1	Two channels	2,700	86.75	125,500.
	model 2	One channel	1,850	48.00	96,300.
	model 3	Two channels (800 char/inch)	3,300	88.75	155,300.
	7155	Switch Control Console			
	model 1	For up to 2 tape units	35	5.50	1,775.
	model 2	For up to 4 tape units	55	11.00	2,675.
	model 3	For up to 6 tape units	80	16.50	3,875.
	model 4	For up to 8 tape units	100	22.00	4,775.
	7631	File Control (for 1301 DSU)			
	model 2	For this system only	835	30.00	42,000.
	model 3	For this system and a 1410	1,035	35.00	52,000.
	model 4	For this system and another 7000 series system (except 7072)	1,035	35.00	52,000.

§ 221. PRICE DATA – Contd.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Controllers (Cont'd)	7907	Data Channel			
	model 1	One channel	2,000	61.00	80,000.
	model 2	Two channels	3,000	98.00	120,000.
	3221	Data Channel Attachment (on 7601 and 7602)	450	5.00	18,000.
	3224	Data Channel Switch	25	1.25	650.
Power	7802	Power Converter (required in every system)	400	6.00	20,000.

Note: Maintenance charges apply only to purchased equipment and are based upon a sliding scale; those listed here are for the first 3 years after installation.

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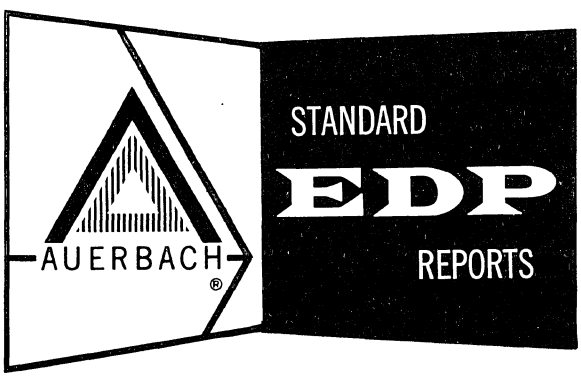
IBM 7072

International Business Machines Corp.



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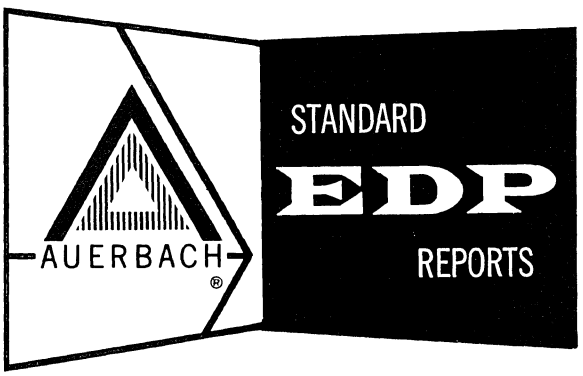
IBM 7072

International Business Machines Corp.



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INTRODUCTION

The 7072 is a solid-state tape oriented system intended for scientific applications. It offers relatively high processing speeds, large core storage capacity, decimal logic, and floating point arithmetic hardware as standard equipment. On typical scientific problems the 7072's internal speeds will be roughly twice as fast as the IBM 704, up to ten times as fast as the IBM 7070, and about 70% as fast as the more expensive IBM 7074.

Core storage may consist of from 5,000 to 30,000 word locations. Each location can hold one single-address instruction, one 5-character alphameric word, or one numeric word of ten decimal digits and sign. Core storage cycle time is six microseconds, as in the IBM 7070. The secret of the 7072's higher performance is its improved internal circuitry; all arithmetic is performed in parallel, and the number of cycles required for virtually every operation has been greatly reduced. The instruction repertoire is versatile and effective; the only significant omission is the lack of automatic editing facilities. Three accumulators are provided, and many of the instructions can refer to any one of the three. Ninety-nine core storage locations can be used as index registers. While the 7072 is basically a fixed word-length system, operand sizes for most internal operations can vary from one to ten digits, and several short fields of like sign can readily be packed into a single core storage location.

A major feature of the 7072 is its ability to transfer several blocks of data to or from different core storage areas in a single operation. This scatter-read and gather-write capability facilitates internal data transfers as well as transfers between core storage and the peripheral units.

Automatic interruption facilitates effective use of the system's capabilities for simultaneous operations. Execution of a priority routine can be initiated automatically whenever an operation is completed by a selected peripheral unit.

The only magnetic tape unit available with the 7072 is the relatively slow IBM 7330. Peak transfer rate is 7,200 or 20,016 characters per second, and the 7330 is fully compatible with the 729 series tape units used in the 7070 and 7074 systems (but not with Hypertape). Up to ten tape units can be connected to each of a maximum of two channels.

A console card reader, rated at 60 cards per minute, is useful for direct card input on an exception basis. No line printer, punched tape, or high-speed card input-output devices are offered for the 7072. It is intended strictly as a tape oriented system, and an IBM 1401 will usually be used for the required off-line data transcription operations.

Nearly all IBM 7070 software is usable without change on the 7072. Autocoder is the basic machine oriented coding system and is offered in three versions for different translating computer configurations. The full, six-tape version includes powerful macro generation and input-output control facilities.

A FORTRAN II processor is available, and a COBOL 61 processor was delivered in March, 1962. A Compiler Systems Tape combines the Autocoder, COBOL, and FORTRAN processors and a Report Program Generator. The manufacturer also offers generalized sort and merge routines, program testing aids, and various utility routines. A wide variety of user-developed routines is available through GUIDE, the 7070 series users' organization.

NOTE: In order to emphasize the close family relationship of the IBM 7072 system to the IBM 7070, report sections covering those items of equipment and software whose form and use are the same in both systems have not been duplicated in this report. In these cases, the Contents section (404:001) refers the reader to the applicable sections of Computer System Report 403 on the IBM 7070.

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SYSTEM CONFIGURATION

§ 031.

VII B. 10-TAPE GENERAL SYSTEM (PAIRED)

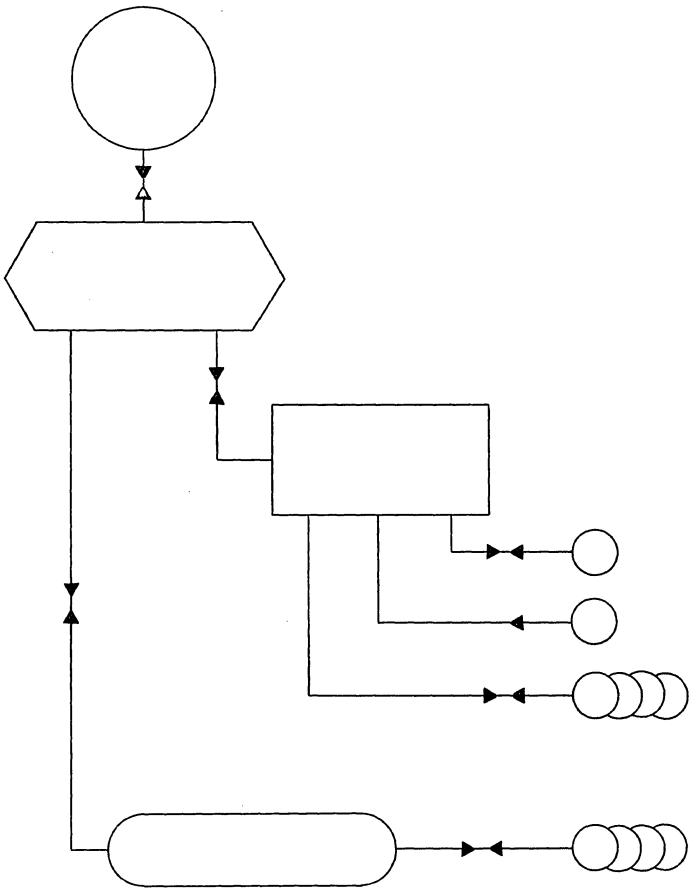
Deviations from Standard Configuration

On-line equipment:	magnetic tapes slower by 40,000 char/sec.
Off-line equipment:	none.

Rental

On-line equipment:	$ 26,850 per month.
Off-line equipment:	$ 6,065 per month.
Total:	$ 32,915 per month

On-line Equipment



Core Storage: 15,000 words

Processor

Power and Tape Control

Console

Console Card Reader: 60 cards/min.

Magnetic Tape Units (4): 7,200 or 20,016 char/sec.

Magnetic Tape Units (4) and Control: 7,200 or 20,016 char/sec.

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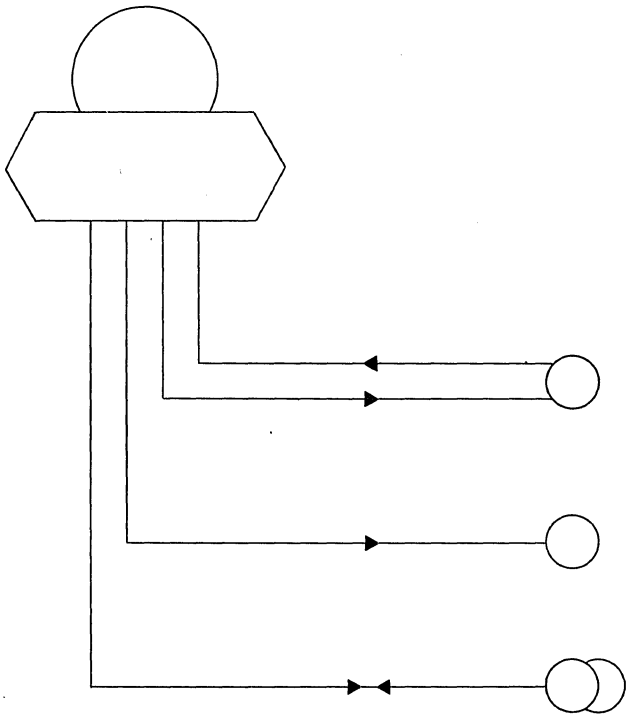
§ 031.

Off-Line Equipment (IBM 1401):



Core Storage: 4,000 positions.

Processing Unit: 1401 Model C3.

Card Read-Punch
Reads: 800 cards/min.
Punches: 250 cards/min.

Printer: 600 lines/min.

Magnetic Tape Units (2): 15,000 or 41,667 char/sec.

Optional Features Included

On-line equipment: . . . . . none.

Off-line equipment: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Compressed Tape.
Early Card Read.

§ 031.

VIII B. 20-TAPE GENERAL SYSTEM (PAIRED)

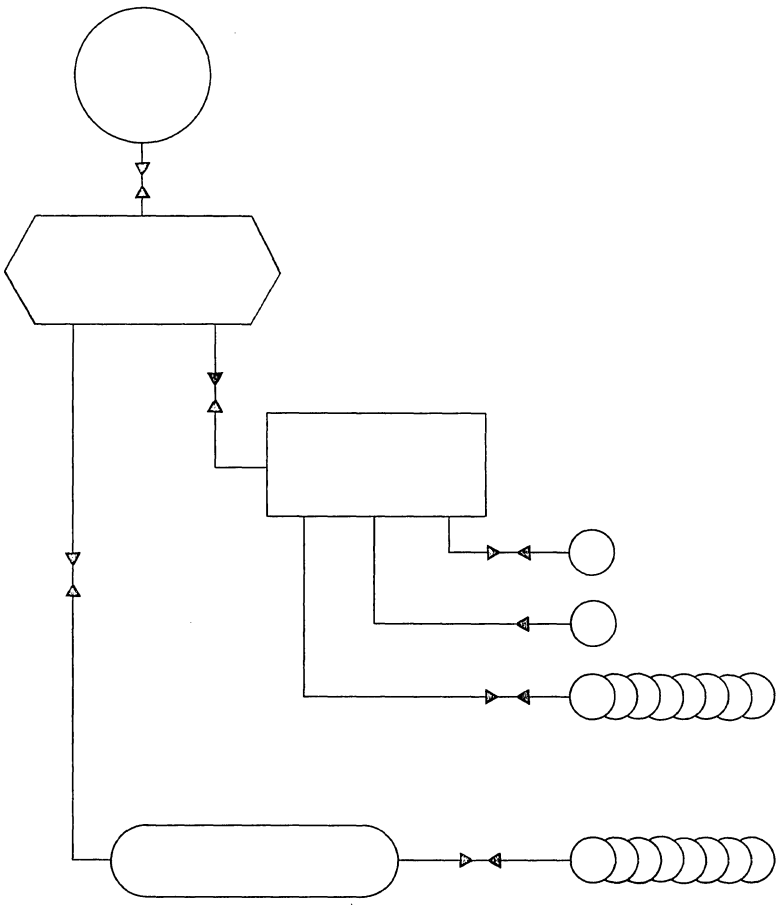
Deviations from Standard Configuration

On-line equipment:	magnetic tapes slower by 100,000 char/sec. two less magnetic tape channels.
Off-line equipment:	none.

Rental

On-line equipment:	$ 40,750 per month.
Off-line equipment:	$ 9,140 per month.
Total:	$ 49,890 per month.

On-line Equipment:



Core Storage: 30,000 words.

Processor

Power and Tape Control

Console

Console Card Reader: 60 cards/min.

Magnetic Tape Units (8): 7,200 or 20,016 char/sec.

Magnetic Tape Units (8) and Control: 7,200 or 20,016 char/sec.

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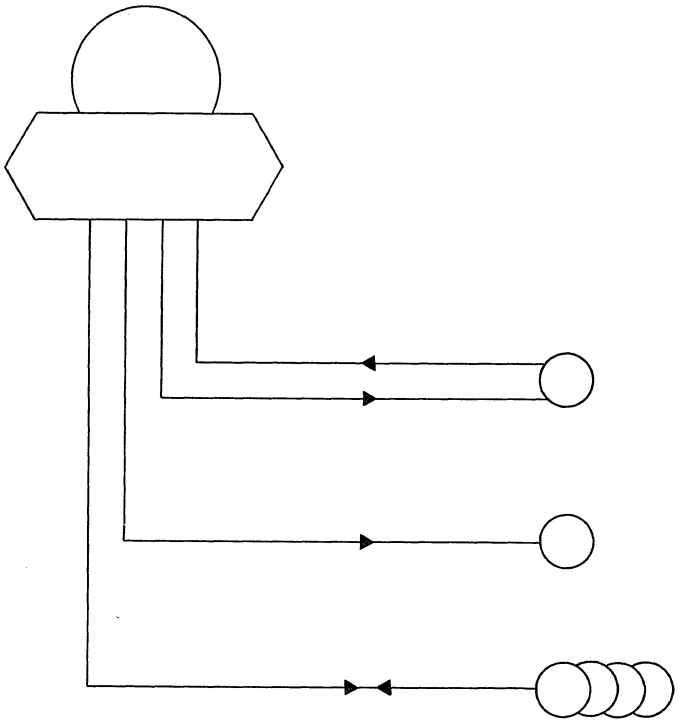
§ 031.

Off-Line Equipment (IBM 1401):



Core Storage: 8,000 positions.

Processing Unit: 1401 Model C4.

Card-Read Punch
Reads: 800 cards/min.
Punches: 250 cards/min.

Printer: 600 lines/min.

Magnetic Tape Units (4):
22,500 or 62,500 char/sec.

Optional Features Included

On-line equipment: . . . . . none.
Off-line equipment: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Compressed Tape.
Print Storage.
Processing Overlap.
Early Card Read.

INTERNAL STORAGE: CORE STORAGE

§ 041

.1 GENERAL

.11 Identity: . . . . . Core Storage.
7301, Models 1, 2, 11, 21, 22, 23.
CS.

.12 Basic Use: . . . . . working storage.

.13 Description:

Each core storage location in the 7072 system can hold one numeric word consisting of ten decimal digits and sign, one alphameric word consisting of five characters, or one single-address instruction. Each digit is represented by a two-out-of-five-bit code combination, and validity checks insure that each digit transferred to or from storage contains exactly two bits. Two successive digit positions are required for each alphameric character. Core storage cycle time is six microseconds, and all transfers are parallel by word.

The 7072's scatter-read and gather-write capabilities make it possible to distribute a block of data in core storage into a number of smaller blocks or to assemble several blocks into one larger block. Individual digits or fields within a word can be addressed through the 7072's field definition feature.

7301 Models 1 and 11 each contain 5,000 word locations of core storage; Model 2 contains 9,990 locations; and Models 21, 22, and 23 each contain 10,000 locations. Up to three modules may be used in a system, for a maximum core storage capacity of 30,000 words. When more than 9,990 words are used, Additional Core Storage Attachments must be added to the High Speed Processor and all Tape Controls. Programs which utilize the additional core storage must be coded and run in a different mode from those which do not; the details are covered in the Central Processor report, 404:051.12.

.14 Availability: . . . . . 12 to 15 months.

.15 First Delivery. . . . . June, 1962.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	99	none.
Arith registers:	0.	
Logic registers:	0.	
I-O control:	40	none.
Table look-up:	1	none.
Electronic switches:	3	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.23 Storage Phenomenon: . . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions:. . . . . yes.
.242 Data regenerated constantly:. . . . . no.
.243 Data volatile:. . . . . no.
.244 Data permanent:. . . . . no.
.245 Storage changeable:. . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.283 Type of access:. . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rate: . . . . . 166,667 cycles/sec.
Unit of data: . . . . . word.
Conversion factor: . . .53 bits/word.
Data rate: . . . . . 166,667 words/sec.
Compound data rate: . 166,667 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	Minimum Storage; Model 1	Model 2	Models 22 and 11
Words:	5,000	9,990	15,000
Digits:	50,000	99,900	150,000
Characters:	25,000	49,900	75,000
Instructions:	5,000	9,990	15,000
Modules:	1	1	2

Identity:	Models 22 and 21	Models 22, 23 and 11	Maximum Storage; Models 22, 23, and 21.
Words:	20,000	25,000	30,000.
Digits:	200,000	250,000	300,000.
Characters:	100,000	125,000	150,000.
Instructions:	20,000	25,000	30,000.
Modules:	2	3	3.

.32 Rules for Combining Modules: . . . . . all combinations are shown above.

.4 CONTROLLER

.41 Identity: . . . . . High-Speed Scientific Processor.
7105 Model 1 or 2.

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§ 041

.42 Connection to System

.421 On-Line: . . . . . .1.
.422 Off-Line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . up to 3 modules, as shown in .31.
.432 Restrictions: . . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: . . . . . one access device per system.

.52 Simultaneous Operations: . . . . . .none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 6 μ sec.
Cycle time: . . . . . 6 μ sec.
For data unit of: . . . one word, or a field-defined portion thereof.

.6 CHANGEABLE STORAGE: . . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possibilities
With self: . . . . . yes.

.72 Transfer Load Size

With self: . . . . . one digit to several blocks; length and number of blocks are limited only by capacity of core storage.

.73 Effective Transfer Rate

With self: . . . . . 83,300 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	stop & alarm.
Receipt of data:	validity check	stop & alarm.
Recording of Data:	none.	
Recovery of data:	validity check	stop & alarm.
Dispatch of data:	none.	
Field overflow*:	check	alarm & indicator; optional stop.
Sign change*:	check	alarm & indicator; optional stop.

* When storing field-defined portion of a word.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . High-Speed Scientific Processor.
7105.
HSP.

.12 Description

The 7105 High-Speed Scientific Processor executes the stored program instructions and performs all arithmetic operations in a 7072 system. It contains three accumulators, an adder, an instruction counter, and the program, arithmetic, auxiliary, and synchronizer registers. Each of the accumulators and registers has a capacity of one word and can hold ten decimal digits plus sign or five alphameric characters. All internal transfers are parallel by word. Floating point arithmetic is a standard feature, using an 8-digit fixed point part and a 2-digit exponent. Internal speeds are from 3 to 25 times as high as those of the IBM 7070 system and about 30 per cent lower than the speeds attained by the more expensive IBM 7074.

A feature of the 7072 is its versatile instruction repertoire. Full arithmetic facilities are provided, including addition to and subtraction from a core storage location. Ninety-nine index registers are standard: they occupy core storage locations 0001 through 0099, and a full complement of instructions is provided for loading, incrementing, and testing them. A unique "split-shift" operation permits shifting of only those digits to the right or left of any specified position in the 20-digit register composed of accumulators 1 and 2 coupled together. There are no facilities for bit manipulation, but 30 "electronic switches" (each consisting of one digit position in core storage) can be turned on or off or tested by the program. Table look-up operations can be carried out automatically on tables divided into any number of core storage blocks. Internal facilities for editing and format control are severely limited. Many load, store, add, subtract, compare, and branch operations can be carried out in any of the three accumulators, and the accumulators can be addressed and used as instruction operands. Multiplication and division require all three accumulators.

The most common operand length is one 10-digit word, but the 7072's field definition feature permits arithmetic, load, store, compare, and table look-up operations to be carried out on specified portions of a word. The control portion of an instruction specifies the high- and low-order digit positions of the field to be used. Several fields of like sign can therefore be stored in a single core storage location. Store and add-to-storage operations using field definition can result in field overflows (when digit positions beyond the field-defined ones are affected) or sign changes (when the sign of the stored field differs from that of the storage location). Depending upon console or programmed switch settings, these errors can cause system halts or the setting of testable indicators.

The 7072's scatter-read and gather-write capabilities can be used in internal transfers as well as in input-output operations. A block of data in core storage can be scattered into a number of smaller blocks, or a number of blocks can be gathered into one larger block. The addresses of the several blocks that data is to be gathered from or scattered into are specified in a list of record definition words, one word for each block to be transferred. The end of a block transfer operation is indicated by a record definition word with a minus sign. Conversions between the numeric and alphameric modes can be made during core-to-core block transfers. Each 10-digit numeric word becomes two 5-character alphameric words, and leading zeros can be converted to blanks. Only numeric data should be converted from alphameric to numeric mode; all even-numbered digit positions are lost, so alphabetic or special characters are converted into unrelated numeric codes.

Automatic interruption of the stored program and transfer of control to a priority routine can occur whenever an operation is completed by a selected input-output device. This capability is called "Priority Processing". It permits a limited degree of multi-running, but it is not possible for one priority routine to interrupt another.

Optional Features

Additional Core Storage (ACS): Permits up to 30,000 words of core storage to be used in a 7072 system, in increments of 5,000 words. An internal switch, turned on or off by special instructions, selects the additional storage mode or the normal storage mode. In the normal mode, only the low-order 10,000 words can be addressed, and all IBM 7070 programs with standard 4-digit addresses can be run without change. In the additional storage mode, the values 00 through 09 in the index portion of an instruction specify no indexing; instead, the index digits serve as an extension of the normal 4-digit operand address. Index values 10 through 99 cause the addition of a 5-position field in the specified index word to the 4-position operand address, forming a 5-digit effective address. All record definition words must be stored below location 10,000, and there are several other minor programming complications. Routines using the additional storage mode cannot be run on systems not equipped with this feature.

.13 Availability: . . . . . 12 to 15 months.

.14 First Delivery: . . . . June, 1962.

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§ 051.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-Subtract	automatic	decimal	1 word (FD).
Multiply			
Short:	none.		
Long:	automatic	decimal	1 word (FD).
Divide			
No remainder:	none.		
Remainder:	automatic	decimal	1 word (FD).
.212 Floating point			
Add-Subtract:	automatic	decimal	8 & 2 digits.
Multiply:	automatic	decimal	8 & 2 digits.
Divide:	automatic	decimal	8 & 2 digits.
.213 Boolean			
AND:	none.		
Inclusive OR:	none.		
.214 Comparison			
Numbers:	automatic		1 word (FD).
Absolute:	automatic		1 word (FD).
Letters:	automatic		1 word (FD).
Mixed:	automatic		1 word (FD).
Collating sequence:	specials, A to Z, 0 to 9.		

	Provision	From	To	Size
.215 Code translation:	automatic	numeric	alphameric	1 to N words (RD).
	automatic	alphameric	numeric	1 to N words (RD).
.216 Radix conversion:	none.			

	Provision	Comment	Size
.217 Edit format			
Alter size:	automatic	in code translation operations only	1 to N words (RD).
Suppress zero:	automatic		
Round off:	automatic	in right shifts only	1 or 2 words.
Insert point:	none.		
Insert spaces:	none.		
Float:	none.		
Protection:	none.		
.218 Table look-up			
Equality:	automatic		1 word (FD, RD).
Equal or greater:	automatic		1 word (FD, RD).
Greatest:	none.		
Least	automatic		1 word (FD, RD).
.219 Others			
Add to storage:	automatic		1 word (FD).
Subtract from storage:	automatic		1 word (FD).
Record gather:	automatic		1 to N words (RD).
Record scatter:	automatic		1 to N words (RD).
Electronic switches:	automatic	test, turn on or off	30 switches available.

(FD): Field definition is applicable to this operation (1 to 10 digits).

(RD): Record definition words are used to define blocks of data locations.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value with negative sign.

.222 Zero: . . . . . plus zero is greater than minus zero in comparisons; both give same results in arithmetic.

.223 Operand size determination: . . . . 1 word or a portion thereof, defined by control portion of instruction.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout:

Part	Operation	Index	Control	Address
Size (digits)	sign + 2	2	2	4

.233 Instruction parts

Name	Purpose
Operation:	specifies operation to be formed.
Index:	1) specifies indexing word to be added to address; or 2) serves as extension of operand address (in additional storage mode only).
Control:	1) specifies high- and low-order digit positions of a field within the addressed core storage location (field definition); or 2) augments the operation code.
Address:	1) specifies operand address in core storage; 2) specifies destination of a jump; 3) contains a positive literal; or 4) augments the operation code.

.234 Basic address structure: 1 + 0.

.235 Literals

Arithmetic: . . . . . none.

Comparisons and tests: . . . . . 1 digit.

Incrementing modifiers: . . . . . 4 digits.

.236 Directly addressed operands

.2361 Internal storage type	Minimum size	Maximum size	Volume accessible
Core:	1 character	1 word	total capacity in additional storage mode; maximum of 10,000 words in normal storage mode.

.2362 Increased address capacity: . . . . . none.

.237 Address indexing

.2371 Number of methods: 1.

.2372 Name: . . . . . indexing.

.2373 Indexing rule: . . . . addition, modulo 10,000.

§ 051.

.2374 Index specification: . index portion of the modified instruction (2 digits).
.2375 Number of potential indexers
Normal storage mode: . . . . . 99 (core storage locations 0001 through 0099).
Additional storage mode: . . . . . 90 (core storage locations 0010 through 0099).
.2376 Addresses which can be indexed: . . . . address portion of all instructions.
.2377 Cumulative indexing: none.
.2378 Combined index and step: . . . . . yes.
.238 Indirect addressing: . none.
.239 Stepping
.2391 Specification of increment: . . . . . address portion of stepping instruction.
.2392 Increment sign: . . . always positive, but may be added or subtracted.
.2393 Size of increment: . 4 digits.
.2394 End value: . . . . . zero, non-negative, or value specified in indexing word.
.2395 Combined step and test: . . . . . for increment of 1 or decrement of up to 4 digits.

.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in digits	Program usage
Arithmetic and Program Control:	3	10 + sign	accumulators.
Arithmetic and Program Control:	1	4	instruction counter.
Arithmetic and Program Control:	1	10 + sign	program register.

.242 Category of storage	Total number locations	Physical form	Access time μ sec	Cycle time μ sec
Processor:	5	core	6	6.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . . . 1.
.314 Special sub-sequence counters: . . . . . none.
.315 Sequence control step size: . . . . . 1 word.
.316 Accessibility to routines: . . . . . can be stored in an indexing word.
.317 Permanent or optional modifier: . . . . . no.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes
In-out units: . . . . . completion of an operation by a magnetic tape unit.
In-out controllers: . . as above.
Storage access: . . . none.
Processor errors: . . none.
Other: . . . . . none.
.332 Control by routine
Individual control: . . individual tape channels.
Method: . . . . . stacking latches, set by a mask word in core storage, enable interruption by specific units or groups.
Restriction: . . . . . none.
.333 Operator control: . . . none.
.334 Interruption conditions: 1) not in priority mode.
2) completion of operation by a unit whose stacking latch is not masked.
Note: Upon completion of magnetic tape operations, interruption may occur always or only in the event of an error or unusual condition, depending upon sign of the tape instruction.
.335 Interruption process
Disabling interruption: yes; enters priority mode.
Registers saved: . . . stores instruction counter contents in index word 97 and indicator settings in index word 100.
Destination: . . . . . depends on cause.
.336 Control methods
Determine cause: . . destination usually indicates cause; for tape operations, initial and final status words can be tested.
Enable interruption: . "priority release" instruction.

.34 Multi-running: . . . . . limited capability.

.341 Method of control: . . . own coding, using interruption facilities described above.
.342 Maximum number of programs: . . . . . 2 is practical limit, since one priority routine cannot interrupt another.
.343 Precedence rules: . . . own coding.
.344 Program protection:
Storage: . . . . . none.
In-out units: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ secs

.411 Fixed point
Add-subtract: . . . . 12.
Multiply (average): . . 30 + 3.4D.
Divide (average): . . . 30 + 6.8D.
.412 Floating point
Add-subtract: . . . . 20.
Multiply (average): . . 32 + 3.4D.
Divide (average); . . . 30 + 6.8D.

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.413 Additional allowance for
- Indexing: . . . . . 7.
- Normalization: . . . . 1.0D, for shift of D positions.
- Re-complementing
  - Fixed point: . . . . . 2.
  - Floating point: . . . 3.

.414 Control
- Compare: . . . . . 12.
- Branch: . . . . . 6.
- Compare and branch: 18.

.415 Counter control
- Step: . . . . . 20.
- Step and test: . . . . . 20.
- Test: . . . . . 14.

.416 Edit: . . . . . 12 + 18N + 6R, for conversions between alphameric and numeric forms, where N is number of numeric words moved and R is number of record definition words.

.417 Convert: . . . . . none.

.418 Shift: . . . . . 6 + D, for shift of D positions.

.42 Processor Performance in μ secs

.421 For random addresses	Fixed point (10 digits)	Floating point
c = a + b:	36	44.
b = a + b:	30	44.
Sum N items:	12	20.
c = ab:	84	84.
c = a/b:	115	110.

.422 For arrays of data	Fixed point (10 digits)	Floating point
$c_i = a_i + b_j$:	118	126.
$b_j = a_i + b_j$:	106	126.
Sum N items:	39	47.
$c = c + a_i b_j$:	166	185.

.423 Branch based on comparison
- Numeric data (up to 10 digits): . . . . . 103.
- Alphabetic data (up to 5 char): . . . . . 103.

.424 Switching
- Unchecked: . . . . . 42.
- Checked: . . . . . 78.
- List search: . . . . . 37 + 45N.

.425 Format control per character
- Unpack: . . . . . 5.
- Compose: . . . . . 30 (**).

.426 Table look up per comparison
- For a match: . . . . . 6.
- For least or greatest: 6.
- For interpolation point: . . . . . 6.

.427 Bit indicators
- Set bit in separate location: . . . . . 30.
- Set bit in pattern: . . impractical.
- Test bit in separate location: . . . . . 20.
- Test bit in pattern: . . impractical.
- Test AND for B bits: . impractical.
- Test OR for B bits: . . impractical.

.428 Moving
- 1 digit: . . . . . 30.
- 1 word: . . . . . 24.
- N words: . . . . . 12 + 12N + 6R, where R is number of record definition words.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow	check	alarm; stop or set indicator.
Underflow (float-pt):	check	alarm & indicator.
Zero divisor:	causes overflow.	
Invalid data:	fixed count check	stop & alarm.
Invalid operation:	check	stop & alarm.
Arithmetic error:	none.	
Invalid address:	check	stop & alarm.
Receipt of data:	fixed count check	stop & alarm.
Dispatch of data:	fixed count check	stop & alarm.
Field overflow*:	check	alarm; stop or set indicator.
Sign change*:	check	alarm; stop or set indicator.

* Can occur only when storing a field-defined portion of a word.

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INPUT-OUTPUT: 7330 MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit.
7330 Model 1.
MT.

.12 Description

The 7330 is the only magnetic tape unit offered in the 7072 system. It is slower, simpler, and less expensive than the 729 series tape units used in the IBM 7070 and 7074, and is fully compatible with them except that the 800 character-per-inch recording density and the "set density" instructions cannot be used.

Tape speed is 36 inches per second, and peak transfer rate is either 7,200 or 20,016 characters per second, depending upon the recording density selected. Lateral and longitudinal parity checks are made on both reading and recording.

The 7330's main drawback is its inability to terminate a high speed rewind without unloading the tape from the vacuum columns and read-record head. A full rewind without unloading requires 13.3 minutes. Up to ten tape units can be connected to each of two channels. Simultaneous tape reading, writing, and internal processing are possible in a two channel system.

The 7072's scatter-read and gather-write capabilities make it possible to distribute sub-blocks of a block of data read from tape into various portions of core storage under the control of record definition words in the stored program. Similarly, data from different sections of core storage can be assembled into one block on tape.

The optional record-mark control mode provides additional flexibility and facilitates the handling of variable-length records. Detection of a record mark in a data word signals the end of a sub-block, and control is transferred to the next sequential record definition word.

Since a 7072 word may consist of either ten numeric digits plus sign or five alphameric characters, a mode change character, Δ, is automatically recorded on the tape whenever the data mode changes from alphameric to numeric or vice versa. When the tape is read, the mode change characters insure that each word will be translated back into the proper internal form. When recording in the numeric mode, up to five high-order zeros in each word can be eliminated; they are filled in automatically when the tape is read.

Every tape instruction that might cause a priority signal when it is completed automatically creates an initial status word in a fixed core storage location; a final status word is generated at the end of each read or write operation. The status words are used by the priority routine to determine the specific cause of the priority signal. At the programmer's option, priority interruptions may occur at the end of every tape operation or only when error conditions are detected by the numerous checking circuits.

Because the internal data structures of the IBM 7072 and 1401 systems are different, certain precautions must be observed to insure tape compatibility between the two systems. The 7072 mode change and segment mark characters have no special significance to the 1401; they will be read into its core storage just as any other characters. When preparing tape for the 7072 however, the 1401 must insert the mode change character between alphameric and numeric sections of data. The 1401's word separator character, =, has no significance to the 7072 and should not be used in preparing tapes for it. The optional Compressed Tape Feature enables the 1401 to process tapes written by a 7072 in the zero elimination mode.

Optional Feature

Read Binary Tape: Permits odd-parity binary tapes prepared by systems such as the IBM 704, 709 or 7090 to be read by the 7072, on tape channel number 1 only. Each binary row on tape is converted to two octal digits, and each octal digit occupies one digit position in 7072 storage. Since the 7072's internal logic is entirely decimal, the octal data must be converted to decimal form or processed by means of programmed subroutines.

.13 Availability: . . . . . 6 to 8 months.

.14 First Delivery: . . . . . October, 1961 (in IBM 1401 system).

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 1.5 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

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.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200 or 556 char/inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
Data: . . . . . 6.
Redundancy check: . . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . . 1.
Timing: . . . . . 0.
Control signals: . . . . 0 (record and segment marks are optional).
Unused: . . . . . 0.
Inter-block gap: . . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 4.

.34 Format Compatibility

Other device or system	Code translation
IBM 729, 727 tape units:	not required.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Power and Tape Control. 7624 Model 1. (for channel #1 - required).
Tape Control. 7625 Model 1. (for channel #2 - optional).

.42 Connection to System

.421 On-line: . . . . . one 7624 and one 7625.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . up to 6 per channel; or up to 10 per channel with Additional 7330 Tape Attachments #7851 on channel #1 and #7852 on channel #2.
.432 Restrictions: . . . . . none

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words from (or into) different areas of core storage, as specified by record definition words.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word (each digit by field definition).
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . yes; scatter-read and gather-write, controlled by record definition words.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words, limited by available core storage.

.512 Block demarcation
Input: . . . . . gap on tape or negative record definition word in core storage.
Output: . . . . . negative record definition word.

.52 Input-Output Operations

.521 Input: . . . . . read one block forward into core storage locations specified by record definition word(s); record mark control is optional.
.522 Output: . . . . . write one block forward from core storage locations specified by record definition word(s); record mark control is optional.
.523 Stepping . . . . . none.
.524 Skipping: . . . . . 1) one block backward (backspace). 2) 4 inches forward (to skip and erase defective tape areas). 3) N segments forward or backward (N is specified in record definition word; a segment is the data between two segment marks on the tape).

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.525 Marking: . . . . . .inter-block gap, segment mark (SM), tape mark (TM), and mode change (Δ).

.526 Searching: . . . . . .none.

.53 Code Translation: . . . .automatic, between tape codes in Data Code Table No. 4 and internal numeric or alphameric modes (Δ on tape signifies mode changes).

.54 Format Control

Control: . . . . . .program.
Format alternatives: . . .undefined.
Rearrangement: . . . . .yes; scatter-read and gather-write.
Suppress zeroes:. . . . .yes; up to 5 per numeric word.
Insert point:. . . . . .no.
Insert spaces:. . . . . .no.
Recording density: . . . .no; "set density" instructions are ignored.
Section sizes: . . . . . yes.

.55 Control Operations

Disable:. . . . . disabled after unloading.
Select format:. . . . . yes; normal, all alphameric, zero elimination, or record mark control.
Select code:. . . . . no.
Rewind:. . . . . yes.
Unload:. . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . no.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks:. yes; 14 feet from physical end
End of segment: . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 7,200 or 20,016 char/sec.

.622 Important parameters
Density:. . . . . 200 or 556 char/inch.
Tape speed:. . . . . 36.0 inches/sec.
Inter-block gap:. . . . 0.75 inch.
Full rewind time
With unloading: . . . . 2.2 minutes.
Without unloading:. . . 13.3 minutes
Start time
Read:. . . . . 7.6 m. sec.
Write: . . . . . 5.0 m. sec.
Stop time
Read:. . . . . 12.9 m. sec.
Write: . . . . . 15.3 m. sec.

.623 Overhead: . . . . . 20.4 m. sec/block.

.624 Effective speeds
At 200 char/inch:. . . 7,200N/(N + 147) char/sec.
At 556 char/inch: . . 20,016/(N + 408) char/sec.
Where N = char/block (see graph)

.63 Demands on System

Component	Condition	m.sec per block	Percentage of Transfer time
Core Storage:	200 char/inch	0 + 0.0012N	0.9.
	556 char/inch	0 + 0.0012N	2.4.
		Where N = char/block	

NOTE: These demands are based upon alphameric mode; they will be half as high in numeric mode when there is no zero elimination.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	200 or 556 char/inch.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	key	loads tape into reservoirs.
Unload:	key	
File protection:	ring on reel	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	2,400 feet; for 1,000-character blocks, 5,000,000 char at 200 char/inch or 11,300,000 char at 556 char/inch.

.732 Replenishment time:. . . 1.0 to 1.5 mins. Tape unit needs to be stopped.

.734 Optimum reloading period:. . . . . 13 mins.

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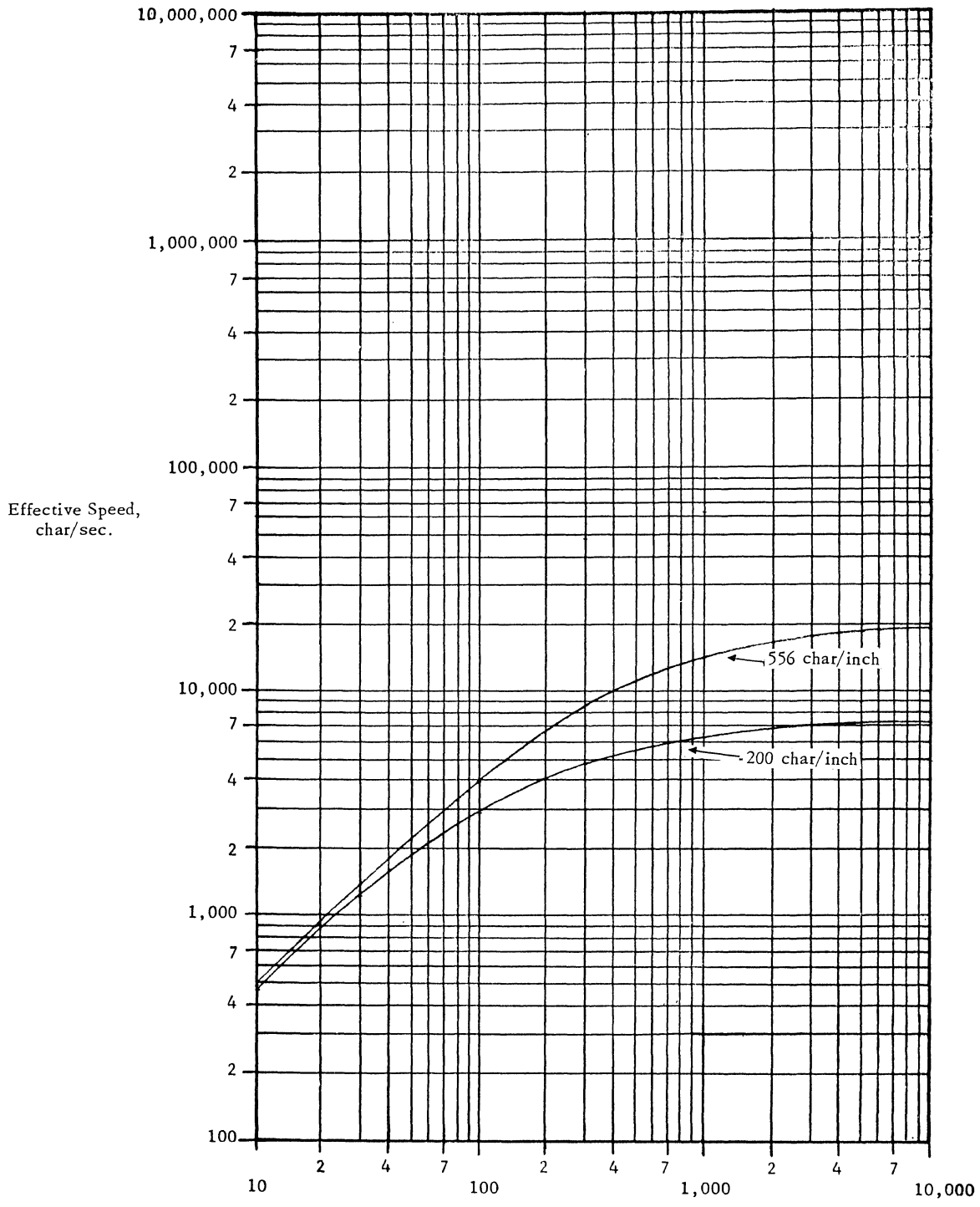
.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral & longitudinal parity	priority signal.
Reading:	read-after-write; lateral parity check	priority signal.
Input block size:	compare working & stop addresses when gap is reached	priority signal.
Output block size:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	priority signal.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Recording level:	signal strength check	priority signal.
Word length:	check	priority signal.
Misplaced character:	check	priority signal.
Code translation:	2-out-of-5 bit check	priority signal.

NOTE: "Priority signal" indicates that digit position 1 of the final status word is set to a particular condition code and control is transferred to a tape priority routine which takes the appropriate action.

EFFECTIVE SPEED
IBM 7330



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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS: . . . . none.

.12 Description

The only input-output devices available for the 7072 are magnetic tape, the console typewriter, and the console card reader. Since the typewriter and reader are unbuffered, simultaneous operations are limited to one magnetic tape read or write operation per channel while computing; the maximum number of tape channels is two. Execution of the stored program is delayed for one 6-microsecond cycle for each word transferred between core storage and the magnetic tape control.

.2 CONFIGURATION CONDITIONS: . . . . . none.

.3 CLASSES OF OPERATIONS

Class	Member
A:	read card.
E:	read or write on magnetic tape.
F:	rewind magnetic tape unit.
I:	input or output on console typewriter.
P:	internal processing.

.4 RULES

a + i + p = at most 1.
e = at most T.
e + f = at most 10T.

where T = number of magnetic tape channels (maximum of 2).

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IBM 7072
SYSTEM PERFORMANCE

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IBM 7072 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration			Reference
			VII B & VIII B			
1 Input-Output Times	Char./block	(File 1)	1,080			4:200.112
	Records/block	K (File 2)	10			
	m. sec/block	File 1 = File 2	74.4			
		File 3	24.4			
		File 4	26.4			
	m. sec/switch	File 1 = File 2	0			
		File 3	0			
		File 4	0			
	m. sec penalty	File 1 = File 2	1.2			
		File 3	0.1			
		File 4	0.1			
2 Central Processor Times	m. sec/block	a1	0.25			4:200.1132
	m. sec/record	a2	0.57			
	m. sec/detail	b6	0.64			
	m. sec/work	b5 + b9	0.89			
	m. sec/report	b7 + b8	3.75			
3 Standard Problem A F=1.0	m. sec for C. P. and dominant column.	a1	0.3			4:200.114
		a2K	5.7			
		a3K	52.4			
		File 1 Master In	1.2			
		File 2 Master Out	1.2	74.4		
		File 3 Details	1.0			
		File 4 Reports	1.0	264.0		
		Total	62.8	338.4		
4 Standard Problem A Space	Unit of measure	(words)				4:200.1151
		Std. routines	1,500			
		Fixed	247			
		3 (Blocks 1 to 23)	102			
		6 (Blocks 24 to 48)	792			
		Files	880			
		Working	32			
		Total	3,553			

IBM 7072 SYSTEM PERFORMANCE –Contd.

WORKSHEET DATA TABLE 2							
Worksheet	Item			Configuration			Reference
				VII B & VIII B			
5	Fixed/Floating point			Floating			
	Unit name		input	7330 Mag. Tape			
			output	7330 Mag. Tape			
	Size of record		input	80 char (unblocked)			
			output	100 char (unblocked)			
Standard Mathematical Problem A	m. sec/block		input T1	24.4			4:200.413
			output T2	25.4			
	m. sec penalty		input T3	0.1			
			output T4	0.1			
	m. sec/record		T5	0.7			
	m. sec/5 loops		T6	4.2			
	m. sec/report		T7	1.6			
7	Unit name			7330 Mag. Tape			
	Size of block			30 char			
	Records/block		B	1			
Standard Statistical Problem A	m. sec/block		T1	23.4			4:200.512
	m. sec penalty		T3	0.1			
	C. P.	m. sec/block	T5	– –			
		m. sec/record	T6	0.83			
		m. sec/table	T7	0.13			

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SYSTEM PERFORMANCE

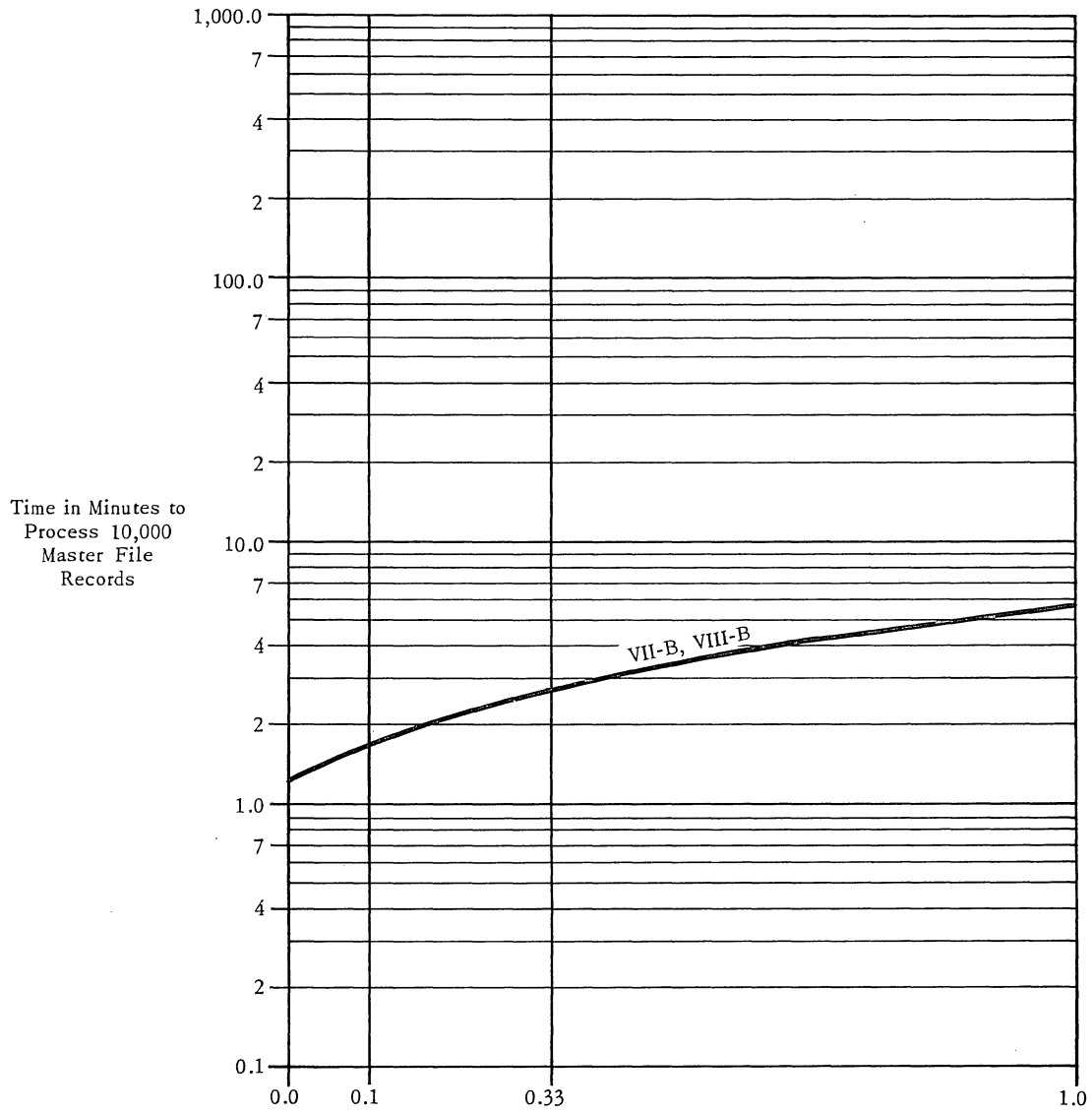
§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A Estimates

.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.
.113 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.113.
.114 Graph: . . . . . see graph below.
.115 Storage space required
Configuration VIIB: . 3,500 words.
Configuration VIIIB: . 3,500 words.



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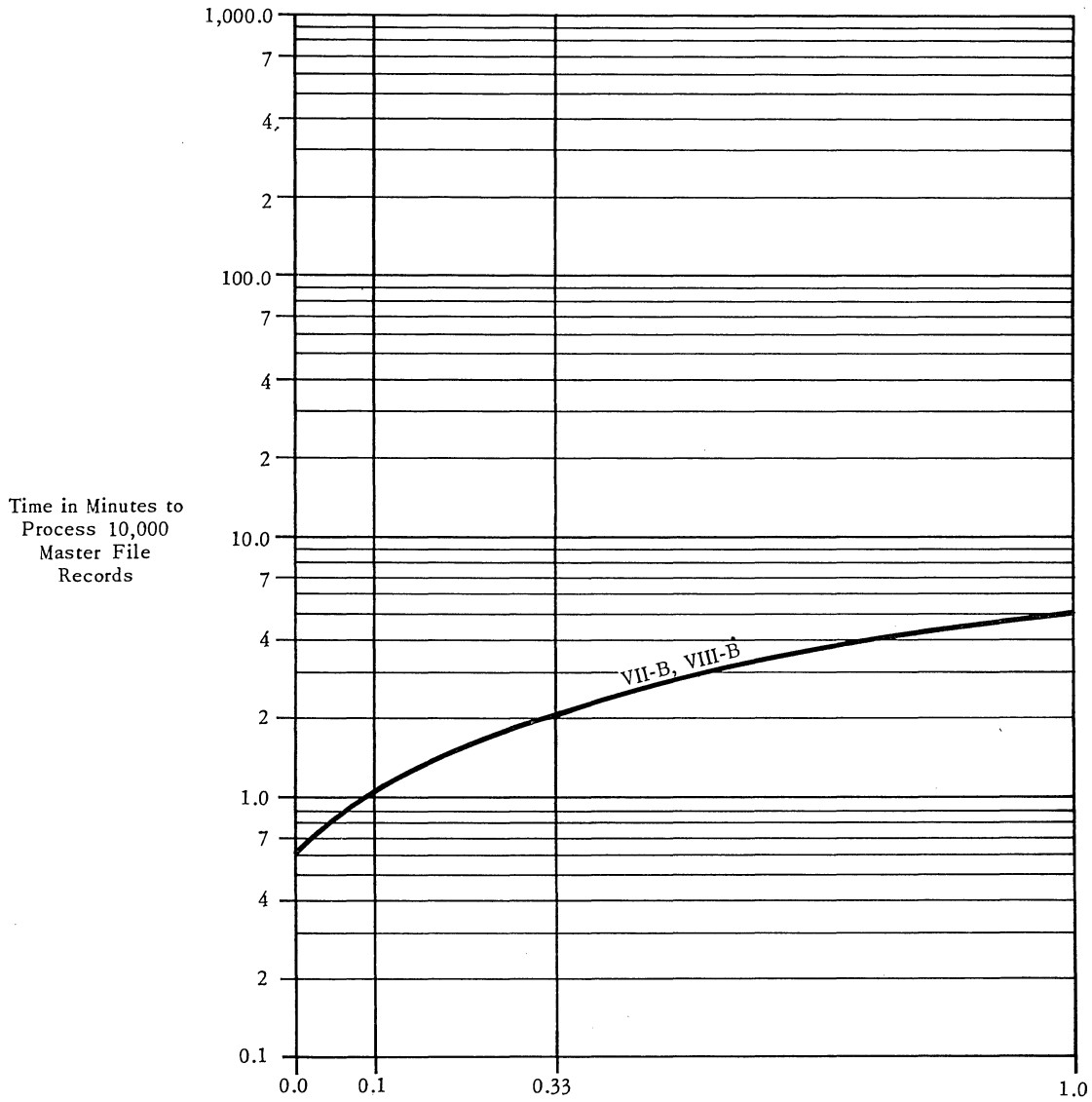
§ 201.

.12 Standard File Problem B Estimates

.121 Record sizes
Master file:. . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.122 Computation:. . . . . standard.
.123 Timing basis:. . . . . using estimating procedure outlined in User's Guide, 4:200.12.
.124 Graph:. . . . . see graph below.



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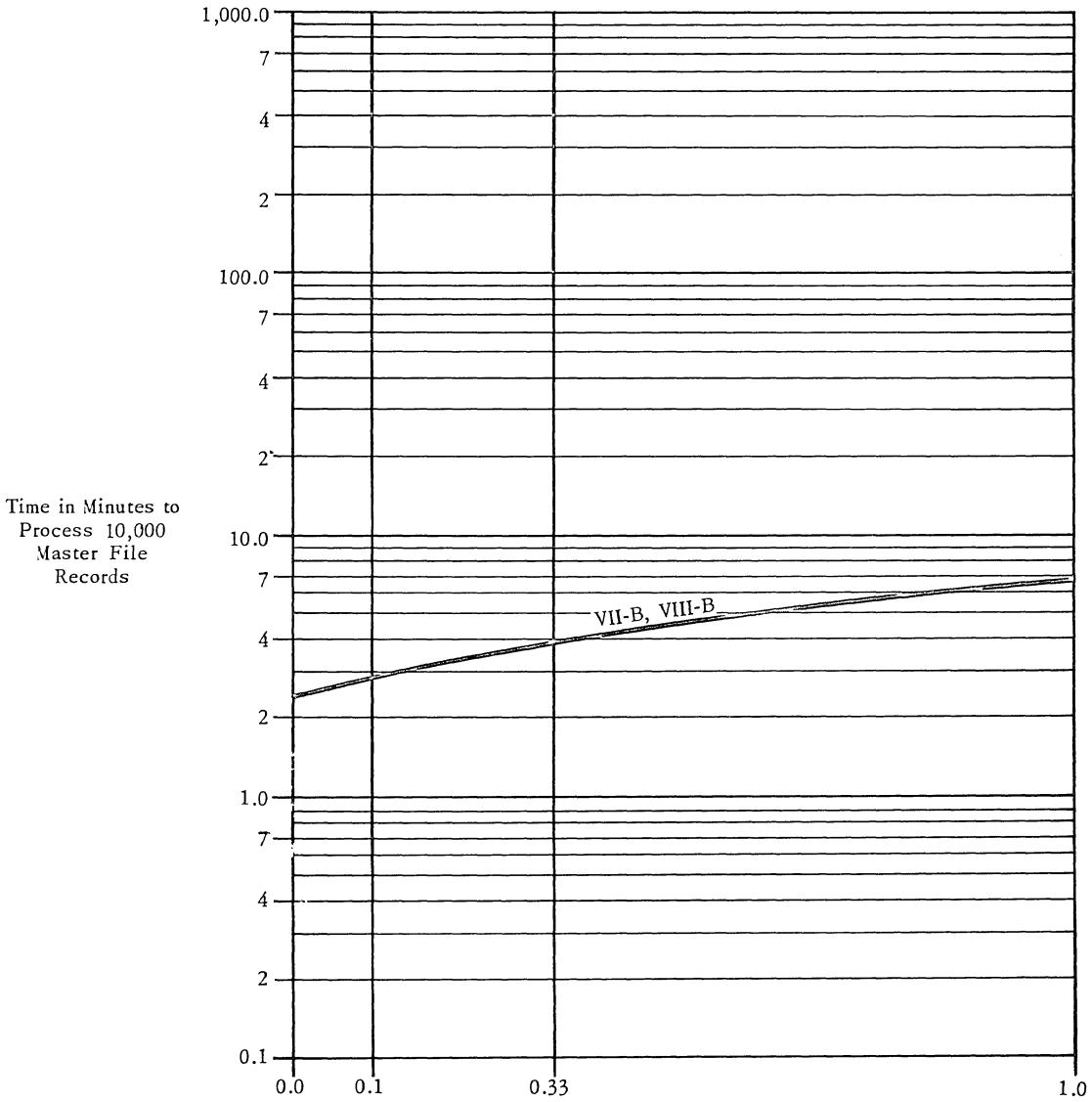
.13 Standard File Problem C Estimates

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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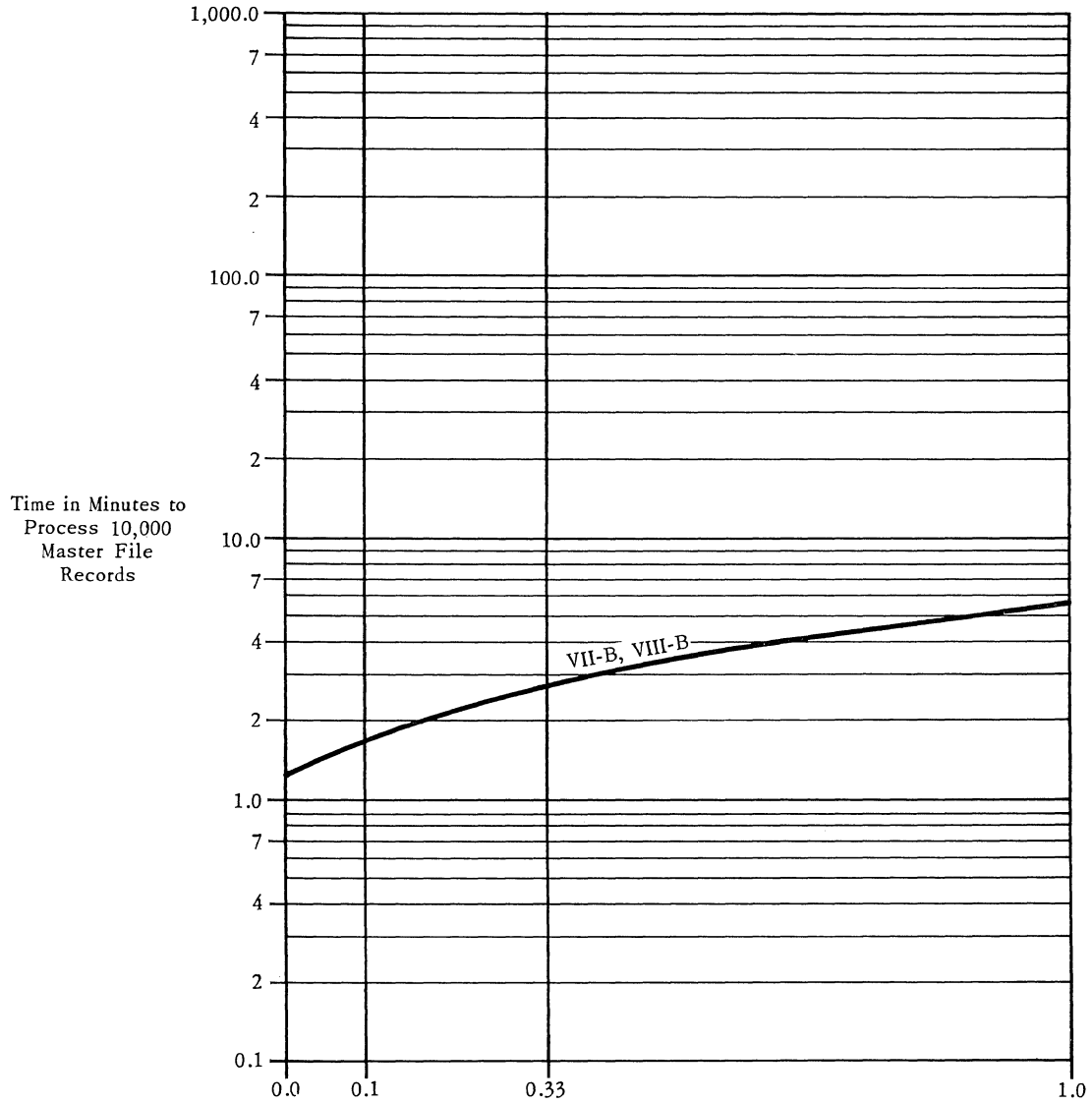
§ 201.

.14 Standard File Problem D Estimates

.141 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



§ 201.

.2 SORTING

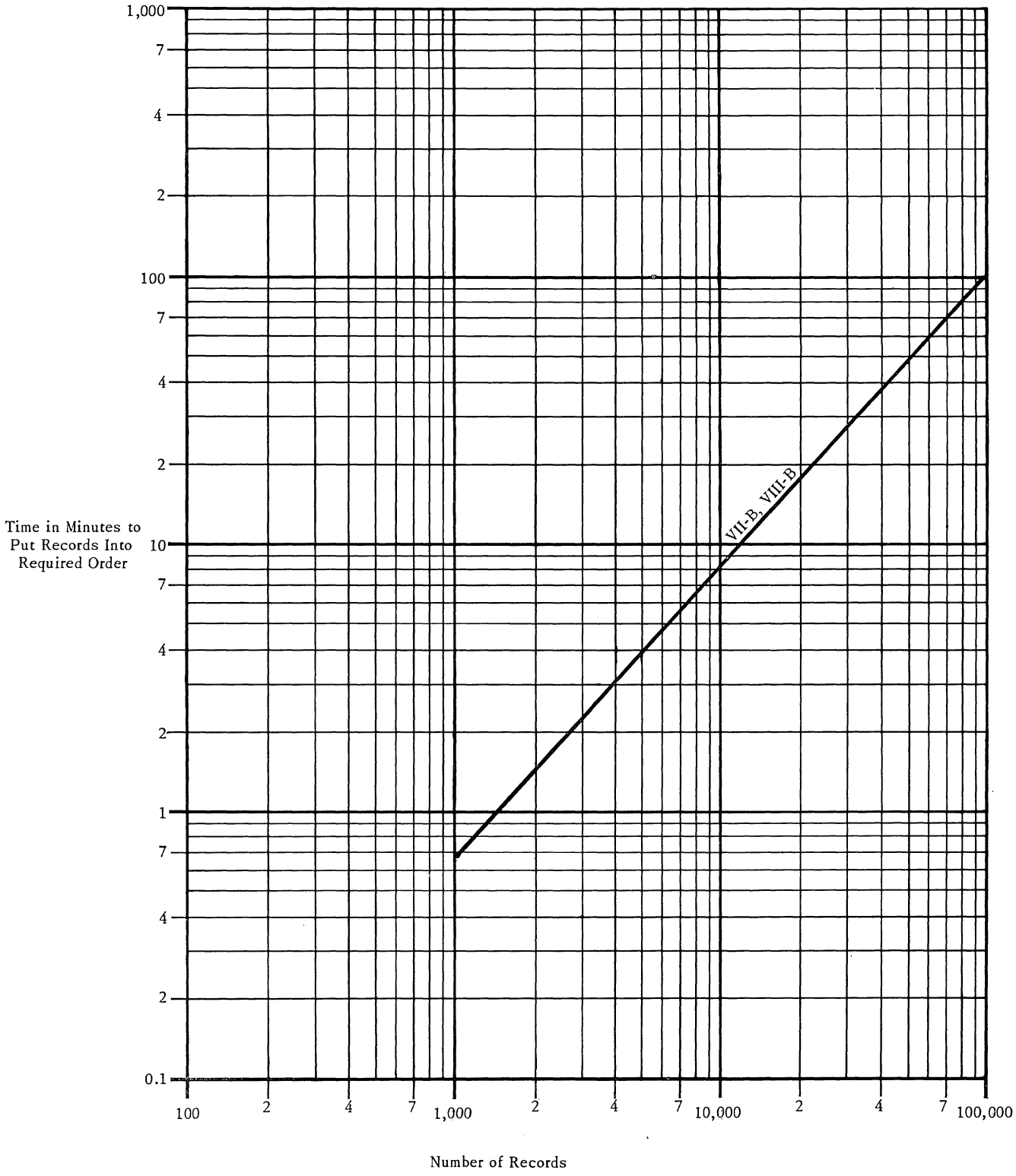
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



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§ 201.

.3 MATRIX INVERSION

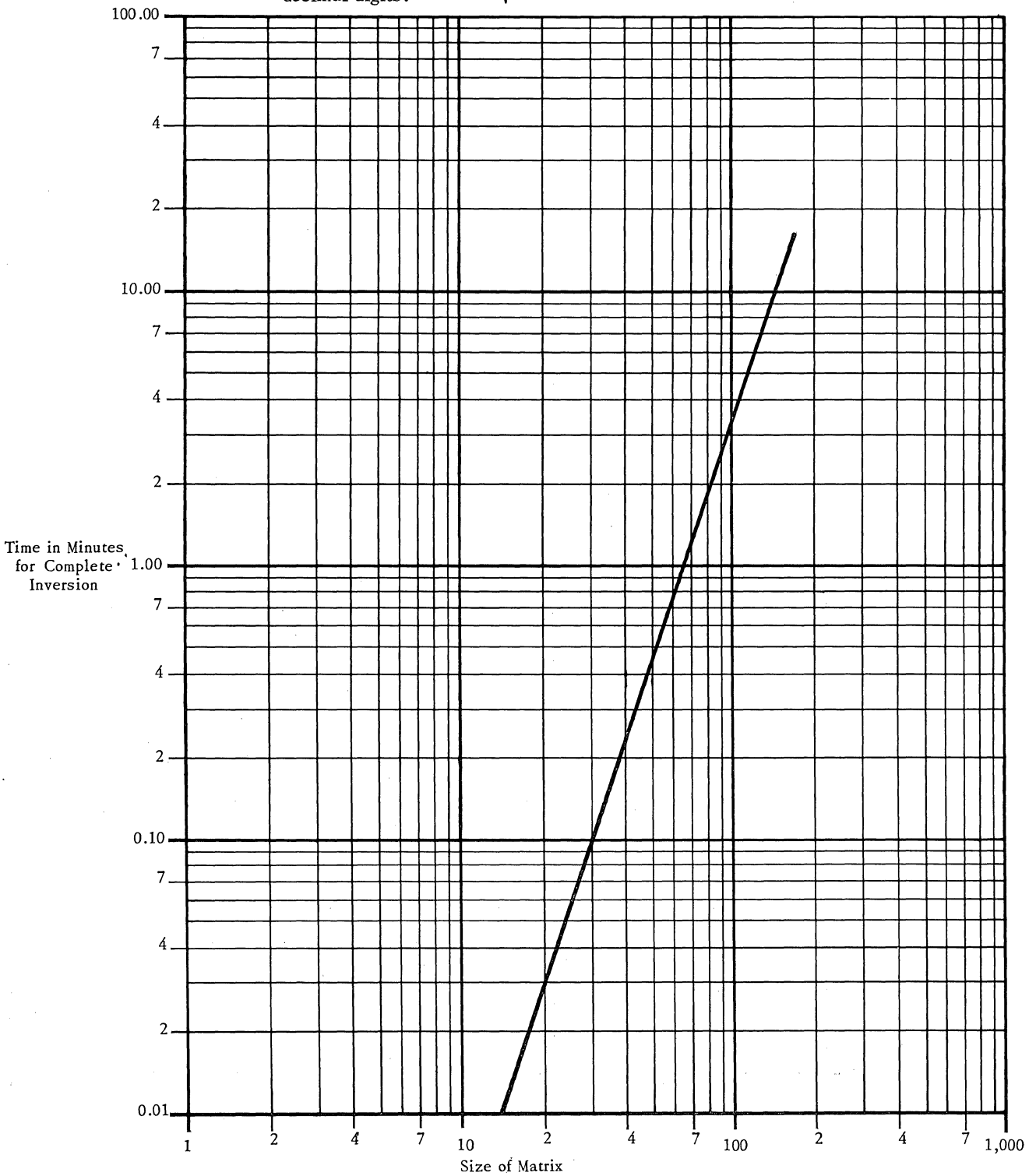
.31 Standard Problem Estimates

.311 Basic parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.312.

.313 Graph: . . . . . see graph below.

.314 Maximum matrix sizes
5,000 core storage locations: . . . 67.
10,000 core storage locations: . . . 97.
20,000 core storage locations: . . . 139.
30,000 core storage locations: . . . 171.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

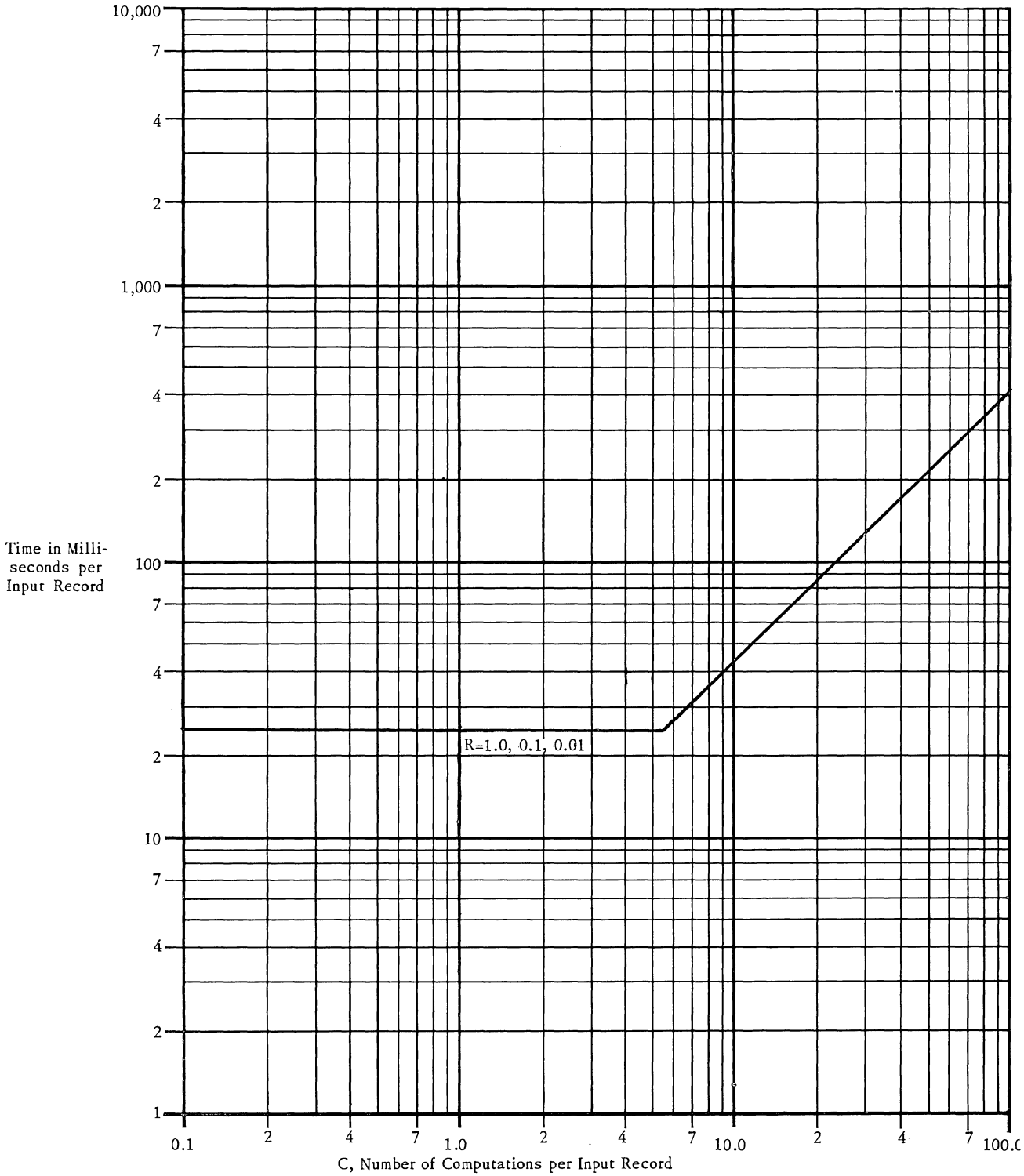
.411 Record sizes: . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.413.

.414 Graph: . . . . . see graph below.

Configurations VII-B and VIII-B; Single length (8 digit precision); Floating point.
R = Number of Output Records per Input Record



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§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

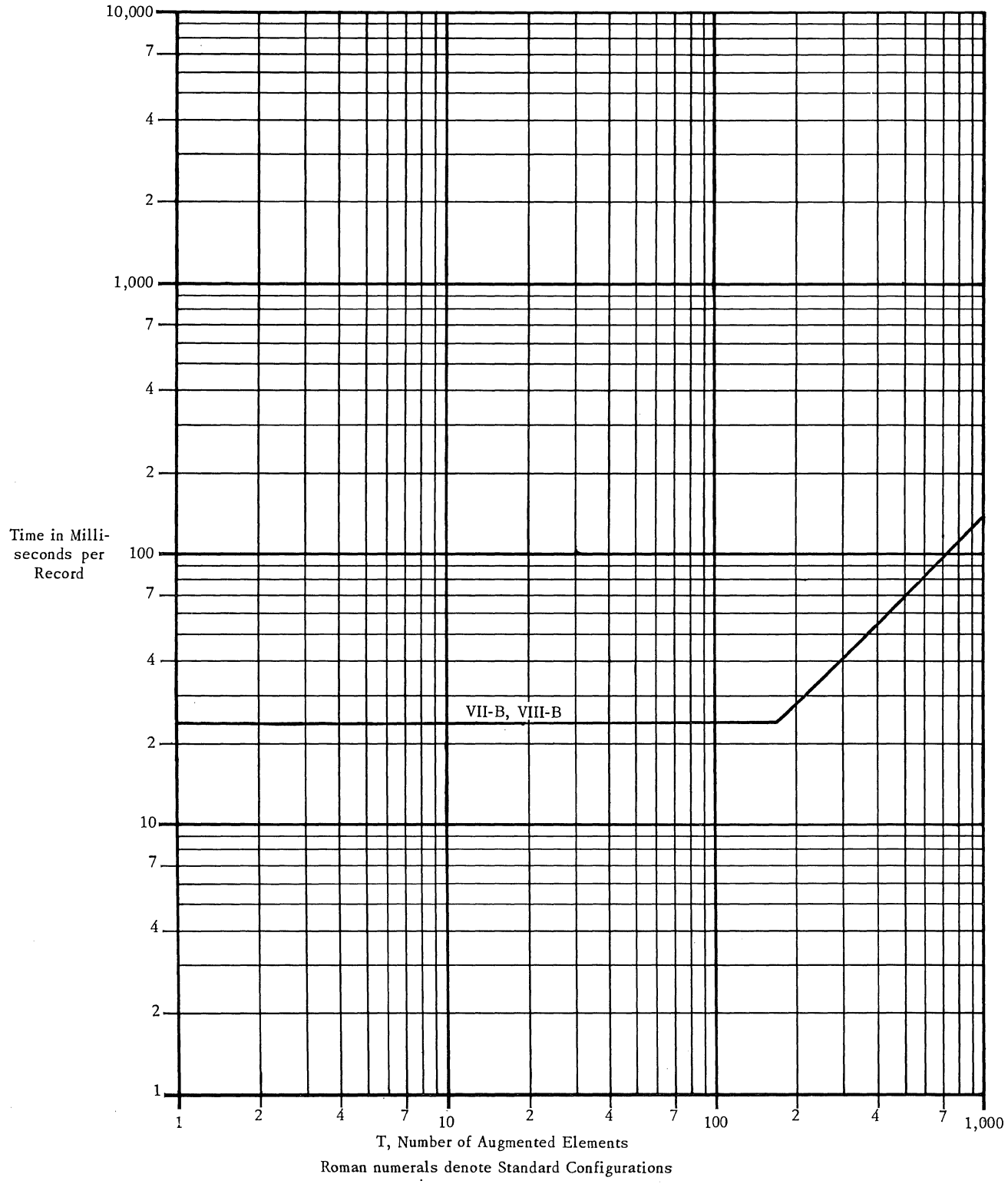
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



Roman numerals denote Standard Configurations

AUERBACH / BNA

IBM 7072
PHYSICAL CHARACTERISTICS

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IBM 7072 PHYSICAL CHARACTERISTICS–Contd.

IDENTITY	Unit Name		Magnetic Tape Unit	Console Card Reader	Power and Tape Control	Tape Control	Power Converter
	Model Number		7330	7501	7624	7625	7802
PHYSICAL	Height × Width × Depth, in.		58 × 29 × 31	39 × 33 × 29	69 × 30 × 68	69 × 30 × 68	69 × 30 × 68
	Weight, lbs.		650	200	1,800	2,100	1,700
	Maximum Cable Lengths to Designated Units, feet		80 (7625) 90 (7624) See Note.	35 (7624)	14 (power)	14 (power)	14 (power)
ATMOS-PHERE	Storage Ranges	Temperature, °F.	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110
		Humidity, %	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80
	Working Ranges	Temperature, °F.	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Heat Dissipated, BTU/hr.		3,415	800	1,900	400	13,200
	Air Flow, cfm.		150	800	220	400	800
	Internal Filters						
ELEC-TRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance	±8%	±8%	±8%	±8%	±8%
	Cycles	Nominal	60	60	60	60	60
		Tolerance	±0.5	±0.5	±0.5	±0.5	±0.5
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		1.1	0.3	0.4	0.3	12.7
NOTES			Cable lengths are totals for all 7330s on a channel.				

AUERBACH / BNA

IBM 7072 PHYSICAL CHARACTERISTICS

			Processor	Console	CE Console	Core Storage
IDENTITY	Unit Name		Processor	Console	CE Console	Core Storage
	Model Number		7105	7150	Part of 7150	7301
PHYSICAL	Height × Width × Depth, in.		69 × 30 × 68	40 × 66 × 33	23 × 46 × 21	69 × 30 × 68
	Weight, lbs.		2,500	400	300	1,500
	Maximum Cable Lengths to Designated Units, feet		----	35 (7624)	35 (7624)	----
ATMOSPHERE	Storage Ranges	Temperature, °F.	50 - 110	50 - 110	50 - 110	50 - 110
		Humidity, %	0 - 80	0 - 80	0 - 80	0 - 80
	Working Ranges	Temperature, °F.	65 - 90	65 - 90	65 - 90	65 - 90
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80
	Heat Dissipated, BTU/hr.		12,000	800	Included in 7150	6,600
	Air Flow, cfm.		800	----	----	400
	Internal Filters					
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance	±8%	±8%	±8%	±8%
	Cycles	Nominal	60	60	60	60
		Tolerance	±0.5	±0.5	±0.5	±0.5
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		Included in 7802	0.02	Included in 7150	1.4

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§ 221. PRICE DATA

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Central Processor	7105	High-Speed Scientific Processor			
	Model 1	One tape channel	7,675	260.00	310,000
	Model 2	Two tape channels	7,775	263.00	314,000
Storage	7301	Core Storage			
	Model 1 and 11	5,000 words	3,500	31.25	195,000
	Model 2	9,990 words	6,800	37.50	343,000
	Model 21, 22 & 23	10,000 words	6,800	37.50	343,000
Input-Output	7330	Magnetic Tape Unit	450	52.25	22,000
		Optional Features			
	5980	Read Binary Tape (channel 1 only)	350	1.50	14,000
		Additional Tape Attachment (required when more than 6 7330s are connected to a channel)			
	7851	For channel 1	100	0.50	4,500
	7852	For channel 2	100	0.50	4,500
	7150	Console Control Unit	300	15.50	13,050
	7501	Console Card Reader	75	5.75	3,100
Controllers	7624	Power and Tape Control (channel 1)	2,050	73.00	84,000
	7625	Tape Control (channel 2)	1,850	48.00	75,000
		Additional Core Storage Attachments (required when more than 10,000 words are used)			
	1017	On 7105 Processor	450	9.25	18,450
	1018	On 7624 Power and Tape Control	25	2.00	900
	1018	On 7625 Tape Control	25	2.00	900
Power	7802	Power Converter (required in every system)	400	6.00	20,000

NOTE: Monthly maintenance charges apply to purchased equipment only; they are based on a graduated scale, and the charges shown here apply to the first three years after installation.

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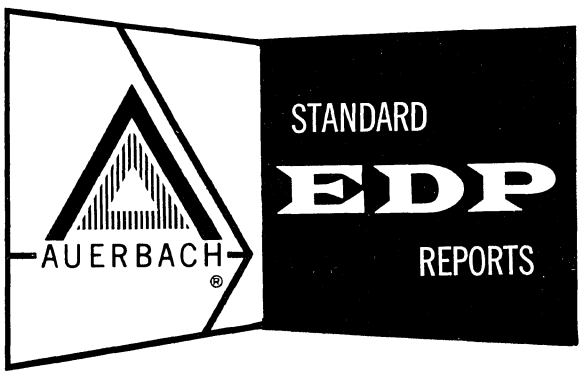
IBM 7074

International Business Machines Corp.



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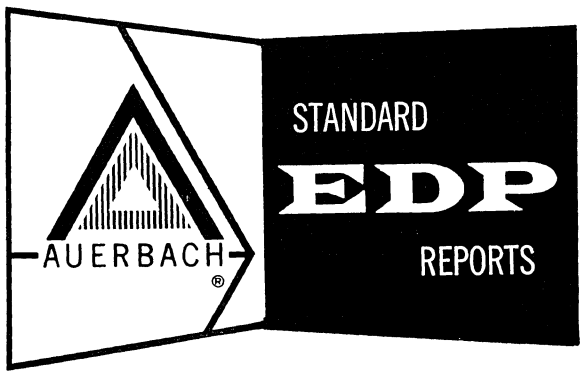
IBM 7074

International Business Machines Corp.



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INTRODUCTION

The solid-state 7074 system is the most powerful member of IBM's 7070 series. It is most effective as a tape oriented system for high volume business applications, and the IBM 1401 is commonly used with it to perform the off-line data transcription operations. Because it offers relatively high internal speeds, large core storage capacity, and optional floating point hardware, the 7074 can also be effective as a scientific processor.

An IBM 7070 system can be converted to a 7074 in the field by replacing the central processor and power converter and altering the internal circuitry in the core storage units and console. The 7074's internal speed is, on the average, about six times as fast as the 7070 and about 1.4 times as fast as the 7072. Overall system throughput for a 7074 on typical commercial applications will average twice that of a similarly equipped 7070, according to the manufacturer. Program compatibility among all members of the 7070 series is virtually complete.

Core storage may consist of from 5,000 to 30,000 word locations. Each location can hold one single-address instruction, one 5-character alphameric word, or one numeric word of ten decimal digits and sign. The 7074's core storage cycle time is four microseconds, compared to six microseconds in the 7070 and 7072 systems.

The instruction repertoire is versatile and effective; the only significant omission is the lack of automatic editing facilities. Three accumulators are provided, and many of the instructions can refer to any one of the three. Ninety-nine core storage locations can be used as index registers. While the 7074 is basically a fixed word-length system, operand sizes for most internal operations can vary from one to ten digits, and several short fields of like sign can readily be packed into a single core storage location.

A major feature of the 7074 is its ability to transfer several blocks of data to or from different core storage areas in a single operation. This scatter-read and gather-write capability facilitates internal data transfers as well as transfers between core storage and magnetic tape, disc storage, or unit record devices.

Automatic interruption facilitates effective use of the system's capabilities for simultaneous operations. Execution of a priority routine can be initiated automatically whenever an operation is completed by a selected peripheral unit or a manual inquiry request is made.

The IBM 729 series of magnetic tape units offers peak transfer rates from 15,000 to 90,000 characters per second. Up to ten 729 tape units can be connected to each of a maximum of four channels, and up to four tape read/write operations can occur simultaneously with internal processing.

Up to ten of IBM's Hypertape Drives can be connected to each of two tape channels in place of the 729s. Hypertape offers transfer rates of up to 170,000 alphameric characters or 340,000 decimal digits per second plus backward reading, fast stops and starts, and efficient cartridge loading. Hypertape, however, is not compatible with the other IBM tape units.

Two different types of auxiliary magnetic disc storage can be used; the maximum system capacity is 278 million characters.

A line of unit record devices, including a 500 card-per-minute reader, a 250 card-per-minute punch, and a 150 line-per-minute printer, is offered for the 7070 on an "as availabe" basis. A maximum of three readers and three output devices (printers and/or punches) can be connected. A console card reader, rated at 60 cards per minute, is useful in tape systems for direct card input on an exception basis.

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INTRODUCTION–Contd.

Paper tape readers, remote inquiry stations, data transmission terminals, and telegraph transmitters and receivers can be connected to the system through the 1414 Input/Output Synchronizer and the 7907 Data Channel.

Nearly all IBM 7070 software is usable without alteration on the 7074. Autocoder is the basic machine oriented coding system and is offered in three versions for different translating computer configurations. The full, six-tape version includes powerful macro generation and input-output control facilities.

A FORTRAN II processor is available, and a COBOL 61 processor was delivered in March, 1962. A Compiler Systems Tape combines the Autocoder, COBOL, and FORTRAN processors and a Report Program Generator. The manufacturer also offers generalized sort and merge routines, program testing aids, and various utility routines. A wide variety of user-developed routines is available through GUIDE, the 7070 series users' organization.

NOTE: In order to emphasize the close family relationship of the IBM 7074 system to the IBM 7070, report sections covering those items of equipment and software whose form and use are the same in both systems have not been duplicated in this report. In these cases, the Contents section (405:001) refers the reader to the applicable sections of Computer System Report 403 on the IBM 7070.

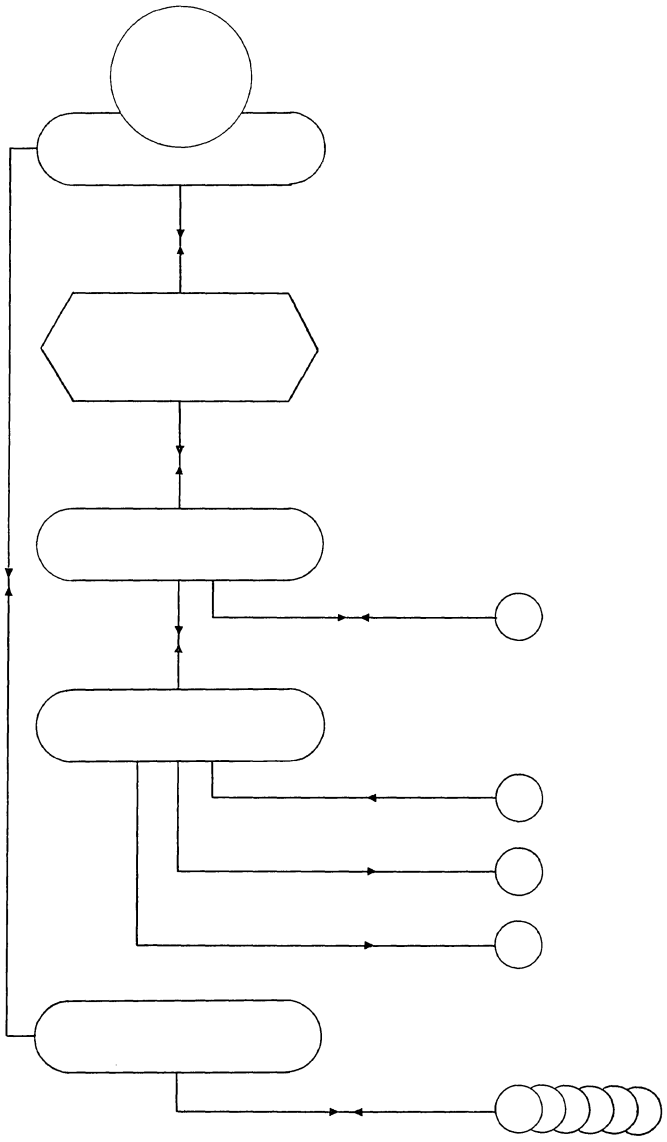
SYSTEM CONFIGURATION

§ 031.

III. 6-TAPE BUSINESS SYSTEM

Deviations from Standard Configuration: . . . . . printer slower by 350 lines/min.

Rental: . . . . . $24,700 per month.



Core Storage: 5,000 words.

Core Storage Control.

High-Speed Processor.

Input/Output Control, Model 1.

Console.

Input/Output Synchronizer, Model 3.

Card Reader: 500 cards/min.

Card Punch: 250 cards/min.

Printer: 150 lines/min.

Tape Control, one channel.

Magnetic Tape Units (6): 15,000 or 41,667 char/sec.

Optional Features Included: . . . . . none.

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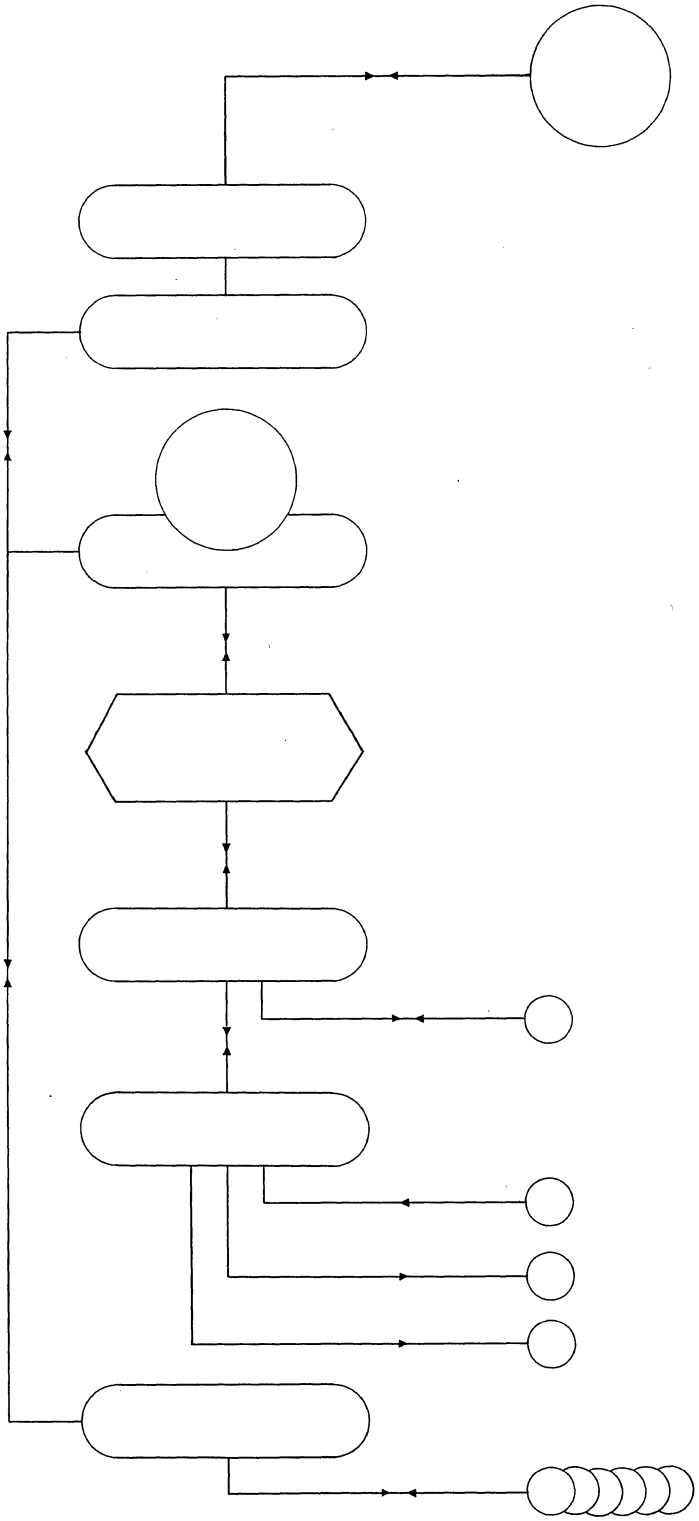
§ 031.

V. 6-TAPE AUXILIARY STORAGE SYSTEM

Deviations from Standard Configuration: . . . . . printer slower by 350 lines/min.

Rental: . . . . . $29,860 per month.



Disc Storage: 1301 Model 1; 27,800,000 characters max.

File Control.

Data Channel, Model 1.

Core Storage: 5,000 words.

Core Storage Control.

High-Speed Processor.

Input/Output Control, Model 1.

Console.

Input/Output Synchronizer, Model 3.

Card Reader: 500 cards/min.

Card Punch: 250 cards/min.

Printer: 150 lines/min.

Tape Control, one channel.

Magnetic Tape Units (6): 15,000 or 41,667 char/sec.

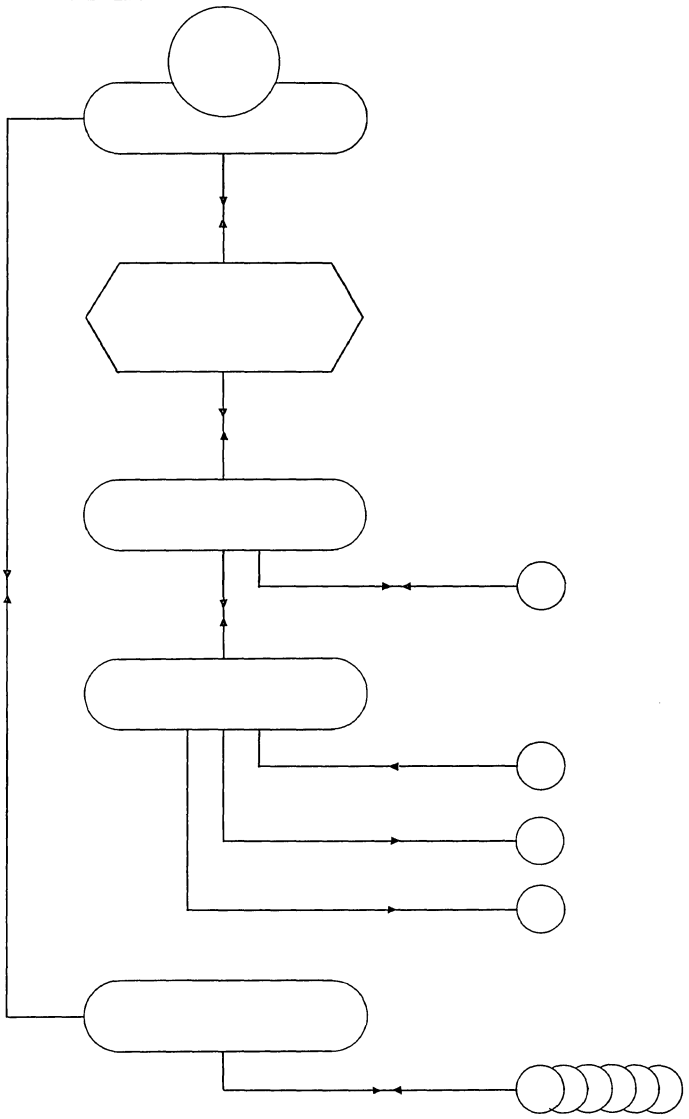
Optional Features Included: . . . . . Cylinder Mode (Disc Storage).

§ 031.

VI. 6-TAPE BUSINESS/SCIENTIFIC SYSTEM

Deviations from Standard Configuration: . . . . . printer slower by 350 lines/min.

Rental: . . . . . $34,175 per month.



Core Storage: 15,000 words.

Core Storage Control.

High-Speed Processor.

Input/Output Control, Model 1.

Console.

Input/Output Synchronizer, Model 3.

Card Reader: 500 cards/min.

Card Punch: 250 cards/min.

Printer: 150 lines/min.

Tape Control, one channel.

Magnetic Tape Units (6): 15,000 or 41,667 char/sec.

Optional Features Included: . . . . . Floating Decimal Arithmetic.

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§ 031.

VII. B 10-TAPE GENERAL SYSTEM (PAIRED)

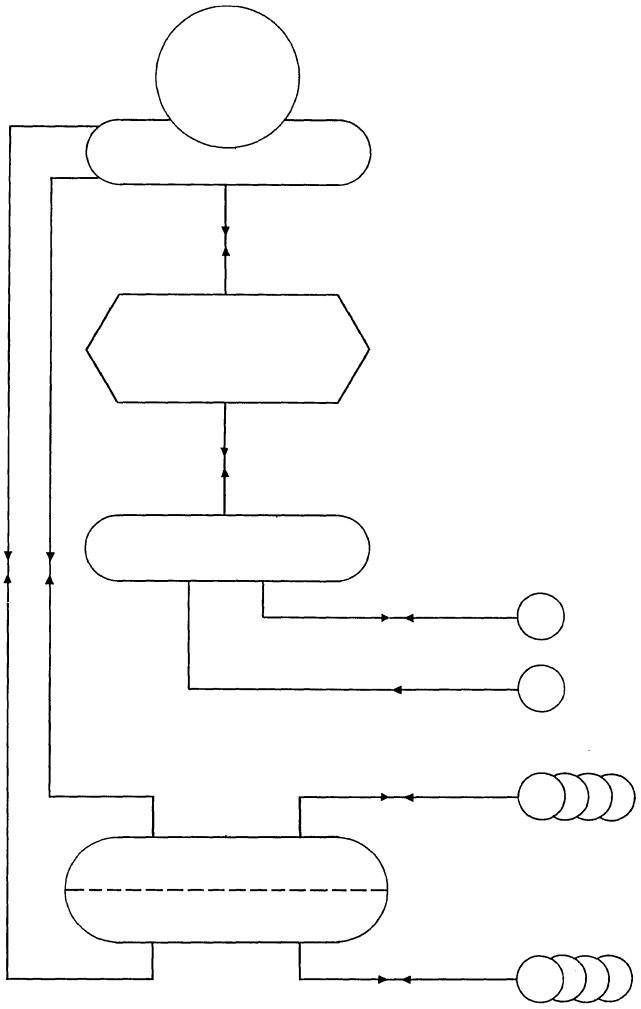
Deviations from Standard Configuration

On-line equipment: . . . . . none.
Off-line equipment: . . . . . none.

Rental

On-line equipment: . . . . . $34,400 per month.
Off-line equipment: . . . . . $ 6,065 per month.
Total: . . . . . $40,465 per month.

On-Line Equipment:



Core Storage: 15,000 words.

Core Storage Control.

High-Speed Processor.

Input/Output Control, Model 2.

Console.

Console Card Reader: 60 cards/min.

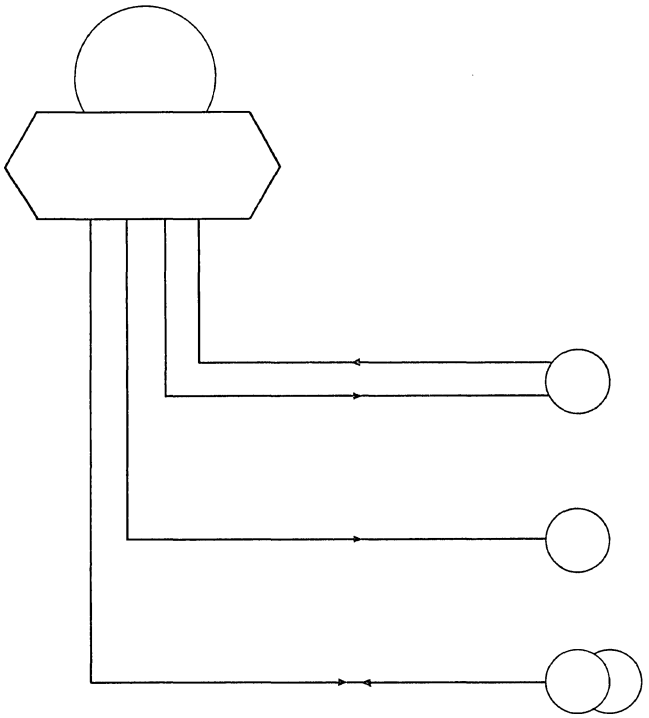
Magnetic Tape Units (4): 22,500 or 62,500 char/sec.

Tape Control, two channels.

Magnetic Tape Units (4): 22,500 or 62,500 char/sec.

§ 031.

Off-Line Equipment (IBM 1401):



Core Storage: 4,000 positions.

Processing Unit: 1401 Model C3.

Card Read-Punch
Reads: 800 cards/min.
Punches: 250 cards/min.

Printer: 600 lines/min.

Magnetic Tape Units (2): 15,000 or 41,667 char/sec.

Optional Features Included

On-line equipment:	Floating Decimal Arithmetic.
Off-line equipment:	High-Low-Equal Compare. Advanced Programming. Read Punch Release. Sense Switches. Print Storage. Compressed Tape. Early Card Read.

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§ 031.

VIII. B 20-TAPE GENERAL SYSTEM (PAIRED)

Deviations from Standard Configuration

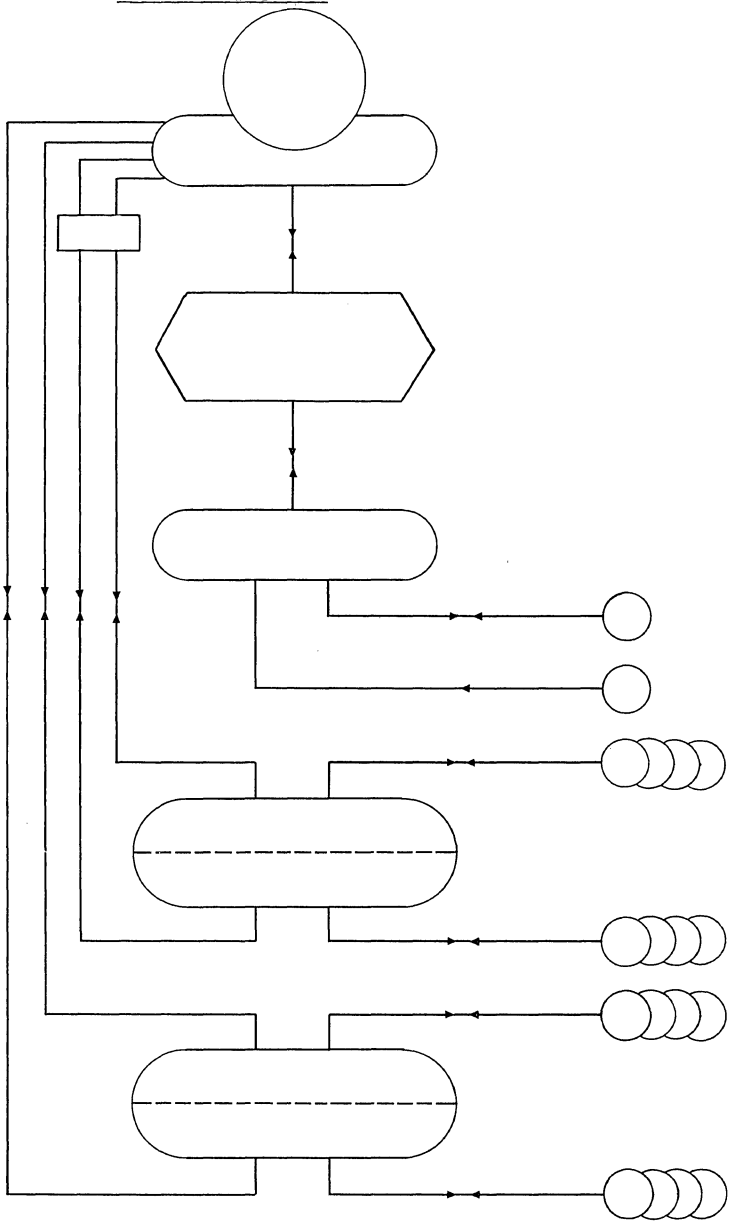
On-line equipment: . . . . . none.

Off-line equipment: . . . . . none.

Rental

On-line equipment: . . . . . $63,700 per month.
Off-line equipment: . . . . . $ 9,140 per month.
Total: . . . . . $72,840 per month.

On-Line Equipment



Core Storage: 30,000 words.

Core Storage Control.

Data Channel, Model 2.

High-Speed Processor.

Input/Output Control, Model 2.

Console.

Console Card Reader: 60 cards/min.

Hypertape Drives (4): 170,000 char/sec. or 340,000 digits/sec.

Hypertape Control, two channels.

Hypertape Drives (4): 170,000 char/sec. or 340,000 digits/sec.

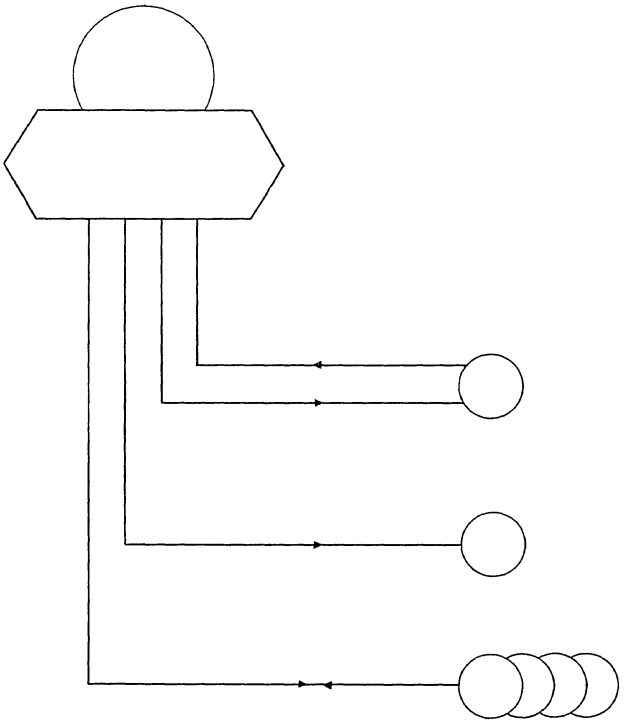
Magnetic Tape Units (4): 22,500, 62,500 or 90,000 char/sec.

Tape Control, two channels.

Magnetic Tape Units (4): 22,500, 62,500 or 90,000 char/sec.

§ 031.

Off-Line Equipment (IBM 1401):



Core Storage: 8,000 positions.

Processing Unit: 1401 Model C4.

Card Read-Punch
Reads: 800 cards/min.
Punches: 250 cards/min.

Printer: 600 lines/min.

Magnetic Tape Units (4): 22,500 or 62,500 char/sec.

Optional Features Included

On-line equipment: . . . . . Floating Decimal Arithmetic.
Off-line equipment: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Compressed Tape.
Print Storage.
Processing Overlap.
Early Card Read.

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INTERNAL STORAGE: CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . . Core Storage.
7301, Models 3, 4, 31, 41, 42, 43.
CS.

.12 Basic Use: . . . . . working storage.

.13 Description

Each core storage location in the 7074 system can hold one numeric word consisting of ten decimal digits and sign, one alphameric word consisting of five characters, or one single-address instruction. Each digit is represented by a two-out-of-five-bit code combination, and validity checks insure that each digit transferred to or from storage contains exactly two bits. Two successive digit positions are required for each alphameric character. Core storage cycle time is four microseconds, and all transfers are parallel by word.

The 7074's scatter-read and gather-write capabilities make it possible to distribute a block of data in core storage into a number of smaller blocks or to assemble several blocks into one larger block. Individual digits or fields within a word can be addressed through the 7074's field definition feature.

The 7301 Model 3 contains 5,000 word locations of core storage; Model 4 contains 9,900 words, which was the maximum core storage capacity in the 7074 as originally conceived. More recently, the 7301 Model 31, with 5,000 words, and Models 41, 42, and 43, each with 10,000 words, were introduced. Up to three of these modules may be used in a system, extending the maximum core storage capacity to 30,000 words. When more than 9,900 words are used, Additional Core Storage Attachments must be added to the High Speed Processor, the Input/Output Control, and all Tape Controls. Programs which utilize the additional core storage must be coded and run in a different mode from those which do not; the details are covered in the Central Processor report, 405:051.12.

.14 Availability: . . . . . 12 to 15 months.

.15 First Delivery: . . . . November, 1961.

.16 Reserved Storage

Purpose	Number of locations	Locks
Index registers:	99	none.
Arith registers:	0.	
Logic registers:	0.	
I-O control:	144	none.
Table look-up:	1	none.
Electronic switches:	3	none.

Note: All locations can also be used as working storage.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rate: . . . . . 250,000 cps.
Unit of data: . . . . . word.
Conversion factor: . . 53 bits/word.
Data rate: . . . . . 250,000 words/sec.
Compound data rate: . 250,000 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity	Minimum Storage Model 3	Model 4	Models 42 & 31
Words	5,000	9,900	15,000
Digits:	50,000	99,000	150,000
Characters:	25,000	49,500	75,000
Instructions:	5,000	9,900	15,000
Modules:	1	1	2

Identity	Models 42 & 41	Models 42, 43, & 31	Maximum Storage Models 42, 43 & 41.
Words:	20,000	25,000	30,000.
Digits:	200,000	250,000	300,000.
Characters:	100,000	125,000	150,000.
Instructions:	20,000	25,000	30,000.
Modules:	2	3	3.

.32 Rules for Combining Modules: . . . . . all combinations are shown above.

.4 CONTROLLER

.41 Identity: . . . . . Core Storage Control.
7602 Model 6.

.42 Connection to System

.421 On-line: . . . . . one.
.422 Off-line: . . . . . none.

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.43 Connection to Device

.431 Devices per controller: up to 3 modules, as shown in .31.

.432 Restrictions:. . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: one access device per system.

.52 Simultaneous Operations: . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 4 μ sec.
Cycle time:. . . . . 4 μ sec.
For data unit of: . . . . one word, or a field-defined portion thereof.

.6 CHANGEABLE STORAGE: . . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possibilities
With self: . . . . . yes.

.72 Transfer Load Size

With self: . . . . . one digit to several blocks; length and number of blocks are limited only by capacity of core storage.

.73 Effective Transfer Rate

With self: . . . . . 125,000 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	stop & alarm.
Receipt of data:	validity check	stop & alarm.
Recording of data:	none.	
Recovery of data:	validity check	stop & alarm.
Dispatch of data:	none.	
Field overflow*:	check	alarm & indicator; optional stop.
Sign change*:	check	alarm & indicator; optional stop.

* When storing field-defined portion of a word.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . High-Speed Processor.
7104.
HSP.

.12 Description

The 7104 High-Speed Processor executes the stored instructions and performs all arithmetic operations in a 7074 system. It contains three accumulators, an adder, an instruction counter, and the program, arithmetic, auxiliary, and synchronizer registers. Each of the accumulators and registers has a capacity of one word and can hold ten decimal digits plus sign or five alphameric characters. All internal transfers are parallel by word. Internal speeds are from 4 to 30 times as high as those of the IBM 7070 system, depending upon the application; in typical commercial applications the 7074's internal speed will be about six times as fast.

A feature of the 7074 is its versatile instruction repertoire. Full fixed point arithmetic facilities are provided, including addition to and subtraction from a core storage location. Ninety-nine index registers are standard; they occupy core storage locations 0001 through 0099, and a full complement of instructions is provided for loading, incrementing, and testing them. A unique "split-shift" operation permits shifting of only those digits to the right or left of any specified position in the 20-digit register composed of accumulators 1 and 2 coupled together. There are no facilities for bit manipulation, but 30 "electronic switches" (each consisting of one digit position in core storage) can be turned on or off or tested by the program. Table look-up operations can be carried out automatically on tables divided into any number of core storage blocks. Internal facilities for editing and format control are severely limited. Many load, store, add, subtract, compare, and branch operations can be carried out in any of the three accumulators, and the accumulators can be addressed and used as instruction operands. Multiplication and division require all three accumulators.

The most common operand length is one 10-digit word, but the 7074's field definition feature (FD) permits arithmetic, load, store, compare, and table look-up operations to be carried out on specified portions of a word. The control portion of an instruction specifies the high- and low-order digit positions of the field to be used. Several fields of like sign can therefore be stored in a single core storage location. Store and add-to-storage operations using field definition can result in field overflows (when digit positions beyond the field-defined ones are affected) or sign changes (when the sign of the stored field differs from that of the storage location). Depending upon console switch settings, these errors can cause system halts or the setting of testable indicators.

The 7074's scatter-read and gather-write capabilities can be used in internal transfers as well as in input-output operations. A block of data in core storage can be scattered into a number of smaller blocks, or a number of blocks can be gathered into one larger block. The addresses of the several blocks that data is to be gathered from or scattered into are specified in a list of record definition (RD) words, one word for each block to be transferred. The end of a block transfer operation is indicated by a record definition word with a minus sign. Conversions between the numeric and alphameric modes can be made during core-to-core block transfers. Each 10-digit numeric word becomes two 5-character alphameric words, and leading zeros can be converted to blanks. Only numeric data should be converted from alphameric to numeric mode; all even-numbered digit positions are lost, so alphabetic or special characters are converted into unrelated numeric codes.

Automatic interruption of the stored program and transfer of control to a priority routine can occur whenever an operation is completed by a magnetic tape unit, disc storage unit, or unit record device, or when an inquiry request is made. This capability is called "Priority Processing." It permits a limited degree of multi-running, but it is not possible for one priority routine to interrupt another.

Optional Features

Floating Decimal Arithmetic (FDA): Provides a full complement of floating point arithmetic operations using an 8-digit fixed point part and a 2-digit exponent. Sixteen-digit results are formed in addition, subtraction, and multiplication.

Interval Timer (IT): Records time in 30-second intervals for up to 8.3 hours, and may be interrogated or reset to zero by the stored program. The Console Card Reader Attachment is a prerequisite.

Additional Core Storage (ACS): Permits up to 30,000 words of core storage to be used in a 7074 system, in increments of 5,000 words. An internal switch, turned on or off by special instructions, selects the additional storage mode or the normal storage mode. In the normal mode, only the low-order 10,000 words can be addressed, and all IBM 7070 and 7074 programs with standard 4-digit addresses can be run without change. In the additional storage mode, the values 00 through 09 in the index portion of an instruction specify no indexing; instead, the index digits serve as an extension of the normal 4-digit operand address. Index values 10 through 99 cause the addition of a five-position field in the specified index word to the four-position operand address, forming a 5-digit effective address. All record definition words must be stored below location 10,000, and there are several other minor programming complications. Routines using the additional storage mode cannot be run on systems not equipped with this feature.

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.13 Availability: . . . . . 12 to 15 months.

.14 First Delivery: . . . . November, 1961.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-Subtract	automatic	decimal	1 word (FD).
Multiply			
Short:	none.		
Long:	automatic	decimal	1 word (FD).
Divide			
No remainder:	none.		
Remainder:	automatic	decimal	1 word (FD).
.212 Floating point			
Add-Subtract:	optional FDA	decimal	8 & 2 digits.
Multiply:	optional FDA	decimal	8 & 2 digits.
Divide:	optional FDA	decimal	8 & 2 digits.
.213 Boolean			
AND:	none.		
Inclusive OR:	none.		
.214 Comparison			
Numbers:	automatic		1 word (FD).
Absolute:	automatic		1 word (FD).
Letters:	automatic		1 word (FD).
Mixed:	automatic		1 word (FD).
Collating sequence:	specials, A to Z, 0 to 9.		

	Provision	From	To	Size
.215 Code translation:	automatic	numeric	alphameric	1 to N words (RD).
	automatic	alphameric	numeric	1 to N words (RD).

.216 Radix conversion: none.

	Provision	Comment	Size
.217 Edit format			
Alter size:	automatic	in code translation operations only	1 to N words (RD).
Suppress zero:	automatic	in right shifts only	1 or 2 words
Insert point:	none.		
Insert spaces:	none.		
Float:	none.		
Protection:	none.		
.218 Table look-up			
Equality:	automatic		1 word (FD, RD).
Equal or greater:	automatic		1 word (FD, RD).
Greatest:	none.		
Least:	automatic		1 word (FD, RD).
.219 Others			
Add to storage:	automatic		1 word (FD).
Subtract from storage:	automatic		1 word (FD).
Record gather:	automatic		1 to N words (RD).
Record scatter:	automatic		1 to N words (RD).
Electronic switches:	automatic	test, turn on or off	30 switches available.

(FD): Field definition is applicable to this operation (1 to 10 digits)
(RD): Record definition words are used to define blocks of data locations.

.22 Special Cases of Operands

.221 Negative numbers: . . . absolute value with negative sign.
.222 Zero: . . . . . plus zero is greater than minus zero in comparisons; both give some results in arithmetic.
.223 Operand size determination: . . . . 1 word or a portion thereof, defined by control portion of instruction.

23 Instruction Formats

.231 Instruction structure: . 1 word.
.232 Instruction layout:

Part	Operation	Index	Control	Address
Size (digits)	sign + 2	2	2	4

233 Instruction parts

Name	Purpose
Operation:	specifies operation to be performed.
Index:	1) specifies indexing word to be added to address; or 2) serves as extension of operand address (in additional storage mode only).
Control:	1) specifies high- and low-order digit positions of a field within the addressed core storage location (field definition); or 2) augments the operation code.
Address:	1) specifies operand address in core storage; 2) specifies destination of a jump; 3) contains a positive literal; or 4) augments the operation code.

.234 Basic address structure: 1 + 0.
.235 Literals
Arithmetic: . . . . . none.
Comparisons and tests: . . . . . 1 digit.
Incrementing modifiers: . . . . . 4 digits.

.236 Directly addressed operands

.2361 Internal storage type	Minimum size	Maximum size	Volume accessible
Core:	1 character	1 word	total capacity in additional storage mode; maximum of 10,000 words in normal storage mode.

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.2362 Increased address capacity:. . . . . none.
.237 Address indexing
.2371 Number of methods: 1.
.2372 Name: . . . . . indexing.
.2373 Indexing rule: . . . . addition, modulo 10,000.
.2374 Index specification: . index portion of the modified instruction (2 digits).
.2375 Number of potential indexers
Normal storage mode: . . . . . 99 (core storage locations 0001 through 0099).
Additional storage mode: . . . . . 90 (core storage locations 0010 through 0099).
.2376 Addresses which can be indexed: . . . . address portion of all instructions.
.2377 Cumulative indexing: none.
.2378 Combined index and step: . . . . . yes.
.238 Indirect addressing: . none.
.239 Stepping
.2391 Specification of increment:. . . . . address portion of stepping instruction.
.2392 Increment sign: . . . always positive, but may be added or subtracted.
.2393 Size of increment: . 4 digits.
.2394 End value:. . . . . zero, non-negative, or value specified in indexing word.
.2395 Combined step and test: . . . . . for increment of 1 or decrement of up to 4 digits.

.24 Special Processor Storage

.241

Category of storage	Number of locations	Size in digits	Program usage
Arithmetic and Program Control:	3	10 + sign	accumulators.
Arithmetic and Program Control:	1	4	instruction counter.
Arithmetic and Program Control:	1	10 + sign	program register.

.242

Category of storage	Total number locations	Physical form	Access time μ sec	Cycle time μ sec
High-Speed Processor:	5	core	4	4

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.
.314 Special sub-sequence counters: . . . . . none.
.315 Sequence control step size: . . . . . 1 word.
.316 Accessibility to routines: . . . . . can be stored in an indexing word.
.317 Permanent or optional modifier: . . . . . no.
.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes
In-out units: . . . . . completion of an operation by a maghetic tape unit or unit record device; manual inquiry request.
In-out controllers: . . as above.
Storage access: . . . completion of a disc storage seek, read, or write operation.
Processor errors: . . none.
Other: . . . . . none.
.332 Control by routine
Individual control: . . individual unit record devices, tape channels, inquiry controls, disc storage seek, and/or disc storage read/write.
Method: . . . . . stacking latches, set by a mask word in core storage, enable interruption by specific units or groups.
Restriction: . . . . . none.
.333 Operator control: . . . console switches determine which 2 unit record devices can cause interruption.
.334 Interruption conditions: 1) not in priority mode.
2) completion of operation by a unit whose stacking latch is not masked.
Note: Upon completion of magnetic tape or disc storage operations, interruption may occur always or only in the event of an error or unusual condition, depending upon sign of the tape or disc instruction.
.335 Interruption process
Disabling interruption: yes; enters priority mode.
Registers saved: . . . stores instruction counter contents in index word 97 and indicator settings in index word 100.
Destination: . . . . . depends on cause.
.336 Control methods
Determine cause: . . destination usually indicates cause; for tape and disc operations, initial and final status words can be tested.
Enable interruption: . "priority release" instruction.

.34 Multi-running: . . . . . limited capability.

.341 Method of control: . . . own coding, using interruption facilities described above.
.342 Maximum number of programs: . . . . . 2 is practical limit, since one priority routine cannot interrupt another.
.343 Precedence rules: . . . own coding.
.344 Program protection:
Storage: . . . . . none.
In-out units: . . . . . none.

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.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ secs.

.411 Fixed point
- Add-subtract: . . . . 8.
- Multiply (average): . . 26 + 3.4D.
- Divide (average): . . . 26 + 6.8D.

.412 Floating point (with FDA)
- Add-subtract: . . . . 16.
- Multiply (average): . . 28 + 3.4D.
- Divide (average): . . . 26 + 6.8D.

.413 Additional allowance for
- Indexing: . . . . . 5.
- Normalization: . . . . 1.0D.
- Re-complementing
  - Fixed point: . . . . . 2.
  - Floating point: . . . 3.

.414 Control
- Compare: . . . . . 8.
- Branch: . . . . . 4.
- Compare and branch: 12.

.415 Counter control
- Step: . . . . . 14.
- Step and test: . . . . . 14.
- Test: . . . . . 10.

.416 Edit: . . . . . 8 + 12N + 4R, for conversions between alphameric and numeric forms, where N is number of numeric words moved and R is number of record definition words.

.417 Convert: . . . . . none.

.418 Shift: . . . . . 6 + D, for shift of D positions.

.42 Processor Performance in μ secs.

.421 For random addresses	Fixed point (10 digits)	Floating point (with FDA)
c = a + b:	24	32.
b = a + b:	20	32.
Sum N items:	8	16.
c = ab:	72	72.
c = a/b:	103	98.
.422 For arrays of data		
$c_i = a_i + b_j$:	81	89.
$b_j = a_i + b_j$:	72	89.
Sum N items:	27	35.
$c = c + a_i b_j$:	128	140.

.423 Branch based on comparison
- Numeric data (up to 10 digits): . . . . . 70.
- Alphabetic data (up to 5 chars): . . . . . 70.

.424 Switching
- Unchecked: . . . . . 28.
- Checked: . . . . . 52.
- List search: . . . . . 25 + 31N.

.425 Format control per character
- Unpack: . . . . . 4.
- Compose: . . . . . 20 (**).

.426 Table look up per comparison
- For a match: . . . . . 6.
- For least or greatest: 6.
- For interpolation point: . . . . . 6.

.427 Bit indicators
- Set bit in separate location: . . . . . 20.
- Set bit in pattern: . . impractical.
- Test bit in separate location: . . . . . 12.
- Test bit in pattern: . . impractical.
- Test AND for B bits: . impractical.
- Test OR for B bits: . . impractical.

.428 Moving
- 1 digit: . . . . . 20.
- 1 word: . . . . . 16.
- N words: . . . . . 8 + 8N + 4R, where R is number of record definition words.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	alarm; stop or set indicator.
Underflow (float-pt):	check	alarm & indicator.
Zero divisor:	causes overflow.	
Invalid data:	fixed count check	stop & alarm.
Invalid operation:	check	stop & alarm.
Arithmetic error:	none.	
Invalid address:	check	stop & alarm.
Receipt of data:	fixed count check	stop & alarm.
Dispatch of data:	fixed count check	stop & alarm.
Field overflow: ∔	check	alarm; stop or set indicator.
Sign change: ∔	check	alarm; stop or set indicator.

∔ Can occur only when storing a field-defined portion of a word.

INPUT-OUTPUT: 729 MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit. 729 II, IV, V, VI. MT.

.12 Description

These tape units are used in the IBM 1401, 1410, 7040, 7080, and 7090 series systems as well as in the 7070 and 7074. In tape width, density and format, they are compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These differences are summarized in the following table:

Model	Tape speed, inches/sec.	Density, char/inch	Transfer rate, char/sec.
II	75.0	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75.0	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

Up to ten tape units can be connected to each of four channels in a 7074 system, and up to four tape operations can be performed simultaneously with internal processing. Only two of the channels can utilize the 800 characters-per-inch density. When 7340 Hypertape Drives are used in a system, the maximum number of channels for 729 tape units is reduced to two. Different models of the 729 can be intermixed on the same channel.

The 7074's scatter-read and gather-write capabilities make it possible to distribute sub-blocks of a block of data read from tape into various portions of core storage under the control of record definition words in the stored program. Similarly, data from different sections of core storage can be assembled into one block on tape.

The optional record-mark control mode provides additional flexibility and facilitates the handling of variable-length records. Detection of a record mark in a data word signals an end of a sub-block, and control is transferred to the next sequential record definition word.

Since a 7074 word may consist of either ten numeric digits plus sign or five alphameric characters, a mode change character, Δ , is automatically recorded on the tape whenever the data mode changes from alphameric to numeric or vice versa. When the tape is read, the mode change characters insure that each word will be translated back into the proper internal form. When recording in the numeric mode, up to five high-order zeros in each word can be eliminated and not recorded on the tape; they are filled in automatically when the tape is read.

Every tape instruction that might cause a priority signal when it is completed automatically creates an initial status word in a fixed core storage location; a final status word is generated at the end of each read or write operation. The status words are used by the priority routine to determine the specific cause of the priority signal. At the programmer's option, priority interruptions may occur at the end of every tape operation or only when error conditions are detected by the numerous checking circuits.

Because the internal data structures of the IBM 7074 and 1401 systems are different, certain precautions must be observed to insure tape compatibility between the two systems. The 7074 mode change and segment mark characters have no special significance to the 1401; they will be read into its core storage just as any other characters. When preparing tape for the 7074 however, the 1401 must insert the mode change character between alphameric and numeric sections of data. The 1401's word separator character, =, has no significance to the 7074 and should not be used in preparing tapes for it. The optional Compressed Tape Feature enables the 1401 to process tapes written by a 7074 in the zero suppression mode.

Optional Features

Tape Switching Feature: Modifies a tape unit so that it can be logically switched between two tape channels, two computers, or a computer and an off-line auxiliary unit under operator control. The 7155 Switch Control Console is also required.

Read Binary Tape: Permits odd-parity tapes prepared by systems such as the IBM 704, 709 or 7090 to be read by the 7074, on tape channel number 1 only. Each binary row on tape is converted to two octal digits, and each octal digit occupies one digit position in 7074 storage. Since the 7074's internal logic is entirely decimal, the octal data must be converted to decimal form or processed by means of programmed subroutines.

.13 Availability: . . . . . 12 to 15 months with 7074 system or 7 to 9 months alone.

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.14 First Delivery

729 II: . . . . . March, 1960.
729 IV: . . . . . March, 1960.
729 V: . . . . . May, 1962.
729 VI: . . . . . May, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or (Models V and VI) 800 rows per inch; N limited by available core storage.
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.

.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0 (record and segment marks are optional).
Unused: . . . . . 0.
Inter-block gap: . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 4.

.34 Format Compatibility

Other device or system	Code translation
IBM 7330, 727 tape units:	not required.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Tape Control. 7604 Models 1, 2, or 3. TC.

.42 Connection to System

.421 On-line

Model 1 has two channels and handles 200 and 556 char/inch only.
Model 2 has one channel and handles 200 and 556 char/inch only.
Model 3 has two channels and handles 200, 556, and 800 char/inch.
The following combinations are possible:

	Number of 729 Tape Channels	First 7604 Model No.	Second 7604 Model No.
Without 7907 Data Channel:	1	2	-
	2	1 or 3	-
	3	1	2
	4	1 or 3	1
With 7907 Model 1 or 2, used for 1301 Disk Storage and/or 1414 Synchronizer:	1	2	-
	2	1 or 3	-
	3	1	2
	4	1	1
With 7907 Model 2, 3, or 4, used for 7340 Hypertape:	1	2	-
	2	1 or 3	-

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.422 Off-line: . . . . . may be switched to another channel, another computer, or an off-line auxiliary unit by means of the optional 7830 Tape Switching Feature and 7155 Switch Control Console.

.43 Connection to Device

.431 Devices per controller: up to six 729 IIs, IVs, Vs, and VIs, in any combination, per tape channel (up to 10 per channel with Additional Tape Attachment, 7835, 7836, 7837, or 7838)

.432 Restrictions:. . . . . 729 Vs and VIs at 800 char/inch can be connected only to 7604 Model 3.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words from (or into) different areas of core storage, as specified by record definition words.

.442 Input-output areas: . . core storage.

.443 Input-output area access: . . . . . each word (each digit by field definition).

.444 Input-output area lockout: . . . . . none.

.445 Table control: . . . . . yes; scatter-read and gather-write, controlled by record definition words.

.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words, limited by available core storage (blocks less than 3 words long are normally treated as noise).

.512 Block demarcation
Input: . . . . . gap on tape or negative record definition word in core storage.
Output: . . . . . negative record definition word.

.52 Input-Output Operations

.521 Input: . . . . . read one block forward into core storage locations specified by record definition word(s); record mark control is optional.

.522 Output: . . . . . write one block forward from core storage locations specified by record definition word(s); record mark control is optional.

.523 Stepping: . . . . . none.

.524 Skipping: . . . . . 1) one block backward (backspace).
2) 4 inches forward (to skip and erase defective tape areas).
3) N segments forward or backward (N is specified in record definition word; a segment is the data between two segment marks on the tape).

.525 Marking: . . . . . inter-block gap, segment mark (SM), tape mark (TM), and mode change (Δ).

.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, between tape codes in Data Code Table No. 4 and internal numeric or alphameric modes (Δ on tape signifies mode changes).

.54 Format Control

Control: . . . . . program.
Format alternatives: . undefined.
Rearrangement: . . . . yes; scatter-read and gather-write.
Suppress zeros: . . . . yes; up to 5 per numeric word.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . yes.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes; priority signal.
Select format: . . . . . yes; normal, all alphameric, zero suppression, or record mark control.
Select code: . . . . . no.
Rewind: . . . . . yes.
Unload: . . . . . yes.

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.56 Testable Conditions

Disabled:	yes.
Busy device:	no.
Output lock:	no.
Nearly exhausted:	no.
Busy controller:	yes.
End of medium marks:	yes; 14 feet from physical end.
End of segment:	yes.

.6 PERFORMANCE

.61 Conditions: none.

.62 Speeds

.621 Nominal or peak speed

Model II:	15,000 or 41,667 char/sec.
Model IV:	22,500 or 62,500 char/sec.
Model V:	15,000, 41,667 or 60,000 char/sec.
Model VI:	22,500, 62,500 or 90,000 char/sec.

.622 Important parameters

Name	Value
Density	
Models II & IV:	200 or 556 char/inch.
Models V & VI:	200, 556 or 800 char/inch.
Tape speed	
Models II & V:	75.0 inches/sec.
Models IV & VI:	112.5 inches/sec.
Start time	
Models II & V	
read:	10.5 m.sec.
write:	7.5 m.sec.
Models IV & VI	
read:	6.7 m.sec.
write:	5.0 m.sec.
Stop time	
Models II & V	
read:	2.1 m.sec.
write:	5.1 m.sec.
Models IV & VI	
read:	2.1 m.sec.
write:	3.8 m.sec.
Full rewind time	
Models II & V:	1.2 min.
Models IV & VI:	0.9 min.
Inter-block gap:	0.75 inch.

.623 Overhead

Models II & V:	12.6 m.sec/block.
Models IV & VI:	8.8 m.sec/block.

.624 Effective speeds

Models II & V	
200 char/inch:	15,000N/(N + 189) char/sec.
556 char/inch:	41,667N/(N + 525) char/sec.
Models IV & VI	
200 char/inch:	22,500N/(N + 198) char/sec.
556 char/inch:	62,500N/(N + 550) char/sec.
Model V	
800 char/inch:	60,000N/(N + 756) char/sec.
Model VI	
800 char/inch:	90,000N/(N + 792) char/sec.

where N = char/block (See graphs).

.63 Demands on System

Component	Condition	m.sec. per block,	or	Percentage of transfer time
Core Storage:	Models II & V			
	200 char/inch	0 + 0.0008N		1.2.
	556 char/inch	0 + 0.0008N		3.4.
	Models IV & VI			
	200 char/inch	0 + 0.0008N		1.8.
	556 char/inch	0 + 0.0008N		5.0.
	Model V			
	800 char/inch	0 + 0.0008N		4.8.
	Model VI			
	800 char/inch	0 + 0.0008N		7.2.
		where N = char/block		

Note: These demands are based upon alphameric mode; they will be half as high in numeric mode when there is no zero elimination.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (Models V and VI only).

§ 091.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	button	lowers tape into reservoirs and rewinds tape to load point.
Unload:	button	removes tape from reservoirs and raises upper portion of head assembly.
File protection:	ring on reel	ring permits writing.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	2,400 feet; for 1,000-char blocks, 5,000,000 chars at 200-char/inch, 11,300,000 chars at 556-char/inch, or 14,400,000 chars at 800 char/inch.

.732 Replenishment time: . . 1.0 to 1.5 mins. tape unit needs to be stopped.

.734 Optimum reloading period

Models II & V: . . . . 6 mins.
Models IV & VI: . . . 4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral & longitudinal parity	priority signal.
Reading:	read-after-write; lateral parity check	priority signal.
Input block size:	compare working & stop addresses when gap is reached	priority signal.
Output block size:	none.	
Invalid Code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	priority signal.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait.
Recording level:	signal strength check	priority signal.
Word length:	check	priority signal.
Misplaced character:	check	priority signal.
Code Translation:	2-out-of-5 bit check	priority signal.

Note: "Priority signal" indicates that digit position 1 of the final status word is set to a particular condition code and control is transferred to a tape priority routine which takes the appropriate action.

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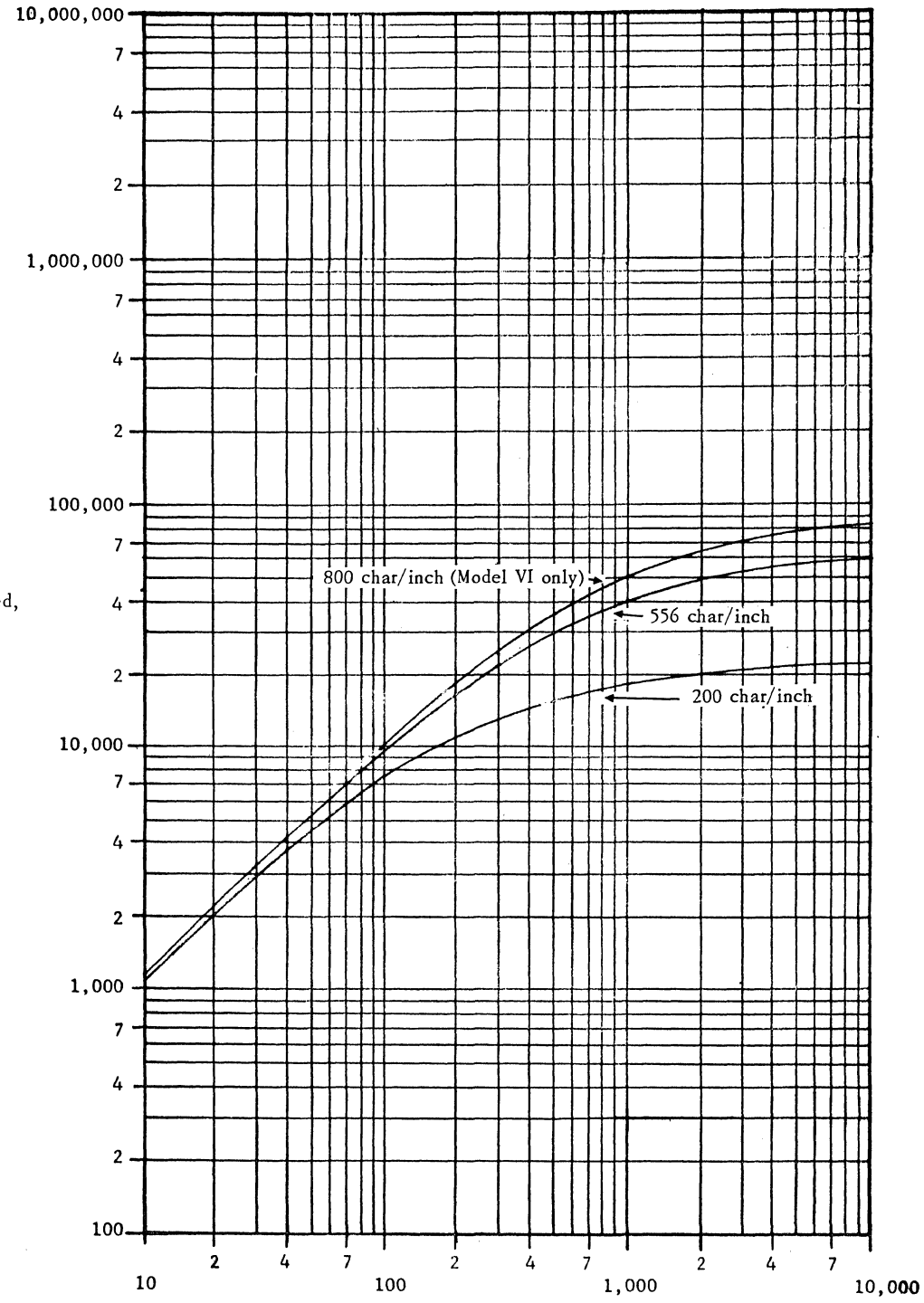
EFFECTIVE SPEED
IBM 729 IV & 729 VI



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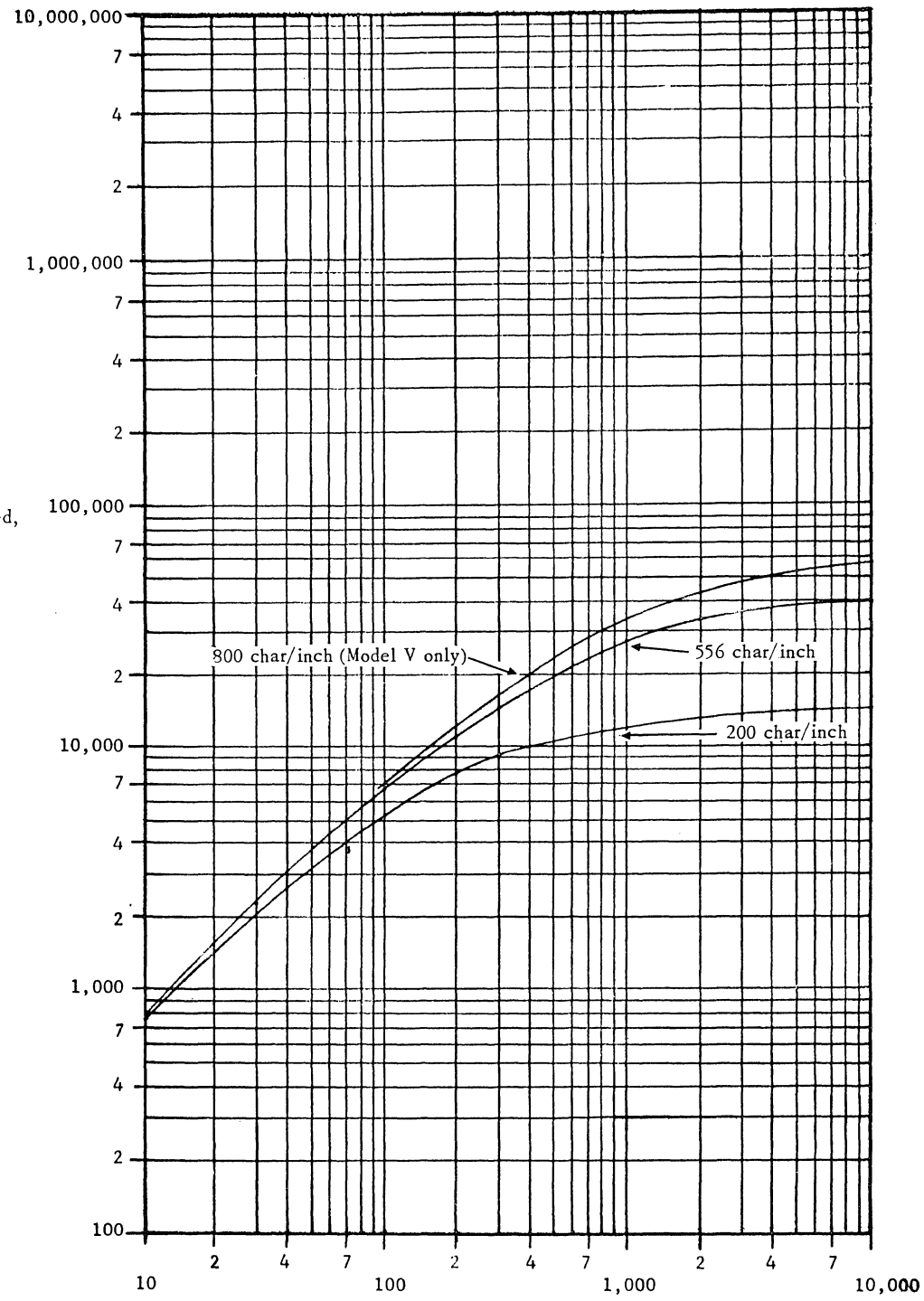
EFFECTIVE SPEED
IBM 729 II & 729 V



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INPUT-OUTPUT: HYPERTAPE DRIVE

§ 092.

.1 GENERAL

.11 Identity: . . . . . Hypertape Drive.
7340 Model 1.
MT.

.12 Description

Announced in October, 1961, Hypertape is the most advanced magnetic tape equipment in the IBM line. It is currently available only with the IBM 7074, 7080, 7090, and 7094 data processing systems. One Hypertape Control can be connected to a 7074 through a 7907 Data Channel. The Hypertape Control has two independent tape channels, and a maximum of ten Hypertape Drives can be connected to each channel. When Hypertape is used, the maximum number of 729 tape channels is reduced from four to two.

Recording density is 1,511 rows per inch and tape speed is 112.5 inches per second. The peak transfer rate is 170,000 characters per second. In the optional packed format, two decimal digits are recorded in each tape row, and transfer rates of up to 340,000 digits per second are possible. Unlike other IBM tape equipment, the Hypertape Drive can read backward as well as forward. Average access time to the next sequential tape block is 4.2 milliseconds, compared to 7.3 milliseconds for the 729 IV and VI.

Ten tracks are recorded on one-inch-wide tape; there is no format compatibility with other IBM tape units. Two tracks are used for double-odd parity checking, and bit detection is based on signal phase rather than signal strength. The manufacturer states that these factors make possible detection of all errors and automatic correction of all single-bit and most double-bit errors.

In the unpacked format, six tracks are used for data and two are unused. Data is recorded in the form of one BCD character per row. Since a 7074 word may consist of either ten numeric digits plus sign or five alphameric characters, a mode change character, Δ, is automatically recorded on tape whenever the mode changes from alphameric to numeric or vice versa. When the tape is read, the mode change characters insure that each word will be translated back into the proper internal form.

In the packed format, the eight data bits in one tape row can hold either two decimal digits or one alphameric character. Therefore, five tape rows fill one 7074 word regardless of the internal mode, and the mode change character is unnecessary. Another special character, θ, is automatically recorded before and after the five tape rows representing each negative numeric word.

A major feature of the Hypertape Drive is its cartridge loading technique. Supply and take-up reels holding 1,800 feet of tape are enclosed in a sealed cartridge that measures about 17 by 10 by 2 inches and weighs about eight pounds. The operator loads a reel of tape by simply raising the top cover, sliding the cartridge into place, lowering the cover, and depressing the load-unload button. Then the tape reels move backward to engage the hubs, the tape is lowered into the vacuum columns, and the read-record head moves into position. Unloading is accomplished by reversing the procedure. It is not necessary to rewind the tape before unloading. The file protection device on each cartridge can be turned on manually or by program control; resetting must be done manually when the cartridge is not loaded on the drive.

Two Hypertape operations, one on each channel, can in general be performed simultaneously. The only exceptions are read-read and write-write, which cannot occur simultaneously because the two channels share the same read and write circuitry. Every Hypertape operation is initiated by a "channel select" instruction, which sends the core storage address of the initial channel command word to the specified Data Channel. Internal processing then continues while the Data Channel independently controls the tape operation. Scatter-read, gather-write, record-mark control, and priority signaling, as described for the 729 Magnetic Tape Unit in section 405:091.120, are also available with Hypertape.

Optional Feature

Automatic Cartridge Loader: Reduces lost time during tape changes by automatically unloading one Hypertape cartridge and loading another under manual or program control. Maximum time for a complete unload and load cycle is 30 seconds. The loader is mounted on top of the Hypertape Drive.

.13 Availability: . . . . . 18 to 20 months.

.14 First Delivery: . . . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . non-coated surface of tape is held against single capstan by vacuum action of reservoirs.

.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum columns.
Capacity: . . . . . about 4 feet.

.213 Feed drive: . . . . . motor.

.214 Take-up drive: . . . . . motor.

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.22 Sensing and Recording Systems

.221	Recording system:	magnetic head.
.222	Sensing system:	magnetic head.
.223	Common system:	two-gap head provides read-after-write checking.
.23	Multiple Copies:	none.

.24 Arrangement of Heads

Use of station:	recording.
Stacks:	1.
Heads/stack:	10.
Method of use:	1 row at a time.
Use of station:	sensing.
Distance:	?
Stacks:	1.
Heads/stack:	10.
Method of use:	1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311	Medium:	plastic tape with magnetizable surface.
.312	Phenomenon:	magnetization.

.32 Positional Arrangement

.321	Serial by:	1 to N rows at 1,511 rows per inch; N is limited by available core storage.
.322	Parallel by:	10 tracks.
.323	Bands:	1.
.324	Track use	
	Data:	8 or 6.
	Redundancy check:	2.
	Timing:	0 (self-clocking).
	Control signals:	0.
	Unused:	0 or 2.
	Total:	10.
.325	Row use	
	Data:	1 to N.
	Redundancy check:	0.
	Timing:	0.
	Control signals:	0 (record marks are optional).
	Unused:	0.
	Inter-block gap:	0.45 inch (nominal).

.33 Coding

Unpacked format:	one character per row, as in Data Code Table No. 4; only 6 tracks are used for data.
Packed format:	one alphameric character or two decimal digits per row.

.34	Format Compatibility:	only with Hypertape Drives on other IBM 7074, 7080, 7090, and 7094 systems, using unpacked alphameric format.

.35 Physical Dimensions

.351	Overall width:	1.0 inch.
.352	Length:	1,800 feet per cartridge.

.4 CONTROLLER

.41	Identity:	Hypertape Control. 7640 Model 1. Data Channel. 7907 Model 2, 3, or 4. (Both units are required.)

.42 Connection to System

.421	On-line:	one 7640 (containing two tape channels) connected to one 7907 Model 2, 3, or 4; Models 3 or 4 permit connection of 1 or 2 7631 File Controls for 1301 Disk Storage Units. When Hypertape is used, maximum number of 729 tape channels is two.
.422	Off-line:	none.

.43 Connection to Device

.431	Devices per controller:	20; up to 10 drives on each of the 2 tape channels.
.432	Restrictions:	none.

.44 Data Transfer Control

.441	Size of load:	1 to N words.
.442	Input-output areas:	core storage.
.443	Input-output area access:	each word (each digit by field definition).
.444	Input-output area lockout:	none.
.445	Table control:	yes; scatter-read and gather-write, with separate channel command for each sub-block.
.446	Synchronization:	automatic.

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.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words; limited by available core storage.

.512 Block demarcation
Input: . . . . . gap on tape or channel read command with minus sign.
Output: . . . . . channel write command with minus sign.

.52 Input-Output Operations

.521 Input: . . . . . read one block forward or backward into core storage area(s) specified by one or more channel read commands; record mark control is optional for forward reading only.

.522 Output: . . . . . write one block forward from core storage area(s) specified by one or more channel write commands; record mark control is optional.

.523 Stepping: . . . . . none.

.524 Skipping: . . . . . skip one block forward (space) or backward (backspace); skip forward or backward to tape mark or end-of-tape marker; or skip forward and erase 8 inches (to skip defective tape areas).

.525 Marking: . . . . . inter-block gap; tape mark; mode change, Δ (unpacked format only); negative word identifier θ (packed format only).

.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . program.
Format alternatives: . undefined.
Rearrangement: . . . . yes; scatter-read and gather-write.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes; priority signal.
Select format: . . . . . yes; packed or unpacked.
Select code: . . . . . no.
Rewind: . . . . . yes.
Unload: . . . . . yes.
Enter file-protect status: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted: . . . yes; 40 feet from end-of-tape mark.
Busy controller: . . . . yes.
End of medium marks: yes; 25 feet from physical end.
Operator attention required: . . . . . yes.
Correction occurred: . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . alphameric data in packed or unpacked format.
II: . . . . . numeric data in unpacked format.
III: . . . . . numeric data in packed format.

.62 Speeds

.621 Nominal or peak speed
I: . . . . . 170,000 char/sec.
II: . . . . . 170,000 digits/sec.
III: . . . . . 340,000 digits/sec.

.622 Important parameters
Recording density: . . 1,511 rows/inch.
Tape speed: . . . . . 112.5 inches/sec.
Start time: . . . . . 3.0 m.sec. maximum.
Stop time: . . . . . 3.0 m.sec. maximum.
Full rewind time: . . 1.5 minutes.
Rewind speed: . . . . 250 inches/sec.
Inter-block gap: . . . 0.45 inch.

.623 Overhead (average): . . 4.2 m.sec/block.

.624 Effective speeds (in tape-limited applications)
I: . . . . . 170,000C/(C + 715) char/sec.
II: . . . . . 170,000D/(D + 715) digits/sec.
III: . . . . . 340,000D/(D + 1,430) digits/sec., where C and D = number of characters and digits per block (See graph).

.63 Demands on System

Component	Condition	m.sec per block,	or Percentage of transfer time
Core Storage:	I	0 + 0.0008C	13.6.
	II	0 + 0.0004D	6.8.
	III	0 + 0.0004D	13.6.

where C and D are equal to the number of characters and digits per block.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

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.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0 through 9.
Load-unload:	button	lowers tape into reservoirs and moves head into position.
Rewind:	button.	

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Cartridge:	1,800 feet; for 1,000-row blocks, 19,000,000 characters in unpacked format.

.732 Replenishment time: . . 0.3 to 0.5 mins. tape drive needs to be stopped.

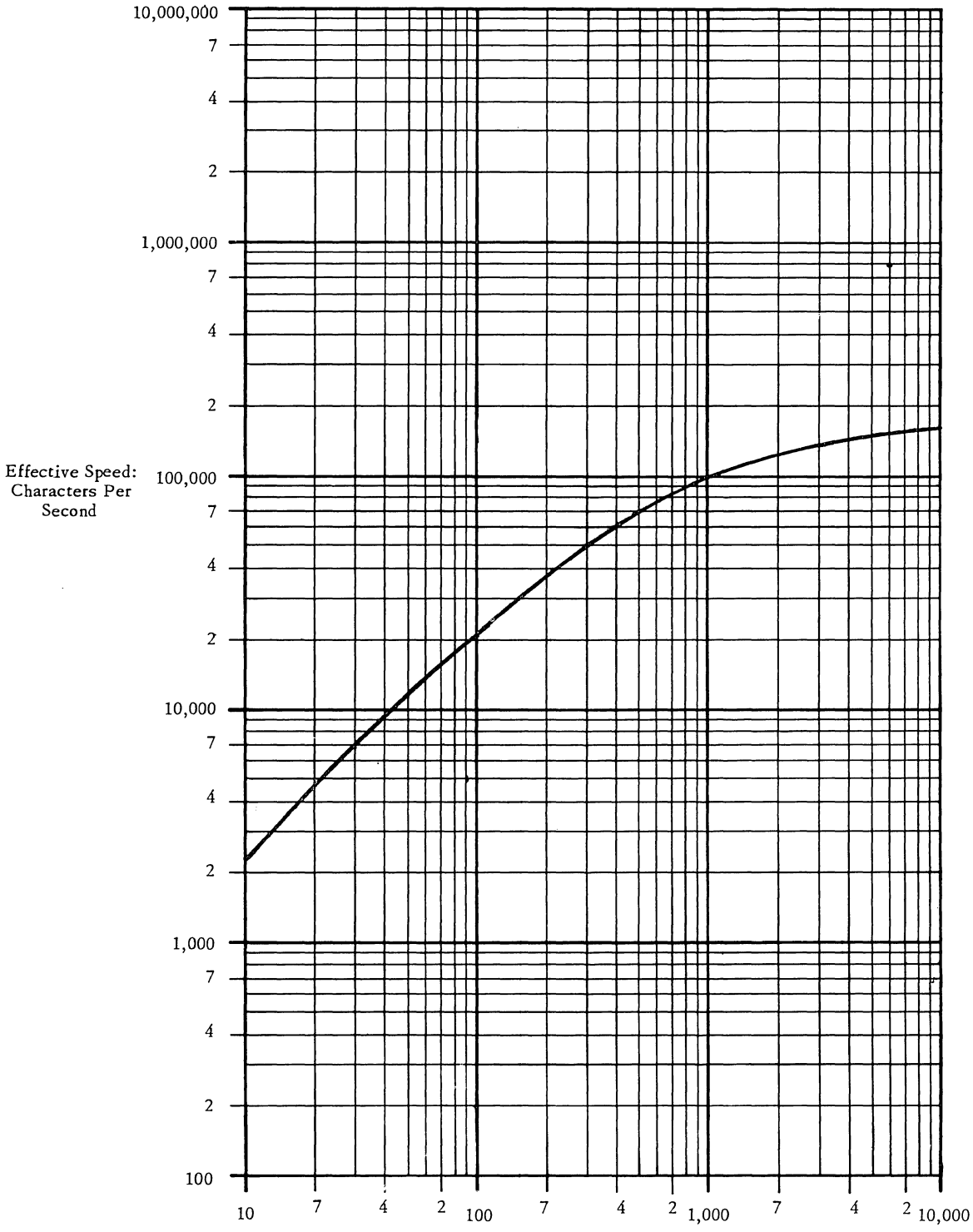
.734 Optimum reloading period: . . . . . 3.1 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write dual-row parity	indicator.
Reading:	dual-row parity	indicator; correct error if possible.
Input area overflow:	none.	
Output block size:	none.	
Invalid operation code:	check	indicator.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing conflicts:	overrun check	indicator.
Excessive skew:	check	indicator.
Circuit failure:	check	indicator.

Note: These error indications and other status information are transmitted from the Hypertape Control to core storage (in the form of three 10-digit words) in response to a "sense channel" command.

Effective Speed
Hypertape Drive



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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS: . . . . none.

.12 Description

A major feature of the 7074 is the flexibility and simultaneity of its input-output operations. Up to four magnetic tape channels can be attached, and a read or write operation on each channel can occur simultaneously with internal processing. Magnetic tape and disc storage have direct access to core storage through their respective controllers. Execution of the stored program is delayed for one 4-microsecond cycle each time a word is transferred between core storage and the tape or disc storage controller.

In systems using unit record input-output, up to three 7500 Card Readers and three output devices (printers and/or card punches) can operate simultaneously. They are buffered by means of a magnetic drum revolving at 12,375 revolutions per minute in the 7600 Model 1 Input/Output Control. The stored program is delayed from one to six milliseconds each time a load of data (one card or one line) is transferred between a unit record buffer and core storage.

Console Card Reader and Console Typewriter operations are unbuffered and cannot occur simultaneously with other operations.

Effective utilization of the 7074's capabilities for simultaneous operations is facilitated by the "Priority Processing" feature, which can interrupt the stored program and transfer control to priority routines upon completion of selected input-output or auxiliary storage operations.

.2 CONFIGURATION CONDITIONS: . . . . none.

.3 CLASSES OF OPERATIONS

Class	Member
A:	read card on Console Card Reader.
B:	read card on 7500 Card Reader.
C:	punch card.
D:	print or advance forms on 7400 Printer.
E:	read or write on 729 Magnetic Tape Unit.
F:	rewind 729 Magnetic Tape Unit.
G:	read or write in disc storage.
H:	seek record in disc storage.
I:	input or output on Console Typewriter.
J:	input or output on Inquiry Station.
K:	read on Hypertape Drive
M:	write on Hypertape Drive.
N:	rewind Hypertape Drive.
O:	input or output on devices attached to 1414 Input/Output Synchronizer.
P:	internal processing.

.4 RULES

a + i + p	= at most 1.
b	= at most 3.
c + d	= at most 3.
e	= at most T.
e + f	= at most 10T.
g	= at most 2.
g + h	= at most 10 (for 1301 Disk Storage).
g + h	= at most 12 (for 7300 Disk Storage).
e + g	= at most 4.
j	= at most 2.
k	= at most 1.
m	= at most 1.
k+m+n	= at most 20.
o	= at most 12 (6 per 1414 Synchronizer).

where T = number of 729 magnetic tape channels (T is at most 4; when Hypertape is used, T is at most 2).

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IBM 7074
SYSTEM PERFORMANCE

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IBM 7074 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration III		Configuration VII B		Configuration VIII B		Reference
1 Input-Output Times	Char/block	(File 1)	1,080		1,080		1,080		
	Records/block	K (File 1)	10		10		10		
	m. sec/block	File 1 = File 2	38.5		26.1		10.6		
		File 3	120		10.1		9.7		
		File 4	400		10.7		10.1		
	m. sec/switch	File 1 = File 2	0		0		0		4:200.112
		File 3	0		0		0		
		File 4	0		0		0		
	m. sec penalty	File 1 = File 2	1.2		1.2		1.2		
		File 3	6		0.1		0.1		
		File 4	6		0.1		0.1		
2 Central Processor Times	m. sec/block	a1	0.18		0.18		0.18		
	m. sec/record	a2	0.38		0.38		0.38		
	m. sec/detail	b6	0.44		0.44		0.44		4:200.1132
	m. sec/work	b5 + b9	0.66		0.66		0.66		
	m. sec/report	b7 + b8	2.51		2.51		2.51		
3 Standard Problem A F = 1.0	m. sec for C. P. and dominant column.	a1	0.2		0.2		0.2		
		a2 K	3.8		3.8		3.8		
		a3 K	35.8		35.8		35.8		
		File 1 Master In	1.2		1.2		1.2		
		File 2 Master Out	1.2		1.2	26.1	1.2		4:200.114
		File 3 Details	60.0		1.0		1.0		
		File 4 Reports	60.0	4000	1.0	107.0	1.0	101.0	
		Total	162.2	4000	44.2	133.1	44.2	101.0	
4 Standard Problem A Space	Unit of measure	(words)							
		Std. routines	1,500		1,500		1,500		
		Fixed	247		247		247		
		3 (Blocks 1 to 23)	102		102		102		
		6 (Blocks 24 to 48)	792		792		792		4:200.1151
		Files	864		880		880		
		Working	32		32		32		
		Total	3,537		3,553		3,553		

IBM 7074 SYSTEM PERFORMANCE—Contd.

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration III	Configuration VII B	Configuration VIII B	Reference
5	Fixed/Floating point				Floating*	Floating*	4:200.413
	Unit name		input		729 IV	729 VI	
			output		729 IV	729 VI	
	Size of record		input		80 char (unblocked)	80 char (unblocked)	
			output		100 char (unblocked)	100 char (unblocked)	
Standard Mathematical Problem A	m. sec/block		input T1		10.1	9.7	
			output T2		10.4	9.9	
	m. sec penalty		input T3		0.1	0.1	
			output T4		0.1	0.1	
	m. sec/record		T5		0.5	0.5	
	m. sec/5 loops		T6		3.6	3.6	
	m. sec/report		T7		1.1	1.1	
7	Unit name				729 IV	729 VI	4:200.512
	Size of block				30 char	30 char	
	Records/block		B		1	1	
Standard Statistical Problem A	m. sec/block		T1		9.8	9.5	
	m. sec penalty		T3		0.1	0.1	
	C. P.	m. sec/block	T5		— —	— —	
		m. sec/record	T6		0.56	0.56	
		m. sec/table	T7		0.10	0.10	

* Using optional Floating Decimal Arithmetic feature.

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SYSTEM PERFORMANCE

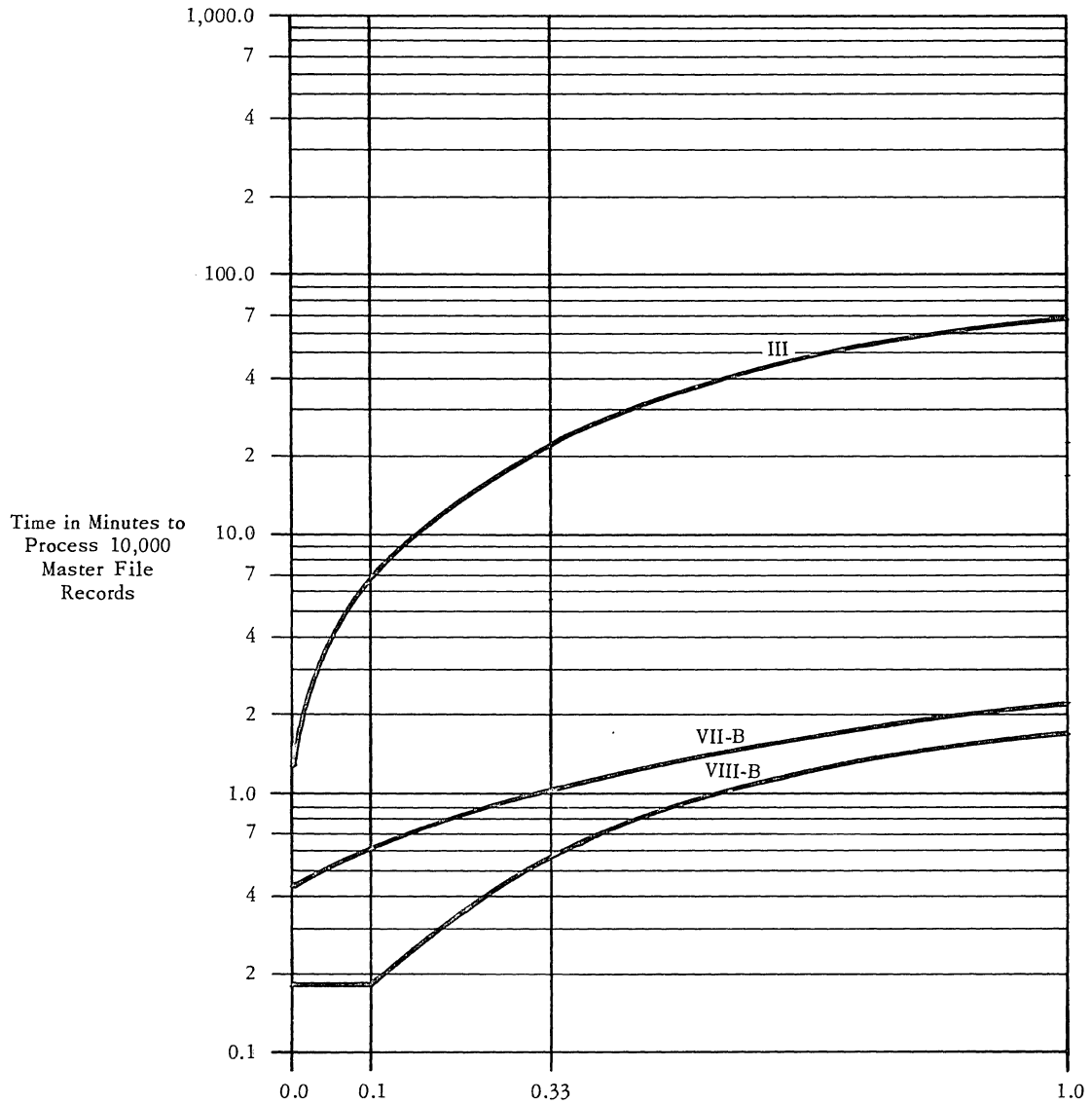
§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A Estimates

.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.
.113 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.113.
.114 Graph: . . . . . see graph below.
.115 Storage space required
Configuration III: . . 3,500 words.
Configuration VII B. . 3,500 words.
Configuration VIIIB: . 3,500 words.



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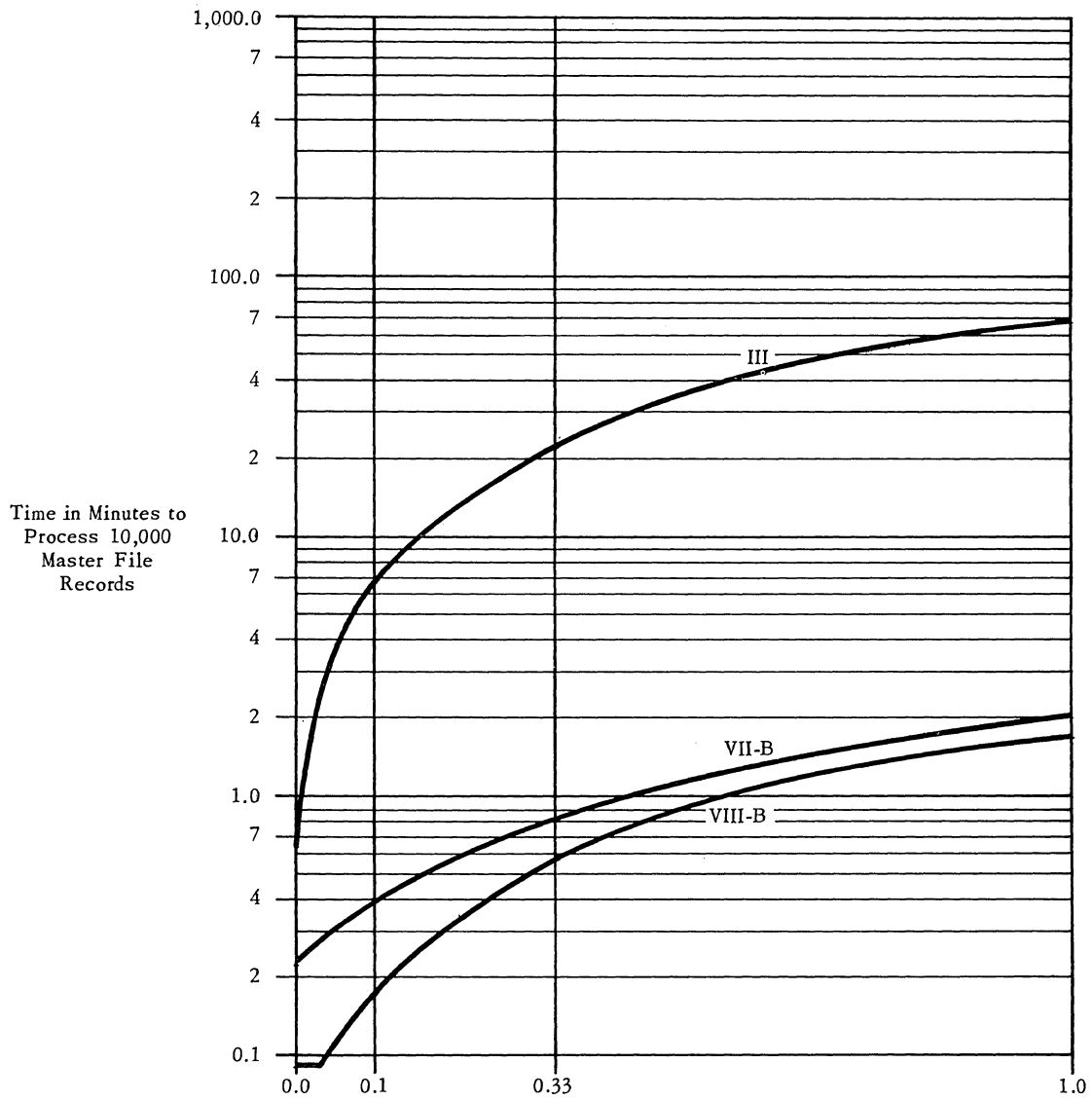
§ 201.

.12 Standard File Problem B Estimates

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in User's Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



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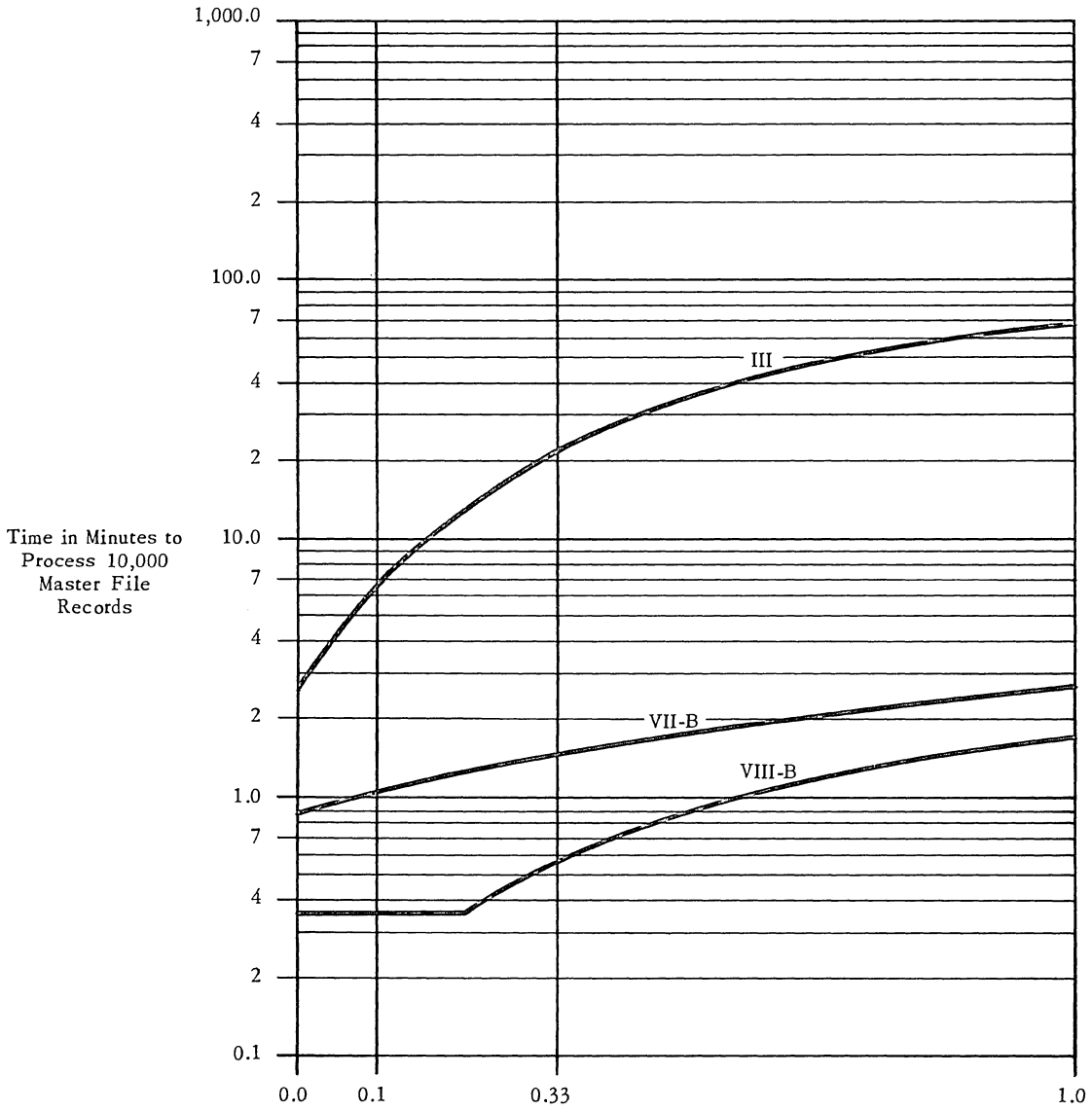
§ 201.

.13 Standard File Problem C Estimates

.131 Record sizes
Master file:. . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis:. . . . . using estimating procedure outlined in User's Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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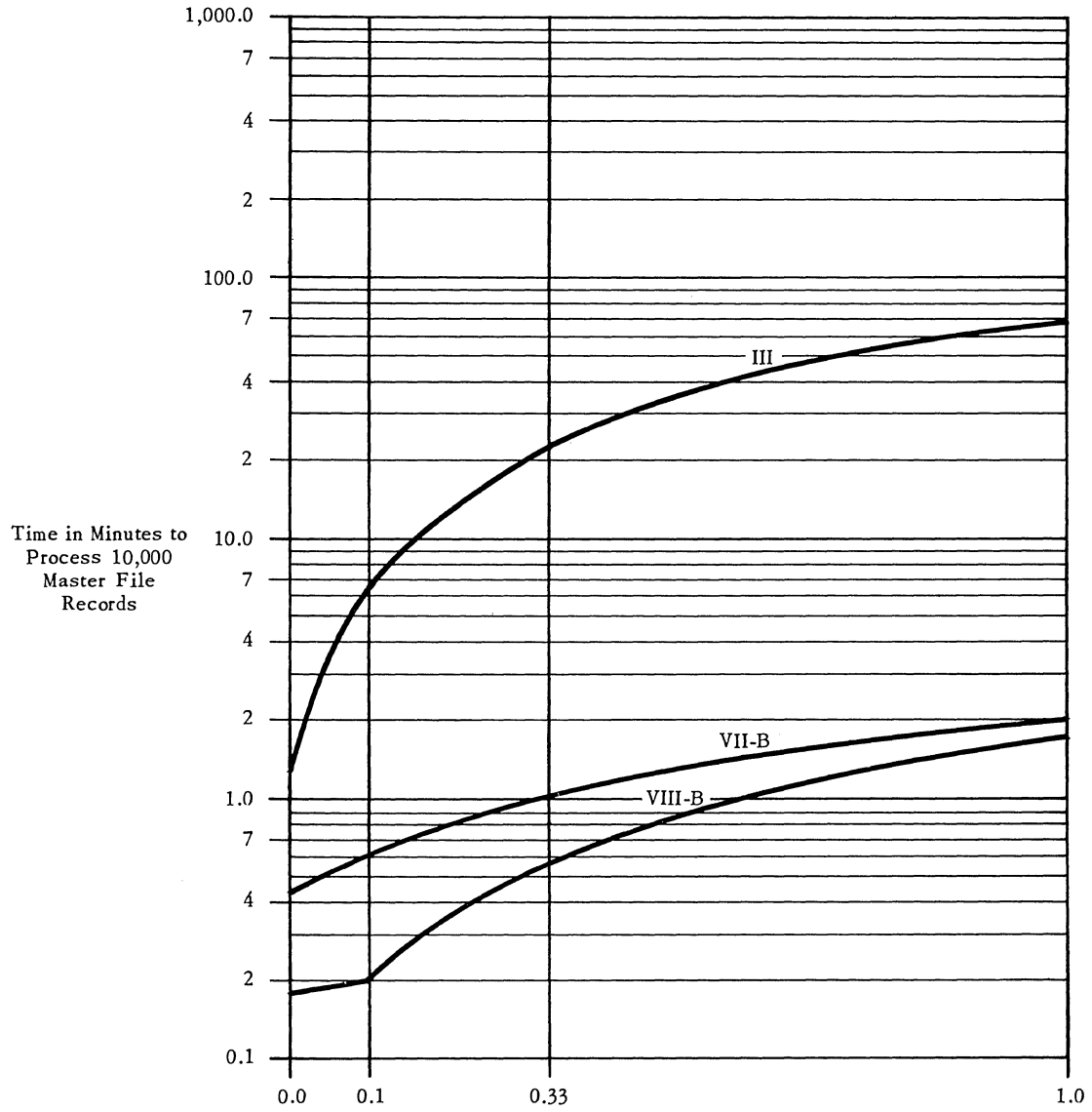
§ 201.

.14 Standard File Problem D Estimates

.141 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: using estimating procedure. outlined in User's Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



§ 201.

.2 SORTING

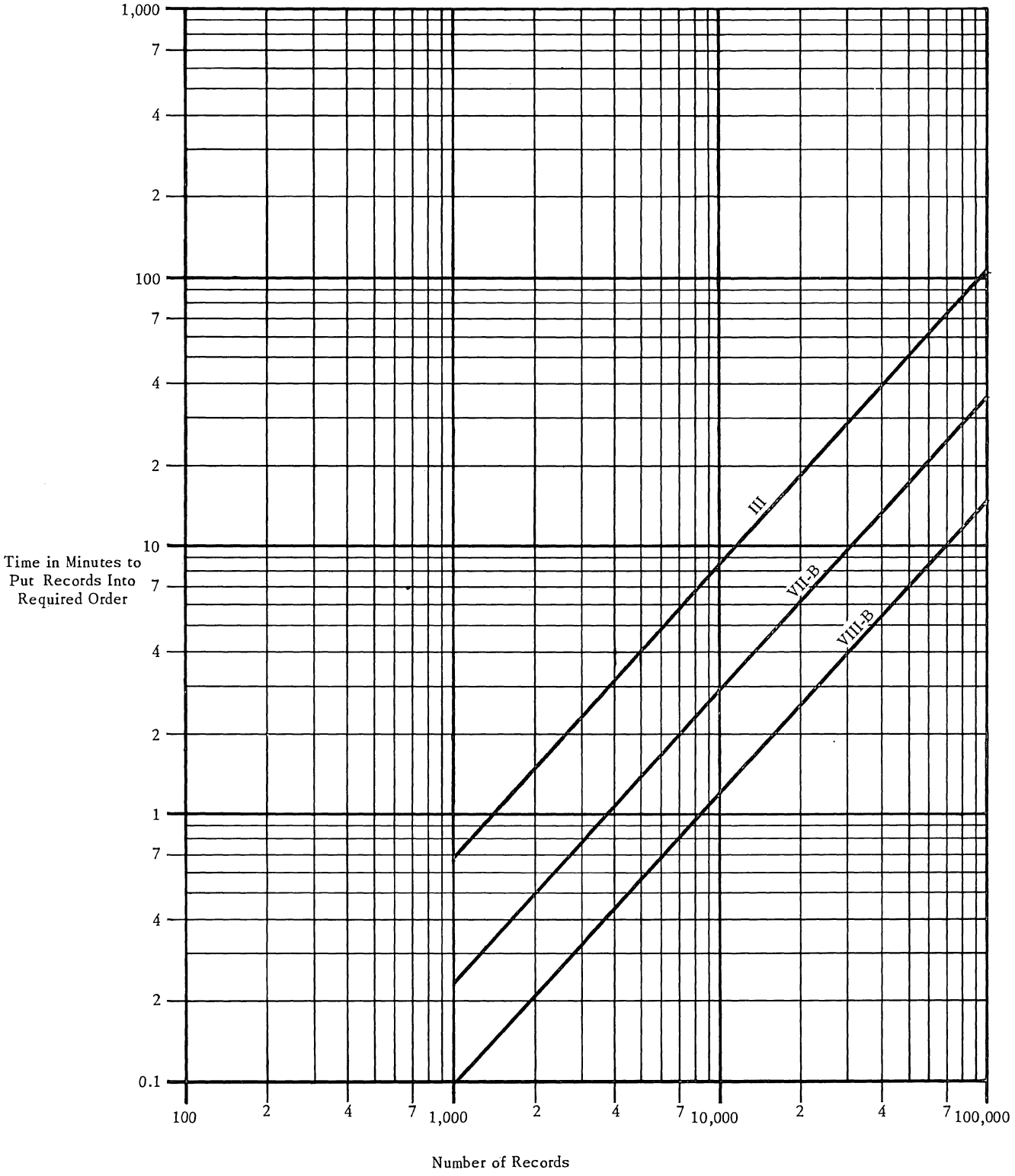
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.213.

.214 Graph:. . . . . see graph below.



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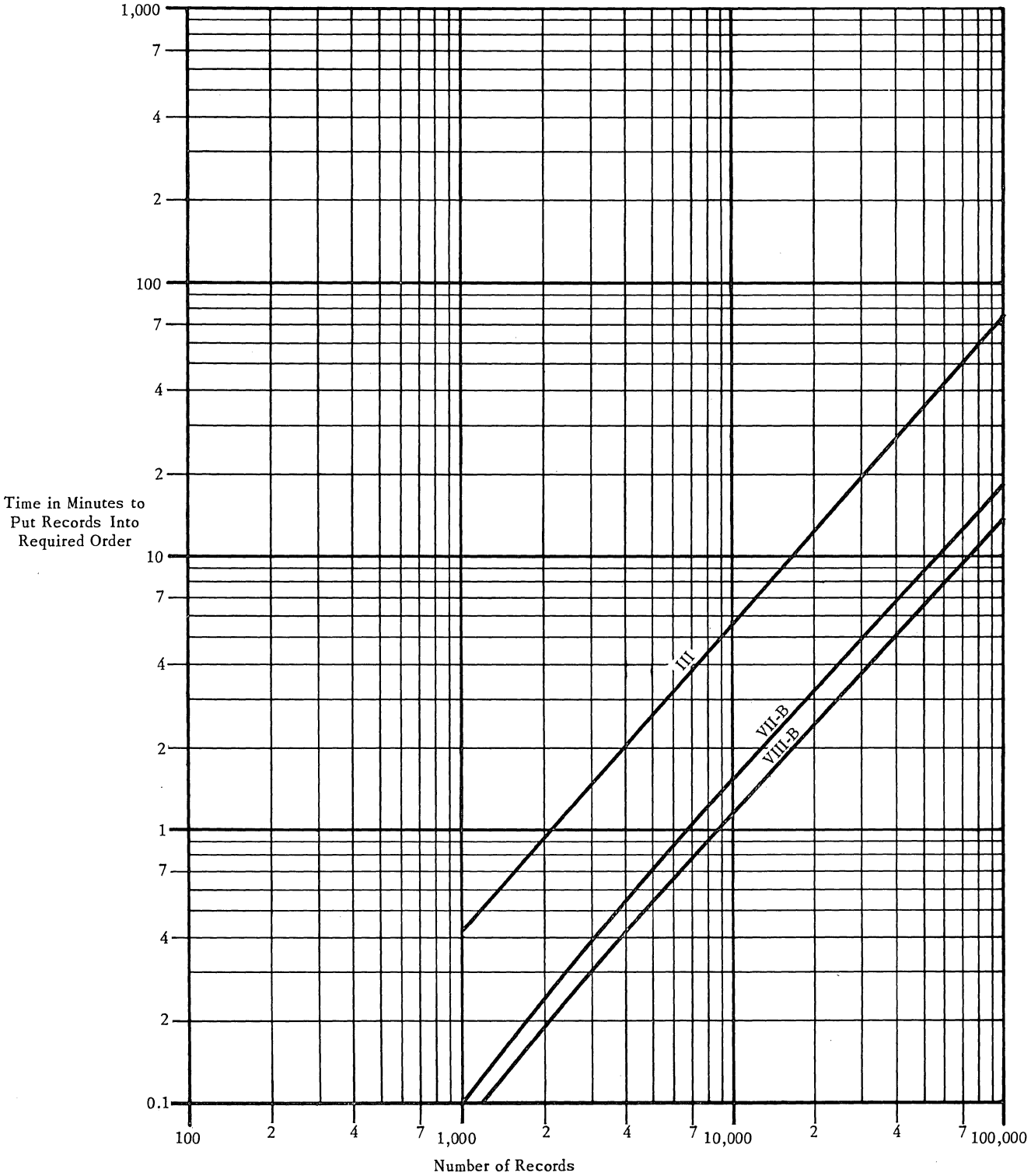
§ 201.

.22 IBM 7070/7074 SORT 90 TIMES

.221 Record size: . . . . . 80 characters.

.222 Key size: . . . . . 8 characters.
.223 Timing basis: . . . . IBM Publication C28-6111, pp. 76-84.
.224 Graph: . . . . . see graph below.



NOTE: Times for Configuration VIII-B are based on use of the 729 VI magnetic tape units; see next page for Hypertape sort times.

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§ 201.

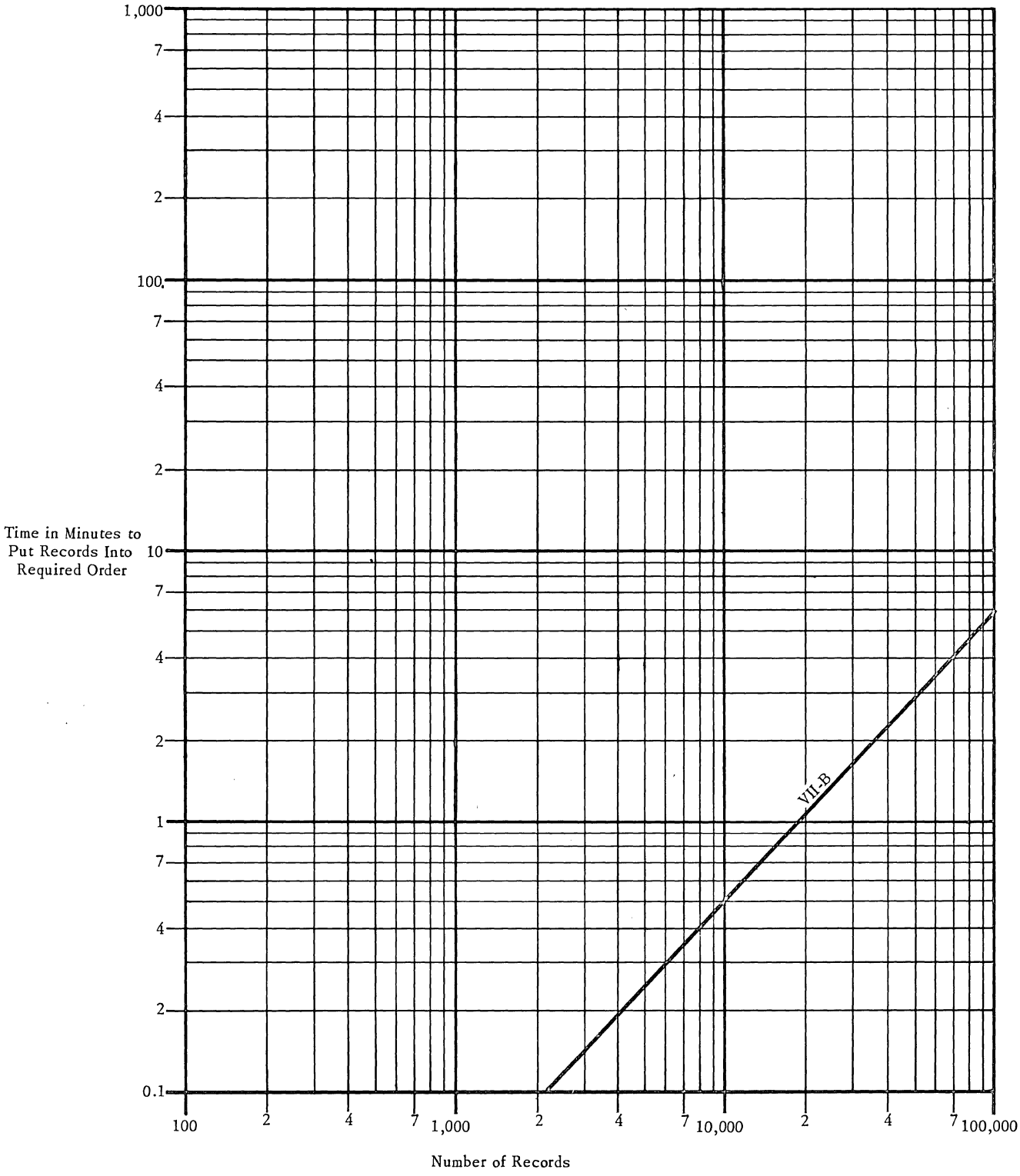
.22 HYPERTAPE SORT TIMES

.221 Record size: . . . . . 80 characters.

.222 Key size: . . . . . 8 characters.

.223 Timing basis: . . . . IBM Publication J28-6154, pp. 10-32: IBM 7074 Generalized Sorting Program Using Hypertape Drives. (Routine will be available in fourth quarter of 1963.)

.224 Graph: . . . . . see graph below.



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§ 201.

.3 MATRIX INVERSION

.31 Standard Problem Estimates

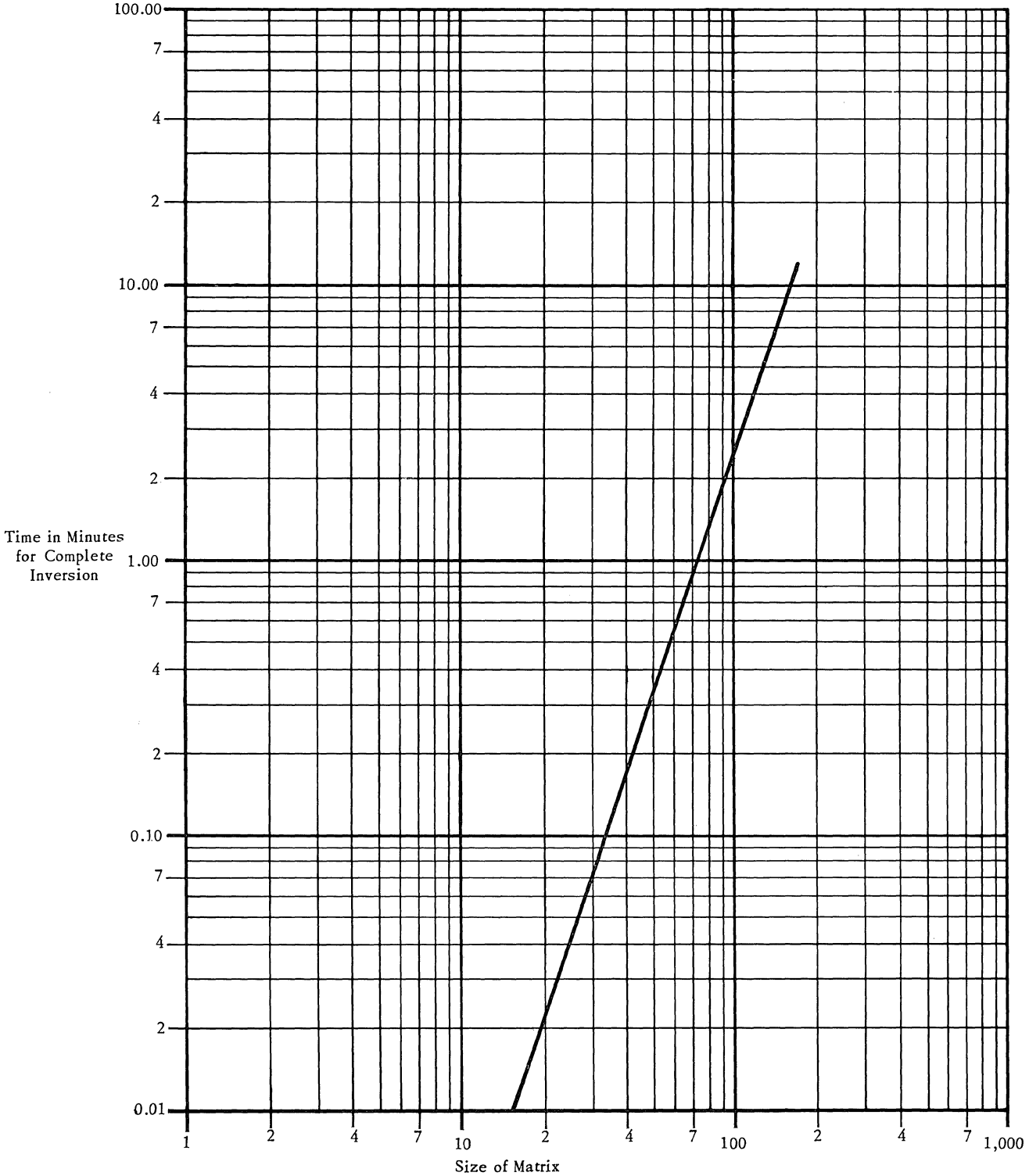
.311 Basic parameters: . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.312; with Floating Decimal Arithmetic option.

.313 Graph: . . . . . see graph below.

.314 Maximum matrix sizes

5,000 core storage locations: . . . 67.
10,000 core storage locations: . . . 97.
20,000 core storage locations: . . . 139.
30,000 core storage locations: . . . 171.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

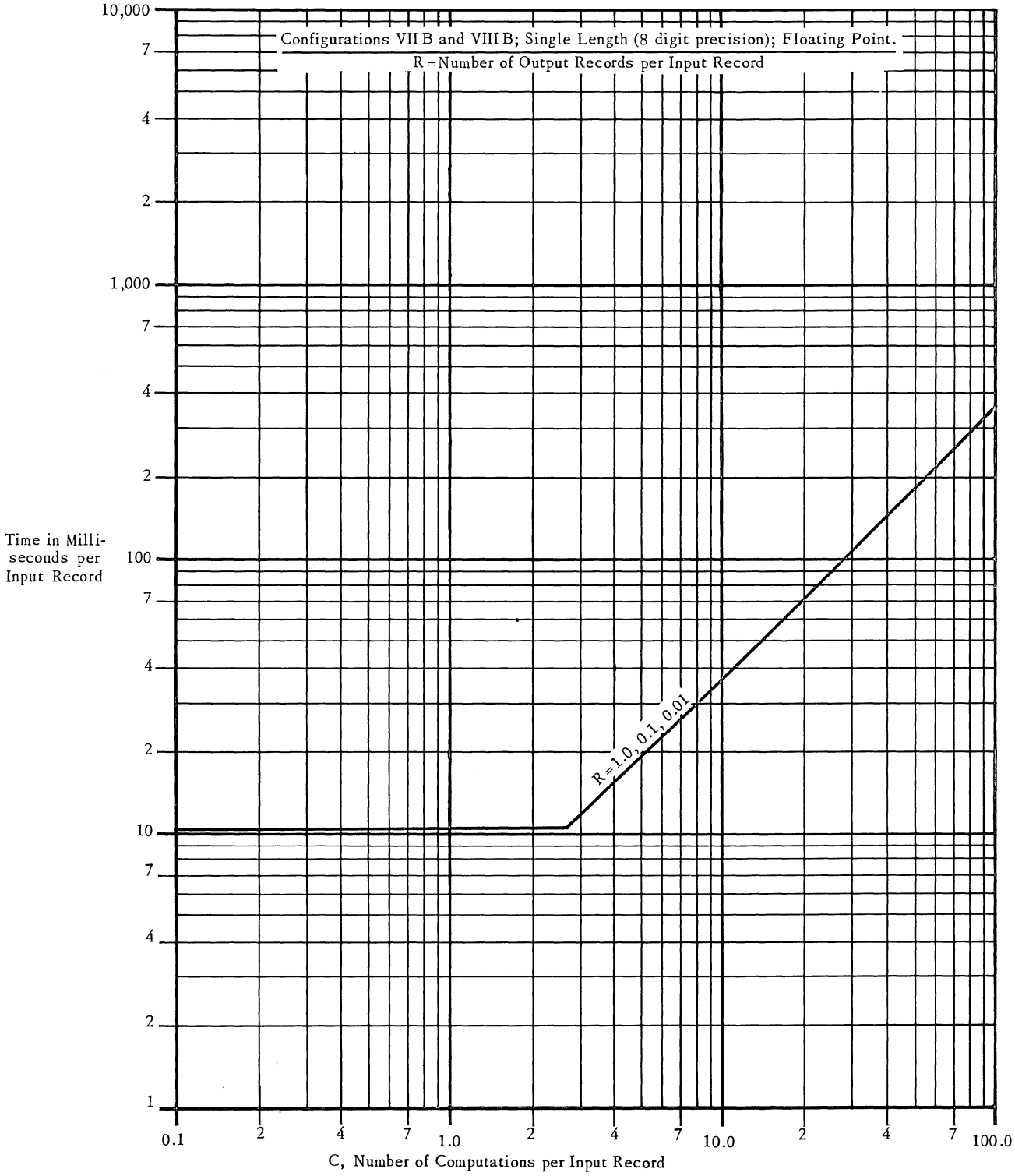
.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in User's Guide, 4:200.413; with optional Floating Decimal Arithmetic.

.414 Graph: . . . . . see graph below.



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§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

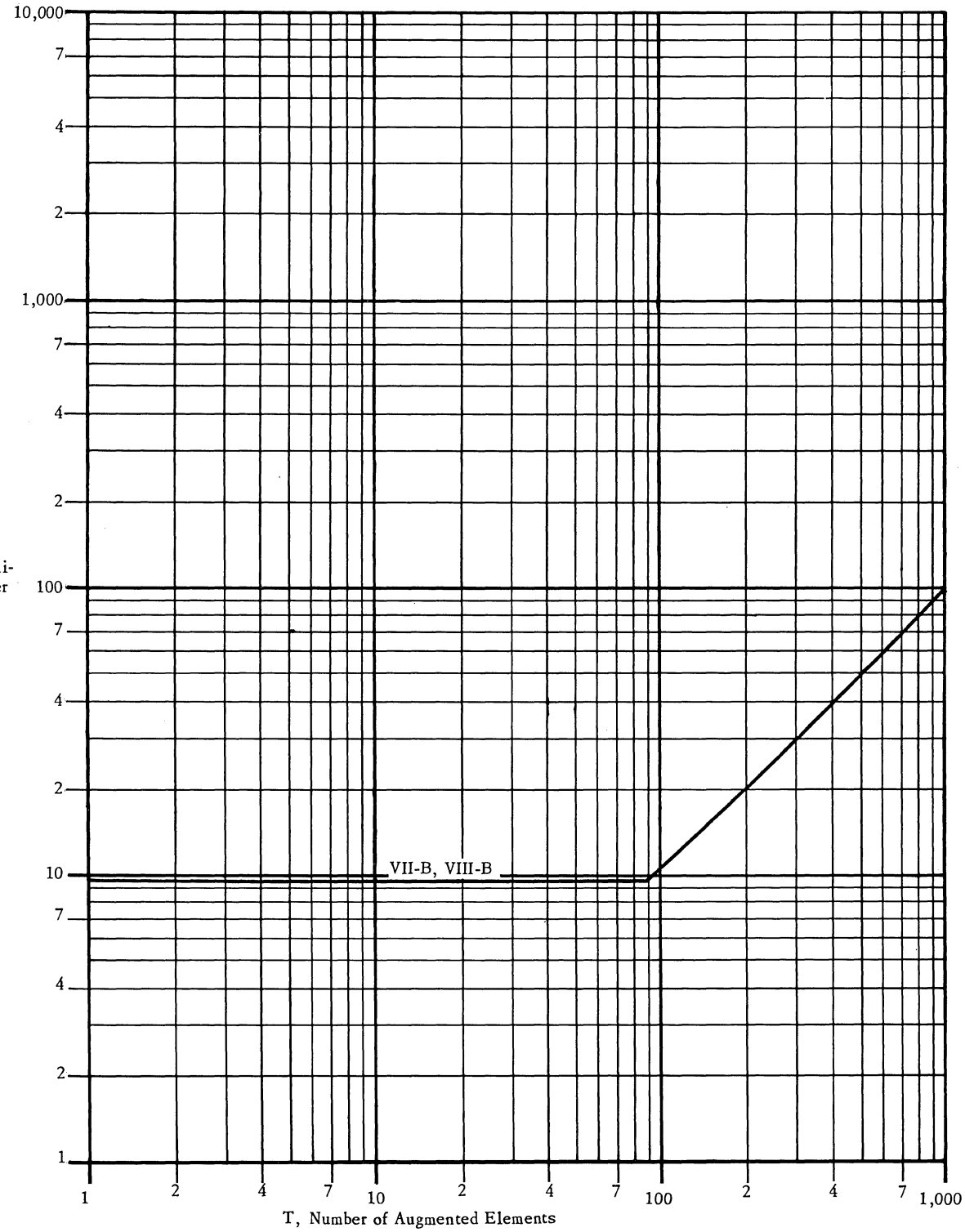
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . using estimating procedure outlined in User's Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



Roman numerals denote Standard Configurations

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IBM 7074
PHYSICAL CHARACTERISTICS

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IBM 7074 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		High-Speed Processor	Magnetic Tape	Disc Storage	Disc Storage	Console	CE Console	Disc Storage	Remote Compressor
	Model Number		7104	729	1301 Model 1	1301 Model 2	7150	Part of 7150	7300	Part of 7300 DSU
PHYSICAL	Height × Width × Depth, in.		69 × 30 × 68	69 × 29 × 34	69 × 86 × 33	69 × 86 × 33	40 × 66 × 33	23 × 45 × 21	71 × 62 × 30	29 × 40 × 33
	Weight, lbs.		2,500	1,200	3,625	3,825	400	300	2,300	700
	Maximum Cable Lengths to Designated Units, feet		35 (7150)	100 (7604) 90 (7602) See note.	100 (7631)	100 (7631)	35 (7104) 35 (7600) 40 (7602)	See 7150	45 (7605) 160 total (Compressor)	72 (7605) 160 total (7300s)
ATMOSPHERE	Storage Ranges	Temperature, °F.	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110
		Humidity, %	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80
	Working Ranges	Temperature, °F.	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Heat Dissipated, BTU/hr.		12,000	3,900	16,700	20,000	800	Included in 7150	9,100	10,800
	Air Flow, cfm.		800	550	1,800	1,800	— — —	— — —	300	300
	Internal Filters									
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%
	Cycles	Nominal	60	60	60	60	60	60	60	60
		Tolerance	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		Included in 7802	1.6	7.5	9.0	0.02	Included in 7150	3.7	4.0
NOTES				Cable lengths are totals for all 729s on a channel.						

IBM 7074 PHYSICAL CHARACTERISTICS—Contd.

			Core Storage	Hypertape Drive	Printer	Card Reader	Console Card Reader	Card Punch	I/O Control	Core Storage Control	I/O Synchronizer	Tape Control	Disc Control	File Control	Hypertape Control	Power Converter	Inquiry Station	Data Channel	Data Transmission Unit	Paper Tape Reader	Remote Inquiry Unit	Input/ Output Synchronizer
IDENTITY	Unit Name																					
	Model Number		7301	7340	7400	7500	7501	7550	7600	7602	7603	7604	7605	7631	7640	7802	7900	7907	1009	1011	1014	1414 Model 6
PHYSICAL	Height × Width × Depth, in.		69 × 30 × 68	48 × 29 × 60	49 × 60 × 31	43 × 29 × 35	39 × 33 × 29	43 × 29 × 35	69 × 30 × 68	69 × 30 × 68	69 × 30 × 68	69 × 30 × 68	69 × 30 × 68	70 × 38 × 32	70 × 74 × 31	69 × 30 × 68	29 × 48 × 30	69 × 20 × 68	40 × 29 × 31	60 × 32 × 36	35 × 29 × 24	70 × 74 × 32
	Weight, lbs.		1,500	1,350	1,900	1,000	200	1,000	2,100	1,100	2,300	2,100	1,200	500	1,000	1,700	400	1,500	500	529	175	1,100
	Maximum Cable Lengths to Designated Units, feet		55 (7907)	130 (7640) See note.	40 (7603)	40 (7603)	35 (7600)	40 (7603)	See 7150, 7501, 7900.	44 (7150) 75 (7602)	See 7400, 7500, 7550.	See 729.	45 (7300) 72 (Compr)	55 (7907)	55 (7907) 130 (7340s; total per channel)	75 (7602)	50 (7600) 50 (other 7900s)	55 (7640) 55 (7631)	60 (1414) 15 (power)	90 (1414) 14 (power)	8 miles (1414) 14 (power)	55 (7907)
ATMOSPHERE	Storage Ranges	Temperature, °F.	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110	50 - 110
		Humidity, %	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80	0 - 80
	Working Ranges	Temperature, °F.	65 - 90	50 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	50 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90	65 - 90
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Heat Dissipated, BTU/hr.		6,600	12,000	4,800	4,400	800	4,800	3,600	600	4,600	4,600	1,800	4,800	3,400	19,500	500	7,800	1,000	4,100	1,000	4,450
	Air Flow, cfm.		400	700	— — —	— — —	— — —	— — —	560	220	800	400	320	400	450	800	— — —	400	120	150	— — —	1,000
	Internal Filters																					
ELECTRICAL	Voltage	Nominal	208 or 230	208	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208	208 or 230	115	208 or 230	115	208 or 230	115	208 or 230
		Tolerance	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	+10%, −8%	±10%	±10%	±10%	±10%
	Cycles	Nominal	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
		Tolerance	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5	±0.5
	Phases and Lines		3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	1φ, 3-wire	3φ, 4-wire	1φ, 3-wire	1φ, 3-wire	1φ, 3-wire	3φ, 4-wire
	Load KVA		1.4	4.0	1.7	1.5	0.3	1.5	0.9	0.1	0.9	0.3	0.3	2.5	0.1	17.8	0.2	2.25	0.3	1.8	0.35	1.30
NOTES				Cable length is total for all 7340s on a channel.													Cable lengths to 2,500 feet by special arrangement.					

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Central Processor	7104	High-Speed Processor			
	model 1	Card-only system	7,300	215.00	313,000.
	model 2	One tape channel	7,400	217.00	317,000.
	model 3	Two tape channels	7,500	220.00	321,000.
	model 4	Three tape channels	7,700	225.00	329,000.
	model 5	Four tape channels	7,800	227.00	333,000.
		Optional Features			
	4420	Floating Decimal Arithmetic	1,000	23.00	45,000.
	4760	Interval Timer	70	1.75	3,375.
Storage	7301	Core Storage			
	model 3 & 31	5,000 words	4,700	48.75	225,000.
	model 4	9,900 words	8,000	55.00	373,000.
	model 41, 42, & 43	10,000 words	8,000	55.00	373,000.
	1301	Disk Storage			
	model 1	55,600,000 BCD characters	2,100	138.00	115,500.
	model 2	111,200,000 BCD characters	3,500	238.00	185,500.
		Optional Feature			
		Cylinder Mode	25	1.00	1,250.
	7300	Disk Storage			
	model 1	6,000,000 digits	975	194.00	62,200.
	model 2	12,000,000 digits	1,500	306.00	74,800.
Input - Output	729 II	Magnetic Tape Unit	700	116.00	36,000.
	729 IV	Magnetic Tape Unit	900	128.00	41,250.
	729 V	Magnetic Tape Unit	750	122.00	37,200.
	729 VI	Magnetic Tape Unit	950	134.00	42,450.
		Optional Features			
	7835, 7836, 7837, or 7838	Additional 729 Attachment (on 7602; required when more than 6 729s are used on a channel)	100	0.50	4,500.
	7830	Tape Switching Feature (on 729 II/IV/V/VI)	85	6.50	4,400.
	5980	Read Binary Tape (channel 1 only)	350	1.50	14,000.
	7340	Hypertape Drive	1,300	130.00	78,000.
		Optional Feature			
	1284	Automatic Cartridge Loader	125	16.00	7,500.
	7400	Printer	950	40.50	37,000.
	7500	Card Reader	400	44.75	13,100.

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PRICE DATA–Contd.

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Input - Output (Cont'd)	7550	Card Punch	550	36.75	19,500.
	7501	Console Card Reader (Price includes #2265 Console Card Reader Attachment on 7600.)	100	6.25	4,300.
	7900	Inquiry Station	250	26.75	10,300.
	7150	Console Control Unit	300	15.50	13,050.
	1414	Input/Output Synchronizer (Model 6)	850	12.00	43,350.
	1009	Data Transmission Unit (requires 3238)	500	11.50	26,400.
	1011	Paper Tape Reader (requires 5514)	500	42.50	22,400.
	1014	Remote Inquiry Unit (requires 6136)	200	12.50	11,000.
	7864	Telegraph Input/Output	500	11.00	30,500.
	7871	Telegraph Input (requires 7864)	110	3.25	6,750.
	7875	Telegraph Output (requires 7864)	125	3.25	7,750.
	3238	Data Transmission Unit Adapter	200	3.50	11,000.
	5514	Paper Tape Reader Adapter	100	1.50	3,750.
	6136	Remote Inquiry Unit Adapter	200	5.75	11,500.
Controllers	7602, model 6	Core Storage Control	1,200	25.00	49,400.
		Additional Core Storage Attachments (required with more than 10,000 words)			
	1017	On High-Speed Processor	400	8.25	16,350.
	1018	On Input/Output Synchronizer	50	1.00	2,100.
	1019	On 7604 Tape Control, model 1	50	4.00	1,800.
	1020	On 7604 Tape Control, model 2	25	2.00	900.
	7631	File Control (for 1301 DSU)			
	model 2	for this system only	835	30.00	42,000.
	model 3	for this system and a 1410	1,035	35.00	52,000.
	model 4	for this system and another 7000 series system (except 7072)	1,035	35.00	52,000.
	7605	Disk Storage Control (for 7300 DSU)	3,900	36.75	141,800.
	3315	Disk Storage Attachment (on High-Speed Processor)	300	0	14,250.
	7600	Input/Output Control			
	model 1	for any card system	1,400	41.00	63,000.
	model 2	for tape/disc systems	800	19.75	33,000.
	4671	Inquiry Control - Synchronizer #1	400	6.50	18,250.
	4672	Inquiry Control - Synchronizer #2 (on 7600)	350	5.00	15,250.

PRICE DATA–Contd.

§ 221.

CLASS	IDENTITY		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Controllers (Cont'd)	7603	Input/Output Synchronizer (unit record)			
	model 1	one input and one output	1,000	22.75	35,900.
	model 2	two inputs and one output	1,300	30.50	46,000.
	model 3	one input and two outputs	1,350	31.25	48,300.
	model 4	two inputs and two outputs	1,650	39.00	59,300.
	model 5	two inputs and three outputs	2,000	47.50	72,700.
	model 6	one input and three outputs	1,700	39.75	61,600.
	model 7	three inputs and one output	1,600	38.25	57,100.
	model 8	three inputs and two outputs	1,950	46.75	70,400.
	model 9	three inputs and three outputs	2,300	55.25	83,700.
	7907	Data Channel (for 1301 DSU, 1414 I-OS, and/or Hypertape)			
	model 1	one channel	2,000	61.00	80,000.
	model 2	two channels	3,000	98.00	120,000.
	model 3	three channels	4,500	135.00	192,000.
	model 4	four channels	5,500	172.00	234,000.
	3221	Data Channel Attachment (on High-Speed Processor)	200	11.00	8,000.
	3224	Data Channel Switch	25	1.25	650.
	7604	Tape Control (for 729s)			
	model 1	two channels	2,700	86.75	125,500.
	model 2	one channel	1,850	48.00	96,300.
	model 3	two channels (800 char/inch)	3,300	88.75	155,300.
	7155	Switch Control Console			
	model 1	for up to 2 tape units	35	5.50	1,775.
	model 2	for up to 4 tape units	55	11.00	2,675.
	model 3	for up to 6 tape units	80	16.50	3,875.
	model 4	for up to 8 tape units (7830 is required on each tape unit to be switched.)	100	22.00	4,775.
	7640	Hypertape Control	3,400	102.00	218,000.
Power	7802	Power Converter (required in every system)	400	6.00	20,000.

Note: Monthly maintenance charges apply to purchased equipment only; they are based on a graduated scale, and the charges shown here apply to the first three years after installation.

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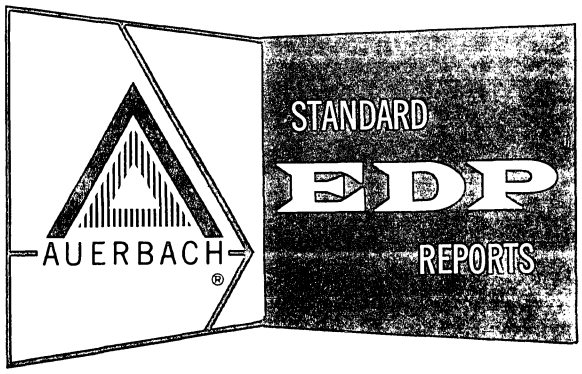
IBM 704

International Business Machines Corp.



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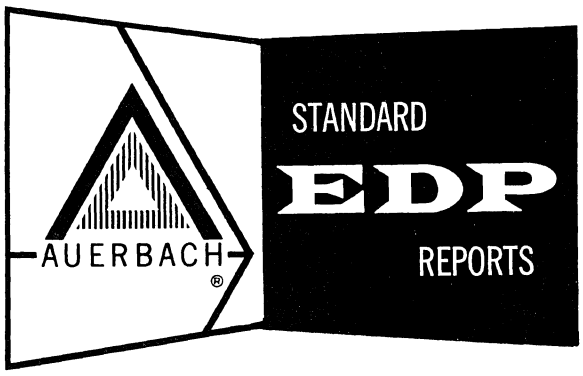
IBM 704

International Business Machines Corp.



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INTRODUCTION

§ 011.

The IBM 704 is a large-scale, vacuum tube, parallel, 36-bit word, binary, scientific data processing system. Although it is no longer being produced, it is now available as used and/or rebuilt equipment. The 704 was the first commercial large-scale system with built-in floating point instructions; execution speeds of about 40,000 instructions per second; and from 4,096 to 32,678 words of magnetic core storage all included in one system. These features made possible the development of FORTRAN, the first process oriented language to gain wide acceptance.

Being binary, the IBM 704 is most widely used for "scientific" computation. Business applications, however, have not been neglected. Even with the burden of radix conversion, the 704 can keep up with or out-perform most of its predecessors in an interpretive mode. Special business data processing systems are available. Whether business or scientific, there is more software available, as of this year, for the IBM 704 system than for any other system in the world. It is maintained by the SHARE users group.

The IBM 704 Processor has three index registers which modify instruction addresses by subtraction. Arithmetic is performed in two's complement and sign notation. Its basic cycle time is 12 microseconds, and most instructions require 2 cycles. Exceptions are floating point add and subtract (5 to 11 cycles), multiply and divide (18 to 22 cycles), and input-output instructions, timings depend on the mechanics of the various units (ranging from 2 cycles to 110 milliseconds). The processor program controls all data transfers to the input-output units. Computation can be overlapped with input-output, but only editing, error checking, and control routines are generally used during such operations. Any logical combination can be generated since the processor has the AND, inclusive OR, and NOT functions built in as instructions.

Internal storage is provided by the IBM 737, Models 1 or 2, and the IBM 738 Core Storage units. Each unit of the 737 provides storage for 4,096 36-bit words; whereas, the 738 can replace one or two 737's with 32,768 36-bit word storage locations. A read or write cycle for either unit requires 12 microseconds, and no parity check is provided during access.

The optional IBM 733 Magnetic Drum, Model 1, provides 8,192 words of drum storage, and the Model 2 version can provide an additional 8,192 words of storage. For interchanges of data, the drum is treated as an input-output unit having a peak transfer rate of about 10,400 words per second. Although the average access time is 12.3 milliseconds, depending on the time of the previous instruction and the drum position, an individual access can require up to 62.7 milliseconds.

The IBM 727 Magnetic Tape Unit has a peak data transfer speed of 15,000 characters per second. The effective speed, however, is 12,900 characters per second when reading or writing 1000 character blocks with a check sum. Some automatic and programmed error correction and detection is possible for tape written data.

Although two models of the IBM 711 Card Reader were available, the 250 cards per minute unit (Model 2) is the most widely used. The Model 2 permits the overlapping of up to 75 percent of the read time, which is usually used to convert the 864 bit card image to 72 six bit BCD characters stored in packed form in the core store in 12 words. At least 25 milliseconds are available for other computing before the reader is stopped. Only 72 out of 80 (as wired on a plugboard) columns can be read, and are read in two 36-bit groups from each row of a punched card. The data is generally stored as a "map" image of the card in 24 word locations.

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INTRODUCTION–Contd.

§ 011.

The IBM 721 Card Punch will punch up to 100 cards per minute. This unit also uses an 864 bit image as does the 711 Card Reader. However, more than 72 card columns can be punched since gang punching is possible by specific wiring of the plugboard. The plugboard has two sense exits that can be impulsed by the processor to control which card fields are to be punched.

The 150 line per minute IBM 716 Printer is the only unit that can be checked by the processor without limiting throughput. The checking feature requires more time than unchecked printing and the conversion of + and - signs to alternative image configurations. The unit can print a 120 character line, but requires two separate data transmission cycles, which reduces the printing speed to 75 lines per minute.

The features of the IBM 716 are similar to those of the IBM 407 except that it cannot read cards. All of the editing features including zero-suppression control are contained on the 716's plugboard. The carriage can be controlled by a paper tape loop and/or by program. The processor can accept one signal from the 716 and, in turn, transmit nine different signals to the printer, in addition to data.

The printer acts as a controller for the punch and is also the power distribution unit for the card reader and punch. For these reasons it is required with the system when either reader or punch is to be used.

A 7-inch cathode ray tube (CRT) and 35 millimeter camera, IBM 740 CRT Recorder, is available with the system. Horizontal, vertical or 45 degree upper-right moving lines can be displayed as well as point-by-point plots on the face of the CRT.

The IBM 780 CRT Display is an accessory for the IBM 740. This unit reproduces the IBM 740 display on a 21-inch CRT for on-line monitoring. All power and decoding networks for the 740 are built into the 780.

Being a vacuum tube machine, the IBM 704 system has rather high power and air-conditioning requirements. At large installations the air cooling capacity is as high as 20 tons. Although this is a disadvantage, the advantages of the greatly reduced price, and the abundance of available software in the SHARE library may more than offset all of the disadvantages, including the higher speeds of the newer solid-state equipment.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word:	36 bits	data and instructions.
Record:	1 to N words	magnetic tape.
File:	1 to N records	magnetic tape.
Unit Record:	24 words	punched card.
Sector:	8 words	magnetic drum.
Logical Drum:	256 sectors	magnetic drum.
Physical Drum:	2 logical drums	magnetic drum.

.2 INFORMATION FORMATS

Type of Information	Representation
Alphanumeric:	6 bits.
Fixed point number: . .	sign bit plus 35 bit number.
Floating point number:	sign bit plus 8 bit characteristic plus 27 bit fraction.
Instruction:	36 bits.
Data:	36 bits.

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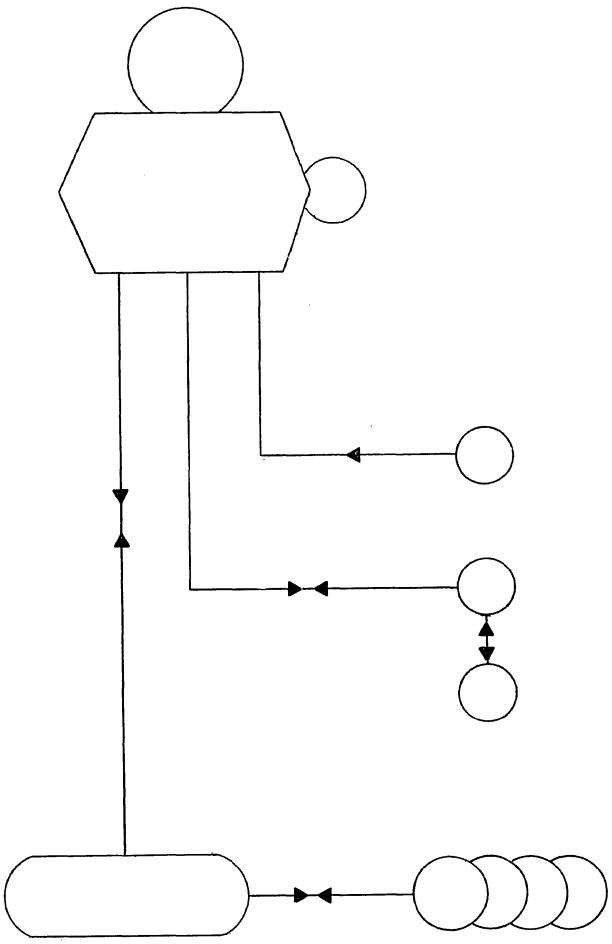
SYSTEM CONFIGURATIONS

§ 031.

I STANDARD CONFIGURATION XI

Deviations from Standard Configuration: . . . . . has 1,100 words less storage.
card reader is 50% slower.
card punch is 50% slower.
no simultaneous input-output.
has two additional index registers.
the on-line printer and console are used in place of a typewriter.



Equipment	Rental	60 Month Purchase *
Core Storage: 8,192 words.	$ 7,400	$ 1,827.80
Processor and Console:	9,700	2,220.83
Card Reader: 250 cards/minute	800	240.00
Printer: 150 lines/minute	1,200	345.55
Card Punch: 100 cards/minute	600	159.38
Magnetic Tape System:		
4 Magnetic Tapes (15,000 chars/second)	2,200	618.80
1 Controller	2,350	396.67
Power Supplies:	3,900	963.67
Total:	$ 28,150	$ 6,772.70
Total Down Payment:		$30,821.00

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

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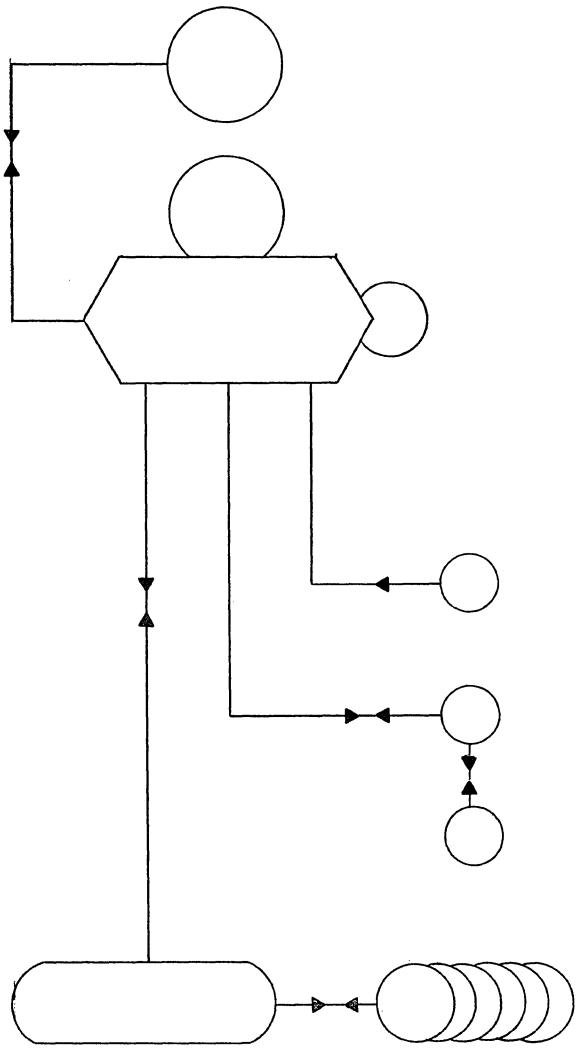
II STANDARD CONFIGURATION VI

Deviations from Standard Configuration: . . . . . has 1,000 words less storage using a drum store.
card reader is 50% slower.
printer runs 80% slower.
no simultaneous input-output.
the on-line printer and console are used in place of a typewriter.
the magnetic tape units are 50% slower.



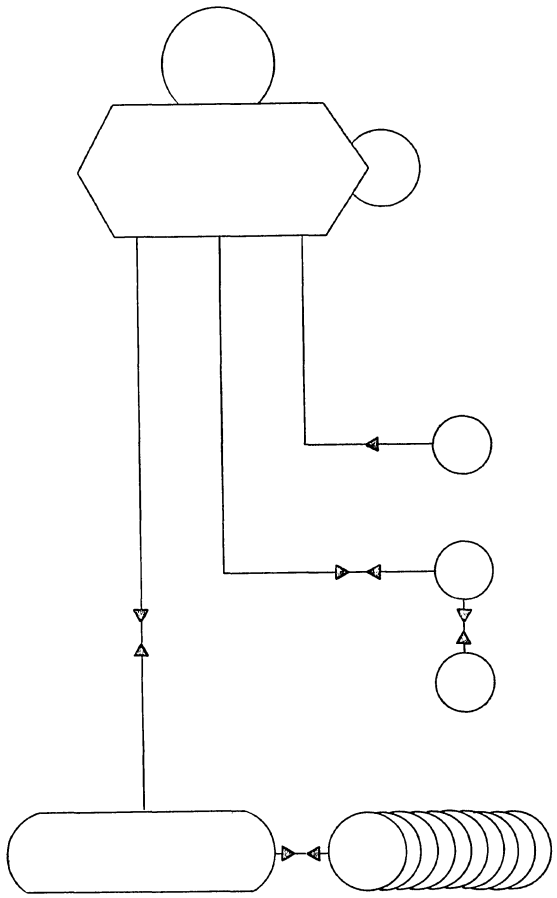
Equipment	Rental	60 Month Purchase *
Drum Storage: 8,192 words	$ 2,900	$ 522.50
Core Storage: 4,096 words	3,700	913.90
Processor and Console:	9,700	2,220.83
Card Reader: 250 cards/minute	800	240.00
Printer: 150 lines/minute	1,200	345.55
Card Punch: 100 cards/minute	600	159.38
Magnetic Tape System:		
6 Magnetic Tapes (15,000 char/second)	3,300	928.20
1 Controller	2,350	396.67
Power Supplies:	3,900	963.67
Total:	28,450	6,690.70
Total Down Payment:		$31,211.00

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

§ 031.

III STANDARD CONFIGURATION VII A

Deviations from Standard Configuration: . . . . . has 12,800 words more storage.
card reader is 50% slower.
printer is 80% slower.
no input-output simultaniety.
has only 3 index registers.
has no typewriter.



Equipment	Rental	60 Month Purchase *
Core Storage: 32,768 words	$ 19,700	$ 4,465.00
Processor and Console:	9,700	2,220.83
Card Reader: 250 cards/minute	800	240.00
Printer: 150 lines/minute	1,200	345.55
Card Punch: 100 cards/minute	600	159.38
Magnetic Tape System:		
10 Magnetic Tapes (15,000 chars/second)	5,500	1,547.00
1 Controller	2,300	396.67
Power Supplies:	3,800	938.60
Total:	$ 43,600	$10,313.03
Total Down Payment:		$48,899.00

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

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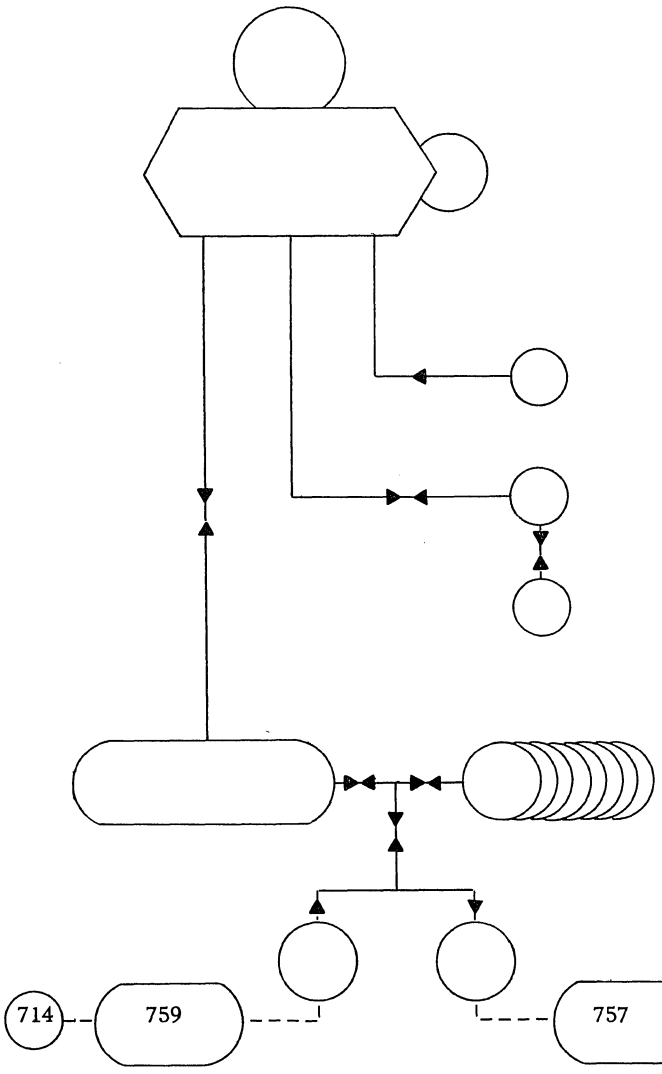
§ 031.

IV. STANDARD CONFIGURATION VII B

Deviations from Standard Configuration: . . . . . has 18,700 words more storage.
the on-line card reader is 250% faster.
the card punch is on-line.
the on-line printer compensates for a typewriter, and the off-line tape-to-printer unit will, in almost all cases, be equivalent to the standard.
the off-line card-to-tape and tape-to-printer units were the equivalents of the smaller processor.
the magnetic tape units are 75% slower.
has only 3 index registers.



Equipment	Rental	60 Month Purchase *
Core Storage: 32,768 word	$ 19,700	$ 4,465.00
Processor and Console:	9,700	2,220.83
Card Reader: 250 cards/minute	800	240.00
Printer: 150 lines/minute	1,200	345.55
Card Punch: 100 cards/minute	600	159.38
Magnetic Tape System:		
8 Magnetic Tapes (15,000 chars/sec)	4,400	1,237.00
1 Controller	2,300	396.67
Tape Switch (for 3 tapes)	RPQ	RPQ
Two Magnetic Tapes: (15,000 char/sec)	1,100	309.40
Card Reader and Controller:	2,400	697.07
Printer and Controller:	2,157	631.13
Power Supplies:	3,800	938.60
Total:	$ 48,157	$ 11,640.63
Total Down Payment:		$ 62,007.00

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

INTERNAL STORAGE: CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . . Core Storage.
Type 737, Model 1 and 2.
Type 738, Model 1.

.12 Basic Use: . . . . . working storage.

.13 Description

Core stores are used to provide either 4,096, 8,192, or 32,768 words of working storage. Each word, composed of 36 bits, can hold one number or one instruction. The cycle time of the store is 12 microseconds. There are no checks applied to data recorded in, or read from, the store.

Three stores are available: the 737, Models 1 and 2; and 738. Each model of the 737 has a capacity of 4,096 words and the 738, a capacity of 32,768 words. A 704 configuration may contain either a 737 Model 1; or one each of Models 1 and 2; or a 738.

.14 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.15 First Delivery: . . . . December, 1955.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic core.

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . yes.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.282 Reading method: . . . . sense wire.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 83,333 cps.
Unit of data: . . . . . 1 word.
Conversion factor: . . 36 bits/word.
Data rate: . . . . . 83,333 words/sec.
Compound data rate: . 83,333 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
	737	737	738
Identity:	Model 1	Model 2	Model 1
Words:	4,096	4,096	32,768
Characters:	24,576	24,576	196,608
Instructions:	4,096	4,096	32,768
Digits:	43,008	43,008	344,064

.32 Rules for Combining Modules: . . . . . either a 737 model 1, or a 737 model 1 and 2, or a 738.

.4 CONTROLLER: . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads: one access device for all core storage.

.52 Simultaneous Operations: . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Cycle time: . . . . . 12 μ sec.
For data unit of: . . . 1 word.
.532 Variation in access time: . . . . . none.

.6 CHANGEABLE STORAGE: . . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage unit possibilities
With Self: . . . . . no.
With Processor: . . . yes.

.72 Transfer Load Size

With Processor: . . . . 1 word.

.73 Effective Transfer Rate

With Processor (operands and instructions): . . . . . 83,333 words/sec.

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§ 041.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	not possible	Address modulo storage size.
Invalid code:	not possible.	
Receipt of data:	none.	
Recording of data:	none.	
Recovery of data:	none.	
Dispatch of data:	none.	
Timing conflicts:	not possible.	
Physical record missing:	not possible.	
Reference to locked area:	not possible.	

INTERNAL STORAGE: 733 MAGNETIC DRUM

§ 042.

.1 GENERAL

.11 Identity: . . . . . Magnetic Drum. Type 733. Model 1 and 2.

.12 Basic Use: . . . . . auxiliary storage.

.13 Description

Magnetic drums are used to provide either 4,096, 8,192, 12,288, or 16,384 words of auxiliary storage. Each word location on the drum is addressable and can hold one 36-bit word. A block transfer is program controlled word by word. Average access time to the first word is 13 milliseconds and the maximum access time is 25.5 milliseconds. Full words are recorded in, or read from successive word locations at a rate of approximately 10,000 words a second.

Two models of a 733 Magnetic Drum Unit are available. Model 1 may contain either one or two physical drums, each drum having a capacity of 4,096 words. A physical drum consists of two logical drums, each with a storage capacity for 2,048 words. The Model 2 is used as a second unit, with the same feature as the Model 1 and provides an additional 8,192 words of storage for the system.

.14 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.15 First Delivery: . . . . December, 1955.

.16 Reserved Storage: . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic drum.

.22 Physical Dimensions

.222 Drum or Disc
Diameter: . . . . . ?
Thickness or length: . ?
Number on shaft: . . . 1.

.23 Storage phenomenon: . . . . . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . no.
.244 Data permanent: . . . no.
.245 Storage changeable: . . yes.

.25 Data volume per band of 36 tracks

Words: 2,048
Characters (6.bit.BCD): 12,288
Digits (binary equivalent): 21,504
Instructions: 2,048

.26 Bands per physical unit: . . . . . 2.

.27 Interleaving Levels: . . 8

.28 Access Techniques

.281 Recording method: . . fixed heads.
.282 Reading method: . . . fixed heads.
.283 Type of access

description of stage
(a) Select instruction to specify choice of drum and read or write status.
(b) Locate instruction to specify first drum address for transfer if other than yes.
(c) Individual copy instructions to specify the core address corresponding to the next drum word.
(d) Transfer stops when no copy instruction occurs within 36 microseconds.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 2,419 rpm.
Track/head speed: . . ? inches/sec.
Bits/inch/track: . . . ?
Bit rate per track: 83,333 bits/sec/track.

.292 Peak data rates
Unit of data: word (six 6-bit char).
Conversion factor: . . . . . 36 bits/word.
Gain factor: . . . . . 36 tracks/band.
Loss factor: . . . . . 8 interleaving levels.
Data rate: . . . . . 10,416 words/sec.
Compound data rate: . . . . . 10,416 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage	Maximum Storage
Drums:	1	4
Words:	4,096	16,384
Characters:	24,576	98,304
Instructions:	4,096	16,384
Bands:	2	8
Digits:	43,008	172,032
Modules:	1	2

.32 Rules for Combining Modules: . . . . . 1 or 2 drums may be contained in a module; up to 2 modules may be used.

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.§ 042.

.4 CONTROLLER

.41 Identity: . . . . . functions carried out by stored program.

.42 Connection to System

.421 On-Line: . . . . . 1.

.43 Connection to Device

.431 Devices per controller: . . . . . 2 drum modules (each containing 1 or 2 drums).

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-Output area: . . core storage.
.443 Input-Output area access: . . . . . 1 word.
.444 Input-Output area lockout: . . . . . no.
.445 Synchronization: . . . programmed.
.446 Synchronizing aids: . . wait for access to drum location.
.447 Table control: . . . . no.
.448 Testable conditions: . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
Heads per stack: . . 36
Stacks per system: 8
Stacks per yoke: . . 2
Stacks per module: . 4

.512 Stack movement: . . . none.

.513 Stacks that can access any particular location: 1

.514 Accessible locations
By single stack: . . . 2,048 words.
By all stacks: . . . all per module.

.52 Simultaneous Operations: . . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . 0.7 to 25.5 m.sec.
Cycle time: . . . . 24.8 m.sec.
For data unit of: . . 1 word.

.532 Variation in access time

Stage	Variation (m.sec.)	Example (m.sec.)
Select same drum*	0.0 to 23.9	12.3
Select another drum*	0.0 to 47.7	
Select read status*	0.5 or 15.0	0.5
Select write status*	0.0 to 15.0	
Load drum address:	0.6	0.6
Transfer N words:	0.103N	103.2; N = 1000
Consecutive reads of 1000 words:		116.6

* all part of the same command

.6 CHANGEABLE STORAGE: . . . . . none.

.7 STORAGE PERFORMANCE

.71 Data Transfer,

Pair of storage units possibilities
With self: . . . . . no.
With core store: . . yes.

.72 Transfer Load Size: . . . . . 1 word.

.73 Effective Transfer Rate

With core store: . . . 10,076 words/sec.

8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	not possible	
Invalid code:	not possible	
Receipt of data:	none	
Recording of data:	none	
Recovery of data:	none	
Dispatch of data:	none	
Timing conflicts:	check	stall processor and alarm.
Physical record missing:	none	
Reference to locked area:	none	

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . Central Processing Unit. IBM 704.

.12 Description

The IBM 704 Processor has a binary arithmetic unit operating on 36 bit words in both fixed and floating point using two's complement arithmetic. Each single address instruction is 36 bits in size and there are several instruction formats. All instructions take a multiple of 12 microseconds and most take 24 microseconds. The processor contains one accumulator and three index registers. The index registers are the same size as the address part of the instructions (15 bits) and are used to modify addresses by subtraction. Either no indexing, or indexing by any one register, or indexing by the ORed sum of two or three registers can be specified for each instruction. All operations can be indexed except those that set, test, or alter the index registers.

The processor controls all input-output operations completely from the selection of a unit until the last data transfer. Overlapped operation is possible and the majority of the software available from SHARE utilizes this time to perform data conversions and accuracy checks. However, multiplication and division operations cannot be performed during data transfers of one unit record because the same register used for these operations (MQ register) is used as the input-output buffer register.

Since the system does not have internal parity checking, it is not uncommon to use check sums on magnetic tape, and periodically to hash-total important sections of the program. Occasional output of restart parameters is an accepted technique for long running programs.

Standard features of the processor include four sense lights and six sense switches. The sense lights are useful for storing program decisions, and can be set, tested and reset under program control. The sense switches can be turned on and off by the operator at any time and can be tested by the program. These switches provide program breakpoints or program option control such as print suppression.

The processor console provides load buttons which initiate program loading from cards, drum, or tape. All locations in core storage can be cleared, the logic of the processor reset, and the contents of registers and store locations displayed using other buttons provided. Data or instructions can be keyed in manually through a 36 key input register.

Built-in diagnostic features include buttons for single step and slow speed execution of instructions. A special feature is Transfer Trapping. This feature is a program diagnostic aid used under program control at processor speeds. All transfer instructions except the trap transfer cause the contents of the program counter to be stored in one storage location and control to be transferred to an instruction stored in another location. This latter location generally contains a trap transfer to a routine that prints-out a message giving the address of the "trapped" instruction and the register contents. Control is then transferred to the location where the "trapped" instruction would have sent control. This trap record is useful in debugging programs written in FORTRAN as well as SAP.

.12 Description (Contd.)

The software for the processor and system is very complete and is maintained by the SHARE organization. There is virtually no need to program any diagnostic aids, operating systems, or any arithmetic function from transcendentals through complex numbers, many at n-tuple precision. With either FORTRAN II or SAP and the rest of the SHARE library, little more than the logic of a problem need be programmed or coded for the machine.

Optional Features

Several optional features can be incorporated in the processor. One of these is a half-word option which permits using the accumulator as though it were two 18-bit registers for single register operations. Six extra sense switches can be added to the console for additional program optional control. Another option is a Tape Switch which will connect any of three magnetic tape units to the processor or an off-line device such as a tape controlled printer. An audible alarm attachment can be added which sounds when the processor is stopped.

Other processor options contain special instructions and their associated hardware which perform the following functions:

Copy and Add Logical Word:

This instruction is the same as the copy and skip operation for input-output data transfers, but this instruction also forms a check sum of the transmitted words in the accumulator.

Enter (Leave) Floating Trap Mode:

This instruction enables (inhibits) a feature which causes the processor to trap (see transfer above) when a floating point overflow occurs, storing an indication of this in one storage location and transferring control to another.

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§ 051.

.12 Description (Contd.)

Optional Features (Contd.)

Backspace file:

This option winds a magnetic tape backward until the first end-of-file gap is found, then moves the tape forward so that the first record of the file is positioned under the read-write head of the tape unit.

Input-output equipment options are available for use under program control. Included among these are a Rewind-Disable option for magnetic tapes and a real-time clock which can be sampled by "reading" the printer where it is located.

.13 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.14 First Delivery: . . . . December, 1955.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size	
.211 Fixed point				
Add-subtract:	automatic	binary	35 bits & sign.	
Multiply				
Long:	automatic	binary	35 bits & sign.	
Divide				
Remainder:	automatic	binary	35 bits & sign.	
.212 Floating point				
			Fraction	Characteristic
Add-subtract:	automatic	binary	27 bits	8 bits.
Multiply:	automatic	binary	27 bits	8 bits.
Divide:	automatic	binary	27 bits	8 bits.
.213 Boolean				
AND:	automatic	binary	36 bits.	
Inclusive OR:	automatic	binary	36 bits.	
NOT:	automatic	binary	36 bits.	
.214 Comparison				
Numbers:	automatic		36 bits.	
Letters:	see numbers.			
Mixed:	see numbers.			
Collating sequence:	0 to 9 # @ + A to I ö . □ - J to R ō $ * BLANK / S to Z ‡ , %			

.215 Code translation: . . . none.
.216 Radix conversion: . . . none.
.217 Edit format: . . . . . none.
.218 Table look-up: . . . . . none.

.22 Special Cases of Operands

.221 Negative numbers: . . . sign bit (most significant) set; two's complement and sign.
.222 Zero: . . . . . plus or minus not equal in comparison.
.223 Operand size determination: . . . . . fixed at 1 word (and right or left half word as optional feature).

.23 Instruction Formats

.231 Instruction structure: . 1 word.
.232 Instruction layout

Part	OPERATION	NOT USED	TAG	ADDRESS
Size (bits)	12	6	3	15

Part	OPERATION	DECREMENT	TAG	ADDRESS
Size (bits)	3	15	3	15

.233 Instruction parts

Name	Purpose
Operation:	command code.
Decrement:	for index limits and modification values.
Tag:	indicates which index registers will be applied to the address.
Address:	address of data or next instruction.

.234 Basic address structure: 1 address (sequential).
.235 Literals
Arithmetic: . . . . . none.
Comparisons and tests: . . . . . none.
Incrementing modifiers: . . . . . 1 to 32, 767.
.236 Directly addressed operands

.2361 Internal storage	Minimum size	Maximum size	Volume accessible
Core Store:	1 word	1 word	entire storage.
Magnetic Drum:	1 word	1 word	entire storage.

.2362 Increased address capacity: . . . . . none.
.237 Address indexing
.2371 Number of methods: 1.
.2372 Names: . . . . . indexing (can be multiple indexes).
.2373 Indexing rule: . . . . the contents of the indicated index registers are ORed together then subtracted from the address of the instruction to form the effective address.
.2374 Index specification: . each of the index bits specify an index register.
.2375 Number of potential indexers: . . . . . 3.
.2376 Addresses which can be indexed: . . . . all.
.2377 Cumulative indexing: none.
.238 Indirect addressing: . . none.
.239 Stepping: . . . . . index registers.
.2391 Specification of increment: . . . . . in stepping instructions.
.2392 Increment sign: . . . positive.
.2393 Size of increment: . 0 to 32, 767 (words).
.2394 End value: . . . . . value of increment.
.2395 Combined step and test: . . . . . yes.

.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in bits	Program usage
Accumulator:	1	38	arithmetic unit.
Multiplier-Quotient:	1	36	arithmetic unit & input output.
Index:	3	15	address modification.

§ 051.

.241 Category of storage (Contd.)

	Number of locations	Size in bits	Program usage
Program Counter:	1	15	specified instruction address.
Sense Lights:	4	1	save condition.
Sense Switches:	6	1	accept condition.
Storage:	1	36	buffer with store.
Instruction:	1	18	shift counter, holds instruction.

.242 Category of storage

	Total number locations	Physical form	Access time μ.sec	Cycle time μ.sec
Accumulator:	1	register	2	12.
Multiplier-Quotient:	1	register	2	12.
Index:	3	register	2	12.
Program Counter:	1	register	2	12.
Sense Lights:	4	flip-flop	2	12.
Sense Switches:	6	switch	2	12.
Storage:	1	register	2	12.
Instruction:	1	register	2	12.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1.

.314 Special sub-sequence counters

Number	Purpose
1:	counts shifts (not accessible by program).

.315 Sequence control step size: . . . . . 1 word.

.316 Accessibility to program: . . . . . change, or save in index, see paragraph .33.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes
- Other: . . . . . on encountering transfer of control instruction while in trapping mode.

.332 Control by routine
- Individual control: . . processor.
- Method: . . . . . enter or leave trapping mode instruction (ETM, LTM).
- Restriction: . . . . . none.

.333 Operator control: . . . execute ETM or LTM instruction from console.

.334 Interruption conditions: trapping mode on and a transfer of control instruction.

.335 Interruption process
- Disabling interruption: LTM instruction.
- Registers saved: . . . location of next instruction in normal sequence in a fixed location.
- Destination: . . . . . fixed location.

.336 Control methods
- Determine cause: . . fixed.
- Enable interruption: . ETM instruction.

.34 Multi-running: . . . . . none.

.35 Multi-sequencing: . . . none.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ Sec.

.411 Fixed point
- Add-subtract: . . . . 24.
- Multiply: . . . . . 240.
- Divide: . . . . . 240.

.412 Floating point
- Add-subtract: . . . . 72 to 132.
- Multiply: . . . . . 204.
- Divide: . . . . . 216.

.413 Additional allowance for
- Indexing: . . . . . none.
- Re-complementing: . none.

.414 Control
- Branch: . . . . . 24.
- Compare & branch: . 24 to 36.

.415 Counter control
- Step: . . . . . 24.
- Step and test: . . . . . 24.
- Test: . . . . . 24.

.416 Edit: . . . . . none.

.417 Convert: . . . . . none.

.418 Shift: . . . . . 24 to 84 (252 possible).

.42 Processor Performance in μ Sec.

.421 For random addresses	Fixed point	Floating point
c = a + b:	72	156 ± 24.
b = a + b:	72	156 ± 24.
Sum N items:	24N	(108 ± 24)N.
c = ab:	288	252.
c = a/b:	288	264.
.422 For arrays of data		
$c_i = a_i + b_j$:	120N	(204 ± 24)N.
$b_j = a_i + b_j$:	120N	(204 ± 24)N.
Sum N items:	48N	48 + (132 ± 24)(N - 1).
$c = c + a_i b_j$:	360N	408N.

.423 Branch based on comparison
- Numeric data: . . . . 72 + 132N.
- Alphabetic data: . . . 96 + 132N.

.424 Switching
- Unchecked: . . . . . 72.
- Checked: . . . . . 120.
- List search: . . . . . 72 + 60N.

.425 Format control per character
- Unpack: . . . . . 550 from cards, 170 from tape (using off-line card-to-tape converter).
- Compose: . . . . . 250.

.426 Table look-up per comparison
- For a match: . . . . . 48 + 84N.
- For least or greatest: 48 + 108N.
- For interpolation point: . . . . . 48 + 84N.

.427 Bit indicators
- Set bit in separate location: . . . . . 24.
- Set bit in pattern: . . 48.
- Test bit in separate location: . . . . . 24.
- Test bit in pattern: . . 72.
- Test AND for B bits: . 72.
- Test CR for B bits: . . 72.

.428 Moving N words
- 4 instructions: . . . . 24 + 72N.
- 2N instructions: . . . 48N.

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.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	sets indicator.
Underflow:	check	sets indicator.
Zero divisor:	check	sets indicator and/or stops processor.
Invalid data:	not possible.	
Invalid operation	none.	attempts operation.
Arithmetic error:	none.	
Invalid address:	check	modulo memory size.
Receipt of data:	none.	
Dispatch of data:	none.	

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . Console panel; a part of the Central Processor.

.12 Associated Units: . . . none.

.13 Description

The Console panel is a physical part of the Central Processing Unit. The panel contains neon lights, incandescent lamps, buttons, and switches. The contents of the Program Counter, Instruction, Storage, Accumulator, and MQ registers are displayed on a set of neon lamps. The contents of index registers may also be displayed on a separate set of neon lamps by depressing appropriate buttons. More than one index register can be manually displayed in sequence. Thirty-six panel input switches are available to allow manual insertion of a word or words into the Processor and core storage.

.2 CONTROLS

.21 Power

Name	Form	Comment
Power-On:	button	turns AC power on.
Normal-Off:	button	turns off all power.
DC-On:	button	turns DC power on.
DC-Off:	button	turns DC power off.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
Start:	button	starts computer operation after a program halt, read/write check, or when in automatic mode.
Automatic-Manual:	switch	stops computer operation after instruction in process is executed. When I/O device is in operation, computer stops after device disconnects.

.24 Stepping

Name	Form	Comment
Single Step:	button	used only in manual mode to execute program, one instruction at a time.
Multiple Step:	button	used only in manual mode to automatically execute program at a slow speed.

.25 Resets

Name	Form	Comment
Clear:	button	resets all registers in processor and in core storage.
Reset:	button	resets all registers and indicators in logical section of machine.

.26 Loading

Name	Form	Comment
Load Cards: Load Drum: Load Tape:	button	permits operator to initiate the loading of a self-loading program stored on cards, drum or tape.

.27 Special

Name	Form	Comment
Enter MO:	button	transfers manually keyed-in word to the MQ register.
Index Display:	button	3 index display buttons permit operator to display contents of any of the index registers while in manual mode.
Enter Instruction:	button	causes manually keyed-in word to be executed.
Sense Switches	switch	6 switches, the settings are program testable.
Display Storage:	button	the contents of the location specified by the address part of the manually keyed-in word are displayed in this register.
Display Effective Address:	button	displays in the address field of the storage register the difference between the contents of the address field of the storage register and the specified index register.

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§ 061.

.3 DISPLAY

.31 Alarms

Name	Form	Conditions Indicated
Accumulator Overflow:	light	accumulator overflow.
MQ Overflow:	light	MQ overflow.
Divide Check:	light	divide-check condition.
Read-Write Check:	light	improper instruction sequence or a CPY instruction received too late.

.32 Conditions

Name	Form	Conditions Indicated
Ready:	light	on when computer is ready to begin operating.
Power:	light	
Automatic:	light	on when computer is in automatic mode.
Trap Indicator:	light	on when computer is operating in the trap mode.
Sense Lights:	light	four sense lights controlled by the program.
Program Stop:	light	turned on when computer executes halt instruction.
Read-Write Select:	light	turned on when an I/O device has been selected for reading or writing.

.33 Control Registers

Name	Form	Comment
Instruction:	lights	18 neon lights, allocated to sign bit and bits 1 through 17 to indicate instruction operation.
Instruction Counter:	lights	15 neon lights, allocated to bits 21 through 35 to indicate location of next instruction.

.33 Control Registers (Contd.)

Name	Form	Conditions Indicated
Accumulator:	lights	38 neon lights; one for each bit position plus one for Q and one for P.
MQ:	lights	36 neon lights; one for each bit position.

.34 Storage: . . . . . 36 neon lights to indicate contents of core storage buffer register.

.4 ENTRY OF DATA

.41 Into Control Registers

(1) desired word keyed into panel input switches, then

(2) depress Enter MQ button.

.42 Into Storage: . . . . . one core storage location is written into by using enter instruction push-button with a store instruction keyed into the 36 manual input switches.

.5 CONVENIENCES

.51 Communication: . . . . optional.

.52 Clock: . . . . . optional.

.53 Desk Space: . . . . . none.

.54 View: . . . . . when operator is at console, all the equipment can easily be seen if conveniently placed.

INPUT-OUTPUT: 711 CARD READER

§ 071.

.1 GENERAL

.11 Identity: . . . . . Card Reader.
Type 711.
Model 1 or Model 2.

.12 Description:

Only one card reader can be used in a 704 configuration. It may be either model of the 711 Card Reader. The Model 1 reads cards at a rate of 150 cards a minute, and the Model 2 reads cards at 250 cards per minute, otherwise there are no basic differences. Cards are fed from a hopper with a capacity of approximately 700 cards and placed in a stacker that holds approximately 1,500 cards.

During read operations data read from cards goes to the MQ register before being sent to storage. Therefore, any data stored in this register from previous operations is destroyed. Words are stored in storage in the form of a "card image". Each card image represents 72 characters. Data may be punched on cards in either binary or BCD codes, and by a suitable program, BCD data may be converted to binary data. The card image is represented by twenty-four 36-bit words; two words per row of the card image. The reader will read any 72 out of 80 columns of each card.

The program must control the entire input operation, from starting the first read cycle to sending pairs of words to storage at each index point. It is possible to interleave up to 292 milliseconds of other computing in a 400 millisecond card cycle for Model 1, and up to 180 milliseconds of other computing in a 240 millisecond card cycle for Model 2. This maximum computing time requires careful programming. When using standard routines virtually no overlapping is possible; the routines, however, utilize the spare time for each operation as conversion between BCD and card image.

There are two card reading stations; first station is for control and the second for read operations.

The 711 contains a plugboard that can be wired to control format of a card read at the second station. Format control signals can be read from a card at the first station by control brushes and decoded by plugboard wiring. A minimum of 10 different formats can be conveniently wired, and all 80 columns can be controlled by these rearrangements.

A programmed check of card reading of selected columns can be arranged by reading those columns at both stations. However, the total number of columns read, counting two for a column read at both stations, is still only 72. Thus, a total of 36 checked columns can be read.

.12 Description (Contd.)

Manual controls are provided for normal run-in of cards. Various contacts are used to sense for improper feeding of cards, and lamps are provided to indicate when a malfunction exists within the unit.

.13 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.14 First Delivery: . . . . December, 1955.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.

.23 Multiple Copies: . . . . none.

.231 Maximum number

.24 Arrangement of Heads

Use of station: . . . . . reading (control).
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.
Use of station: . . . . . reading.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.

.324 Track use
Data: . . . . . 72.
Redundancy check: . . 0.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 8.
Total: . . . . . 80.
.325 Row use: . . . . . all for data.

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.33 Coding: . . . . . binary or Hollerith Code. (see Data Code Table No. 2).

.34 Format Compatibility: . all devices using standard 80-column cards.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . built into processor (functions carried out by programmed instructions).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . no.
.446 Synchronization: . . . . programmed.
.447 Synchronizing aids: . . wait on row index pulse.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . one card (24 words).
.512 Block demarcation Input: . . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . . transfer 1 to 24 words to core storage for one card.
.522 Output: . . . . . none.
.523 Stepping: . . . . . 1 card forward.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . must be programmed.

.54 Format Control

Control (plugboard or program): . . . . . plugboard.
Format alternatives (number): . . . . . 10, as selected on plugboard.
Rearrangement: . . . . by plugboard.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Offset card: . . . . . no.
Select stacker: . . . . . no.
Select format: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Nearly exhausted: . . . no.
End of medium marks: none.
Hopper empty: . . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions

I: . . . . . Model 1.
II: . . . . . Model 2.
III: . . . . . continuous running.
IV: . . . . . starting from rest.

.62 Speeds

.621 Nominal or peak speed
I: . . . . . 150 cards per minute.
II: . . . . . 250 cards per minute.

.622 Important parameters

	I	II
Cycle time:	400 m. sec.	240 m. sec.
Data transfer time per card:	108 m. sec.	60 m. sec.
Maximum computing time per card: . . .	292 m. sec.	180 m. sec.
Time to first copy from select at rest, avg:	270 m. sec.	110 m. sec.
Maximum safe computing time during startup:	50 m. sec.	55 m. sec.

Available minimum computing time, m. sec.

	I & III	I & IV	II & III	II&IV
Between select and start of transfer of data:	100.0	50.0	74.0	55.0
Between pairs of data transfer: . . .	15.0	15.0	8.0	8.0
Between transfers in a pair of transfers:	0.5	0.5	0.5	0.5
Between last copy and next select:	20.0	20.0	12.0	12.0

.623 Overhead: . . . . . single point clutch.
.624 Effective speeds: . . . I 150 cards/min.
II 250 cards/min.
provided computing time per card is less than 292 milliseconds and 180 milliseconds, respectively, for I and II.

§ 071.

.63 Demands on System

Component	Condition	m.sec per cycle	Percentage
I:	best coding	108	27
I:	simplest coding	380	95
II:	best coding	60	25
II:	simplest coding	220	92

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Start	button	places unit in "ready" status.
Stop	button	removes control from computer by placing unit in "not ready" status. Resets error indicators.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	700 cards
Stacker:	1500 cards

.732 Replenishment time: . . 0.25 to 0.50 mins. reader does not need to be stopped.

.733 Adjustment time: . . . 0.25 to 1.0 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	check	programmed.
Input area overflow:	none.	
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	none.	

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INPUT OUTPUT: 721 CARD PUNCH

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Punch. Type 721.

.12 Description

The 721 punches cards, one row at a time, at a maximum rate of 100 cards per minute. Cards are fed from a hopper with a capacity of approximately 600 cards and stored in a stacker that holds approximately 600 cards.

Punching format is controlled by the arrangement of data in storage and a plugboard, which is wired to punch specific functions according to the requirements of the operation. Words to be punched are stored in core storage in the form of a "card image," i.e., each of the 864 possible punch positions is represented by a bit in the store; a zero indicating no punch and a one indicating a punch. Each card image represents 72 characters. The card image is represented by twenty-four 36-bit words; two words per row of the card image. It is only possible to punch 72 out of 80 columns on each card with one set of punch instructions. However, the other eight columns can be gang punched simultaneously with the punching of data from the store.

During the punch operations the MQ register is used as a buffer for data transfers to the punch unit. Therefore, any data stored in this register from previous operations is destroyed.

The program must control the entire output operation, from starting the first punch cycle to sending pairs of words to the punch at each index point. It is possible to interleave up to 442 milliseconds of other computing in a 600 millisecond cycle, but this requires careful programming. When using standard routines virtually no overlapping is possible; the routines, however, utilize the spare time for such operations as conversion between BCD and card image.

The 721 Card Punch can be used for on-line or off-line gang punch operations by proper wiring of the plugboard. On-line gang punch operations can be activated by plugboard wiring and program control. Four different possible format rearrangements can be wired on the plugboard.

The punch unit makes use of six control brush hubs which can also control format rearrangement by sensing control punches in the 8-row of a pre-punched card.

In order to use a 721 Card Punch in a computer configuration, a 716 Printer must also be attached since the Punch uses some of the Printer's circuitry.

.12 Description (Contd.)

The 721 contains keys for normal manual operations and lamps to indicate various conditions that may exist in the unit. There is a double punch or blank column check feature to check card punching.

.13 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.14 First Delivery: . . . . December, 1955.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punch.
.222 Sensing system: . . . brushes.
.223 Common system: . . . none.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . control brushes.
Stacks: . . . . . 1.
Heads/stack: . . . . . 6.
Method of use: . . . . 1 row at a time.

Use of station: . . . . punch dies.
Distance: . . . . . 3 rows.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . checking, and/or gang punching control.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.

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.324 Track use
Data: . . . . . 72 or 80.
Unused: . . . . . 8 or 0.
Total: . . . . . 80 80.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . Hollerith (see Data Code Table No. 2).

.34 Format Compatibility: . . . . . all other devices using standard 80-column cards.

.35 Physical Dimensions: . . . . . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . built into processor (functions carried out by programmed instructions).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . programmed.
.447 Synchronizing aids: . . wait on row index pulse.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . one card.
.512 Block demarcation Output: . . . . . one WRS (PUNCH). 0 to 24 CPY instructions.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 card forward, 0 to 24 CPY instructions.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . one card forward.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched (card image required) and subroutine conversion.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . 4.
Rearrangement: . . . yes.
Suppress zeros: . . . no.
Insert character: . . . yes.
Insert spaces: . . . . yes.
Section sizes: . . . . yes.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . no.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . yes.
Select code: . . . . . no.
Select character: . . . yes.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Output lock: . . . . . no.
Nearly exhausted: . . no.
Hopper empty: . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditons: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 100 cards/min.
.622 Important parameters
Continuous running cycle time: . . . . 600 m.sec.
Maximum computing time per card (continuous): . . . 442 m.sec.
Available computing time:
between select when running and first copy: . . . . . 70.0 m.sec.
between pairs of data transfers: . . . . 31.0 m.sec.
between transfers in a pair of transfers: . . . . . 0.5 m.sec.
between last copy and next select: . . 25.0 m.sec.
between select at rest and first copy: . . . . . 70. m.sec.
Average time between from select at rest to first copy: . . . 400 m.sec.

§072.

.623 Overhead: . . . . . single point clutch.
.624 Effective speeds: . . . 100 cards/min.

.63 Demands on System

Component	Condition	m.sec per card	Percentage
Processor:	best coding	158	39.5
	simplest coding*	375	93.5

* e.g. using standard routines which utilize spare time for functions such as conversions between BCD and "image".

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Start:	key	makes unit "ready" when hopper is filled and control panel is in place.
Stop:	key	places unit in a "not ready" status and clears error detection circuitry.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	600 cards.
Stacker:	600 cards.

.732 Replenishment time: . . . . . 0.25 to 0.50 mins. punch does not need to be stopped.
.733 Adjustment time: . . 0.25 to 1 mins.
.734 Optimum reloading period: . . . . . 6 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	see blank column and double punch.	
Output block size:	interlock	stops processor.
Invalid code:	see blank column and double punch.	
Exhausted medium:	check	punch stops.
Imperfect medium:	check	punch stops.
Timing conflicts:	check	computer stalls.
Misfeed:	check	punch stops.
Double Punch:	check	punch stops.
Blank Column:	check	punch stops.

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INPUT-OUTPUT: 716 PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer. Type 716.

.12 Description

The 716 is a modification of the 407 Accounting Machine. The 716 prints data from 120 print wheels which form a solid bank 12 inches wide. Each print wheel has 48 characters, including all the numerals, all the letters of the alphabet, and 12 special characters engraved on its rim. A line of printing is pitched at ten characters to the inch. Line spacing is either 6 or 8 single spaced lines-to-the-inch controlled by a manually-operated lever.

Printing format is controlled by the arrangement of data in storage and a plugboard, which is wired to perform specific functions according to the requirements of the operation. The printer has a tape-controlled carriage which uses a standard 12-channel paper tape to control the skipping and spacing of forms. Functions of the carriage, such as changing or suppressing line spacing, selecting the channel on the punched tape to control skipping, or sensing end-of-page, may be controlled through various hubs on the plugboard. Forms up to 22 inches long may be used.

Printing is controlled by the stored program. Words to be printed are stored in core storage in the form of a "card image." Each card image contains one record of 72 characters. The card image is represented by twenty-four 36-bit words, two words per row of the card image. To print a full line, two print actions, with no intervening line feed, are necessary. However, if less than 73 characters are printed, only one print action is necessary, and by use of the plugboard, the 72 characters can be arranged in several distinctly different layouts. When two print actions are required for each line, the effective lines per minute are usually halved.

The print wheels generate "echo pulses" which may be used, by proper programming, to check the printing. The echo pulses indicate the position of the print wheels at 8-3, 8-4, and 9 through 1 print positions. No check is possible on the 0-, 11-, and 12-zone times. It is possible to check the printing of all characters except zero. In continuous printing, without echo checking, 322 milliseconds of the print cycle of 400 milliseconds are available for computing. The 78 milliseconds difference is required for executing the printer instructions and synchronization of mechanical and electrical components. When using echo checking, 313 milliseconds of the print cycle are available for computing.

.12 Description (Contd.)

The usual printer adjustment operations may be controlled manually by keys and switches located on the printer. In addition, the printer has lamps which indicate to the operator different printer conditions that may be present.

The plugboard can also be wired so that a variety of conditions can activate a pulse which can be sensed by program. These conditions include end-of-page, printer busy, and alteration switch setting.

The program must control the entire output operation from starting the first print cycle, sending pairs of words to the printer at each index point, and checking echo pulses. It is possible to interleave up to 322 milliseconds of other computing in a 400-millisecond cycle, but this requires careful programming. When using standard routines, virtually no overlapping is possible, but the routines utilize the spare time for such operations as conversion between BCD and card image.

.13 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.14 First Delivery: . . . . December, 1955.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . marginally punched pin feed continuous forms driven by forms tractor.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved wheels.

.222 Sensing system: . . . . impulses from print wheels.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . 1 + 5.

.232 Types of master
Multilith: . . . . . yes.
Xerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 120.
Method of use: . . . . . 1 line at a time.

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.25 Range of Symbols

Numerals:	10	0 through 9.
Letters:	26	A through Z.
Special:	9	$.+,-/%*
Alternatives:		optional.
FORTRAN set:		optional.
Required COBOL set:		no.
Total:	45.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: continuous fanfold form pin feed punched stationery.
single sheets.
roll paper.
address tape.

.312 Phenomenon: printing.

.32 Positional Arrangement

.321 Serial by: 1 line at 6 or 8 lines per inch.

.322 Parallel by: 120 print positions at 10 per inch.

.33 Coding: as in Data Code Table No. 3.

.34 Format Compatibility: IBM 1418, optical character reader can read a single line.
IBM 1428, can read a series of lines.

.35 Physical Dimensions

.351 Overall width: 4.75 to 16.75 inches.

.352 Length
Forms: 1 to 22 by 1/6 inches at 6 lines/in.
1 to 22 by 1/8 inches at 8 lines/in.

.353 Maximum margins
Left: 19.4 inches.
Right: 19.4 inches.

.4 CONTROLLER

.41 Identity: built into processor (functions carried out by programmed instructions).

.42 Connection to System

.421 On-line: 1.
.422 Off-line: none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: none.

.44 Data Transfer Control

.441 Size of load: 1 word.
.442 Input-output areas: core storage.
.443 Input-output area access: 1 word.
.444 Input-output area lockout: no.
.445 Table control: no.
.446 Synchronization: programmed.
.447 Synchronizing aids: wait on row index pulse.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: up to 120 print positions per line.

.512 Block demarcation
Output: one WRS (PRINTER) and up to 24 CPYs.
one RDS (PRINTER) and up to 46 CPYs.

.52 Input-Output Operations

.521 Input: none.
.522 Output: start printer cycle.
copy a word as necessary to printer by individual instruction; up to 24 per print action.
.523 Stepping: step size 1 or 2 lines, set on plugboard; occurs before printing.
suppress step before print in cycle.
call extra step after print in cycle.
.524 Skipping: controlled by carriage paper tape loop with punched channels 1 to 12.
skip channel 11, less than 7 lines before print in a cycle with no extra step.
skip channel 11, less than 3 lines after print in a cycle as an extra step.
skip channel 1 to 10, following print in a cycle, up to form length using extra cycles.
skip channel 1 to 10, up to 2 inches following print in cycle with no extra cycles.
end-of-page signal from channel 12 can be plugged to give a skip on another channel.
.525 Marking: none.
.526 Searching: none.

.53 Code Translation: automatic from card image.

.54 Format Control

Control: program and plugboard.
Format alternatives: 4 manual alteration switches.
Rearrangement: plugboard.
Suppress zeros: plugboard.
Insert character: plugboard.
Insert spaces: plugboard.
Section sizes: plugboard.

§ 081.

.55 Control Operations

Disable:	yes.
Request interrupt:	no.
Select format:	yes.
Select code:	no.
Suppress print in cycle:	yes.
Short skip control:	inhibits interlock.

.56 Testable Conditions: the program can test one exit hub signal from the plugboard; this can be wired for a variety of conditions including exhausted, end-of-page, busy, and even disabled.

.6 PERFORMANCE

.61 Conditions

I:	using short skip and optimum choices of paper feed up to 2 inches.
II:	not using short skips.
III:	line less than 73 char.
IV:	line more than 72 char.

.62 Speeds

.621 Nominal or peak speed: 150 lines per minute for 72 char (one print cycle per line).
75 lines per minute for 120 char (two print cycles per line).

.622 Important parameters

Wait for synchronization when starting from rest:	400.0 m.sec max. 280.0 m.sec avg.	
Cycle time:	400 m.sec.	
Printing internal:	78 m.sec.	
Skipping speed:	6 to 7 in/sec.	
Available minimum computing time, m.sec:	Continuous	From Rest
between select and transfer of data:	173	58
between pairs of data transfers:	13	13
between transfers in a pair of transfers:	0.5	0.5
between last copy and next select when checking:	12	12
when not checking:	16	16
Actual average mechanical time, m.sec.		
between select and transfer of data:	210	280
between pairs of data transfers:	16	16
between transfers in a pair of transfers:	0.5	0.5
between last copy and next select when checking:	12	12
when not checking:	16	16

.623 Overhead: single point clutch.

.624 Effective speeds

I & III:	150 lines/min.
I & IV:	75 lines/min.
II & III	
up to 4 inches:	150 lines/min.
4 to 6 inches:	75 lines/min.
II & IV	
up to 4 inches:	75 lines/min.
4 to 6 inches:	50 lines/min.

.63 Demands on System

Component	Condition	m.sec per cycle	Percentage
Processor:	best coding	78	19.5.
Processor:	simplest coding	388	97.0.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	platen and vernier knobs.	
Horizontal alignment:	adjustable forms tractor.	
Form thickness:	dial	varies distance between print wheels and platen.
Line spacing:	shift cam	may be set for either 6 or 8 lines/in.

.72 Other Controls

Function	Form	Comment
Alteration switches 1, 2, 3, 4:	toggle switches	used to alter plugboard.
Stop before printing:	toggle switch	removes printer from automatic status prior to printing each line.
Test:	toggle switch	allows print cycle key to initiate a print cycle for test operations.
Form stop:	toggle switch	turns "form" light on when paper is exhausted.
Print:	key	initiates a print cycle under special conditions.
Stop:	key	inhibits printing and makes unit "not ready".
Start:	key	makes unit "ready" for channel equipment.
Restore (carriage control):	key	restores carriage to home position.
Stop (carriage control):	key	stops carriage operation.
Space (carriage control):	key	advances form.

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.73 Loading and Unloading

.731 Volumes handled: . . . continuous or single-sheet forms.

.732 Replenishment time:. . 2 to 3 hours. printer needs to be stopped.

.733 Adjustment time: . . . 3 to 5 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	programmed echo check	program.
Output block size:	interlock.	
Invalid code:	none	uncertain.
Exhausted medium:	check	turns on indicator and stops printer.
Imperfect medium:	none.	
Timing conflicts:	none	wrong output.

INPUT-OUTPUT: 727 MAGNETIC TAPE UNIT

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit
Type 727
Models 1, 2, and 3.

.12 Description:

These tape units are used in IBM's 650, 705 and 7080 systems as well as in the 704. In tape width, density and format, they are compatible with the 729 and 7330 tape units. There are three models: models 1, 2, and 3. Only model 3 is now in production. The essential differences in the models are only in appearance and housing.

Up to ten Type 727 Magnetic Tape Units can be connected to a 704 configuration through a 753 Tape Controller, but only one unit can read or write at a time.

The data on the tape may be recorded in one of two modes, binary or BCD. Each is recorded in rows of seven bits: six data bits and one parity bit per row, even parity for BCD and odd parity for binary. Each block is recorded with a final row which contains an even parity bit for each track. In the binary mode, a 36-bit word is copied directly onto 6 rows; the original data being binary patterns or characters in the binary 6-bit code. In the BCD mode each word is considered as being 6 characters in binary 6-bit code in storage and BCD 6-bit code on tape; the conversion between the two codes is automatic.

Reading or writing is performed at the rate of 2,500 words or 15,000 characters a second while the tape is moving at 75 inches per second. (When writing 1,000 character blocks with a check sum, an effective speed of 12,900 characters per second can be maintained.) Records are written or read by a single-gap head under control of the program. This read/write head is preceded by an erase head which erases the tape prior to writing. A reel on which data has been written may be protected from inadvertent writing by removing a circular plastic insert from the back of the file reel. Tapes are read or written in a forward direction only.

Writing is initiated by programming a write select (WRS) instruction followed by a series of copy (CPY) instructions. The WRS instruction starts the selected tape in motion and selects the recording mode. A single CPY instruction causes the transfer of one word between core storage and the controller.

Reading is initiated by executing a read select (RDS) instruction followed by a series of CPY instructions. The RDS instruction starts the selected tape in motion, selects the checking mode and clears the multiplier quotient (MQ) register. Each CPY causes one word read from tape to be transferred to core storage. When end-of-record or file is reached, no data is transferred and the CPY acts as a skip instruction in this case.

.12 Description (Cont'd)

There is no automatic read-back check but the tape may be written, backspaced and then read to perform a check, and if in error, backspaced and rewritten under program control up to 10 times. Both row and track parity are checked when reading.

Some error correction may be done on reading an incorrect block provided that a check sum was recorded on writing. This can be accomplished by using the CAD instruction, then recording the check sum with the block. By using the CAD instruction on reading, the check sum can be regenerated in the accumulator. If after each CAD the parity indicator is checked, any word read in error can be isolated. If only one word read was in error, a simple routine involving the check sums and the error word will correct the error. It is convenient to use this procedure because very little useful computation can be done while tape is read or written, and the check sum may even pick up errors that the parity circuitry does not. The correction procedure is useful in reconstructing a tape that has been broken and carefully spliced or for drop-outs caused by tape flaws or dust.

During read and write operations, the MQ register is used as a buffer between core storage and the tape units; therefore, the MQ cannot be used for any divide or multiply operations between successive CPY instructions.

Each input-output transfer must be carefully programmed. When writing, 324 microseconds of other computing can be performed between the CPYs. If the CPY is delayed longer, the end-of-record gap will be written. When reading, 276 microseconds of other computing can be performed between copies. If the CPY is delayed longer, the transfers will cease and the tape will be stopped at the next gap, and the processor stalls.

The normal rewind of the tape is 75 inches per second for a low-speed rewind and 500 inches per second for a high-speed rewind. A high-speed rewind is initiated when more than 450 feet of tape has been used. Rewinding a full reel of tape (2,400 feet) takes approximately 1.2 minutes.

Each tape unit contains manual controls for placing the unit under computer control or removing the unit from computer control, loading tape, unloading tape, address selection, and lamps to indicate various conditions that may exist within the unit. A mechanical interlock is mounted in the reel door to prevent tape operation when the door is open.

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.12 Description (Contd.)

Optional Features

Backspace file (BSF) instruction. This instruction may be used to backspace an entire file or to locate the beginning of file on tape. An on-line/off-line switch is available.

.13 Availability: . . . . . only model 3 is in production, model 1 and 2 can be rented or purchased only as used or rebuilt equipment.

.14 First Delivery: . . . . December, 1955.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . approx. 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.
.222 Sensing system: . . . magnetic head.
.223 Common system: . . . yes, one gap read/write head.

.23 Multiple Copies: . . . up to 3 units can be connected to common output at one time to prepare duplicate tapes.

.24 Arrangement of Heads

Use of station: . . . . erase.
Stacks: . . . . . 1.
Method of use: . . . . erase tape before writing.
Use of station: . . . . read/write.

Distance: . . . . . 0.375 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N characters at 200 characters/inch.
.322 Parallel by: . . . . . 7 tracks.

.324 Track Use
Data: . . . . . 6.
Redundancy check: . 1.
Timing: . . . . . 0 (self clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.

.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 0.
Gap: (inter-record) . 0.75 inch.
Gap: (end-of-file) . . 3.75.

.33 Coding: . . . . . one character to a row, using 6 bits as in Data Code Table No. 2 or 4.

.34 Format Compatibility: . . . . . IBM 729 low density.
IBM 7330 low density.

.35 Physical Dimensions

.351 Over-all width: . . . . 0.5 inch.
.352 Length: . . . . . 30 to 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Tape Control. Type 753.

.42 Connection to System

.421 On-Line: . . . . . 1.
.422 Off-Line: (On-line off-line switch is available)

Use	Associated equipment
Tape to Card: . . .	Type 758 Card Punch Control.
Card to Tape: . . .	Type 759 Card Reader Control.
Tape to 717 Printer:	Type 757 Printer Control.
Tape to 720, 730 Printer:	Type 760 Control and Storage.

.43 Connection to Device

.431 Devices per controller: . . . . . 10.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . possible by program.
.446 Synchronization: . . . programmed.
.447 Synchronizing aids: . . wait for next word.

§ 091.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words.
.512 Block demarcation:
Input: . . . . . 0.75 inch inter-record or block gap.
Output: . . . . . no CPY at row time.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward with cut off as programmed.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . one block forward or backward.
.524 Skipping: . . . . . optional BSF to backspace to "End-of-File" mark.
.525 Marking: . . . . . End-of-File: 3.75 inch blank space followed by a special character (tape mark).
End-of-Record or block gap; 0.75 inch blank space on tape.
.526 Searching: . . . . . none.

.53 Code Translation: . . matched codes for binary 6-bit.
automatic for BCD 6-bit.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . no.
Select format: . . . . no.
Select code: . . . . . binary or BCD, specified by I/O instruction.
Rewind: . . . . . yes.
Unload: . . . . . no.
Record "End-of-File": . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . no.
Output lock: . . . . . no.
Nearly exhausted: . . yes, 14 feet.
Busy controller: . . . no.
End of medium marks: yes (write only).
Sense "End-of-File": . yes.
Error in last word read: . . . . . yes.
Error in last block read: . . . . . yes.

.6 PERFORMANCE

.61 Conditions

.62 Speeds

.621 Nominal or peak speed: 15,000 char/sec.
.622 Important parameters
Gap passing time with no stop: . . . . . 10.8 in/sec.
Start time: . . . . . 10 m.sec.
Stop time: . . . . . 7 m.sec.
Computing time available between:
Select and write instructions: . . . 7 m.sec.
Select and read instructions: . . . 3 m.sec.
Two consecutive read or write instructions: . . . 0.288 m.sec.
Tape speed: . . . . . 75 in/sec.
Character Time: . . . 67 μ sec/char.
Rewind Speed: . . . . high speed: 500 in/sec. (avg).
low speed: 75 in/sec.
.623 Overhead: . . . . . stop time of one tape can be overlapped with start time of another.
.624 Effective speeds: . . . 15,000N/(N + 162) char/sec.

.63 Demands on System

Component	Condition	m.sec per word	Percentage
Processor:	Writing	0.084	21.
Processor:	Reading	0.144	36.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	determines tape unit address.
File protection:	ring on back of reel	inhibits writing when removed from reel.
Load Rewind:	button	lowers tape into column and rewinds tape to load point.
Reset:	button	turns off ready light and changes from high-speed rewind to slow-speed.
Start:	button	places tape unit in ready status.

.73 Loading and Unloading

731 Volumes handled
Storage Capacity
Reel: . . . . . 2,400 feet.
.732 Replenishment time: . . 1.0 to 1.5 mins. tape unit needs to be stopped.
.734 Optimum reloading period: . . . . . 7 mins.

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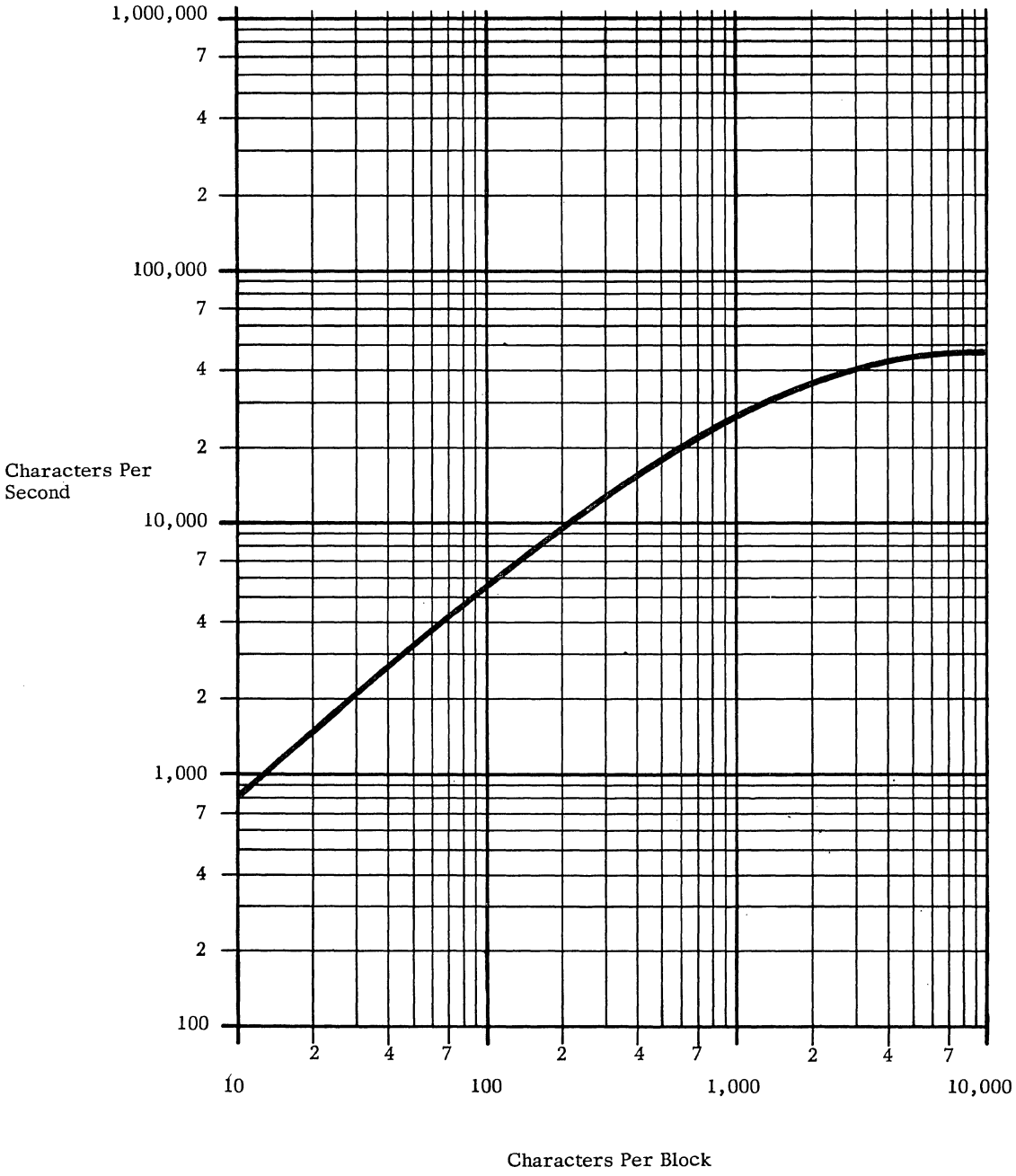
§ 091.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	none.	
Reading:	lateral + longitudinal parity	indicator + alarm.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	yes	see reading.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	yes	halt the unit.
Timing conflicts:	interlock	stalls processor.
Improper Command Sequence:	alarm	indicator and halts processor.

§ 091.

EFFECTIVE SPEED
IBM 727



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INPUT-OUTPUT: CATHODE RAY TUBE OUTPUT RECORDER AND DISPLAY

§ 101.

.1 GENERAL

.11 Identity: . . . . . Cathode Ray Tube Output.
740 CRT Recorder.
780 CRT Display.

.12 Description

The 740 CRT Recorder and 780 CRT Display Units are used as output units to display data in the form of dots under control of a stored program. Data is presented point by point to form alphameric characters, symbols, curves, or any plot desired; each point being controlled by the computer program. On the 740 unit, data is displayed on a 7-inch CRT and recorded on 35mm commercial film. Simultaneously, the data points can be displayed on the 21-inch CRT of a 780 unit.

The 740 unit can be used independently of the 780, but the 780 cannot be used independently of the 740. Conversion of the digital data to analog voltages is performed in the 740. The 780, therefore, can operate only when connected to this unit.

Dots are displayed at a rate that exceeds 7,000 a second. Three instructions, write, copy and sense, are required to initiate the recording and display operations. The write instruction selects the units; the copy instruction transfers the data from storage to the deflection register in the 740; and the sense instruction is used to advance the film to a new frame. An interlock is provided which delays the execution of a copy instruction when film is being advanced. One data word is used to specify the x and y coordinates of a point written. Data transfers to the CRT units are through the MQ register; therefore, all data in this register from previous operations is destroyed.

Two types of output can be recorded, a single point or an axis.

.12 Description (Contd.)

A point is specified by its coordinates in a square 1024x1024 position matrix. A spot can be recorded in either normal or high intensity, to distinguish certain points. Two points four increments apart appear separate, and points in adjacent positions appear as a smooth line. The time to display one point is 140 microseconds.

An axis is specified by the coordinates of a point and two control bits to denote that a line is to be generated from that point. The control bits will cause a sweep to be made either up to the top of the frame across to the right of the frame, or at 45 degrees up and to the right of the point. The time to display one axis is approximately 220 microseconds.

The 7-inch CRT of the 740 Recorder uses a display area of 3.366 inches by 3.366 inches and has a persistency of a few microseconds. The manufacturer claims that position stability of dots is better than 0.1 percent of full deflection and a maximum error of 0.5 percent positional accuracy may be expected. The 35mm camera has capacity for 100 feet of perforated or unperforated film which can be easily loaded.

The 21-inch CRT of the 780 Display uses a display area of 10 inches by 15 inches and has a persistency of approximately two seconds. Depending on the amount of ambient light, the persistency may vary from 0 to 7 seconds. Accuracy is 1 percent of full deflection and a dot on a square matrix will not drift more than 1 percent of full deflection in one hour. The 780 has its own controls for focus, axis intensity, dot intensity, vertical and horizontal gain, and vertical and horizontal centering.

.13 Availability: . . . . . not in production, can be rented or purchased only as used or rebuilt equipment.

.14 First Delivery: . . . December, 1956

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . none.

.12 Description

The IBM 704 is not capable of any simultaneous operations; however, overlapped computing during input-output operations is possible. In a sense this mode of operation is mandatory because the processor must select a unit and execute a data transfer instruction (CPY or CAD) for each word transferred.

The kind of computing that is usually performed in overlapped operation is peculiar to the unit selected. The computation usually involves editing, radix conversion, and error checking. Most of the available software for input-output functions utilizes this input-output time overlap to perform the required functions and permit the input-output units to run at their maximum speeds.

Input-output operations cannot be overlapped with each other because only one unit can be "selected" by the program at one time. Selecting another unit logically disconnects the previously selected unit.

.2 CONFIGURATION CONDITIONS: none.

.3 CLASSES OF OPERATION

A: . . . . . compute, general.
B: . . . . . compute, editing and conversion.
C: . . . . . compute, input-output checking and control.
D: . . . . . mechanical acceleration time (between unit selection and first data transfer) for one of these units: card reader or card punch.
E: . . . . . mechanical acceleration time for the printer.

.3 CLASSES OF OPERATION (Contd.)

F: . . . . . read magnetic tape or drum, or write drum (the period during which data is being transferred).
G: . . . . . write the same block of data on 1, 2, or 3 magnetic tapes simultaneously.
H: . . . . . read or punch a card.
I: . . . . . print a line.
J: . . . . . space form on printer.
K: . . . . . rewind or backspace all of the magnetic tapes (10 max.) connected to system.

.4 RULES

a + b + c = at most 1.
d + e + f + g + h + i = at most 1.
a + j + k = at most 3.
b + (d + e) = at most 2.
(b + c) + (h + i) = at most 2.
c + (h + g) = at most 2.
(d + f + g + h) + j + k = at most 3.

.5 TABLE

Class	Sets of Possible Simultaneous Operations						
a	1						
b		1	1	1	1		
c				1	1	1	1
d		1					
e			1				
f						1	
g							g
h				1			
i					1		
j	1	1		1			
k	k	k	k	k	k	k-f*	k-g

* one tape only, not including drum.

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INSTRUCTION LIST

§ 121.

INSTRUCTION				OPERATION
Mnemonic Code	Decrement	Tag	Address	Accumulator (AC) bits are called S, Q, P, 1 thru 35. Multiplier-Quotient (MQ) bits are called S, 1 thru 35. Q and P hold overflows, S's sign.
				Fixed Point Arithmetic (AC and MQ use bits S, 1 thru 35 unless overflow in AC, then P and Q)
ADD	X	T	Y	(Y) + (AC) → AC
ADM	X	T	Y	|(Y)| + (AC) → AC
SUB	X	T	Y	(AC) - (Y) → AC
SBM	X	T	Y	(AC) - |(Y)| → AC
MPY	X	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ
MPR	X	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ, and if $MQ_1 = 1$; AC + 1 → AC
DVH	X	T	Y	(MQ) ÷ (Y) → MQ (quotient), AC (remainder). If overflow, set divide-check indicator and halt processor.
DVP	X	T	Y	Same as for DVH except processor is not halted.
				Floating Point Arithmetic
FAD	X	T	Y	(Y) + (AC) → (AC), (MQ).
UFA	X	T	Y	(Y) + (AC) → (AC), (MQ).
FSB	X	T	Y	(Y) + (AC) → (AC), (MQ).
UFS	X	T	Y	(Y) + (AC) → (AC), (MQ).
FMP	X	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ.
FDH	X	T	Y	(AC) ÷ (Y) → MQ (quotient), AC (remainder). If overflow, set divide-check indicator and halt processor.
FDP	X	T	Y	Same as for FDH except processor is not halted.
				Data Transfer (Arithmetic)
LDQ	X	T	Y	(Y) → (MQ).
STQ	X	T	Y	(MQ) → (Y).
SLQ	X	T	Y	$(MQ)_{S, 1-17} \rightarrow (Y)_{S, 1-17}$.
STO	X	T	Y	(AC) → (Y).
STZ	X	T	Y	0 → (Y); sign is plus.
STP	X	T	Y	$(AC)_{P, 1, 2} \rightarrow (Y)_{S, 1, 2}$.
STD	X	T	Y	$(AC)_{3-17} \rightarrow (Y)_{3-17}$.
STA	X	T	Y	$(AC)_{21-35} \rightarrow (Y)_{21-35}$.
CLA	X	T	Y	(Y) (AC).
CLS	X	T	Y	(-Y) (AC).
				Data Transfers (Logical)
CAL	X	T	Y	(Y) → (AC)
SLW	X	T	Y	(AC) → (Y)
				Logical Operations (Uses ACP, 1 through 35)
ACL	X	T	Y	(Y) + (AC) → AC
ANA	X	T	Y	(AC) "AND" (Y) → AC
ANS	X	T	Y	(AC) "AND" (Y) → Y
ORA	X	T	Y	(AC) "OR" (Y) → AC
ORS	X	T	Y	(AC) "OR" (Y) → Y

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§ 121. INSTRUCTION LIST–Contd.

INSTRUCTION				OPERATION
Mnemonic Code	Decrement	Tag	Address	
				Shift Operations (All are modulo 256 places)
ALS	X	T	Y	(AC) shifted left Y, sign unchanged.
ARS	X	T	Y	(AC) shifted right Y, sign unchanged.
LLS	X	T	Y	(AC) and (MQ) shifted left Y, $(MQ)_S \longrightarrow (AC)_S$.
LRS	X	T	Y	(AC) and (MQ) shifted right Y, $(AC)_S \longrightarrow (MQ)_S$.
LGL	X	T	Y	(AC) and (MQ) shifted left Y, signs unchanged.
RQL	X	T	Y	(MQ) rotated left Y.
				Control Operations
NOP	X	T	Y	Next instruction in sequence is executed.
HPR	X	T	Y	Halts processor; processor steps to next instruction when Start key is depressed.
HTR	X	T	Y	Halts processor; processor steps to instruction in location Y when Start key is depressed.
TRA	X	T	Y	Next instruction is taken from location Y.
TZE	X	T	Y	(AC) = 0, next instruction taken from location Y.
TNZ	X	T	Y	(AC) $\neq$ 0, next instruction taken from location Y.
TPL	X	T	Y	If sign bit of AC positive, next instruction taken from location Y. Sign bit negative, next instruction executed.
TMI	X	T	Y	If sign bit of AC negative, next instruction taken from location Y. If sign bit positive, next instruction executed.
TOV	X	T	Y	If overflow indicator on, it is turned off and processing continues from location Y.
TNO	X	T	Y	If overflow indicator off, continue from location Y.
TQP	X	T	Y	If sign bit of MQ positive, next instruction taken from location Y.
TQO	X	T	Y	If MQ overflow indicator turned off, next instruction taken from location Y.
TLQ	X	T	Y	(MQ) < (AC) next instruction taken from location Y.
TSX	X	T	Y	2's complement of location Y placed in index register T. *
TXI	D	T	Y	Adds the value of D to the number in index register T and takes next instruction from Y. *
TXH	D	T	Y	If number in index register T greater than value of D, next instruction taken from location Y. *
TXL	D	T	Y	If number in index register T is less than or equal to the value of D, next instruction taken from location Y. *
TIX	D	T	Y	If number in index register T is greater than the value of D, the number in index register T is reduced by the value of D and next instruction is taken from Y. *
TNX	D	T	Y	If number in index register T is greater than the value of D, number in index register T is reduced by the value of D and transfers to the next instruction; otherwise the index is unchanged and the next instruction is taken from Y. *
TTR	X	T	Y	Processor takes its next instruction from location Y and proceeds whether or not in trapping mode.
CAS	X	T	Y	(Y) < (AC) next instruction executed. If (Y) = (AC) skip next instruction. If (Y) > (AC) skip next two instructions.
LXA	X	T	Y	Address portion of (Y) replaces number in index register T. *
LXD	X	T	Y	Decrement portion of (Y) replaces number in index register T. *
				* Not indexable.

§ 121.

INSTRUCTION LIST–Contd.

INSTRUCTION				OPERATION
Mnemonic Code	Decrement	Tag	Address	
SXD	X	T	Y	(T) replaces decrement part of location location Y. *
PAX	X	T	Y	Address part of (AC) replaces the number in the index register T. *
PDX	X	T	Y	Decrement part of (AC) replaces the number in the index register T. *
PXD	X	T	Y	0 $\longrightarrow$ (AC) and number in index register T is placed in the decrement part of the AC. *
				Input-Output Operations
RDS	X	T	Y	Start the unit specified by Y in the read mode.
WRS	X	T	Y	Start the unit specified by Y in the write mode.
BST	X	T	Y	Backspace tape designated by Y one record.
WEF	X	T	Y	An end-of-file gap and mark and a redundancy character is written on the tape on unit Y.
REW	X	T	Y	Rewind tape unit Y.
ETT	X	T	Y	When tape indicator light is on, light is turned off and next instruction executed. If indicator is off, the ETT instruction is ignored and the next instruction is skipped.
LDA	X	T	Y	The first location of the record to be read or written on the drum is Y.
CPY	X	T	Y	Transfer one word between storage and an input-output unit. If the transfer occurs, then execute the next instruction; otherwise, halt the processor. During input operations, if an end-of-file condition is encountered, no data is transferred and the next instruction is skipped. If an end-of-record condition was encountered no data is transferred and the next two instructions are skipped.
PSE	X	T	X	Provides a means for testing the status of sense switches, controlling sense lights, and the sampling of or sending of impulses to the printer and punch. Other functions include: (1) Clear Magnitude (AC) (2) Low order bit test (AC) (3) Change sign (AC) (4) Set sign plus (AC) (5) Complement magnitude (AC) (6) Enter trapping mode (7) Round $(MQ)_1 \times 2^{-35} + (AC) \longrightarrow AC$ (8) Divide check test
MSE	X	T	X	Provides a means for testing and turning off the sense lights. Other functions include: (1) P bit test (AC) (2) Leave floating trap mode (3) Enter floating trap mode (4) Set sign minus (5) Leave trapping mode (6) Redundancy tape test (7) End-of-tape test

Optional Instructions (see Central Processor Description)

Copy and Add Logical Word (CAD)
Leave Floating Trap Mode (LFM)
Enter Floating Trap Mode (EFM)
Backspace File (BSF)

* Not indexable.

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§ 121.

INSTRUCTION LIST NOMENCLATURE

Symbol	Definition
MSB:	most significant bit.
LSB:	least significant bit.
AC:	accumulator.
MQ:	multiplier-quotient.
(Y):	contents of Y.
| (Y) | :	absolute value of the contents of Y.

In the instruction format:

X is part of the operation code.
T is the Tag (index specification).
Y is the address.

N. B. All address fields are indexable unless specifically noted.

CODING SPECIMEN: SAP

§ 131.

.1 CODING SPECIMEN

```
        TSX   LFS, 2          LOCATE FIELD START          DPP10224
        COM                                               DPP10225
        PAX   0, 2            SET IR-2= 1COM(A+Q)         DPP10226
        CAL   INSN                                        DPP10227
INS6    ARS   18                                          DPP10228
        PAX   0, 4            SET IR-4=N                  DPP10229
        ADD   UDB             (UD+N)                      DPP10230
        STA   INSU                                        DPP10231
        CAL   STAB+1, 1       SET UP INITIAL SHIFT        DPP10232
        STA   INS2                                        DPP10233
        LDQ   -1, 2           GET FIRST PACKED WORD       DPP10234
INS2    LGL   (  )            INITIAL SPIN                DPP10235
INS4    ALS   6                                           DPP10236
        RQL   6                                           DPP10237
INSU    ACL   (  ), 4         INSERT                      DPP10238
        TNX   INS3, 4, 1      TEST FOR N CHAR.            DPP10239
        TIX   INS4, 1, 1      TEST FOR 6 CHAR.            DPP10240
        SLW   -1, 2           STORE PACKED WORD           DPP10241
        LXA   6A, 1           SET IR-1=6                  DPP10242
        LDQ   0, 2            GET NEXT PACKED WORD        DPP10243
        TXI   INS4, 2, -1     STEP P.W. ADDR.             DPP10244
INS5    LGL   6               SPIN LAST                   DPP10245
INS3    TIX   INS5, 1, 1      PACKED WORD                 DPP10246
        SLW   -1, 2                                       DPP10247
        LXD   INSB, 2         RESTORE                     DPP10248
        LXD   INSC, 4         AND                         DPP10249
        TRA   1, 2            RETURN                      DPP10250
INSX    SXD   INSB, 2           SAVE I. R.                DPP10251
        SXD   INSC, 4                                     DPP10252
        LXD   XTRR, 1           SET IR-1=(6-REM)          DPP10253
        LXA   XTRC, 2         SET IR-2= 1COM(A+Q)         DPP10254
        CAL   XTRN            SET N                       DPP10255
        TRA   INS6                                        DPP10256
                                                          DPP10257
              DECIMAL TO BINARY CONVERSION                DPP10258
                                                          DPP10259
DTB     SXD   XA, 1           SAVE I. R.                  DPP10260
        SXD   XB, 2                                       DPP10261
        CLA   1, 4            GET N                       DPP10262
        PAX   0, 1            SET IR-1=N                  DPP10263
        TOV   DB1             TURN OFF OV. TRIGGER        DPP10264
DB1     CLA   2, 4            EXTRACT FIELD               DPP10265
        TSX   XTR, 2          TO BE CONVERTED             DPP10266
        STA   DB3             SET (UD+N)                  DPP10267
        STZ   T1              CLEAR PARTIAL SUM           DPP10268
        LDQ   9A              SET MQ=9                    DPP10269
DB3     CLA   (  ), 1                                     DPP10270
        TLQ   DB4             TEST FOR PURE DIGIT         DPP10271
        ADD   T1                                          DPP10272
        TXL   DB5, 1, 1       TEST FOR UNITS DIGIT        DPP10273
        STO   T1              PROGRAMMED                  DPP10274
        ALS   3               MULT.                       DPP10275
        ADD   T1              BY                          DPP10276
        ADD   T1              10                          DPP10277
        STO   T1                                          DPP10278
        TIX   DB3, 1, 1                                   DPP10279
```

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IBM 704
Data Code Table
Internal
Magnetic Drum
Magnetic Tape

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . binary 6-bit code.
internal.
magnetic drum.
magnetic tape.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: . . . . . 4 numeric bits; 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	&	-	Blank
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10		+ o	- o	ǂ
11	#	.	$	,
12	@	□	*	%
13				
14				
15				

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . punch card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	&	-	0
12	&	&	oc	+ o
11	-	oc	-	- o
0	0	+ o	- o	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	Ø	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2		+	-	≠
8-3	#	.	$	,
8-4	@	□	*	%
8-5				
8-6				
8-7	TM	≠	Δ	

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: . . . . . 4 numeric bits: 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	Blank		-	+
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10				
11	+	,	$	.
12		%	*	□
13				
14				
15				

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DATA CODE TABLE NO. 4

•§ 144.

.1 USE OF CODE: . . . . BCD 6-bit code. magnetic tape.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: . . . . . 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: . . . . . 4 numeric bits, 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0		Blank	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	ǂ	-0	+0
11	#	,	$	.
12	@	%	*	□
13				
14				
15	TM		Δ	ǂ

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PROBLEM ORIENTED FACILITIES

§ 151.

.1 UTILITY ROUTINES

.11 Simulators of Other Computers

IBM 650
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
SIFON4 MURA 650 ON 704 SIMULATOR
Simulates an IBM 650 with floating point and indexing accumulators on an IBM 704 with 8, 192 words of core storage. SIFON4 is from 5 to 10 times slower than an optimized 650.

IBM 709
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
LOADS BINARY ABSOLUTE, CORRECTION AND TRANSFER
Cards-simulates 709 execution of program. By means of control cards, logical trace is available. By means of call card, memory dump is available. CORR/471.

.12 Simulation by Other Computers

TYDAC
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
TYDAC (PSEUDO COMPUTER) SIMULATOR
This computer is described in the book Digital Computer Programming by D. C. McCracken.

.13 Data Sorting and Merging

CF0065
Reference: . . . . . SHARE.
Record size: . . . . . W*N words.
Block size: . . . . . N words.
Key size: . . . . . K words.
File size: . . . . . any.
Number of tapes: . . . 4 or more.
Date available: . . . . May, 1959.
Description
GENERALIZED MEMORY SORTING ROUTINE
Places in ascending logic sequence a block of N consecutive items of W words each in core storage using K words of each item as the sorting key. Requires 100 storages + (W*N + N) COMMON.

OR SRT3
Reference: . . . . . SHARE.
Record size: . . . . . Optimum.
Block size: . . . . . $\leq$ 0.5 record.
Key size: . . . . . N words.
File size: . . . . . 2^X blocks.
Number of tapes: . . . >4.
Date available: . . . . May, 1959.

.13 Data Sorting and Merging (Contd.)

OR SRT3 (Contd.)
Description
SORT, ALGEBRAIC, MULTIWORD KEYS. (WHOLE WORD KEYS ONLY)
Number items a power of 2. One-word clues (which give loc. of keys) are ordered to match sorted keys. Only clues moved. Words of key must be adjacent cells. WKG STG=2* (No. clues). 90 cells.

.14 Report Writing

CE J4G
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
OUTPUT CONVERSION WITH FORMAT CONTROL
A general output conversion routine (Binary to BCD) with completely flexible locations and format control. Text may be interspersed anywhere in print line and successive lines may be the same or different. Format can be changed at load time with use of CE 14G. Prepares BCD for punching or printing (with or without overpunched signs).

CF 0013
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
GENERALIZED, PACKAGED, ON-LINE INPUT-OUTPUT SUBROUTINE
Loads decimal data from variable field cards directly into core storage with automatic conversion. Conversion may be fixed-to-fixed, fixed-to-floating, or floating-to-floating. Also loads and/or prints card images. Prints decimal data in variable format form directly from core storage with automatic conversion. Conversion may be fixed-to-fixed, floating-to-fixed, or floating-to-floating. Page identification is handled automatically and column headings are optionally automatic. Requires 1, 180 cells + 295 COMMON.

.15 Data Transcription

BE CTX1
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
BINARY/BCD CARD-TO-TAPE SIMULATOR
Simulates the card-to-tape converter, accepting a mixed deck of Hollerith and SHARE standard column binary cards and producing BCD and/or Binary Card Images on tape 10. Column binary control punches are not deleted from the binary record written. Operates the card reader at full speed. Non self-loading executive routine. Program (30-332), Erasable storage (333-417) octal.

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§ 051.

.15 Data Transcription (Contd.)

MU R704
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
MURA REFLECTED 704
Causes the 704 to behave like a 407 in its role as a reader and printer of cards. Fifty words program plus 24 words for lower binary loader. Reader and printer operate at full speed.

UA TPH2
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
OFF-LINE PRINTER SIMULATOR
Simulates the tape-to-off-line-printer machine. The tape is redundancy-checked, and print wheel echo-checking is performed. The carriage control (program device) is simulated. Printer usually operates at something less than half speed.

.16 File Maintenance

DI TPC1
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
TAPE CORRECTOR
Duplicates a BCD tape and makes insertions, deletions, or changes. Corrections may be read on-line or off-line.

.17 Other

MU EAS2
Reference: . . . . . SHARE.
Date available: . . . . May, 1959.
Description
MURA EFFECTIVE ADDRESS SEARCH ROUTINE
Self loading. Searches memory for any effective address (i.e., account taken of indexing) set up on panel switches. Account is taken of multiple indices. Locations and words found are printed. Occupies first 110 words of memory timing. About 4 seconds per address searched plus one line of print for each reference thereto found.

.2 PROBLEM ORIENTED LANGUAGES

DPP1
Reference: . . . . . IBM Manual.
Date available: . . . . May, 1959.
Description
The Data Processing Package is an integrated set of subroutines which allow the 704 to operate on binary coded decimal (BCD) information. Input, output, information transfer and manipulation and arithmetic are all performed on packed BCD data. Regardless of which subroutines are called into use, a section of the Data Processing Package known as the Universal Routine must always be present. The principal function of the Universal Routine is to supply a mechanism for reference to the various subroutines and to provide universal constants and erasable storage.

PROCESS ORIENTED LANGUAGE: 704 FORTRAN II

§ 161.

.1 GENERAL

.11 Identity: . . . . . FORTRAN II Automatic Coding System for the IBM 704.

.12 Origin: . . . . . IBM Data Processing Division.

.13 Reference: . . . . . IBM Manual C28-6106.

.14 Description

The 704 FORTRAN II is an augmented version of the original 704 FORTRAN I translator. A group of control statements establishing linkage to subroutines and functions are available in this present version which were not present in 704 FORTRAN I. The principal difference between 704 FORTRAN II and 709/7090 FORTRAN II is that 709/7090 FORTRAN II operates under control of a "monitor system" whereas 704 FORTRAN II does not include the supervisory monitor routine.

It is possible to enter SAP coding directly into a FORTRAN program by use of an S in column 1 of the statement. Recognition of this character causes the translator to assume the statement to be in SAP form (using and generating FORTRAN II variables and constants). Boolean statements are also possible.

Programs written in FORTRAN I may be compiled by FORTRAN II compiler systems tapes.

There is no provision in 704 FORTRAN II for double precision floating point computation or manipulation of complex variables.

.15 Publication Date: . . . . 1958.

.2 PROGRAM STRUCTURE

.21 Divisions: . . . . . one division, composed of the following types of statements.

Procedure statements: . algebraic formulae.
comparisons and jumps.
input and output.

Data statements: . . . . FORMAT: describes the layout, size, scaling and code of input-output data.
EQUIVALENCE: used to cause two variables to have a common location or to specify synonyms.

.21 Divisions (Contd.)

COMMON: used to cause a name to be common to more than one segment rather than local to each.
DIMENSION: describes the elements in each dimension of an array or set of arrays.

Optimizing statement: . FREQUENCY: optional statement of ratio of expected use of alternative paths at branch point or average repetitions of loops.

.22 Procedure Entities

Program: . . . . . statements.
subroutines.
Subroutine: . . . . . statements.
Statement: . . . . . characters; blanks are ignored, except in Alphameric field in FORMAT statement.
Function: . . . . . statements.

.23 Data Entities

Arrays: . . . . . all variables.
Item: . . . . . a floating point variable or a constant.
an integer variable or a constant.
a Hollerith item.
an alphameric item.
Hollerith item: . . . . . alphameric item that can only be used for output.
Alphameric item: . . . alphameric item that can only be input during a run; it can be used for output or as a format statement.

.24 Names

.241 Simple name formation
Character set: . . . . A to Z, 0 to 9.
Size: . . . . . 1 to 6 char.
Avoid key words: . . . no.
Formation rule: . . . first char must be a letter.
a final F may not be used if the name is subscripted and/or is more than 3 characters long.

.242 Designators
Procedures
Statement label: . . . unsigned integer.
Function label: . . . . similar to variable being defined, except 4 to 7 characters with a terminal F.
Subroutine label: . . . same as variable being defined.

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§ 161.

.242 Designators (Contd.)

Data	
Integer variables:	initial I, J, K, L, M, N.
Floating point variables:	any other initial letter.
Equipment	
Card:	implied by verbs READ, PUNCH.
Magnetic tape:	use key word TAPE.
Printer:	implied by verb PRINT.
Magnetic Drum:	use key word DRUM.
Sense Light or Switch:	implied by noun SENSE.
Overflow Triggers:	implied by noun OVERFLOW.
Divide Check Trigger:	implied by phrase DIVIDE CHECK.
Input or Output:	implies BCD data on tape.
Comments:	C in col. 1 of statement.
Translator control:	key words FREQUENCY, EQUIVALENCE, or COMMON.

.25 Structure of Data Names

.251	Qualified names:	none.
.252	Subscripts	
	Number per item:	0 to 3.
	Applicable to:	all variables.
	Class may be	
	Special index variable:	no special index variables.
	Any variable:	only integers.
	Literal:	yes.
	Expression:	at most C * N ± C'; where C and C' are literals.
	Form may be	
	Integer only:	C, C' and N.
	Signed:	no.
	Truncated fraction:	no.
	Rounded fraction:	no.
.253	Synonyms	
	Preset:	EQUIVALENCE statement causes sharing of storage locations.
	Dynamically set:	no.

.26 Number of Names

.261	All entities:	?
.262	Procedures	
	Subroutine and Function:	750
	Numbered Procedures:	750
	Arithmetic Functions:	50
	Assigned GO TO Variables:	25
	IF, ASSIGN, GO TO:	300
	SAP Skip type:	425
	CALL:	400
	DO:	150
.263	Data	
	Files:	no limit.
	Record formats:	less than 4, 285 char in FORMAT statements.
	Data levels:	3 levels by subscripting.
	Right of =:	750 fixed point variables.
	Left of =:	500 fixed point variables.
	Dummy variables:	180.
	Floating point variables:	no limit.
.264	Equipment	
	Tapes:	1 to 10.
	Printer:	1.
	Card Reader/Punch:	1 each.
	Drums:	1 to 8.

.27 Region of Meaning of Names

In the straightforward use of FORTRAN each name is established in a subroutine and is local to that routine. Thus, a name in a lower subroutine can only be used by use of a COMMON statement

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311	Concise item picture:	FORMAT statement only.
.312	List by kind:	no.
.313	Qualify by adjective:	no.
.314	Qualify by phrase:	no.
.315	Qualify by code:	first letter of name.
.316	Hierarchy by list:	no.
.317	Level by indenting:	no.
.318	Level by coding:	no.
.319	Others	
	Array size:	DIMENSION ARRAY (4, 7).
	Four-digit integer:	FORMAT (I4).
	Four-digit integers, 5:	FORMAT (5I4).
	Floating point items:	FORMAT (F8.3, E12.4). Δ999.999Δ Δ9.9999EΔ99 (Δ means blank or minus sign).

.32 Files and Reels

.321	File labels	
	Variable layout:	own coding.
.322	Reel sentinels:	no multi-reel files.

.33 Records and Blocks

.331	Variable record size:	dynamic.
.332	Variable block size:	dynamic.
.333	Record size range:	1 to 999,999 words.
.334	Block size range:	1 to 999,999 words.
.335	Choice of record size:	READ, WRITE statement and FORMAT statement.
.336	Choice of block size:	READ, WRITE statement.
.337	Sequence control:	none.
.338	In-out error control:	automatic.
.339	Blocking control:	FORMAT statement.

.34 Data Items

.341	Designation of class:	by name.
.342	Possible classes	
	Integer:	yes.
	Fixed point:	no.
	Floating point:	yes.
	Alphabetic:	yes.
	Alphameric:	yes.
.343	Choice of external radix:	FORMAT statement.
.344	Possible external radices	
	Decimal:	yes.
	Octal:	yes.
.345	Internal justification:	alpha automatic left justified. integers automatic right justified in decrement of word.

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.346 Choice of code: . . . . FORMAT statement and READ, WRITE statements.

.347 Possible codes
- Decimal: . . . . . yes.
- Octal: . . . . . yes.
- Hollerith: . . . . . yes.
- Alphameric: . . . . yes.

.348 Internal item size
- Variable size: . . . . fixed, 1 word.
- Designation: . . . . . none.
- Range
  - Fixed point numeric: fixed, 1 word.
  - Floating point numeric: . . . . . fixed, 1 word.
  - Alphameric: . . . . fixed, 1 word.

.349 Sign provision: . . . . . optional.

.35 Data Values

.351 Constants
- Possible sizes
  - Integer: . . . . . 2^{17}.
  - Fixed point: . . . . . none.
  - Floating point: . . . 10^{-38} to 10^{+38}.
  - Alphabetic: . . . . . 660 char/statement.
  - Alphameric: . . . . 660 char/statement.
- Subscriptable: . . . . yes.
- Sign provision: . . . . optional.

.352 Literals: . . . . . same as constants.

.353 Figuratives: . . . . . own coding.

.354 Conditional variables: . . computed GO TO.

.36 Special Description Facilities

.361 Duplicate format: . . . yes; by multiple references to a single FORMAT statement.

.362 Re-definition: . . . . . COMMON statement. EQUIVALENCE statement.

.363 Table description
- Subscription: . . . . . mandatory in DIMENSION statement.
- Multi-subscripts: . . 1 to 3.

.364 Other subscriptable entities: . . . . . tape units, and drum.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator list

+ :	addition, also unary.
- :	subtraction, also unary.
* :	multiplication.
/ :	division.
** :	exponentiation.
= :	is set equal to.
ABSF ( )‡:	absolute value.
INTF ( )‡:	entire.
MODF (A, B)‡:	remainder A ÷ B.
MAXOF (A, . . .)‡: . .	max value, result fixed.
MAX1F (A, . . .)‡: . .	max value, result floated.
MINOF (A, . . .)‡: . .	min value, result fixed.
MIN2F (A, . . .)‡: . .	min value, result floated.
DIMF (A, B)‡:	diminish A by B.
LOGF ( ) :	natural log.
SINF ( ) :	sine.
COSF ( ) :	cosine.
EXPF ( ) :	exponential.
SQRTF ( ) :	square root.
ATANF ( ) :	arctangent.
TANHF ( ) :	hyperbolic tangent.
FLOATF ( ) :	float an integer.
XFIXF ( ) :	fix a floating point variable.
SIGNF ( )‡:	sign change.

Note: ‡ Functions may have an X in front to specify fixed point operands.

.412 Operands allowed
- Classes: . . . . . numeric only.
- Mixed scaling: . . . . yes, but restricted.
- Mixed classes: . . . . only in exponentiation and functions.
- Mixed radices: . . . . no.
- Literals: . . . . . yes.

.413 Statement structure
- Parentheses
  - a - b - c means: . . (a-b) - c.
  - a + b x c means: . . a + (b x c).
  - a ÷ b ÷ c means: . . (a ÷ b) ÷ c.
  - a^{b^c} means: . . . . . illegal; parentheses must be used.
- Size limit: . . . . . 660 char.
- Multi-results: . . . . no.

.414 Rounding of results: . . truncation of integers at each step in expression.

.415 Special cases

	Fixed	Floating
x = -x:	K=-K	X=-X
x = x + 1:	K=K+1	X=X+1.
x = 4.7 y:	K=47*K/10	X=4.7*Y
$x = 5 \times 10^7 + y^2$:	too large	X=5.E7+Y**2
x = |y|:	K=XABSF(L)	X=ABSF(Y)
x = integer part of (y):	K=XINTF (Y)	X=INTF(Y)

.416 Typical examples: . . .
```
X=(-B+SQRTF(B*B-4.0*A*
  C))/(2.0*A)
 18 ALPHA = CON
    DO 20 I = 2, N
 20 ALPHA = ALPHA * X +
    CON (I)
```

.42 Operations on Arrays

.421 Matrix operations: . . . none.

.422 Logical operations
- Sizes of operands: . . 36 bits.
- AND: . . . . . *
- Inclusive OR: . . . . . +
- Exclusive OR: . . . . none.
- NOT: . . . . . -
- Designation: . . . . . B in col. 1 of statements.

.423 Scanning: . . . . . none.

.43 Other Computation

.431 Operator list: . . . . . S in col. 1 denotes SAP (symbolic) entry.

.44 Data Movement and Format

.441 Data copy example: . . Y = X.

.442 Levels possible: . . . . items.

.443 Multiple results: . . . . none.

.444 Missing operands: . . . not possible.

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.445 Size of operands
- Exact match: . . . . . output only.
- Alignment rule
  - Numbers: . . . . . right justified or normalized.
  - Alpha: . . . . . left justified.
- Filler rule
  - Numbers: . . . . . zeros.
  - Alpha: . . . . . blanks.
- Truncating rule
  - Numbers: . . . . . truncate at left for integers; right for floating.
  - Alpha: . . . . . truncate at right.
- Variable size destination: . . . : no.

.446 Editing possible
- Change class: . . . . integer to floating or fixed point, floating to integer or fixed point, integer or floating to octal.
- Change radix: . . . . yes.
- Insert editing symbols
  - Actual point: . . . . . automatic.
  - Suppress zeroes: . . . automatic.
  - Insert: . . . . . automatic point.
  - Float: . . . . . minus sign only.

.447 Special moves: . . . . . none.
.448 Code translation: . . . automatic.
.449 Character manipulation: none.

.45 File Manipulation

- Open: . . . . . own coding.
- Close: . . . . . own coding.
- Advance to next record: READ, WRITE, PUNCH, PRINT.
- Step back a record: . . BACKSPACE.
- Set restart point: . . . none.
- Restart: . . . . . none.
- Start new reel: . . . . . own coding.
- Start new block: . . . . implied in each input-output statement.
- Search on key: . . . . . none.
- Rewind: . . . . . REWIND.
- Unload: . . . . . none.

.46 Operating Communication

.461 Log of progress: . . . . PRINT uses on-line printer.
.462 Messages to operator: . same as log.
.463 Offer options: . . . . . PAUSE and octal display.
PRINT message.
SENSE LIGHT.
STOP and octal display.
.464 Accept option: . . . . . use sense switch or usual operator intervention.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	IF clause	own coding.
In-out:	automatic	stall.
Invalid data:	none.	

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . statement.
.512 Unconditional jump: . . GO TO N.
.513 Switch: . . . . . GO TO M, (35, 47, 18).
.514 Setting a switch: . . . . ASSIGN 35 TO M.
.515 Switch on data: . . . . . GO TO (35, 47, 18), I.

.52 Conditional Procedures

.521 Designators
- Condition: . . . . . IF.
- Procedure: . . . . . implied.

.522 Simple conditions: . . . single form of multiple condition; see example paragraph .528.
.523 Conditional relations: . IF (A) B, C, D
If the value of the expression A is less than, equal to, or greater than zero, respectively, go to B, C or D.
.524 Variable conditions: . . expression always against zero.
.525 Compound conditionals: no.
.528 Typical examples: . . . IF (X**2.0 - 3.0) 29, 37, 18; means go to 29, 37, or 18 if x^2-3 is respectively less than, equal to, or greater than zero.

.53 Subroutines

.531 Designation
- Single statement: . . . not possible.
- Set of statements
  - First: . . . . . SUBROUTINE.
  - Last: . . . . . END.

.532 Possible subroutines: . any number of statements.
.533 Use in-line in program: no.
.534 Mechanism
- Cue with parameters: CALL XXX (X, Y, Z).
- Number of parameters: . . . . no practical limit.
- Cue without parameter: . . . . . CALL XXX.
- Formal return: . . . . RETURN, at least once.
- Alternative return: . . none.

.535 Names
- Parameter call by value: . . . . . no.
- Parameter call by name: . . . . . yes.
- Non-local names: . . use COMMON.
- Local names: . . . . . all.
- Preserved own variables: . . . . . all.

.536 Nesting limit: . . . . . 300.
.537 Automatic recursion allowed: . . . . . no.

.54 Function Definition by Procedure

.541 Designation
- Single statement: . . . same as set.
- Set of statements
  - First: . . . . . FUNCTION.
  - Last: . . . . . END.

.542 Level of procedure: . . any number of statements.
.543 Mechanism
- Cue: . . . . . by name in expression.
- Formal return: . . . . RETURN.

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.544 Names
- Parameter call by value: . . . . . yes.
- Parameter call by name: . . . . . yes.
- Non-local names: . . use COMMON.
- Local names: . . . . . all.
- Preserved own variables: . . . . . all.

.55 Operand Definition by Procedure: . . . . . none.

.56 Loop Control

.561 Designation of loop
- Single procedure: . . none.
- First and last procedures: . . . . . current place to named end; e.g., DO 173 I = 1, N, 2.

.562 Control by count: . . . possible.

.563 Control by step Parameter
- Special index: . . . . no.
- Any variable: . . . . integer only.
- Step: . . . . . positive integers.
- Criteria: . . . . . equal to or greater than.
- Multiple parameters: no.

.564 Control by condition: . possible.

.565 Control by list: . . . . possible.

.566 Nesting limit: . . . . . 50 of DO type.

.567 Jump out allowed: . . . yes.

.568 Control variable exit status: . . . . . available.

.6 EXTENSION OF THE LANGUAGE: . . . . . can write new function in library.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . 704 FORTRAN library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.

.722 Expandable master: . . yes.

.73 Storage Form: . . . . . tape or cards.

.74 Varieties of Contents: . subroutines. functions.

.75 Mechanism

.751 Insertion of new item: . separate run.

.752 Language of new item: . SAP and/or FORTRAN.

.753 Method of call: . . . . . named in procedures.

.76 Types of Routine

.761 Open routines exist: . . yes; ABSF, XABSF only.

.762 Closed routines exist: . yes.

.763 Open-closed is variable: no.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . yes; SAP.

.82 Optimizing Information Statements

.821 Process usage statements: . . . . . FREQUENCY.

.822 Data usage statements: COMMON. EQUIVALENCE. S DED, (I).

.83 Translator Environment: . . . . . implicit.

.84 Target Computer Environment: . . . . . implicit.

.85 Program Documentation Control: . . . . . yes.

.86 Output Options Translator: . . . . . END (I_1, I_2, $I_3 \ldots I_6$)

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: WRITE DRUM. READ DRUM. WRITE TAPE. READ TAPE.

.92 Address Allocation: . . absolute for drum.

.93 Arrangement of Items in Word in Unpacked Form: . . . . . none.

.94 Assignment of Input-Output Devices: . . . yes.

.95 Input-Output Areas: . . implicit.

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MACHINE ORIENTED LANGUAGE: UA SAP 3-7

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.1 GENERAL

.11 Identity: . . . . . UA SAP 3-7.

.13 Reference: . . . . . SHARE Distribution 347.
SHARE Distribution 564.
SHARE Distribution 716.

.14 Description

UA SAP 3-7 is a two pass, batched job assembly system which incorporates most of the features that can be usefully employed in preparing a program at the machine code level. The operation codes, including pseudo-operations, are represented by three character mnemonic codes. The addressing scheme can be in either absolute addresses and/or in one to six character symbolic address labels. Relative addressing is possible as is address arithmetic.

The input and output to or from the program may be on cards or magnetic tape. Although an input statement can contain only one instruction (or a maximum of 61 words of constants), the output record will contain either 22 words, including loading information such as relocatability and a checksum, or 24 words depending on the kind of output requested. A listing of the program can be generated on-line or off-line.

An input statement is simple to prepare. The first six columns of a card may contain a symbolic label which identifies the following data with a storage location. Leading blanks are always eliminated so that this source of key-punching error is virtually eliminated. The next field of the statement is the operation field which contains the mnemonic operation code. Following this is the variable length field which contains the address, tag (i.e., index call) and decrement parts of the instructions if they are required. The address, tag, and decrement parts are separated by commas, and all may be in symbolic form and use "address" arithmetic. Constants are also entered in this field separated by commas, and may be in octal, decimal (fixed and right justified or floating point) or in binary coded decimal (alphameric). After the first space in the variable length field, a comment can be added to use up the rest of the field. The last field can be used for program identification and/or sequence number codes since the assembly translator does not use it.

Error detection is limited to the peculiarities of the assembly system although this is very complete. Undefined and missing operation, address, tag, and decrement instruction parts are annoted next to the error on the listing. Undefined symbolic addresses are symbolic labels that appear in the variable length field but not in the label field. Those undefined addresses that are not automatically defined by the DEF pseudo-operation are listed after the first-pass of the assembly on the on-line printer as are labels

.14 Description (Contd.)

appearing in the label field more than once (double definitions). In the event of error, the field in error is assembled as zeros on tape or no punches on cards. This permits easy hand correction without reassembly. Error counts and other statistics are printed at the end of the second and final pass.

One minor inconvenience is that all numbers except constants must be entered in decimal. This occurs only when assembling corrections or adding to programs since the addresses on the listings are in octal and must be hand converted to decimal to make up some of the new input statements.

.15 Publication Date: . . . October 7, 1957.

.2 LANGUAGE FORMAT

.21 Diagram: . . . . . refer to diagram at end of section.

.22 Legend

H:	used for heading number or normal symbol.
Location:	location - actual or symbolic of the instruction or constant.
OP:	mnemonic code, for operation or pseudo op to be performed.
Address, Tag, Decrement:	symbolic or actual address of data or index register branch, tag digit, arithmetical address decrement; all separated by commas.

.23 Corrections: . . . . . pseudo operation C/T restricted, best used for patching.

.24 Special Conventions

.241	Compound addresses: .	allowed.
.242	Multi-addresses: . . .	not allowed.
.243	Literals:	EQU pseudo operation.
.244	Special coded addresses:	this address * ZERO ** or * - * this address squared *** ONE */*

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.245 Other address computation

X/Y:	divide X by Y.
X*Y:	multiply X by Y.
X + Y:	add X to Y.
X - Y:	subtract Y from X.

As many address manipulation symbols can be used as can be placed on a line separated by labels or numbers (decimal), e.g., DOG * CAT / 2 + 3 - MICE. Decimal integer values less than 10^6 must be used. The resultant value modulo 2^{15} is used as the value of the address.

.3 LABELS

.31 General

.311 Maximum number of labels:	1097 + (core store size - 4096) /2.
.312 Common label formation rule:	1 to 6 characters, A-Z and 0-9, "=", and "-". = and - (8-3 and 8-4 punch card codes respectively) are considered numeric.
.313 Reserved labels	
For temporary storage in library routines: .	COMMON.
For temporary storage in library routines:	VULGAR.
.315 Designators:	psuedo-operations.
DEC:	decimal.
OCT:	octal.
BCD:	binary coded decimal.
.316 Synonyms permitted: .	yes.

.32 Universal Labels

.321 Labels for procedures	
Existence:	optional unless referred to by another procedure.
Formation rule	
First character: . .	A-Z, 0-9, =, -.
Last character: . .	A-Z, 0-9, =, -.
Others:	A-Z, 0-9, =, -.
Number of characters:	1 to 6, one of which is alphabetic.
.322 Labels for library routines	
Existence:	same as procedures.
.323 Labels for constants:	same as procedures.
.324 Labels for files: . . .	none.
.325 Labels for records: . .	none.
.326 Labels for variables:	same as procedures.
.327 Labels for allocated areas:	same as procedures.
.33 Local Labels:	see HED Pseudo-Operation.
.331 Region:	between HED statements.
.332 Labels for procedures	
Existence:	mandatory if specifically referred to by another procedure statement.
Region:	between HED statements.
Formation rule	
First character: . .	blank.
Last character: . .	A-Z, 0-9, =, -.
Others:	same as last character.
Number of characters:	1 to 5, one of which is alphabetic.
.333 Labels for library routines	
Existence:	same as procedures.
.334 Labels for constants	
Existence:	same as procedures.
.335 Labels for files:	none.
.336 Labels for records: . .	none.
.337 Labels for variables:	same as procedures.
.338 Labels for Allocated areas:	same as procedures.

.4 DATA

.41 Constants

.411 Maximum size constants	
Integer	
Decimal:	$2^{35} - 1$.
Octal:	12 digits.
Fixed numeric	
Decimal:	$2^{35} - 1$.
Floating numeric	
Decimal:	10^{+38} to 10^{-38}.
Alphabetic:	60.
Alphameric:	60.
.412 Maximum size	
laterals:	EQU pseudo-operation.
Integer	
Decimal:	less than 10^6.
Fixed numeric: . . .	none.
Floating numeric: . .	none.
Alphabetic:	6 char.
Alphameric:	6 char.
.42 Working Areas:	see paragraph .313.
.421 Data layout:	own coding.
.422 Data type:	no specification must be implied by a comment.
.423 Redefinition:	yes.

.43 Input-Output Areas

.431 Data layout:	own coding or as required by LIB routine.
.432 Data type:	no specification, must be implied by a comment.
.433 Copy layout:	as special case of REP pseudo-op.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic	
Existence:	mandatory.
Number:	104.
Example:	TXL 127, 1, 1.
Comment:	26 codes are extended.

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.512 Absolute: only as constants or special pseudo operations.
Number: . . . . . all instructions.
Example: . . . . . OCT 700001100127.
Comment: . . . . . equivalent.

.513 Special pseudo-operations
Existence: . . . . . optional.
Number: . . . . . 12.
Example: . . . . . MTH A, 1, 1.
Comment: . . . . . equivalent to operation TXL 127, 1, 1.

.52 Macro-Codes

.521 Number available: . . . none.

.53 Interludes: . . . . . psuedo operation PLB.

PLB simulates the Load Card Button in either pass 1 (which generates the symbol table) or pass 2 (which generates the machine code) or both. It is possible to read in a program via the card reader that will perform any desired function including loading the assembled program, generating constants or modifying the assembler itself.

Re-entry points to the assembly are provided. It is possible to assemble the interlude, execute it, and cause it not to appear in the final object program.

.54 Translator Control: . . pseudo operations.

.541 Method of control
Allocation counter: . BES, BSS.
Label adjustment: . . SYN, EQU
Annotation: . . . . . REM.

.542 Allocation counter
Set to absolute: . . . ORG, LOC.
Set to label: . . . . ORG, LOC.
Step forward: . . . . BSS, BES.
Step back ward: . . . BSS, BES.
Reserve area: . . . not possible.

.543 Label adjustment
Set labels equal: . . SYN.
Set absolute value: . . SYN, EQU.
Clear label table: . . RST.
Load symbol table: AST.
Define Undefined symbols: . . . . . DEF.

.544 Annotation
Comment phrase: . . follows first blank after col. 11.
Title phrase: . . . . REM pseudo-operation, remarks appear in listing.

.545 Other
Insert new operation code: . . . . . OPD.
Adjust output format: . . . . . ABS, FST, FUL, PLR, PST, SKP, SPC, TCD, WST.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic: . . none.

.62 Special Functions

.621 Facilities: . . . . . may be supplied to library.
.622 Method of call: . . . . LIB pseudo-operation.

.63 Overlay Control: . . . own coding.

.64 Data Editing

.641 Radix conversion: . . . DEC - converts decimal to binary.
OCT - converts octal to binary.
Code translation: . . . BCD - input to 6 bit BCD.

.642 Format control: own coding or library routines.

.65 Input-Output Control: . . . . . own coding or library routines.

.66 Sorting: . . . . . own coding or library.

.67 Diagnostics: . . . . . own coding or library generally inserted by operator into object program as required.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . SHARE supplied or own coding.

.72 Kinds of Libraries

.721 Fixed master: . . . . possible.
.722 Expandable master: . . generally.
.723 Private: . . . . . generally.

.73 Storage Form: either card or magnetic tape.

.74 Varieties of Contents: . . . . . conversion and editing Input-Output, mathematics, utility, generators, and others.

.75 Mechanism

.751 Insertion of new item: . . . . . special run.
.752 Language of new item: . . . . . SAP.
.753 Method of call: LIB pseudo-operation.

.76 Insertion in Program

.761 Open routines exist: . . yes.
.762 Closed routines exist: . . . . . yes.
.763 Open-closed is optional: . . . . . yes.
.764 Closed routines appear once: . . . . . yes.

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . . none.

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.82 Pseudos

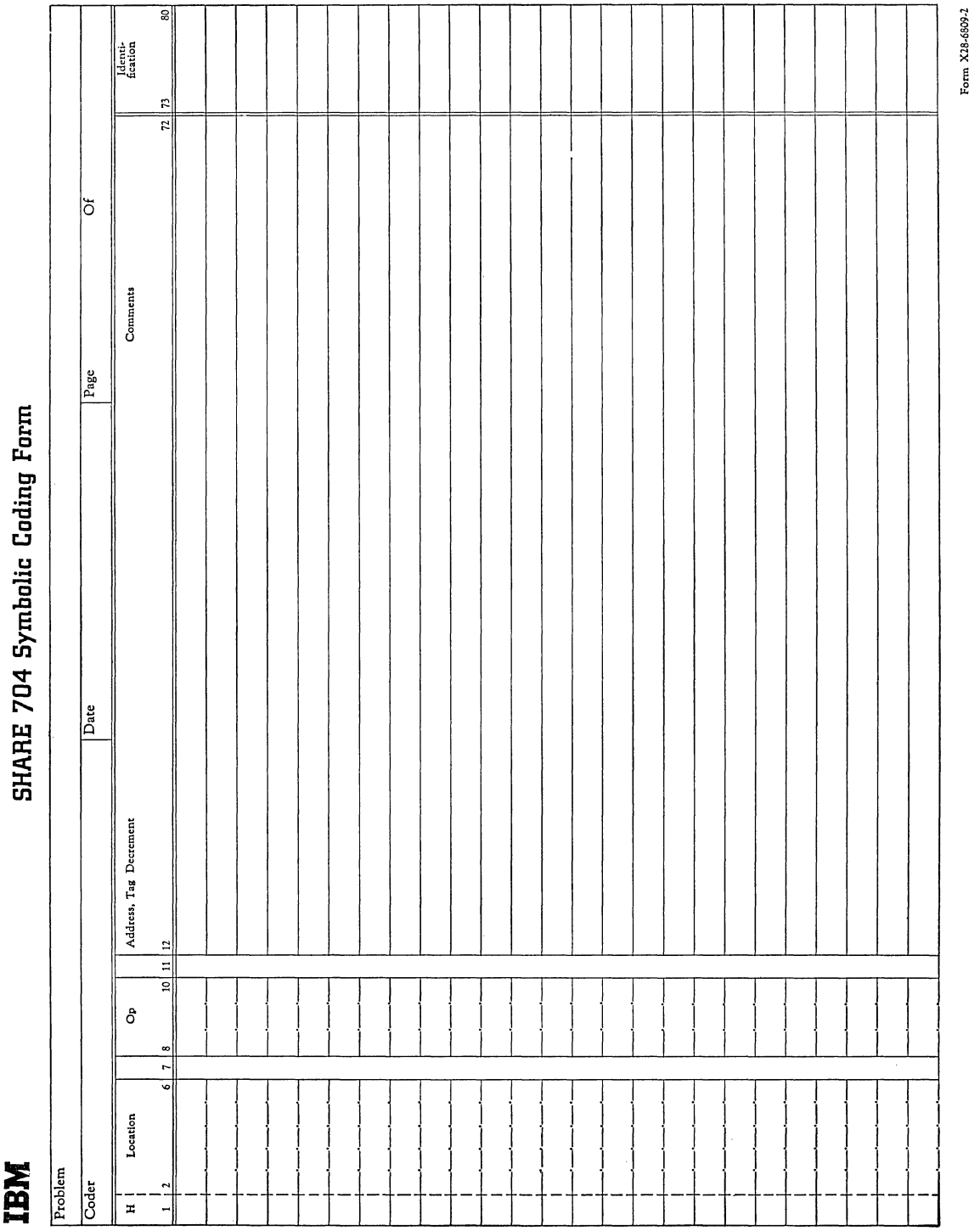
Code	Description
ABS :	changes binary output mode to absolute binary card format.
S BCD V :	inserts "V" BCD words, S identifies first word.
S BCD nnH :	inserts "nn" BCD characters following the H, S identifies first word.
S BES N :	advances LC N places. S is then assigned to LC setting + 1.
S BSS N :	S is assigned to this location. LC is advanced by N.
S DEC :	converts decimal to binary.
DEF M, N :	defines next N undefined symbols as M, M + 1, ... M + N - 1.
END S :	marks end of assy. Transfer to S card for loader routine.
S EQU T :	define preset program parameter S as equals to T.
FIN :	marks finish of a batch of stacked assemblies.
FST :	punch final symbol table.
FUL :	changes binary output mode to 24 wds/card.
H HED :	heads all 5 or fewer character symbols with the "H" number.
LIB N :	obtains specified library routine from library tape N.
LOC S :	resets assembler's location counter to S.
OCT :	convert octal input to binary.
DRG S :	punches waiting output and sets new program origin at S.
PLB N :	pushes load button in (1st, 2nd, both) passes if N = 1, 2, blank.
PLR :	causes library routines to print.
REL :	changes binary output mode to relocatable format.

.82 Pseudos (Cont'd)

REM :	copies remarks into listing.
REP M, N :	repeats preceeding M words N times.
RST M, N :	replace current symbol table with Nth symbol table on tape M. If M, N are blank, table is from cards.
SKP N :	causes carriage skip to paper tape control channel N during assembly.
SPC N :	cause single or double spacing if N is 1 or 2 during assembly.
S SYN T :	sets symbol "S" to refer to the same location as T.
TCD S :	punches waiting output and a binary transfer card (TRA S).
WST M, N :	write the current symbol table as the Nth Table on tape M. If M, N all blank, punch on line.
MTH :	first octal digit of this word is 7.
SVN :	first octal digit of this word is 7.
MTW :	first octal digit of this word is 6.
SIX:	first octal digit of this word is 6.
MON :	first octal digit of this word is 5.
FVE :	first octal digit of this word is 5.
MZE :	first octal digit of this word is 4.
FOR :	first octal digit of this word is 4.
PTH :	first octal digit of this word is 3.
PTW :	first octal digit of this word is 2.
PON :	first octal digit of this word is 1.
PZE :	first octal digit of this word is 0.

Note: LC is Location Counter.

§ 171.



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PROGRAM TRANSLATOR: UA SAP 3-7

§ 181.

.1 GENERAL

.11 Identity: . . . . . UA SAP 3-7.

.12 Description

The translator program for UA SAP 3-7 is a very fast assembly program which handles batched assemblies by completing each two-pass assembly before starting the next. Input-output control is accomplished by using the console sense switches and by using special assembly control pseudo-operations. This program and the object programs it produces can be used on the IBM 709, 7090/94, and 7040/44, when the IBM 704 compatibility features and routines are used.

Pseudo operations are also used to control storage allocation. Since the IBM 704 is a sequential magnetic core storage machine, storage allocation involves advancing the location indicator used for storage assignment rather than reserving storage blocks. Other pesudo operations can be used to set the location counter to a particular location address. One of these set-type pseudo-ops is used to keep the first few hundred locations unassigned because many of the utility routines use this area.

A very extensive library of both programs and routines are available and maintained by the SHARE users group. Each installation takes the routines that it needs from the SHARE library and generates a library tape sequencing the routines in the manner best suited to them. This is a rather important consideration in that whenever a library call statement is encountered in a program being assembled, the routine is searched for on the library tape. No other part of the assembly can be done while this search is in progress. The individual library call statement in the source program should be sequenced in the order that the called routines appear on the library tape in order to minimize search time. It is also important to sequence the source program correctly before assembling since there is no sorting option built into the assembler.

The assembler can be modified permanently by a maintenance routine or temporarily by using interludes. The interlude may also be used to generate tables of data and/or instructions. The interlude can be used in either pass of the assembly. Thus, it is possible to assemble the interlude program, execute it, and then continue to the end of the assembly.

The object program can be output in a number of ways including absolute or relocatable binary with and without check sums on any combination of cards and tape. Printed output can also be controlled in that the printing of library routines, any section of a program, or the whole program can be suppressed. Paper spacing options are also available.

Efficient and fast as the translator is, some users have added the pseudo operation "Midpoint" (MDP). This requires an extra magnetic tape unit but can save the time required for the rewinding of a tape that normally occurs between passes one and two.

.13 Originator: . . . . . United Aircraft.

.14 Maintainer: . . . . . SHARE.

.15 Availability: . . . . . September, 1957

.2 INPUT

.21 Language

.211 Name: . . . . . UA SAP 3-7
.212 Exemptions: . . . . . library must be compiled at each installation.

.22 Form

.221 Input media: . . . . . cards or card images on tape.
.222 Obligatory ordering: . must be sequenced in the order in which groups of instruction are to be executed.
.223 Obligatory grouping: . programs must be separated by "END" statements.

.23 Size Limitations

.231 Maximum number of source statements: . no practical limit.
.232 Maximum size source statements: . . . . . 72 characters if cards. 80 characters if tape.
.233 Maximum number of data items: . . . . . unlimited.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . 704 Binary Format.
.312 Language style: . . . row on column binary.
.313 Output media: . . . . cards and/or tapes and/or listing.

.32 Conventions

.321 Standard inclusions: . yes.
.322 Compatible with: . . . 709, 7090, 7094, 7040, 7044.

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§ 181.

.33 Documentation

Subject	Provision
Source program: . .	listing.
Object program: . .	listing.
Language errors: . .	listing.
Statistics:	listing.
Library routines: . .	listing (optional).

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

First Pass:	assigns absolute value to symbols.
Second Pass:	prepares binary output and listing.

.42 Optional Mode

.421 Translate:	yes.
.422 Translate and run: . .	yes.
.423 Check only:	yes.
.424 Patching:	yes.
.425 Updating:	yes.

.43 Special Features

.431 Alter to check only: .	yes.
.432 Fast unoptimized translate:	not required.
.433 Short translate on restricted program: .	yes.

.44 Bulk Translating: . . . yes.

.45 Program Diagnostics

.451 Tracers:	library.
.452 Snapshots:	library.
.453 Dumps:	library.

.46 Translator Library

.461 Identity:	library (tape, cards).
.462 User restriction: . . .	none.
.463 Form Storage medium: . .	tape or cards (or drum).
.464 Contents:	produced by each installation.
.465 Librarianship	
Insertion:	possible.
Amendment:	possible.
Call Procedure: . . .	LIB card.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . .	none.
.512 Space required for each input-output file:	own coding.
.513 Approximate expansion of procedures: .	all but constants, 1 for 1. constants 1 to 57 for 1.

.52 Translation Time

.521 Normal translating (tape output):	card input 0.008S mins. tape input 0.002S mins.
.522 Checking only (symbols only): . . .	twice normal speed.
.524 Output options	
Print:	0.133S to 0.267S.
Punch:	0.001S. S = number of source statements.
.53 Optimizing Data: . . .	not required.
.54 Object Program Performance:	unaffected.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration:	one 727 tape unit. one printer. one card reader. one card punch.
.612 Larger configuration advantages: . . .	library on tape, additions and changes to assembly program.

.62 Target Computer

.621 Minimum configuration:	one 704.
.622 Usable extra facilities:	any extra facility may be fully utilized.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	none.	
Unsequenced entries:	none.	
Duplicate names:	check	listing.
Improper format:	check	assembly stops.
Incomplete entries:	check	blanks inserted into assembly.
Hardware failure:	interlock	halts processor.
Symbol table packed:	check	messge.
Tape redundancy check:	check	message and after 4 tries an error. Interlock occurs and the processor stops.

.8 ALTERNATIVE TRANSLATORS: . . this program can be run on the 704, 7040, 7044, 709, 7090, 7094, and 7030 with 704 compatibility routines.

PROGRAM TRANSLATOR: FORTRAN II

§ 182.

.1 GENERAL

.11 Identity: . . . . . IBM 704 FORTRAN II Automatic Coding System.

.12 Description:

FORTRAN II is a batched job compiler that accepts both punched cards and magnetic tape input. Translation is effected by creating tables from the various types of information found on source statement cards. The statement cards are referenced only once and compilation begins as soon as the first card is read in. A total of eight separate routines operating as one, translate the source statements into a highly optimized, well-coded machine language program. The object program can expected to require very little if any more storage space or running time than good quality SAP coding. Compilation time is almost directly comparable with SAP assembly time when the number of object instructions is taken into account.

Provisions are made to translate SAP coding within the body of the FORTRAN program. Although "logic" operations can be entered as Boolean statements, it is not uncommon to find complex logic manipulations done in SAP notation. FORTRAN II variable names are translated when used in SAP sections as they would be in regular FORTRAN II notation. SAP notation is also useful for inserting data into tables specified in DIMENSION statements.

The compiler checks for many kinds of errors. Should an error which prevents further translation be detected, the translator automatically ceases translating and scans the remainder of the source program cards for errors. Error notes are printed as soon as an error is encountered.

A library of standard mathematical routines is supplied and may be expanded to contain any routines the user desires. It is maintained by the SHARE users group and is very extensive. The contents library tape are selected from the SHARE library and arranged in a sequence best suited to each installation. This is necessary because the compilation is stalled while searching for a library routine. Each subroutine compiled with a program appears only once regardless of the number of statements referenced to it.

Various kinds of listings can be specified. The object program is output on cards or tape in relocatable binary format. A "load and go" option is available and can be used between batched compilations.

.13 Originator: . . . . . IBM Data Processing Division, Applied Programming.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . ?

.2 INPUT

.21 Language

.211 Name: . . . . . 704 FORTRAN II.

.22 Form

.221 Input media: . . . . . cards or tape.

.222 Obligatory ordering: . all statements must be in order.

.223 Obligatory grouping: . each individual subprogram must be segregated.

.23 Size Limitations

.231 Maximum number of source statements: . no limit.

.232 Maximum size source statements: . . . . . 660 char.

.233 Maximum number of data items: . . . . . no limit.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . 704 Relocatable Binary Format.

.312 Language style: . . . binary.

.313 Output media: . . . . punched cards and/or tape, controlled by END.

.32 Conventions: . . . . . Input-Output routines exist as closed subroutines linked to a FORMAT interpreter.

.33 Documentation

Subject	Provision
Source program: . .	in listing.
Object program: . .	in octal and symbolic listing.
Storage map:	listing.
Language errors: . .	listing.

.4 TRANSLATING PROCEDURE

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§ 182.

.41 Phases and Passes

Section One (1 pass)
1. Generates primary file of instruction in CIT file.
2. Partially translates IF and GO TO statements.
3. Gathers information for subprogram definition statements.
4. Compiles all instructions for I/O statements except those involving DO's implied by I/O statement lists.
5. Assigns internal statement number to all statements.
6. Compiles instructions for Arithmetic and Arithmetic Function statements and places instructions in COMPAIL file.
7. Keeps track of all constants and variables.

Section One Prime (6 passes)
1. Generates tables for DO statements.

Section One Double Prime (optional pass)
1. Error and Diagnostic Routine.

Section Two (approx. 30 passes)
1. Builds COMPDO file consisting of computing and indexing instructions for DO statements (4 passes).
2. Builds TRALEV and TRASTO tables from transfer instructions and DO statements (4 passes).
3. Processes relative constants (approx. 4 passes).
4. Optimizes the use of index registers.

Section Three (1 full pass and many partials)
1. Merges COMPAIL and COMPDO.
2. Creates indexing instructions for transfers out of a DO.
3. Combines COMPAIL and COMPDO with TRALEV and TRASTO files to create TIFGO file.
4. Assigns actual IR's to indexing instructions.

Section Four
1. Analyzes program flow pattern and builds tables used to assemble linkages to subprograms (approx. 8 passes).
2. Reassigns IR's if necessary (optional passes).

Section Five (approx. 8 passes)
1. Generates region assignments based on FREQUENCY statement.
2. Adds all instructions to CIT table and completes CIT table except for index register saving constants, pure constants, Hollerith data and BSS loader information.

Section Five Prime (1 pass)
1. Places constants and source program data in CIT file.

Section Pre-Six (2 passes)
1. Places Index register saving constants in CIT file.
2. Places Hollerith data in CIT file.
3. Places BSS loader data in CIT file.
4. Write CIT file on tape 4 and place end file mark on the tape (1 pass).

Section Six (2 passes)
1. Assemble symbolic CIT on tape 4 to absolute binary format.

.42 Optional Mode

.421 Translate: . . . . . yes.
.422 Translate and run: . . yes.
.423 Check only: . . . . . yes.
.424 Patching: . . . . . no.
.425 Updating: . . . . . yes.

.43 Special Features

.431 Alter to check only: . . no.
.432 Fast unoptimized translate: . . . . . yes.
.433 Short translate on restricted program: . no.

.44 Bulk Translating: yes.

.45 Program Diagnostics

.451 Tracers: . . . . . from library at object time.
.452 Snapshots: . . . . . from library at object time.
.453 Dumps: . . . . . from library at object time.

.46 Translator Library

.461 Identity: . . . . . 704 FORTRAN LIBRARY.
.462 User restriction: . . . none.
.463 Form
Storage medium: . . tape.
Organization: . . . . card images or blocked records.
.464 Contents
Routines: . . . . . open and closed.
Functions: . . . . . yes.
Data descriptions: . no.

.465 Librarianship
Insertion: . . . . . possible.
Amendment: . . . . possible.
Call procedure: . . . call by name.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

§ 182.

.511 Fixed overhead

Name	Space	Comment
I/O and Format:	1,400 words	948 locations for format interpreter and BCD converter, the rest for I/O.
Package Routines:	693 words	supervisory routines.

.512 Space required for each input-output file: . . . . . one 120 character area for card input-output and printer only.

.513 Approximate expansion of procedures: . . . 5 to 6.

.52 Translation Time

.521 Normal translating: . . 1 + 0.7 S min.
.522 Checking only: . . . . 1 + 0.015 S min.
.523 Unoptimized translating: 1 + 0.69 S min.

.53 Optimizing Data

Frequency statement: . space and time.
Equivalence statement: space and time.
Common statement: . . space.

.54 Object Program Performance

Type	Time	Space
Elementary algebra:	decreased	decreased.
Complex formulae:	decreased	decreased.
Deep nesting:	unaffected	unaffected.
Heavy branching:	slightly increased	increased.
Complex subscripts:	increased	increased.
Data editing:	increased	doubled.
Overlapping operations:	not possible.	

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 4,096 word store.
4 tape units.
1 card punch.
1 reader.
1 printer.

.612 Larger configuration advantages: . . . . . multiple program (compiles 3 extra tapes).

.62 Target Computer

.621 Minimum configuration: any 704.
.622 Usable extra facilities: all except CRT may be used.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check if referenced	message.
Unsequenced entries:	check if referenced	message.
Duplicate names:	check if referenced	message.
Improper format:	check if referenced	message.
Incomplete entries:	check if referenced	message.
Target computer overflow:	no detection.	
Inconsistent program:	check if logic of program is faulty	error messages.

.8 ALTERNATIVE TRANSLATORS: this translator can be run on the 709/7090, 7094, 7040, 7044 and 7030 by using compatibility features and routines.

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OPERATING ENVIRONMENT

§191.

.1 GENERAL

.11 Identity: . . . . . BS CRB
DA ZOO2
GM FSI
GM IOS1
GS TOP
CS ENKI
RL 0183

.12 Description

The following SHARE abstracts summarize a few of the environment programs.

BS CRB CORBIE, AUTOMATIC OPERATOR SYSTEM

Reads Symbolic code cards. Stores codes on tape. Automatically finds codes on tape and corrects them or runs them. Prints monitored record but no listing. Library of subroutines is available on tape. Includes SAP Assembler. No peripheral tape equipment is used. Suitable for remote use of computer by programmers. Code checking features are included.

DA ZOO2 SUPERVISORY CONTROL PROGRAM

ZOO2 is an executive program which makes a stacked program-stacked output system of operation possible. Programs and output may be on or off-line at the discretion of the 704 operator. ZOO2 prints monitoring information at the beginning of each job and provides a halt between jobs if desired. It includes master input and general output subroutines and also contains an automatic core dump routine and a console print subroutine. It requires only the minimum 704, occupies 963 words of core, and uses 51 words of common.

GM FS1 THE F SYSTEM

This is an executive program that controls FORTRAN to allow multi-job multi-function operation. Any combination of compile, execute, or compile and execute jobs may be placed on the input tape. Normal operation utilizes instruction decks that are acceptable to the peripheral equipment. Binary decks may be obtained. The SAP listing may be printed or punched. Operation is single phase with FOR-

.12 Description (Contd.)

GM FS1 THE F SYSTEM (Contd.)

TRAN unchanged. It requires 3 tapes beyond the machine components needed by FORTRAN.

GM IOS1 INPUT-OUTPUT SYSTEM

An executive routine which controls multi-job non-stop off-line operation of the 704. Operates in three phases (1) Converts all jobs from BCD to binary, (2) Supervises sequencing of jobs during program execution and (3) converts binary output to BCD for all jobs. Also provides SAP assemblies with optional immediate execution, two types of debugging routines and job acctg. Requires 6 tapes, 1 core, drum 1 and a programmable clock (optional).

GS TOP TAPE OPERATOR PROGRAM (TOP)

TOP is a self-contained program that automatically sequences a set of completely independent calculations. The programs necessary for these calculations are self-contained and self-loaded from program file tapes, each of which contains many programs, or from binary cards, or chinese binary tapes. The input data for the calculations and the chinese binary programs, if any, are entered on the input tape. TOP inspects the input file to determine the program required, locates this program and initiates a self-loading sequence for the program.

CS ENK1 TAPE ASSIGNMENT AND CONTROL PROGRAM

Provides communication between the operator, the program and the machine for connecting, disconnecting, assigning and disassigning magnetic tapes.

RL 0183 STORAGE CONTROL PROGRAM EXECUTIVE ROUTINE.

All entries to the storage control program are through the executive routine. The storage control program provides a means of utilizing available core storage in the most economical fashion. To accomplish this, SCP calls upon tape input and output routines, a print routine, and other routines which construct or eliminate tables or individual table entries. Communication with the users program is through call sequences and a communication table.

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SYSTEM PERFORMANCE

§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

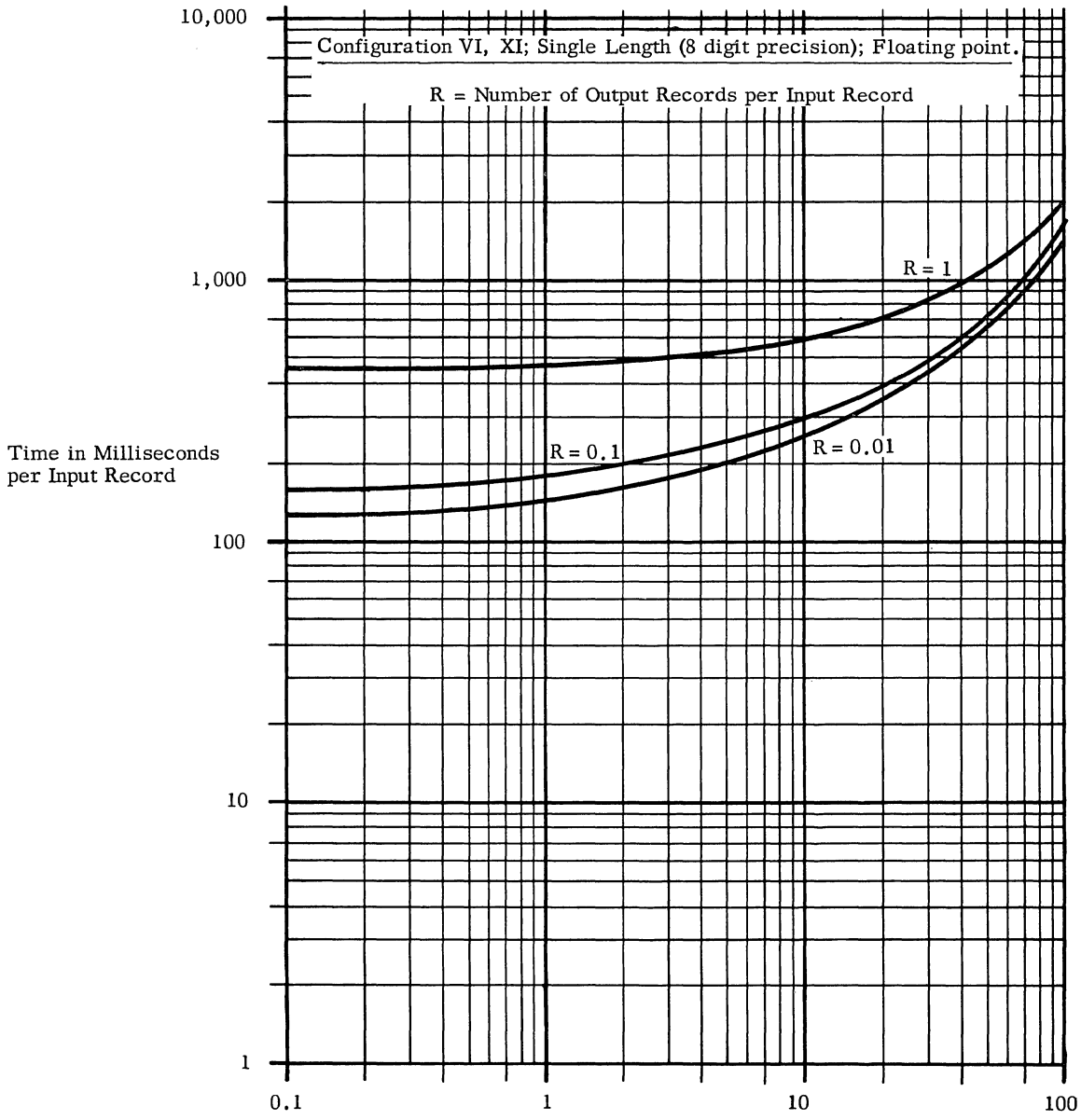
.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in User's Guide, 4:200.413.

.414 Graph: . . . . . Configuration VI, XI; card reader input, on-line printer output, floating point machine coding.



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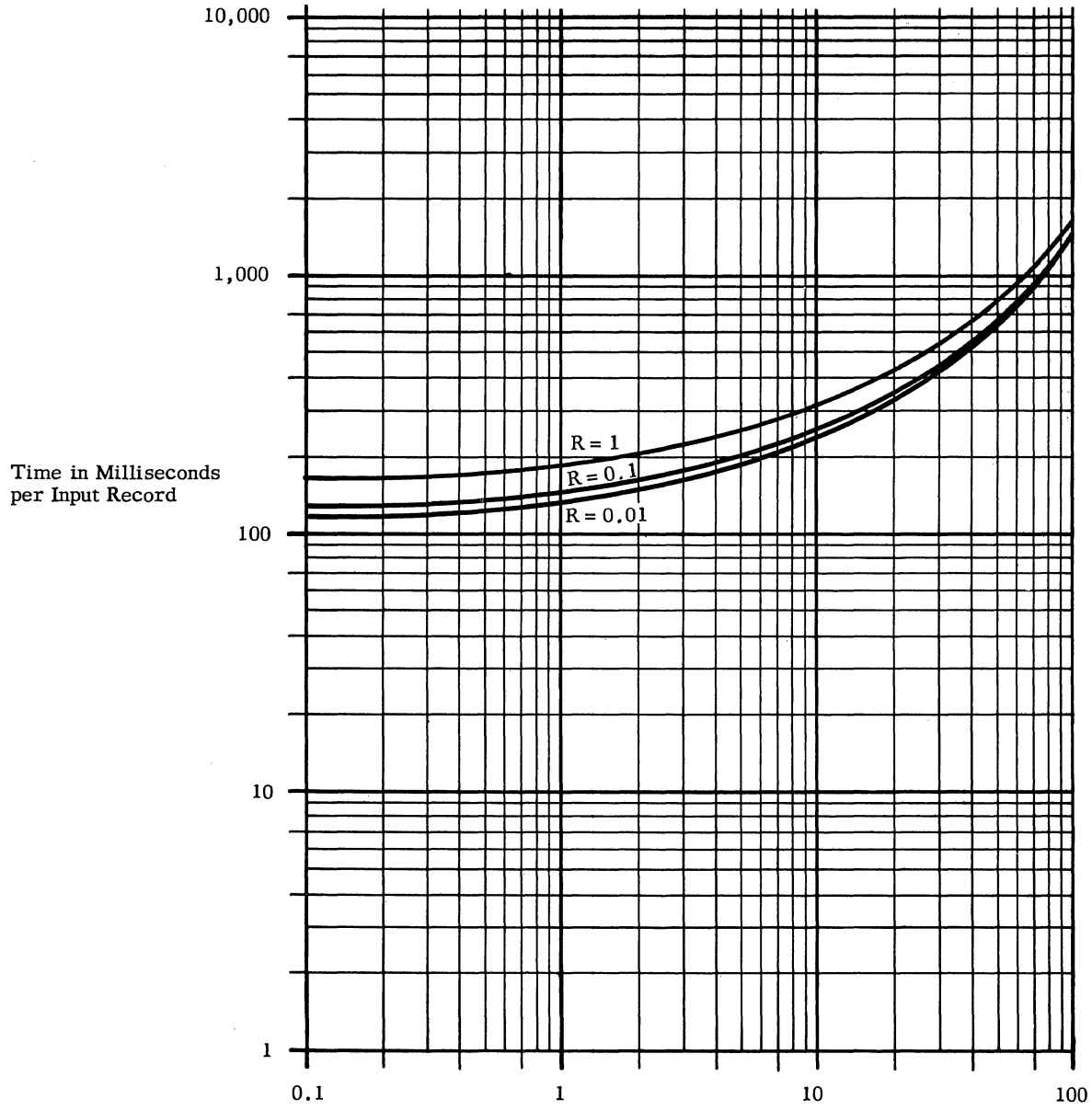
§ 201.

.415 Graph: . . . . . Configuration VII A; card reader input, off-line printer output, floating point machine coding.

Configuration VII A; Single Length (8 digit precision); Floating point.

R = Number of Output Records per Input Record

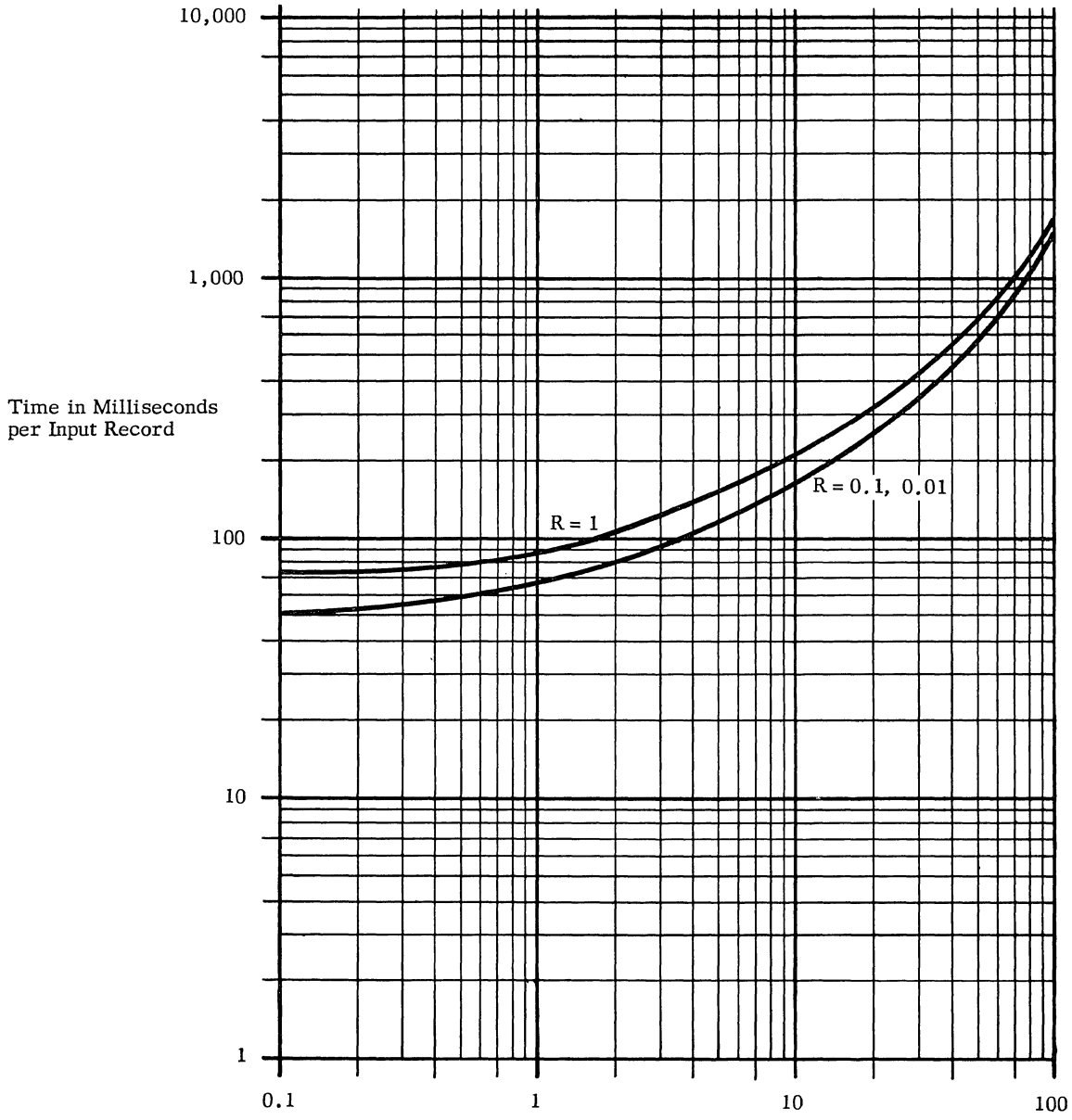


§ 201.

.416 Graph: . . . . . Configuration VII B; magnetic tape input, off-line printer output, floating point machine coding.

Configuration VII B; Single Length (8 digit precision); Floating point.

R = Number of Output Records per Input Record



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IBM 704
PHYSICAL CHARACTERISTICS

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IBM 704 PHYSICAL CHARACTERISTICS

			Central Processing Unit	Core Storage	Drum Storage	Card Reader	Card Punch	Printer	Magnetic Tape Unit
IDENTITY	Unit Name								
	Model Number		704	737	733	711	721	716	727
PHYSICAL	Height × Width × Depth, in.		66 × 72 × 37	64 × 105 × 31	67 × 55 × 31	32 × 32 × 30	50 × 40 × 26	47 × 59 × 30	69 × 29 × 31
	Weight, lbs.		3,150	1,620	1,930	560	670	1,910	950
	Maximum Cable Lengths, ft.								
	To Central Processor		---	22	22	---	---	35	---
	To 746		42	75	73	---	---	95	---
	To Designated Unit		---	---	---	30 (716)	44 (716)	---	100 (753)
ATMOSPHERE	Storage Ranges	Temperature, °F.	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Working Ranges	Temperature, °F.	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80
		Humidity, %	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60
	Heat Dissipated, BTU/hr.		109,800	16,400	25,200	1,700	9,000	7,850	4,100
	Air Flow, cfm.		5,400	1,240	800	---	---	---	220
	Internal Filters		Yes	Yes	Yes	None	None	None	Yes
ELECTRICAL	Voltage	Nominal	208	208	208	208	208	208	208
		Tolerance, %	±8	±8	±8	±8	±8	±8	±8
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance, cycles	±1	±1	±1	±1	±1	±1	±1
	Phases and Lines		3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire	3φ, 4-wire
	Load KVA		40.3	6.4	10.4	0.7	3.5	3.1	2.3
NOTES									

IBM 704 PHYSICAL CHARACTERISTICS–Contd.

IDENTITY	Unit Name		CRT Recorder	Tape Control	Power Distribution Unit	Power Supply	Power Supply	CRT Display	Core Storage
	Model Number		740	753	746	736	741	780	738
PHYSICAL	Height × Width × Depth, in.		52 × 26 × 37	67 × 60 × 32	65 × 41 × 34	65 × 61 × 34	65 × 61 × 34	22 × 24 × 28	64 × 159 × 95
	Weight, lbs.		740	2,240	1,170	2,380	3,030	250	4,000
	Maximum Cable Lengths, ft.								
	To Central Processor		22	90	42	---	---	---	35
	To 746		60	---	---	---	---	---	75
	To Designated Unit		---	14 (3ϕ, 208V, AC)	40 (736 or 741)	40 (746)	40 (746)	40 (740)	---
ATMOSPHERE	Storage Ranges	Temperature, °F.	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Working Ranges	Temperature, °F.	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80
		Humidity, %	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60
	Heat Dissipated, BTU/hr.		6,140	9,200	3,000	14,700	14,700	---	60,500
	Air Flow, cfm.		---	550	---	2,800	2,800	---	2,760
	Internal Filters		Yes	None	Yes	Yes	Yes	None	Yes
ELECTRICAL	Voltage	Nominal	208	208	208	208	208	208	208
		Tolerance, %	±8	±8	±8	±8	±8	±8	±8
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance, cycles	±1	±1	±1	±1	±1	±1	±1
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		2.4	6.0	1.2	5.8	5.8	---	23.4
NOTES									

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PRICE DATA

§ 221.

Production of the IBM 704 system has been discontinued. However, these systems are now becoming available as used and/or rebuilt equipment. This equipment can be purchased at discounted prices when it is available.

The Processor, Internal Storage, Tape Control, and CRT units are discounted by 70 percent of their original prices, but have no trade-in value. Five percent of their discounted price is the required down payment for these units. Terms can be arranged to pay the balance over a period of up to 60 months.

The other equipment can be traded-in. Down payments of 15 percent of the discounted price are required. The term of monthly payments for the units purchased depends on the age of each individual unit. The maximum term is 60 months and is reduced by the age in months over 48 down to the minimum term of 12 months. Included in this group are the Magnetic Tape units which are discounted by 10 percent per year of age. All of the other units are reduced in price by 0.833 percent per month of age from the original price for at least the first five years.

For the purposes of maintenance contracts, the equipment is considered 37 months old. These rates are shown below. The systems are fully guaranteed for the first month or 176 hours of use, which ever elapses first.

Class	Identity of Unit			Prices				
	No.	Model	Name	List Price	Discount Price	Down Payment	Rental	Maintenance
CENTRAL PROCESSOR	704	1	Central Processing Unit	450,000	135,000	6,750	9,700	1,007.00
	736	2	Power Supply	57,200	17,160	858	1,100	65.25
	741	2	Power Supply	72,800	21,840	1,092	1,400	44.50
	746	2	Power Distribution Unit	72,800	21,840	1,092	1,400	28.25
	746	3	Power Distribution Unit	67,600	20,280	1,014	1,300	28.25
	753	1	Tape Control	80,000	24,000	1,200	2,350	224.00
STORAGE	737	1	Magnetic Core Storage	192,400	57,720	2,886	3,700	133.00
	737	2	Magnetic Core Storage	192,400	57,720	2,886	3,700	133.00
	738	1	Magnetic Core Storage	940,000	282,000	14,100	19,700	640.00
	733	1	Magnetic Drum Storage	110,000	33,000	1,650	2,900	218.00
	733	2	Magnetic Drum Storage	110,000	33,000	1,650	2,900	218.00
INPUT-OUTPUT	711	2	Card Reader	32,000	14,400	2,160	800	79.75
	716	1	Printer	54,200	24,390	3,657	1,200	145.00
	721	1	Card Punch	25,000	11,250	1,687	600	78.50
	727	1	Magnetic Tape Unit	18,200	10,920	1,638	550	120.00
	740	1	CRT Recorder	96,000	28,800	1,400	2,450	215.00
	780	1	CRT Display	16,000	4,800	240	400	65.50
OPTIONAL OFF-LINE INPUT-OUTPUT	714		Card Reader	64,450	29,000	4,350	1,500	193.00
	759		Card Reader Control	45,000	20,250	3,075	900	76.75
	717		Printer	55,000	24,750	3,712	1,507	233.00
	757		Printer Control	44,000	19,800	2,970	650	88.75

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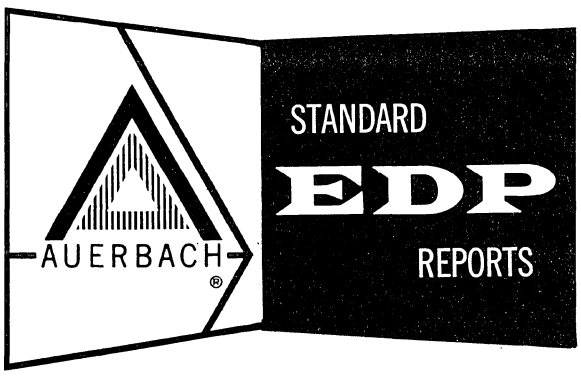
PRICE DATA–Contd.

§ 221.

Class	No.	Name	Rental	RPQ No.
SPECIAL OPTIONS	727	On-line off-line Switch (3 tapes)	- - -	- - - -
	716	Printer Carriage change 6 or 10 lines/inch	25.00	74718
		6 or 15 lines/inch	25.00	72234
		Printer Accounting Clock	50.00	78054
		Printer Co-selector	5.00/selector	51014
		Type Wheel Cradle Assembly	1,725.00(sale price plus $15.00 for use).	70958
	721	Card Punch		
		Double punch blank column check (DPBC)	15.00 for 10 positions	51402
	704	Central Processor		
		Sense Switches 7-12	75.00	59489
		Half-word arithmetic	500.00	60169
		Rewind Unload	40.00	W 90207
	753	Tape Control Rewind Unload	17.00	W 90207
	727	Magnetic Tape Unit Rewind Unload	17.00	W 90207

IBM 709

International Business Machines Corp.



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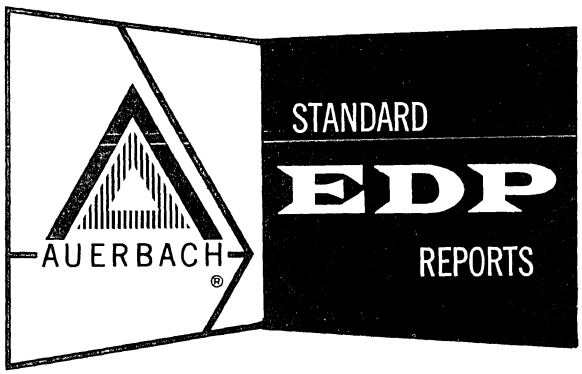
IBM 709

International Business Machines Corp.



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RIP = Report in process

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INTRODUCTION

§ 011.

The IBM 709 is a large-scale, vacuum tube, parallel, 36-bit word, binary general-purpose, data processing system. Although it is no longer being produced, it is now available as used and/or rebuilt equipment. The 709 is very similar to the 704 (see penultimate paragraph) in that it has built-in floating point instructions; execution speeds of about 40,000 instructions per second; and 32,768 words of magnetic core storage. In addition to these features, indirect addressing and automatic simultaneous input-output, via data channels, is included. These latter computer features first appeared commercially in the 709. Although automatic simultaneous input-output was not new, this was the first use of buffer areas in internal storage, able to handle variable length blocks of large size, rather than fixed-length buffer store devices, and able to use the data as it arrived.

Being binary, the IBM 709 is most widely used for scientific computation. However, simple arithmetic in any radix up to base $2^{20}-1$ can be performed, as well as code conversion instructions. These instructions permit addition and subtraction of numbers held in 6-bit BCD code. Multiplication and division operations are much more difficult using the convert instructions arithmetically. However, they are useful in converting between BCD operands and either fixed or floating point binary values. In file manipulation problems, these instructions can speed the processing considerably.

The IBM 709 Processor has three index registers which modify instruction addresses by subtraction, which is the equivalent of subscripting. Double and triple subscripting is possible by using the indirect addressing feature and the recursive "Execute" instruction. The "Execute" instruction can apply indirect addressing. It causes the addressed instruction to be executed but does not change the sequence of the program steps unless the addressed instruction causes a transfer of program control. Normally, only one level of indirect addressing is possible, which provides two-level subscripting. However, by using the Execute instruction (which can perform any number of other Execute instructions), other levels of subscripting are easily achieved.

Arithmetic is performed in binary two's complement and sign notation. The basic store cycle time is 12 microseconds, and most of the instructions require two cycles. Exceptions are: floating point add and subtract (5 to 11 cycles); multiply and divide (18 to 22 cycles); and the "count controlled" instructions, variable length multiply and divide, shift and convert (2 to 256 cycles). Any logical combination of bit patterns can be generated because the processor has AND, both Exclusive and Inclusive OR, and NOT functions built in as instructions.

Up to three IBM 766 Data Synchronizers, each of which contains two independent data channels, can be connected to the system. One channel on each synchronizer can accommodate card equipment, but if these are present, one must be a printer. The printer provides data and power connections for one card punch and one reader. In addition, each channel can have up to eight magnetic tapes connected to it. A data channel controls the transfers between one of its connected units and the magnetic core storage. Non-data transmission operations, such as paper-spacing or rewinding magnetic tapes, are controlled by the selected unit and do not require the data channel, except for a relatively short start-up period.

The data channels are actually small processors, having their own program counter, a repertoire of commands, an address register, an operation register, and a data buffer register. Most of the commands deal with data transmission (or skipping) and can be count controlled, i.e., variable length operands. Since the channel has its own program counter, it can itself select the next command after completing the current command. Thus, the data channel can be used to read from, or write into, the core storage at many different places in the store for one block of data, i.e., programmed scatter-read and gather-write. This feature is very useful in sorting because the data does not have to be moved from place to place in the store.

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INTRODUCTION–Contd.

§ 011.

The status of the data channels can be ascertained both by interrupts and by test instructions in the processor. In addition to the three data channel interrupts, the processor can also be interrupted by the occurrence of a transfer instruction, a 704 type input-output instruction, an external signal, or a floating point overflow.

Internal storage is provided by the IBM 737, Models 1 or 2, and the IBM 738 core storage units. Each unit of the 737 provides for 4,096 36-bit words. The 738 can replace one or two 737's with 32,768 36-bit words of storage. A read-or-write cycle for either unit requires 12 microseconds. The core storage has the facility for performing a multiplex function. This facility decides which unit should receive the next storage access. Since a data channel must operate at a speed dictated by the mechanical characteristics of the device that it is servicing, data channel access requests have priority over processor requests. Data channel requests are handled on a first-come, first-serve basis. Neither the 737 nor the 738 have provision for parity checking.

Additional storage is provided by magnetic drums. The optional IBM 733 Magnetic Drum, Model 1, provides 8,192 words of drum storage, and the Model 2 version can provide an additional 8,192 words of storage. For interchanges of data, the drum is treated as an input-output unit having a peak transfer rate of about 10,400 words per second. Although the average access time is 12.3 milliseconds depending on the time of the previous instruction and the drum position, an individual access can require up to 62.7 milliseconds. This unit is connected directly to the processor, not via a data channel. In accessing storage, it takes priority over a data channel.

The IBM 729 I Magnetic Tape Unit has a peak data transfer speed of 15,000 characters per second. The effective speed, however, is 12,900 characters per second when reading or writing 1,000 character blocks of data with check sums. Some automatic and programmed error correction and detection is possible for tape written data. The unit has a read-after-write, two-gap head which checks all data recorded.

The IBM 711 Card Reader, Model 2, reads at a speed of 250 cards per minute. The data from a card is stored as a 864-bit card image of 72 card columns. The card image can be converted into BCD characters and stored in packed form in only 12 words. The 72 columns to be read, are selected on a plugboard. The data channel commands can read as much of a card as is necessary or as many cards as are necessary for one load.

The IBM 721 Card Punch will punch up to 100 cards per minute. This unit also uses an 864-bit card image, as does the 711 Card Reader. However, more than 72 card columns can be punched since gang-punching is possible by specific wiring of its plugboard. The plugboard has two sense exits that can be impulsed by the processor to control the card fields which are to be punched. The data channel commands can punch more than one card for one load.

The 150-line per minute IBM 716 Printer can be echo-checked. The checking feature requires more time than unchecked printing, and the conversion of plus and minus signs to alternative configurations. The unit can print a 120-character line, but if more than 72 of the print positions are used, the printer requires two separate data transmission cycles, which reduces the printing speed to 75 lines per minute. As with the card punch and reader, a data channel command can print any number of lines for one load.

The features of the IBM 716 are similar to those of the IBM 407, except that it cannot read cards. All of the editing features, including zero suppression control are contained on the 716 plugboard. The carriage can be controlled by a paper tape loop and/or by program. The processor can accept one signal from the 716 and, in turn, transmit nine different signals to the printer in addition to data.

A 7-inch Cathode Ray Tube (CRT) and 35-millimeter camera IBM 740 CRT recorder is available with the system. Horizontal, vertical, or 45° upper right moving lines can be displayed on the face of the CRT as well as point by point plots. The 740 is controlled by the processor, not by the data channels.

INTRODUCTION–Contd.

§ 011.

The IBM 780 CRT display is an accessory for the 740. This unit reproduces the IBM 740 display on a 21 inch CRT for on-line monitoring. All power and decoding networks for the 740 are built into the 780.

The IBM 709 has been made compatible with the 704 by use of special instructions and features that are controlled by a program called Compatibility II. With the exception of a few instructions and units which are not common between systems, programs written for the 709, 7090/94, and 7040/44 can be run on any of these machines. Almost all of the programs for these other machines are available for use on the 709. A very comprehensive library of programs is therefore available to the 709 system by using the programs prepared for all of these machines. This library is maintained in the SHARE library.

Being a vacuum tube machine, the 709 has rather high power and air conditioning requirements. At large installations, the air cooling required may exceed twenty tons. Although this is a disadvantage, the advantages of greatly reduced price, and the abundance of available software in the SHARE library, may more than offset all the disadvantages, including the higher speeds of the newer solid-state equipment.

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DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word:	36 bits	data and instructions.
Record:	1 to N words	magnetic tape.
File:	1 to N records	magnetic tape.
Unit Record:	24 words	punched card.
Sector:	8 words	magnetic drum.
Logical Drum:	256 sectors	magnetic drum.
Physical Drum:	2 logical drums	magnetic drum.

.2 INFORMATION FORMATS

Type of Information	Representation
Alphanumeric:	6 bits.
Fixed point number: . .	sign bit plus 35 bit number.
Floating point number: .	sign bit plus 8 bit characteristic plus 27 bit fraction.
Instruction:	36 bits.
Data:	36 bits.

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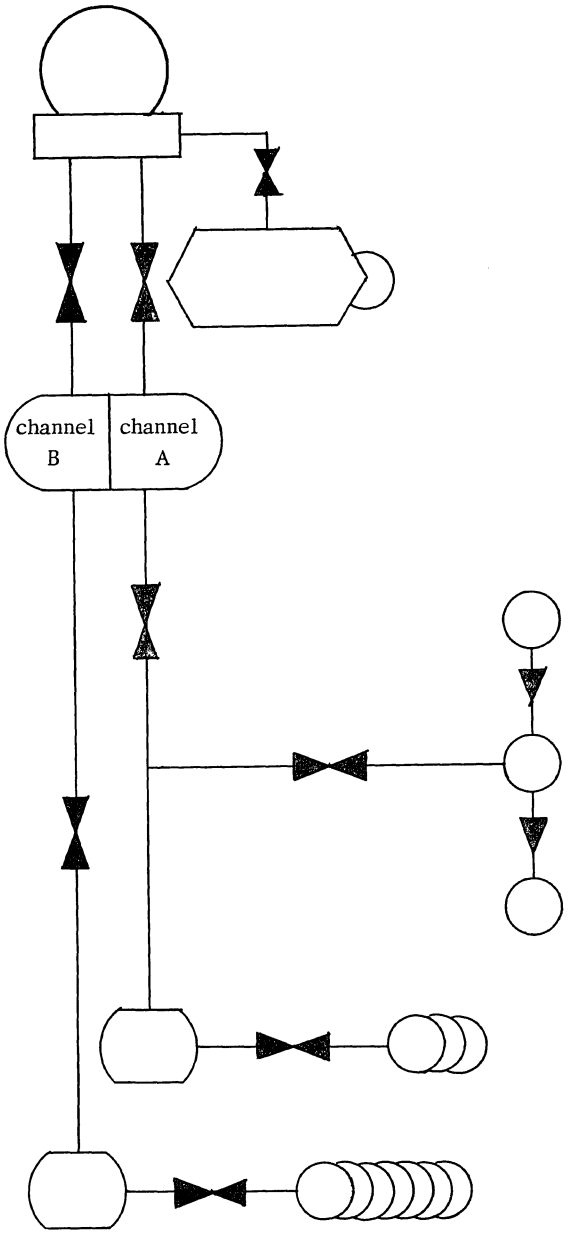
SYSTEM CONFIGURATION

§ 031.

.1 VII A 10-TAPE GENERAL INTEGRATED CONFIGURATION

Deviations from Standard Configuration: . . . . . has 12,000 words more storage.
printer 80% slower.
card reader 50% slower.
has 3 less index registers.
no typewriter included.
3 simultaneous transfers.
magnetic tapes 75% slower.



Equipment	Rental	60-month Purchase*
Core Storage: 32,768 with mutiplexor	$ 19,700	$ 4,465
Processor and Console:	10,000	4,250
Data Synchronizer: 2 channels	3,600	1,615
Card Reader: 250 cards/minute	800	204
Printer: 150 lines/minute	1,200	346
Card Punch: 100 cards/minute	600	159
Tape controller:	1,500	765
3 Magnetic Tapes: 15,000 char/second	2,100	702
Tape Controller:	1,500	765
7 Magnetic Tapes: 15,000 char/second	4,900	1,638
Power Supplies:	3,800	937
Total:	49,700	15,846
Total Down Payment:		$ 125,514

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

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§ 031.

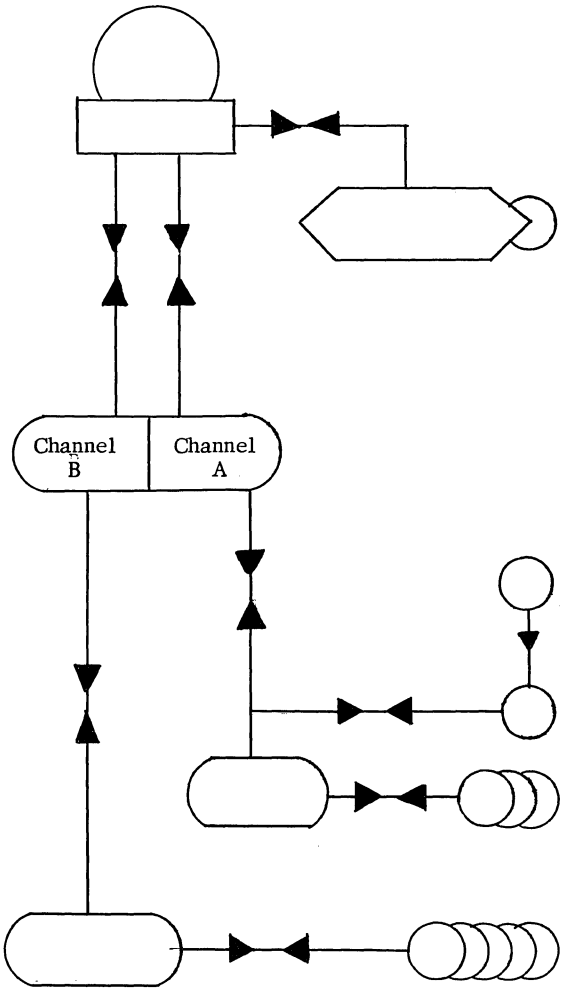
.2 VII B 10 TAPE GENERAL, PAIRED

Deviations from Standard Configuration

On-line: . . . . . has 17,400 words more storage.
includes card reader.
3 simultaneous transfers.
magnetic tapes 75% slower.

Off-line . . . . . card reader 60% faster.
card punch 250% faster.
printer 20% faster.
no typewriter included.
has 3 index registers.

On-Line Equipment



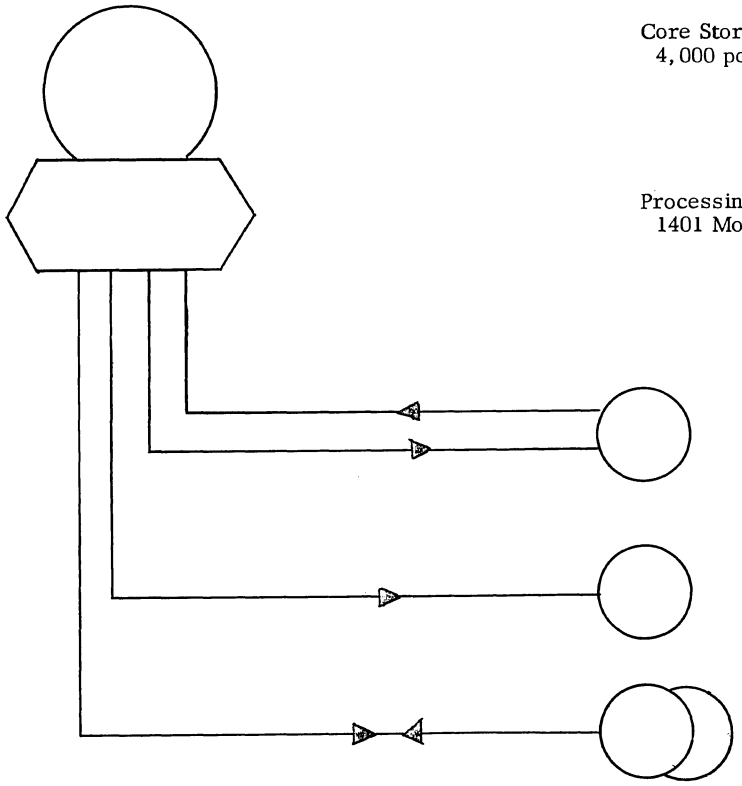
Equipment	Rental	60-month Purchase*
Core Storage: 32,768 words with multiplexor	$ 19,700	$ 4,465
Processor and Console:	10,000	4,250
Data Synchronizer: 2 channels	3,600	1,615
Card Reader: 250 cards/minute	800	204
Printer: 150 lines/minute	1,200	346
Tape Controller:	1,500	765
3 Magnetic Tapes: 15,000 char/second	2,100	702
Tape Controller:	1,500	765
5 Magnetic Tapes: 15,000 char/second	3,500	1,170
Power Supplies:	3,800	937
Total:	47,700	15,219
Total Down Payment:		$ 118,564

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

§ 031.

.2 VII B 10 TAPE GENERAL, PAIRED (CONTD.)

Off-Line Equipment (IBM 1401)



Equipment	Rental
Core Storage: 4,000 positions Processing Unit: 1401 Model C3	2,680
Card Read-Punch: Reads 800 cards/min. Punches 250 cards/min.	550
Printer: 600 lines/minute	835
2 Magnetic Tape Units: 15,000 or 41,667 char/second	1,400

Optional Features Included

Off-line equipment:	High-Low-Equal Compare:	75
	Advanced Programming:	105
	Read Punch Release:	25
	Sense Switches:	15
	Print Storage:	375
	Early Card Read:	10
	Total:	$ 6,070

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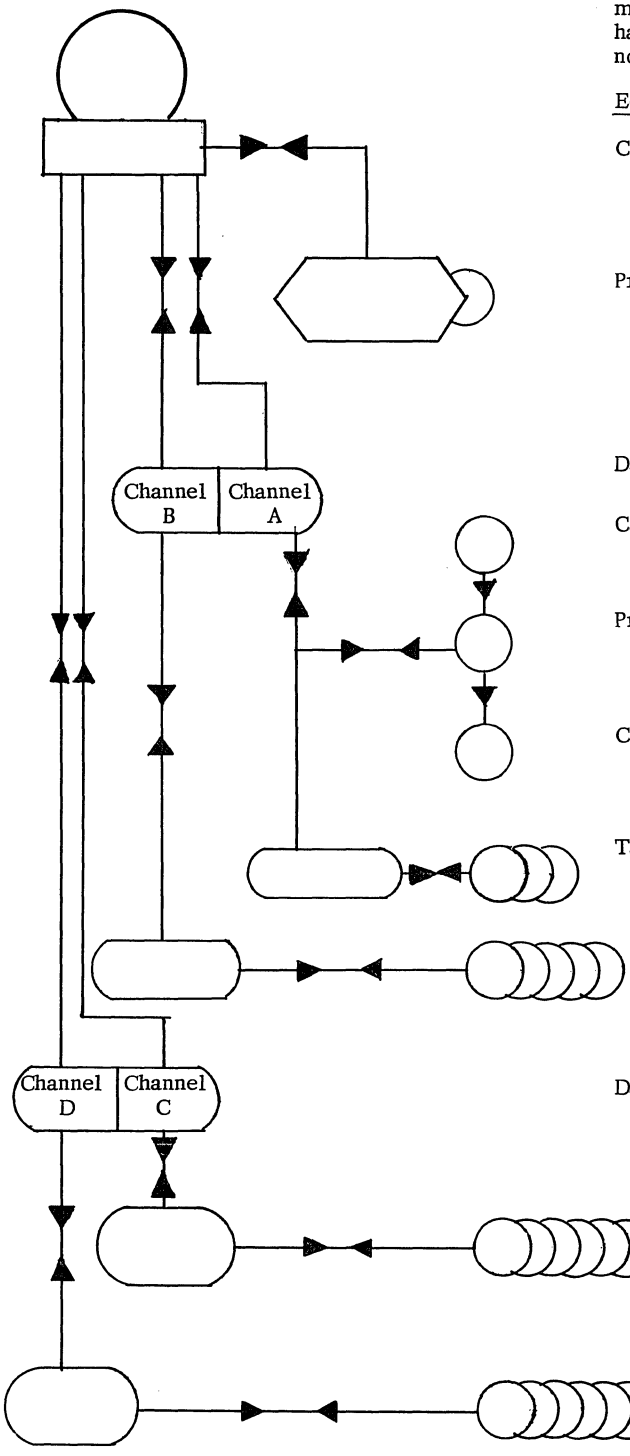
§ 031.

.3 VIII A 20-TAPE GENERAL INTEGRATED CONFIGURATION

Deviations from Standard Configuration:

has 7, 300 words less storage.
printer 90% slower.
card reader 75% slower.
card punch 50% slower.
magnetic tapes 87% slower.
has one less data channel.
no typewriter included.



Equipment	Rental	60-month Purchase *
Core Storage: 32,768 words with multiplexor	19,700	4,465
Processor and Console:	10,000	4,250
Data Synchronizer: 2 channels	3,600	1,615
Card Reader: 250 cards/minute	800	204
Printer: 150 lines/minute	1,200	346
Card Punch: 100 cards/minute	600	159
Tape Controller:	1,500	765
3 Magnetic Tapes: 15,000 char/second	2,100	702
Tape Controller:	1,500	765
5 Magnetic Tapes: 15,000 char/second	3,500	1,134
Data Synchronizer: 2 channels	3,600	1,615
Tape Controller:	1,500	765
6 Magnetic Tapes: 15,000 char/second	4,200	1,404
Tape Controller:	1,500	765
6 Magnetic Tapes: 15,000 char/second	4,200	1,404
Power Supplies:	3,800	937
Total:	63,300	21,295
Total Down Payment:		$ 183,564

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

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§ 031.

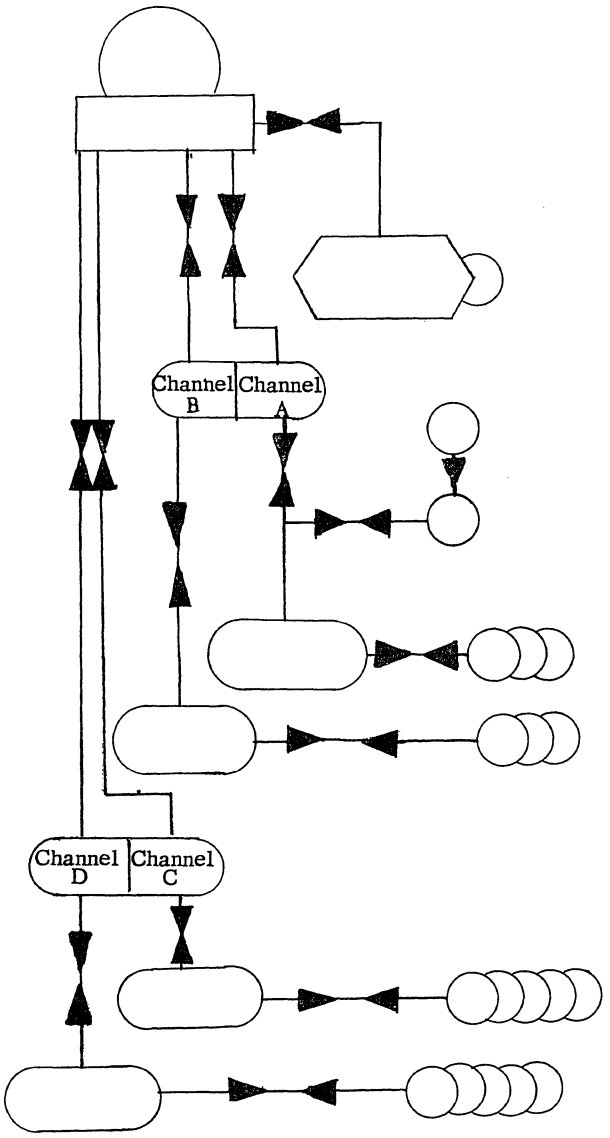
.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION

Deviation from Standard Configuration

On-line: . . . . . has 6,100 words more storage.
includes card reader.
5 simultaneous transfers.
magnetic tapes 87% slower.

Off-line: . . . . . card reader 20% slower.
card punch 25% faster.
printer 40% slower.
no typewriter included.

On-Line Equipment



Equipment	Rental	60-month Purchase*
Core Storage: 32,768 words with multiplexor.	19,700	4,465
Processor and Console:	10,000	4,250
Data Synchronizer: 2 channels	3,600	1,615
Card Reader: 250 cards/minute	800	204
Printer: 150 lines/minute	1,200	346
Tape Controller:	1,500	765
3 Magnetic Tapes: 15,000 char/second	2,100	702
Tape Controller:	1,500	765
3 Magnetic Tapes: 15,000 char/second	2,100	702
Data Synchronizer: 2 channels	3,600	1,615
Tape Controller:	1,500	765
5 Magnetic Tapes: 15,000 char/second	3,500	1,170
Tape Controller:	1,500	765
5 Magnetic Tapes: 15,000 char/second	3,500	1,170
Power Supplies:	3,800	937
Total:	59,900	20,272
Total Down Payment:		$ 171,977

* This is the discounted monthly payment exclusive of system maintenance and interest charges for a four year old, used system.

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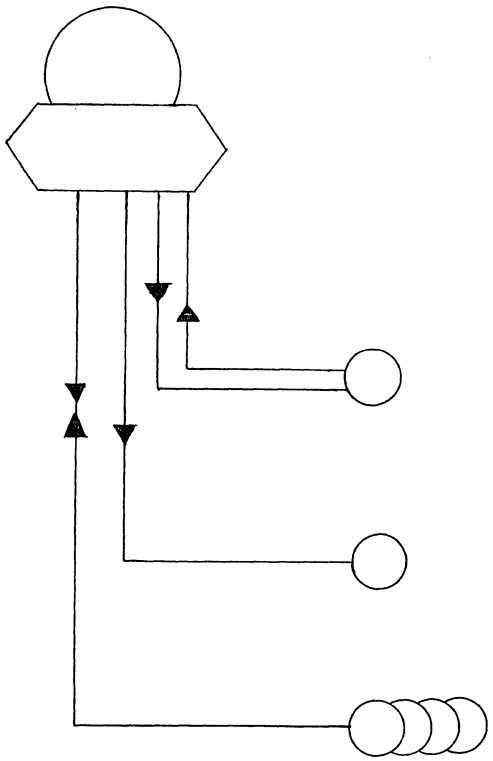
§ 031.

.4 VIII B 20-TAPE GENERAL, PAIRED CONFIGURATION (CONTD.)

Off-Line Equipment (IBM 1401)



Equipment	Rental
Core Storage 8,000 positions Processing Unit: 1401 Model C4	3,305
Card Read-Punch: Reads: 800 cards/minute Punches: 250 cards/minute	550
Printer: 600 lines/minute	835
4 Magnetic Tape Units 22,500 or 62,500 char/second	3,600

Optional Features Included

Off-line equipment:	High-Low-Equal Compare:	75
	Advanced Programming:	105
	Read Punch Release:	25
	Sense Switches:	15
	Print Storage:	375
	Processing Overlap:	250
	Early Card Read:	10
	Total:	$ 9,145

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . Central Processor. IBM 709.

.12 Description

The IBM 709 Processor is an expanded and updated version of the earlier IBM 704. Both machines have binary, two's complement, arithmetic units which operate on either fixed or floating point 36-bit operands. The cycle time of both machines is the same since both use similar vacuum tube logic and essentially the same core storage units. The three index registers are handled identically; i.e., an instruction can call none, one, two, or all three index registers which are "ORed" together, then subtracted from the instruction address.

Indirect addressing was first made available on a commercial scientific processor in the IBM 709. This "indirect" feature in the 709 permits two index registers to be used to locate a piece of data, greatly facilitating the programmed use of two dimensional tables; i.e., direct use of double subscripting. When indirect addressing is called for by an instruction, the instruction address and index registers are used to locate a word in storage. Both the address and index registers called for by this word are combined to form the location of the data. The word from which the address of data is generated is not checked for further levels of indirection.

One of the new instructions incorporated in the 709 is "Execute" which provides another form of indirection. This command permits the execution of an instruction without altering the program counter, unless the program counter is changed by the executed instruction. It is also possible to use indirect addressing with this instruction, thus making possible triple subscripting. Since "Execute" instructions can execute "Execute" instructions, it would appear that n-tuple subscripting is possible; but because only three index registers are available, this is not practical. This instruction is recursive and can cause an indefinite delay if the last "Execute" instruction in a string addresses any of the other "Execute" instructions in that string. Another use of this instruction is in trace routines where one instruction is executed and the result of the instruction is then printed-out (this would be used with the transfer trapping feature noted below).

Another major innovation in the 709 system was the data channel, which controls input-output transmissions to be performed simultaneously with computing. Storage cycles are shared between the input-output units and the processor (multiplexing), thus eliminating the necessity of using large capacity buffer units and relatively short time buffer-to-memory transfers which halt the processor during the transfer. The 709 Processor instructions must only specify the I/O unit and channel, the action to be taken, and where the channel can find the commands in the core storage to control the data transfer operations. This is all accomplished by one processor instruction. The status of the channels (and units) can be interrogated by a set of test instructions.

.12 Description (Cont'd)

A set of convert instructions is also provided which can be used to do arithmetic using six-bit BCD characters, radix conversions, editing, and character conversion (both size and bit configuration).

In addition to four standard sense lights there is a 36-bit indicator register. A large number of instructions are provided to set, reset, and test this register. The register can be used very effectively for multi-sequencing or input-output control routines. The keyboard can be used as a sense switch register that can be stored then tested. The six standard sense switches can be tested, but no instruction is provided to store them.

Five kinds of "Traps" or automatic interrupts are provided. When a trap occurs, the program counter at the time of the trap and/or the conditions that caused it are stored in specific storage locations. The program counter is set to access the next instruction from another specific storage location. The specific locations are different for each type of trap. Traps are caused by: any transfer order which results in a transfer (the address is stored in any event); the data channel signals (command completed, end-of-file, and magnetic tape error); encountering a 704 input-output instruction (Simulate Mode); an external signal; or encountering a floating point underflow or overflow (spill). All of these trap conditions except external signal can be turned on or off by instruction.

The 709 Processor can accept all 704 programs and most of the 7090/94 and 7040/44 programs. A program called Compatibility II is available which handles input-output differences between the 704 and 709. When running programs written for other machines, it is necessary to eliminate references to input-output devices that do not exist on the 709, and also a few instructions that are not included in the 709 instruction repertoire. The slower speed of the 709 can cause timing problems when programs tightly coded for faster machines are run on it. The inverse of the above is true when running 709 programs on faster machines.

With the updating of the FORTRAN compiler, COMTRAN, the abundance of 704 software, and the newer 709 (7090) software, program preparation for the 709 is greatly simplified, especially in the arithmetic function and precision areas. These software and hardware features, together with the discounted prices of IBM used equipment, make this processor

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§ 051.

.12 Description (Contd.)

a serious contender for those installations that have a mixture of business and scientific problems, provided the faster speed of the newer processors (about 10 times) is not required.

.13 Availability: . . . . . not in production, can only be rented or purchased used or rebuilt when available.

.14 First Delivery: . . . . August, 1958.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-subtract:	automatic	binary	35 bits & sign
Multiply Long:	automatic	binary	35 bits & sign
Divide Remainder:	automatic	binary	35 bits & sign
.212 Floating point			Fraction / Characteristic
Add-subtract:	automatic	binary	27 bits / 8 bits
Multiply:	automatic	binary	27 bits / 8 bits
Divide:	automatic	binary	27 bits / 8 bits
.213 Boolean			
AND:	automatic	binary	36 bits
Inclusive OR:	automatic	binary	36 bits
Exclusive OR:	automatic	binary	36 bits
NOT:	automatic	binary	37 bits
.214 Comparison			
Numbers:	automatic		36 bits
Absolute:	automatic		36 bits
Letters:	automatic		36 bits
Mixed:	automatic		36 bits

.215 Code translation	Provision	From	To	Size
	automatic	any code	any code	36 bits
	standard subroutine	card image	BCD	36 bits or 6 chars.
	standard subroutine	6-bit BCD	card image	36 bits or 6 chars.

.216 Radix conversion	Provision	From	To	Size
	automatic	6-bit BCD	any radix	20 bits.
	standard subroutine	any radix	6-bit BCD	36 bits or 6 chars.

.217 Edit format	Provision	Comment	Size
Suppress zero:	automatic	uses convert instructions and/or logical instructions.	six 6-bit characters
Round off:	automatic		
Insert point:	automatic		
Insert spaces:	automatic		
Insert character:	automatic		
Float character:	automatic		
Protection	automatic		

.218 Table look-up: . . . . . none.

.219 Others

Test: . . . . . 1 to 36 bits.

.22 Special Cases of Operands

.221 Negative numbers: . . . two's complement and sign.

.222 Zero: . . . . . + or - ; may or may not be equal, depends on instructions.

.223 Operand size determination: . . . . 36, 18, 15, 3, or 1 bits; variable 0 to 36 bits in multiply and divide, and also six 6-bit characters.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout

Part	Operations	Flag/Count	Tag	Address
Size (bits)	12	6	3	15

Part	Operation	Flag	Not Used*	Tag	Address
Size (bits)	3	2	4	3	15

Part	Operation	Decrement	Tag	Address
Size (bits)	3	15	3	15

* Not used for most instructions.

.233 Instruction parts

Name	Purpose
Operation:	operation code
Flag:	indirect addressing specification.
Tag:	index register specification.
Address:	operand address.
Count:	variable length operands counts.

.234 Basic address structure: 1 address (sequential).

.235 Literals

Arithmetic: . . . . . none.

Comparisons and tests: . . . . . none.

Incrementing modifiers: . . . . . 0 to 32, 767.

Setting modifiers: . . 0 to 32, 767.

.236 Directly addressed operands

.2361 Internal storage type	Minimum size	Maximum size	Volume accessible
Core Store:	1 word	1 word	entire storage
Magnetic Drum:	1 word	1 word	entire storage

.2362 Increased address capacity: . . . . . none.

.237 Address indexing

.2371 Number of methods: . 1.

.2372 Names: . . . . . indexing (can be multiple indexes).

.2373 Indexing rule: . . . . . the contents of the indicated index registers are ORed together then subtracted from the address of the instruction to form the effective address.

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.2374 Index specification: . . each of the index bits specifies an index register.

.2375 Number of potential indexers: . . . . . 3.

.2376 Addresses which can be indexed:

Type of address	Application
After ESNT instruction: . . .	0 to 16, 383.
After LSNT instruction: . . .	0 to 32, 767.

.2377 Cumulative indexing: . via indirect addressing and EXC instruction.

.2378 Combined index and step: . . . . . yes.

		I.A. flag bits	EXECUTE instructions
.238	Indirect addressing		
.2381	Recursive:	no.	yes.
.2382	Designation:	2 bits in the instruction.	operation code EXC with or without I.A. flag bits.
.2383	Control:	automatic, one level only.	n level, will not stop until another instruction, other than EXC, is encountered.
.2384	Indexing with indirect addressing:	yes; possible before and after going to the indirect address.	

.239 Stepping: . . . . . index registers.

.2391 Specification of increment: . . . . . in stepping instruction.

.2392 Increment sign: . . . . positive.

.2393 Size of increment: . . 0 to 32, 767.

.2394 End value: . . . . . value of increment.

.2395 Combined step and test: . . . . . yes.

.24 Special Processor Storage

.241	Category of storage	Number of locations	Size in bits	Program usage
	Accumulator	1	38	arithmetic unit.
	Multiplier-Quotient:	1	36	arithmetic unit & input-output.
	Index:	3	15	address modification.
	Program counter:	1	15	specified instruction address.
	Sense lights:	4	1	save conditions.
	Sense switches:	6	1	accept condition.
	Storage register:	1	36	buffer with store.
	Instructions:	1	18	shift counter, holds instruction.
	Indicator:	1	36	save condition.

.242	Category of storage	Total number locations	Physical form	Access time μ sec	Access time μ sec
	Accumulator:	1	register	2	12
	Multiplier-Quotient:	1	register	2	12
	Index:	3	register	2	12
	Program counter:	1	register	2	12
	Sense lights:	4	flip-flops	2	12
	Sense switches:	6	switch	2	12
	Storage register:	1	register	2	12
	Instruction:	1	register	2	12
	Indicator:	1	register	2	12

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1 sequential.

.314 Special sub-sequence counters

Number	Purpose
1:	counts shifts (not accessible by program).

.315 Sequence control step size: . . . . . 1 word.

.316 Accessibility to routines: . . . . . change, save in index, or store.

.317 Permanent or optional modifier: . . . . . none.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes

In-out units:	external signal. tape error. end-of-file. 704 I/O instruction in copy trap mode.
In-out controllers: . .	when free.
Storage access: . . .	none.
Processor errors: . .	floating point underflow; overflow in floating trap mode.
Other:	on encountering transfer of control instruction while in trapping mode.

.332 Control by routine

Individual control: . .	for I/O, mask and instruction.
Method:	request by instruction.
Restriction:	external signal trap is always active and may cause timing conflicts.

.333 Operator control: . . . can clear or set traps manually.

.334 Interruption conditions: only when specifically requested (floating point trap mode is normally on).

.335 Interruption process

Disabling interruption:	first interrupt.
Registers saved: . . .	program counter.
Destination:	fixed location, depends on cause.

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.336 Control methods
Determine cause: . . indication stored in a particular location.
Enable interruption: . instruction.

.34 Multi-running

.341 Method of control: . . . own coding.
.342 Maximum number of programs: . . . . . own coding.
.343 Precedence rules: . . . own coding.
.344 Program protection
Storage: . . . . . words 0 to 16,383 can be used, with words, 16,384 to 32,767 made unavailable by ESNT instruction.
In-out units: . . . . . own coding.
Maximum separate sets: . . . . . own coding.

.35 Multi-sequencing: . . . see paragraph .344.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ secs

.411 Fixed point
Add-subtract: . . . . 24.
Multiply: . . . . . 24 to 240 (190 avg.).
Divide: . . . . . 36 to 240 (240 avg.).
.412 Floating point
Add-subtract: . . . . 72 to 180 (77 avg.).
Multiply: . . . . . 24 to 204 (170 avg.).
Divide: . . . . . 36 to 216 (216 avg.).
.413 Additional allowance for
Indexing: . . . . . none.
Indirect addressing: . 12.
Re-complementing: . none.
.414 Control
Compare: . . . . . 24.
Branch: . . . . . 24.
Compare and branch: 36.
.415 Counter control
Step: . . . . . 24.
Step and test: . . . . . 24.
Test: . . . . . 24.
.416 Edit: . . . . . none.
.417 Convert: . . . . . 24 to 96 (avg.).
.418 Shift: . . . . . 24 to 96 (276 max).

.42 Processor Performance in μ secs

.421 For random addresses	Fixed point	Floating point
$c = a + b$:	72	125
$b = a + b$:	72	125
Sum N items:	24 N	77 N
$c = ab$:	238	218
$c = a/b$:	288	264

.422 For arrays of data	Fixed point	Floating point
$c_i = a_i + b_j$:	120 N	149 N
$b_j = a_i + b_j$:	120 N	149 N
Sum N items:	48 N	48+77(N-1).
$c = c + a_i b_j$:	360 N	408 N

.423 Branch based on comparison
Numeric data: . . . . 72 + 66 N.
Alphabetic data: . . . 72 + 66 N.
.424 Switching
Unchecked: . . . . . 72.
Checked: . . . . . 120.
List search: . . . . . 72 + 60 N.
.425 Format control per character
Unpack: . . . . . 0.621 card image to BCD.
0.121 BCD to binary.
Compose: . . . . . ?
.426 Table look up per comparison
For a match: . . . . . 48 + 84 N.
For least or greatest: 48 + 108 N.
For interpolation point: . . . . . 48 + 84 N.
.427 Bit indicators
Set bit in separate location: . . . . . 24.
Set bit in pattern: . . 24.
Test bit in separate location: . . . . . 24.
Test bit in pattern: . . 48.
Test AND for B bits: . 48.
Test OR for B bits: . . 72.
.428 Moving N words
4 instructions: . . . . 24 + 72 N.
2 N instructions: . . . 48 N.

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	sets indicator.
Underflow (float-pt):	check	sets indicator.
Zero divisor:	check	sets indicator and/or stops processor.
Invalid data:	not possible	
Invalid operation:	none	attempts operation.
Arithmetic error:	none.	
Invalid address:	check	modulo memory size.
Receipt of data:	none.	
Dispatch of data:	none.	

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . Console panel; a part of the central processor.

.12 Description

The operator's console for the 709 is a hinged panel connected to the central processor unit. No desk facilities are provided with this panel for operator's convenience. The panel contains neon lights, incandescent lamps, buttons and switches. The contents of the Program Counter, Instruction, Storage, Accumulator, and MQ registers are displayed on individual sets of neon lamps. The contents of the three index registers may also be displayed. Individual index buttons are provided to allow the operator to visually check the contents of any of the index registers while the computer is in manual operation. Display registers are marked off in groups of three for easy visual conversion from binary to octal notation. Incandescent lamps are used to indicate operating modes, status conditions, and results of computer operations. Manual controls are provided for entering data into the computer and for executing various computer functions.

.2 CONTROLS

.21 Power

Name	Form	Comment
Power-On:	button	cycles up AC power then DC power.
Normal-Off:	button	turns off all power.
DC-ON:	button	turns DC power on.
DC-OFF:	button	turns DC power off.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
Start:	button	starts computer operation after a program halt, read/write check, or when in automatic mode.
Auto-manual:	switch	stops computer operation after instruction in process is executed. When I/O device is in operation, computer stops after device disconnects.

.24 Stepping

Name	Form	Comment
Single Step:	button	used only in manual mode to execute program, one instruction at a time.
Multiple Step:	button	used only in manual mode to execute program automatically at a slow speed.

.25 Resets

Name	Form	Comment
Clear:	button	resets all registers in processor and the contents of core storage.
Reset:	button	resets all registers and indicators in logical section of computer.

.26 Loading

Name	Form	Comment
Load Cards:	buttons	allows operator to initiate the loading of a self-loading program stored on cards, drum or tape.
Load Drum:		
Load Tape:		

.27 Special

Name	Form	Comment
Enter MQ:	button	transfers manually keyed-in data to the MQ register.
Index Display:	button	3 Index Display buttons allow operator to display contents of any of the index registers while in manual mode.
Enter Instruction:	button	causes manually keyed-in word to be executed.
Sense Switches:	switch	6 switches, the settings are program testable.
Display Storage:	button	the contents of the location specified by the address part of the manually keyed-in word are displayed in this register.
Display Effective Address:	button	displays in the address field of the storage register the difference between the contents of the address field of the storage register and the specified index register.

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.27 Special (Contd.)

Name	Form	Comment
Panel Input Switches:	switches	36 input switches used for manually inserting a word.
Display Sense Indicator:	button	displays the contents of the 36 sense indicators in the storage register.

.3 DISPLAY

.31 Alarms

Name	Form	Condition
Alarm	bell	DC power turned off.

.32 Conditions

Name	Form	Conditions Indicated
Accumulator Overflow:	light	indicates overflow during fixed point operation or shift operation.
MQ Overflow:	light	indicates MQ overflow when the processor is using the compatibility program.
Divide Check:	light	indicates in fixed point division that the dividend is greater than or equal to the divisor.
Tape Check:	lights	6 tape check lights, one for each channel. A light is turned on when an error is detected.
Ready:	light	indicates circuits have reached their operating level.
Power:	light	indicates power is applied to the system.
Automatic:	light	on when computer is in automatic mode.
Tape Indicator:	light	on when computer is operating in the transfer tape mode.
Sense Lights:	lights	4 sense lights controlled by the program.
I/O Check:	light	on when a specific condition is encountered.
Channel Select:	lights	6 select lights, one for each channel. Each light turned on according to channel in operation.
Class Select:	lights	3 class select lights (tape, drum and card machines). One light will be on to indicate the I/O device selected.

.32 Conditions (Contd.)

Name	Form	Conditions Indicated
Simulate:	light	on when 709 is operating in the 704-709 compatability feature.
Program Stop:	light	turned on when computer executes a halt instruction.
I/O Fuse:	light	turned on when an I/O indicating fuse is blown.
Read-Write Select:	light	turned on when an I/O device has been selected for reading or writing.

.33 Control Registers

Name	Form	Comment
Instruction:	lights	18 neon lights, allocated to sign bit and bits 1 through 17.
Instruction Counter:	lights	15 neon lights, allocated to bits 21 through 35 to indicate location of next instruction.
Accumulator:	lights	38 neon lights, one for each bit position plus one for Q and one for P bit positions.
MQ:	lights	36 neon lights, one for each bit position of a word.

.34 Storage: . . . . . 36 neon lights to indicate contents of the processor buffer register.

.4 ENTRY OF DATA

.41 Into Registers

(1) Desired word keyed into the 36 panel input switches, then
(2) Depress Enter MQ button.

.42 Into Storage: . . . . . one core storage location is written into by using the enter instruction button with a store instruction keyed into the 36 manual input switches.

.5 CONVENIENCES

.51 Communication: . . . optional.

.52 Clock: . . . . . optional.

.53 Desk Space: . . . . . none.

.54 View: . . . . . when operator is at console, all the equipment can easily be seen if conveniently placed.

INPUT-OUTPUT: 711 CARD READER

§ 071.

.1 GENERAL

.11 Identity: . . . . . Card Reader.
Type 711.
Model 2.

.12 Description

The 711 Card Reader model 2 is used in a 709 configuration. This unit reads cards at a rate of 250 cards a minute. Cards are fed from a hopper with a capacity of approximately 600 cards and placed in a stacker that holds approximately 1,200 cards. The card reader is connected directly to core storage through a 766 Data Synchronizer. Channels A, C and E may have a card reader attached to it; however, a printer must also be attached to the same channel because the printer supplies power to the reader.

During read operations, data read from cards is sent directly to storage under control of the Data Synchronizer. Synchronizer commands can cause a number of cards or part of one card to be read and stored sequentially or randomly into the core store, but as a "card image". Each card image represents 72 characters. Data read from cards may be in either binary or BCD codes, and by a suitable program, BCD data may be converted to binary data. The card image is represented by twenty-four 36-bit words; two words per row of the card image. The reader will only read 72 columns of each card.

There are two card reading stations. Reading format is controlled by the stored program and a plugboard located on the reader. Format control signals can be read from a card at the first station by control brushes and decoded by plugboard wiring. The plugboard can be wired to control format of a card read at the second read station. A minimum of 10 different formats can be conveniently wired and up to 70 columns can be controlled by these rearrangements.

The 711 Card Reader has a 240 millisecond card cycle in which there are four clutch points.

A programmed check of card reading of selected columns can be arranged by reading those columns at both stations. However, the total number of columns read, counting two for a column read at both stations, is still only 72. Thus, a total of 36 checked columns can be read.

Manual controls are provided for normal run-in of cards. Various contacts are used to sense for improper feeding of cards, and lamps are provided to indicate when a malfunction exists within the unit.

.13 Availability: . . . . . not in production, can be rented or purchased used or rebuilt only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . none.
.222 Sensing system: . . . . brush.

.24 Arrangement of Heads

Use of station: . . . . reading (control).
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . reading.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80-columns at standard spacing.
.324 Track use
Data: . . . . . 72.
Redundancy check: . 0.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 8.
Total: . . . . . 80.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . binary or Hollerith code (see Data Code Table No. 2).

.34 Format Compatibility: . . . . . all devices using standard IBM 80-column cards.

.35 Physical Dimensions: . . . . . standard 80-column card.

.4 CONTROLLER

.41 Identity: . . . . . Data Synchronizer.
766.

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.42 Connection to System

.421 On-line: . . . . . 1 to 3 controllers.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . . a Type 716 Printer must be attached to a channel before a card reader can also be attached. Only one of the two channels of each controller can accept a printer.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words of a 72 column binary image in the sequence 9 row left, 9 row right, thru 12 row left, 12 row right, and sometimes continuing through consecutive cards.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . yes.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 1 card (24 words).
.512 Block demarcation Input: . . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . . transfer 1 to N words to core storage.
.522 Output: . . . . . none.
.523 Stepping: . . . . . N cards at a time.
.524 Skipping: . . . . . yes, skip N words under program control.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . by processor program from card image.

.54 Format Control

Control: . . . . . plugboard and program.
Format alternatives: . 1 as selected on plugboard.
Rearrangement: . . . by plugboard.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . yes.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted: . . no.
Busy controller: . . . yes.
End of medium marks: . . . . . no.
Hopper empty: . . . . yes.
Stacker full: . . . . . no.
End of card: . . . . . yes.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . . . . . 250 chards/min.
.622 Important parameters
Cycle time: . . . . 240 m.sec.
Clutch point: 60 m.sec.
.623 Overhead: . . . . . 4 clutch points.
.624 Effective speeds: . . . 250 cards/min.

.63 Demands on System

Core store: . . . . . less than 1 percent.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Start:	key	places unit in "ready" status.
Stop:	key	removes control from computer by placing unit in "not ready" status.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	600 cards.
Stacker:	1,200 cards.

.732 Replenishment time: . . . . . 2.5 to 5.0 mins. reader does not need to be stopped.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	check	programmed.
Input area overflow:	none.	
Exhausted medium:	check	indicator.
Imperfect medium:	none.	
Timing conflicts:	check	indicator
Invalid Code:	all codes valid	

INPUT-OUTPUT: 721 CARD PUNCH

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Punch. Type 721.

.12 Description

A 721 Card Punch is used in the 709 Data Processing System to provide punched card output. Data is punched on standard 80-column cards at a rate of 100 cards per minute. Data to be punched is stored in core storage in the form of a card image. The path for transferreng data from core storage to the punch unit is through a 766 Data Synchronizer. One punch unit may be attached to Channels A, C, and E of a synchronizer. Any channel having a punch attached to it must also have a 716 Printer attached since the printer controls the punching operation. Punching operations, however, are specified by the stored channel commands through the data synchronizer.

Data can be punched into card columns in binary, BCD, or any other code. The punching format is controlled by the stored program and a plugboard located on the punch unit. Cards are fed to the punch unit from a hopper with a capacity of approximately 600 cards. Each of the 12 rows of a card is divided into two parts: the first part consists of columns 1 to 36; and the second part consists of columns 37 to 72. Each part is treated as a 36-bit word to accomodate the word length used in the 709. Twenty-four words can be punched in one card.

The minimum time between word transfers is 300 microseconds, and 31 milliseconds between rows. These times should be considered when load data channel instructions are used to synchronize the punch with the CPU. The card punch requires a 600 milliseconds punch cycle to perform a series of operations relating to punching a card.

The machine can be used for on- or off-line gang punch punching operations by proper wiring of the plugboard. Manual controls and indicating lights are provided. Manual controls are used to run-in and -out cards and the lights are used to indicate that a malfunction within the unit exists.

.13 Availability: . . . . . not in production, can be rented or purchased used or rebuilt only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punch.
.222 Sensing system: . . . brushes.
.223 Common system: . . . none.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . control brushes.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . punch dies.
Distance: . . . . . 3 rows.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . punch brushes.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.

.324 Track use
Data: . . . . . 72.
Unused: . . . . . 8.
Total: . . . . . 80.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . Hollerith (see Data Code Table No. 2).

.34 Format Compatibility: . all other devices using standard 80-column cards.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Data Synchronizer. 766.

.42 Connection to system

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

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.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions:. . . . . connected to channels A, C, and E only.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access:. . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic.
.447 Synchronizing aids: . . wait on row index pulse.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:. . . . . 1 card (24 words).
.512 Block demarcation Output:. . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . N cards forward.
.523 Stepping: . . . . . N cards.
.524 Skipping: . . . . . N rows.
.525 Marking: . . . . . none.
.526 Searching: . . . . . yes.

.53 Code Translation: . . matched codes (card image) or programmed.

.54 Format Control

Control: . . . . . plugboard and program.
Format alternatives: . 4.
Rearrangement: . . . yes.
Suppress zeros: . . . no.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . yes.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . yes.
Select code: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted:. . . no.
Busy controller: . . . yes.
End of medium marks: no.
Hopper empty: . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions:. . . . . none.

.62 Speeds

.621 Nominal or peak speed: 100 cards/min.
.622 Important parameters
Cycle time:. . . . . 600 m.sec.
Time between words in same row: . . . 300 m.sec.
Time between processive rows:. . . . . 31 m.sec.
.623 Overhead: . . . . . single clutch point.
.624 Effective speeds: . . . 100 cards/min.

.63 Demands on System

Core store: . . . . . less than 1 percent.

.7 EXTERNAL FACILITIES

.71 Adjustments:. . . . . none.

.72 Other Controls

Function	Form	Comment
Start:	key	makes unit "ready" when hopper is full and control panel is in place.
Stop:	key	places unit in a "not ready" status.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:.	600 cards.
Stacker:.	1,000 cards.

.732 Replenishment time: . . 0.6 to 1.0 mins.

.734 Optimum reloading period:. . . . . 6 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Exhausted medium:	check	punch stops.
Imperfect medium:	check	punch stops.
Timing conflicts:	check	indicator and punch stops.
Misfeed:	check	punch stops.

INPUT-OUTPUT: 716 PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer. Type 716.

.12 Description

A 716 Printer may be attached to a 709 system through data channels A, C and E. The 716 Printer is a modification of the 407 Accounting Machine. It prints information from 120 print wheels which form a solid bank 12 inches wide. Each print wheel has 48 characters, including all the numerals, all the letters of alphabet, and 12 special characters. A line of printing is spaced at 10 characters to the inch. Line spacing is 6 or 8 lines-to-the-inch, single spaced, under control of a mechanical shift lever.

Printing is performed at a rate of 150 lines per minute for 72 characters and 75 lines per minute for 120 characters. Printing format is controlled by the arrangement of data in core storage and a plugboard, which is wired to perform specific functions according to the requirements of the operation. The printer has a paper tape-controlled carriage, which uses a standard 12-channel paper tape to control the skipping and spacing of the form. Functions of the carriage such as changing or suppressing line spacing, selecting the channel on the carriage control tape to control skipping, or sensing sheet overflow may be controlled by various hubs on the plugboard Various size forms and masters may be used for printing.

Printing is controlled by the stored program. One record is printed on a line, and a record consists of twenty-four 36-bit words (72 characters) stored in the form of a card image in core storage. The wiring of the printer plugboard determines which of the 120 print wheels will be used for the print operation. Through use of special hubs on the plugboard and programming, up to 120 characters can be printed per line at the reduced speed of 75 lines per minute. Card image words are sent to a data channel at 300 microseconds between words (each row containing two words) and 13 milliseconds between rows. Pulses representing the image set the print wheels for the printing operation.

To provide for reliable operation each print wheel generates an echo pulse for the character printed. By proper programming, printing with checking can be accomplished using these echo pulses. Through the use of sense instructions, various conditions can be determined, thus, providing more flexibility in the printer operation.

.13 Availability: . . . . . not in production, can be rented or purchased used or rebuilt only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . marginally punched pin feed continuous forms driven by forms tractor.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved wheel.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . . 1 + 5.

.232 Types of master
Multilith: . . . . . yes.
Zerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 120.
Method of use: . . . . 1 line at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	12	$. #, □ /
Alternatives:	†	% @ & - * BLANK
FORTRAN set:	†	
Basic COBOL set: . . .	†	
Total:	48.	

† available

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold form pin feed punched stationery.
single sheets.
roll paper.

.312 Phenomenon: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 lines per inch.

.322 Parallel by: . . . . . 120 print positions at 10 per inch.

.324 Track use: . . . . . all for data.

.325 Row use: . . . . . all for data.

.33 Coding: . . . . . as in Data Code Table No. 3.

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§ 081.

.34 Format Compatibility: . . . . . IBM 1418, Optical Character Reader can read a single line.
IBM 1428, can read a series of line.

.35 Physical Dimensions

.351 Overall width: . . . . 4.75 to 16.75 in., vernier.
.352 Length
Forms: . . . . . 1 to 22 by 1/6 in. at 6 lines/inch.
1 to 22 by 1/8 in. at 8 lines/inch.
.353 Maximum margins
Left: . . . . . 17 inches.
Right: . . . . . 17 inches.

.4 CONTROLLER

.41 Identity: . . . . . Data Synchronizer.
766.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . . can only be connected to channels A, C, or F.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic
.447 Synchronizing aids: . . wait on row index pulse.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . up to 120 print positions per line.
.512 Block demarcation
Output: . . . . . up to 72 characters; fixed (every 24 words).
up to 120 characters; plugboard wiring.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . start printer cycle.
send a word as necessary to printer by individual instruction; up to 24 per print action.
.523 Stepping: . . . . . step size, 1 or 2 lines, set on plugboard; occurs before printing.
suppress step before print in cycle.
call extra step after print in cycle.
.524 Skipping: . . . . . controlled by carriage paper tape loop with punched channels 1 to 12.
skip channel 11, less than 7 lines before print in a cycle with no extra step.
skip channel 11, less than 3 lines after print in a cycle as an extra step.
skip channel 1 to 10, following print in a cycle, up to form length using extra cycles.
skip channel 1 to 10, up to 2 inches following print in cycle with no extra cycles.
end-of-page signal from channel 12 can be plugged to give a skip on another channel.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . programmed to card image.

.54 Format Control

Control: . . . . . program and plugboard.
Format alternatives: . . . . . 4 manual alteration switches.
Rearrangement: . . . plugboard.
Suppress zeros: . . . plugboard.
Insert point: . . . . . plugboard.
Insert spaces: . . . . plugboard.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . yes.
Select format: . . . . yes.
Select code: . . . . . yes.
Suppress print in cycle: . . . . . yes.
Short skip control: . . . . . inhibits interlock.

.56 Testable Conditions

The program can test one exit hub signal from the plugboard. This can be wired for a variety of conditions including, exhausted, end-of-page, busy and even disabled.

.6 PERFORMANCE

.61 Conditions

I: . . . . . using short skip and optimum choices of paper feed up to 2 inches.
II: . . . . . not using short skips.
III: . . . . . line less than 73 char.
IV: . . . . . line more than 72 char.

§ 081.

.62 Speeds

.621 Nominal or peak speed: 150 lines per minute for 72 char (one print cycle per line).
75 lines per minute for 120 char (two print cycles per line).

.623 Overhead: . . . . . single point clutch.

.624 Effective speeds

I & III:	150 lines/min.
I & IV:	75 lines/min.
II & III	
up to 4 inches: . . .	75 lines/min.
4 to 6 inches:	50 lines/min.
II & IV	
up to 4 inches: . . .	50 lines/min.
4 to 6 inches:	37 lines/min.

.63 Demands on System

Core store: . . . . . less than 1 percent.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	platen and vernier knobs.	
Horizontal alignment:	adjustable forms tractor.	
Form thickness:	dial	varies distance between print wheels and platen.
Line spacing:	shift cam	may be set for either 6 or 8 lines per inch.

.72 Other Controls

Function	Form	Comment
Alteration switches 1, 2, 3, 4:	toggle switches	used to alter plugboard.
Stop before printing:	toggle switch	removes printer from automatic status prior to printing each line.
Test:	toggle switch	allows print cycle key to initiate a print cycle for test operations.
Form stop:	toggle switch	turns "form" light on when paper is exhausted.
Print:	key	initiates a print cycle under special conditions.
Stop:	key	inhibits printing and makes unit "not ready".
Start:	key	makes unit "ready" for channel equipment.
Restore (carriage control):	key	restores carriage to home position.
Stop (carriage control):	key	stops carriage operation.
Space (carriage control):	key	advances form.

.73 Loading and Unloading

.731 Volumes handled: . . . continuous or single sheet forms.

.732 Replenishment time: . . 2 to 3 mins.
printer needs to be stopped.

.733 Adjustment time: . . . 3 to 5 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	programmed echo check.	
Output block size:	implicit.	
Invalid code:	none	overprint.
Exhausted medium:	check	turns on indicator and stops printer.
Imperfect medium:	none.	
Timing conflicts:	check	turns on indicator.

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INPUT-OUTPUT: 729-I MAGNETIC TAPE UNITS

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit
Type 729
Model 1

.12 Description

Up to eight Type 729-I Magnetic Tape Units can be connected through a 755 Tape Control Unit to each 766 Data Synchronizer Channel associated with a 709 configuration. Since each Data Synchronizer contains two channels and up to three synchronizers can be appended to a 709 configuration, a maximum of 48 tape units can be attached to a system.

The data on the tape may be recorded in one of two modes, binary or BCD. Each is recorded in rows of seven bits: six data bits and one parity bit per row, even parity for BCD and odd parity for binary. Each block is recorded with a final row which contains an even parity bit for each track. In the binary mode, a 36-bit word is copied directly onto 6 rows; the original data being binary patterns or characters in the binary 6-bit code. In the BCD mode each word is considered as being 6 characters in binary 6-bit code in storage and BCD 6-bit code on tape, and the conversion between the two codes is automatic.

Reading or writing is performed at the rate of 2,500 words or 15,000 characters a second while tape is moving at 75 inches a second. A two-gap read-after-write head is used which provides for more reliable data transcriptions. As data is written, old data is automatically erased as the new data is recorded. In addition, the new data is checked, and if an error occurs, an indicator will be turned on. This tape unit uses dual-level sensing to increase discrepancy detection. During write operation, a bit mismatch at either level is an error. However, in the read mode, only parity errors at both levels will turn on an indicator.

A reel on which data has been written may be protected from inadvertent writing by removing a circular plastic insert from the back of the file reel. Tapes are read or written in a forward direction only.

The normal rewind of the tape is 75 inches per second for a low-speed rewind and 500 inches per second for a high-speed rewind. A high-speed rewind is initiated when more than 450 feet of tape has been used. Rewinding a full reel of tape (2,400 feet) takes approximately 1.2 minutes.

Each tape unit contains manual controls for placing the unit under computer control or removing the unit from computer control, loading tape, unloading tape,

.12 Description (Cont'd)

address selection, and lamps to indicate various conditions that may exist within the unit. A mechanical interlock is mounted in the reel door to prevent tape operation when the door is open.

.13 Availability: . . . . . not in production, can be rented or purchased used or rebuilt only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . each approx. 7 ft.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 frame or row at a time.

Use of station: . . . . . reading (dual-level).
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N characters at 200 characters/inch.
.322 Parallel by: . . . . . 7 tracks.

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§ 091.

.324 Track use
- Data: . . . . . 6.
- Redundancy check: . . 1.
- Timing: . . . . . 0 (self-clocking).
- Control signals: . . . 0.
- Unused: . . . . . 0.
- Total: . . . . . 7.

.325 Row use
- Data: . . . . . 1 to N.
- Redundancy check: . . 1.
- Timing: . . . . . 0.
- Control signals: . . . 0.
- Unused: . . . . . 0.
- Inter-block gap: . . . 0.75 inches.

.33 Coding: . . . . . one character to a row, using 6 bits as in Data Code Table No. 1.

.34 Format Compatibility: . IBM 727 low density.
IBM 7330 low density.
IBM 729 II, III, IV, V, VI low density.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . Tape Control 755, connected to a 766 Data Synchronizer.

.42 Connection to System

.421 On-line: . . . . . two 755 Control units per 766 synchronizer.
Maximum of three 766 synchronizers can be connected to a system.

.422 Off-line

Use	Associated equipment
Tape to Card:	Type 758 Card Punch Control.
Card to Tape:	Type 759 Card Reader Control.
Tape to 717 Printer:	Type 757 Printer Control.
Tape to 720, 730 Printer:	Type 760 Control and Storage.

.43 Connection to Device

.431 Devices per controller: 8 per 755; 16 per 766.
.432 Restrictions: . . . . . 2 channels per 766 controller; 8 tape units can be connected to each channel; punched card equipment can be attached to only one of the channels - a 717 Printer must be used if a card punch or printer is used.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . yes.
.446 Synchronization: . . . . automatic.
.447 Synchronizing aids: . . wait for next row.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words.
.512 Block demarcation
- Input: . . . . . 0.75 inch inter-record or block gap.
- Output: . . . . . termination of any of three channel commands, i.e., the disconnecting of a tape unit.

.52 Input-Output Operations

.521 Input: . . . . . 1 to N words forward with cut-off as programmed.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . backspace one block or file.
.524 Skipping: . . . . . (a) 1 block backward (backspace record).
(b) 1 file backward until an end-of-file record or load point is reached (backspace file).
(c) skip N words forward under channel command control.
.525 Marking: . . . . . End-of-File; 3.75 inch blank space followed by a special character (tape mark).
End-of-Record or block gap; 0.75 inch blank space on tape.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched codes for binary 6-bit; automatic for BCD 6-bit.

.54 Format Control: . . . . none.

.55 Control Operations

- Disable: . . . . . optional.
- Request interrupt: . . . yes.
- Select format: . . . . . no.
- Select code: . . . . . binary or BCD; specified by I/O instruction.
- Rewind: . . . . . yes.
- Unload: . . . . . no.
- Record "End of-File": yes.

§ 091.

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Output lock:	yes.
Nearly exhausted:	yes, 14 feet.
Busy controller:	yes.
End of medium marks:	yes.
Channel signals:	yes, by data channel trap feature.
Sense "End of File":	yes.

.6 PERFORMANCE

.62 Speeds

.621	Nominal or peak speed:	15,000 char/sec.
.622	Important parameters	
	Start-stop time:	10.8 m.sec.
	Character time:	67 μsec.
	Tape speed:	75 inches/sec.
	Rewind speed:	high speed: 500 inches/sec (avg.). low speed: 75 inches/sec.
.623	Overhead:	10.8 m.sec/block. stop time of one tape can be overlapped with start time of another.
.624	Effective speeds:	15,000 N/(N+161) char/sec.

.63 Demands on System

Component	m.sec per block	Percentage
Memory:	0.012(C+N)+0.60	3(C+N)/N.
Processor:	less than or equal to memory cycle time	4 max. 1 avg. ‡

Tape passing time (actual time): T+0.4N+10.8R+51F.

C = total number of commands involved (small compared to N).
N = total number of words in all records.
R = number of records to be read.
F = number of files or file gaps involved.

‡ based on floating point computations.

.7 EXTERNAL FACILITIES

.72 Other Controls

Function	Form	Comment
Address selection:	dial	determines tape unit address.
File protection:	ring on back of reel	inhibits writing when removed from reel.
Load-Rewind:	key	lowers tape into column and rewinds tape to load point.
Unload:	key	removes tape from columns and raises head assembly.
Reset:	key	turns off ready light and changes from high speed rewind to low speed rewind.
Start:	key	places tape unit in ready status.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Reel:	2,400 feet.

.732	Replenishment time:	1.0 to 1.5 mins.
.734	Optimum reloading period:	6 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	not possible.	
Output block size:	not possible.	
Invalid code:	yes	see reading.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	yes	halts tape drive.
Timing conflicts:	interlock	stalls processor.
Recording level:	dual level signal strength check	indicator & alarm.

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766 DATA SYNCHRONIZER

§ 101.

.1 GENERAL

.11 Identity: . . . . . .Data Synchronizer.
766.
DS.

.12 Description

A 766 Data Synchronizer provides for simultaneous computing and independent data transfers between core storage and input-output units. Each synchronizer contains a pair of channels which logically connect the input-output units to the central processor via core storage. The channels operate independently of each other and are used for input or output transfers. Up to three data synchronizers can be used in a 709 configuration; that is, a total of six channels. The three pairs of channels are designated A and B, C and D, and E and F. Each channel may have up to eight tape units connected to it through a 755 Tape Control Unit. In addition, channels A, C and E may have one card reader, one card punch, and one printer attached to a channel. The printer must be included if a card reader or card punch is attached to a 766. No controller is necessary for the card units.

Channel operation is initiated by the execution of two instructions in the Central Processor Unit (CPU). One instruction sets the selected device in motion while the other specifies the core storage location of the program for channel operation. Channel programs are termed commands to distinguish them

.12 Description (Contd.)

from the central processor orders called instructions. The channels operate independently of the CPU once core storage transfers the first command to the synchronizer. However, only one I/O device per channel can operate at a time. A data channel controls the quantity and destination of all data transmitted between core storage and the selected I/O device. The rate at which the channel transfers data is dependent upon the speed of the selected I/O device.

Data is transferred to and from core storage 36 bits at a time. The transfer of a 36-bit word between any channel and core storage takes 12 microseconds. The 766 Data Synchronizers have priority over the CPU when both are requesting core storage at the same time. However, a drum operation has higher priority than the data synchronizer when requesting a storage cycle. Thus, 766 Data Synchronizer accesses may be delayed during transfers between drum and core storage. When all data channels connected to a system require core storage cycles simultaneously, the sequence of transmission is handled automatically.

.13 Availablity: . . . . . not in production, can be rented or purchased used or rebuilt only when available.

.14 First Delivery: . . . . August, 1958.

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766 DATA SYNCHRONIZER CONSOLE

§ 102.

.1 GENERAL

.11 Identity: . . . . . DSC Console; part of the 766 Data Synchronizer.

.12 Description

The 766 Data Synchronizer Console (DSC) is a panel that is a part of the unit itself. The upper section of the panel contains neon indicators which are used to display the contents of all the synchronizer registers and counters. Beneath the indicators are pushbuttons, keys, and switches necessary for manual operation of the synchronizer. In addition to the above, incandescent lamps are provided to indicate various conditions that may occur within the 766 unit.

The automatic, read-write select, channel select, tape check or I/O check lights on the central processor console will not be turned on when a channel is in manual operation.

.2 CONTROLS

.21 Power

Name	Form	Comment
Power-On:	pushbutton	turns on power in proper sequence.
DC-Off:	pushbutton	removes all DC voltages from tube panels; however, power is still supplied to filaments, blowers, and power supplies.
Power-Off:	pushbutton	removes all power except power to 40 volt supply and 110 volt AC convenience outlet.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
Auto-manual Channel A or B:	two locking keys (one for each channel)	auto position - permits operation of selected channel and permits resets initiated by 709 to reset channel. manual position - activates other manual controls and entry keys for selected channel.

.24 Stepping: . . . . . none.

.25 Resets

Name	Form	Comment
Reset:	pushbutton	resets all indicators, registers and counters only when in manual operation.

.26 Loading

Name	Form	Comment
Load Data Register:	spring-return key	loads data set in entry keys into the data register.
Load Control Word:	spring return key	loads data set in entry keys into the indicators, word counter, and address register.
Load Location Counter:	spring return key	loads data set in entry keys into the location counter.

.27 Special

Name	Form	Comment
Entry keys:	locking key	36 entry keys used for manually composing a word.
BCD:	locking key	selects BCD mode of operation.
Store Data Register:	spring-return key	causes contents of data register to be stored in core storage.
Display Storage:	spring-return key	causes contents of storage location to be displayed in the selected channel's data register.
Write Punch: Write Printer: Read Tape: Write Tape: Read Reader:	spring-return keys	each key causes its particular operation to be executed. Operation requires a series of key settings before being initiated.
Rewind: Write End-of-File: Backspace Record: Backspace File:	spring-return keys	each key causes its particular operation to be executed.
Unit Selection Switches:	dial switch	2 dial switches, one for each channel; used to control unit selection.

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§ 102.

.3 DISPLAY

.31 Alarms

Name	Form	Conditions Indicated
Tape Check:	light	2 lights, one for each channel, turned on if an error is detected during reading or writing.
Filament Detection:	light	indicates loss of filament voltage; used for maintenance.

.32 Conditions

Name	Form	Conditions Indicated
I/O Check:	light	on for lack of a storage reference cycle on one channel operation.
End-of-Tape (EOT):	light	on when end-of-tape reflective spot is detected.
Beginning of Tape (BOT):	light	on whenever tape is backspaced to its load point or attempts to backspace beyond its load point.
End-of-File (EOF):	light	turned on when an end-of-file condition is sensed.
Word Count Equal to Zero:	light	turned on whenever word count equals zero.
Read Gate: Write Gate: Data Register Loaded:	lights	used for maintenance only.

.32 Conditions (cont'd)

Name	Form	Conditions Indicated
Read Tape: Write Tape: BCD: WEOF: Rewind: Backspace Record: Backspace File:	lights	turned on whenever the particular operation is being executed.
Unit Selected:	lights	10 lights; each light indicates which unit is selected.
Read Card Reader: Write Printer: Write Punch: Read Printer: Print Binary:	lights	these indicators are associated with channels A, C, or E. Turned on whenever the particular card machine is selected.
A Select: B Select:	lights	indicates which channel is in operation.
Unit Priority:	light	indicates which synchronizer of three has greater priority.
A Priority: B Priority:	light	indicates which channel has priority.
Manual A, B:	light	indicates setting of auto-manual switches.
Fuse:	light	indicates blown fuse in the synchronizer.
Ready:	light	indicates both channels are available for automatic operation.
Thermal:	light	when lit, indicates that the synchronizer temperature has gone beyond limits.
Power-On:	light	indicates AC power is on.
DC-On light:	light	indicates all voltages have reached operating level.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS: . . . . IBM 766 Data Synchronizer containing two data channels.

.12 Description

The IBM 709 data channels permit almost totally simultaneous computation and input-output transfers. Two units, the 733 Magnetic Drum and the 740 Cathode Ray Tube (CRT) Display, are not controlled by the data channels, but by the processor.

Reading or writing on the Drum causes processing to stop and reduces the processor to the equivalent of a data channel. In this status the processor must wait for drum positioning (latency) and then perform only data transfer operations until the transfer with storage is complete, stopping computation but permitting other data channels to access the store.

Displaying data on the CRT has no latency in almost all applications. The delay required between data transmissions is about five instruction times which is shorter than the time that would be required to generate a channel command to display it. Except for the single instruction that actually displays each datum, the processor is actually performing necessary computation. On this basis, use of the CRT is considered to be simultaneous with computation even though the processor is acting as the data channel.

The data channels operate simultaneously with computation sharing memory cycles with the processor. However, the devices that the channels control are treated as though they were connected to an unbuffered processor without data channels. Only one data transmission operation between the data channel and a selected device is possible. Non-data transmission operations such as paper-spacing or magnetic tape rewinding can be performed on all devices connected to a data channel provided that they are started before a data transmission occurs.

One restriction is built into each 766 Data Synchronizer. This is that only one (odd) of its data channels can have a card reader and/or a card punch in addition to a printer connected to it.

.2 CONFIGURATION CONDITIONS: . . . . assume maximum configuration on each channel.

.3 CLASSES OF OPERATION

CLASS	MEMBER
A	Compute (including write CRT).
B	Read or write drum(s).
C	Rewind or backspace magnetic tape on each channel.
D	Data transmission (read or write) on each channel.
E	Feed a card or space paper on odd numbered channels.

.4 RULES

	odd channels	even channels	all channels
a+b =	1	1	1
c =	8	8	48
d =	1	1	6
e =	3	-	9
c+d =	8	8	51
c+d+e=	11	-	57
c+e =	11	-	57
d+e =	4	-	15

.5 TABLE

	odd channels	even channels	all channels
a or b	1	1	1
c	$8-d_c$	8-d	$48-d_c$
d	1	1	6
e	$3-d_e$	0	$9-d_e$

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INSTRUCTION LIST

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	Accumulator (AC) bits are called S, Q, P 1 thru 35. Multiplier-Quotient (MQ) called S, 1 thru 35. Q, P, hold overflows, S's sign.
					Fixed Point Arithmetic (AC and MQ use bits S, 1 thru 35 unless overflow in AC, then P and Q).
ADD	X	F	T	Y	(Y) + (AC) → AC
ADM	X	F	T	Y	|(Y)| + (AC) → AC
SUB	X	F	T	Y	(AC) - (Y) → AC
SBM	X	F	T	Y	(AC) - |(Y)| → AC
MPY	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ
MPR	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ, and if MQ_1 = 1; AC + 1 → AC
DVH	X	F	T	Y	(MQ ÷ (Y) → MQ (quotient), AC (remainder). If overflow, set divide-check indicator and halt processor.
DVP	X	F	T	Y	Same as for DVH except processor is not halted.
VLM	X	F C	T	Y	(Y) x $(MQ)_{35-C}$ → AC and MQ.
VDH	X	F C	T	Y	(AC) ÷ $(Y)_{1 \text{ to } C}$ → $(MQ)_{35-C \text{ to } 35}$, remainder in AC; If (Y) ≤ (AC), halt processor.
VDP	X	F C	T	Y	(AC) ÷ $(Y)_{1 \text{ to } C}$ → $(MQ)_{35-C \text{ to } 35}$, remainder in AC.
					Floating Point Arithmetic
FAD	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
UFA	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; unnormalized.
FSB	X	F	T	Y	(Y) - (AC) → (MSB)AC, (LSB)MQ; normalized.
UFS	X	F	T	Y	(Y) - (AC) → (MSB)AC, (LSB)MQ; unnormalized.
FMP	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ; normalized.
FDH	X	F	T	Y	(AC) ÷ (Y) → MQ (quotient) normalized, AC (remainder). If overflow, set divide-check indicator and halt processor.
FDP	X	F	T	Y	Same as for FDH except processor is not halted.
FAM	X	F	T	Y	(Y) + (AC) → AC and MQ, normalized.
UAM	X	F	T	Y	(Y) + (AC) → AC and MQ, unnormalized.
FSM	X	F	T	Y	(AC) - |(Y)| → AC and MQ, normalized.
USM	X	F	T	Y	(AC) - |(Y)| → AC and MQ, unnormalized.
FRN	X	F	T	Y	(AC) + $(MQ)_9$ → (AC) normalized.
UFM	X	F	T	Y	(Y) x (MQ) → AC and MQ, unnormalized.
					Data Transfer (Arithmetic)
LDQ	X	F	T	Y	(Y) → MQ.
STQ	X	F	T	Y	(MQ) → Y.
SLQ	X	F	T	Y	$(MQ)_{S, 1-17}$ → $Y_{S, 1-17}$.
STO	X	F	T	Y	(AC) → Y.
STZ	X	F	T	Y	0 → (Y); sign is plus.
STP	X	F	T	Y	$(AC)_{P, 1, 2.}$ → $Y_{S, 1, 2.}$
STD	X	F	T	Y	$(AC)_{3-17}$ → Y_{3-17}.
STA	X	F	T	Y	$(AC)_{21-35}$ → Y_{21-35}.
CLA	X	F	T	Y	(Y) → AC.
CLS	X	F	T	Y	(-Y) → AC.
					Data Transfers (Logical)
CAL	X	F	T	Y	(Y) → AC.
SLW	X	F	T	Y	(AC) → Y.

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INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
STT	X	F	T	Y	$(AC)_{18-20} \rightarrow Y_{18-20}$; remaining positions remain unchanged.
STL	X	F	T	Y	Location of STL instruction + 1 $\rightarrow Y_{21-35}$; remaining positions of Y unchanged.
STR	X	X	X	X	Location of STR instruction + 1 $\rightarrow$ to positions 21 to 35 of location 0, take next instruction from location 2.
XCA	X	X	X	X	$(AC)_{S,\ 1-35}$ exchanged with $(MQ)_{S,\ 1-35}$; positions P and Q of AC are cleared.
XCL	X	X	X	X	$(AC)_{P,\ 1-35}$ exchanged with $(MQ)_{S,\ 1-35}$; positions S and Q of AC are cleared.
ENK	X	X	T	X	Contents of manual input switches $\rightarrow$ (MQ). (See PSE)
					Logical Operations (AC used P, 1 thru 35 unless overflow in AC, then Q.)
ACL	X	F	T	Y	(Y) + (AC) $\rightarrow$ AC.
ANA	X	F	T	Y	(AC) "AND" (Y) $\rightarrow$ AC.
ANS	X	F	T	Y	(AC) "AND" (Y) $\rightarrow$ Y.
ORA	X	F	T	Y	(AC) "OR" (Y) $\rightarrow$ AC.
ORS	X	F	T	Y	(AC) "OR" (Y) $\rightarrow$ Y.
ERA	X	F	T	Y	(AC) "EXCLUSIVE OR" (Y) $\rightarrow$ AC (binary half add).
					Shift Operations (All are modulo 256 places).
ALS	X	X	T	Y	(AC) shifted left Y, sign unchanged.
ARS	X	X	T	Y	(AC) shifted right Y, sign unchanged.
LLS	X	X	T	Y	(AC) and (MQ) shifted left Y, $(MQ)_S \rightarrow AC_S$.
LRS	X	X	T	Y	(AC) and (MQ) shifted right Y, $(AC)_S \rightarrow MQ_S$.
LGL	X	X	T	Y	(AC) and (MQ) shifted left Y, signs unchanged.
RQL	X	X	T	Y	(MQ) rotated left Y.
LGR	X	X	T	Y	(AC) and (MQ) shifted right Y, signs unchanged.
					Control Operations
NOP	X	X	X	X	Next instruction in sequence is executed.
HPR	X	X	X	X	Halts processor; processor steps to next instruction when Start key is depressed.
HTR	X	F	T	Y	Halts processor; processor steps to instruction in location Y when Start key is depressed.
TRA	X	F	T	Y	Next instruction is taken from location Y.
TZE	X	F	T	Y	(AC) = O, next instruction taken from location Y.
TNZ	X	F	T	Y	(AC) $\neq$ O, next instruction taken from location Y.
TPL	X	F	T	Y	If sign bit of AC positive, next instruction taken from location Y. Sign bit negative, next instruction executed.
TMI	X	F	T	Y	If sign bit of AC negative, next instruction taken from location Y. If sign bit positive, next instruction executed.
TOV	X	F	T	Y	If overflow indicator on, it is turned off and processing continues from location Y.
TNO	X	F	T	Y	If overflow indicator off, continue from location Y.
TQP	X	F	T	Y	If sign bit of MQ positive, next instruction taken from location Y.
TQO	X	F	T	Y	If MQ overflow indicator turned off, next instruction taken from location Y.
TLQ	X	F	T	Y	(MQ) < (AC) next instruction taken from location Y.
TSX	X	X	T	Y	2's complement of location Y placed in index register T. *
					* Not indexable.

INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
TXI	D	D	T	Y	Adds the value of D to the number in index register T and takes next instruction from Y. *
TXH	D	D	T	Y	If number in index register T greater than value of D, next instruction taken from location Y. *
TXL	D	D	T	Y	If number in index register T is less than or equal to the value of D, next instruction taken from location Y. *
TIX	D	D	T	Y	If number in index register T is greater than the value of D, the number in index register T is reduced by the value of D and next instruction is taken from Y. *
TNX	D	D	T	Y	If number in index register T is greater than the value of D, number in index register T is reduced by the value of D and transfers to the next instruction; otherwise the index is unchanged and the next instruction is taken from Y. *
TTR	X	F	T	Y	Processor takes its next instruction from location Y and proceeds whether or not in trapping mode.
CAS	X	F	T	Y	(Y) < (AC) next instruction executed. If (Y) = (AC) skip next instruction. If (Y) > (AC) skip next two instructions.
LXA	X	X	T	Y	Address portion of (Y) replaces number in index register T. *
LXD	X	X	T	Y	Decrement portion of (Y) replaces number in index register T. *
SXD	X	X	T	Y	(T) replaces decrement part of location Y. *
PAX	X	X	T	Y	Address part of (AC) replaces the number in the index register T. *
PDX	X	X	T	Y	Decrement part of (AC) replaces the number in the index register T. *
PXD	X	X	T	Y	O $\longrightarrow$ (AC) and number in index register T is placed in the decrement part of the AC. *
XEC	X	F	T	Y	Execute instruction in location Y.
BTT	X	X	T	Y	Test the status of data channel BOT indicator. Channel specified by value of Y.
ZET	X	F	T	Y	$(Y)_{1-35}$ = O, next instruction is skipped and processing continues. If $(Y)_{1-35} \neq$ O, next sequential instruction is executed.
NZT	X	F	T	Y	If $(Y)_{1-35} \neq$ O, the next instruction is skipped and processing continues. If $(Y)_{1-35}$ = O, next sequential instruction is executed.
LAS	X	F	T	Y	(AC) compared logically with (Y). If (AC) > (Y), next sequential instruction is executed. If (AC) = (Y), next instruction is skipped and processing continues. If (AC) < (Y), next two instructions are skipped and processing continues.
TCOA	X	F	T	Y	Next instruction taken from location Y if channel A is in operation.
TCNA	X	F	T	Y	Next instruction taken from location if channel A is not in operation.
TRCA	X	F	T	Y	When tape check indicator for channel A is on, next instruction taken from location Y. If indicator is off, next instruction in sequence is executed.
TEFA	X	F	T	Y	When end-of-file indicator for channel A is on, next instruction taken from location Y. If indicator is off, next instruction in sequence is executed.
LAC	X	X	T	Y	$(NOT(Y)_{21-35}) + 1 \longrightarrow (T)$.
LDC	X	X	T	Y	$(NOT\ (Y)_{21-35}) + 1 \longrightarrow (T)$.
					* Not indexable.

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INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
AXT	X	X	T	Y	Y → (T).
AXC	X	X	T	Y	(NOT Y) + 1 → (T).
PAC	X	X	T	X	(NOT $(AC)_{21-35}$) + 1 → (T).
PDC	X	X	T	X	(NOT $(AC)_{3-17}$) + 1 → (T).
SXA	X	X	T	Y	(T) → $(Y)_{21-35}$.
PXA	X	X	T	Y	O → AC; (T) → AC_{21-35}.
					Input-Output Operations
RDS	X	X	T	Y	Start the unit specified by Y in the read mode.
WRS	X	X	T	Y	Start the unit specified by Y in the write mode.
BST	X	X	T	Y	Backspace tape designated by Y one record.
WEF	X	X	T	Y	An end-of-file gap and mark and a redundancy character is written onthe tape on unit Y.
REW	X	X	Y	Y	Rewind tape unit Y.
LDA	X	F	T	Y	The first location of the record to be read or written on the drum is Y.
CPY	X	X	T	Y	Transfer one word between storage and an input-output unit. If the transfer occurs, then execute the next instruction; otherwise, halt the processor. During input operations, if an end-of-file condition is encountered, no data is transferred and the next instruction is skipped. If an end-of-record condition was encountered, no data is transferred and the next two instructions are skipped.
PSE	X	X	T	X	Provides a means for testing the status of sense switches, controlling sense lights, and the sampling of or sending of impulses to the printer and punch. Other functions include: (1) Clear Magnitude (AC). (2) Low order bit test (AC). (3) Change sign (AC). (4) Set sign plus (AC). (5) Complement magnitude (AC). (6) Enter trapping mode. (7) Round $(MQ)_1 \times 2^{-35}$ + (AC) → AC. (8) Divide check test.
MSE	X	X	T	X	Provides a means for testing and turning off the sense lights. Other functions include: (1) P bit test (AC). (2) Leave floating trap mode. (3) Enter floating trap mode. (4) Set sign minus. (5) Leave trapping mode. (6) Redundancy tape test. (7) End-of-tape test.
BSF	X	X	T	Y	Selected tape Y is moved backward until end-of-file or load point is reached.
CAD	X	X	T	Y	A combination of the CPY and ACL functions.
					Sense Indicator Operations
PAI	X	X	X	X	$(AC)_{P,\ 1-35}$ → SI.
PIA	X	X	X	X	(SI) → $AC_{P,\ 1-35}$; O → positions S and Q.
LDI	X	F	T	Y	(Y) → SI_{0-35}.
STI	X	F	T	Y	(SI) → Y.
OAI	X	X	X	X	(AC) "OR" (SI) → SI.
OSI	X	X	T	Y	(Y) "OR" (SI) → SI.
SIL	X	X	Y	Y	Y "OR" $(SI)_{0-17}$ → SI_{0-17}.
SIR	X	X	Y	Y	Y "OR" $(SI)_{18-35}$ → SI_{18-35}.

INSTRUCTION LIST–Contd.

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
RIA	X	X	X	X	"NOT" (AC) "AND" (SI) → SI.
RIS	X	F	T	Y	"NOT" (Y) "AND" (SI) → SI.
RIL	X	X	Y	Y	"NOT" (Y) "AND" $(SI)_{0-17} \rightarrow SI_{0-17}$.
ONT	X	F	T	Y	If (Y) "AND" (SI) = (Y), skip next instruction.
OFT	X	F	T	Y	If (Y) "AND NOT" (SI) = (Y), skip next instruction.
LNT	X	X	Y	Y	If (Y) "AND" $(SI)_{0-17}$ = (Y), skip next instruction.
RNT	X	X	Y	Y	If (Y) "AND" $(SI)_{18-35}$ = (Y), skip next instruction.
LFT	X	X	Y	Y	If (Y) "AND NOT" (SI_{0-17}) = (Y), skip next instruction.
RFT	X	X	Y	Y	If (Y) "AND NOT (SI_{18-35}) = (Y), skip next instruction.
RIR	X	X	Y	Y	"NOT(Y)"AND" $(SI)_{18-35} \rightarrow SI_{18-35}$.
IIA	X	X	X	X	(AC) "EXC. OR" (SI) → SI.
IIS	X	F	T	Y	(Y) "EXC. OR" (SI) → SI.
IIL	X	X	Y	Y	(Y) "EXC. OR" $(SI)_{0-17} \rightarrow SI_{0-17}$.
IIR	X	X	Y	Y	(Y) "EXC. OR" $(SI)_{18-35} \rightarrow SI_{18-35}$.
IIO	X	F	T	Y	IF (AC) "AND" (SI) = (AC), take next instruction from Y.
TIF	X	F	T	Y	IF (AC) "AND NOT" (SI) = (AC), take next instruction from Y.
					Channel Trap Instructions
ENB	X	X	T	Y	Enable from Y. The (Y) determines which channel signals cause a trapping operation.
RCT	X	F	T	Y	Restore channel traps. Allows traps to occur as specified by ENB. Cancels the inhibiting effect of an executed trap.
					Input-Output Transmission Operations
SCHA	X	F	T	Y	Store Channel A. (Y) replaced with contents of Channel A.
RCHA	X	F	T	Y	Reset and load Channel A. Channel A is reset and loaded with the (Y).
LCHA	X	F	T	Y	Load Channel A with the (Y).
CVA	X	C	X	Y	Y → (SR). ($(AC)_{30-35}$ + (SR)) → (SR), (AC)/64 → (AC), $(SR)_{P-5} \rightarrow (AC)_{P-5}$, C times.
CRQ	X	C	X	Y	Y → (SR). ($(MQ)_{S-5}$ + (SR) → (SR), (MQ) x 64 → (MQ), $(SR)_{S-5} \rightarrow (MQ)_{30-35}$, C times.
CAQ	X	C	X	Y	Y → (SR). ($(MQ)_{S-5}$ + (SR) → (SR), RQL 6, (AC) + (SR) → AC, C times.
					Data Channel Commands
IOCD	C	F	N	Y	Input-Output C words starting at Y and disconnect.
IOCP	C	F	N	Y	Input-Output C words starting at Y and proceed to next channel command.
IORP	C	F	N	Y	Input-Output up to C words of one record starting at Y, then proceed to the next channel command.
IOCT	C	F	N	Y	Input-Output C words of one record starting at Y then accept the waiting LCH instruction or disconnect.
IORT	C	F	N	Y	Input-Output up to C words of one record starting at Y then accept the waiting LCH instruction or disconnect.
IOSP	C	F	N	Y	Input-Output the smaller of 1 record or C words, starting at Y then accept the next channel command.
IOST	C	F	N	Y	Input-Output the smaller of 1 record or C words starting at Y then accept the waiting LCH instruction or disconnect.
TCH	X	F	X	Y	Take next channel command from Y.

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DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . binary 6-bit code.
internal.
magnetic drum.
magnetic tape.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits; 8, 4, 2, 1

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	&	-	Blank
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10		+ o	- o	‡
11	#	.	$	,
12	@	□	*	%
13				
14				
15				

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . punch card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	&	-	0
12	&	&	∝	+ o
11	-	∝	-	- o
0	0	+ o	- o	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	$	D	M	U
5	5	E	N	V
6	6	F	Ø	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2		+	-	
8-3	#	.	$	,
8-4	@	□	*	%
8-5				
8-6				
8-7	TM	≠	Δ	

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . . printer.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits: 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	Blank		-	+
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10				
11	+	,	$	.
12	-	%	*	□
13				
14				
15				

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DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . BCD 6-bit code. magnetic tape.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits, 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0		Blank	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	‡	$\overset{-}{0}$	$\overset{+}{0}$
11	#	,	$	.
12	@	%	*	□
13				
14				
15	TM		Δ	≠

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IBM 709
SYSTEM PERFORMANCE

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IBM 709 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration								Reference
			VII A		VII B		VIII A		VIII B		
1 Input-Output Times	Char/block	(File 1)	1008		4032		1008		4032		4:200.112
	Records/block	K (File 1)	8		32		8		32		
	m. sec/block	File 1 = File 2	77		286		77		286		
		File 3	12		77†		12		77†		
		File 4	12		77†		12		77†		
	m. sec/switch	File 1 = File 2									
		File 3									
		File 4									
	m. sec penalty	File 1 = File 2	0.2		0.7		0.1		0.2		
		File 3	0.1		0.2		0.1		0.1		
		File 4	0.1		0.2		0.1		0.1		
2 Central Processor Times	m. sec/block	a1	1.37		1.37		1.37		1.37		4:200.1132
	m. sec/record	a2	1.42		1.42		1.42		1.42		
	m. sec/detail	b6	1.00		1.00		1.00		1.00		
	m. sec/work	b5 + b9	2.46		2.46		2.46		2.46		
	m. sec/report	b7 + b8	51.19		51.19		51.19		51.19		
3 Standard Problem A F = 1.0	m. sec for C. P. and dominant column.	a1	1.4		1.4		1.4		1.4		4:200.114
		a2 K	11.3		45.2		11.3		45.2		
		a3 K	437.4		1749.6		437.4		1749.6		
		File 1 Master In	1.0	77	1.0	286	1.0	77	1.0	286	
		File 2 Master Out	1.0		1.0		1.0		1.0		
		File 3 Details	0.1	12	0.4	77	0.1		0.4		
		File 4 Reports	0.1		0.4		0.1		0.4		
		Total	452.3	89	1799.0	363	452.3	77	1799.0	286	
4 Standard Problem A Space	Unit of measure	(words)									4:200.1151
		Std. routines	620		620		620		620		
		Fixed	0		0		0		0		
		3 (Blocks 1 to 23)	400		450		400		450		
		6 (Blocks 24 to 48)	2,000		2,000		2,000		2,000		
		Files	756		3,360		756		3,360		
		Working	200		200		200		200		
		Total	3,976		6,630		3,976		6,630		

† 8 records per block.

IBM 709 SYSTEM PERFORMANCE–Contd.

WORKSHEET DATA TABLE 2								
Worksheet	Item			Configuration				Reference
				VII A	VII B	VIII A	VIII B	
5 Standard Mathematical Problem A	Fixed/Floating point			Floating	Floating	Floating	Floating	4:200.413
	Unit name		input	CR 711	729 I	CR 711	729 I	
			output	PR 716	729 I	PR 716	729 I	
	Size of record		input	72 chars	90 chars	72 chars	90 chars	
			output	120 chars	120 chars	120 chars	120 chars	
	m. sec/block		input T1	240	17	240	17	
			output T2	800	19	800	19	
	m. sec penalty		input T3	45	0	45	0	
			output T4	75	0	75	0	
	m. sec/record		T5		9.9			
	m. sec/5 loops		T6		17.9			
	m. sec/report		T7		74.0			
7 Standard Statistical Problem A	Unit name			729 I	729 I	729 I	729 I	4:200.512
	Size of block			1000 chars	1000 chars	1000 chars	1000 chars	
	Records/block		B	100	100	100	100	
	m. sec/block		T1	77.4	77.4	77.4	77.4	
	m. sec penalty		T3	0.8	0.8	0.8	0.8	
	C. P.	m. sec/block	T5	0.25	0.25	0.25	0.25	
		m. sec/record	T6	4.06	4.06	4.06	4.06	
		m. sec/table	T7	0.40	0.40	0.40	0.40	

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SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

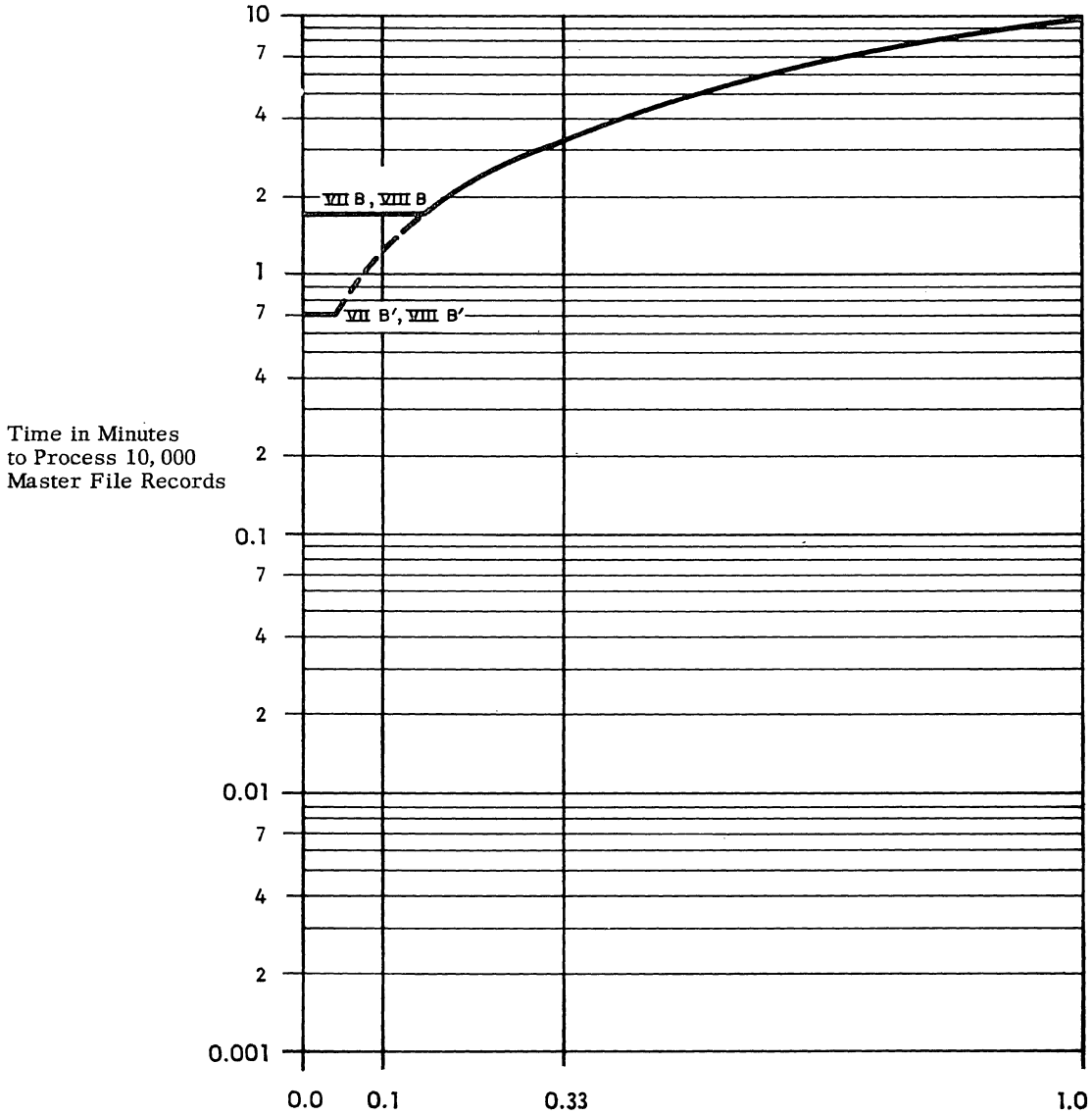
.111 Record sizes
Master file:. . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.112 Computation:. . . . . standard.

.113 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph:. . . . . see graph below.

.115 Storage space required
Unblocked detail and report files
Configuration VII B:. . . . 3,976.
Configuration VIII B: . . . 3,976.
Blocked detail and report files
Configuration VII B:. . . . 6,630.
Configuration VIII B: . . . 6,630.



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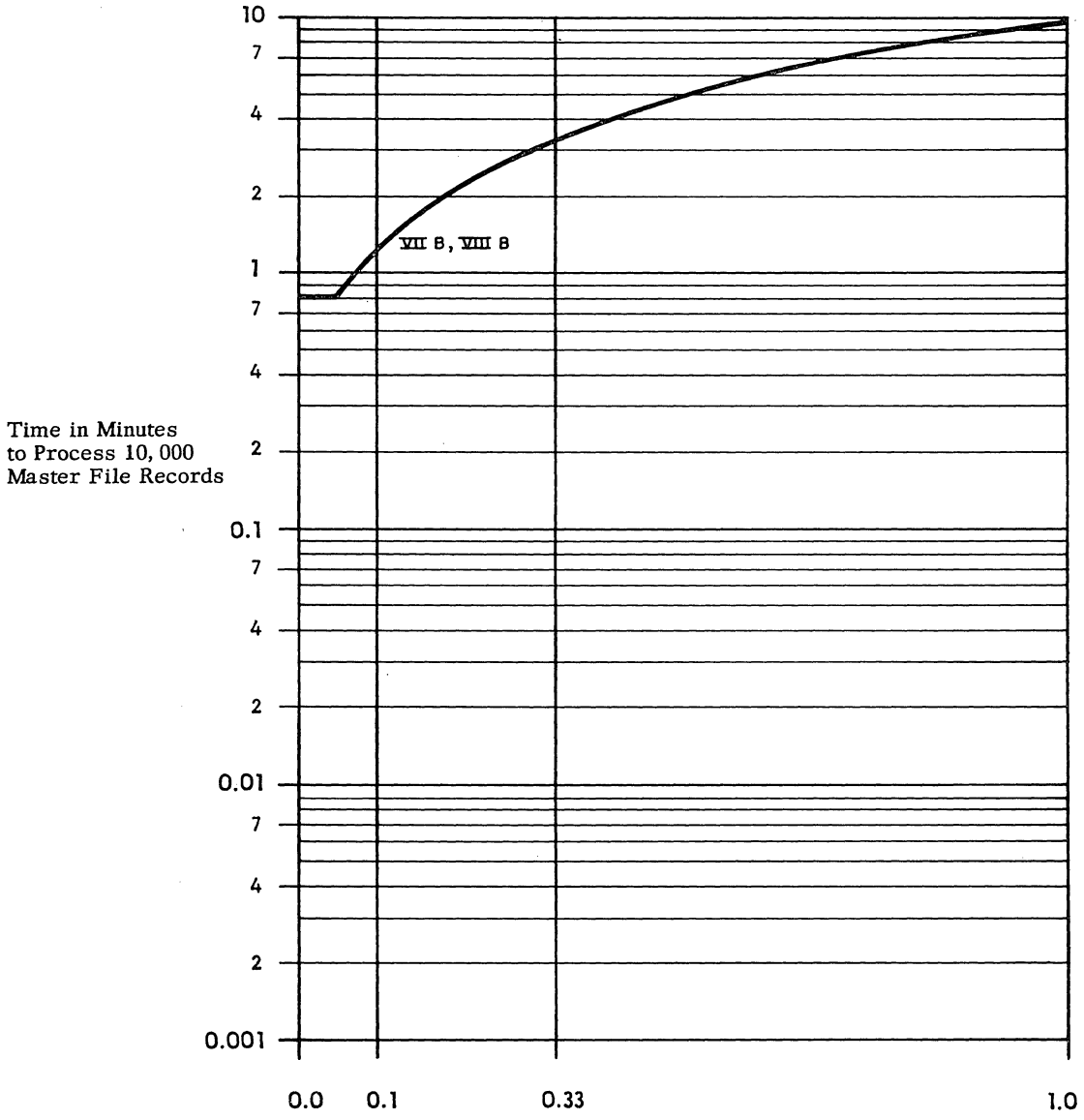
§ 201.

.12 Standard File Problem B

.121 Record sizes
Master file:. . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



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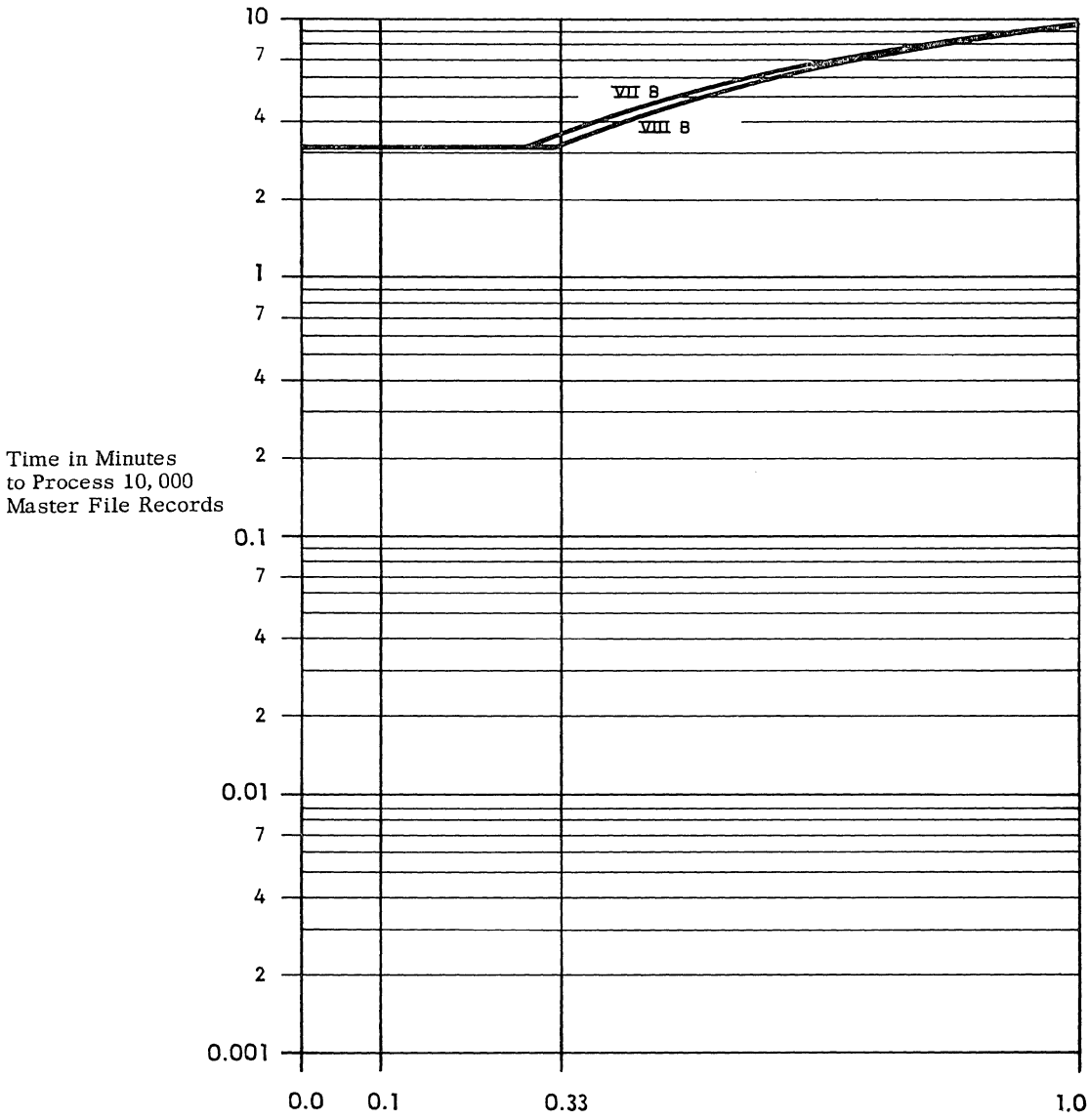
§ 201.

.13 Standard File Problem C

.131 Record sizes
Master file:. . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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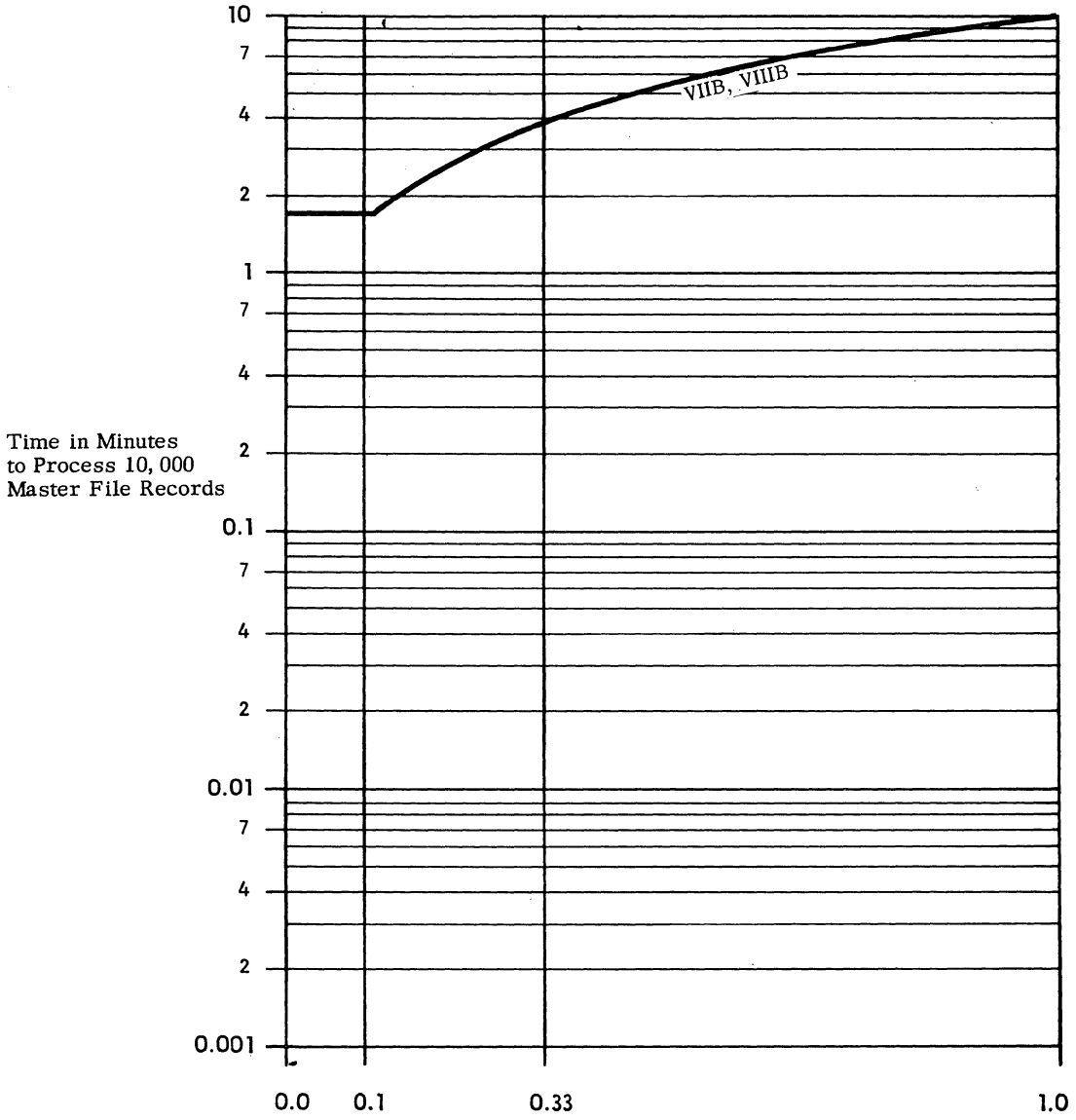
§ 201.

.14 Standard File Problem D

.141 Record sizes
Master file:. . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



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§ 201.

.2 SORTING

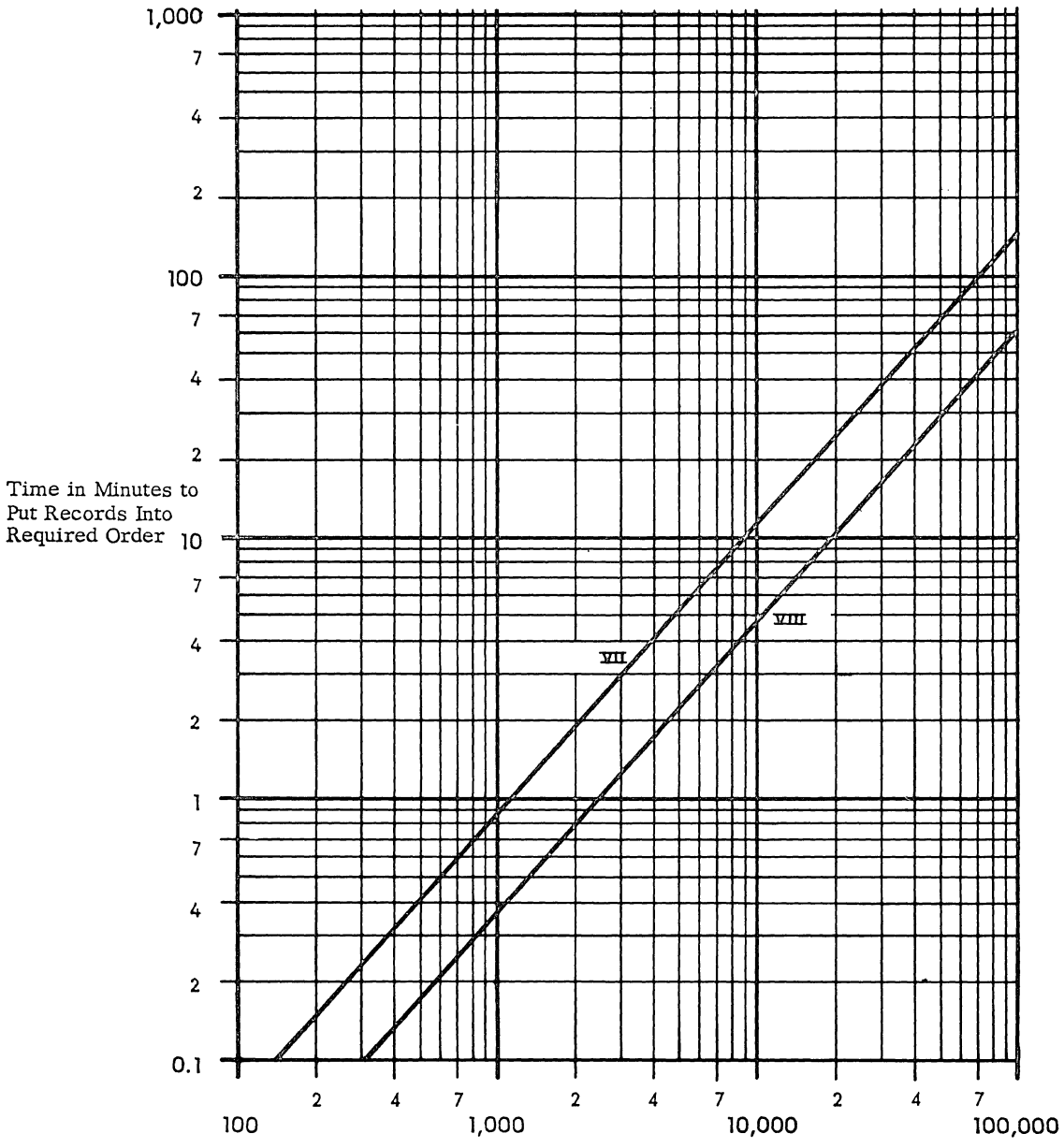
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



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§ 201.

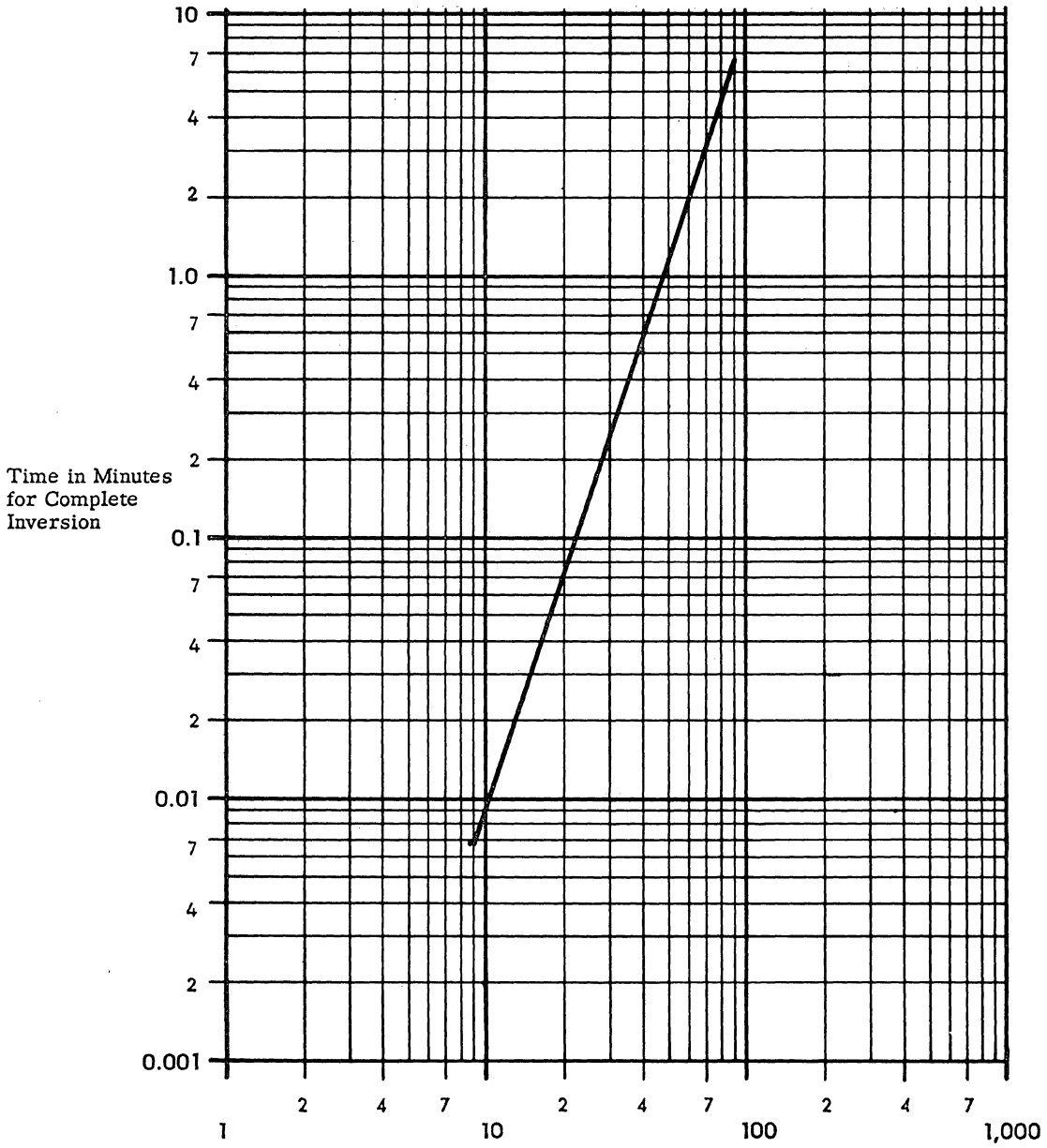
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal points.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . . see graph below.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

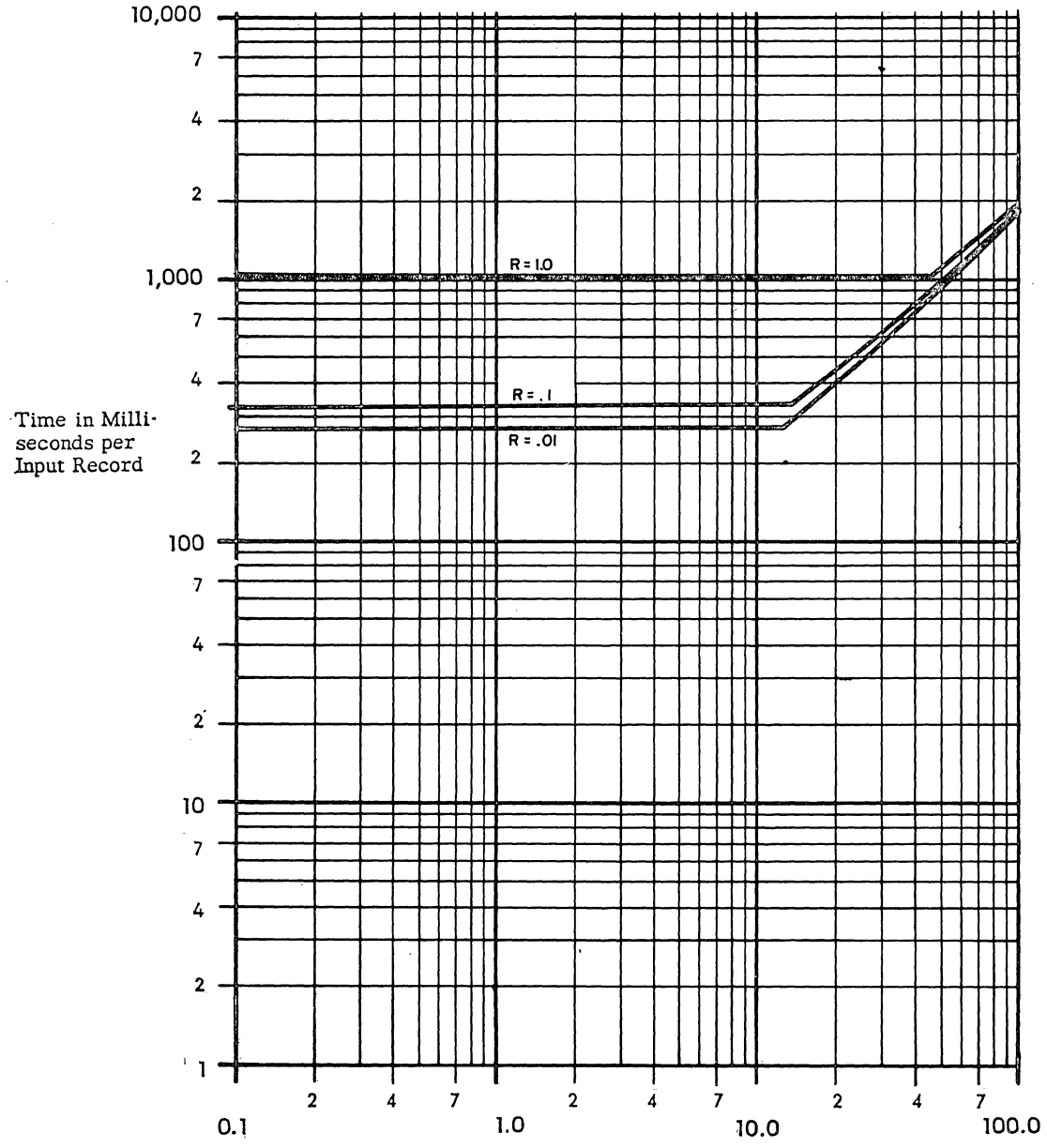
.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . . see graph below.

CONFIGURATIONS VII A AND VIII A; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT.

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



C, Number of Computations per Input Record

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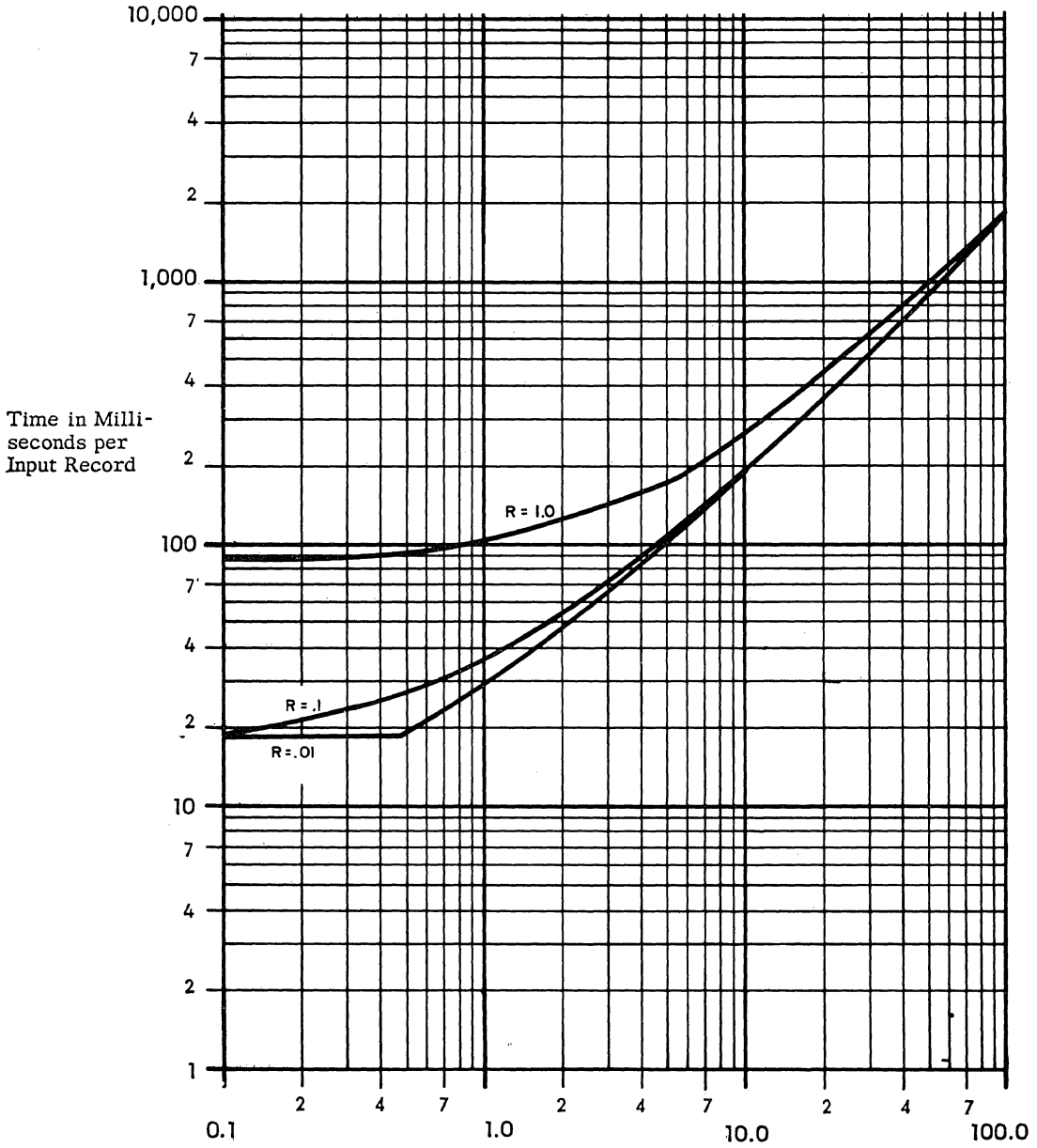
§ 201.

.415 Graph: . . . . . see graph below.

CONFIGURATIONS VII B AND VIII B; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT.
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

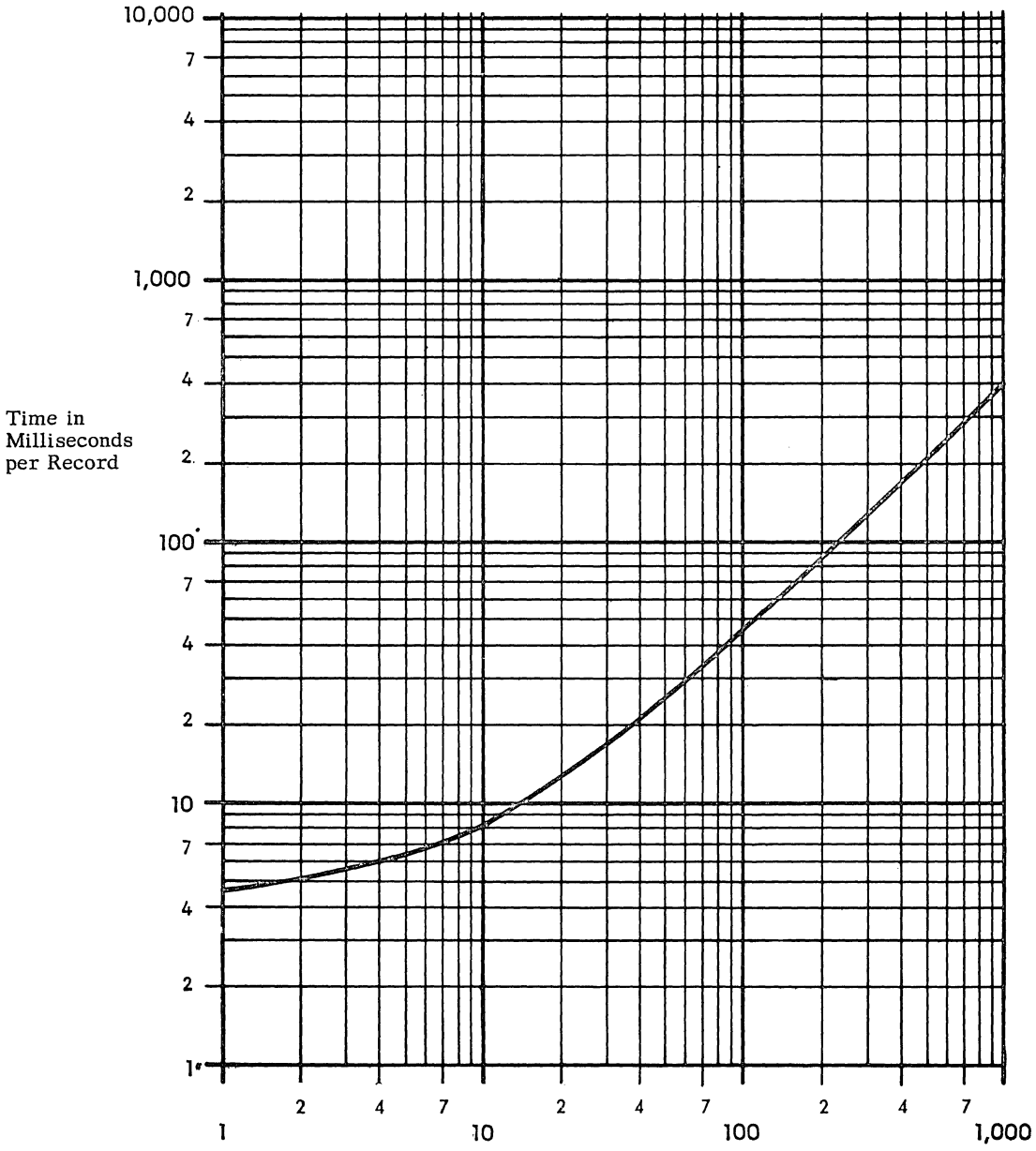
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



T, Number of Augmented Elements
Roman numerals denote Standard Configuration

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IBM 709
PHYSICAL CHARACTERISTICS

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IBM 709 PHYSICAL CHARACTERISTICS

			Central Processing Unit	Core Storage	Core Storage	Drum Storage	Card Reader	Card Punch	Printer
IDENTITY	Unit Name								
	Model Number		709	737	738	733	711	721	716
PHYSICAL	Height × Width × Depth, in.		66×72×37	64×105×31	64×159×95	67×55×31	32×32×30	50×40×26	47×59×30
	Weight, lbs.		3,150	1,620	4,000	1,930	560	670	1,910
	Maximum Cable Lengths								
	To Central Processor		---	35	45	22	---	---	35
	To 746		42	75	75	73	---	---	95
	To Designated Unit		---	---	---	---	30 (716)	44 (716)	---
ATMOSPHERE	Storage Ranges	Temperature, °F.	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Working Ranges	Temperature, °F.	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 110
		Humidity, %	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 80
	Heat Dissipated, BTU/hr.		109,800	16,400	60,500	25,200	1,700	9,000	7,850
	Air Flow, cfm.		5,400	1,240	2,760	800	---	---	---
	Internal Filters		Yes	Yes	Yes	Yes	None	None	None
ELECTRICAL	Voltage	Nominal	208	208	208	208	208	208	208
		Tolerance, %	±8	±8	±8	±8	±8	±8	±8
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance, cycles	±1	±1	±1	±1	±1	±1	±1
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		40.3	6.4	23.4	10.4	0.7	3.5	3.1
NOTES									

IBM 709 PHYSICAL CHARACTERISTICS–Contd.

IDENTITY	Unit Name		Magnetic Tape Unit	Tape Control	CRT Recorder	Power Distribution Unit	Power Supply	Power Supply	CRT Display
	Model Number		729	755	740	746	736	741	780
PHYSICAL	Height × Width × Depth, in.		69 × 29 × 31	60 × 67 × 32	52 × 26 × 37	65 × 41 × 34	65 × 61 × 34	65 × 61 × 34	22 × 24 × 28
	Weight, lbs.		950	2,250	740	1,170	2,380	3,030	250
	Maximum Cable Lengths								
	To Central Processor		---	---	22	42	---	---	---
	To 746		---	---	60	---	---	---	---
	To Designated Unit		90 (755)	30 (766)	---	40 (Power Frame)	40 (746)	40 (746)	40 (740)
ATMOSPHERE	Storage Ranges	Temperature, °F.	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110	65 - 110
		Humidity, %	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80	20 - 80
	Working Ranges	Temperature, °F.	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80	65 - 80
		Humidity, %	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60	20 - 60
	Heat Dissipated, BTU/hr.		4,100	9,200	6,140	3,000	14,700	14,700	---
	Air Flow, cfm.		220	550	---	---	2,800	2,800	---
	Internal Filters		Yes	None	Yes	Yes	Yes	Yes	None
ELECTRICAL	Voltage	Nominal	208	208	208	208	208	208	208
		Tolerance, %	±8	±8	±8	±8	±8	±8	±8
	Cycles	Nominal	60	60	60	60	60	60	60
		Tolerance, cycles	±1	±1	±1	±1	±1	±1	±1
	Phases and Lines		3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire	3ϕ, 4-wire
	Load KVA		2.2	6.0	2.4	1.2	5.8	5.8	---
NOTES									

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PRICE DATA

§ 221.

Production of the IBM 709 system has been discontinued. However, these systems are now becoming available as used and/or rebuilt equipment. This equipment can be purchased at discounted prices when it is available.

The Processor, Internal Storage, Tape Control, and CRT units are discounted by 70 percent of their original prices, but have no trade-in value. Five percent of their discounted price is the required down payment for these units. Terms can be arranged to pay the balance over a period of up to 60 months.

The other equipment can be traded-in. Down payments of 15 percent of the discounted price are required. The term of monthly payments for the units purchased depends on the age of each individual unit. The maximum term is 60 months and is reduced by the age in months over 48 down to the minimum term of 12 months. Included in this group are the Magnetic Tape units which are discounted by 10 percent per year of age. All of the other units are reduced in price by 0.833 percent per month of age from the original price for at least the first five years.

For the purposes of maintenance contracts, the equipment is considered 37 months old. These rates are shown below. The systems are fully guaranteed for the first month or 176 hours of use, which ever elapses first.

Class	Identity of Unit			Prices				
	No.	Model	Name	List Price	Discount Price	Down Payment	Rental	Maintenance
Central Processor	709	1	Central Processing Unit	500,000	300,000	45,000	10,000	1,456.00
	736	2	Power Supply	57,200	17,160	858	1,100	97.25
	741	2	Power Supply	72,800	21,840	1,092	1,400	66.50
	741	3	Power Supply	72,800	21,840	1,092	1,400	66.50
	746	2	Power Distribution Unit	72,800	21,840	1,092	1,400	42.00
	746	3	Power Distribution Unit	67,600	20,280	1,014	1,300	42.00
	753	1	Tape Control	90,000	27,000	1,350	1,500	210.00
	766	1	Data Synchronizer Max. 3 per system. Each has 2 Data Channels.	190,000	114,000	17,100	3,600	502.00
Storage	733	1	Magnetic Drum Storage	110,000	33,000	1,650	2,900	372.00
	733	2	Magnetic Drum Storage	110,000	33,000	1,650	2,900	372.00
	737	3	Magnetic Core Storage	192,400	57,720	2,886	3,700	238.00
	737	4	Magnetic Core Storage	192,400	57,720	2,886	3,700	238.00
	738	1	Magnetic Core Storage	940,000	282,000	14,100	19,700	960.00
Input/Output	729	1	Magnetic Tape Unit Max. 8 per channel.	27,500	16,500	2,475	700	216.00
	716	1	Printer	54,200	24,390	3,659	1,200	217.00
	711	2	Card Reader	32,000	14,400	2,160	800	119.00
	721	1	Card Punch 711 and 721 must be connected to a 716.	25,000	11,250	1,688	600	117.00
	740	1	CRT Reader	96,000	28,800	1,440	2,450	215.00
	780	1	CRT Display	16,000	4,800	240	400	65.50

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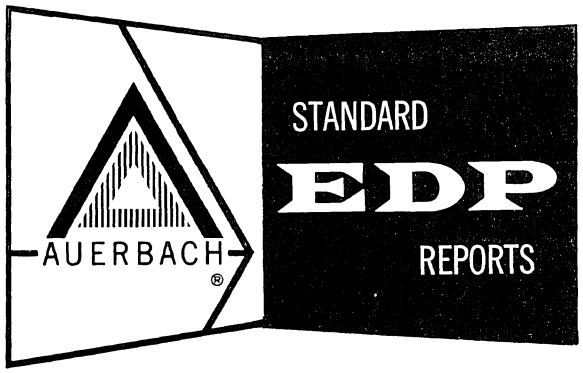
PRICE DATA–Contd.

§ 221.

Class	No.	Name	Rental	RPQ No.
SPECIAL OPTIONS	727	On-line off-line Switch (3 tapes)	- - -	- - - -
	716	Printer Carriage change 6 or 10 lines/inch	25.00	74718
		6 or 15 lines/inch	25.00	72234
		Printer Accounting Clock	50.00	78054
		Printer Co-selector	5.00/selector	51014
		Type Wheel Cradle Assembly	1,725.00 (sale price plus $15.00 for use).	70958
	721	Card Punch		
		Double punch blank column check (DPBC)	15.00 for 10 positions	51402
	704	Central Processor		
		Sense Switches 7-12	75.00	54989
		Half-word arithmetic	500.00	60169
		Rewind Unload	40.00	W 90207
	753	Tape Control Rewind Unload	17.00	W 90207
	727	Magnetic Tape Unit Rewind Unload	17.00	W 90207

IBM 7090

International Business Machines Corp.



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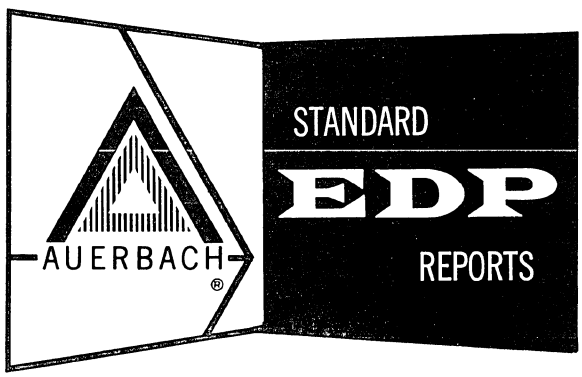
IBM 7090

International Business Machines Corp.



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§ 011.

INTRODUCTION

The IBM 7090 is a large-scale data processing system with the same general characteristics as the 704 and 709 general purpose computers. Comparative throughput capacities indicate that the 7090 has a six to seven times advantage over the 704. Because only low-speed printers, card readers, and punches can be connected to the system, 7090 systems are magnetic tape oriented and usually supported by off-line IBM 1401 data processing systems. The 1401 systems perform card-to-tape and tape-to-printer or tape-to-card operations, in addition to some editing for the 7090. Magnetic tape units can be switched between the 7090 and 1401 systems. Monthly rentals for two-channel, eight-tape 7090 systems start at approximately $60,000 (see System Configuration 408:031).

The 7090 transmits and receives data via a unit called the 7606 Multiplexor, which time shares the data flow between the 32,768-word core storage unit and either the processor or data channels. These data transfers are executed through 36-bit word parallel circuits. The multiplexor determines which unit requires access to storage most urgently and grants that unit access. In general, a processor request is less urgent than a data channel request because the channel controls mechanical equipment, such as magnetic tape units, which have a fixed demand cycle.

The basic cycle time of the 7090 central processor, i.e., the time for accessing the store and performing a part of an instruction, is 2.18 microseconds. Most instructions are executed in two cycles, permitting speeds of nearly 227,000 instruction executions per second in data processing applications. Multiplication and division instructions require more cycles, and are executed at 41,700 and 35,400 executions per second respectively. Therefore, applications demanding heavy use of multiply and divide operations use a larger share of central processor time than those involving primarily data movement and simple arithmetic operations. In applications that involve throughput of large volumes of data, the system tends to be speed-limited by the input-output facilities.

The processor uses binary arithmetic for both fixed and floating point operations. Fixed point arithmetic is performed on 35 bits, plus sign and two overflow bits. Floating point operands have eight-decimal-digit precision, and can assume positive or negative values between 10^{+38} and 10^{-38}, including zero. Three "table look-at" instructions in the repertoire are very useful for code conversions, radix conversions, six-bit BCD addition and subtraction, and simple editing. Address modification is facilitated by three decrementing index registers. These registers use two's complement arithmetic rather than the absolute value and sign arithmetic of the processor. However, a set of index register modification instructions compensate for this incompatibility of two types of arithmetic. In programs which use many indices for varied loop control, more indexing is required than three index registers can provide. As a result, the storing and reloading of the index registers may be required comparatively often. These operations require both data and program storage, and add a non-productive burden which, although small, is unusual in a large system of this type.

The instruction repertoire of the 7090 is comprehensive and varied, and includes five types of logical operators, single- and partial-word data transfers, input-output instructions (used to start data channels and select input-output units), and an extensive set of test and conditional transfer instructions. Interrupts (called traps by IBM) can occur when encountering: a transfer instruction, a 7040 or 7044 instruction, floating point underflow or overflow, a 704 input-output instruction, or an external signal; and for certain data channel conditions.

A 7090 system can include any of three different types of data channels: the 7607 Data Channels, which can control 729 Magnetic Tapes and peripheral unit-record equipment; the 7909 Data Channel, which can be connected to 7340 Hypertapes, 1301 Disk Units, and 7320 Drums; or the 7281 II Data Communications Channel, which can control up to 32 "real-time" communication units. The 7281 II is different from the others in that it: is restricted

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§ 011. INTRODUCTION (Contd.)

to one area of storage; can only be turned on or off; requires the Direct Data option and instructions; and has higher priority interrupts than the 7607 and 7909.

The 7607 and 7909 Data Channels are actually small processors which have program and address counters, indirect addressing, and command registers. The function of these units is to transmit data from the core store to an input-output unit, and vice versa. Data transfers to and from the store are performed through parallel 36-bit word circuits. In all of the input-output units, data transfers are serial by character to or from a six-character word. Both units can control scatter-read and gather-write operations, and skip entire data blocks or parts of data blocks being read from an input-output unit.

The 7607 Data Channel can also have a Direct Data Connection added to it to permit on-line storage-to-storage data transfers between 7040, 7044, and 7094 systems. The 7607 can act as a controller for connecting up to ten 729 Magnetic Tape units, a printer, a card reader, and a card punch.

The 7909 Data Channel has a more extensive command set than the 7607. These commands give the 7909 the ability to handle many of the input-output unit conditions that would require processor intervention with the 7607 Data Channel. The 7909 can be used for input-output editing, but the processor can perform editing tasks more economically. The 7909 has a transmit command which transfers blocks of up to 32,768 words simultaneously with other processing.

The software for the 7090 system that is supplied by IBM is rather extensive. Included in this software are the process oriented languages FORTRAN II and IV, COBOL, and COMTRAN. Source statements in these languages are translated into machine code and into FAP or IBMAP, which are the machine oriented languages for the system.

Problem oriented languages include: 9PAC for file maintenance and report generation, IOCS for automatic input-output editing for formatting, various sort programs, and Disk and Hypertape utility routines. Each program has its own monitor routine to permit processing with a minimum of operator intervention. All of the software can be used as a part of the IBSYS Processor Operating System, which permits input-output unit assignment and can call the programs in the system, in addition to its normal monitor and maintenance functions.

The 7090 can accept nearly all 704, 709, 7040 and 7094 programs directly, as compiled on those systems. A special program, Compatibility II, is provided for 704 programs. Because of the compatibility features built into the 7090, very little interpretive running is required. Thus, programs generated for the other systems run proportionately faster on the 7090 than on the system they are generated for. With the exception of the double-precision arithmetic instruction, 7094 programs can also be run on the 7090.

A wide range of programs for handling mathematical function routines and service and utility routines, as well as many complete program systems, have been compiled and are maintained by the SHARE users organization since it was formed by 704 users. The 7090 can accept nearly all of these programs directly.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word position:	36 bits	basic addressable location in core storage.
Row:	6 bits + parity	character on magnetic tape.
Column:	single column code	character on punched cards.
Unit Record:	24 words	punched card or its image in core storage.
Group or "byte":	6 or 8 bits + parity bit	a BCD char on band of a disk surface.
Band:	2,790 char max	usable length of band in disk store.
Record:	1 to 2,790 char	related char in a band.
Record:	1 to N words	related words on mag tape.
Cylinder:	40 bands	addressable group of bands.
File:	1 to N records	mag tape or disk store.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	BCD char on mag tape or disk. card column.
Alphameric char: . .	BCD char on mag tape or disk. card column. 6 bits of word.
Fixed point number:	sign bit plus 35 bits in word.
Floating point number:	sign bit plus 8 bit characteristic plus 27 bit fractional part in word.
Instruction:	1 word.
Data:	1 word.

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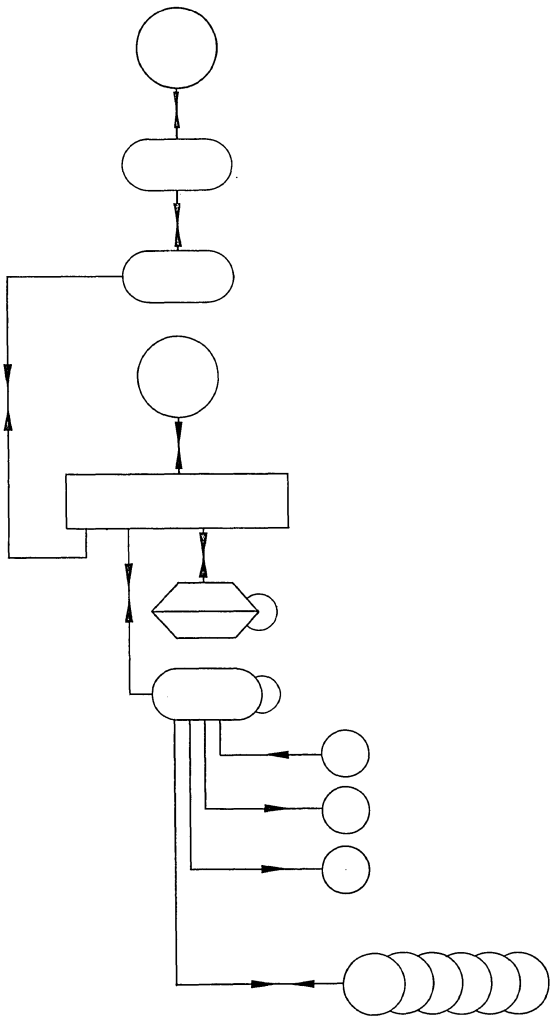
SYSTEM CONFIGURATION

§ 031.

.1 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . . card reader slower by 250 cards/min.
printer slower by 350 lines/min.
magnetic tapes faster by 11,700 char/sec.
floating point included.
no typewriter output.

Rental: . . . . . $ 64,060 per month.



Equipment	Rental
1301 Model 1 Disk Storage: 27,900,000 char.	$ 2,125
7631 Model 2 Disk Storage Control	835
7909 Data Channel	2,800
7302 Core Storage: 32,768 words	17,500
7606 Multiplexor	3,900
7108 Instruction Processing Unit	10,600
7109 Arithmetic Sequence Unit	8,675
7151 Console Control Unit	1,225
7607 Model 1 Data Channel	4,275
7617 Console	225
711 Card Reader: 250 cards/min.	800
721 Card Punch: 100 cards/min.	600
716 Printer: 150 lines/min.	1,200
729 II Magnetic Tape Units (6): 41,700 char/sec.	4,200
Power Supplies	1,600
Total Rental:	$64,060

Optional Features Included: . . . . . Cylinder Mode (Disk Storage).

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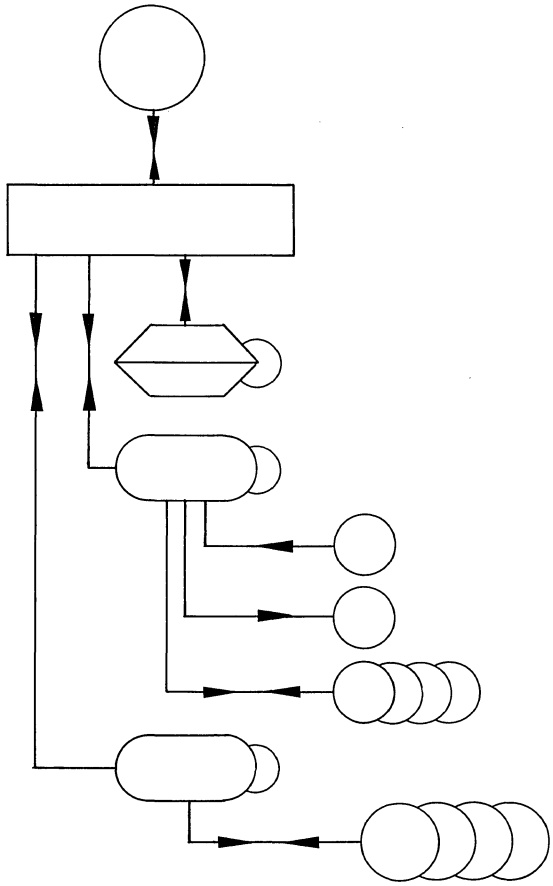
§ 031.

.2 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VII B

Main Computer



Equipment	Rental
7302 Core Storage: 32,768	17,500
7606 Multiplexor	3,900
7108 Instruction Processing Unit	10,600
7109 Arithmetic Sequence Unit	8,675
7151 Console Control Unit	1,225
7607 Model 1 Data Channel	4,275
7617 Console	225
711 Card Reader: 250 cards/min.	800
716 Printer: 150 lines/min.	1,200
729 IV Magnetic Tape Units (4): 62,500 char/sec.	3,600
7607 Model 2 Data Channel	3,275
7617 Console	225
729 IV Magnetic Tape Units (4): 62,500 char/sec.	3,600
Power Supplies	1,600
Total Rental:	$60,700

Deviations from Standard Configuration: . . . . . 19,500 words more storage.
printer not required.
card reader 150 cards/min. faster.
3 fewer index registers.
no input-output by typewriter.

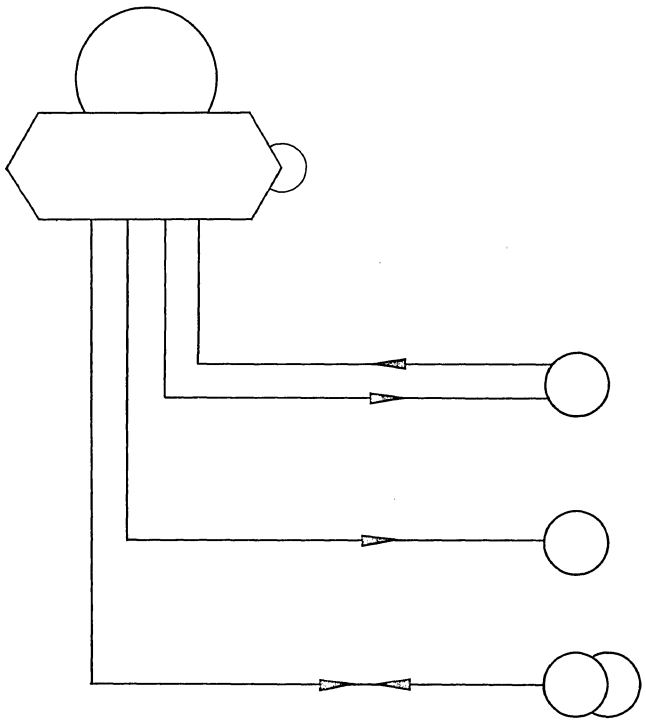
Rental: . . . . . $60,700 per month.

Optional Features Included: . . . . . printer (required for operation of card reader).

§ 031.

.2 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VII B (Contd.)

Auxiliary Computer (IBM 1401)



Equipment	Rental
1406 Core Storage: 4, 000 positions Processing Unit: 1401 Model C3 Console	$2, 680
1402 Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
1403 Printer: 600 lines/min.	835
729 II Magnetic Tape Units (2): 15, 000 or 41, 667 char/sec.	1, 400
Optional Features	605
Total Rental:	$6, 070

Deviations from Standard Configuration: . . . . . none.

Rental: . . . . . $6, 070 per month.

Optional Features Included: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Early Card Read.

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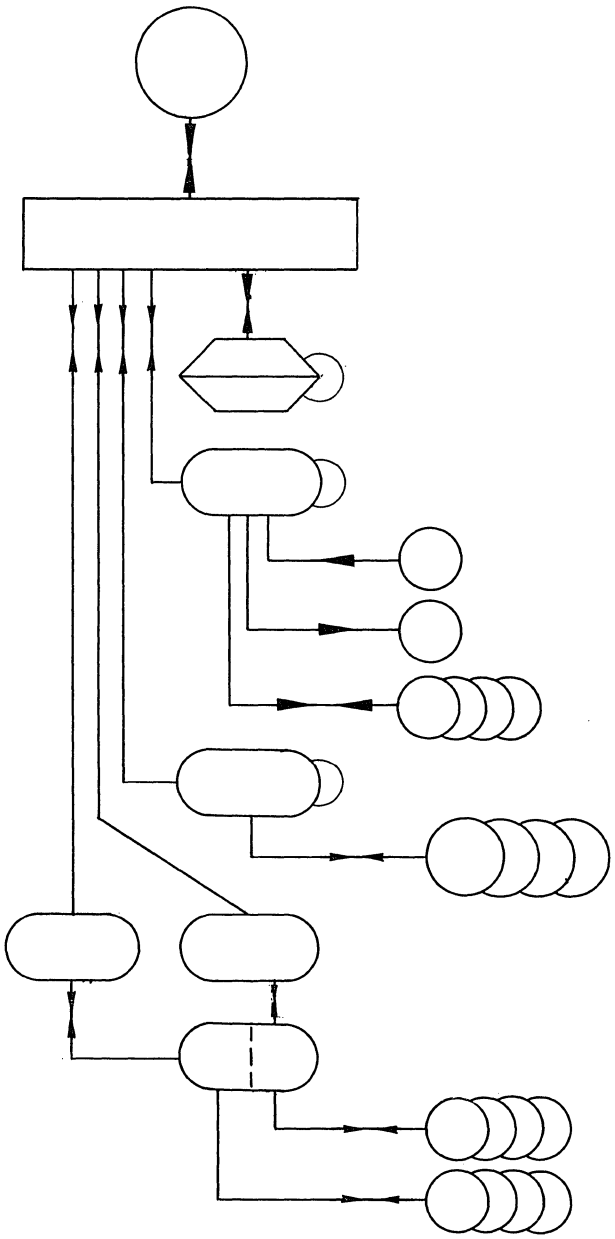
§ 031.

.3 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIII B

Main Computer



Equipment	Rental
7302 Core Storage: 32, 768 words	$17, 500
7606 Multiplexor	3, 900
7108 Instruction Processing Unit	10, 600
7109 Arithmetic Sequence Unit	8, 675
7151 Console Control Unit	1, 225
7607 Model 3 Data Channel	4, 360
7617 Console	225
711 Card Reader: 250 cards/min.	800
716 Printer: 150 lines/min.	1, 200
729 VI Magnetic Tape Units (4): 90, 000 char/sec.	3, 800
7607 Model 4 Data Channel	3, 360
7617 Console	225
729 VI Magnetic Tape Units (4): 90, 000 char/sec.	3, 800
7909 Data Channels (2)	5, 600
7640 Control	3, 400
7340 Hypertape Drives (4): 170, 000 char/sec.	5, 200
7340 Hypertape Drives (4): 170, 000 char/sec.	5, 200
Power Supplies	1, 600
Total Rental:	$80, 670

Deviations from Standard Configuration . . . . . 6, 100 words more storage.
printer not required.
card reader 150 cards/min. faster.
7 fewer index registers.
no input-output registers.
8 tapes 30, 000 char/sec. slower.
8 tapes 50, 000 char/sec. faster.

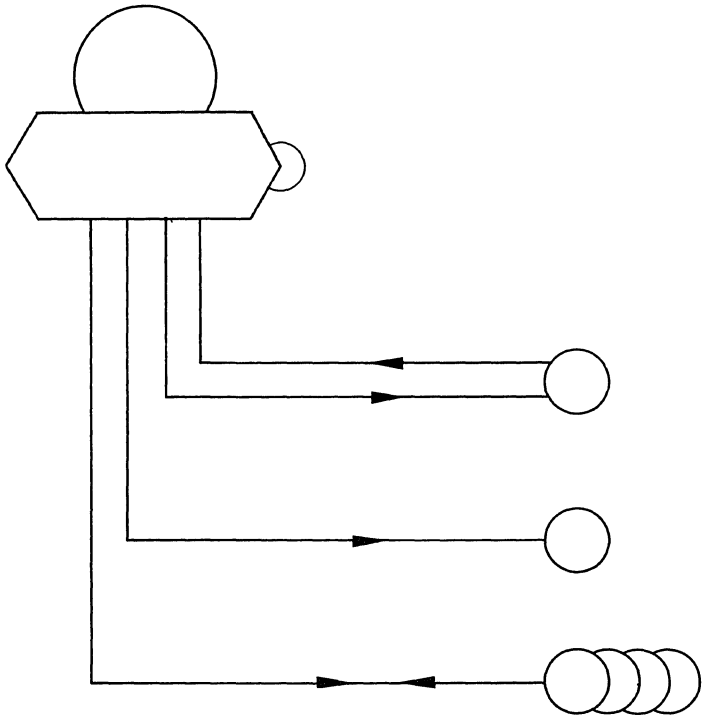
Rental: . . . . . $80, 670 per month.

Optional Features Included: . . . . . printer (required for operation of card reader).

§ 031.

.3 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIII B (Cont'd)

Auxiliary Computer (IBM 1401)



Equipment	Rental
1406 Core Storage: 8,000 positions	$ 575
Processing Unit: 1401 Model C4	2,730
Console	
1402 Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
1403 Printer: 600 lines/min.	835
729 V Magnetic Tape Units (4): 60,000 char/sec.	3,000
Optional Features	855
Total Rental:	$ 8,545

Deviations from Standard Configuration . . . . . none.

Rental . . . . . $8,545 per month.

Optional Features Included: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Processing Overlap.
Early Card Read.

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INTERNAL STORAGE: 7302 CORE STORAGE

§041.

.1 GENERAL

.11 Identity: . . . . . 7302 Core Storage.

.12 Basic Use: . . . . . working storage.

.13 Description

The IBM 7302 storage unit is used with the 7030, 7080, 7090, 7094 systems. The unit is attached to a 7090 through a 7606 Multiplexor. The 7302 has a capacity of 32,768 words of 36 bits each. Error or check bits are not used. The unit does, however, contain circuits that may be used for checking or as an aid to servicing.

Data is accessed in the store in 72 data bit groups. In the 7090 system, the unwanted 36 bit group is ignored.

.16 Reserved Storage

Purpose	Number of locations
I/O Control:	6 to 36.
Transfer trapping: . .	3.
Floating point trap: .	2.

.2 PHYSICAL FORM

.21 Storage Medium: . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter: . . . 50 mils.
Core bore: . . . . . 30 mils.
Array size: . . . . . 72 bits by 128 bits by 128 bits.
80 inches by 36 inches by 70 inches.

.23 Storage phenomenon: . . . . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . yes
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . yes.
.244 Data permanent: . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . coincident current.
.282 Reading method: . . . sense wire.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates

	Peak	Effective
Cycling rates: . .	500,000 cps.	458,716 cps.
Unit of data: . . .	1 word.	
Conversion factor:	36 bits/word.	
Data rate: . . .	18,000,000 bits/sec.	16,523,776 bits/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage
Identity:	7302
Words:	32,768.
Characters:	196,608.
Instructions:	32,768.
Modules:	1.

.32 Rules for Combining Modules: . . . . . not permitted.

.4 CONTROLLER

.41 Identity: . . . . . 7606. Multiplexor.

.42 Connection to System

.421 On-Line: . . . . . one.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks: . . one.

.52 Simultaneous Operations: . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access	Peak	Effective
Access time:	0.55 μ sec.	2.18
Cycle time:	2.00 μ sec.	2.18
For data unit of: . . .	2 words.	1 word.

.6 CHANGEABLE STORAGE: . . . . . none.

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§041.

.7 PERFORMANCE

.71 Data Transfer

Pair of storage units possible

With self (Via 7909 Data Channel): . . . yes
With self (Via 7090 Processor): . . . . yes

.72 Transfer Load Size

With self (via 7909): . . N words.
With self (via 7090): . . 1 word.

.73 Effective Transfer Rate

With self (via 7909): . . 230,000 words/sec.
4.36 μ. sec/word.
With self (via 7090): . . 78,000 words/sec.
12.8 μ.sec/word.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	not possible.	
Invalid code:	not possible.	
Receipt of data:	none.	
Recording of data:	none.	
Recovery of data:	none.	
Dispatch of data:	none.	
Timing conflicts:	none.	data is lost, (see 408:111.4).
Reference to locked area:	none.	module restricted store size.

INTERNAL STORAGE: 1301 DISK STORAGE UNIT

§ 042.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit. 1301 Models 1 and 2.

.12 Basic User: . . . . auxiliary storage.

.13 Description

The 1301 Model 1 Disk Storage Unit can store up to 27,900,000 alphameric characters. Model 2 has two modules on a single vertical shaft and can store up to 55,800,000 characters. Each module contains 25 discs; 40 of the 50 disc surfaces are used for data storage. Each module is served by a comb-like access mechanism. Forty data read-write heads, one for each data surface, move horizontally between the discs. The entire access mechanism moves as one unit, so the horizontal position of all the heads serving a given module is always the same. The 40 bands, one on each disc surface, that can be read or recorded upon when the access mechanism is in any given position are referred to as a "cylinder."

There are 250 bands on each disc surface. The size and number of records stored in each band are variable. Their formats are controlled by a format surface that can be written upon only by a special instruction after manually releasing a write lock. Each of the 250 bands on the format surface controls the record format of the entire cylinder in the corresponding position. A different record format can be used in each of the 250 cylinders in each module.

Data can be recorded in either the 6-bit or 8-bit mode. In the 6-bit mode each band can store up to 2,790 characters. In the 8-bit mode, only 2,160 alphameric characters can be stored in a band, and 6-bit groups are stacked in 8-bit locations. The other 2 bits on the disc are ignored or cleared. When more than one record is stored in a band, the data capacity is reduced by 38 characters for each additional record address. Instructions are provided to read or record a single record, a full band, or, with the optional Read/Write Cylinder feature (RC), a full cylinder of up to 111,600 characters.

Time for access mechanism movement ranges from zero (for a record in a previously-selected cylinder) to 180 milliseconds. Maximum rotation delay time is 34 milliseconds. Total reference cycle time to read a randomly-placed record of 270 characters, update it, re-write it, and execute a programmed write check is 248 milliseconds. If no access motion is required, the total reference cycle time is reduced to 88 milliseconds. Using the Read/Write Cylinder feature, an effective bulk transfer rate of 13,833 words, or 83,000 characters, per second can be achieved in the 6-bit mode.

.13 Description (Cont'd)

Checking features include a validity check upon data received by the File Control, a comparison of the record address on the disc with the address in the stored program, and checks for illegal operation codes or sequences of instructions. Three check characters are generated and recorded during each write operation. When the record is read, the check characters are automatically generated again and compared with the ones read from the disc. As in the 7300 RAMAC unit, a programmed comparison of data recorded on a disc with data in core storage can be made.

A maximum of five 1301 Disk Storage Units can be connected to one or two 7631 File Controls. Each 7631 is attached to a 7090/94 via 7909 Channels. Two read or write operations can occur simultaneously when two File Controls are used. Every disc storage operation is initiated by a "channel select" instruction, which sends the core storage address of the initial channel command word to the specified Data Channel. Internal processing then continues while the Data Channel independently controls the disc operation. A group of 1301 units can be shared by two IBM 7000 series and/or 1410 systems.

Optional Features

#3213 Cylinder Mode (RC). Enables transfers of data, by one instruction, of a complete cylinder of up to some 18,600 words, or 111,600 characters.

.14 Availability: . . . . . 12 to 15 months (**).

.15 First Delivery: . . . July, 1962.

.16 Reserved Storage

Purpose	Number of locations	Locks
Clocking:	1 disc surface	not addressable.
Spares:	6 disc surfaces	not addressable.
	2 disc surfaces	no heads available.
Format:	1 disc surface	manual lock.
Addresses:	31 + 38R char/band, for R records/band	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Disc

Diameter: . . . . . 24 inches.
Thickness: . . . . . thin.
Number on shaft: . . Model 1, 25 discs.
Model 2, 50 discs.

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§ 042.

.23 Storage Phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . no.
.244 Data permanent: . . . no.
.245 Storage changeable: . . . . no.

.25 Data Volume per Band of 1 Track

	6-bit mode	8-bit mode
Words:	465	360.
Characters:	2,790	2,160.
Digits:	2,790	2,160
Instructions:	465	360.

Note: These are maximum capacities, based upon 1 record per band; each additional record address requires 38 characters, or 7 words.

.26 Bands per Physical Unit: . . . . . 250 per disc surface.

.27 Interleaving Levels: . . 1.

.28 Access Techniques

.281 Recording method: . . magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to selected band: . .	if new band is selected.
Wait for selected record:	if same band was previously selected.
Wait for transfer of data:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . 1,800 rpm.
Bit rate per track: . . 630,000 bits/sec, including char. gaps.
540,000 bits/sec, data bits only.
Note: based on 6-bit mode.

.292 Peak data rates
Unit of data: . . . . character.
Conversion factor: . 7 or 9 (including space bit).
Gain factor: . . . . 1 track/band.
Data rate
6-bit mode: . . . . 90,000 char/sec.
8-bit mode: . . . . 70,000 char/sec.
8,750 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	Minimum Storage	1301 Model 1	1301 Model 2	Maximum Storage 5 1301s. Model 2.
Discs:	0	20 data	40 data	200 data.
Words:	0	4,650,000	9,300,000	46,500,000.
Characters:	0	27,900,000	55,800,000	279,000,000.
Instructions:	0	4,650,000	9,300,000	46,500,000.
Cylinder char:		111,600	223,200	1,116,000.
Cylinder word:		18,600	37,200	180,000.
Modules:	0	1	2	10.
Basis:	6-bit mode, 1 record/band.			

.32 Rules for Combining Modules: . . . . . up to five 1301s, Model 1 and/or Model 2 in any combination.

.4 CONTROLLER

.41 Identity: . . . . . File Control.
7631 Model 2, 3, or 4.

Data Channel.
7909 (see 708:102.12).

.42 Connection to System

.421 On-Line: . . . . . one 7631 with one 7909, or two 7631s with two 7909s (two channels).
.422 Off-Line: . . . . . 7631 Model 3 permits shared use of 1301s with an IBM 1410 system.

7631 Model 4 permits shared use with another 7000 series system (except 7072).

.43 Connection to Device

.431 Devices per controller: . . . . 5.
.432 Restrictions: . . . . maximum of 5 1301s per system, whether 1 or 2 7631s are used.

.44 Data Transfer Control

.441 Size of load: . . . . 1 record of up to 2,790 chars, 1 band of up to 2,790 chars, or (with read/write cylinder option) 1 cylinder of up to 111,600 characters.

§ 042.

.442 Input-output area: . . . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . automatic.
.447 Table control: . . . yes; scatter-read and gather-write, controlled by channel commands.
.448 Testable conditions: . . . . access not ready, access inoperable, and various error conditions are signaled by the File Control in response to a "sense" command.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
- Stacks per system: . 40 to 400, data only.
- Stacks per module: . 40.
- Stacks per yoke: . . 40.
- Yokes per module: . 1.
- Total per system: . 50 to 500, including spares and control, (see 408:042.16).

.512 Stack movement: . . horizontal.
.513 Stacks that can access any particular location: . . . . . 1.
.514 Accessible locations
- By single stack
  - With no movement: . 1 band.
  - With all movement: . . . . . 250 bands.
- By all stacks
  - With no movement: . . . . . 40 bands per module. 40 to 400 bands per system.

.515 Relationship between stacks and locations: . . . . . first 4 digits of 6-digit home address for each band denote head and band number.

.52 Simultaneous Operations

A: . . . . . seeking a specified location.
B: . . . . . reading.
C: . . . . . recording.

a + b + c = at most 1 per DSU module.
b + c = at most 1 per File Control.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, m.sec.	Example, m.sec.
Move head to selected band:	0 or 50 to 180	160.0.
Wait for selected record:	0 to 34	17.0.
Read one record:	0.4 to 34	4.0.
Read one band:	34.	
Total:	0.4 to 248	181.0.

.6 CHANGEABLE STORAGE: . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possibilities
- With self: . . . . no.
- With core storage: . yes.

.72 Transfer Load Size

With core storage: . 1 record, 1 band, or (with RC) 1 cylinder.

.73 Effective Transfer Rate

With core storage, using optional RC
- 6-bit mode: . . . 83,700 char/sec. 13,950 words/sec.
- 8-bit mode: . . . 65,000 char/sec. 10,833 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	indicator.
Invalid code:	check	indicator.
Receipt of data:	parity bit check	indicator.
Recording of data:	programmed write check; generate check characters	indicator.
Dispatch of data:	parity	indicator.
Timing conflicts:	check	indicator.
Physical record missing:	check	indicator.
Reference to locked area:	ignored.	
Access inoperative:	check	indicator.
Circuit failure:	check	indicator.
Illegal instruction sequence:	check	indicator.
Illegal format character:	check	indicator.

Note: These error indications are transmitted from the File Control to the computer in response to a "sense" command.

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CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . Central Processor.

IBM 7108.
Instruction Processing Unit.

IBM 7109.
Arithmetic Sequencing Unit.

.12 Description

The 7090 is a large-scale binary computer. It is particularly suited to large-scale numeric, real-time, and simulation applications. The single-address instructions provided cover an extensive range of fixed and floating point operations on 36-bit words. Useful instructions are included to cover both logical and table look-up operations. Addition and multiplication instructions each take about 4 and 25 microseconds respectively.

The IBM 7090 processor is the solid-state successor to the 709 processor. Although it is composed of two physical units, it can be considered a single unit from a user's point of view. The 7090 processor includes all of the characteristics of the 709. Using the 2.18 microsecond cycle core storage, the processor times are approximately one tenth of those for the 709. The 7090 can execute approximately 250,000 additions or 40,000 multiplications per second. The differences from the 709 are summarized in the last paragraph.

The numeric representation is sign bit and binary magnitude, using binary arithmetic for both fixed and floating point arithmetic. On the other hand, the index registers use two's complement arithmetic, and the 7090 includes extra instructions to complement binary values being transferred to, but not from, the index registers. The three index registers are again used as in the 709 and 704; i.e., an instruction can call none, one, two, or all three index registers which are "ORed" together, then subtracted from the instruction address.

An idea of the variety of the facilities can be given by specific examples.

A set of "convert" instructions is provided which can be used to do arithmetic using six-bit BCD characters, radix conversions, editing, and character conversion (both size and bit configuration). These are in reality compound "table look-up" operations. The table is a list which contains an entry for each possible value of a six-bit character. Each list entry contains in one word both a value and the base address of a list. Unless successive characters have no positional significance (e.g., blanks), a list is required for each level of significance. The values may be used for addition or concatenation, for radix and code conversion respectively.

.12 Description (Contd.)

This radix-to-binary conversion for six digit numbers is straightforward in one instruction and a table. Editing is considerably simplified. Conversion from binary is still awkward.

There is one level of indirect addressing. The second address is not checked for an indirect address indicator. Both addresses are indexable, one before, the other after the indirect address is used.

There is a fully recursive execute operation.

In addition to four standard sense lights, there is a 36-bit indicator register. A large number of instructions are provided to set, reset, and test this register. The register can be used very effectively for multi-sequencing or input-output control routines. The keyboard can be used as a sense switch register that can be stored, then tested. The six standard sense switches can be tested, but no instruction is provided to store them.

The central processor is used to initiate Data Channel operations. The 7090 has two kinds of data channels. First, the 7607 Data Channel, for use with 729 tape units and unit record equipment, is a solid-state version of a data Synchronizer. With the exception of a new Reset Channel instruction, it is identical to the 766 from a programming viewpoint. Second, there is the new 7909 Data Channel that the 7090 uses for controlling 7340 Hypertapes and 1301 Discs, and which has required the addition of a few new processor instructions and new control commands for the new units.

Additional "trap" locations have also been added for the 7090 Data Channels, because a 7909 Data Channel can accept and act on interrupts (traps) without disturbing the processor. When a trap occurs, the program counter at the time of the trap, and/or the conditions that caused it, are stored in specific storage locations. The program counter is set to access the next instruction from another specific storage location. The specific locations are different for each type of trap. Traps are caused by: any transfer order which results in a transfer (the address is stored in any event); the data channel signals (command completed, end-of-file, and magnetic tape error); encountering a 704 or 709 input-output instruction (Simulate Mode); an external signal; or encountering a floating point underflow or overflow (spill). All of these trap conditions except the external signal can be turned on or off by instruction.

The main feature of the Central Processor facilities is great variety. This variety can be considered from three viewpoints. First, it provides scope for many types of operations to be performed efficiently for all types of logical and numerical working.

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.12 Description (Contd.)

Second, the variety presents serious problems in learning all the possible ramifications. Third, this also makes it difficult to write efficient generalized routines because of the many special cases that must be covered. It is particularly difficult for tyros to understand expert coding which uses the variety extensively, and the extensive descriptions are often distributed in pieces throughout many manuals. On the other hand, a tyro need not use the full variety, and the manuals are well set out for learning. In the first instance, the subtraction of modifiers, inherited in the 704, and the complement arithmetic of the index registers seem unnatural. In general, the 7090 processor is a tool for experts rather than tyros.

The most restricting items in the specification are the limit of three index registers and 36-bit word size. The 7094 provides more index registers (in a compatible manner) and double-length operations.

The 7090 processor can accept all 704 or 709 programs and most of the 7094 and 7040/44 programs. A program called Compatibility II is available which handles input-output differences between the 704, 709, or 7090. When running programs written for other machines, it is necessary to eliminate references to input-output devices that do not exist on the 7090, and a few instructions that are not included in the 7090 instruction repertoire. The faster speed of the 7090 can cause timing problems when programs tightly coded for slower machines are run on it. The inverse of the above is true when running 7090 programs on slower machines.

In summary, the differences between the 7090 and the 709 are, the

additional interrupts, i.e., "traps".

elimination of the Drum and CRT instructions.

additional Disc and Hypertape instructions and orders.

additional index instructions; load complement, etc.

standard inclusion of 709 input-output optional features; rewind and lock, etc.

The changes are:

the arithmetic speed is increased approximately ten times.

the console is a separate unit.

the 709 is a vacuum-tube processor, whereas the 7090 is solid-state.

less air conditioning is required.

an off-line computer (as opposed to a tape-to-printer unit) is required for efficient operation.

.13 Availability: . . . . . not in production, can only be rented or purchased used or rebuilt when available.

.14 First Delivery: . . . . November, 1959.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-subtract:	automatic	binary	35 bits & sign.
Multiply			
Short:	automatic	binary	0 to 35 bits and sign.
Long:	automatic	binary	35 bits & sign.
Divide			
Remainder:	automatic	binary	35 bits & sign.

.212 Floating point

			Fraction	Characteristic
Add-subtract: ‡	automatic	binary	27 bits & sign	8 bits
Multiply: ‡	automatic	binary	27 bits & sign	8 bits
Divide: ‡	automatic	binary	27 bits & sign	8 bits

‡ Both normalized and unnormalized.

.213 Boolean

AND:	automatic	binary	36 bits
Inclusive OR:	automatic	binary	36 bits
Exclusive OR:	automatic	binary	36 bits
NOT:	automatic	binary	37 bits

.214 Comparison

Numbers:	automatic	36 bits
Absolute:	automatic	36 bits
Letters:	automatic	36 bits
Mixed:	automatic	36 bits

.215 Code translation

Provision	From	To	Size
†	any code	any code	six 6-bit char
standard subroutine	card image	BCD	36 bits or 6 chars.
standard subroutine	6-bit BCD	card image	36 bits or 6 chars.

† Special tables are specified to be used with convert instructions.

.216 Radix conversion

automatic	6-bit BCD	any radix	20 bits.
standard subroutine	any radix	6-bit BCD	36 bits or 6 chars.

† Special tables are specified to be used with convert instructions.

.217 Edit format

	Provision	Comment	Size
Suppress zero:	semi-automatic	separate sequences using convert instructions and/or logical instructions, with appropriate tables	six 6-bit characters.
Round off:	semi-automatic		
Insert point:	semi-automatic		
Insert spaces:	semi-automatic		
Insert character:	semi-automatic		
Float character:	semi-automatic		
Protection:	semi-automatic		

.218 Table look-up: . . . . . none.

.219 Others

Test: . . . . . 1 to 36 bits.

.22 Special Cases of Operands

.221 Negative numbers: . . . binary magnitude and sign.

.222 Zero: . . . . . + or -; may or may not be equal, depends on instructions.

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.223 Operand size determination: . . . . 36, 18, 15, 3, or 1 bits; variable 0 to 36 bits in multiply and divide, and also six 6-bit characters.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout

Part	Operations	Flag/Count	Tag	Address
Size (bits)	12	6	3	15

Part	Operation	Flag	Not Used*	Tag	Address
Size (bits)	3	2	4	3	15

Part	Operation	Decrement	Tag	Address
Size (bits)	3	15	3	15

* Not used for most instructions.

.233 Instruction parts

Name	Purpose
Operation:	operation code
Flag:	indirect addressing specification.
Tag:	index register specification.
Address:	operand address.
Count:	variable length operands and counts.

.234 Basic address structure: 1 address (sequential).

.235 Literals

Arithmetic:	none.
Comparisons and tests:	none.
Incrementing modifiers:	0 to 32,767.
Setting modifiers: . .	0 to 32,767.

.236 Directly addressed operands

.2361 Internal storage type	Minimum size	Maximum size	Volume accessible
Core Store:	3 bits	entire store †	entire storage
Magnetic Disc:	1 word	18,600 words ‡	entire storage

† Only one word unless 7909 Data Channel included.

‡ Only 465 words unless R/C option is included (see 408:042.013).

.2362 Increased address capacity: . . . . . none.

.237 Address indexing

.2371 Number of methods: . 1.

.2372 Names: . . . . . indexing (can be multiple indexes).

.2373 Indexing rule: . . . . . the contents of the indicated index registers are ORed together then subtracted from the address of the instruction to form the effective address.

.2374 Index specification: . . each of the index bits specifies an index register.

.2375 Number of potential indexers: . . . . . 3.

.2376 Addresses which can be indexed:

Type of address	Application
After ESNT instruction: . . .	0 to 16,383.
After LSNT instruction, normal condition: . .	0 to 32,767.

.2377 Cumulative indexing: . via indirect addressing and EXC instruction.

.2378 Combined index and step: . . . . . yes.

.238 Indirect addressing	IA bits	EXC instructions
.2381 Recursive:	no.	yes.
.2382 Designation:	2 bits in the instruction.	operation code EXC with or without IA bits.
.2383 Control:	automatic, one level only.	n level, will not stop until another instruction, other than EXC is encountered.

.2384 Indexing with indirect addressing: . . . . . yes; possible before and after going to the indirect address.

.239 Stepping: . . . . . index registers.

.2391 Specification of increment: . . . . . in stepping instruction.

.2392 Increment sign: . . . . positive.

.2393 Size of increment: . . 0 to 32,767.

.2394 End value: . . . . . value of increment.

.2395 Combined step and test: . . . . . yes.

.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in bits	Program usage
Accumulator	1	38	arithmetic unit.
Multiplier-Quotient:	1	36	arithmetic unit & input-output.
Index:	3	15	address modification.
Program counter:	1	15	specified instruction address.
Sense lights:	4	1	save conditions.
Sense switches:	6	1	accept condition.
Storage register:	1	36	buffer with store.
Instructions:	1	18	shift counter, holds instruction.
Indicator:	1	36	save condition.
7151 Console Keys:	1	36 bits	enter data.

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Category of storage	Total number locations	Physical form	Access time μ sec	Access time μ sec
Accumulator	1	register	0.36	2.18
Multiplier-Quotient:	1	register	0.36	2.18
Index:	3	register	0.36	2.18
Program counter:	1	register	0.36	2.18
Sense lights:	4	flip-flops	0.36	2.18
Sense switches:	6	switch	1.45	
Storage register:	1	register	0.36	2.18
Instruction:	1	register	- -	- -
Indicator:	1	register	0.36	2.18
7151 Console Keys:	1	36 switches	1.45	- -

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1 sequential.

.314 Special sub-sequence counters

Number	Purpose
1:	counts shifts (not accessible by program).

.315 Sequence control step size: . . . . . 1 word.

.316 Accessibility to routines: . . . . . change, save in index, or store.

.317 Permanent or optional modifier: . . . . . none.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes

In-out units: . . . . . external signal.
tape error.
end-of-file.
704 I/O instruction in copy trap mode.
direct data.

In-out controllers: . . when free.
Storage access: . . . none.
Processor errors: . . floating point underflow; overflow in floating trap mode.
Other: . . . . . on encountering transfer of control instruction while in trapping mode.

.332 Control by routine

Individual control: . . for I/O mask and instruction.
Method: . . . . . request by instruction.
Restriction: . . . . . external signal trap is always active and may cause timing conflicts.
some interrupts use common locations.

.333 Operator control: . . . can clear or set traps manually.

.334 Interruption conditions: only when specifically requested (floating point trap mode is normally on).
high to low class of interrupts; floating point, direct data, external signal data channel.

.335 Interruption process

Disabling interruption: first interrupt in any class disables all interrupts except higher classes.
Registers saved: . . . program counter.
Destination: . . . . . fixed location, depends on cause.

.336 Control methods

Determine cause: . . indication stored in a particular location.
Enable interruption: . instruction.

.34 Multi-running

.341 Method of control: . . . own coding.

.342 Maximum number of programs: . . . . . own coding.

.343 Precedence rules: . . . own coding.

.344 Program protection

Storage: . . . . . words 0 to 16,383 can be used, with words, 16,384 to 32,767 made unavailable by ESNT instruction.
In-out units: . . . . . own coding.
Maximum separate sets: . . . . . own coding.

.35 Multi-sequencing: . . . see paragraph .344.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ secs

.411 Fixed point

Add-subtract: . . . . 4.36.
Multiply: . . . . . 4.36 to 30.52 (25.29 avg.).
Divide: . . . . . 6.54 to 30.52 (30.52 avg.).

.412 Floating point

Add-subtract: . . . . 13.08 to 32.70 (13.95 avg.).
Multiply: . . . . . 4.36 to 28.34 (23.98 avg.).
Divide: . . . . . 6.54 to 28.34 (28.34 avg.).

.413 Additional allowance for

Indexing: . . . . . none.
Indirect addressing: . 2.18.
Re-complementing: . none.

.414 Control

Compare: . . . . . 4.36.
Branch: . . . . . 2.18.
Compare and branch: 6.54.

.415 Counter control

Step: . . . . . 4.36.
Step and test: . . . . . 4.36.
Test: . . . . . 4.36.

.416 Edit: . . . . . none.

.417 Convert: . . . . . 4.36 to 17.44 (17.44 avg.).

.418 Shift: . . . . . 4.36 to 17.44.

.42 Processor Performance in μ secs

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		Fixed point	Floating point
.421	For random address		
	$c = a + b$:	13.08	22.67
	$b = a + b$:	13.08	22.67
	Sum N items:	4.36 N	13.95 N
	$c = ab$:	34.01	32.70
	$c = a/b$:	39.24	37.06
.422	For arrays of data		
	$c_i = a_i + b_j$:	26.16	31.39
	$b_j = a_i + b_j$:	26.16	31.39
	Sum N items:	8.72	18.31
	$c = c + a_i b_j$:	45.78	55.27
.423	Branch based on comparison		
	Numeric data:	15.26N	
	Alphabetic data:	15.26N	
.424	Switching		
	Unchecked:	6.54.	
	Checked:	15.26.	
	List search:	13.08 (N+1).	
.425	Format control per character		
	Unpack:	112.92 card image to BCD. 16.48 BCD to binary.	
	Compose:	?	
.426	Table look up per comparison		
	For a match:	13.08 (N+1).	
	For least or greatest:	13.08 (N+1).	
	For interpolation point:	13.08 (N+1).	
.427	Bit indicators		
	Set bit in separate location:	2.18.	
	Set bit in pattern:	2.18.	
	Test bit in separate location:	4.36.	
	Test bit in pattern:	4.36.	
	Test AND for B bits:	4.36.	
	Test OR for B bits:	8.72.	
.428	Moving		
	XMT (With 7909 Data Channel):	6.54 + 4.36N.	
	4 instructions:	2.18 + 13.08N.	
	2N instructions:	8.72N.	

.5 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Overflow:	check	sets indicator.
Underflow (float-pt):	check	sets indicator.
Zero divisor:	check	sets indicator and/or stops processor.
Invalid data:	not possible.	
Invalid operation:	none	attempts operation.
Arithmetic error:	none.	
Invalid address:	check	modulo memory size.
Receipt of data:	none.	
Dispatch of data:	none.	

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CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . IBM 7151 Console Control.

.12 Description

The IBM 7151 Console Control is a free-standing desk unit which is basic to all 7090 systems. Power switches and indicators are part of this unit. Provision has been made for display of all processor registers in a set of individual lights (with the exception of the Sense Indicators, which are displayed in the Storage register). The Data Channel status indicators for each Channel, and the display, operation and entry controls present adequate information to assess the status of the 7090 system and to operate it.

Entry of data through the keyboard is somewhat cumbersome, as it is a two-step operation. However, a simple program that reads data and addresses from the entry keys can be used to facilitate the process.

.2 CONTROLS

.21 Power

Name	Form	Comment
Normal-On:	button	cycles up power in stages.
Normal-Off:	button	turns off all power in stages.
Emergency-Off:	pull switch	turns off all power immediately.

.22 Connections: . . . . . none.

.23 Stops and Restarts

Name	Form	Comment
Start:	button	starts computer operation after a program halt, read/write check, or when in automatic mode.
Auto-manual:	switch	stops computer operation after instruction in process is executed. When I/O device is in operation, computer stops after device disconnects.

.24 Stepping

Name	Form	Comment
Single Step:	button	used only in manual mode to execute program, 1 instruction at a time.
Multiple Step:	button	used only in manual mode to execute program automatically at a slow speed.

.25 Resets

Name	Form	Comment
Clear:	button	resets all registers in processor and the contents of core storage.
Reset:	button	resets all registers and indicators in logical section of computer.

.26 Loading

Name	Form	Comment
Load Cards: Load Drum: Load Tape:	buttons	allows operator to initiate the loading of a self-loading program stored on cards, drum or tape.

.27 Special

Name	Form	Comment
Enter MQ:	button	transfers manually keyed-in data to the MQ register
Enter Instruction:	button	causes manually keyed-in word to be executed.
Sense Switches:	switch	6 switches, the settings are program testable.
Display Storage:	button	the contents of the location specified by the address part of the manually keyed-in word are displayed in this register.
Display Effective Address:	button	displays in the address field of the storage register the difference between the contents of the address field of the storage register and the specified index register.
Panel Input Switches:	switches	36 input switches used for manually inserting a word.
Display Sense Indicator:	button	displays the contents of the 36 sense indicators in the storage register.

.3 DISPLAY

.31 Alarms

Name	Form	Condition
Alarm	bell	DC power turned off.

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.32 Conditions

Name	Form	Conditions Indicated
Accumulator Overflow:	light	indicates overflow during fixed point operation or shift operation.
MQ Overflow:	light	indicates MQ overflow when the processor is using the compatibility program.
Divide Check:	light	indicates in fixed point division that the dividend is greater than or equal to the divisor.
Channel Select:	lights	8 select lights, 1 for each channel. Each light turned on according to channel in operation.
Channel Check Trap:	lights	8 lights, 1 for each channel, lit when Tape Check Trap is enabled.
Command Trap:	lights	8 lights, 1 for each channel, lit when End of File or Command Trap is enabled.
Channel Tape Check:	lights	8 tape check lights, for each channel. A light is turned on when an error is detected.
Ready:	light	indicates circuits have reached their operating level.
Power:	light	indicates power is applied to the system.
Automatic:	light	on when computer is in automatic mode.
Trap Control:	light	on when computer is operating in the trap mode.
Sense Lights:	lights	4 sense lights controlled by the program.
I/O Power Check:	light	fuse blown or circuit breaker tripped in I/O equipment.
Simulate:	light	on when 7090 is operating in the 704-709 compatibility feature.
Program Stop:	light	turned on when computer executes a halt instruction.
Read-Write Select:	light	turned on when an I/O device has been selected for reading or writing.

.32 Conditions (Contd.)

Name	Form	Conditions Indicated
Console Processor:	light	on when the console is on.
Computer Components Check:	light	on when a fuse is blown or a circuit breaker is tripped in the Processor, Store, or Multiplexor.

.33 Control Registers

Name	Form	Comment
Instruction:	lights	18 neon lights, allocated to sign bit and bits 1 through 17.
Instruction Counter:	lights	15 neon lights, allocated to bits 21 through 35 to indicate location of next instruction.
Accumulator:	lights	38 neon lights, 1 for each bit position plus 1 for Q and 1 for P bit positions.
MQ:	lights	36 neon lights, 1 for each bit position of a word.
Index:	lights	15 neon lights for each of 3 index registers.

.34 Storage: . . . . . 36 neon lights to indicate contents of the processor buffer register.

.4 ENTRY OF DATA

.41 Into Registers

(1) Desired word keyed into the 36 panel input switches, then
(2) Depress Enter MQ button.

.42 Into Storage: . . . . . 1 core storage location is written into by using the enter instruction button with a store instruction keyed into the 36 manual input switches.

.5 CONVENIENCES

.51 Communication: . . . . optional.

.52 Clock: . . . . . optional.

.53 Desk Space: . . . . . none.

.54 View: . . . . . when operator is at console, all the equipment can easily be seen if conveniently placed.

INPUT-OUTPUT: 711 CARD READER

§071.

.1 GENERAL

.11 Identity: . . . . . Card Reader. Type 711, Model 2.

.12 Description

The 711 Card Reader, Model 2, reads cards at a rate of 250 cards a minute. Cards are fed from a hopper with a capacity of approximately 600 cards and placed in a stacker that holds approximately 1,200 cards.

A 711 Card Reader may be connected to each 7607, Model 1 or 3 (see 408:101.12) that has a 716 Printer attached. At least one 711 is required on each 7090 system.

During read operations, data read from cards is sent directly to storage under control of the Data Channel (see also 408:101). Words may be read into non-consecutive locations, through use of channel commands. This card is stored in the form of a "card image". Each card image represents 72 characters. Data read from cards may be in either binary or BCD codes, and by a suitable program, BCD data may be converted to binary data. The card image is represented by twenty-four 36-bit words; two words per row of the card image. The reader will only read 72 out of 80 columns of each card.

There are two card reading stations. Reading format is controlled by the stored program and a plugboard located on the reader. Format control signals can be read from a card at the first station by control brushes and decoded by plugboard wiring. The plugboard can be wired to control the format of a card read at the second read station. A minimum of 10 different formats can be conveniently wired and up to 80 columns can be controlled by these rearrangements.

The 711 Card Reader has a 240 millisecond card cycle in which there are four clutch points.

A programmed check of card reading of selected columns can be arranged by reading those columns at both stations. However, the total number of columns read, counting two for a column read at both stations, is still only 72. Thus, a total of 36 checked columns can be read.

Manual controls are provided for normal run-in of cards. Various contacts are used to sense for improper feeding of cards, and lamps are provided to indicate when a malfunction exists within the unit.

.13 Availability: . . . . not in production, can be rented or purchased used or rebuilt only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . . . clutch driven rollers.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . none.
.222 Sensing system: . . brush.

.24 Arrangement of Heads

Use of station: . . . reading (control)
Stacks: . . . . . 1.
Heads/stack: . . . . 80.
Method of use: . . . 1 row at a time.

Use of station: . . . reading.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . 80.
Method of use: . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Paralled by: . . . . 80-columns at standard spacing.
.324 Track use
Data: . . . . . 72.
Redundancy check: . 0.
Timing: . . . . . 0.
Control signals: . . 0.
Unused: . . . . . 8.
Total: . . . . . 80.
.325 Row use: . . . . . all for data.

.33 Coding

External: . . . . . row binary.
Hollerith code (see Data Code Table No. 2)
Internal: . . . . . card image of 72 columns.

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.34 Format Compatibility: . . . . . all devices using standard 80-column cards.

.35 Physical Dimensions: . . . . . standard 80-column card.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel 7607 (see 408:101). Models 1 or 3.

.42 Connection to System

.421 On-line: . . . . . 1 to 8 controllers.
.422 Off-line: . . . . . none.

.43 Connection to Device:

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . a Type 716 Printer must be attached to a channel before a card reader can also be attached.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N words of a 72 column binary image in the sequence 9 row left, 9 row right, thru 12 row left, 12 row right, and sometimes continuing through consecutive cards.
.442 Input-output areas: . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . yes.
.446 Synchronization: . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . 1 card (24 words).
.512 Block demarcation Input: . . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . . transfer 1 to 24 words per card to core storage, see .441.
.522 Output: . . . . . none.
.523 Stepping: . . . . . 1 card at a time.
.524 Skipping: . . . . . yes, skip N words under program control.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . by processor program from card image.

.54 Format Control

Control: . . . . . plugboard and program.
Format alternatives: . . . 1 as selected on plugboard.
Rearrangement: . . by plugboard.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . yes.
Offset card: . . . . no.
Select stacker: . . . no.
Select format: . . . no.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . yes.
Output lock: . . . . yes.
Nearly exhausted: . . . . no.
Busy controller: . . . . yes.
End of medium marks: . . . . . no.
Hopper empty: . . . yes.
Stacker full: . . . . no.
End of card: . . . . yes.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed: . 250 cards/min.
.622 Important parameters
Cycle time: . . . . . 240 m.sec.
Clutch point: . . . . . 60 m.sec.
.623 Overhead: . . . . . 4 clutch points.
.624 Effective speeds: . . . 250 cards/min.

.63 Demands on System

Core store: . . . . less than 1 percent.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . none.

.72 Other Controls

Function	Form	Comment
Start:	key	places unit in "ready" status.
Stop:	key	removes control from computer by placing unit in "not ready" status.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	600 cards.
Stacker:	1,200 cards.

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.732 Replenishment time: . . . . . 0.25 to 0.50 min. reader does not need to be stopped.
.733 Adjustment time: . . 0.25 to 1.0 min.
.734 Optimum reloading period: . . . . . 2.4 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	check	programmed.
Input area overflow:	none.	
Exhausted medium:	check	stop and alarm.
Imperfect medium:	none.	
Timing conflicts:	check	indicator
Invalid Code:	all codes valid.	

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INPUT-OUTPUT: 721 CARD PUNCH

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Punch. Type 721.

.12 Description

A 721 Card Punch is used in the 7090 Data Processing System to provide punched card output. Data is punched on standard 80-column cards at a rate of 100 cards per minute. Data to be punched is stored in core storage in the form of a card image.

A 721 Card Punch may be connected to each 7607 Model 1 or 3 Data Channel (see 408:101.12).

A channel having a punch attached to it must also have a 716 Printer attached since the printer controls the punching operation. Punching operations, however, are specified by the stored channel commands through the Data Channel (see 408:101).

Data is punched into cards by row in binary. The punching format is controlled by the stored program and a plugboard located on the punch unit. BCD or other codes can be also programmed. Cards are fed to the punch unit from a hopper with a capacity of approximately 600 cards. Each of the 12 rows of a card is divided into two parts: the first part consists of columns 1 to 36; and the second part consists of columns 37 to 72. Each part is treated as a 36-bit word to accommodate the word length used in the 7090. Twenty-four words can be punched in one card in any 72 out of 80 card columns.

The minimum time between word transfers is 300 microseconds, with 31 milliseconds between rows. These times should be considered when load data channel instructions are used to synchronize the punch with the CPU. The card punch requires a 600-millisecond punch cycle to perform a series of operations relating to punching a card.

The machine can be used for on- or off-line gang punch punching operations by proper wiring of the plugboard. Manual controls and indicating lights are provided. Manual controls are used to run-in and -out cards and the lights are used to indicate that a malfunction within the unit exists.

Optional Feature

2250 Consecutive Number Punching: This feature enables four digit consecutive numbers to be punched automatically into any four columns. The counter may be reset by hand, and overflows from 9999 to 0000.

.13 Availability: . . . . . not in production, can be rented or purchased used or rebuilt, only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punch.
.222 Sensing system: . . . brushes.
.223 Common system: . . . none.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station:. . . . control brushes.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . punch dies.
Distance: . . . . . 3 rows.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . punch brushes.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use
Data: . . . . . 72 (or 80 when also gang punching).
Unused: . . . . . 8.
Total: . . . . . 80.
.325 Row use: . . . . . all for data.

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.33 Coding

External: . . . . . row binary. Hollerith (see Data Code Table No. 2).
Internal: . . . . . binary image.

.34 Format Compatibility: . . . . . all other devices using standard 80-column cards.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel 7606, Model 1 or 3 (see 408:101).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . . a 716 Printer must also be attached to the Data Channel.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 1 card (24 words).
.512 Block demarcation Output: . . . . . end of card.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 to 24 N words forward.
.523 Stepping: . . . . . 1 card.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . matched codes (card image) or programmed.

.54 Format Control

Control: . . . . . plugboard and program.
Format alternatives: . 4.
Rearrangement: . . . yes.
Suppress zeros: . . . no.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . yes.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . yes.
Select code: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted: . . no.
Busy controller: . . . yes.
End of medium marks: no.
Hopper empty: . . . . no.
Stacker full: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 100 cards/min.
.622 Important parameters
Cycle time: . . . . . 600 msec.
Time between words in same row: . . . 300 μ.sec.
Time between processive rows: . . . 31 msec.
.623 Overhead: . . . . . single clutch point.
.624 Effective speeds: . . . 100 cards/min.

.63 Demands on System

Core store: . . . . . less than 1 percent.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Start:	key	makes unit "ready" when hopper is full and control panel is in place.
Stop:	key	places unit in a "not ready" status.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	600 cards.
Stacker:	1,000 cards.

.732 Replenishment time: . . . . . 0.6 to 1.0 min, unit does not need to be stopped.
.734 Optimum reloading period: . . . . . 6 mins.

§ 072.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Exhausted medium:	check	punch stops.
Imperfect medium:	check	punch stops.
Timing conflicts:	check	indicator and punch stops.
Misfeed:	check	punch stops.

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INPUT-OUTPUT: 716 PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer.
Type 716.

.12 Description

The 716 Printer is a modification of the 407 Accounting Machine. It prints information from 120 print wheels which form a solid bank 12 inches wide. Each print wheel has 48 characters, including all the numerals, all the letters of alphabet, and 12 special characters. A line of printing is spaced at 10 characters to the inch. Line spacing is 6 or 8 lines-to-the-inch, single spaced, under control of a mechanical shift lever.

A 716 Printer may be connected to each 7607 model 1 or 3 (see 708:101.12). At least one 716 is required in each 7090 system.

Printing is performed at a rate of 150 lines per minute for 72 characters and 75 lines per minute for 120 characters. Printing format is controlled by the arrangement of data in core storage and a plugboard, which is wired to perform specific functions according to the requirements of the operation. The printer has a paper tape-controlled carriage, which uses a standard 12-channel paper tape to control the skipping and spacing of the form. Functions of the carriage such as changing or suppressing line spacing, selecting the channel on the carriage control tape to control skipping, or sensing sheet overflow may be controlled by various hubs on the plugboard. Various size forms and masters may be used for printing.

Printing is controlled by the stored program (see also 408:101). One record is printed on a line, and a record consists of twenty-four 36-bit words (72 characters) stored in the form of a card image in core storage. The wiring of the printer plugboard determines which of the 120 print wheels will be used for the print operation. Through use of special hubs on the plugboard and programming, up to 120 characters can be printed per line at the reduced speed of 75 lines per minute. Card image words are sent to a data channel at 300 microseconds between words (each row containing two words) and 13 milliseconds between rows. Pulses representing the image, set the print wheels for the printing operation.

To provide for reliable operation each print wheel generates an echo pulse for the character printed. By proper programming, printing with checking can be accomplished using these echo pulses. Through the use of sense instructions, various conditions can be determined, thus, providing more flexibility in the printer operation.

.12 Description (Contd.)

A special output operation is available to "Write Binary", in which a series of lines can be printed in 0's and 1's representing the binary patterns of consecutive words in the core store.

.13 Availability: . . . . . not in production, can be rented or purchased used or rebuilt only when available.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . marginally punched pin feed continuous forms driven by forms tractor.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . engraved wheel.

.23 Multiple Copies

.231 Maximum number
Interleaved carbon: . . 1 + 5.

.232 Types of master
Multilith: . . . . . yes.
Zerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . 120.
Method of use: . . . . 1 line at a time.

.25 Range of Symbols

Numerals: . . . . . 10 0 - 9.
Letters: . . . . . 26 A - Z.
Special: . . . . . 12 $.#,□/
Alternatives: . . . . * %@ & - *
FORTRAN set: . . . . *
Basic COBOL set: . . . no.
Total: . . . . . 48.

* available; see Data Code Tables No. 3A to 3G.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold form pin feed punched stationery.
single sheets.
roll paper.

.312 Phenomenon: . . . . printing.

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.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 lines per inch.
.322 Parallel by: . . . . . 120 print positions at 10 per inch.
.324 Track use: . . . . . 72 for data plus extras by double print cycles or plugboard control.
.325 Row use: . . . . . all for data.

.33 Coding

Internal: . . . . . card image, as in Data Code Table No. 3.

.34 Format Compatibility: . . . . . IBM 1418, Optical Character Reader can read a single line.
IBM 1428, can read a series of lines.

.35 Physical Dimensions

.351 Overall width: . . . . 4.75 to 16.75 in., vernier.
.352 Length
Forms: . . . . . 1 to 22 by 1/6 in. at 6 lines/inch.
1 to 22 by 1/8 in. at 8 lines/inch.
.353 Maximum margins
Left: . . . . . 17 inches.
Right: . . . . . 17 inches.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel 7607 (see 408:101).

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 N words.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic.
.447 Synchronizing aids: . . . . . wait on row index pulse.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . up to 120 print positions per line.
.512 Block demarcation
Output: . . . . . up to 72 characters; fixed (every 24 words).
up to 120 characters; plugboard wiring.

.52 Input-Output Operations

.521 Input: . . . . . same as below (for checking).
.522 Output: . . . . . start printer cycle.
send a word as necessary to printer by individual instruction; up to 24 per print action.
.523 Stepping: . . . . . step size, 1 or 2 lines, set on plugboard; occurs before printing.
suppress step before print in cycle.
call extra step after print in cycle.
.524 Skipping: . . . . . controlled by carriage paper tape loop with punched channels 1 to 12.
skip channel 11, less than 7 lines before print in a cycle with no extra step.
skip channel 11, less than 3 lines after print in a cycle as an extra step.
skip channel 1 to 10, following print in a cycle, up to form length using extra cycles.
skip channel 1 to 10, up to 2 inches following print in cycle with no extra cycles.
end-of-page signal from channel 12 can be plugged to give a skip on another channel.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . programmed to card image.

.54 Format Control

Control: . . . . . program and plugboard.
Format alternatives: . . . . . 4 manual alteration switches.
Rearrangement: . . . plugboard.
Suppress zeros: . . . plugboard.
Insert point: . . . . . plugboard.
Insert spaces: . . . . plugboard.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . yes.
Select format: . . . . yes.
Select code: . . . . . yes.
Suppress print in cycle: . . . . . yes.
Short skip control: . . inhibits interlock.

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.56 Testable Conditions

The program can test one exit hub signal from the plugboard. This can be wired for a variety of conditions including, exhausted, end-of-page, busy and even disabled.

.6 PERFORMANCE

.61 Conditions

I: . . . . . using short skip and optimum choices of paper feed up to 2 inches.
II: . . . . . not using short skips.
III: . . . . . line less than 73 char.
IV: . . . . . line more than 72 char.

.62 Speeds

.621 Nominal or peak speed: . . . . . 150 lines per minute for 72 char (one print cycle per line).
75 lines per minute for 120 char (two print cycles per line).
.623 Overhead: . . . . . single point clutch.
.624 Effective speeds
I & III: . . . . . 150 lines/min.
I & IV: . . . . . 75 lines/min.
II & III
up to 4 inches: . . . 75 lines/min.
4 to 6 inches: . . . 50 lines/min.
II & IV
up to 4 inches: . . . 50 lines/min.
4 to 6 inches: . . . 37 lines/min.

.63 Demands on System

Core store: . . . . . less than 1 percent.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	platen and vernier knobs.	
Horizontal alignment:	adjustable forms tractor.	
Form thickness:	dial	varies distance between print wheels and platen.
Line spacing:	shift cam	may be set for either 6 or 8 lines per inch.

.72 Other Controls

Function	Form	Comment
Alteration switches 1, 2, 3, 4:	toggle switches	used to alter plugboard.
Stop before printing:	toggle switch	removes printer from automatic status prior to printing each line.
Test:	toggle switch	allows print cycle key to initiate a print cycle for test operations.
Form stop:	toggle switch	turns "form" light on when paper is exhausted.
Print:	key	initiates a print cycle under special conditions.
Stop:	key	inhibits printing and makes unit "not ready".
Start:	key	makes unit "ready" for channel equipment.
Restore (carriage control):	key	restores carriage to home position.
Stop (carriage control):	key	stops carriage operation.
Space (carriage control):	key	advances form.

.73 Loading and Unloading

.731 Volumes handled: . . . continuous or single sheet forms.
.732 Replenishment time: . . 2 to 3 mins.
printer needs to be stopped.
.733 Adjustment time: . . . 3 to 5 mins.
.734 Optimum reloading period: . . . . . 290 min.
Basis: . . . . . 2-part forms, 22 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	programmed echo check.	
Output block size:	implicit.	
Invalid code:	none	overprint.
Exhausted medium:	check	turns on indicator and stops printer.
Imperfect medium:	none.	
Timing conflicts:	check	turns on indicator.

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INPUT-OUTPUT: 729 MAGNETIC TAPE UNITS

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit 729 II, IV, V VI.

.12 Description

These tape units are used in the IBM 1401, 1410, 7040, 7070 and 7080 series systems as well as in the 709, 7090 and 7094. They use a standard reel and half-inch tape compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are summarized in the following table:

Model	Tape speed, inches/sec	Density char/inch	Peak transfer rate, char/sec
II	75	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

Up to ten tape units may be connected to each 7607 Data Channel in a 7090 system. Tape operations may be performed parallel with internal processing; however, in normal operation, tapes attached to a single channel cannot be involved in simultaneous data transmission. Any number of non-data transmitting operations may occur simultaneously. It is usually economical to use the highest density of a given model in order to achieve the maximum transmission rates; however, compatability with other machines (such as the 704) may dictate the occasional use of lower density settings.

The 7090 input-output command system permits scatter read and gather write capabilities as well as selection or deletion of recorded information. Efficient use of the command system requires a fairly sophisticated level of programming, but the time-sharing of input-output and elementary scatter or gather coding is understood by most programmers and results in a considerable saving on large volume input-output tasks.

In most installations, the 7090 system uses magnetic tape as the primary input-output mode. A smaller computer such as the 1401 is usually used to transcribe information from cards to tape, tape to printer, etc. Usually some formating is performed by this smaller computer. Normally, library and system routines are also held on tape and one tape station (channel A, Tape 1) is reserved for a system tape.

.12 Description (Contd.)

.13 Availability: . . . . . 12 to 15 months.

.14 First Delivery

729 II: . . . . . November, 1959.
729 IV: . . . . . November, 1959.
729 V: . . . . . May, 1962.
729 VI: . . . . . May, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . two-gap head provides read-afterwrite checking.

.23 Multiple Copies: . . . . multiple copies may be obtained by dialing two or more tapes on a given channel to the same number. This procedure is not recommended.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

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.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or (models V and VI) 800 rows per inch (see 408:091.431).
.322 Parallel by: . . . . . 7 tracks.

.324 Track use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.

.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0 (record and segment marks are optional).
Unused: . . . . . gaps.
Inter-block gap: . . . 0.75 inch.
Inter-file gap: . . . . 3.75 inch.
Erased gap (to skip flaw area): . . . . 3.75 inch.

.33 Coding: . . . . . column binary as in core with odd parity redundancy check.
binary coded decimal (BCD) as in Data Table No. 4 with even parity check.

.34 Format Compatibility

Other device or system	Code translation
727:	matched, low recording density only.
7330:	matched, low recording density only.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.
Leader: . . . . . 25 feet.
Trailer: . . . . . 25 feet.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel. 7607, Models 1, 2, 3, 4.

.42 Connection to System

.421 On-line: . . . . . up to 8 data channels with a maximum of ten tape drives each, (see 408:101.12).
.422 Off-line
Associated equipment: . . . . . may be switched to another channel, another computer, or an off-line auxiliary unit either manually or by means of the optional 7830 switching feature and 7155 Switch Control Console.

.43 Connection to Device

.431 Devices per controller:
Model 1: . . . . . ten 729 II/IV, one each 711, 716, 712.
Model 2: . . . . . ten 729 II/IV/V/VI, one each 711, 716, 712.
Model 3: . . . . . ten 729 II/IV.
Model 4: . . . . . ten 729 II/IV/V/VI.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . yes; scatter read and gather write, controlled by channel commands.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words in block.
1 to N blocks in files.
.512 Block demarcation
Input: . . . . . 0.75 inch inter-record gap.
3.75 inch inter-file gap.
Output: . . . . . 0.75 inch end of transmission.
3.75 inch gap written by instruction.

.52 Input-Output Operations

.521 Input: . . . . . forward only.
read until either N words or end-of-record or read N words skipping over end-of-record gaps.
end-of-file gap always terminates reading.
.522 Output: . . . . . write N words followed by end-of-record.
erase gap.
write end-of-file gap.
.523 Stepping: . . . . . non-transmit channel commands used to skip N words during reading.
.524 Skipping: . . . . . one block backward.
one block forward.
one file backward.
.525 Marking: . . . . . inter block or inter file gap.
.526 Searching: . . . . . none.

.53 Code Translation: . . . code (binary or BCD) selected by program - translations are automatic.

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.54 Format Control

Control: . . . . . program.
Format alternatives: . . densities (2 or 3).
Rearrangement: . . . . no.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . yes.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . . yes.
Select format: . . . . . no.
Select code: . . . . . yes.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted: . . . yes (25 feet).
Busy controller: . . . . yes.
End of medium marks: . . . . . no.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed

Model II: . . . . . 15,000 or 41,667 char/sec.
Model IV: . . . . . 22,500 or 62,500 char/sec.
Model V: . . . . . 15,000, 41,667, or 60,000 char/sec.
Model VI: . . . . . 22,500, 62,500 or 90,000 char/sec.

.622 Important parameters

Name	Models II	IV	V	VI
Density (char/inch):	200 or 556		200, 556 or 800	
Tape speed (inches/sec):	75.	112.5	75.	112.5
Start time (msec)				
read:	10.5	6.7	10.5	6.7
write:	7.5	5.0	7.5	5.0
Stop time (msec)				
read:	2.1	2.1	2.1	2.1
write:	5.1	3.8	5.1	3.8
Full rewind time (min):	1.2	0.9	1.2	0.9
Gaps block (inches):	0.75	0.75	0.75	0.75
file (inches):	3.75	3.75	3.75	3.75

.623 Overhead:

Gap crossing time (msec):	Model II and IV	V and VI
Block:	10.	6.67.
File:	50.	33.33.

.624 Effective speeds

Models II and V
200 char/inch: . . . 15,000N/ (N + 150) char/sec.
556 char/inch: . . . 41,667N/ (N + 417) char/sec.

Models IV and VI
200 char/inch: . . . 22,500N/ (N + 150) char/sec.
556 char/inch: . . . 62,500N/ (N + 417) char/sec.

Model V
800 char/inch: . . . 60,000/ (N + 600) char/sec.

Model VI
800 char/inch: . . . 90,000N/ (N + 600) char/sec.

.63 Demands on System

Component	Condition	msec per word	Percentage
Core storage:	200 char/inch	.00218	0.545 (1 + A + C).
	556 char/inch	.00218	1.415 (1 + A + C).
	800 char/inch	.00218	2.180 (1 + A + C).

Note: A = number of indirect address per word transferred.
C = number of commands obeyed per word transferred, (see 408:111.4).

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (models V and VI only), (see 408:101.12), 200/556, 556/800, 200/800.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	button	lowers tape into reservoirs and rewinds tape to load point.
Unload:	button	removes tape from reservoirs and raises upper portion of head assembly.
File protection:	ring on reel	ring permits writing.

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§ 091.

.73 Loading and Unloading

.731 Volume handled

Data format		Words per reel at Density (cpi)		
Words/ record	Records/ file	200	556	800
20	20	384,000	498,000	548,000
40	20	548,000	872,200	960,000
20	50	408,000	542,000	600,000
40	50	572,000	926,000	1,036,000
167 (1,000 char.)	50	752,000	1,845,000	2,350,000
167 (1,000 char.)	1	752,000	1,845,000	2,350,000

Note: 1 word = 6 char.

.732 Replenishment time: . . . . . 1.0 to 1.5 mins. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . . 6 mins.
Models IV & VI: . . . 4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none - not possible.	
Output block size:	none - not possible.	
Invalid code:	yes	see reading.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	yes	halts tape drive.
Timing conflicts:	interlock	stalls processor.
Recording level:	dual level signal strength check	indicator & alarm.

INPUT-OUTPUT: HYPERTAPE

§ 092.

.1 GENERAL

.11 Identity: . . . . . Hypertape drive. 7340.

.12 Description

The IBM 7340 Hypertape drive is available for use with the 7074, 7080, 7090 and 7094 systems. Up to 170,000 characters per second may be written on or read from the one inch wide, 1,800 foot tape, of which 1,750 feet is usable. The effective speed for 1,000 character blocks is 100,000 characters per second. The 7090 may record data on eight of the ten tape tracks at a density of 1,511 characters per inch. Two of the eight used tracks contain codes which automatically correct all single and most double-bit errors. The tape may be read forward or backward (optional feature) at a rate of 112.5 inches per second. Because of a short (0.45 inch) interblock gap, average access time to a block is 4.2 milliseconds compared to 7.3 milliseconds for the 729 IV or VI. Rewinding speed is 225 inches per second but tapes may be dismounted without rewinding.

The Hypertape contains three reflective strips instead of the usual two. Two of these, beginning-of-tape and end-of-tape, occur on other IBM tapes; however, it is not possible to cause the Hypertape to move beyond these marks. A third spot, called the end-of-tape warning, occurs 40 feet before the end-of-tape and may be sensed by the 7090 program in either read or write mode.

Another feature of the 7340 which differs from other IBM units is the setting, by program, of a file protect condition. Program removal of file protection is not possible and may only be accomplished with the tape cartridge removed from the unit.

Only tape cartridges can be used with the Hypertape drive. Supply and take-up reels holding 1,800 feet of tape are enclosed in a sealed cartridge that measures about 17 by 10 by 2 inches and weighs about 8 pounds. The operator loads a reel of tape by raising the top cover, sliding the cartridge into place, lowering the cover, and depressing the load-unload button. After the tape reels engage the drive mechanism, the tape is then automatically positioned for use. Unloading is accomplished by reversing the procedure.

The automatic Cartridge Loader feature can operate under program control. It accommodates one cartridge. When the change tape command is given, the tape cartridge being used is unloaded to a discharge station, then the waiting cartridge is loaded. The operation requires about 30 seconds. This feature helps eliminate operator set-up delays, especially when using an automatic run-scheduling program.

.12 Description (Cont'd)

Whenever tape is rewound, unloaded, or the drive is not ready for use, an "attention indicator" is set. This indicator is program testable (as are many other conditions, e.g., beginning or end of tape). Indicators on each drive can be lit by the program to inform the operator. These are Reserved, Change Cartridge (set automatically after any unload command), File Protect, and the Check light, which is used to call the operator's attention and not to signal hardware errors automatically.

Hypertape drives can be connected to a 7090 through a 7640 Hypertape Control, which is connected to two 7909 Data Channels (or if Data Channel Switches are used, any two switch legs) and thence to the 7606 multiplexor. The 7640 has two separate channels which can each accommodate 10 Hypertape drives. If each 7640 channel is connected to a 7909 Data Channel, it can read tape on one channel and write tape on the other channel. However, read-read or write-write operations are not possible because the 7640 has only one set each of read and write equipment.

Optional Feature

Automatic Cartridge Loader: Reduces time lost during tape changes by automatically unloading one Hypertape cartridge and loading another under manual or program control. Maximum time for a complete unload and load cycle is 30 seconds. The loader is mounted on top of the Hypertape Drive.

Optional features on the 7909 Data Channel (see 408:102) can be provided to enable the use of backward reading, and conversion of 6-bit BCD code.

.14 First Delivery: . . . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . non-coated surface of tape is held against single capstan by vacuum action of reservoirs.

.212 Reservoirs
- Number: . . . . . 2.
- Form: . . . . . vacuum columns.
- Capacity: . . . . . about 4 feet.

.213 Feed drive: . . . . . motor.

.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.

.222 Sensing system: . . . . magnetic head.

.223 Common system: . . . two-gap heads provides read-after-write checking.

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§ 092.

.24 Arrangement of Heads

Use of station:	recording.
Stacks:	1.
Heads/stack:	10.
Method of use:	1 row at a time.
Use of station:	sensing.
Distance:	0.3 inch.
Stacks:	1.
Heads/stack:	10.
Method of use:	1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:	plastic tape with magnetizable surface.
.312 Phenomenon:	magnetization.

.32 Positional Arrangement

.321 Serial by:	1 to N rows at 1,511 rows per inch.
.322 Parallel by:	10 tracks.
.323 Bands:	1.
.324 Track use	
Data:	6.
Redundancy check:	2.
Timing:	0 (self clocking).
Control signals:	0.
Unused:	2.
Total:	10.
.325 Row use	
Data:	1 to N.
Redundancy check:	0.
Timing:	0.
Control signals:	0.
Unused:	0.
Gap:	0.45 inch.
Tape mark:	3.75 inches.
.33 Coding:	Binary 6 bit/row as in core. BCD 6 bit/row as in Data Code Table No. 4 (optional). Only with Hypertape drives on other IBM 7074, 7080, 7090 and 7094 systems.

.35 Physical Dimensions

.351 Overall width:	1.0 inch.
.352 Length:	1,800 feet per cartridge.
.353 Maximum margins	
Left:	25 feet.
Right:	25 feet.

.4 CONTROLLER

.41 Identity:	Hypertape Control. 7640.

.42 Connection to System

.421 On-line:	one 7640 (containing two tape channels) connected to two 7909s or two 3224 Data Channel Switches on one or two 7909 Data Channels, and connected to 7606. Note: 7909 requires special option in order to read backward on hypertape.
.422 Off-line:	none.

.43 Connection to Device

.431 Devices per controller:	20; up to 10 to each 7909 Channel or 3224 Switch.
.432 Restrictions:	none.

.44 Data Transfer Control

.441 Size of load:	1 to N words.
.442 Input-output areas:	core storage.
.443 Input-output area access:	each word.
.444 Input-output area lockout:	none.
.445 Table control:	yes, scatter-read and gather-write, with separate channel commands for each field of data (see 408:109).
.446 Synchronization:	automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block:	1 to N words.
.512 Block demarcation:	gap on tape write command.

.52 Input-Output Operations

.521 Input:	read one block forward or (optional; see 408:109.12) backward into core storage area(s) specified by one or more channel read commands.
.522 Output:	write one block forward from core storage area(s) specified by one or more channel write commands.
.523 Stepping:	step one block forward or backward. step forward or backward to end-of-file mark. erase 8 inches (to step over defective tape areas).
.524 Skipping:	skip N words or records when reading.
.525 Marking:	inter-block gap. end-of-file gap.
.526 Searching:	none.
.53 Code Translation:	matched. automatic with optional BCD feature.

§ 092.

.54 Format Control

Control:	program.
Format alternatives:	two.
Rearrangement:	yes; scatter-read and gather-write.
Suppress zeros:	no.
Insert point:	no.
Insert spaces:	no.
Recording density:	no.
Section sizes:	yes.

.55 Control Operations

Disable:	disabled after unloading.
Request interrupt:	yes, priority signal.
Select format:	no.
Select code:	binary or optional BCD.
Rewind:	yes.
Unload:	yes.
Enter file protect status:	yes.
Change Cartridge:	yes.

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Output lock:	yes.
Nearly exhausted:	yes, 40 feet from end-of-tape mark.
Busy controller:	yes.
Beginning of tape mark:	yes.
End of tape mark:	yes.
Not ready:	yes.
Not loaded:	yes.
Correction occurred:	yes.
Uncorrected error:	yes.
Code check:	yes.
Write failure:	yes.
Timing error:	yes.
Forward or backward:	yes.
Attention required:	yes.
File protection on:	yes.

.62 Speeds

.621	Nominal or peak speed:	170, 000 char/sec.
.622	Important parameters	
	Recording density:	1, 511 rows/inch.
	Tape speed:	112.5 inches/sec.
	Start time:	3.0 msec. maximum.
	Stop time:	3.0 msec maximum.
	Full rewind time:	1.5 minutes.
	Rewind speed:	225 inches/sec.
	Inter-block gap:	0.45 inches/sec.
	Tape mark:	3.75 inches.
.623	Overhead:	4.3 msec/block.
.624	Effective speeds:	170, 000N/(N + 714).

.63 Demands on System

Component:	core storage.
Condition:	reading or writing.
Msec per word:	0.00218 (1 + C + A).
Percentage:	5.8 (1 + C + A); see also 408:111.4).
A:	number of indirect addresses per word transferred.
C:	number of commands obeyed in Data Channel per word transferred.

.7 EXTERNAL FACILITIES

.71 Adjustments: none.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0 through 9.
Start key:	button	makes unit available to computer.
Stop key:	button	removes unit from computer control; stops any operation in progress.
Load-unload button:	button	loads if cartridge in unload status.
Rewind:	button	indicates rewind if tape not in ready (available to computer).

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Cartridge:	1, 800 feet; for 1, 000 row blocks, 14, 000, 000 characters.

.732 Replenishment time: 0.5 to 1.5 min. tape drive needs to be stopped, however, if cartridge loader is employed, tapes can be placed in loader at any time and changed under program control.

.734 Optimum reloading period: 3.1 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write dual row parity	indicator.
Reading:	dual-row parity	indicator-error corrected if possible.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	check	indicator.
Exhausted medium:	reflective spots	indicator, inhibit movement passed mark.
Imperfect medium:	check	indicator.
Timing conflicts:	disconnect	indicator.
Excessive skew:	check	indicator.
Circuit failure:	check	indicator.

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INPUT-OUTPUT: 7607 DATA CHANNEL

§ 101.

.1 GENERAL

.11 Identity: . . . . . Data Channel. #7607. Models 1, 2, 3, and 4. #7617 Data Channel Console.

.12 Description

The #7607 unit provides an independently operating data channel to the core storage for all models of 729 units in any mixture, the 711 Card Reader, 721 Card Punch, and 716 Printer.

There are four models. They differ in the units that they may control, and the number that may be connected to a system.

Model 1: Up to ten 729's (II or IV), one 711, one 721, one 716.
3: Up to ten 729's (II, IV, V, or VI), one 711, one 721, one 716.
2: Up to ten 729's (II or IV).
4: Up to ten 729's (II, IV, V, or VI).

Models 3 and 4 have a Tape Densities Option Switch to select any one of these density pairs: 200/556, 200/800, or 556/800 characters per inch. The program may choose "high" or "low" density.

Each 7607 has a special 7617 console, which can be used to control the Data Channel and associated units, but not transfers with the core storage.

Every 7090 must have one 7607 model 1 or 3 with both a 711 Card Reader and a 716 Printer. A 721 Card Punch is optional.

There may be a maximum of eight 7607 units in a configuration, but this is substantially restricted when any 7909 are used. A table showing the joint maximum possibilities is in 408:111.41.

Each Data Channel behaves as a separate control unit in selecting and executing instructions. The Central Processor may execute instructions (see 408:121) to:

- Start in motion a selected unit on a specific channel.
- Start the control unit by specifying the location of the first Data Channel instruction.

.12 Description (Cont'd)

- Specify a new location from which the next Data Channel instruction is to be taken, ignoring the remainder of the current sequence.
- Copy the current contents of the Data Channel control registers into core storage without affecting channel operation, including instruction location, word counter, operation control bits.
- Backspace, rewind, unload, set density, or write control marks.

The individual Data Channels may execute instructions (called commands by IBM) (see 408:121) to:

- Copy data controlled by counters or block delimiters.
- Change sequence.
- Disconnect, i.e., execute no more instructions until directed by the Central Processor.
- Sense for control, access, and error indicators.

The individual adapters and controllers for peripheral units can sometimes execute instructions (called orders by IBM).

A Data Channel has a large degree of autonomy and its own sequence of instructions can be interrupted by control and error conditions. The interrupts can be inhibited if required.

Data is transferred between all Data Channels #7909 or #7607 and core storage via the #7606 Multiplexer. The Multiplexer shares the access of all devices to the core storage on a priority basis. To ensure maximum simultaneous operation with no access conflicts, the Data Channels are connected in the sequence of their peak demands (see 408:111.43).

Data is transferred to core storage in 36-bit word units as necessary. One access cycle is required for each word transferred, each instruction selected, and for each indirect address in an instruction. A maximum of three accesses may be required for one word. These parameters affect the actual demands on the core storage. The maximum values affect the safe number of simultaneous transfers (see 408:111.43).

.13 Availability: . . . . . ?

.14 First Delivery: . . . . November, 1959.

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INPUT-OUTPUT: 7909 DATA CHANNEL

§ 102.

.1 GENERAL

.11 Identity: . . . . . Data Channel. #7909.

.12 Description

The #7909 unit provides an independently operating data channel to the core storage for such units as Hypertape Drives, 1301 Disk Storages, and TELEPROCESSING units.

A maximum of four #7909 data channels can be used in a system, but the maximum is also affected by the use of #7607 data channels. The table in 408:111.41 shows the maximum combinations.

Only one Hypertape Control #7640, can be connected to a system. It contains two independent input-output highways, and requires two #7909's for full use, or one #7909 for restricted use (see 408:092.4).

Up to two #7631 Disk Storage Controllers can be connected to a system. Each controller requires one #7909 (see 408:042).

Up to two #1414 Synchronizers can be connected to a system. Each controller requires one #7909 (see 408:103).

Each Data Channel behaves as a separate control unit in selecting and executing instructions. The Central Processor may execute instructions (see 408:121) to:

- Start in motion a selected unit on a specific channel.
- Start the control unit by specifying the location of the first Data Channel instruction.
- Specify a new location from which the next Data Channel instruction is to be taken, ignoring the remainder of the current sequence.
- Copy the current contents of the Data Channel control registers into core storage without affecting channel operation, including instruction location, word counter, operation control bits.
- Backspace, rewind, unload, set density, or write control marks.

The individual Data Channels may execute instructions (called commands by IBM) (see 408:121) to:

- Copy data controlled by counters or block delimiters.
- Change sequence.

.12 Description (Cont'd)

- Disconnect, i.e., execute no more instructions until directed by the Central Processor.
- Sense for control, access, and error indicators.

The individual adapters and controllers for peripheral units can sometimes execute instructions (called orders by IBM).

A Data Channel has a large degree of autonomy and its own sequence of instructions can be interrupted by control and error conditions. The interrupts can be inhibited if required.

Data is transferred between all Data Channels #7909 or #7607 and core storage via the #7606 Multiplexer. The Multiplexer shares the access of all devices to the core storage on a priority basis. To ensure maximum simultaneous operation with no access conflicts, the Data Channels are connected in the sequence of their peak demands (see 408:111.43).

Data is transferred to core storage in 36-bit word units as necessary. One access cycle is required for each word transferred, each instruction selected, and for each indirect address in an instruction. A maximum of three accesses may be required for one word. These parameters affect the actual demands on the core storage. The maximum values affect the safe number of simultaneous transfers (see 408:111.43).

Optional Features

#3224 Data Channel Switch. One manual switch can be fitted to each channel to enable the channel to be switched to one of two devices, selected from a Hypertape Control, a 1301 Disk Control, and a 1414 Teleprocessing Adapter.

#1471 BCD Translation. This feature provides a translation between the internal 6-bit binary code of the 7090 (see 408:141), and the 6-bit BCD input-output code, for compatibility with other IBM systems (see 408:144).

#5975 Read Backward Character Assembly and Storage. This feature enables the 7640 Hypertape Control read backward feature to be used..

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

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INPUT-OUTPUT: 1414 SYNCHRONIZER

§ 103.

.1 GENERAL

.11 Identity: . . . . . Input-Output Synchronizer. 1414 Model 6.

.12 Description

The 1414 Model 6 Input/Output Synchronizer is used to control a variety of communications devices in a 7090 system. It contains six 80-character buffers. Each buffer can be equipped with the appropriate adapter and assigned to the input or output line of a specific device. The 1414 Input/Output Synchronizer is in turn connected to one 7909 Data Channel on the 7090 system. Four 1414s (one per data channel) can be connected to a system (see 408:112.12).

Each buffer can be operating with a unit simultaneously. The fact that transfers between the 7909 and 1414 are serial for each buffer is not a restriction.

Delays in executing the stored program are minimized during communications device input-output operations. A "channel select" instruction selects the I/O channel and sends the address of the first of a series of channel commands to the 7909 Data Channel; the 7909 then assumes control of the input-output operation while the central processor continues executing the stored program. Channel commands may be of the read, write, control, or sense type. A read or write command initiates the transfer of a block of up to 80 characters between a buffer in the 1414 and core storage. A control command transmits an order to the 1414 which selects the desired communications device. A sense command causes two words to be sent to core storage which indicates the status of the selected device. The interrupt facilities of the 7090 series are utilized to service the communications devices.

Data transfer between the 1414 and the 7909 Data Channel requires 11 microseconds per character. Transfer rates between the 1414 and the communications devices connected to it depend upon the individual devices; these are described below.

The unit can have a maximum of six buffer units and can transfer data at rates of up to 90,000 characters per second. A selection of the following units can be attached up to the limit of six buffers.

Units requiring two buffers:

Data Transmission Unit Adapter (#3238), uses #1009 Data Transmission Unit.
Read and Punch Column Binary (#6025), 12-bit column to two 6-bit char.

1st Remote Inquiry Unit Adapter (#6136), uses up to 10 #1014 Remote Inquiry Units.
2nd Remote Inquiry Unit Adapter (#6136), uses up to 10 #1014 Remote Inquiry Units.
Telegraph Input/Output Feature (#7864), for #7871 and 7875.

Units requiring one buffer:

Paper Tape Reader Adapter (#5514), uses #1011 Paper Tape Reader.
1st Telegraph Input Feature (#7871), needs #7864.
2nd Telegraph Input Feature (#7871), only if no #7875.
1st Telegraph Output Feature (#7875), needs #7864.
2nd Telegraph Output Feature (#7875), only if no #7871.

.121 Data Transmission Unit, 1009 Model 1: This device enables the 7090 system to transmit and receive data over telephone or telegraph lines at speeds of 75, 150, 250, or 300 characters per second. The unit at the other end of the line can be a similarly equipped IBM 7000 or 1400 series system, a 7701 or 7702 Magnetic Tape Transmission Terminal, or a 1013 Card Transmission Terminal. The 1009 uses two of the six buffers in a 1414 Synchronizer and requires the #3238 Data Transmission Unit Adapter. One buffer is loaded while the other is unloaded, so messages of variable length can be processed. (See also Section 402:101).

.122 Paper Tape Reader, 1011 Model 1: This unit reads data from punched paper tape at a speed of 500 rows per second. From five to eight tracks can be read. The tape can be either chad or chadless and in the form of strips, reels, or centerfeed rolls. The 1011 uses one of the six buffers in a 1414 Synchronizer and requires the #5514 Paper Tape Reader Adapter. Block length is limited to 80 characters. (See also Section 402:071).

.123 Remote Inquiry Unit, 1014 Model 1: This unit consists of a modified electric typewriter with control circuits and indicator lights, mounted on a 29-by 24-inch table. It is used for interrogating and printing replies from a 7090 system, and may be located up to eight miles away. Message length is limited to 78 characters. Up to ten Inquiry Units can be connected to a #6136 Remote Inquiry Adapter, and one or two adapters can be connected to a 1414 Synchronizer. Each adapter requires two of the six buffers. (See also Section 402:102).

.124 Telegraph Input-Output, #7864: This adapter permits direct connection of a telegraph transmitter and receiver to a 7070 or 7074 system. Maximum data transmission rate is about ten characters per second, and the data portion of a message should not exceed 80 characters in length. The #7864 adapter controls one telegraph input unit and one output unit; each unit requires one buffer in the 1414 Synchronizer. A total of up to four telegraph units can be connected to the 1414 through the addition of the #7871 Telegraph Input and/or the #7875 Telegraph Output, which control, one unit each.

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INPUT-OUTPUT: 7155 SWITCH CONTROL CONSOLE

§ 104.

.1 GENERAL

.11 Identity: . . . . . Switch Control Console. #7155.

.12 Description

The Switch Control Console is a manual switching center from which especially modified 729 II, IV, V, and VI Magnetic Tape Units may have their connections rapidly altered. Switching may occur only when units are idle.

The possibilities include:

- Switching a unit from its normal channel to a preset alternative channel. The other channel may be on the same or a different computer.
- Switching a unit to a preset off-line connection as an alternative to its normal channel.
- Switching a unit to a computer channel from its normal off-line connection.

.12 Description (Contd.)

The restrictions are:

- Each unit to be switched must be modified.
- Only two units per channel can be modified.
- If n extra units are switched to a channel, only (n-2) normal units of that channel can be switched to other channels or equipment.
- Only two extra units can be switched to a channel.

The controls of the 729 units are arranged so that one switch on each unit specifies local or remote (7155) control. Only when it is in remote control can switches on the 7155 specify normal or alternative connection.

The power supplies are not switched, but the cables can be changed by hand.

The console can control up to eight tape units in the standard form or ten upon special request.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . ?

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INPUT-OUTPUT: 7281 II DATA COMMUNICATION CHANNEL

§ 105.

.1 GENERAL

.11 Identity: . . . . . IBM 7281 II Data Communication Channel.

.12 Description

The IBM 7281 Data Communication Channel is used when connection is required between a 7090/94 system and on-line "real-time" devices. The size of the unit is adequate to handle 32 subchannels, provided most of the units to be serviced are slow in speed and use small data items, e.g., 5-bit Teletype, which can also be handled by the 1414 Model 6, using a 7909 Data Channel. Although each 7281 II can logically have up to 32 input and/or output subchannels, the actual maximum may be less than 32 subchannels because the physical size of the subchannel electronics may limit the number of subchannels that will fit in a 7281 II unit. Each subchannel can control one unit. Since this is an RPQ item, special requirements can probably be met, but the cost might be disproportionately high. Possible uses of the 7281 II include communication with radar, non-IBM units, and other computers.

Each subchannel "word" is a fixed-size data unit of any size from 5 to 36 bits. Each subchannel can be preset to associate the external data unit with any set of bits in a 7090 36-bit word format.

The 7281 II can transmit or receive data with the 7302 store at a peak rate of approximately 229,000 "words" per second. The fastest possible subchannel is limited to 10,000 "words" per second. The slow channels, such as Teletype, operate at 10 "words" per second (in this last case a "word" is a 5-bit character).

The 7281 II is connected to the 7302 Core Storage via the 7606 Multiplexor. Data transfers between core and the 7281 II are initiated by a 7281 II request. Requests are caused by a subchannel having received data or requiring data for transmission, and are sampled by a device called a sequencer. The sequencer normally samples all of the subchannels sequentially; however, the first ten subchannels are arbitrarily of higher priority and are always checked before proceeding with normal sequential servicing.

The connection requirements of a 7281 II to a 7090 system are the same as those for a 7607 Data Channel. When real-time devices are attached to a system, a 7281 II unit replaces a 7607 channel. Up to four 7281 II channels can be connected to a system. The channel designations are the same (A through H) as those used for the Data Channels.

.12 Description (Contd.)

The 7090 processor must be modified with the Direct Data Connection hardware so that the new instructions (which start and stop the subchannels and traps) and the traps (which signal end-of-block or end-of-message) are included. A set of address switches is provided on the 7281 II to select a 256-word block of the lower half of core storage to be the buffer area for the channel. In addition, each subchannel has a set of address switches that can select an 8-word portion of the buffer area for its store. A modulo 8 counter in each subchannel is used to address a word in its buffer area. When this counter reaches a maximum, again set on switches, the subchannel is selected by the sequencer and if its interrupt has been enabled by the 7090 processor, the 7090 is interrupted.

The handling of interrupts (or "traps") is somewhat complex in that the Direct Data, the 7281 II, and the External Signal interrupts all use the same "trapping" locations. Although the Direct Data and 7281 II interrupts set bits to indicate their presence and type, the External Signal interrupt has no such indicators. Should the External Signal occur simultaneously with any combination of the other two interrupts, it would not be possible from this information to determine that the External Signal had occurred.

A rather complex control routine is required to handle External Signal interrupts. Some of the requirements of this routine are:

1. Determine type of interrupt.
2. Determine unit affected.
3. Determine action to be taken.
4. Check for multiple interrupts.
5. Ascertain that data channels for activated input-output units have data transmission commands.
6. Prepare for subsequent interrupts.
7. Re-enable channel traps.

There are eight types of subchannels currently available; they are:

1. 36-bit 40-volt input: . . . . . RPQ 882003.
2. 36-bit 40-volt output: . . . . . RPQ 882004.
3. 8-bit 40-volt input: RPQ 882005.
4. 5-bit 40-volt output: . . . . . RPQ 882006.
5. 18-bit 40-volt sense output: . . RPQ 882007.
6. 36-bit 8-volt input with 40-volt output control lines: . . RPQ F91715.
7. 5-bit Teletype input: . . . . . RPQ F88733.
8. 5-bit Teletype output: . . . . . RPQ F88671.

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . #7909.
Data Channel.

#7607.
Data Channel.

#7606.
Multiplexor.

.12 Description

In general, every Data Channel and Central Processor may operate simultaneously. There are three types of limitations: The maximum allowable combinations of channels, the units and channels attached, and the demand limitations on the core storage.

The Data Channels are described in 408:101 and 408:102. In general, one unit on each Data Channel may be operating (transmitting or receiving data) simultaneously. In fact, each channel acts as a separate control unit, selecting and executing its own sequences of instructions as initiated by the central processor.

In IBM terminology the central processor executes instructions, the data channels execute commands, and the special adapters and controls execute orders. The various groups are all set out in the Instruction List (see 408:121).

.2 CONFIGURATION CONDITIONS

R: . . . . . number of #7909 Data Channels.
S: . . . . . number of #7640 Hypertape Controls.
T: . . . . . number of #7631 Disk Storage Controls.
U: . . . . . number of #1414 Synchronizers.
V: . . . . . number of #7607 Data Channels, Model 1.
W: . . . . . number of #7607 Data Channels, Model 3.
X: . . . . . number of #7607 Data Channels, Model 2.
Y: . . . . . number of #7607 Data Channels, Model 4.

.3 CLASSES OF OPERATION

A: . . . . . compute.
B: . . . . . read or write 729 tapes.
C: . . . . . rewind, backspace record or file or skip remainder of a record on 729 tapes, feed remainder of a card or space paper.

.3 CLASSES OF OPERATION (Contd.)

D: . . . . . read cards.
E: . . . . . punch cards.
F: . . . . . print.
G: . . . . . read or write Hypertapes.
H: . . . . . rewind, backspace or skip a record on Hypertapes.
I: . . . . . read or write, disc store.
J: . . . . . seek access, disc store.
K: . . . . . 1414 devices input-output.

.4 RULES

.41 Configuration Limitations On Equipment

Class	Possible Sets						
R	4	3	2	2	2	1	0
S	1	1	1	1	0	0	0
T	2	1	0	0	2	1	0
U	2-t	1-t	0	0	2-t	2-t	0
V	1	1	1	0	1	1	1
W	1-v	1-v	0	1	1-v	1-v	1-v
X	0	1	1	2	4	5	7
Y	0	1-x	1-x	2-x	4-x	5-x	7-x

.42 Configuration Limitations On Channels

a - at most 1.
b + d + e + f - at most V + W + X + Y.
c - at most 10(V + W + X) - b.
d + e + f - at most V + W.
g - at most 25.
h - at most 20S - g.
i - at most T.
j - at most 5 - i.
k - at most 6 μ.
g + i + k - at most R.

.43 Demand Limitations

If the units are assigned to channels such that those with highest weights have priority, the total weight of units operating may not be more than 100. Otherwise, the weight may not be more than 70.

Device	Rate KC	Weight
729 II, V (200)	15	2.1
729 IV, VI (200)	22.5	3.2
729 II, V (556)	41.7	6.2
729 V (800)	60	9.4
7750	71.5	9.4
729 IV, VI (556)	62.5	9.9
1301	90	12.4
1414 6	90	12.5
729 VI (800)	90	15.6
7340	174	37.2

These weights allow for the usual worst case, in which three access may be required for each word transferred: the word itself, an instruction to the data channel, or an indirect address.

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INSTRUCTION LIST

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	Accumulator (AC) bits are called S, Q, P 1 thru 35. Multiplier-Quotient (MQ) called S, 1 thru 35, Q, P, hold overflows, S's sign.
					Fixed Point Arithmetic (AC and MQ use bits S, 1 thru 35 unless overflow in AC, then P and Q).
ADD	X	F	T	Y	(Y) + (AC) → AC
ADM	X	F	T	Y	|(Y)| + (AC) → AC
SUB	X	F	T	Y	(AC) - (Y) → AC
SBM	X	F	T	Y	(AC) - |(Y)| → AC
MPY	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ
MPR	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ, and if $MQ_1 = 1$; AC + 1 → AC
DVH	X	F	T	Y	(MQ ÷ (Y) → MQ (quotient), AC (remainder). If overflow, set divide-check indicator and halt processor.
DVP	X	F	T	Y	Same as for DVH except processor is not halted.
VLM	X	FC	T	Y	$(Y) \times (MQ)_{35-0} \rightarrow$ AC and MQ.
VDH	X	FC	T	Y	$(AC) \div (Y)_{1 \text{ to } C} \rightarrow (MQ)_{35-C \text{ to } 35}$, remainder in AC; If (Y) ≤ (AC), halt processor.
VDP	X	FC	T	Y	$(AC) \div (Y)_{1 \text{ to } C} \rightarrow (MQ)_{35-C \text{ to } 35}$, remainder in AC.
					Floating Point Arithmetic
FAD	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
UFA	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; unnormalized.
FSB	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
UFS	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; unnormalized.
FMP	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ; normalized.
FDH	X	F	T	Y	(AC) ÷ (Y) → MQ (quotient) normalized, AC (remainder). If overflow, set divide-check indicator and halt processor.
FDP	X	F	T	Y	Same as for FDH except processor is not halted.
FAM	X	F	T	Y	|(Y)| + (AC) → AC and MQ, normalized.
UAM	X	F	T	Y	|(Y)| + (AC) → AC and MQ, unnormalized.
FSM	X	F	T	Y	(AC) - |(Y)| → AC and MQ, normalized.
USM	X	F	T	Y	(AC) - |(Y)| → AC and MQ, unnormalized.
FRN	X	F	T	Y	$(AC) + (MQ)_9 \rightarrow$ (AC) normalized.
UFM	X	F	T	Y	(Y) x (MQ) → AC and MQ, unnormalized.
					Data Transfer Arithmetic)
LDQ	X	F	T	Y	(Y) → MQ.
STQ	X	F	T	Y	(MQ) → Y.
SLQ	X	F	T	Y	$(MQ)_{S, 1-17} \rightarrow Y_{S, 1-17}$.
STO	X	F	T	Y	(AC) → Y.
STZ	X	F	T	Y	0 → (Y); sign is plus.
STP	X	F	T	Y	$(AC)_{P, 1, 2} \rightarrow Y_{S, 1, 2}$
STD	X	F	T	Y	$(AC)_{3-17} \rightarrow Y_{3-17}$.
STA	X	F	T	Y	$(AC)_{21-35} \rightarrow Y_{21-35}$.
CLA	X	F	T	Y	(Y) → AC.
CLS	X	F	T	Y	(-Y) → AC.
CVA	X	C	X	Y	Y → (SR). $((AC)_{30-35} + (SR)) \rightarrow (SR)$, (AC)/64 → (AC), $(SR)_{P-5} \rightarrow (AC)_{P-5}$, C times.
CRQ	X	C	X	Y	Y → (SR). $((MQ)_{S-5} + (SR) \rightarrow (SR)$, (MQ) x 64 → (MQ), $(SR)_{S-5} \rightarrow (MQ)_{30-35}$, C times.
CAQ	X	C	X	Y	Y → (SR). $(MQ)_{S-5} + (SR) \rightarrow (SR)$, RQL 6, (AC) + (SR) → AC, C times.

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INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Data Transfers (Logical)
CAL	X	F	T	Y	(Y) → AC.
SLW	X	F	T	Y	(AC) → Y.
STT	X	F	T	Y	$(AC)_{18-20} \rightarrow Y_{18-20}$; remaining positions remain unchanged.
STL	X	F	T	Y	Location of STL instruction + 1 → Y_{21-35}; remaining positions of Y unchanged.
STR	X	X	X	X	Location of STR instruction + 1 → to positions 21-35 of location 0000.
XCA	X	X	X	X	$(AC)_{S,\ 1-35}$ exchanged with $(MQ)_{S,\ 1-35}$; positions P and Q of AC are cleared.
XCL	X	X	X	X	$(AC)_{P,\ 1-35}$ exchanged with $(MQ)_{S,\ 1-35}$; positions S and Q of AC are cleared.
ENK	X	X	T	X	Contents of manual input switches → MQ. (See PSE)
					Logical Operations (AC used P, 1 thru 35 unless overflow in AC, then Q.)
ACL	X	F	T	Y	(Y) + (AC) → AC.
ANA	X	F	T	Y	(AC) "AND" (Y) → AC.
ANS	X	F	T	Y	(AC) "AND" (Y) → Y.
ORA	X	F	T	Y	(AC) "OR" (Y) → AC.
ORS	X	F	T	Y	(AC) "OR" (Y) → Y.
ERA	X	F	T	Y	(AC) "EXCLUSIVE OR" (Y) → AC (binary half-add).
					Shift Operations (All are modulo 256 places).
ALS	X	X	T	Y	(AC) shifted left Y, sign unchanged.
ARS	X	X	T	Y	(AC) shifted right Y, sign unchanged.
LLS	X	X	T	Y	(AC) and (MQ) shifted left Y, $(MQ)_S \rightarrow AC_S$.
LRS	X	X	T	Y	(AC) and (MQ) shifted right Y, $(AC)_S \rightarrow MQ_S$.
LGL	X	X	T	Y	(AC) and (MQ) shifted left Y, signs unchanged.
RQL	X	X	T	Y	(MQ) rotated left Y.
LGR	X	X	T	Y	(AC) and (MQ) shifted right Y, signs unchanged.
					Control Operations
NOP	X	X	X	X	Next instruction in sequence is executed.
HPR	X	X	X	X	Halts processor; processor steps to next instruction when Start key is depressed.
HTR	X	F	T	Y	Halts processor; processor steps to instruction in location Y when Start key is depressed.
TRA	X	F	T	Y	Next instruction is taken from location Y.
TZE	X	F	T	Y	If (AC) = 0, next instruction taken from location Y.
TNZ	X	F	T	Y	If (AC) ≠ 0, next instruction taken from location Y.
TPL	X	F	T	Y	If sign bit of AC positive, next instruction taken from location Y. Sign bit negative, next instruction executed.
TMI	X	F	T	Y	If sign bit of AC negative, next instruction taken from location Y. If sign bit positive, next instruction executed.
TOV	X	F	T	Y	If overflow indicator on, it is turned off and processing continues from location Y.
TNO	X	F	T	Y	If overflow indicator off, continue from location Y.
TQP	X	F	T	Y	If sign bit of MQ positive, next instruction taken from location Y.
TQO	X	F	T	Y	If MQ overflow indicator turned off, next instruction taken from location Y.
TLQ	X	F	T	Y	(MQ < (AC) next instruction taken from location Y.
TSX	X	X	T	Y	2's complement of location Y placed in index register T.*
TXI	D	D	T	Y	Adds the value of D to the number in index register T and takes next instruction from Y.*
TXH	D	D	T	Y	If number in index register T greater than value of D, next instruction taken from location Y.

INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Control Operations (Cont'd)
TXL	D	D	T	Y	If number in index register T is less than or equal to the value of D, next instruction taken from location Y.*
TIX	D	D	T	Y	If number in index register T is greater than the value of D, the number in index register T is reduced by the value of D and next instruction is taken from Y.*
TNX	D	D	T	Y	If number in index register T is greater than the value of D, number in index register T is reduced by the value of D and transfers to the next instruction; otherwise the index is unchanged and the next instruction is taken from Y.*
TTR	X	F	T	Y	Processor takes its next instruction from location Y and proceeds whether or not in trapping mode.
CAS	X	F	T	Y	If (Y) < (AC), next instruction is executed. If (Y) = (AC) next instruction is skipped. If (Y) > (AC), next two instructions are skipped.
LXA	X	X	T	Y	Address portion of (Y) replaces number in index register T.*
LXD	X	X	T	Y	Decrement portion of (Y) replaces number in index register T.*
SXD	X	X	T	Y	0 $\rightarrow$ (Y) and (T) replaces decrement part of location Y.*
PAX	X	X	T	Y	Address part of (AC) replaces the number in the index register T.*
PDX	X	X	T	Y	Decrement part of (AC) replaces the number in the index register T.*
PXD	X	X	T	Y	0 $\rightarrow$ (AC) and number in index register T is placed in the decrement part of the AC.*
XEC	X	F	T	Y	Execute instruction in location Y.
BTT	X	X	T	Y	Test the status of data channel BOT indicator. Channel specified by value of Y.
ZET	X	F	T	Y	If $(Y)_{1-35} = 0$, next instruction is skipped and processing continues. If $(Y)_{1-35} \neq 0$, next sequential instruction is executed.
NZT	X	F	T	Y	If $(Y)_{1-35} \neq 0$, the next instruction is skipped and processing continues. If $(Y)_{1-35} = 0$, next sequential instruction is executed.
LAS	X	F	T	Y	(AC) compared logically with (Y). If (AC) > (Y), next sequential instruction is executed. If (AC) = (Y), next instruction is skipped and processing continues. If (AC) < (Y), next two instructions are skipped and processing continues.
TCOA	X	F	T	Y	Next instruction taken from location Y if channel A is in operation.
TCNA	X	F	T	Y	Next instruction taken from location if channel A is not in operation.
TRCA	X	F	T	Y	When tape check indicator for channel A is on, next instruction taken from location Y. If indicator is off, next instruction in sequence is executed.
TEFA	X	F	T	Y	When end-of-file indicator for channel A is on, next instruction taken from location Y. If indicator is off, next instruction in sequence is executed.
LAC	X	X	T	Y	$(NOT(Y)_{21-35}) + 1 \rightarrow (T)$.
LDC	X	X	T	Y	$(NOT(Y)_{21-35}) + 1 \rightarrow (T)$.
AXT	X	X	T	Y	$Y \rightarrow (T)$.
AXC	X	X	T	Y	$(NOT\ Y) + 1 \rightarrow (T)$.
PAC	X	X	T	X	$(NOT\ (AC)_{21-35}) + 1 \rightarrow (T)$.
PDC	X	X	T	X	$(NOT\ (AC)_{3-17}) + 1 \rightarrow (T)$.
SXA	X	X	T	Y	$(T) \rightarrow (Y)_{21-35}$.
PXA	X	X	T	Y	$0 \rightarrow AC;\ (T) \rightarrow AC_{21-35}$.
					* Not indexable.

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INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Input-Output Operations
RDS	X	X	T	Y	Start the unit specified by Y in the read mode.
WRS	X	X	T	Y	Start the unit specified by Y in the write mode.
BST	X	X	T	Y	Backspace tape designated by Y one record.
WEF	X	X	T	Y	An end-of-file gap and mark and a redundancy character is written on the tape on unit Y.
REW	X	X	Y	Y	Rewind tape unit Y.
LDA	X	F	T	Y	704/709 Input-Output instruction.
CPY	X	X	T	Y	704/709 Input-Output instruction.
PSE †	X	X	T	X	Provides a means for testing the status of sense switches, controlling sense lights, and the sampling of or sending of impulses to the printer and punch. These functions include:
LBT					Low order bit test (AC).
CHS					Change sign (AC).
SSP					Set sign plus (AC).
ENK					(Console Keys) $\rightarrow$ (AC).
IOT					Test for input-output error.
COM					Complement magnitude (AC).
ETM					Enter trapping mode.
RND					Round $(MQ)_1 \times 2^{-35} + (AC) \rightarrow AC$.
SLN					Turn on Sense Light.
BTT					Test for beginning of tape.
DCT					Divide check test.
RCT					Test for tape error.
SLF					Turn off Sense Lights.
CLM					Clear Magnitude (AC).
SWT					Test Sense Switch.
SPU					Send signal to Card Reader.
SPT					Test for Printer signal.
SPR					Send signal to Printer.
RIC					Reset Data Channel.
RDC					Reset and Disconnect Data Channel.
FRN					Floating Point Round.
MSE †	X	X	T	X	Provides a means for testing and turning off the sense lights. These functions include:
PBT					P bit test (AC).
EFTM					Enter floating trap mode.
SSM					Set sign minus.
LFTM					Leave floating trap mode.
ESTM					Enter Storage Nullification Mode.
ECTM					Enter Copy Trap Mode.
LTM					Leave trapping mode.
LSTM					Leave Storage Nullification Mode.
SLT					Test Sense Light and turn it off.
ETT					End of Tape Test.
RTT					704 instruction.
BSF	X	X	T	Y	Selected tape Y is moved backward until end-of-file or load point is reached.
CAD	X	X	T	Y	704/709 input-output instruction.
					Sense Indicator Operations
PAI	X	X	X	X	$(AC)_{P,\ 1\text{-}35} \rightarrow SI$.
PIA	X	X	X	X	$(SI) \rightarrow AC_{P,\ 1\text{-}35}$; 0 $\rightarrow$ positions S and Q.
LDI	X	F	T	Y	$(Y) \rightarrow SI_{0\text{-}35}$.
STI	X	F	T	Y	$(SI) \rightarrow Y$.
OAI	X	X	X	X	(AC) "OR" (SI) $\rightarrow$ SI.
OSI	X	X	T	Y	(Y) "OR" (SI) $\rightarrow$ SI.
SIL	X	X	Y	Y	Y "OR" $(SI)_{0\text{-}17} \rightarrow SI_{0\text{-}17}$.
SIR	X	X	Y	Y	Y "OR" $(SI)_{18\text{-}35} \rightarrow SI_{18\text{-}35}$.
RIA	X	X	X	X	"NOT" (AC) "AND" (SI) $\rightarrow$ SI.

† Note: Except for the sign bit, the first 11 PSE have identical operation codes to the corresponding MSE codes. The particular variation is determined by the indexable address field.

§ 121.

INSTRUCTION LIST (Cont'd)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
RIS	X	F	T	Y	"NOT" (Y) "AND" (SI) → SI.
RIL	X	X	Y	Y	"NOT" (Y) "AND" $(SI)_{0-17} \rightarrow SI_{0-17}$.
ONT	X	F	T	Y	If (Y) "AND" (SI) = (Y), skip next instruction.
OFT	X	F	T	Y	If (Y) "AND NOT" (SI) = (Y), skip next instruction.
LNT	X	X	Y	Y	If Y "AND" $(SI)_{0-17}$ = (Y), skip next instruction.
RNT	X	X	Y	Y	If Y "AND" $(SI)_{18-35}$ = (Y), skip next instruction.
LFT	X	X	Y	Y	If Y "AND NOT" (SI_{0-17}) = (Y), skip next instruction.
RFT	X	X	Y	Y	If Y "AND NOT" (SI_{18-35}) = (Y), skip next instruction.
RIR	X	X	Y	Y	"NOT" Y "AND" $(SI)_{18-35} \rightarrow SI_{18-35}$.
IIA	X	X	X	X	(AC) "EXC. OR" (SI) → SI.
IIS	X	F	T	Y	(Y) "EXC. OR" (SI) → SI.
IIL	X	X	Y	Y	Y "EXC. OR" $(SI)_{0-17} \rightarrow SI_{0-17}$.
IIR	X	X	Y	Y	Y "EXC. OR" $(SI)_{18-35} \rightarrow SI_{18-35}$.
IIO	X	F	T	Y	If (AC) "AND" (SI) = (AC), take next instruction from Y.
TIF	X	F	T	Y	If (AC) "AND NOT" (SI) = (AC), take next instruction from Y.
					Systems Compatibility Operations
ESNT	X	F	T	Y	Half effective storage for 704 simulation transfer to Y - (T).
LSNM	X	X	T	X	Return to normal storage mode.
ESTM	X	X	T	X	Enter select trap mode. Input-output instructions set to cause trapping.
ECTM	X	X	T	X	Enter copy trap mode CPY CAD, and LDA will be trapped.
					Channel Trap Instructions
ENB	X	X	T	Y	Enable from Y. The (Y) determines which channel signals cause a trapping operation.
RCT	X	F	T	Y	Restore channel traps. Allows traps to occur as specified by ENB. Cancels the inhibiting effect of an executed trap.
					Input-Output Transmission Operations
RUN	X	X	T	Y	Rewind and unload tape.
SDN	X	X	X	Y	Set density of designated tape unit.
RDC	X	X	T	Y	Zero all registers and indicators in the designated data channel.
RIC	X	X	T	Y	Reset all conditions in data channel.
SCHA	X	F	T	Y	Store Channel A. (Y) replaced with contents of Channel A.
RCHA	X	F	T	Y	Reset and load Channel A. Channel A is reset and loaded with the (Y).
LCHA	X	F	T	Y	Load Channel A with the (Y).
					Data Channel Commands (7607)
IOCD	C	F	N	Y	Input-Output C words starting at Y and disconnect.
IOCP	C	F	N	Y	Input-Output C words starting at Y and proceed to next channel command.
IORP	C	F	N	Y	Input-Output up to C words of one record starting at Y, then proceed to the next channel command.
IOCT	C	F	N	Y	Input-Output C words of one record starting at Y then accept the waiting LCH instruction or disconnect.
					Data Channel Commands (7607) (Cont'd)
IORT	C	F	N	Y	Input-Output up to C words of one record starting at Y then accept the waiting LCH instruction or disconnect.
IOSP	C	F	N	Y	Input-Output the smaller of 1 record or C words starting at Y, then accept the next channel command.
IOST	C	F	N	Y	Input-Output the smaller of 1 record or C words starting at Y, then accept the waiting LCH instruction or disconnect.
TCH	X	F	X	Y	Take next channel command from Y.

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INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Data Channel Commands (7909)
CTL	X	X	X	Y	Information is sent to the adapters starting with (Y).
CTLR	X	X	X	Y	Prepared to read from the adapter. Must be followed by a copy.
CTLW	X	X	X	Y	Prepare to write to the adapter. Must be followed by a copy.
SNS	X	X	X	X	Prepare to read sense data. Must be followed by a copy.
CPYD	X	CF	X	Y	Transmit C words between the channel and core starting with location Y.
CPYP	X	CF	X	Y	Transmit C words between the channel and core starting with location Y then obtain next sequential command.
LAR	X	F	X	Y	(Y) $\longrightarrow$ (AR).
SAR	X	F	X	Y	(AR) $\longrightarrow$ (Y).
XMT	X	CF	X	Y	(XTM+1), (XTM+2), ..., (XTM+C+1) $\longrightarrow$ (Y+1), (Y+2), ..., (Y+C). Next channel instruction taken from (Y+C+1).
LCC	X	CF	X	X	C $\longrightarrow$ (CC).
TDC	X	F	X	X	If (C) > 0, then (C) - 1 $\longrightarrow$ (C) and next instruction is taken from (Y); if (C) = 0, command is no operation.
ICC	X	C	X	X	If C = 0, SMS indicators $(AR)_{31-36}$. If C = 1 - 6 (CC) $\longrightarrow$ (AR) character C. If C = 7 instruction is no operation.
TCM	X	CFM	X	Y	Transfer on condition met, select a character by: C = 0, use channel check register. C = 1 - 6, use (AR) character C. C = 7, go to Y; if M = 0, next command; otherwise for C $\neq$ 7, go to Y. If character = M and $(TCM)_{11}$ = 0, or if character "AND" M = M and $(TCM)_{11}$ = 1; otherwise use next command in sequence.
SMS	X	F	X	X	Set mode and select; $(SMS)_{30-35}$ $\longrightarrow$ status indicators.
WTR	X	F	X	Y	Wait and transfer; a start channel instruction will cause the next command to be taken from location Y.
TWT	X	F	X	Y	Trap and wait; the channel suspends operation until a start channel instruction is executed. If control word trap is enabled, the CPU traps.
LIP	X	X	X	X	Leave interrupt program, the channel resumes a program that has been interrupted.
LIPT	X	F	X	Y	Leave interrupt program and transfer, the channel enters a non-interrupted condition and takes its next command from location Y.
					Control Orders (Disc)
DNOP					No Operation
DREL					Release
DEBM					Eight-Bit Mode
DSBM					Six-bit Mode
DSEK					Seek
DVSR					Prepare to Verify (single record)
DWRF					Prepare to Write Format
DVTN					Prepare to Verify (track with no addresses)
DVCY					Prepare to Verify (cylinder operation)*
DWRC					Prepare to Write Check
DSAI					Set Access Inoperative
DCTA					Prepare to Verify (track with addresses)
DVHA					Prepare to Verify (home address)

§ 121.

INSTRUCTION LIST (Cont'd)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Control Orders (Hypertape)
HNOP					No Operation
HEOS					End of Sequence
HRLF					Reserved Light Off
HRLN					Reserved Light On
HCLN					Check Light On
HSEL					Select
HSBR					Select for Backward Reading
HCCR					Change Cartridge and Rewind
HRWD					Rewind
HRUN					Rewind and Unload Cartridge
HERG					Erase Long Gap
HWTM					Write Tape Mark
HBSR					Backspace
HBSF					Backspace File
HSKR					Space
HSKF					Space File
HCHC					Change Cartridge
HUNL					Unload Cartridge
HFPN					File Protect On

Terms:

C means count value.
D means decrement value.
F means indirect addressing flag.
M means mask character.
N means non-transmit to storage.
T means index register tag.
X means part of the operation code.
Y means the address or value.

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DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . . binary 6-bit code.
internal.
magnetic tape.
magnetic disk.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: 2 zone bits; B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits; 8, 4, 2, 1

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0	0	&	-	Blank
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
10		+ o	- o	‡
11	#	.	$	,
12	@	□	*	%
13				
14				
15				

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . . punch card input-output.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	&	-	0
12	&	&	∝	+ o
11	-	∝	-	- o
0	0	+ o	- o	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	$	D	M	U
5	5	E	N	V
6	6	F	Ø	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2		+	-	
8-3	#		$	,
8-4	@	□	*	%
8-5				
8-6				
8-7	TM	ǂ	Δ	

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DATA CODE TABLES NO. 3

§ 143.

DATA CODE TABLE NO. 3

.1 USE OF CODE: . . . . printer (standard set).

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 card column.

.23 Character Codes (note: see alternative symbol sets on this page; A, B, C, D, F, G.)

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None		&	-	0
12				
11				
0				
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2				
8-3	#		$	,
8-4	@	□	*	%

DATA CODE TABLE NO. 3-A

.1 USE OF CODE . . . . printer alternate symbol set A (FORTRAN set).

.2 STRUCTURE OF CODE

.21 Character Size: . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	+	-	0
1				/
8-3	=	.	$	,
8-4	-	)	*	(

DATA CODE TABLE NO. 3-B

.1 USE OF CODE . . . . printer alternate symbol set B.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None		/	-	
1				&
8-3	#	.	$	,
8-4	@	□	*	%

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§ 143.

DATA CODE TABLE NO. 3-C

.1 USE OF CODE . . . . printer alternate symbol set C.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None		&	-	
1				0
8-3	#	.	$	,
8-4	@	□	*	%

DATA CODE TABLE NO. 3-D

.1 USE OF CODE . . . . printer alternate symbol set D.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None		-	-	
1				/
8-3	#	.	$	,
8-4	@	□	*	%

DATA CODE TABLE NO. 3-F

.1 USE OF CODE . . . . printer alternate symbol set F.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None		+	-	
1				/
8-3	=	.	$	,
8-4	-	)	*	(

DATA CODE TABLE NO. 3-G

.1 USE OF CODE . . . . printer alternate symbol set G.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None		+	-	
1				/
8-3	+	.	$	,
8-4	-	□	*	%

DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . BCD 6-bit code.
magnetic tape.
magnetic disk.

.2 STRUCTURE OF CODE

.21 Character Size: . . . . 6 bits.

.22 Character Structure

.221 More significant pattern: 2 zone bits: B, A = 32, 16.

.222 Less significant pattern: 4 numeric bits, 8, 4, 2, 1.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN			
	0	16	32	48
0		Blank	-	&
1	1	/	J	A
2	2	S	K	B
3	3	T	L	C
4	4	U	M	D
5	5	V	N	E
6	6	W	O	F
7	7	X	P	G
8	8	Y	Q	H
9	9	Z	R	I
10	0	‡	$\overset{-}{0}$	$\overset{+}{0}$
11	#	,	$	.
12	@	%	*	□
13				
14				
15	TM		Δ	≠

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PROCESS ORIENTED LANGUAGE: 709/7090 FORTRAN II

§ 161.

.1 GENERAL

.11 Identity: . . . . . FORTRAN II Automatic Coding System for the IBM 709/7090.

.12 Origin: . . . . . IBM Data Processing Division.

.13 Reference: . . . . . IBM Reference Manual C28-6054-2.

.14 Description

The FORTRAN II language is the most widely used process oriented language for scientific programming. Although the language is machine-independent, it has been designed primarily for use with the IBM 700/7000 series scientific systems, and is strongly oriented toward their hardware features. However, because of its large community of users and its proven facilities in scientific applications, some version of FORTRAN II has been implemented by almost all system manufacturers.

FORTRAN II for the 7090 can perform double precision, Boolean, and complex arithmetic operations, but lacks disc and drum input-output facilities. The FORTRAN II Monitor, of which the translator is a part, includes service functions that relieve the programmer of many of the less productive aspects of machine coding, debugging, and operating tasks.

The FORTRAN II language has a pseudo-algebraic format in which expressions describing arithmetic operations appear in "equation" form. The left-hand side of the equation is a variable, the value of which is determined by evaluating the arithmetic expression on the right-hand side of the equal sign. The equal sign loses its algebraic equivalence meaning and takes the meaning of replacement; e.g., K = K + 1 means increment the value of K by one.

In addition to the basic arithmetic statement, 37 other distinct statement types are provided to handle control, input-output, and data description functions. Logical decisions are handled by the IF statement, which transfers control to one of three numbered statements depending upon whether the value of an arithmetic expression is less than, equal to, or greater than zero. Looping is controlled by the DO statement, which precedes the sequence of statements comprising the loop and causes them to be executed an appropriate number of times. The format, sequencing, and effect of each type of statement are summarized in the Table of Source Program Statements, Paragraph .43.

FORTRAN II labels for source statements are numbers less than 32,768. Variable, subroutine, and function labels consist of from one to six characters. The first character of a variable label must be alphabetic, and denotes the representation to be used for the variable. Floating-point is the standard representation unless the first letter is I, J, K, L, M, or N in which case the variable is represented as a fixed point integer. Literal numbers used in the source language are expressed in floating point if they are written with a decimal point included; otherwise they are considered fixed point. All the operands in a single expression must be in the same mode; i.e., all must be fixed or all must be floating point.

.14 Description (Contd.)

Floating point mode is used for most calculations because of its range ($\pm 10^{\pm 38}$) and, when necessary, its precision (8 or 16 decimal digits). Fixed point mode, which is used mainly for counting and control, is restricted to integers under 131,072 (i.e., 2^{17}). Only fixed-point integers, modulo 2^{15}, are considered meaningful subscripts. These limitations are imposed by the equipment rather than the language.

FORTRAN II arithmetic statements with a "B" punched in column 1 are interpreted as Boolean statements, and the symbols +, *, and - denote the Boolean operators OR, AND, and NOT, respectively. All Boolean operations are performed upon the full 36-bit word. Boolean masks and constants are expressed as octal numbers. Arithmetic statements with a "D" in column 1 are executed in double precision floating point, with a precision of 16 decimal digits. An "I" in column 1 denotes complex arithmetic, in which each variable or constant consists of a real part and an imaginary part, each part expressed as a single precision floating point number. Boolean, double precision, and complex variables are named in the same way as single precision floating point variables, and can be subscripted in the same manner. Direct input-output facilities are not provided for double precision or complex variables.

The power of FORTRAN II lies in its ability to use independently prepared subroutines, in the use of subscripted arrays,* in the flexibility of its input-output features, and, in particular, in the relative simplicity of writing FORTRAN II procedures. Every program written is essentially a subprogram. The only difference between the main program and subprograms is in usage: the main program is entered first. There are two kinds of subprograms, functions and subroutines. In the procedural statement, functions appear as variables with specified arguments; e.g., SINF(A+B). These functions cause a subroutine to be entered that will compute the value of the variable using the values of its arguments and then return the computed value to the calling statement. A subroutine in FORTRAN II performs the

* Tables of variables referenced by use of subscript notation.

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§ 161.

.14 Description (Contd.)

same function as in hand-coded programs; that is, it accepts a number of arguments, operates on them, and then returns control to the main program. Naturally, the value of this feature increases as the number of available subroutines increases. For the 709/7090 this value is considerable because of the large number of subroutines in the library maintained by the SHARE users' group. Subroutines can be coded in FORTRAN or FAP. They can be taken from the library tape, compiled with the source program itself, or be separately compiled routines on either cards or tape.

The input-output facilities allow considerable flexibility in handling numeric data, which is adequate for most scientific uses but somewhat limited in other areas of processing. The variables to be input or output are listed in the same statement that specifies the input-output unit and, in the case of tapes, whether external representation is binary or binary-coded decimal. Each BCD input and output statement references a FORMAT statement which specifies the translation required upon the data and its format on the external medium.

Use of the 709/7090 FORTRAN II language imposes the following restrictions on the user:

- Input, processing, and output cannot be overlapped (except for the last physical block of each output record), even though the computer system is equipped to do so.†
- No control over the blocking of logical records on magnetic tape is provided.
- Detailed descriptions of files and record layouts (as in COBOL) are not possible.
- Block transfers of multiple data items from one file or array to another cannot be directly coded.
- Arrays are restricted to three dimensions.
- Subscript expressions, used for referencing individual array elements, are restricted to the form C * N ± C' or a subset thereof, where C and C' are unsigned integer literals and N is an integer variable.
- Although the notation used within the arithmetic statements can be made quite descriptive, the relationships among all the statements comprising a source program are likely to be obscure (especially when the program is segmented) unless extensive comments are included.

Some of the restrictions can be circumvented by the use of subprograms coded in FAP symbolic form (Section 408:171). FAP makes all the hardware facilities of the 7090 available, but requires a knowledge of assembly-level programming.

† Modifications to the input-output facilities of the IBM-supplied FORTRAN II system by individual users have increased the amount of overlapping that can be obtained.

.14 Description (Contd.)

In summary, 709/7090 FORTRAN II is a convenient language for scientific applications. The language is comparatively easy to learn and use, but like most process oriented languages, it requires a skillful and experienced programmer who is also thoroughly familiar with the 7090 in order to use it most effectively. The inability of FORTRAN-coded programs to perform fully overlapped input, processing, and output operations severely limits their maximum overall efficiency. Despite its limitations, the wide use of FORTRAN II has made it the de facto standard process oriented language for scientific applications.

.15 Publication Date: . . . original edition, 1958; current edition, January, 1961; double precision and complex arithmetic added in August, 1961.

.2 PROGRAM STRUCTURE

.21 Divisions: . . . . . one division, composed of the following types of statements.

Procedure statements:	algebraic formulae. comparisons and jumps. input and output.
Data statements:	FORMAT: describes the layout, size, scaling, and code of input-output data. EQUIVALENCE: causes two variables to have a common location or specifies synonyms. COMMON: causes data storage areas to be shared by more than one subprogram. DIMENSIONS: specifies the maximum number of elements in each dimension of an array or set of arrays.
Optimizing statement:	FREQUENCY: optional statement of ratio of expected use of alternative paths at a branch point or average repetitions of loops.

.22 Procedure Entities

Program:	composed of statements, subroutines, and/or functions.
Subroutine:	composed of statements.
Function:	composed of statements.
Statement:	composed of characters; blanks are ignored except when part of alphameric literals.

Note: The general term "subprogram" is applied to each independent subroutine, function, or segment of a main program.

§ 161.

.23 Data Entities

Array:	a group of variables of any one of the following classes; each array element is referenced by the array name followed by 1, 2, or 3 subscripts.
Item:	a floating point variable or constant (single precision, double precision, or complex).
	an integer variable or constant.
	a Boolean variable or constant.
	a Hollerith item.
	an alphameric item.
Hollerith item:	an item composed of alphameric characters that can be used only for output; the item is not named.
Alphameric item:	an item, composed of alphameric characters, that is given a variable or array name and hence can be processed and/or modified.

.24 Names

.241 Simple name formation

Character set:	A to Z, 0 to 9.
Size:	1 to 6 char.
Avoid key words:	no.
Formation rule:	first char must be a letter.
	a final F may not be used if the name is subscripted and is more than 3 characters long.
	a variable name may not be the same as the name of any function without its terminal F.

.242 Designators

Procedures	
Statement label:	unsigned integer.
Function label:	4 to 7 characters with a terminal F for built-in and library functions; no designator for user-coded functions.
Subroutine label:	no designator.
Boolean statement:	B in column 1.
Double precision arithmetic statement:	D in column 1.
Complex arithmetic statement:	I in column 1.
Data	
Integer variable:	initial I, J, K, L, M, N.
Floating point variable:	any other initial letter.
Equipment	
Card:	implied by verbs READ, PUNCH.
Magnetic tape:	use key word TAPE.
Printer:	implied by verb PRINT.

.242 Designators (Contd.)

Equipment (Contd.)	
Sense Light or Switch:	implied by noun SENSE.
Overflow Triggers:	implied by noun OVERFLOW.
Divide Check Trigger:	implied by phrase DIVIDE CHECK.
Input or Output:	implies BCD data on tape.
Comments:	C in column 1 of statement.
Translator control:	key words FREQUENCY, EQUIVALENCE, or COMMON.

.25 Structure of Data Names

.251 Qualified names:	none.
.252 Subscripts	
Number per item:	0 to 3.
Applicable to:	all variables.
Class may be	
Special index variable:	no special index variables.
Any variable:	only integers.
Literal:	yes; only integers.
Expression:	at most C * N $\pm$ C'; where C and C' are literals and N is an integer variable.
Form may be	
Integer only:	C, C', and N.
Signed:	no.
Truncated fraction:	yes (and modulo 2^{15}).
Rounded fraction:	no.
.253 Synonyms	
Preset:	EQUIVALENCE statement causes sharing of storage locations.
Dynamically set:	no.

.26 Number of Names

The maximum number of variable names and procedure numbers permitted in the FORTRAN language is essentially unlimited. The limitations imposed by the IBM 7090 FORTRAN Translator are covered in Section 408:181. These limitations are not very significant because large source programs are usually divided into subprograms which are compiled separately. Current practice is to use fewer than 1,000 source statements per compilation; this number of statements is not likely to exhaust the name capacity of the translator.

.261 All entities:	see .26.
.262 Procedures:	see .26.
.263 Data:	see .26.
.264 Equipment	
Tapes:	0 to 80.
Printer:	1.
Card Reader:	1.
Card Punch:	1.

.27 Region of Meaning of Names

In the straightforward use of FORTRAN, each name is established in a subprogram and is local to that particular subprogram. A name can be made to reference the same storage location in 2 or more subprograms by specifying the name in the same position of a COMMON statement in each subprogram.

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§ 161.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311	Concise item picture: .	FORMAT statement only.
.312	List by kind:	no.
.313	Qualify by adjective: . .	no.
.314	Qualify by phrase: . . .	no.
.315	Qualify by code:	first letter of name.
.316	Hierarchy by list: . . .	no.
.317	Level by indenting: . .	no.
.318	Level by coding:	no.
.319	Others (examples)	
	Four-by-seven array size:	DIMENSION ARRAY (4, 7).
	Four-digit integer: . .	FORMAT (I4).
	Five four-digit integers:	FORMAT (5I4).
	Two floating point items:	FORMAT (F8.3, E12.4) for 999.999 Δ Δ 9.9999E Δ 99 (Δ means either blank or minus sign).

.32 Files and Reels

.321	File labels:	own coding.
.322	Reel Sentinels:	no multireel files.

.33 Records and Blocks

.331	Variable record size: .	dynamic.
.332	Variable block size: . .	dynamic, with fixed upper limits.
.333	Record size:	1 to N blocks.
.334	Block size	
	READ TAPE, WRITE TAPE:	up to 127 data words (binary format).
	READ INPUT TAPE, WRITE OUTPUT TAPE:	up to 120 data characters (BCD format).
	READ, PUNCH: . . .	up to 72 data characters (BCD format).
	PRINT:	up to 120 data characters (BCD format).
.335	Choice of record size: .	implied by input-output list and FORMAT statement.
.336	Choice of block size: .	none; 1 logical record of 1 or more blocks is read or written by each input or output statement.
.337	Sequence control: . . .	none.
.338	In-out error control: .	automatic.
.339	Blocking control:	none; 1 logical record of 1 or more blocks is read or written by each input-output statement.

.34 Data Items

.341	Designation of class: .	by name.
.342	Possible classes	
	Integer:	yes.
	Fixed point:	no.
	Floating point, single length:	yes.
	Floating point, double length:	yes.
.342	Possible classes	
	Floating point, complex:	yes.
	Boolean:	yes.
	Alphameric:	yes, two forms.
.343	Choice of external radix:	FORMAT statement.
.344	Possible external radices	
	Decimal:	yes.
	Octal:	yes.
.345	Internal justification: .	alphameric automatic left justified. integers automatic right justified in decrement of word.
.346	Choice of external code:	FORMAT statement and READ, WRITE statement.
.347	Possible external codes	
	Decimal:	yes.
	Octal:	yes.
	Hollerith:	yes.
	Alphameric:	yes.
.348	Internal item size	
	Variable size:	fixed; 1 word or 2 words.
	Designation:	a D or I in column 1 indicates that variable size is 2 words.
	Range	
	Integer numeric: . .	fixed, 1 word (high order 18 bits).
	Floating point numeric:	fixed, 1 word or 2 words.
	Complex:	fixed, 1-word real part and 1-word imaginary part.
	Boolean:	fixed, 1 word of 36 bits.
	Alphameric:	fixed, 1 word.
.349	Sign provision:	optional.

.35 Data Values

.351	Constants	
	Possible sizes	
	Integer:	$\pm 2^{17}-1$.
	Fixed point:	none.
	Floating point: . . .	$\pm 10^{-38}$ to $\pm 10^{+38}$.
	Alphameric:	660 char/statement or 66 char per card, 10 cards max.
	Subscriptible:	yes.
	Sign provision:	optional.
.352	Literals:	same as constants.
.353	Figuratives:	own coding.
.354	Conditional variables: .	computed GO TO.

.36 Special Description Facilities

.361	Duplicate format: . . .	yes; by multiple references to a single FORMAT statement.
.362	Re-definition:	COMMON statement. EQUIVALENCE statement.
.363	Table description	
	Subscription:	mandatory in DIMENSION statement.
	Multi-subscripts: . .	1 to 3.
.364	Other subscriptible entities:	tape units.

§ 161.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator List

Arithmetic

+	addition; also unary.
-	subtraction; also unary.
*	multiplication.
/	division.
**	exponentiation.
=	replacement: replace value of variable on left side with value of expression on right side.

Logical (designated by B in column 1)

*	AND.
+	inclusive OR.
-	NOT.

Functions

ABSF ( )[a,c]	absolute value.
INTF ( )[a,b]	truncation.
MODF (A,B) [a,b]	remainder A ÷ B; i.e., A modulo B.
MAXOF (A,...) [a,b]	maximum value, result fixed.
MAXIF (A,...) [a,b]	maximum value, result floating.
MINOF (A,...) [a,b]	minimum value, result fixed.
MINIF (A,...) [a,b]	minimum value, result floating.
DIMF (A,B) [a]	diminish A by A or B, whichever is smaller.
LOGF ( ) [c]	natural log.
SINF ( ) [b]	sine.
COSF ( ) [c]	cosine.
EXPF ( ) [c]	exponential.
LOG10F ( ) [b]	base 10 log.
ATAN2F ( ) [b]	arctangent (double length).
SQRTF ( ) [c]	square root.
ATANF ( ) [b]	arctangent.
TANHF ( )	hyperbolic tangent.
FLOATF ( ) [c]	float an integer.
XFIXF ( ) [c]	fix a floating point variable; same as XINTF.
SIGNF ( ) [a,c]	sign change.

Note: [a] Functions may be preceded by an X to specify fixed point operands.
[b] Double length if a D appears in column 1.
[c] Double length or complex if a D or I appears in column 1.

.412 Operands allowed

Classes:	usually numeric, but alphameric is possible.
Mixed scaling:	yes.
Mixed classes:	only in exponentiation and functions.
Mixed radices:	no.
Mixed precision:	no.
Literals:	yes.

.413 Statement structure

Parentheses

a - b - c means:	(a - b) - c.
a + b x c means:	a + (b x c).
a ÷ b ÷ c means:	(a ÷ b) ÷ c.
a^{bc} means:	illegal; parentheses must be used to clarify order.
Size limit:	660 char (10 cards of 66 columns each).
Multi-results:	no.

.414 Rounding of results: truncation of integers at each step in expression.

.415 Special cases

	Integer	Floating
x = -x:	K = -K	X = -X.
x = x + 1:	K = K + 1	X = X + 1.
x = 4.7y:	K = 47 * L/10	X = 4.7 * Y.
$x = 5 \times 10^7 + y^2$:	too large	X = 5. E7 + Y**2.
x = |y|:	K = XABSF(L)	X = ABSF(Y).
x = integer part of (y):	K = XINTF(Y)	X = INTF(Y).

.416 Typical examples:

```
X = (-B+SQRTF(B*B-4.0*A*
C))/(2.0*A).
18 ALPHA = CON.
DO 20 I = 2, N.
20 ALPHA = ALPHA * X +
CON (I).
```

.42 Operations on Arrays:

by own FORTRAN coding only.

.43 Other Computation:

See Table of Source Program Statements.

TABLE OF SOURCE PROGRAM STATEMENTS

Statement	Normal Sequencing	Comment
a = b	next executable statement	arithmetic statement; value of expression b replaces variable a.
ASSIGN i TO n	next executable statement	i is n_1, n_2 etc., in an assigned GO TO statement.
BACKSPACE i	next executable statement	i is a tape number.
CALL Name (a_1, a_2, . . . , a_n)	first statement of subroutine Name	Name is the subroutine label and a_i are arguments.
COMMON A, B,...	not executed	A, B are labels of data storage areas shared by programs.
CONTINUE	next executable statement	dummy statement.
DIMENSION v, v, v, ...	not executed	v is an array label with its maximum subscript values.

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§ 161.

TABLE OF SOURCE PROGRAM STATEMENTS (Contd.)

Statement	Normal Sequencing	Comment
DO n i = m_1, m_2, or DO n i = m_1, m_2, m_3	DO-sequencing, then next executable statement	perform through statement n with i starting at m_1 increased by m_3 (or 1) each time until i is greater than m_2.
END FILE i	next executable statement	write end-of-file mark on tape i.
END (I_1, I_2, I_3, I_4, I_5)	no sequencing; this statement terminates a program.	
EQUIVALENCE (a, b, c, ...), (d, e, f,...),...	not executed	labels within parentheses are assigned to common storage locations.
FREQUENCY n (i, j, ...), m(k, l,...),....	not executed	branch optimizing statement.
FORMAT (Specification)	not executed	translation and placement specification for input-output statement.
FUNCTION Name (a_1, a_2 ..., a_n)	next executable statement	first statement of function subprogram.
GO TO n	statement n	branch to statement n.
GO TO n, (n_1, n_2,..., n_m)	statement last assigned to n	assigned branch.
GO TO (n_1, n_2,..., n_m), i	statement n_i	branch to statement n_i, where i is an integer variable.
IF (a) n_1, n_2, n_3	statement n_1, n_2, or n_3 if (a) < 0, (a) = 0, or if (a) > 0, respectively	a is an expression.
IF ACCUMULATOR OVERFLOW n_1, n_2	statement n_1, n_2 if the 709/7090 FORTRAN internal overflow indicator is On or Off, respectively	
IF DIVIDE CHECK n_1, n_2	statement n_1, n_2 if the Divide Check indicator is On or Off, respectively	
IF QUOTIENT OVERFLOW n_1, n_2	statement n_1, n_2 if the 709/7090 FORTRAN internal overflow indicator is On or Off, respectively	
IF (SENSE LIGHT i) n_1, n_2	statement n_1, n_2 if Sense Light i is On or Off, respectively	
If (SENSE SWITCH i) n_1, n_2	statement n_1, n_2 if Sense Switch is Down or Up, respectively	
PAUSE OR PAUSE n	next executable statement	halt with restart provision.
PRINT n, List	next executable statement	print on-line; n is format, List contains variable labels.
PUNCH n, List	next executable statement	punch on-line; n is format, List contains variable labels.
READ n, List	next executable statement	read cards; n is format, List contains variable labels.
READ DRUM i, j, List	next executable statement	709 only.
READ TAPE i, List	next executable statement	read binary magnetic tape; i is unit, List contains variable names.
READ INPUT TAPE i, n, List	next executable statement	read BCD magnetic tape; i is unit, n is format, List contains variable labels.
RETURN	the statement or part of statement following call	at least one in each function or subroutine.
REWIND i	next executable statement	rewind tape unit i.
SENSE LIGHT i	next executable statement	set sense light.
STOP or STOP n	terminates program	
SUBROUTINE Name (a_1, a_2,... a_n)	next executable statement	first statement in a subroutine.
WRITE DRUM i, j, List	next executable statement	709 only.
WRITE OUTPUT TAPE i, n, List	next executable statement	write BCD magnetic tape; i is unit, n is format, List contains variable labels.
WRITE TAPE i, List	next executable statement	write binary magnetic tape; i is unit, List contains variable labels.

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.44 Data Movement and Format

.441	Data copy example:	Y = X.
.442	Levels possible:	items.
.443	Multiple results:	none.
.444	Missing operands:	not possible.
.445	Size of operands:	fixed for internal operations, preset variable for input and output items in BCD format.
	Alignment rule	
	Numbers:	right justified for integers; normalized for floating point.
	Alpha:	left justified.
	Filler rule	
	Numbers:	zeros.
	Alpha:	blanks.
	Truncating rule	
	Numbers:	truncate at left for integers, right for floating.
	Alpha:	truncate at right.
	Variable size destination:	no.
.446	Editing possible	
	Change class:	integer to floating or fixed point. floating to integer or fixed point. integer or floating to octal.
	Change radix:	yes.
	Insert editing symbols	
	Actual point:	automatic.
	Suppress zeros:	automatic.
	Insert:	automatic scaling indication.
	Float:	minus sign only.
.447	Special moves:	none.
.448	Code translation:	automatic.
.449	Character manipulation:	none.

.45 File Manipulation

Open:	own coding.
Close:	own coding.
Advance to next record:	READ, WRITE, PUNCH, PRINT.
Step back a record:	BACKSPACE.
Set restart point:	none.
Restart:	none.
Start new reel:	own coding.
Start new block:	implied in each input-output statement.
Search on key:	none.
Rewind:	REWIND.
Unload:	none.

.46 Operating Communication

.461	Log of progress:	PRINT uses on-line printer.
.462	Messages to operator:	same as log.
.463	Offer options:	PAUSE and octal display. STOP and octal display. PRINT message. SENSE LIGHT.
.464	Accept option:	use sense switch or usual operator intervention.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	IF clause	own coding.
In-out:	automatic	halt and display error type.
Invalid data:	automatic	halt and display error type.

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511	Destinations allowed:	statement number less than 32,768.
.512	Unconditional jump:	GO TO N.
.513	Switch:	GO TO M, (35, 47, 18).
.514	Setting a switch:	ASSIGN 35 to M.
.515	Switch on data:	GO TO (35, 47, 18), I.

.52 Conditional Procedures

.521	Designators	
	Condition:	IF.
	Procedure:	implied.
.522	Simple conditions:	single form of multiple condition; see example in paragraph .528.
.523	Conditional relations:	IF (A) B, C, D: if the value of the expression A is less than, equal to, or greater than zero, respectively, go to B, C, or D.
.524	Variable conditions:	expression always against zero.
.525	Compound conditionals:	no.
.528	Typical examples:	IF (X**2.0 - 3.0) 29, 37, 18; means go to 29, 37, or 18 if x^2-3 is respectively less than, equal to, or greater than zero. This is the only permitted form for conditional statements.

.53 Subroutines

.531	Designation	
	Single statement:	not possible.
	Set of statements	
	First:	SUBROUTINE.
	Last:	END.
.532	Possible subroutines:	any number of statements.
.533	Use in-line in program:	no.
.534	Mechanism	
	Cue with parameters:	CALL XXX (X, Y, Z).
	Number of parameters:	no practical limit.
	Cue without parameter:	CALL XXX.
	Formal return:	RETURN statement at least once.
	Alternative return:	more RETURN statements.
.535	Names	
	Parameter call by value†:	yes.
	Parameter call by name†:	no.
	Non-local names:	use COMMON.
	Local names:	all.
	Preserved own variables:	all.

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.536 Nesting limit: . . . . . 300.
.537 Automatic recursion allowed: . . . . . no.

† "Call by value" and "call by name" are ALGOL terms describing two methods of supplying parameters to a subroutine or function. The difference between the two methods is in the way the parameters are used by the subroutine, not in the method a programmer uses to specify them. Call by value is a restricted form, and indicates that the parameter, which may be an expression, is evaluated before the subroutine is entered and that this value is then "plugged" into the subroutine. The call by name, the unrestricted form which is correspondingly more difficult to implement, indicates that the called variable or expression must be re-evaluated each time it is used in the subroutine.

.54 Function Definition by Procedure

.541 Designation
Single statement:. . . same as set.
Set of statements
First: . . . . . FUNCTION.
Last: . . . . . END.
.542 Level of procedure: . . any number of statements.
.543 Mechanism
Cue: . . . . . by name in expression.
Formal return:. . . . RETURN.
.544 Names
Parameter call by value†: . . . . . yes.
Parameter call by name†: . . . . . no.
Non-local names: . . use COMMON.
Local names:. . . . . all.
Preserved own variables:. . . . . all.

† See footnote, Paragraph .537.

.55 Operand Definition by Procedure: . . . . . none.

.56 Loop Control

.561 Designation of loop
Single procedure: . . none.
First and last procedures:. . . . . current place to named end; e.g., DO 173 I = 1, N, 2.
.562 Control by count: . . . indirect.
.563 Control by step
Parameter
Special index:. . . . no.
Any variable: . . . . integer only.
Step: . . . . . positive integers.
Criteria: . . . . . greater than.
Multiple parameters: require nested loops.
.564 Control by condition: . no.
.565 Control by list: . . . . no.
.566 Nesting limit: . . . . . 200 of DO type.
.567 Jump out allowed: . . . yes.
.568 Control variable exit status: . . . . . available.

.6 EXTENSION OF THE LANGUAGE: . . can write new function for library.

.7 LIBRARY FACILITIES

.71 Identity: . . . . . FORTRAN library.

.72 Kinds of Libraries

.721 Fixed master: . . . . . no.
.722 Expandable master: . . yes.

.73 Storage Form: . . . . . magnetic tape.

.74 Varieties of Contents: . subroutines. functions.

.75 Mechanism

.751 Insertion of new item: . separate run.
.752 Language of new item:. FAP and/or FORTRAN.
.753 Method of call:. . . . . named in procedures.

.76 Types of Routine

.761 Open routines exist: . . yes; 20 "built-in" functions.
.762 Closed routines exist: . yes.
.763 Open-closed is variable: . . . . . no.

.8 TRANSLATOR CONTROL

.81 Transfer to Another Language: . . . . . yes; FAP subroutines can be used.

.82 Optimizing Information Statements

.821 Process usage statements:. . . . . FREQUENCY.
.822 Data usage statements: COMMON, EQUIVALENCE.

.83 Translator Environment:. . . . . implicit.

.84 Target Computer Environment:. . . . . no.

.85 Program Documentation Control: . . . . . yes; see next entry.

.86 Translator Output Options: . . . . . END (I_1, I_2, I_3, . . . , I_{15}) specifies choice of listing and object program output options.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: CALL CHAIN causes a program segment to be loaded into core storage from tape and executed.

.92 Address Allocation: . . relative to zero; object programs are relocatable.

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.93	Arrangement of Items In Word In Unpacked Form:	standard; no control is provided.
.94	Assignment of Input-Output Devices: . . .	yes; specified in input-output statements.
.95	Input-Output Areas: . .	built into input-output routines; no control is provided.

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PROCESS ORIENTED LANGUAGE: 7090/7094 FORTRAN IV

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.1 GENERAL

.11 Identity: . . . . . IBM 7090/7094 FORTRAN IV.

.12 Origin: . . . . . IBM Data Processing Division.

.13 Reference: . . . . . IBM Publication C28-6274, published January, 1963.

.14 Description

FORTRAN, as originally conceived, was a scientific programming system that handled floating point operations on a specific machine. It had some integer operations (designed for housekeeping only and restricted in scope) and a few machine-based instructions (IF SENSE SWITCH, etc.). Most of the necessary machine-level instructions were implied in the language, making it unnecessary for the non-programmer FORTRAN writer to worry about them.

During the six or seven years since it first came into use, the FORTRAN notation has proved to be very successful. It has spread to almost all scientific computers and has been adapted for many circumstances where the original assumptions did not hold. Some of these adaptations worked, but were not in accordance with the generally accepted meanings of the terms involved (Boolean operations in FORTRAN II, for example, were carried out on 36-bit operands rather than two-valued operands). Different firms started introducing new statements to help programmers (for now there were many FORTRAN programmers) obtain more efficiency and use many types of operands which were not included in the original FORTRAN. These include double-precision floating point, alphameric, and complex number operations.

FORTRAN IV is the result of a joint effort by IBM Corporation and other members of the industry to make the FORTRAN language more generally useful and to eliminate some of the arbitrary rules, misleading nomenclature, etc., that had arisen over the years. The overall scheme of FORTRAN statements, which had been so successful in the past, was basically left untouched, so that no FORTRAN II programmer would have any difficulty in using FORTRAN IV. (The source program statements of IBM 7090/7094 FORTRAN IV are listed and described in Paragraph .142.) Widespread adoption of

.14 Description (Contd.)

FORTRAN IV was further encouraged by the action of SHARE, which organized a cooperative effort to provide a special FORTRAN II to FORTRAN IV translator, SIFT, thus allowing the large SHARE library to be made immediately available to FORTRAN IV users.

FORTRAN IV, like FORTRAN II, has a pseudo-algebraic format in which statements describing arithmetic operations are written in "equation" form. The left-hand side of the equation is a variable, whose value is determined by evaluating the arithmetic expression on the right-hand side of the equal sign. The equal sign loses its algebraic significance and denotes replacement; e.g.,

K = K + 1, which would normally be meaningless, has the meaning "increment the current value of K by 1."

Integers, single- and double-precision floating point numbers, complex numbers, Boolean values, and alphameric items can all be used as variables. They are normally distinguished by being "declared" in Type statements, but the old FORTRAN II method (names starting with the letters I through N are integers; all others are single precision floating point) is allowed as an alternative. From the point of view of the language itself, valid and meaningful procedures can be written, but in 7090/7094 FORTRAN IV some arbitrary limits are placed on this. These limitations apply mainly to what is called "mixed mode arithmetic," which occurs when more than one type of variable or literal is used on the right-hand side of a single FORTRAN "equation."

For example, "I = (Floating Point Number) + (Integer)" is a mixed mode statement. Many mixed mode operations are meaningful; many are not. Thus, "I = (Floating Point Number) + (Integer)" is unambiguous, while "I = (Integer) + (Alphameric Constant)" has no obvious meaning, and "I = (Integer) + (Complex Number)" may be regarded as meaningful if properly defined.

In most implementations of FORTRAN I and II, mixed mode arithmetic was strictly forbidden except in exponents, subscripts, and function arguments. In IBM 7090/7094 FORTRAN IV, there is somewhat more freedom. Single-precision floating point numbers (now misleadingly called type REAL) may be combined with either double-precision or complex numbers (but not both) in add, subtract, multiply, and divide operations. Double-precision or complex numbers, however, may not under any circumstances

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.14 Description (Contd.)

be added, subtracted, divided, or multiplied in a mixed mode manner by variables of types other than single-precision, irrespective of how meaningful the statement is.

The use of integers in mixed mode arithmetic is particularly restricted in the current 7090/7094 version. Integers cannot be used in expressions of any other mode, except as exponents, subscripts, or function arguments. These restrictions, which are not present in some other versions of FORTRAN IV, will complicate desk checking of programs. It is no longer possible to look at a statement by itself and see whether it is correctly written, because a variable's name is no longer necessarily indicative of its type.

FORTRAN IV uses the same control statements as previous FORTRANS. These (the loop-control DO; the unconditional, assigned, or computed GO TO; and the IF test statements) are all based on "statement numbers," which are arbitrary numbers attached to some statements by the programmer. The DO statement, for instance, reads:

DO n I = m_1, m_2, m_3

This indicates a loop from the DO statement through statement n. The loop is to be done first with the index variable I at m_1, and it ends when I has reached the value m_2. I is to be incremented each time round the loop by m_3. FORTRAN IV maintains the old rule that neither values of the index variable, I, nor those of the indexing parameters, m_1, m_2, and m_3, may be amended by the program within the loop itself. This represents a major discrepancy between the ALGOL and FORTRAN languages.

The handling of input-output also sharply divides FORTRAN from ALGOL. ALGOL has no input-output procedures in its language. It assumes that each implementor will specify his own procedures in his own way. FORTRAN IV has well-defined procedures for handling input-output at object time, and also for initializing the values of variables at compile time.

The general input-output statements are READ from or WRITE on a particular logical unit. The FORTRAN II instructions READ TAPE and WRITE TAPE have vanished, but the other hardware-oriented phrases PUNCH, PRINT, BACKSPACE, etc., are still used. One logical record consisting of one or more physical blocks is read or written by each input-output statement. The use of logical numbers to specify input-output devices allows considerable freedom as to configuration and makes FORTRAN IV object programs easily compatible with many operating systems, such as the IBJOB Monitor for the IBM 7090/7094.

.14 Description (Contd.)

Data to be input or output in an externally meaningful format is described by a FORMAT specification. The input or output statement simply names the appropriate FORMAT specification, and at running time this specification is examined and used to handle the necessary conversions, editing, and forms movement. The FORMAT specification allows numeric data to be handled in five different ways, which do not directly correspond to the five types of arithmetic. Alphameric information can be incorporated into the FORMAT specification itself if it is only to be used for headings; alternatively, alphameric items of up to six characters can be specified and manipulated in the same way as any other named variable. Because the FORMAT specification is examined during execution of the object program to control the editing and conversion routines, it is not necessary to decide on precise format details until running time, and two runs can be made with different formats. The FORMAT specification itself can be read in as data, thus allowing self-descriptive records to be used.

Initialization of the object program can be done by means of the new FORTRAN IV statement "DATA." Its form is similar to an input statement, including list of names of variables or arrays. Each list of names is followed, however, by a list of literal values which are to be used to initialize the named variables. A similar facility, BLOCK DATA, is used to initialize the COMMON areas, whose functions are described below.

FORTRAN programs need not be self-contained and, in fact, usually are not. A FORTRAN program usually consists of a main program and a number of sub-programs. The sub-programs can be compiled independently or called from the FORTRAN library. Data values can be interchanged as needed between the main program and its sub-programs.

There are four types of subroutines in FORTRAN IV: "built-in" functions (such as MAX (X, Y, Z)), which cause insertion of open subroutines into the object program; arithmetic statement functions (such as FIRST (ALPHA)), which reference a single user-defined statement such as FIRST (X) = A*(X + B); and, for the case where more than a single statement is needed to define the relationship, the FUNCTION and SUBROUTINE sub-programs. Typical examples of the latter two types include the SIN, COS, and ATAN mathematical subroutines (which are FUNCTION sub-programs) and DVCHK, a SUBROUTINE sub-program that checks the state of the divide-check indicator on the 7090/7094. The distinctions between the FUNCTION and SUBROUTINE sub-programs are that the SUBROUTINE sub-programs must be CALLed by a separate statement and

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.14 Description (Contd.)

cannot be used in the middle of an arithmetic expression, and that they may return more than one value after being executed. The standard "build-in" functions and mathematical subroutines are listed in Paragraph .411. Dumping sub-programs, DUMP, and PDUMP, are used to provide help in program testing.

COMMON facilities provide for the sharing of data values between a program and its sub-programs. A COMMON area in storage is an area which can be used by two or more independent program entities. Any data in this area can be accessed from either program, provided the program knows the position of the data within the COMMON area This position is governed by strict rules (which differ from those of FORTRAN II). FORTRAN IV allows the use of Blank and Labeled blocks of COMMON storage, which further simplifies the programmer's task. (FORTRAN II had only one COMMON area.)

.14 Description (Contd.)

To summarize, FORTRAN IV is a major step forward in that it has made the FORTRAN language conveniently usable for various arithmetic modes, and no longer restricted to being primarily for single-precision floating point variables. The language is relatively easy to learn and use, particularly for persons already familiar with FORTRAN II. The present 7090/7094 translator has a number of restrictions which are unnecessary in the language itself (e.g., restriction to three subscripts and inability to use mixed arithmetic freely). Like its predecessors, FORTRAN IV provides no control over the blocking of logical records on magnetic tape or the manner in which a computer's capabilities for simultaneous operations are utilized. No straightforward facilities are provided for manipulation of individual alphameric characters. Despite these limitations, FORTRAN IV represents an obvious improvement over FORTRAN II, which is currently the most popular process oriented language for scientific applications. As such, FORTRAN IV will undoubtedly be a widely implemented and extensively used language.

.141 Differences Between FORTRAN II and FORTRAN IV

The language differences between IBM 7090/7094 FORTRAN IV and IBM 709/7090 FORTRAN II (Section 408:161) can be summarized as follows:

(1) The FREQUENCY, READ DRUM, and WRITE DRUM statements are available in FORTRAN II but not in FORTRAN IV.

(2) The DATA, BLOCK DATA, and Type statements of FORTRAN IV are not available in FORTRAN II.

(3) The following FORTRAN II statements must be changed to the corresponding FORTRAN IV statements.

FORTRAN II Statement	FORTRAN IV Statement
IF ACCUMULATOR OVERFLOW n_1, n_2	CALL OVERFL (j)
IF QUOTIENT OVERFLOW n_1, n_2	CALL OVERFL (j)
IF DIVIDE CHECK n_1, n_2	CALL DVCHK (j)
IF (SENSE SWITCH i) n_1, n_2	CALL SWITCH (i, j)
SENSE LIGHT i	CALL SLITE (i)
IF (SENSE LIGHT i) n_1, n_2	CALL SLITET (i, j)
READ TAPE i, list	READ (i) list
READ INPUT TAPE i, n list	READ (i, n) list
WRITE TAPE i, list	WRITE (i) list
WRITE OUTPUT TAPE i, n, list	WRITE (i, n) list

(4) The DOUBLE PRECISION, COMPLEX, and EXTERNAL Type statements of FORTRAN IV replace the FORTRAN II column 1 modal punches D, I, and F, respectively.

(5) There is no direct FORTRAN IV counterpart for the 36-bit Boolean capability (designated by the B modal punch) of FORTRAN II.

(6) The LOGICAL (true-false) capabilities of FORTRAN IV are not provided in FORTRAN II.

(7) Function naming is more straightforward in FORTRAN IV.

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.141 Differences Between FORTRAN II and FORTRAN IV (Contd.)

(8) Implicit multiplication is not permitted in FORTRAN IV; in FORTRAN II, it occurs as a result of the combinations C(e), (e)C, and (e)V; where C is a constant, V is a variable, and e is any arithmetic expression

(9) The FORTRAN IV EQUIVALENCE statement cannot affect the ordering of the COMMON storage area or create a gap in it.

(10) The FORTRAN IV COMMON statement may specify array dimensions. (Arrays whose dimensions are specified in COMMON statements cannot be included in DIMENSION statements.)

(11) Type REAL variables can be combined in an arithmetic expression with either DOUBLE PRECISION or COMPLEX variables (but not both) in FORTRAN IV.

(12) Integer constants and variables which are not used as subscripts or DO loop indices may be as large as $2^{35}-1$ in FORTRAN IV, versus a maximum of $2^{17}-1$ in FORTRAN II.

.142 Source Program Statements

Statement	Normal Sequencing	Comment
a = b	next executable statement	arithmetic statement; value of expression b replaces variable a.
ASSIGN i TO n	next executable statement	i is n_1, n_2, etc., in an assigned GO TO statement.
BACKSPACE i	next executable statement	i is a symbolic tape unit number
BLOCK DATA	not executed	heads a special subprogram which loads data into a COMMON area during compilation.
CALL Name (a_1, a_2, ..., a_n)	first statement of subroutine Name	Name is the subroutine label and a_i are arguments.
COMMON a, b, ...	not executed	a, b are names of data storage areas shared by programs.
COMPLEX a, b ...	not executed	specifies that a and b are complex variables or functions.
CONTINUE	next executable statement	dummy statement.
DATA	not executed	loads data values at compile time.
DIMENSION v_1, v_2, v_3 ...	not executed	v_1 are array labels with their maximum subscript values.
DO n i = m_1, m_2, or DO n i = m_1, m_2, m_3	DO-sequencing, then next executable statement	perform following statements through statement n with i starting at m_1, increased by m_3 (or 1) each time until i is greater than m_2.
DOUBLE PRECISION a, b, ...	not executed	a and b are double precision floating point variables or functions.
END	no sequencing; this statement terminates a program.	
END FILE i	next executable statement	write end-of-file mark on tape i.
EQUIVALENCE (a, b, c, ...), (d, e, f, ...), ...	not executed	variable names within parentheses are assigned to the same storage locations.
EXTERNAL a, b ...	not executed	a and b are sub-program names that are arguments of other sub-programs.
FORMAT (Specification)	not executed	specifies conversion and external format of each item in an input-output list.

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.142 Source Program Statements (Contd.)

Statement	Normal Sequencing	Comment
FUNCTION Name (a_1, a_2 ..., a_n)	next executable statement	first statement of a function subprogram; a_i are the formal parameters.
GO TO n	statement n	branch to statement n.
GO TO n, (n_1, n_2 ..., n_m)	statement last assigned to n	assigned branch, or switch, set by ASSIGN statement.
GO TO (n_1, n_2, ... n_m), i	statement n_i	branch to statement n_i, where i is an integer variable.
IF (a) n_1, n_2, n_3	statement n_1, n_2, or n_3 if (a) < 0, (a) = 0, or (a) > 0, respectively	a is an arithmetic expression.
IF (t) s	statement s if t is true; next executable statement if t is false	t is a logical expression; s is any executable statement except DO or another IF (t) s.
INTEGER a, b, ...	not executed	a and b are integer variables or functions.
PAUSE OR PAUSE n	next executable statement	halt with restart provision and optional octal display of n.
PRINT n, List	next executable statement	print on-line; n is format, List contains variable names.
PUNCH n, List	next executable statement	punch on-line; n is format, List contains variable names.
READ n, List	next executable statement	read cards on-line; n is format, List contains variable names.
READ (i) List	next executable statement	read binary magnetic tape; i is unit, List contains variable names.
READ (i, n) List	next executable statement	read BCD magnetic tape; i is unit, n is format, List contains variable names.
REAL a, b, ...	not executed	a and b are single-precision floating point variables or functions.
RETURN	the statement or part of a statement following the reference to this subprogram	used at least once in each function or subroutine.
REWIND i	next executable statement	rewind tape unit i.
STOP	terminates program	returns control to the Monitor.
SUBROUTINE Name (a_1, a_2, ... a_n)	next executable statement	first statement in a subroutine; a_i are the formal parameters.
WRITE (i, n) List	next executable statement	write BCD magnetic tape; i is unit, n is format, List contains variable names.
WRITE (i) List	next executable statement	write binary magnetic tape; i is unit, List contains variable names.

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.2 PROGRAM STRUCTURE

.21 Divisions: . . . . . one division, composed of the following types of statements.

Procedure statements: . . . . . algebraic formulae.
comparisons and jumps.
input and output.

Data statements: . . . FORMAT: describes the layout, size, scaling, and code of input-output data.
EQUIVALENCE: causes two variables to have a common location or specifies synonyms.
COMMON: causes data storage areas to be shared by more than one subprogram.
DIMENSION: specifies the maximum number of elements in each dimension of an array or set of arrays.
TYPE: specifies mode of a list of variables; INTEGER, REAL, LOGICAL.
DATA: assigns constant values to variables at compile time.
EXTERNAL: specifies names of subprograms that are arguments of other subprograms.

.22 Procedure Entities

Program: . . . . . composed of statements, subroutines, and functions.
Subroutine: . . . . . composed of statements.
Function: . . . . . composed of statements.
Statement: . . . . . composed of characters; blanks are ignored except when part of alphameric literals.

Note: The general term "sub-program" is applied to each independent subroutine, function, or segment of a program.

.23 Data Entities

Array: . . . . . a group of related variables of any one of the following types; each array element is referenced by the array name followed by 1, 2, or 3 subscripts.

.23 Data Entities (Contd.)

Item: . . . . . an INTEGER variable or constant.
a REAL (single-precision floating point) variable or constant.
a DOUBLE PRECISION floating point variable or constant.
a COMPLEX variable or constant.
a LOGICAL (Boolean) variable or constant.

Alphameric item: . . a string of up to 6 alphameric characters that is given a variable name (of any type) and hence can be processed and/or modified.

Hollerith item: . . . . an un-named string of up to 132 alphameric characters contained in a FORMAT statement; it can be supplied either as a literal or as input data, and can be used only for output.

.24 Names

.241 Simple name formation

Alphabet:	A to Z, 0 to 9.
Size:	1 to 6 characters.
Avoid key words: . .	yes.
Formation rule: . .	first character must be a letter.

.242 Designators

Procedures

Statement label: .	unsigned integer below 32768.
Function label: . .	governed by the rules of the resulting variables.
Subroutine label: .	no designator.

Data (if not specified in a TYPE statement)

Integer variable: .	initial I, J, K, L, M, N.
Floating point variable:	any other initial letter.

Equipment

Punched card (on-line):	statements "READ n, list" and "PUNCH n, list."
Printer (on-line): .	statement "Print n, list."
Magnetic tape (BCD mode): . . .	statements "READ (i, n) list" and "WRITE (i, n) list."
Magnetic tape (binary mode): .	statements "READ (i) list" and "WRITE (i) list."
Comments:	C in column 1 of statement.
Translator control: . .	key words EQUIVALENCE, COMMON, EXTERNAL.

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.25 Structure of Data Names

.251 Qualified names: . . . . none.
.252 Subscripts
Number per item: . . 0 to 3.
Applicable to: . . . . all variables.
Class may be
Special index variable: . . . . . no.
Any variable: . . . . only integer variables.
Literal: . . . . . yes; except Hollerith.
Expression: . . . . . at most C * N ± C', where C and C' are unsigned integer literals and N is an unsigned integer variable.
Form may be
Integer only: . . . . yes.
Signed: . . . . . no.
Truncated fraction: . . . . . yes.
Rounded fraction: . no.
.253 Synonyms
Preset: . . . . . EQUIVALENCE statement causes sharing of storage locations.
Dynamically set: . . . no.

.27 Region of Meaning of Names

In the straightforward use of FORTRAN, each name is established in a sub-program and is local to that particular sub-program. A name can be made to reference the same storage location in 2 or more sub-programs by specifying the name in the corresponding position of a COMMON statement in each sub-program.

.3 DATA DESCRIPTION FACILITIES

.31 Methods of Direct Data Description

.311 Concise item picture: . FORMAT statement only.
.312 List by kind: . . . . . yes; Type declarations.
.313 Qualify by adjective: . no.
.314 Qualify by phrase: . . . no.
.315 Qualify by code: . . . . by first letter of name if not listed in a Type declaration.
.316 Hierarchy by list: . . . no.
.317 Level by indenting: . . no.
.318 Level by coding: . . . . no.
.319 Others (examples)
Array size (4 by 7): . DIMENSION ARRAY (4, 7).
Four-digit integer: . FORMAT (I4).
Five four-digit integers: . . . . . FORMAT (5I4).
Two floating point items: . . . . . FORMAT (F8.3, E10.4) for +999.999 and +.9999E+99

.32 Files and Reels: . . . . by own coding; no direct language facilities for file labeling or handling of multi-reel files.

.33 Records and Blocks

.331 Variable record size: dynamically variable.
.332 Variable block size: . dynamically variable, with fixed upper limits.
.333 Record size range: . . 1 to N blocks.
.334 Block size range
Magnetic tape (BCD mode): . . . up to maximum line length of off-line printer.
Magnetic tape (binary mode): . . . up to 256 words.
Punched cards (on-line): . . . . . up to 72 characters.
Punched cards (off-line): . . . . . up to 80 characters.
Printer (on-line): . . up to 120 characters.
.335 Choice of record size: . . . . . implied by input-output list and FORMAT statement.
.336 Choice of block size: none; 1 logical record of 1 or more blocks is read or written by each input-output statement.
.337 In-out error control: automatic.
.339 Blocking control: . . . none; see .336 above.

.34 Data Items

.341 Designation of class: . by TYPE declaration (or first letter of name).
.342 Possible classes
Integer: . . . . . yes; type INTEGER.
Fixed point: . . . . . no.
Floating point (single-precision): yes; type REAL.
Floating point (double-precision): yes; type DOUBLE PRECISION.
Complex floating point: . . . . . yes; type COMPLEX.
Alphameric: . . . . . yes; any type.
Boolean: . . . . . yes; type LOGICAL.
.343 Choice of external radix: . . . . . FORMAT statement.
.344 Possible external radices
Decimal: . . . . . yes.
Octal: . . . . . yes.
.345 Internal justification: alpha automatic left justified. integers automatic right justified.
.346 Choice of external code: . . . . . FORMAT statement and READ, WRITE statement.
.347 Possible external codes
Decimal: . . . . . yes.
Octal: . . . . . yes.
Hollerith: . . . . . yes.
Alphameric: . . . . . yes.

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.348 Internal item size

Variable size:	no; sizes are fixed.
Designation:	none.
Range:	
Type INTEGER: .	1 word.
Type REAL:	1 word.
Type DOUBLE PRECISION: . . .	2 words.
Type COMPLEX: .	2 words; 1-word real part and 1-word imaginary part.
Type BOOLEAN: .	1 word; can only assume the values .TRUE. and .FALSE..
Alphameric:	1 word of up to 6 characters.

.349 Sign provision: . . . . optional.

.35 Data Values

.351 Constants

Possible sizes	
Type INTEGER: .	$2^{35}-1$.
Type REAL:	10^{-38} to 10^{+38} (8-digit precision).
Type DOUBLE PRECISION: . . .	10^{-38} to 10^{+38} (16-digit precision).
Type COMPLEX: .	each part same as type REAL.
Type LOGICAL: .	.TRUE. or .FALSE. only.
Hollerith:.	up to 132 characters.
Subscriptible:	yes.
Sign provision: . . .	optional.

.352 Literals: . . . . . same as Constants.

.353 Figuratives: . . . . . by own coding; e.g., TEN = 10.0.

.354 Conditional variables: computed GO TO statement.

.36 Special Description Facilities

.361 Duplicate format: . . yes; by multiple references to a single FORMAT statement.

.362 Re-definition:. . . . . COMMON, EQUIVALENCE statements.

.363 Table description

Subscription:.	mandatory, in DIMENSION statement.
Multi-subscripts: . .	1 to 3.

.364 Other subscriptible entities: . . . . . magnetic tape units.

.4 OPERATION REPERTOIRE

.41 Formulae

.411 Operator List

Arithmetic

+	addition, also unary.
-	subtraction, also unary.
*	multiplication.
/	division.
**	exponentiation.
=	replacement; replace value of variable on left side with value of expression on right side.

Logical

AND	.AND..
Inclusive OR: . . .	.OR..
Exclusive OR: . . .	none.
NOT:	.NOT..

Relational

Equal:	.EQ..
Not Equal:	.NE..
Greater than: . . .	.GT..
Less than:	.LT..
Greater than or equal:	.GE..
Less than or equal:	.LE..

Functions ("built-in;" use open subroutines)

ABS (A)	absolute value; real argument and function.
IABS (A)	absolute value; integer argument and function.
AINT (A)	truncate; reduce to integer value; real argument and function.
INT (A)	truncate; reduce to integer value; real argument and integer function.
AMOD (A, B)	remainder A ÷ B; real argument and function.
MOD (A, B)	remainder A ÷ B; integer argument and function.
AMAX0 (A, . . .) .	maximum value; integer argument and real function.
AMAX1 (A, . . .) .	maximum value; real argument and function.
MAX0 (A, . . .) . .	maximum value; integer argument and function.
MAX1 (A, . . .) . .	maximum value; real argument and integer function.
AMIN0 (A, . . .) . .	minimum value; integer argument and real function.
AMIN1 (A, . . .) . .	minimum value; real argument and function.
MIN0 (A, . . .) . . .	minimum value; integer argument and function.
MIN1 (A, . . .) . . .	minimum value; real argument and integer function.
FLOAT (A)	float an integer.

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.411 Operator List (Contd.)

Functions ("built-in;" use open subroutines)

IFIX (A)	convert a real variable to an integer.
SIGN (A, B)	transfer sign of A to B; real argument and function.
ISIGN (A, B)	transfer sign of A to B; integer argument and function.
DIM (A, B)	diminish A by A or B, whichever is smaller; real argument and function.
IDIM (A, B)	diminish A by A or B, whichever is smaller; integer argument and function.
SNGL (A)	convert double-precision variable to type real.
REAL (A)	obtain real part of a complex argument.
AIMAG (A)	obtain imaginary part of a complex argument.
DABS (A)	absolute value; double-precision argument and function.
IDINT (A)	truncate double-precision argument to an integer.
DMAX1 (A, ...)	maximum value; double-precision argument and function.
DMIN1 (A, ...)	minimum value; double-precision argument and function.
DSIGN (A, B)	transfer sign of A to B; double-precision.
DBLE (A)	convert type real argument to double-precision form.
CMPLX (A, B)	convert 2 real arguments to 1 complex number.
CONJG (A)	obtain conjugate of a complex argument.

Functions (mathematical; use closed subroutines)

EXP (A)	real exponential.
ALOG (A)	real natural logarithm.
ALOG10 (A)	real common logarithm.
ATAN (A)	real arctangent.
SIN (A)	real sine.
COS (A)	real cosine.
TANH (A)	real hyperbolic tangent.
SQRT (A)	square root.
DMOD (A, B)	double-precision remainder.
DEXP (A)	double-precision exponential.
DLOG (A)	double-precision natural logarithm.
DLOG10 (A)	double-precision common logarithm.
DATAN (A)	double-precision arctangent.
DSIN (A)	double-precision sine.
DCOS (A)	double-precision cosine.
DSQRT (A)	double-precision square root.
CABS (A)	complex absolute value.

.411 Operator List (Contd.)

Functions (mathematical; use closed subroutines)

CEXP (A)	complex exponential.
CLOG (A)	complex logarithm.
CSIN (A)	complex sine.
CCOS (A)	complex cosine.
CSQRT (A)	complex square root.

.412	Operands allowed	
	Types:	usually numeric for arithmetic operations, but alphameric is possible.
	Mixed scaling:	yes.
	Mixed types:	generally no; see Description (Paragraph .12) for exceptions.
	Mixed radices:	no.
	Literals:	yes.
.413	Statement structure	
	Parentheses	
	a - b - c means:	(a - b) - c.
	a + b x c means:	a + (b x c).
	a/b/c means:	(a ÷ b) ÷ c.
	a^{bc} means:	not permitted; parentheses must be used.
	Size limit:	1,320 characters (up to 20 cards of 66 characters each).
	Multi-results:	no.
.414	Rounding of results:	truncation of integers after each step in an expression.
.415	Special cases	
	x = -x:	X = -X.
	x = x + 1:	X = X + 1.0.
	x = 4.7 y:	X = 4.7 * Y.
	$x = 5 \times 10^7 + y^2$:	X = 5.E7 + Y**2.
	x = integer part of y:	X = AINT (Y).
.416	Typical examples:	X = (-B + SQRT(B*B - 4.0*A*C))/(2.0*A).
.42	Operations on Arrays:	by own FORTRAN coding only.
.43	Other Computation:	see table of Source Program Statements, Paragraph .142.
.44	Data Movement and Format	
.441	Data copy example:	Y = X.
.442	Levels possible:	items.
.443	Multiple results:	none.
.444	Missing operands:	not possible.
.445	Size of operands	
	Alignment rule	
	Numbers:	right justified or normalized.
	Alpha:	left justified.
	Filler rule	
	Numbers:	zeros.
	Alpha:	blanks.
	Truncating rule	
	Numbers:	truncate at left for integers, right for floating.
	Alpha:	truncate at right.
	Variable size destination:	no.

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.446 Editing possible
- Change class: .... yes.
- Change radix: .... yes.
- Insert editing symbols
  - Actual point: .... automatic.
  - Suppress zeros: .. automatic.
  - Insert: ..... automatic point.
  - Float: ..... minus sign only.

.447 Special moves: .... none.
.448 Code translation: ... automatic.
.449 Character manipulation: .... none.

.45 File Manipulation

- Open: ..... own coding.
- Close: ..... own coding.
- Advance to next record: ..... READ or WRITE.
- Step back a record: . BACKSPACE.
- Set restart point: ... none.
- Restart: ..... none.
- Start new reel: .... own coding.
- Start new block: ... implied in each input-output statement.
- Search on key: .... none.
- Rewind: ..... REWIND.
- Unload: ..... none.

.46 Operating Communication

.461 Log of progress: .... PRINT uses on-line printer.
.462 Messages to operator: same as log.
.463 Offer options: ..... PAUSE with 5-digit octal display in Storage Register. PRINT message.
.464 Accept option: SSWITCH subroutine tests sense switch settings.

.47 Object Program Errors

Error	Discovery	Special Actions
Overflow:	by OVERFL subroutine	set designated integer variable to 1 or 2.
In-out:	automatic	?
Invalid data:	automatic	?

.5 PROCEDURE SEQUENCE CONTROL

.51 Jumps

.511 Destinations allowed: . numbered statements.
.512 Unconditional jump: . GO TO n, where n is a statement number below 32768.
.513 Switch: ..... GO TO M, (35, 47, 18).
.514 Setting a switch: ... ASSIGN 35 to M.
.515 Switch on data: .... GO TO (35, 47, 18), I.

.52 Conditional Procedures

.521 Designators
- Condition: ..... IF.
- Procedure: ..... implied.

.522 Simple conditions: .. arithmetic expression is tested for less than, equal to, or greater than zero. logical expression is tested for true or false.

.523 Conditional relations
- Equal: ..... .EQ..
- Not equal: ..... .NE..
- Greater than: .... .GT..
- Less than: ..... .LT..
- Greater than or equal: ..... .GE..
- Less than or equal: .LE..

.524 Variable conditions: less than, equal to, or greater than zero for arithmetic expressions. true or false for logical expressions.

.525 Compound Conditionals
- IF x AND y: ..... yes.
- IF x OR y: ..... yes.
- IF x DO a AND y DO b: ..... no.
- IF x DO a OR y DO b: ..... no.

.526 Alternative designator: none.
.527 Condition on alternative: ..... no.
.528 Typical examples: . . IF (X**2.0-3.0) 29, 37, 18: go to 29, 37, or 18 if X^2-3 is respectively less than, equal to, or greater than zero.
IF (((A*B).GT.C).AND. (D.EQ.E)) GO TO 7: go to 7 if the expression is true and to the next statement if false.

.53 Subroutines

.531 Designation
- Single statement: . . not possible.
- Set of statements
  - First: ..... SUBROUTINE.
  - Last: ..... END.

.532 Possible subroutines: . any number of statements.
.533 Use in-line in program: ..... no.
.534 Mechanism
- Cue with parameters: CALL XXX (X, Y, Z).
- Number of parameters: .... ?
- Cue without parameters: .... CALL XXX.
- Formal return: ... RETURN.
- Alternative return: additional RETURN statements.

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.535 Names

Parameter call by value*:	yes.
Parameter call by name*:	no.
Non-local names:	use COMMON.
Local names:	all.
Preserved own variables:	all.

* "Call by value" and "call by name" are ALGOL terms describing two methods of supplying parameters to a subroutine or function. The difference between the two methods is in the way the parameters are used by the subroutine, not in the method a programmer uses to specify them. Call by value is a restricted form, and indicates that the parameter, which may be an expression, is evaluated before the subroutine is entered and that this value is then 'plugged' into the subroutine. The call by name, the unrestricted form which is correspondingly more difficult to implement, indicates that the called variable or expression must be re-evaluated each time it is used in the subroutine.

.536	Nesting limit:	?
.537	Automatic recursion allowed:	no.

.54 Function Definition by Procedure

.541	Designation	
	Single statement:	"Arithmetic statement functions," which apply only within the program containing the function definition; e.g., FIRST (X) = A+X**B.
	Set of statements	
	First:	FUNCTION.
	Last:	END.
.542	Level of procedure:	any number of statements.
.543	Mechanism	
	Cue:	use of function name in an expression.
	Formal return:	RETURN.
.544	Names	
	Parameter call by value*:	yes.
	Parameter call by name*:	no.
	Non-local names:	use COMMON.
	Local names:	all.
	Preserved own variables:	all.

* See footnote to Paragraph .535.

.55	Operand Definition by Procedure:	none.

.56 Loop Control

.561	Designation of loop	
	Single procedure:	none.
	First and last procedures:	current place to numbered end; e.g., DO 173 I = 1, N, 2.
.562	Control by count:	indirect.
.563	Control by step	
	Parameter:	integer only.
	Step:	positive integer.
	Criteria:	greater than.
	Multiple parameters:	require nested loops.
.564	Control by condition:	no.
.565	Control by list:	no.
.566	Nesting limit:	?
.567	Jump out allowed:	yes.
.568	Control variable exit status:	available.

.6	EXTENSION OF THE LANGUAGE:	new functions can be added to the library.
.7	LIBRARY FACILITIES	
.71	Identity:	IBLIB library.
.72	Kinds of Libraries:	expandable master.
.73	Storage Form:	magnetic tape.
.74	Varieties of Contents:	FORTRAN mathematical, input-output, and system subroutines.
.75	Mechanism	
.751	Insertion of new item:	special run, using control card parameters.
.752	Language of new item:	MAP (Macro Assembly Program).
.753	Method of call:	automatic.
.76	Types of Routine	
.761	Open routines exist:	yes; 31 "built-in" functions.
.762	Closed routines exist:	yes.
.763	Open-closed is variable:	no.
.8	TRANSLATOR CONTROL	
.81	Transfer to Another Language:	no explicit facilities.
.82	Optimizing Information Statements	
.821	Process usage statements:	none.

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.822 Data usage statements: . . . . . COMMON, EQUIVALENCE.

.83 Translator Environment: . . . . implicit.

.84 Target Computer Environment:. . . . . none.

.85 Program Documentation Control: . . . . . none.

.9 TARGET COMPUTER ALLOCATION CONTROL

.91 Choice of Storage Level: . . . . . none.

.92 Address Allocation: . none.

.93 Arrangement of Items in Words in Unpacked Form: . . . . . standard; no control is provided.

.94 Assignment of Input-Output Devices: . . symbolic references are used for magnetic tape units.

.95 Input-Output Areas:. built into input-output routines; no control is provided.

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MACHINE ORIENTED LANGUAGE: FAP

§ 171.

.1 GENERAL

.11 Identity: . . . . . FORTRAN Assembly Program (FAP).

.12 Origin: . . . . . IBM.

.13 Reference: . . . . . IBM form C28-6235.

.14 Description

FAP is a two-pass, batched job assembly system normally operated under control of the FORTRAN monitor. The Source language includes all of the IBM 704, 709, 7090, and 7094 instructions expressed as mnemonics. However, the translator is only operational on the 709, 7090, and 7094. The FAP features include provisions for macro definition procedures, a reference to a defined system label list, the ability to define new operation codes, and a set of pseudo operations for linking subroutines generated either by FAP or FORTRAN.

The source statements for the assembler consist of card data, or tape records containing the equivalent BCD information. The usual record format presents the location label (where present) a three-letter operation code and a variable field length whose contents are dictated by the operation code. Comments or sequence indication can also be printed. The system output is a binary card deck which can be absolute or relocatable. It can be generated either on- or off-line. In addition, a program listing in source and octal object language is available. The listing contains indications for assembly-detected anomalies (such as labels with multiply definitions, tag missing, or improper sequencing) and optionally, a list of defined labels with their assigned locations and the locations of instructions referring to each label.

The new operation definition feature permits a name to be assigned a binary operation code and a set of characteristics, such as requiring an address, an index register tag, or permitting indirect addressing. This feature allows any special instruction features to be included in FAP and permits assembly of programs for computers other than those normally using FAP-generated routines.

The subroutine linkage feature provides the programmer with an option of combining two languages (FORTRAN and FAP) into one program. FORTRAN permits rapid coding of arithmetic and input-output routines; FAP can be used where high speed, complex logic, or judicious use of storage is required. This feature also allows sections of a large program to be debugged while other sections are still being coded and allows subroutines to be used in many different programs or to be connected together in various ways by various control routines. It is common in scientific programming to develop libraries of special purpose subroutines in this manner.

.14 Description (Contd.)

The FAP update feature is used primarily to modify source and/or object programs that are on a library tape. It can modify a large program by entering only the modifications or references to other existing subroutines. The update feature also permits routines from several tapes to be combined on one output tape and to be assembled as one program, which is especially useful in those installations using special purpose libraries such as those described above.

The major shortcomings of FAP are its complexity and its limitations of expressions. The complexity could be somewhat overcome with more straightforward written procedures. The limitations on expressions arise from two sources. The first of these is the number of passes. A number of pseudo operations require that any labels in the variable field be previously defined, and no preliminary pass exists to accomplish the function. The relocatable format is the second source of limitations. For example, if A and B are address labels, A + 5 is an address, while A - B is a number. The address A + 5 may change as a function of the storage allocation of other routines in the program, and cannot therefore be used as a number unless this number is defined when the program is loaded. The system loader does not have this capability. Similarly, using A - B as an address will not be meaningful, since it is not a fixed location in the routine; in fact, relocation may cause it to be located outside of the routine.

.15 Publication Date: . . . . 1962.

.2 LANGUAGE FORMAT

.22 Legend

*:	* for system control record or comments; may also be part of location field.
Location:	usually blank - can contain alphameric string which is the symbolic location of the instruction; the equivalent of the contents of the address field (see EQU, SYN, BOOL under pseudos .82); the name of a macro instruction; the first location following a BES; or the first location affected by a BSS, VFD, BCI, etc.
Operation:	contains symbolic operation code (followed by * if indirectly addressed) followed by blanks.

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.22 Legend (Contd.)

Address, Tag, Decrement/Count: . . by convention, this field is started in column 16; however, only one blank column need be left between the op code and this field. The field normally is a function of the operation. Some typical field contents and their operations are as follows:
- after TXH, TIX, TXL, TNX, TXI, the field usually contains address, comma, tag, comma, and decrement.
- after shifting operations, the field usually contains a decimal number of shift places and may also contain a tag.
- after BCD or BCI the field contains a word count, a comma, and alphameric information.
- after OCT or DEC; a string of numbers separated by commas. Exponents, locations of binary points, etc., are optional (see .82).
- after some input-output instructions, tape numbers, access and module, track, record, etc.
- after SIR, SIL, IIL, IIR, etc., a mask or data field follows.

Comments: . . . . . this field is normally proceeded by a blank and may be used for explanations of the coding.

Identification: . . . . . this field is used for identification and sequence numbers. The assembly program will detect and note cards out of sequence.

.23 Corrections: . . . . . under system control, a set of records can be merged with an existing symbolic tape.

.231 Insertions: . . . . . cards in the input set are inserted in an order determined by columns 73-80.

.232 Deletions: . . . . . a DELETE pseudo op may be used to avoid copying portions of the symbolic tape.

.232 Alterations: . . . . . any card in the input set with serialization in columns 73-80 that exactly matches a serialization on the input symbolic tape will replace that symbolic tape record.

.24 Special Conventions

.241	Compound addresses: .	none.
.242	Multi-addresses: . . .	separated by commas.
.243	Literals:	yes, may be decimal, octal, or BCD words.
.244	Special coded addresses:	this address*. address to be set by the program**.
.245	Algebraic address forms - addresses are computed mod 2^{35} and taken mod 2^{15}.	
	X * Y:	multiply X by Y.
	X/Y:	divide X by Y.
	X + Y:	add X and Y.
	X - Y:	subtract Y from X.
	X/Y * Z:	divide X by Y and multiply the integer part of the result by Z.
.246	Boolean addresses - variable field of a BOOL pseudo op, a VFD pseudo op, or a type D instruction (SIL, SIR, RIL, IIL, RIR, IIR, LNT, RNT, LFT, RFT).	
	A + B:	A inclusive OR B.
	A - B:	A exclusive OR B.
	A * B:	A and B.
	/A:	one's complement of A.
	A/B:	A */ B.

.3 LABELS

.31 General

.311	Maximum number of labels	
	Locations (including variables):	approximately 10,000.
	Constants (literals): .	1,000.
	Defined operations or macros:	approximately 400.
.312	Common label formation rule:	no.
.313	Reserved labels:	locations within the system storage may be activated by an SST instruction. These locations are either in the FORTRAN monitor or in IBSFAP (IBSYS monitor). FAP is available with either of these systems.
.315	Designators	
	=:	decimal literal.
	=O:	octal literal.
	=H:	BCD literal.
	Decimal data:	pseudo DEC.
	Octal data:	pseudo OCT.
	Pseudo BCD, BCI: . .	binary coded decimal.
.316	Synonyms permitted: .	yes.

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.32 Universal Labels

.321 Labels for procedures
- Existence: . . . . . optional unless referred to by another procedure.
- Formation rule
  - First character: . . A - Z, 0 - 9, . , (,).
  - Last character:. . . A - Z, 0 - 9, . , (,).
  - Others: . . . . . A - Z, 0 - 9, . , (,).
  - Number of characters: . . . . 1 to 6, one of which is alphabetic.

.322 Labels for library routines
- Existence: . . . . . same as procedure.
- Formation rule
  - First character: . . $.
  - Others: . . . . . A - Z, 0 - 9, . , (and).
  - Number of characters: . . . . 3 to 7, one of which is alphabetic.

.323 Labels for constants
- After DEC, OCT, etc.: . . . . . same as procedures.
- As literals:. . . . . in variable field after =.
- Formation rule
  - First character: . . =.
  - Second character: . O if octal. H if Hollerith. +, -, 0 through 9 or blank if decimal.
  - Last character:. . . field terminates with comma or blank if octal or decimal. Terminates after six characters if Hollerith.
  - Others: . . . . . see data.
  - Number of characters: . . . . not defined except for =H.

.324 Labels for files: . . . . none.

.325 Labels for records: . . none.

.326 Labels for variables: . usually same as procedure. Exception is variable tape definition using a TAPE NO pseudo. The single variable A - G cannot be used because of redundant or conflicting meanings.

.327 Labels for allocated areas: . . . . . same as procedures.

.33 Local Labels: . . . . . three levels of tables are available. Labels for COMMON pseudos are universal, labels within a HEAD region can be made to apply in that region only. Other labels are valid within a given routine or subroutine and not elsewhere. Equivalence of locations not defined as COMMON may be obtained as part of a CALL pseudo.

.4 DATA

.41 Constants

.411 Maximum size constants
- Integer
  - Decimal: . . . . . $\pm 2^{35} - 1$ through $\mp 2^{-35}$, 11 decimal digits.
  - Octal: . . . . . $\pm$ 12 octal digits.
- Fixed numeric
  - Decimal: . . . . . $\pm 2^{35} - 1$ through $\mp 2^{-35}$, 11 decimal digits.
  - Octal: . . . . . $\pm$12 octal digits.
- Floating numeric
  - Decimal: . . . . . $\pm 10^{38}$ through $\mp 10^{-38}$, 8 decimal digits.
  - Alphabetic: . . . . . 6 characters.
  - Alphameric: . . . . 6 characters.

.412 Maximum size literals
- Integer
  - Decimal: . . . . . $\pm 2^{35} - 1$ through $\mp 2^{-35}$, 8 decimal digits.
  - Octal: . . . . . $\pm$12 octal digits.
- Fixed numeric
  - Decimal: . . . . . $\pm 2^{35} - 1$ through $\mp 2^{-35}$, 11 decimal digits.
  - Octal: . . . . . $\pm$12 octal digits.
- Floating numeric
  - Decimal: . . . . . $\pm 10^{38}$ through 10^{-38}, 8 decimal digits.
  - Alphabetic: . . . . . 6 characters.
  - Alphameric: . . . . 6 characters.

.42 Working Areas

.421 Data layout: . . . . . own coding.

.422 Data type: . . . . . no specification.

.423 Redefinition: . . . . . by pseudo op.

.43 Input-Output Areas

.431 Data layout: . . . . . own coding.

.432 Data type: . . . . . no specification.

.5 PROCEDURES

.51 Direct Operation Codes

.511 Mnemonic
- Existence: . . . . . optional.
- Number: . . . . . approximately 350.
- Example: . . . . . TXL 127, 1, 1.

.512 Absolute:. . . . . only as constants or special pseudo operations.
- Number: . . . . . all instructions.
- Example: . . . . . OCT 700001100127.
- Comment: . . . . . equivalent.

.513 Defined by coding
- Existence: . . . . . optional.
- Number: . . . . . approximately 400.
- Examples: . . . . . JUMP OPSYN TRA. LOAD OPD 050071160000.
- Comment: . . . . . see .82.

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.52 Macro-Codes

.521 Number available: . . . certain pseudo operations, such as CALL and DUP cause the generation of instructions on a 1-to-N basis. These pseudos are described in Paragraph .82.
The macros defined by the MACRO pseudo operation will be considered herein. The pseudos OPD, OPSYN, etc., which are in effect 1-word macro defining were considered in .513. Up to 400 macros or operations are permitted.

.522 Examples: . . . . . LOAD MACRO A.
CLA A.
LOAD END.
BRANCH MACRO A, B, C, D, E, F, G.
ST'A B.
TX'C D, 4, E.
F G.
BRANCH END.

.53 Interludes

.531 Possible roles
Modify translator: . . redefinition of operations list with OPSYN, OPD, OPVFD or MACRO.
redefinition of object languages 704 or 7090 pseudo operations. Define object computer.
Insert or delete portions of symbolic program: . . . . . update feature.

.54 Translator Control

.541 Method of control
Allocation counter: . . BES BSS.
Label adjustment: . . SYN EQU.
Annotation: . . . . . REM, * in column 1.

.542 Allocation counter
Set to absolute: . . . . ORG, LOC.
Set to label: . . . . . ORG, LOC.
Step forward: . . . . . BSS, BES.
Step backward: . . . . not possible.
Reserve area: . . . . not possible.

.543 Label adjustment
Set labels equal: . . . EQU, SYN, BOOL.
Set absolute value: . . EQU, SYN, BOOL.
Clear label table: . . not possible.

.544 Annotation
Comment phrase: . . follows first blank after variable field.
follows * in column one or REM pseudo.

.544 Annotation (Contd.)
Title phrase: . . . . . first card with * or $ in column 1 in first card group (group of cards preceding first instruction). Additional line may be added by TTL pseudo operation.

.545 Other
Insert new operation code or change operation code: . . . OPD, OPSYN, OPVFD.
Modify output listing: DETAIL, EJECT, INDEX, LBL, LIST, REF, SKP, SPACE, SPC, TITLE, TTL, PCC, UNLIST.
Card format control: . ABS, FUL, TCD, 9LP.

.6 SPECIAL ROUTINES AVAILABLE

.61 Special Arithmetic: . . none.

.62 Special Functions

.621 Facilities: . . . . . may be supplied to library.
.622 Method of call: . . . . as binary cards or from FORTRAN monitor.

.63 Overlay Control: . . . . own coding.

.64 Data Editing

.641 Radix conversion: . . . DEC - converts to fixed or floating decimal from binary (=for literals)
OCT - inserts octal information (=O for literals).
Code translation: . . . BCI (or =H) input to 6-bit BCD.

.642 Format control: . . . . own or library coding.

.65 Input-Output Control: . own or library coding.

.66 Sorting: . . . . . own or library coding.

.67 Diagnostics: . . . . . own coding or monitor subroutines (see FORTRAN).

.7 LIBRARY FACILITIES

.71 Identity: . . . . . SHARE supplied.
own coding.
FORTRAN.

.72 Kinds of Libraries

.721 Fixed master: . . . . . possible.
.722 Expandable master: . . possible.
.723 Private: . . . . . possible.

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.724 Combinations: . . . . . using the UPDATE feature, routines may be extracted from several tapes and used in a given program. Facilities exist for placing column binary cards on tapes or for assembling a number of routines separately and executing the result as one program.

.73 Storage Form: . . . . . either card or magnetic tape.

.74 Varieties of Contents: . not restricted.

.75 Mechanism

.751 Insertion of new item: . update run.
card to tape on off-line machine.
special run for system library.

.752 Language of new item: . usually FAP or FORTRAN.

.753 Method of call: . . . . . from system LIBE card.
from library tape UPDATE.
as binary cards - behind symbolic input.

.754 Linkage to program: . . CALL pseudo operation.
$ before label in variable field.

.76 Insertion in Program

.761 Open routines exist: . . yes.

.762 Closed routines exist: . yes.

.763 Open-closed is optional: yes.

.764 Closed routines appear once: . . . . . yes (or "n" times with "n" UPDATE cards).

.8 MACRO AND PSEUDO TABLES

.81 Macros: . . . . . defined by own coding.

.82 Pseudos

704: . . . . . set to assemble for IBM 704.

7090: . . . . . set to assemble for IBM 7090.

9LP: . . . . . adds prefix bits to the first word of the binary cards assembled by the system. The prefix is: 9 left columns 1, 2, and 3 if row binary, and column one rows 12, 11, and 0 if column binary.

ABS: . . . . . causes output cards to be in absolute (non-relocatable) format.

.82 Pseudos (Contd.)

BCD, BCI: . . . . . used to generate words of binary in 6-bit code. The variable field contains the number of words, comma, and data.

BES: . . . . . the variable field defines a number. This number of addresses is reserved. If a label appears in the location field, the address assigned to the label is that of the first location not reserved by the BES.

BOOL: . . . . . the variable field defines a number (see. 246). The label in the location field is given this value.

BSS: . . . . . same as BES except that a label appearing in the location field is assigned the first reserved address.

CALL: . . . . . causes FAP to assemble a linkage to a subroutine. The variable field must begin with a name. TSX name 4 is assembled. If the name is followed by a list of other names contained in parentheses and separated by commas, these are assembled as TSX NAME1, TSX NAME2, etc. The name of the called subroutine will appear as a BCD word at the beginning of the routine. The list of these BCD words is called the transfer vector. The binary program will contain information yielding the length of this vector and the various loaders will usually convert the BCD words to TTR instructions.

COMMON: . . . . . the name in the location field is assigned the current value of the common counter. The variable field defines a number which is subtracted from the common counter. This counter is initially 77461_8. Normally, COMMON is used to define storage to be shared by more than one routine.

COUNT: . . . . . the variable field is a number. This is the approximate number of cards in the symbolic routine that follows. This number is used by FAP to reduce assembly time.

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.82 Pseudos (Contd.)

DEC: . . . . . the variable field consists of one or more subfields separated by commas. The last subfield is terminated by a blank. The contents of the subfields are decimal numbers which are converted to binary and stored in consecutive locations. Numerical forms are as follows:
field containing no characters (two consecutive commas) - assembled as zero digits - assembled as fixed point.
as above, but containing a decimal point - assembled as floating point.
any of above, followed by E followed by digits or sign and digits - assembled as floating point with the number following the E as an exponent. For example 3.5E - 2 is the same as .035.

DETAIL: . . . . . removes the TITLE listing mode (see TITLE below).

DUP: . . . . . the variable field is divided into two subfields each of which defines a number, m and n. This pseudo instructs the assembler to duplicate the next m instructions n times.

EJECT: . . . . . causes the next line of the listing to appear at the top of a new page. (standard tape to printing routines recognize a 1 in column 1 as a skip to beginning of next page indicator).

END: . . . . . designates the end of a macro or the end of the symbolic deck.

ENDFIL: . . . . . writes an end-of-file mark on the designated tape. Used for updating.

ENDUP: . . . . . terminates an update without assembly. If update with assembly is being performed, ENDUP will be undefined.

ENTRY: . . . . . defines an entry point to a relocatable subprogram. The variable field is a name. This name will appear as the first variable field of any CALL causing a transfer of control to the designated point in the current routine (see CALL).

.82 Pseudos (Contd.)

EQU: . . . . . the name in the location field is made equivalent to the name defined by the variable field.

ETC: . . . . . the variable field of this card is a continuation of the variable field of the previous card.

EXTERN: . . . . . the name appearing in the variable field is inserted in the transfer vector.

FUL: . . . . . causes the binary program to be written as 24 words per card.

HEAD: . . . . . the variable field consists of one or more subfields separated by commas. Each subfield contains a symbol. Any names appearing in instructions following the HEAD will be regarded as preceded by the first symbol of the variable field unless this causes the name to contain more than six characters. Names of less than six characters appearing in the location field of any instruction following the HEAD will be regarded after heading by the first subfield as equivalent.

HED: . . . . . same as HEAD.

IFF: . . . . . the variable field contains an expression and two names. The next instruction (and all ETC cards) will not be assembled if the expression is zero and the two names are identical, or if the expression is non-zero and the two names are not identical.

IGNORE: . . . . . deletes (does not copy) information from an UPDATE input tape.

INDEX: . . . . . used to form a table of selected locations within the listing of the assembled program.

IRP: . . . . . defined within macros only. The first of two IRP pseudos should contain a dummy variable, say X, in its variable field. The macro definition should also contain X. When the macro is coded with (a, b, c, ...) substituted for X in the variable field, the IRP pseudos will cause the instruction between them to be duplicated first with X = a then X = b etc.

LBL: . . . . . causes labeling and sequencing in columns 73-80. of the binary cards.

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.82 Pseudos (Contd.)

LIST:. . . . . removes UNLIST condition on the program or part of program that follows. (see UNLIST).

LOC:. . . . . sets location counter but does not empty punch buffer.

MAC:. . . . . alternate form of MACRO. Name in variable field.

MACRO: . . . . . a name of 3 to 6 characters in the location field is added to the macro table. The names in the variable field are the variables of the macro. The instructions following the macro and terminating with an END with the macro name in its location field define the macro operation (see Paragraph .52).

MAX:. . . . . the name in the location field is given a value equivalent to the maximum of the values of the expressions in the variable field.

MIN: . . . . . the name in the location field is given a value equivalent to the minimum of the values of the expressions in the variable field.

MOP:. . . . . same as MAC.

NOCRS: . . . . . if a macro operation calls for N names in the variable field and an operation of this type is written with only R (N > R) names, the remaining N-R names will normally be replaced by "created symbols". Initially these symbols are two points followed by a 3-digit number. The number is zero for the first such symbol and is incremented to . . 999. The NOCRS pseudo stops the generation of created symbols.

NULL: . . . . . this pseudo is used to cause an undefined instruction to be listed and to have no effect on the assembly. For example, the pseudo operation ENTRY is undefined in an absolute assembly. A card ENTRY OPSYN NULL will cause any ENTRY to be listed as if the assembly were in the relocatable mode.

.82 Pseudos (Contd.)

NUMBER: . . . . . the name in the location field is left justified in columns 73 to 78 of the next record of the update output tape. The number in the variable field is right justified in columns 75 to 79. Subsequent records are numbered by adding 1 to column 79. Carries into alphabetic characters will not occur. Numbering will appear on the program listing.

OCT: . . . . . the variable field is divided into subfields, each of which defines a word of octal data. Each subfield may contain a sign and 1 to 12 integers, not 8 or 9, or be zero. The contents are regarded as an octal integer and are converted to binary, right-justified.

OPD: . . . . . this pseudo defines a machine operation code. The name of the code appears in the location field. The variable field contains twelve octal digits defining the operation code as follows:

Octal Designation of Binary Bits Affected		Meaning
400000	000000	sign.
300000	000000	type A operation code.
077700	000000	type B, C, D, or E operation code.
000060	000000	indirect address permitted (type B).
000010	000000	address required.
000004	000000	tag required.
000002	000000	decrement required.
000001	000000	flags in low-order 13 bits.
000000	400000	indirect address permitted (type A).
000000	200000	non-transmit bit (type A).
000000	100000	machine instruction.
000000	040000	permitted in 704 mode.
000000	020000	permitted in 7090 mode.
000000	017777	part of op code if bit 17-0.
000000	000004	type K disk command.
000000	000002	C instruction or K with low-order (mask) field.
000000	000001	type D instruction.

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.82 Pseudos (Contd.)

OPSYN:. . . . . renames machine codes or pseudo operation.

OPVFD: . . . . . the name in the location field is added to the list of defined operations. The variable field defines a 36-bit number as in VFD pseudo. OPVFD is used to define the machine operation code as in OPD.

ORG: . . . . . the contents of the punch buffer are written. The location counter for assembled instructions is set to a number defined by the variable field.

ORGCRS:. . . . . sets the next created symbol to a value given by the location field. See NOCRS for details on created symbols.

PCC: . . . . . causes DETAIL, EJECT, INDEX, LBL, LIST, REF, SKP, SPACE, SPC, TITLE, and TTL to be listed. Alternate appearances of PCC turn this feature on and off.

PMC: . . . . . causes card images generated by macro-operation to be listed. Alternate appearances turn this feature on and off. It is initially off. Control with the words ON or OFF in the variable field.

PRINT:. . . . . columns 14 to 72 are printed on-line. The assembly then halts.

REF:. . . . . deletes the symbol reference table listing.

REM:. . . . . the variable field contains remarks. The binary output is not affected.

REWIND:. . . . . rewind the addressed update tape.

RMT:. . . . . a pair of RMT instructions within a macro define a region to be assembled elsewhere in the program. When an RMT* occurs, all waiting RMT sets are assembled. If an AMT region is not followed by an RMT*, the assembly will occur after the END statement terminating the routines.

SET: . . . . . the variable field defines a number. The name in the location field assumes the value until it is redefined. Redefinition will not be considered an error.

.82 Pseudos (Contd.)

SKIPTO: . . . . . instructions up to but not including an instruction with matching serialization will be deleted.

SKP: . . . . . causes on-line printer to skip. Channel determined by number in variable field.

SKPFIL: . . . . . advance addressed update tape to end-of-file mark.

SPACE:. . . . . the variable field defines a number. The assembly listing will contain this number of blank lines.

SPC: . . . . . causes the on-line printer to space.

SST: . . . . . includes system symbol table in defined symbols for the program.

SYN: . . . . . same as EQU.

TAPENO:. . . . . the location field contains a name. The variable field contains a tape designation. The name is equated with the tape address.

TCD: . . . . . the variable field defines an address. The TCD pseudo causes a binary transfer card to be generated. This card, during loading, will cause the program to transfer to the defined address.

TITLE:. . . . . causes the listing to contain only the first word of the binary data resulting from generative pseudo operations (OCT, DEC, BCI, BCD, DUP, CALL, ETC, VFD).

TTL: . . . . . if a card containing an * or $ in column 1 appears in the symbolic deck between the FAP card and the first card-generating program, the contents of this card will appear at the top of each page of the listing. A second line of page title may be introduced from columns 11 to 72 of a TTL pseudo.

UMC:. . . . . causes macro definitions and instructions to be deleted during updating. Macro generated coding is inserted on the updated tape.

UNLIST: . . . . . cards following this pseudo will not be listed unless they are flagged as possible errors. List control pseudos other than LIST (reverses UNLIST) will be ignored.

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.82 Pseudos (Contd.)

UNLOAD: . . . . . rewind and unload the addressed tape.

UPDATE:. . . . . causes FAP to enter the update mode. The variable field contains up to 4 subfields. The first 2 subfields designate the update input and output tapes respectively. The third subfield controls blocking of the output tape. The fourth subfield controls assembly.

.82 Pseudos (Contd.)

VFD: . . . . . a data defining pseudo operation. The variable field is composed of subfields separated by commas. Each subfield begins with a type letter, O for octal or Boolean, H for alphameric, blank for symbolic. This is followed by an unsigned decimal integer designating the number of bits in the field. This is followed by a slash. The contents of the field are then defined. Symbolic fields are addresses.

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PROGRAM TRANSLATOR: FAP

§ 181.

.1 GENERAL

.11 Identity: . . . . . FAP.

.12 Description

The FAP translator is a four-phase two-tape-pass system that operates at approximately tape passing speed, thus making possible source-to-object translation speeds of up to 6,000 statements per minute. The translator is a part of the FORTRAN Monitor system which is called from the system tape by a control card.

During the first phase of Pass 1, the entire program is read from cards or tape 80 characters at a time, and each source statement is examined. All storage-allocation operations, label-definition pseudo operations, and macro-operation definition statements are interpreted during this pass. In addition, the location fields are examined for labels. Variable fields are checked for constants and literals. The source deck is (optionally) sequence-checked at this time.

From these definition-type operations, the sorted literal values (with no duplicates), "Common Area", and operation tables are formed and expanded for use in Pass 2. Each source statement, with its operation code, literals, and Pass 2 indicators, is recorded on a work tape in 96-character records, 16 records to a block. When the "Count" pseudo operation is used, or after 1,000 source statements have been recorded, the tape is rewound and a new work tape is started. This action permits the first work tape to be positioned for processing by Pass 2 while the second tape is being rewound.

The second phase of Pass 1 sorts the label table and detects labels with multiple definitions. All subroutine call vectors are placed in front of the program regardless of where they appear in the source deck. Thus, the labels which are relative to location zero (except in the case of an absolute assembly, which uses other subroutine call techniques) must be increased by the amount of the vector table. This information is communicated to Pass 2.

Pass 2 begins by generating a "program" card which contains the name of the program, the length of the transfer vector and program, and the lowest address in the "Common" area in upper storage for use by the relocatable loader at object run time. Next, the program cards for subroutine calls are generated. The remainder of this phase consists of producing object code from the compiled tables in storage and data on the work tapes, detecting and flagging errors, writing tapes for off-line listing or punching, and defining literal addresses. The object code is produced by table look-up for binary equivalents

.12 Description (Contd.)

of operation codes, literals, and other variable field label addresses. The binary equivalents are then combined according to the rules implicit in the FAP source statement format, macro operation skeletons, and the arithmetic or logical operators in the variable length address field. Errors are marked on the listing being generated.

The last phase of the assembly dumps the label table and lists of labels, either undefined or with multiple definitions. Other errors and statistics are also included.

In general, because SAP is a subset of FAP, SAP (see 406:171) coding can be assembled in FAP provided that the proper control cards are added to the SAP coding. One omission in FAP is the inability of the translator to specify any address for undefined labels, a facility that was included in SAP. The macro operation definition facility is very flexible, providing a convenient method for coding open subroutines and for reducing the number of source statements. The pooling of literals may result in reducing storage requirements, especially when more than one person has coded the routine.

The fast translator speed makes it economical to reassemble programs rather than to try binary or octal corrections in a program first. With the correction (as opposed to patching pseudo operations) built into the translator and the ability to "load-and-go", retranslation represents a negligible expense. The most important reason for retranslation is that the source program will always agree with the object program and that documentation of the revised program is provided.

.13 Originator: . . . . . IBM.

.14 Maintainer: . . . . . IBM.

.15 Availability: . . . . . September, 1962.

.2 INPUT

.21 Language

.211 Name: . . . . . FAP.
.212 Exemptions: . . . . . Library usually available from FORTRAN monitor or maintained by installation.

.22 Form

.221 Input media: . . . . . card or card images on magnetic tape.
.222 Obligatory ordering: . . yes; usually in the order in which groups of instructions are to be executed.

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.223 Obligatory grouping:. . programs and subroutines must be together and separated by END statements.

.23 Size Limitations

.231 Maximum number of source statements:. . no practical limit.
.232 Maximum size source statements:. . . . . 10 cards.
.233 Maximum number of data items:. . . . . no limit.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . 704 or 7090.
.312 Language style: . . . . binary.
.313 Output media: . . . . . tape or cards.

.32 Conventions

.321 Standard inclusions: . . column binary is compatible with FORTRAN monitor.
.322 Compatible with:. . . . 704, 709, 7090, 7094, 7040, 7044. Others using operation definitions.

.33 Documentation

Subject	Provision
Source program: . . .	listing.
Object program: . . .	listing.
Storage map:.	listing.
Restart point list: . .	listing.
Language errors: . .	listing.
Symbolic reference table:	listing.
Translation statistics:	listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

First pass:. . . . . assign values to symbols, check serialization (if any).
Second pass: . . . . . prepares binary output and listing.

.42 Optional Mode

.421 Translate: . . . . . yes.
.422 Translate and run:. . . yes.
.423 Check only: . . . . . yes.
.424 Patching:. . . . . yes.
.425 Up-dating: . . . . . yes.

.43 Special Features

.431 Alter to check only: . . yes.
.432 Fast unoptimized translate:. . . . . not required.
.433 Short translate on restricted program: . yes.

.44 Bulk Translating: . . . yes.

.45 Program Diagnostics

.451 Tracers:. . . . . library.
.452 Snapshots: . . . . . library or DUMP (FORTRAN).
.453 Dumps:. . . . . library or DUMP (FORTRAN).

.46 Translator Library

.461 Identity: . . . . . FORTRAN.
.462 User restriction: . . . relocatable mode only.
.463 Form
Storage medium: . . . tape or cards.
Organization:. . . . . closed subroutines.
.464 Contents
Routines:. . . . . see FORTRAN.
.465 Librarianship
Insertion:. . . . . possible.
Amendment: . . . . . possible.
Call Procedure: . . . LIBE card at beginning of program.
CALL pseudo operation within program.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511 Fixed overhead: . . . . none unless FORTRAN monitor used, or relocatable routines loaded with library program (usually BSS loader - uses 100 locations in lower storage and upper storage above 77461_8).
.512 Space required for each input-output file: . . . own coding.
.513 Approximate expansion of procedures: . . . . usually 1-for-1 exceptions are generative pseudo operations and macros.

.52 Translation Time

.521 Normal translating: . . 0.1 + 0.00016S minutes, where S is the number of source statements.
.522 Checking only: . . . . . same.
.523 Unoptimized translating: same.

.53 Optimizing Data

Count of source statements is an optional input which can be used to overlap tape rewind time with processing. (If count is not included, 2,000 statements are assumed.)

.54 Object Program Performance:. . . . . unaffected except for a slight compacting of literal constants.

§ 181.

.6 COMPUTER CONFIGURATION

.61 Translating Computer

.611 Minimum configuration: 1 tape unit.
1 card reader or tape unit.
1 printer.
1 punch or tape unit.

.612 Larger configuration advantages: . . . . . off-line tape-to-printer or tape-to-punch FORTRAN monitor library and control options.

.62 Target Computer

.621 Minimum configuration: the minimum available object system configuration.

.622 Usable extra facilities: any.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	check	error message.
Unsequenced entries:	check	error message.
Duplicate names:	check	error message.
Improper format:	check	error message.
Incomplete entries:	check	error message.
Machine failures:	check	error message; assembly stops.
Table overflow:	check	error message.

.71 Specific Actions

Error flags are printed in the left margin opposite possible errors. These are as follows:

Flag	Meaning
B:	Relocatable or common symbol in Boolean expression. Digit greater than 7 in octal expression.
E:	Error in data-generating pseudo operation.
L:	Error in literal.
O:	Undefined op code.
( ):	Unbalanced parentheses in macro-definition or macro-instruction.
P:	Phase relocation error.
R:	Relocation error.
U:	Undefined symbol.
N:	Programmer-defined operation code with unspecified mode of assembly.
4:	A 704 operation in the 7090 mode.
9:	A 7090 operation in the 704 mode.
A:	Address field not present.
T:	Tag field not present.
D:	Decrement field not present or improper.
I:	Decrement field will cause indirect addressing. Indirect addressing specified where not permitted.
F:	Excessive field.
M:	Reference to label with multiple definition.

.8 ALTERNATIVE TRANSLATORS: . . . FAP can be run on the 709, 7090, and 7094.

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PROGRAM TRANSLATOR: FORTRAN II

§ 182.

.1 GENERAL

.11 Identity: . . . . . IBM 709/7090 FORTRAN Compiler.

.12 Description

The 709/7090 FORTRAN II Compiler is designed to operate under control of the FORTRAN Monitor System, described in Section 408:191. The Compiler translates FORTRAN II source programs into relocatable 7090 machine language object programs. The Monitor makes possible immediate execution of the compiled object programs. The basic IBM-developed FORTRAN II Compiler and Monitor described here have been extensively modified by individual 7090 users.

FORTRAN source program decks can either be read by means of the on-line card reader or transcribed onto magnetic tape in a prior off-line operation. The translation process is divided into six logical sections, described in Paragraph .41. The source program is read only once during a translation, but the necessary manipulation of the generated tables is quite time-consuming. The translation time seems to increase with the square of the number of source statements. Therefore, current practice is to divide large source programs into smaller subprograms to reduce the total translation time and the time required for retranslations due to errors. Each individual subprogram is compiled as a separate entity, and subprograms which are to be executed together need not be compiled at the same time.

Object program output can be on magnetic tape or punched cards, in relocatable column or row binary format. The column binary format must be chosen if the program is to be executed under control of the FORTRAN Monitor. The translator listing is written on magnetic tape for off-line printing, and includes a listing of the source program, a detailed storage map, and an optional listing of the object program instructions in both absolute and FAP symbolic form.

The translator checks for a large number of possible source program errors and prints detailed diagnostic messages which provide on-the-spot, accurate descriptions of most syntactical errors. Errors which are not detected include an incorrect number of variables in a subroutine calling sequence, an out-of-range value for a computed GO TO, and an excessively high subscript for a dimensioned variable. A number of limitations on the size of any one source program are listed in Paragraph .23. There is little danger of exceeding these limitations as long as individual subprograms are restricted to less than 1,000 source statements.

Automatic and programmer-controlled means for improving the efficiency of FORTRAN-compiled object programs are described in Paragraph .53. For

.12 Description (Contd.)

internal processing, the efficiency of FORTRAN-compiled programs written by experienced programmers who have a good understanding of the operation of the 7090 and the FORTRAN compiler will closely approach the efficiency of machine language programs. The primary disadvantage of the 709/7090 FORTRAN II translator is its inability to take advantage of the extensive "hardware" capabilities for simultaneous operations that are built into the computer system. Only one input or output operation can occur at a time, and there is little effective overlapping of input-output operations with internal processing. FORMAT statements are transcribed directly from source to object program and executed interpretively each time they are encountered during the object program execution, making it easy to alter input and output data formats without recompiling, but increasing the execution time of the object program.

The FORTRAN Library consists of the standard FORTRAN input-output and mathematical subroutines. The library is expandable, and additional closed library subroutines and functions can be coded by the user or obtained from the SHARE users' group. Twenty input-output subroutines and three exponential routines are considered "internal to FORTRAN" and are called implicitly when specific input-output statements and the exponential operator appear in the source program. The seven standard library function subroutines (ATANF, EXPF, LOGF, SINF, COSF, SQRTF, TANHF) and all routines added by the user are called explicitly by use of their names in a source statement. The required closed library subroutines can either be included in the object deck at compile time or supplied at run time through use of the FORTRAN Monitor. Twenty standard "built-in functions" (e.g., ABSF, INTF, FLOATF) are compiled as open subroutines and inserted into the object program each time they are called. Up to seven additional built-in functions can be added by an individual user.

.13 Originator: . . . . . IBM Data Systems Division.

.14 Maintainer: . . . . . as above.

.15 Availability: . . . . . 1959.

.2 INPUT

.21 Language

.211 Name: . . . . . IBM 709/7090 FORTRAN II; see Section 408:161.

.212 Exemptions: . . . . . none.

.22 Form

.221 Input media: . . . . . punched cards or card images on magnetic tape.

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.222 Obligatory ordering:. . yes; e.g., a DIMENSION statement for an array must precede the first appearance of the array name in an executable statement.

.223 Obligatory grouping:. . individual subprograms must be segregated and are compiled separately.

.23 Size Limitations

.231 Maximum number of source statements
- Total:. . . . . no specific limit.
- DO statements and DO-implying parentheses: . . . . 600.
- Non-executable statements: . . . . . 1,200.
- Numbered statements: 3,000.
- STOP and RETURN statements: . . . . . 1,200.
- CALL statements: . . 2,400.
- ASSIGN, IF, and GO TO statements: . . . 2,400.
- Arithmetic statement functions: . . . . . 140.

.232 Maximum size source statements
- Number of characters: 660.
- Nested parentheses: . 138 levels.

.233 Maximum number of data items
- Integer constants: . . 400.
- Floating point constants:. . . . . 1,800.
- Array names, total
  - 1-dimensional: . . . 400.
  - 2-dimensional: . . . 400.
  - 3-dimensional: . . . 360.
- Double precision or complex array names: . . . . . 150.
- Double precision or complex non-subscripted variables:. . . . . 400.

.234 Others
- Nested DO loops:. . . 200 levels.
- Literal appearances of variables in COMMON statements: . . 2,400.
- Literal appearances of variables in EQUIVALENCE statements: 6,000.
- Literal appearances of FORMAT statement numbers: . . . . . 2,000.

.3 OUTPUT

.31 Object Program

.311 Language name: . . . . IBM 7090 machine language.

.312 Language style: . . . . relocatable column binary or relocatable row binary.

.313 Output media: . . . . . punched cards, magnetic tape, or retained in core storage for immediate execution.

.32 Conventions

.321 Standard inclusions: . . loader precedes object program when output is in relocatable row binary form. Loader for relocatable column binary is built into the FORTRAN Monitor. The Required FORTRAN library subroutines may be included if desired.

.322 Compatible with:. . . . IBM 709/7090 FORTRAN Monitor System (when output is in relocatable column binary format); and with the FORTRAN input-output subroutines, which must be present at execution time.

.33 Documentation

Subject	Provision
Source program: . . .	listing.
Object program: . . .	optional listing, in FAP symbolic and octal form.
Storage map:	listing.
Restart point list: . .	none.
Language errors: . .	on-line printer messages and listing.

.4 TRANSLATING PROCEDURE

.41 Phases and Passes

Section 1:

The source program is read and internal formula numbers (IFN) are assigned to all statements, first to the non-executable ones and then to the executable ones. The non-executable statements are stored in a buffer area and then written on magnetic tape. The executable statements are scanned, checked for mode, and translated into machine language, resulting in a compiled instruction table (CIT). The CIT is written on tape in the COMPAIL (complete arithmetic, input-output, and logical) file. Storage locations are assigned for all constants and variables. Error checks are made and diagnostic messages written if necessary.

Section 2:

Non-arithmetic instructions associated with indexing are arranged into a COMPDO file. Indexing loops are set up and index registers are assigned symbolic tags.

Section 3:

The COMPAIL and COMPDO files are merged, and the remainder of the non-arithmetic statements are translated to machine language instructions. The object program is now essentially complete, but assumes there is no limit on the number of index registers available.

§ 182.

.41 Phases and Passes (Contd.)

Section 4:

The program flow is analyzed in an effort to assign the symbolic tags to the 3 available index registers in such a way that the number of times the index registers will have to be loaded and unloaded is minimized. Several hundred scans of the object program may be performed in this section.

Section 5:

Actual index registers are assigned, and all indexing instructions are added to the CIT file.

Section 6:

The object program is written on tape in FAP symbolic form for off-line listing, then assembled into relocatable binary form and written on tape, punched on-line, or retained in core storage for immediate execution.

.42 Optional Modes

.421	Translate:	yes.
.422	Translate and run: . . .	yes.
.423	Check only:	no.
.424	Patching:	no; must retranslate or add correction cards to object program.

.43 Special Features

.431	Alter to check only: . .	no.
.432	Fast unoptimized translate:	no.
.433	Short translate on restricted program: .	no.

.44 Bulk Translating: . . . yes, without restriction.

.45 Program Diagnostics

.451	Tracers:	none.
.452	Snapshots:	the source statement CALL PDUMP causes the FORTRAN Monitor to dump the contents of core storage locations between specified limits onto magnetic tape in either octal or floating point format. Control is then transferred to the next executable statement.
.453	Dumps:	the source statement CALL DUMP has the same effect as PDUMP except that it terminates execution of a program and returns control to the FORTRAN Monitor. A DUMP control card causes the Monitor to dump all of core storage in octal format.

.46 Translator Library

.461	Identity:	IBM 709/7090 FORTRAN Library.
.462	User restriction: . . .	none.
.463	Form	
	Storage medium: . . .	magnetic tape.
	Organization:	relocatable binary format; each routine preceded by an identifying program card record.
.464	Contents	
	Routines:	closed input-output and user-coded subroutines.
	Functions:	yes; standard and user-coded.
	Data description: . . .	no.
.465	Librarianship	
	Insertion:	via punched cards, in column or row binary format. The new routine must be inserted at the appropriate point in the library card deck and the entire deck transcribed to magnetic tape.
	Amendment:	add and/or delete cards and transcribe to tape as above.
	Call procedure: . . .	by use of routine name in source statement (e.g., CALL RTNA, X = SQRTF (Y)); or implicitly by use of specific source statement type (e.g., READ INPUT TAPE requires the presence of 8 different input-output subroutines). The LIBE control card causes library routines to be included with the object program; otherwise, they must be supplied separately at run time.

.5 TRANSLATOR PERFORMANCE

.51 Object Program Space

.511	Fixed overhead	
	Name	Space
	FORTRAN Monitor:	305 words.
	Input-output routines:	approx. 2,650 words.
.512	Space required for each input-output file: . . .	contained in standard input-output routines.
.513	Approximate expansion of procedures:	averages 5 to 6 machine instructions per source statement (**).

.52 Translation Time: . . . $0.3 + 0.0003S^2$ minutes, where S is number of source statements (**).

(**) Estimate by the Editorial Staff. See 1:010.400.

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.53 Optimizing Data

.531 Explicit:

FREQUENCY statement provides data for optimizing the coding of branch points and loops.

EQUIVALENCE statement reduces data storage requirements by causing locations to be shared by two or more variables within a program.

COMMON statement reduces data storage requirements by causing locations to be shared by variables in two or more different subprograms that will be loaded at the same time.

.532 Implicit:

Common sub-expressions occurring within a single expression will be evaluated only once if they are enclosed in parentheses at each occurrence.

Do not compute anything within a DO loop that can just as well be computed before entering the loop.

Do not compute the same sub-expression within two or more different statements if the practice can be avoided by evaluating the sub-expression in a separate arithmetic statement.

Keep all subscript expressions as simple as possible.

Check input data for reasonability.

Keep on-line card input and printer output to a minimum.

Do not allow the operator to attempt on-line corrective measures; when the program hangs up, get off the machine.

Use successive multiplications rather than exponentiation to develop squares, cubes, etc.

.533 Automatic:

Program flow is analyzed and coding rearranged for optimum utilization of the 3 available index registers.

Sequences of successive arithmetic operations of the same hierarchy which are not grouped by parentheses will be re-ordered to minimize the number of storage accesses. (Since fixed point division produces truncated results, this optimization process can lead to unexpected results unless parentheses are used to indicate the order of fixed point multiplications and divisions.)

.54 Object Program Performance (**)

Type	Time	Space
Elementary algebra:	unaffected	unaffected.
Complex formulae:	unaffected	unaffected.
Deep nesting:	increased	increased.
Heavy branching:	increased	increased.
Complex subscripts:	increased	increased.
Data editing (FORMAT):	increased greatly	unaffected.
Overlapping operations:	not possible in FORTRAN.	

(**) Estimate by the Editorial Staff. See 1:010.400.

.6 COMPUTER CONFIGURATIONS

.61 Translating Computer

.611 Minimum configuration: 5 magnetic tape units.
1 data channel.
1 card reader.
1 printer.

.612 Larger configuration advantages:. . . . . card punch provides on-line card output.
additional tape units permit tape input, speed up compilation, and permit additional Monitor operations.

.62 Target Computer

.621 Minimum configuration: any IBM 709, 7090, or 7094 system.

.622 Usable extra facilities: all magnetic tape units; any 1 card reader, card punch, and printer.

.7 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Missing entries:	limited checks	message; abandon compilation.
Unsequenced entries:	none.	
Duplicate names:	check	message; abandon compilation.
Improper format:	checks	message; abandon compilation.
Target computer overflow:	checks	message; abandon compilation.
Inconsistent program:	checks	message; abandon compilation.
Mixed arithmetic:	checks	message; abandon compilation.
Table limits exceeded:	checks	message; abandon compilation.

Note: Upon detection of any error, compilation stops, but the remainder of the source program is checked for additional errors.

.8 ALTERNATIVE TRANSLATORS

1. The basic, IBM-developed 709/7090 FORTRAN II translator described here has been extensively modified by numerous individual users.
2. The new IBM 7090/7094 FORTRAN Compiler, which operates under control of the IBJOB Monitor, uses the FORTRAN IV language; the SIFT translator has been developed to convert FORTRAN II source programs into FORTRAN IV.
3. FORTRAN translators for other computer systems are listed in the Index.

OPERATING ENVIRONMENT: FORTRAN MONITOR

§ 191.

.1 GENERAL

.11 Identity: . . . . . IBM 709/7090 FORTRAN Monitor System.

.12 Description

The FORTRAN Monitor is a widely used operating system that coordinates FORTRAN II compilations, FAP assemblies, and execution of object programs. Compilations, assemblies, and object program executions can be intermixed in any order, as specified on control cards. Object programs can be executed immediately upon successful completion of the compilation or assembly process. Programs too large to fit into core storage can be subdivided into a series of program segments, called links. Only one program can be run at a time; i.e., there is no provision for multi-running.

Input to the FORTRAN Monitor is usually on magnetic tape, transcribed from punched cards in an off-line operation. Input can consist of Monitor control cards, FORTRAN source statements, FAP symbolic cards, object program cards (in relocatable column binary form), and/or data cards. The deck for each job must be headed by a series of Monitor control cards, identified by an asterisk in column 1, that specify the job's identity, the operation to be performed, and (for FORTRAN compilations) the desired forms of output.

Convenient diagnostic facilities for snapshots and dumps are built into the FORTRAN Monitor. The FORTRAN source statements CALL DUMP and CALL PDUMP cause the contents of core storage locations between specified limits to be dumped onto magnetic tape in either floating point or octal format. CALL PDUMP then transfers control to the next executable statement, while CALL DUMP terminates the current program and initiates the next job. The control card DUMP can be loaded whenever an unexpected halt occurs; it causes the entire contents of core storage to be dumped in octal form. RESTART control cards permit continuation of Monitor operations after unexpected halts. The current job can be rerun from the beginning, or any subsequent job on the input tape can be initiated. No facilities are provided for establishing restart points within a given program or for tracing the execution of an object program.

The CHAIN function of the Monitor makes it possible to handle a FORTRAN object program that is too large to fit into core storage by executing it as a series of smaller programs called links. Each link or segment consists of a main program with all necessary subprograms. The links are stacked on any of three tape units. The first link is called into core

.12 Description (Contd.)

storage for execution by the Monitor, and each link in turn calls in the next link in the sequence. The control card CHAIN (R,T) must precede each link, and the last executable source statement in each link must be CALL CHAIN (R,T). R is a number that identifies a particular link, and T specifies the tape unit on which the link will be kept at run time. Data values can be passed from one link to another by means of the COMMON statement.

The FORTRAN Monitor requires an on-line printer, on-line card reader, and up to eight magnetic tape units on two channels. The tape unit assignments are as follows:

A1: FORTRAN Monitor System tape.

A2: Input tape.

A3: Output tape for off-line listing.

A4: FORTRAN intermediate tape.

B1: Monitor intermediate tape for CHAIN (segmented) jobs.

B2: Intermediate tape for FORTRAN, DUMP, and PDUMP.

B3: FORTRAN intermediate tape.

B4: Binary output tape for off-line punching.

No central processor time is required by the Monitor during the compilation, assembly, or execution of a program because the monitor only directs program traffic. The Monitor, parts of which are always in core storage, assumes control only upon completion of a job or when a Monitor function such as DUMP or RESTART is called for. The last executable statement of each FORTRAN source program to be executed under Monitor control must be CALL EXIT or CALL DUMP, which returns control to the Monitor for initiation of the next job. Detection of an error in a FORTRAN or FAP source program causes an on-line printout; translation of the remainder of the current program is skipped. Run-time errors (e.g., an illegal character in a data field) in FORTRAN-compiled object programs cause system halts. The operator must determine the reason for the halt from the storage register contents and initiate the appropriate recovery procedure.

.13 Availability: . . . . . 1959.

.14 Originator: . . . . . IBM Data Systems Division.

.15 Maintainer: . . . . . as above.

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IBM 7090
SYSTEM PERFORMANCE

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IBM 7090 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration								Reference
			V		VII B				VIII B		
1 Input-Output Times	Char/block	(File 1)	1,008		1,008		4,032		1,008	4,032	4:200.112
	Records/block	K (File 1)	8		8		32		8	32	
	m.sec/block	File 1 = File 2	34		22.6		66		10.1	27.8	
		File 3	13		8.7		22.7†		8.1	17.9†	
		File 4	13		8.7		22.7†		8.1	17.9†	
	m.sec/switch	File 1 = File 2									
		File 3									
		File 4									
	m.sec penalty	File 1 = File 2	0.3		0.2		0.7		0.1	0.2	
		File 3	0.1		0.1		0.2		0.1	0.1	
		File 4	0.1		0.1		0.2		0.1	0.1	
2 Central Processor Times	m.sec/block	a1	0.22		0.22				0.22		4:200.1132
	m.sec/record	a2	0.25		0.25				0.25		
	m.sec/detail	b6	0.17		0.17				0.17		
	m.sec/work	b5 + b9	0.39		0.39				0.39		
	m.sec/report	b7 + b8	8.86		8.86				8.86		
3 Standard Problem A	m.sec for C.P. and dominant column.	a1	0.2		0.2		0.2		0.2	0.2	4:200.114
		a2K	2.0		2.0		8.0		2.0	8.0	
		a3K	75.4		75.4		301.6		75.4	301.6	
		File 1 Master In	0.3	34	0.2	22.6	0.7	66	0.2	0.7	
		File 2 Master Out	0.3	34	0.2		0.7		0.2	0.7	
		File 3 Details	0.8	104	0.8	69.6	0.8	91	0.8 32.4	0.8 71.6	
		File 4 Reports	0.8	104	0.8		0.8		0.8	0.8	
		Total	79.8	276	79.6	92.2	312.8	157	79.6 32.4	312.8 71.6	
4 Standard Problem A Space	Unit measure	(words)									4:200.1151
		Std. routines	620		620		620		620	620	
		Fixed	0		0		0		0	0	
		3 (Blocks 1 to 23)	400		400		450		400	450	
		6 (Blocks 24 to 48)	2,000		2,000		2,000		2,000	2,000	
		Files	756		756		3,360		756	3,360	
		Working	200		200		200		200	200	
		Total	3,976		3,976		6,630		3,976	6,630	

† 8 records per block

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IBM 7090 SYSTEM PERFORMANCE – Contd.

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration			Reference
					VII B	VIII B	
5 Standard Mathematical Problem A	Fixed/Floating point				Floating	Floating	4:200.413
	Unit name		input		729 IV	729 VI	
			output		729 IV	729 VI	
	Size of record		input		90 char	90 char	
			output		120 char	120 char	
	m.sec/block		input T1		8.2	7.7	
			output T2		8.6	8.0	
	m.sec penalty		input T3		0.1	0.1	
			output T4		0.1	0.1	
	m.sec/record		T5		1.46		
	m.sec/5 loops		T6		2.67		
	m.sec/report		T7		12.26		
7 Standard Statistical Problem A	Unit name				729 IV	Hypertape	4:200.512
	Size of block				9,000 char	21,000 char	
	Records/block		B		150	350	
	m.sec/block		T1		151	128	
	m.sec penalty		T3		2	2	
	C.P.	m.sec block	T5		0.04		
		m.sec record	T6		0.73		
		m.sec table	T7		0.06		

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SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

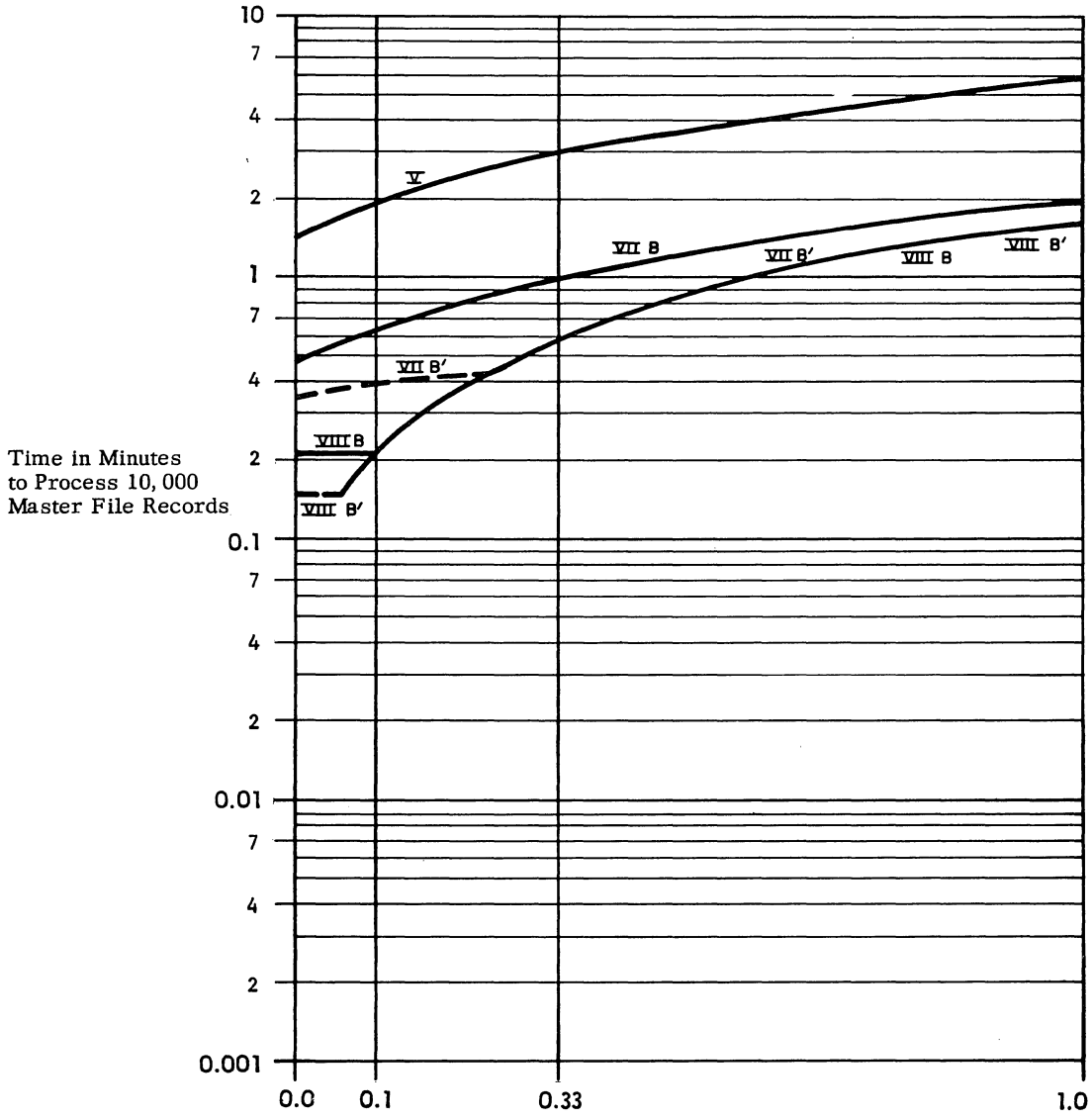
.111 Record sizes
Master file:. . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.112 Computation:. . . . . standard.

.113 Timing basis: . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . . see graph below.

.115 Storage space required
Unblocked detail and report files
Configuration V: . . . . . 3,976.
Configuration VII B:. . . . 3,976.
Configuration VIII B: . . . 3,976.
Blocked detail and report files
Configuration VII B:. . . . 6,630.
Configuration VIII B: . . . 6,630.



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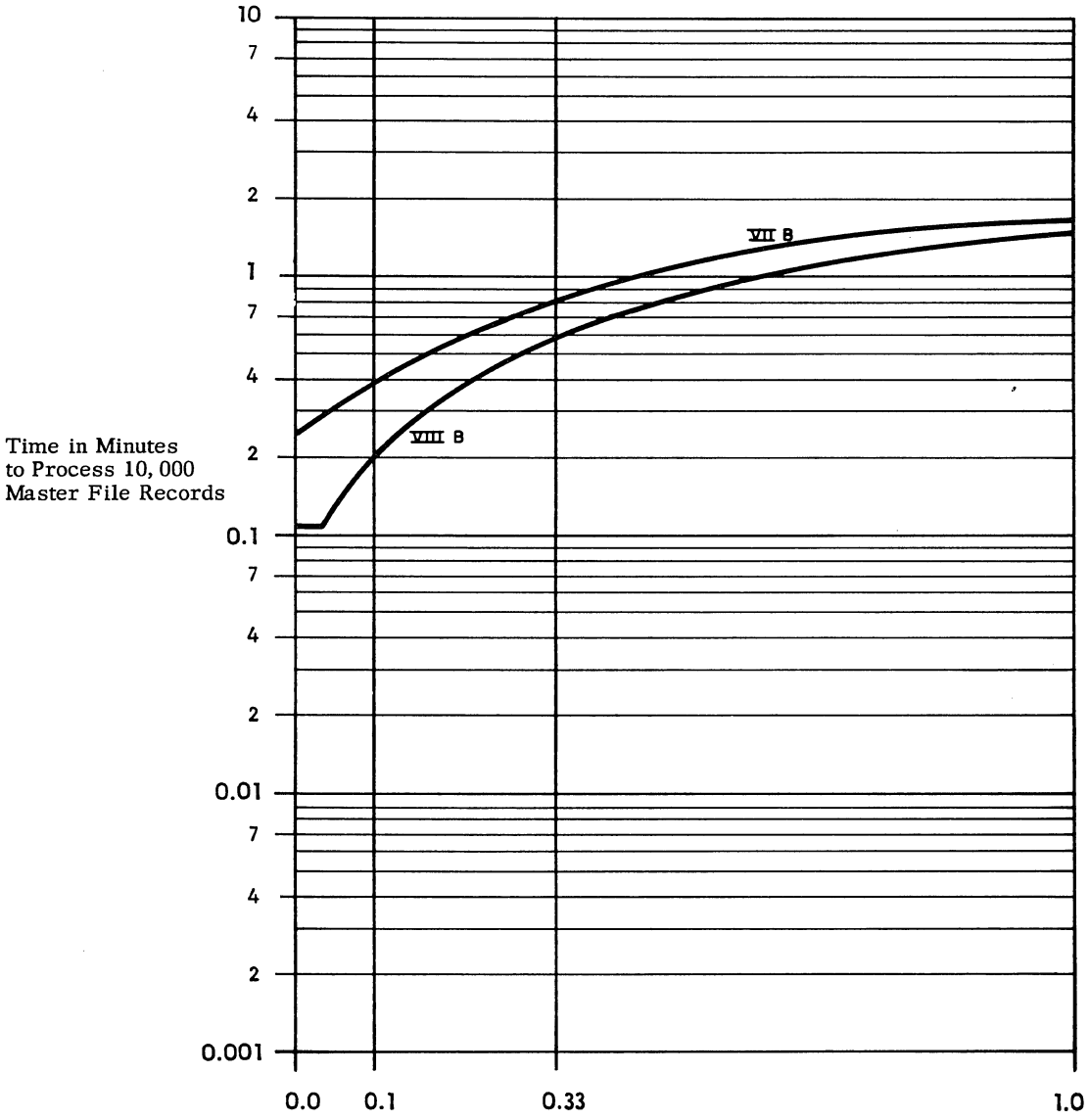
§ 201.

.12 Standard File Problem B

.121 Record sizes
Master file:. . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.122 Computation: . . . . . standard.
.123. Timing basis:. . . . . using estimating procedure outlined in Users' Guide, - 4:200.12.
.124 Graph: . . . . . see graph below.



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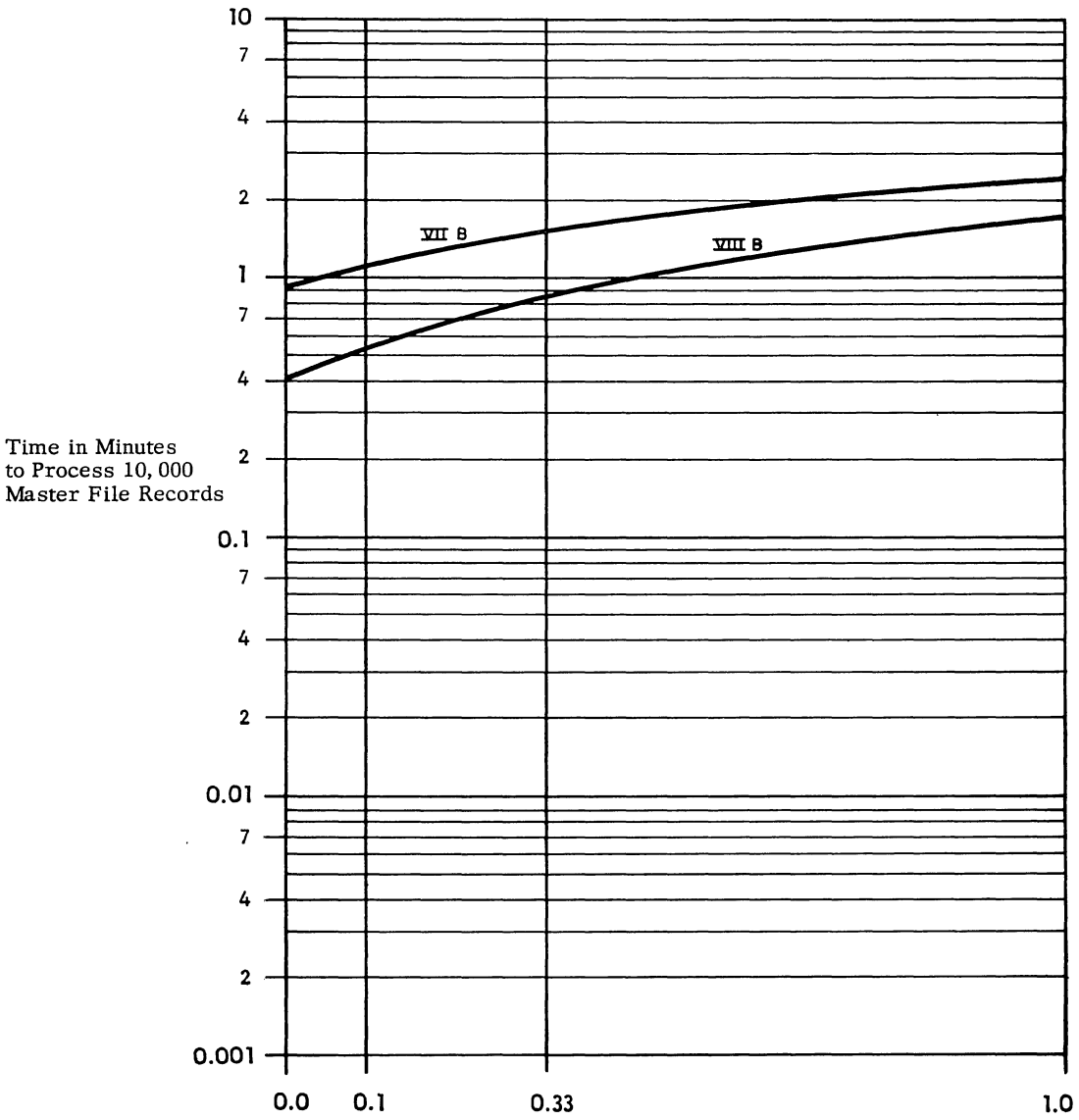
.13 Standard File Problem C

.131 Record sizes
Master file:. . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis:. . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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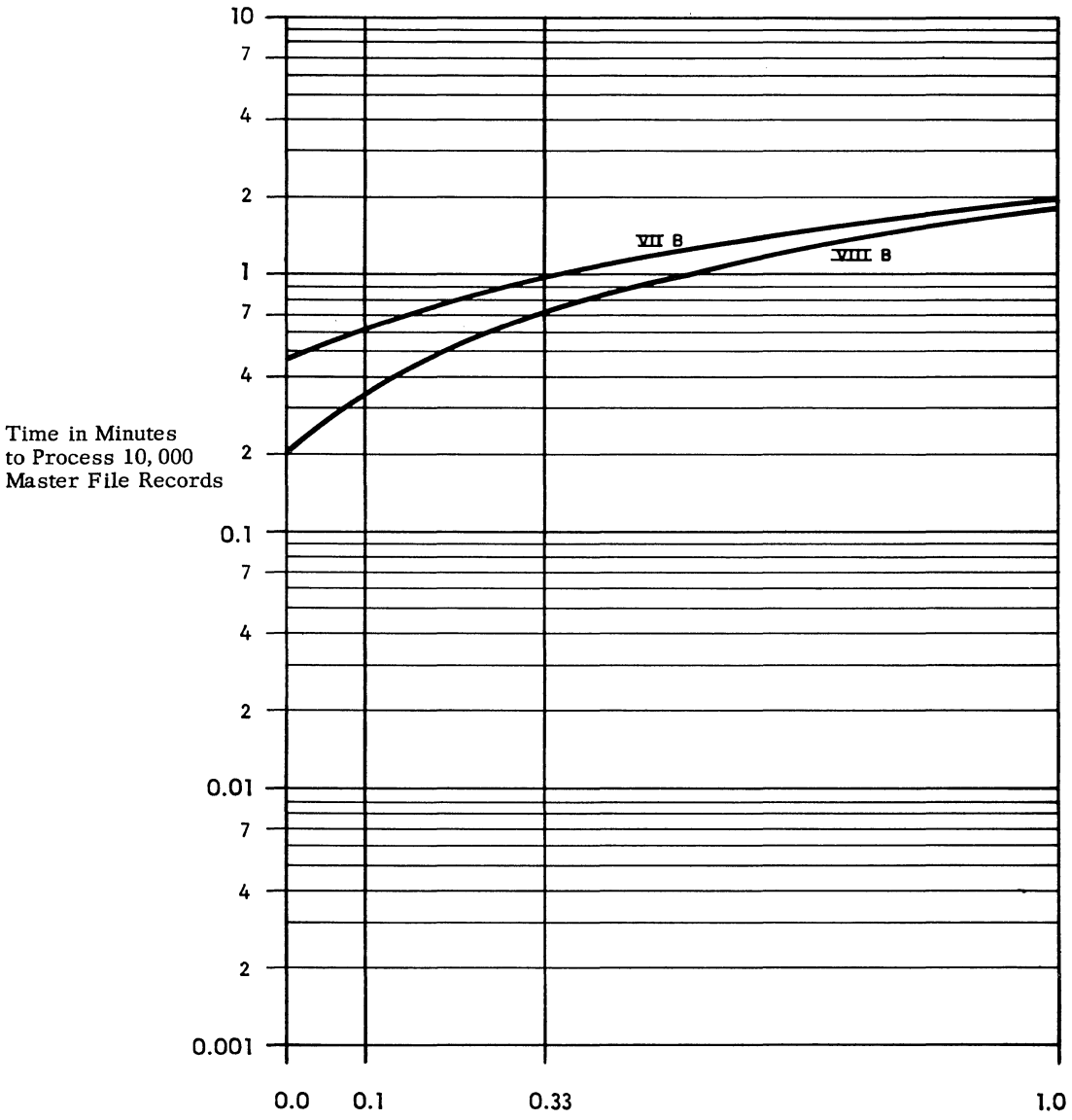
.14 Standard File Problem D

.141 Record sizes
Master file:. . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file:. . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis:. . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



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§ 201.

.2 SORTING

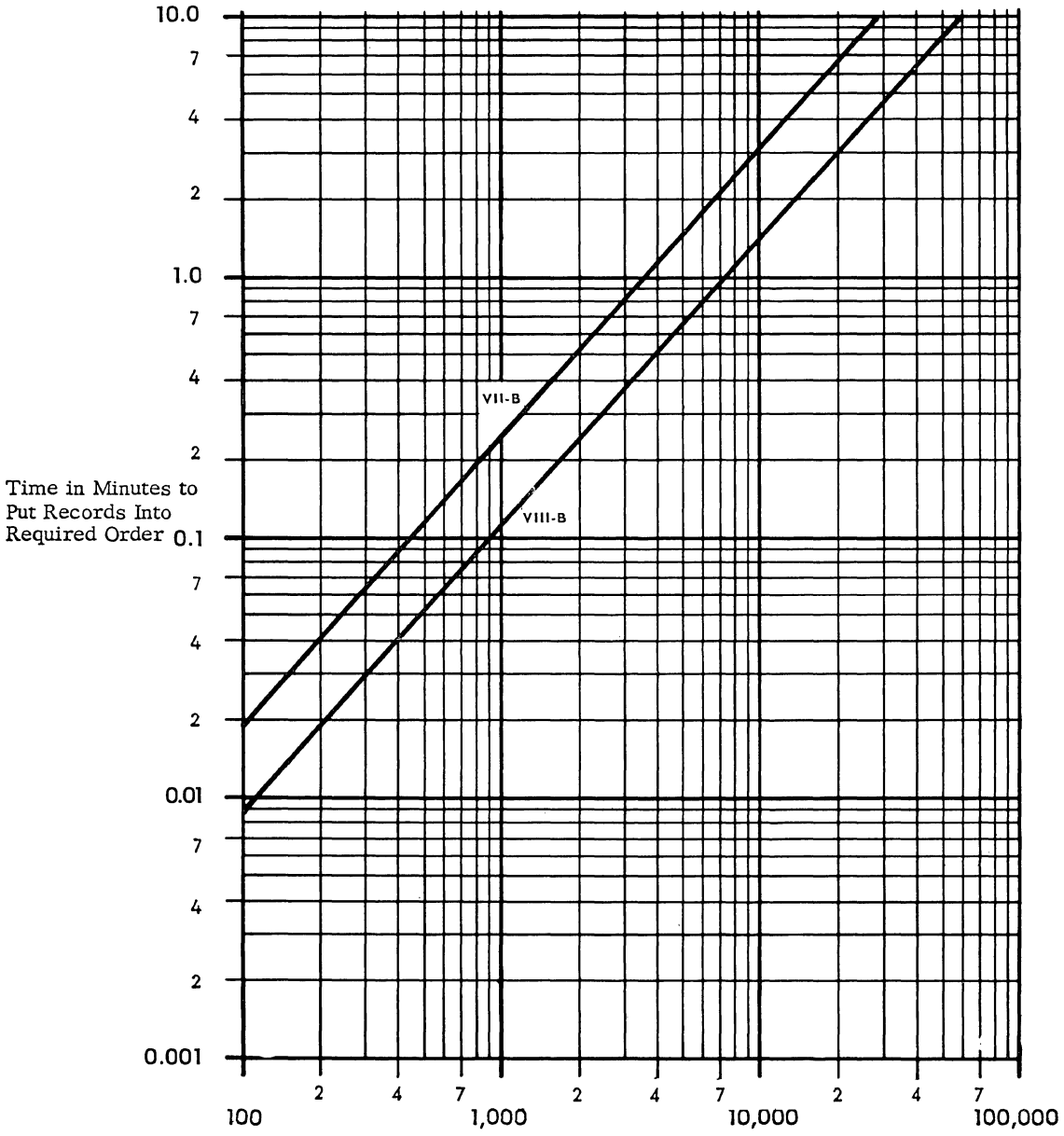
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



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§ 201.

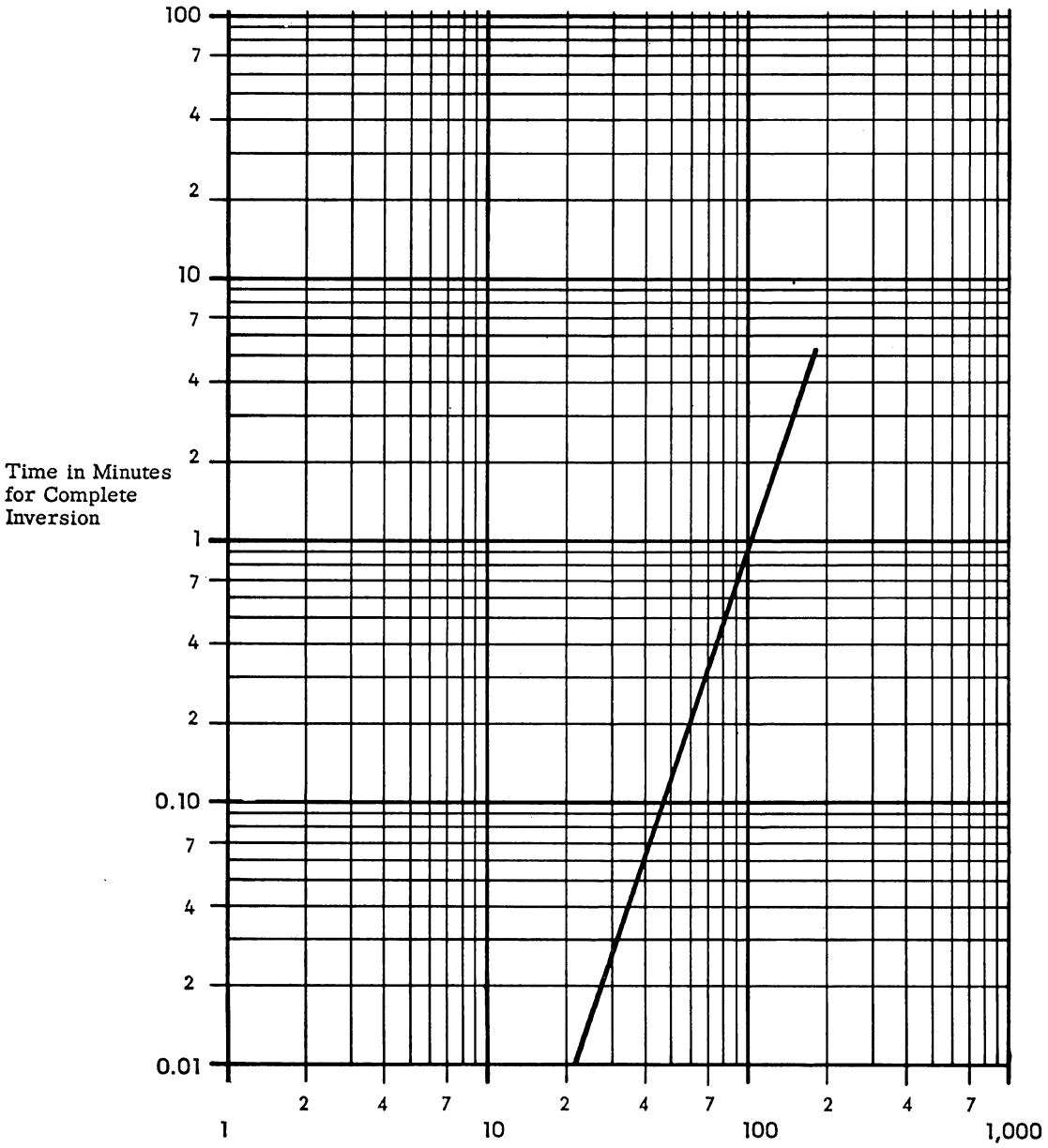
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . . see graph below.



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.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

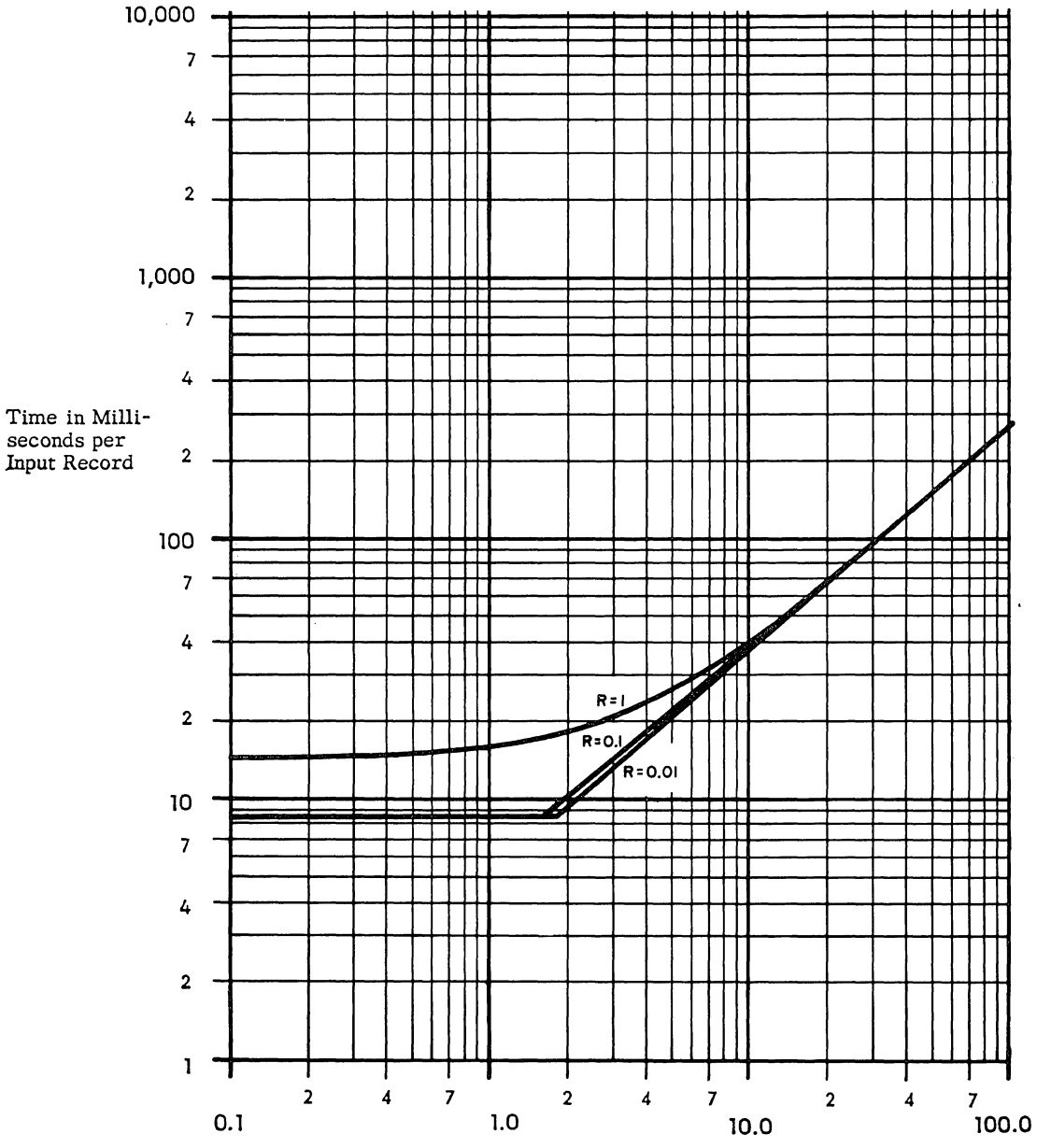
.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . . see graph below.

CONFIGURATION VII B; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT.
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



C, Number of Computations per Input Record

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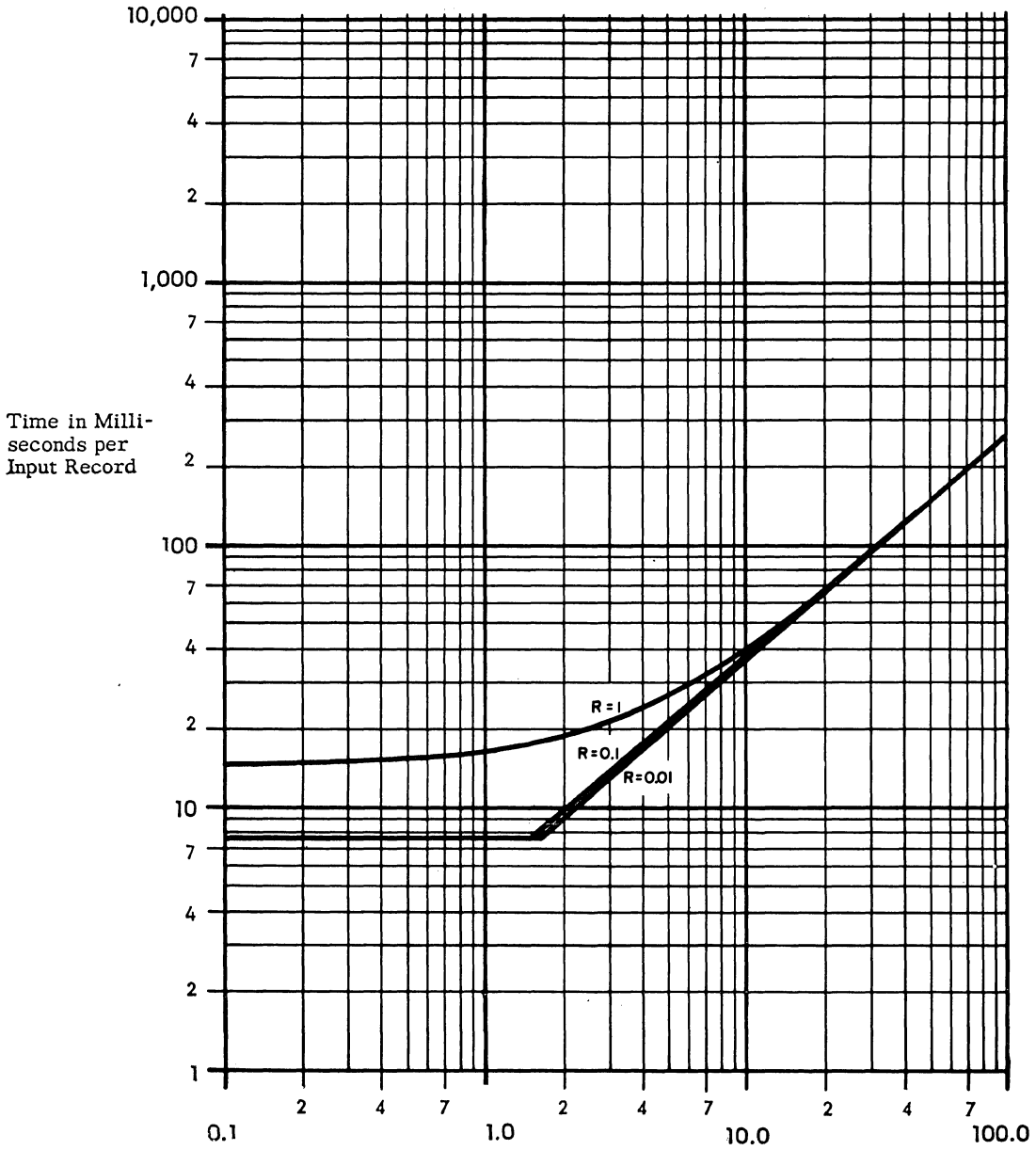
§ 201.

.415 Graph: . . . . . see graph below.

CONFIGURATION VIII B; SINGLE LENGHT (8 DIGIT PRECISION); FLOATING POINT.
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

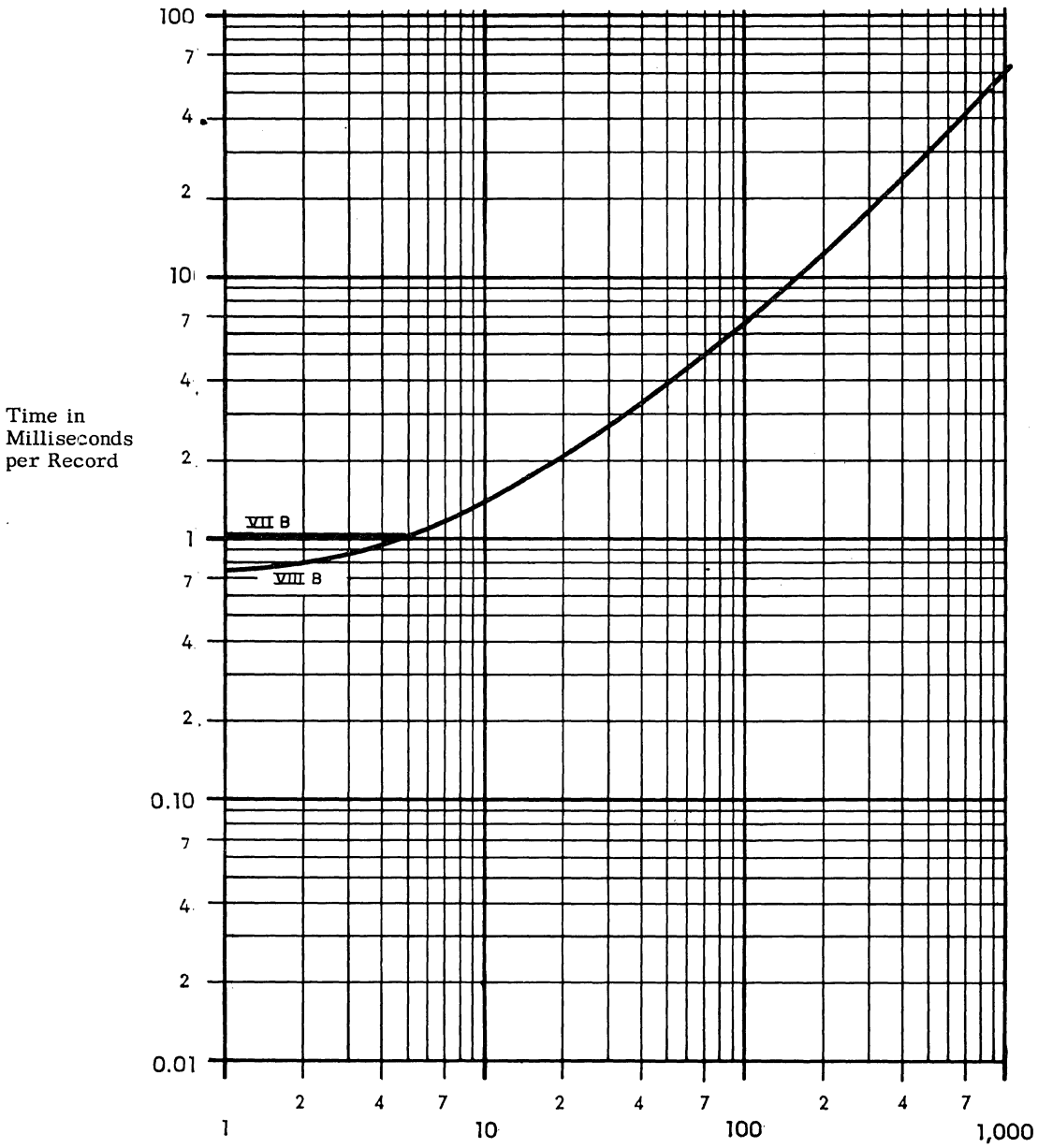
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



T, Number of Augmented Elements
Roman numerals denote Standard Configurations

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IBM 7090
PHYSICAL CHARACTERISTICS

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IBM 7090 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Core Storage	Multiplexor	Disk Storage	Disk Storage	Drum Storage	File Control	Instruction Processing Unit
	Model Number		7302-1	7606-1	1301-1	1301-2	7320-1	7631 II/II/IV	7108
PHYSICAL	Height × Width × Depth, in.		80×36×70	56×30×69	33×85½×65⅝	33×85½×65⅝	30×29×60	38×32×70	69×60×28
	Weight, lbs.		2,450	1,500	3,625	3,825	850	500	2,225
	Maximum Cable Lengths		From 7618 - 75 ft. From 7606 - 18 ft.	From 7618 - 75 ft. From 7151 - 65 ft.					From 7618 - 75 ft. From 7151 - 65 ft.
ATMOSPHERE	Storage Ranges	Temperature, °F.	98 ± 1	←		50 to 110			→
		Humidity, %	oil immersed	←		0 to 80			→
	Working Ranges	Temperature, °F.	←			50 to 80			→
		Humidity, %	←			20 to 80			→
	Heat Dissipated, BTU/hr.		15,420	1,550	16,700	20,000	2,800	4,800	3,620
	Air Flow, cfm.		1,860	400	---	---	---	---	400
	Internal Filters				Yes	Yes	Yes	Yes	
ELECTRICAL	Voltage	Nominal	208	208	208 or 230	208 or 230	208	208 or 230	208
		Tolerance							
	Cycles	Nominal	←			60			→
		Tolerance							
	Phases and Lines		3-phase, 5-wire	3-phase, 5-wire	3-phase, 4-wire	3-phase, 4-wire	3-phase, 4-wire	1-phase, 3-wire	3-phase, 5-wire
	Load KVA		5.83	0.73	7.5	9.0	1.1	2.7	1.59
NOTES					Max 5 Model 1 or 2		Max 5 per 7631 Model 2; 10 per system	Max 2	

IBM 7090 PHYSICAL CHARACTERISTICS (Contd.)

IDENTITY	Unit Name		Arithmetic Sequence Unit	Console Control Unit	Card Reader	Card Punch	Printer	Magnetic Tape Units	Hypertape Drive	Hypertape Control	Paper Tape Reader	Data Channel	Data Channel	Input-Output Synchronizer	Data Channel	Data Channel Console	Data Transmission Unit	Remote Inquiry Unit	Switch Control Console	Programmed Transmission Control	Power Converter	Power Control
	Model Number		7109-1	7151-1	711-2	721	716-1	729 II, IV, V, VI	7340-1	7640-1	1011-1	7607 1 or 3	7607 2 or 4	1414-6	7909-1	7617-1	1009-1	1014-1	7155 1/2/3/4	7750 I, II or III	7608-1	7816-1
PHYSICAL	Height × Width × Depth, in.		69×60×28	49×60×41	32×32×30	50×40×26	47×59×30	29×34×69	60×48×29	70×74×30	60×32×24	69×56×30	69×56×30	70×73×31	70×38×32	30×30×17	40×29×31	35×24×29	12×8×7	70×181×31	58×61×29	69×56×30
	Weight, lbs.		2,225	650	560	670	1,910	1,200	1,350	1,000	529	2,290	2,290	1,100	700	110	500	175	10	2,700	1,680	1,150
	Maximum Cable Lengths		From 7618 - 75 ft.	From 7618 - 75 ft. From 7109 - 65 ft.	From 716 - 30 ft.	From 716 - 20 ft.	From 7618 - 75 ft. From 7607 - 35 ft. To 711 - 30 ft. To 721 - 44 ft.	MTU to MTU 60 ft. From 7607 - 60 ft.			From 1414 - 90 ft.	Max combined cable length between 7607 & furthest tape unit - 60 ft. from plug (one per MTU leg) - 14 ft. from 7618 - 75 ft. From 7606 - 100 ft. From 7617 - 50 ft. Between 7607s 100 ft.		Max of 40 ft. from Data Channel.	For 2 channel system 100 ft per signal leg 140 ft to connect signal legs (total 340) Each additional channel reduces total by 40 ft).		From 1414 - 60 ft.	From 1414 - 50 ft.			50 ft. Input 50 ft. Output 50 ft. converter control connected only to 7618	From plug - 14 ft.
ATMOSPHERE	Storage Ranges	Temperature, °F.	←									50 to 110										→
		Humidity, %	←									0 to 80										→
	Working Ranges	Temperature, °F.	←									50 to 80										→
		Humidity, %	←									20 to 80										→
	Heat Dissipated, BTU/hr.		3,620	1,570	2,600	3,070	7,150	3,900	12,000	3,400	4,100	3,590	3,590	4,450	4,000	---	1,000	500	---	26,000 27,000 with TCP*	19,800	500
	Air Flow, cfm.		400	---	---	---	---	550	---	---	---	500	500	---	---	---	---	---	---	---	1,100	---
	Internal Filters				Yes	Yes	Yes	Yes							Yes	Yes			Yes		Yes	Yes
ELECTRICAL	Voltage	Nominal	←		208		→	208 or 230	208	208	208 or 230	208	208	208 or 230	208	208	115, 208, 230	115, 208, 230	208 or 230	208 or 230	208	208
		Tolerance																				
	Cycles	Nominal	←									60										→
		Tolerance																				
	Phases and Lines		3-phase, 5-wire	3-phase, 5-wire	3-phase, 4-wire	3-phase, 4-wire	3-phase, 4-wire	3-phase	3-phase, 4-wire	3-phase	1-phase, 3-wire	3-phase, 5-wire	3-phase, 5-wire	3-phase	3-phase, 4-wire	3-phase, 5-wire	1-phase, 3-wire	1-phase	3-phase	3-phase, 4-wire	3-phase, 5-wire	3-phase, 5-wire
	Load KVA		1.59	0.71	Supplied by 716 0.7	Supplied by 716 3.5	5.4	1.62	4.0	---	1.8	1.53	1.53	1.3	0.62	---	0.3	0.18	---	10.8	8.69	0.20
NOTES									Max 20	Max 1	Add 13" to depth for reading board.	Model 1 & 2, Max 10 729 II or IVs Model 3 & 4, Max 10 729 II/IV/V/VIs Model 2 & 3 control a 711, 716 & 721. For additional MTU add up to 7-7607 Models 2 or 4. Each requires a 7617.			Max 4. Addition of 7909 reduces number of additional 7607s	One used with each 7607 in the system.				Max 1 *TCB= Telegraph Converter Base	This unit houses the motor-generator.	This unit houses the motor-generator controls and distribution power cables to the 7151, 7302, 7606, 716, 7108, 7109, 7909, & 7607s.

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	7108	Instruction Processing Unit	10,600	555.00	449,500
	7109	Arithmetic Sequence Unit	8,675	453.00	368,000
	7151	Console Control Unit	1,225	13.00	61,700
STORAGE	7606	Multiplexor	3,900	146.00	156,300
	7302	Core Storage	17,500	580.00	840,000
		Additional Storage			
		Disk Storage			
	1301-1	1 disk array } max 5 per system	2,100	138.00	115,500
	1301-II	2 disk array }	3,500	238.00	185,500
	763-II	File Control	835	30.00	42,000
	7631-III	File Control (7090 + 1410) } Max 2	1,035	35.00	52,000
	7631-IV	File Control (7090 + other 7000 except 7072) } attached to 7909s	1,035	35.00	52,000
	#3213	Cylinder Mode (on any 7631)	25	1.00	1,250
DATA CHANNELS		Data Channels			
	7607-1	Channel for 729 II/IVs (max 10), 711,716	4,275	182.00	197,500
	7607-III	Channel for 729 II/IV/V/VIs (max 10), 711,716	4,360	182.00	200,900
	7607-II	Channel for 729 II/IVs (max 10)	3,275	118.00	159,000
	7607-IV	Channel for 729 II/IV/V/VIs (max 10)	3,360	118.00	162,400
	7617	Data Channels Console (An extra 7617 required for each additional 7607)	225	16.00	10,900
		For 1301s, 7340s, 1410s or 7750			
	7909-I	Data Channel (max 4) optional	2,800	125.00	112,000
	#1471	BCD Translation	100	1.00	4,200
	3224	Data channel switch (Addition of 7909s reduces number of 7607s possible)	125	1.00	5,000
INPUT-OUTPUT	711-2	Card Reader	800	63.25	32,000
	716	Printer	1,200	116.00	54,200
	721	Card Punch	600	62.25	25,000
	#2250	Consecutive Number Punching (Optional feature for 721)	35	8.25	2,275
	729 II	Magnetic Tape Unit	700	116.00	36,000
	729 IV	Magnetic Tape Unit	900	128.00	41,250
	729 V	Magnetic Tape Unit	750	122.00	37,200
	729 VI	Magnetic Tape Unit	950	134.00	42,450
		Optional for 729 II/IV/V/VI			
	#7830	Tape Switching Feature	85	6.50	4,400

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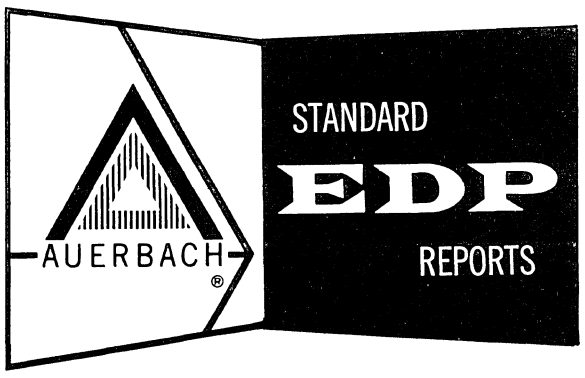
PRICE DATA–Contd.

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT	7155	Switch Control Feature (#7830 required on each MTU) to be switched			
	model 1	for up to 2 MTUs	35	5.50	1,775
	model 2	for up to 4 MTUs	55	11.00	2,675
	model 3	for up to 6 MTUs	80	16.50	3,875
	model 4	for up to 8 MTUs	100	22.00	4,775
	7640	Hypertape Control (max 1)	3,400	102.00	218,000
	7340	Hypertape Drive (max 20)	1,300	130.00	78,000
		Optional for 7340 on 7909			
	#5975	Read Backward Char Assembly and Store	200	1.50	8,400
		Tele-Processing via			
	1414-6	I/O Synchronizer	850	12.00	43,350
	#3238	Data Transmission Unit adaptor for 1009	200	3.50	11,000
	1009	Data Transmission Unit	500	11.50	26,400
	#5514	Paper Tape Reader adaptor for 1011	100	1.50	3,750
	1011	Paper Tape Reader	500	42.50	22,400
	#6136	Remote Inquiry Unit adaptor for 1014	200	5.75	11,500
	1014	Remote Inquiry Unit (10 max)	200	12.50	11,000
	#7864	Telegraph I/O Feature for 7871 and 7875	500	11.00	30,500
	7871	Telegraph Input Feature	110	3.25	6,750
	7875	Telegraph Output Feature	125	3.25	7,750
POWER SUPPLIES	7608	Power Converter	700	1.50	25,000
	7618	Power Control	900	5.00	35,000

IBM 7094

International Business Machines Corp.



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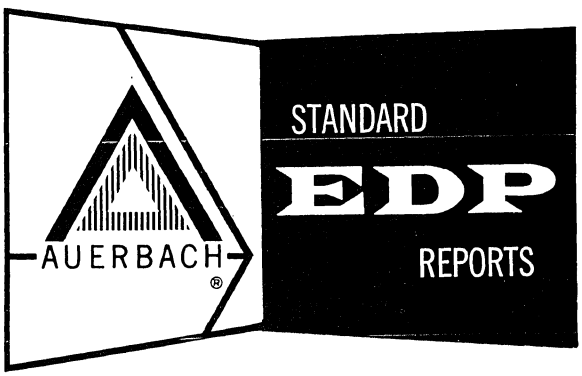
IBM 7094

International Business Machines Corp.



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INTRODUCTION

§ 011.

The IBM 7094 is a large-scale data processing system with the same general characteristics as the 709 and 7090 general purpose computers. Comparative throughput capacities indicate that the 7094 is about twice as fast as its equivalent 7090 system. Because only low-speed printers, card readers, and punches can be connected to the system, 7094 systems are magnetic-tape-oriented and usually supported by off-line IBM 1401 data processing systems. The 1401 systems perform card-to-tape and tape-to-printer or tape-to-card operations in addition to some editing for the 7094. Magnetic tape units can be switched between the 7094 and 1401 systems. Monthly rentals for two-channel, eight-tape 7090 systems start at approximately $66,000 (see System Configuration, 409:031).

The 7094 transmits and receives data via a modified 7606 Multiplexor, which time-shares the data flow between the 32,768-word core storage unit and either the processor or data channels. These data are transferred in parallel in units of 36-bit words. The multiplexor determines which unit requires access to storage most urgently and grants that unit access. In general, a processor request is less urgent than a data channel request, because the channel controls mechanical equipment, such as magnetic tape units, which have a fixed demand cycle.

The 7094 central processor has a basic cycle time of 2 microseconds, which is an increase of almost 10 per cent over that of the 7090. When accessing instructions from even-numbered locations that do not involve double-precision floating point instructions, the processor can accept two instructions during one instruction cycle. The first instruction is executed immediately while the next is held in the register which is normally used for one half of a double precision floating point operand. In most cases, storage access is thus saved for the subsequent instruction, which is actually used to execute the current instruction.

Since most of the commands require 2 cycles, speeds of nearly 300,000 instructions per second are possible. Multiplication and division speeds of the 7094 are almost 3 times those of the 7090, or approximately 120,000 and 65,000 operations per second, respectively. Therefore, applications demanding heavy use of multiply and divide operations use a larger share of central processor time than those involving primarily data movement and simple arithmetic operations. In applications that involve throughput of large volumes of data, the system tends to be speed-limited by the input-output facilities.

The processor uses binary arithmetic for both fixed and floating point operations. Fixed point arithmetic is performed on 35 bits, plus sign and 2 overflow bits. Floating point operands have either 8- or 16-decimal-digit precision, and can assume positive or negative values between 10^{+38} and 10^{-38}, including zero. This instruction repertoire includes double precision load and store instructions, which transfer data between an even-numbered storage address and that address plus one and the accumulator and multiplier-quotient registers, respectively. Failure to observe this addressing convention results in an interrupt (see 409:051.33).

Three "table look-at" instructions in the repertoire are very useful for code conversions, radix conversions, six-bit BCD addition and subtraction, and simple editing. Address modification is facilitated by three decrementing index registers. These registers use two's complement arithmetic rather than the absolute value and sign arithmetic of the processor. However, a set of index register modification instructions compensate for this incompatibility of two types of arithmetic. In programs which use many indices for varied loop control, more indexing is required than three index registers can provide. As a result, the storing and reloading of the index registers may be required comparatively often. These operations require both data and program storage, and add a non-productive burden which, although small, is unusual in a large system of this type.

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INTRODUCTION (Contd.)

The instruction repertoire of the 7094 is comprehensive and varied, and includes five types of logical operators, single- and partial-word data transfers, input-output instructions (used to start data channels and select input-output units), and an extensive set of test and conditional transfer instructions. Interrupts (called traps by IBM) can occur when encountering: a transfer instruction, a 7040 or 7044 instruction, floating point underflow or overflow, a 704 input-output instruction, or an external signal; and for certain data channel conditions.

A 7094 system can include any of 3 different types of data channels: the 7607 Data Channels, which can control 729 Magnetic Tapes and peripheral unit-record equipment; the 7909 Data Channel, which can be connected to 7340 Hypertapes, 1301 Disk Units, and 7320 Drums; or the 7281 II Data Communications Channel, which can control up to 32 "real-time" communication units. The 7281 II is different from the others in that it: is restricted to one area of storage; can only be turned on or off; requires the Direct Data option and instructions; and has higher priority interrupts than the 7607 and 7909.

The 7607 and 7909 Data Channels are actually small processors which have program and address counters, indirect addressing, and command registers. The function of these units is to transmit data from the core store to an input-output unit, and vice versa. Data transfers to and from the store are performed through parallel 36-bit word circuits. In all of the input-output units, data transfers are serial by character to or from a six-character word. Both units can control scatter-read and gather-write operations, and skip entire data blocks or parts of data blocks being read from an input-output unit.

The 7607 Data Channel can also have a Direct Data Connection added to it to permit on-line storage-to-storage data transfers between 7040, 7044, and 7090 systems. The 7607 can act as a controller for connecting up to ten 729 Magnetic Tape units, a printer, a card reader, and a card punch.

The 7909 Data Channel has a more extensive command set than the 7607. These commands give the 7909 the ability to handle many of the input-output unit conditions that would require processor intervention with the 7607 Data Channel. The 7909 can be used for input-output editing, but the processor can perform editing tasks more economically. The 7909 has a transmit command which transfers blocks of up to 32,768 words simultaneously with other processing.

The software for the 7094 system that is supplied by IBM is rather extensive. Included in this software are the process oriented languages FORTRAN II and IV, COBOL, and COMTRAN. Source statements in these languages are translated into machine code and into FAP or IBMAP, which are the machine oriented languages for the system.

Problem oriented languages include: 9PAC for file maintenance and report generation, IOCS for automatic input-output editing for formatting, various sort programs, and Disk and Hypertape utility routines. Each program has its own monitor routine to permit processing with a minimum of operator intervention. All of the software can be used as a part of the IBSYS Processor Operating System, which permits input-output unit assignment and can call the programs in the system, in addition to its normal monitor and maintenance functions.

The 7094 can accept nearly all 704, 709, 7040 and 7090 programs directly as compiled on those systems. A special program, Compatibility II, is provided for 704 programs. Because of the compatibility feature built into the 7094, very little interpretive running is required. Thus, programs generated for the other systems run proportionately faster on the 7094 than on the system they are generated for. Double-precision arithmetic, which give the 7094 a large performance increase over the interpretive subroutines in the 7090 are inserted by the FORTRAN program.

A wide range of routines for handling mathematical function routines and service and utility routines, as well as many complete program systems, have been compiled and are maintained by the SHARE users organization since it was formed by 704 users. The 7094 can accept nearly all of these programs directly.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word position:	36 or 72 bits	basic addressable location in core storage.
Row:	6 bits + parity	character on magnetic tape.
Column:	single column code	character on punched cards.
Unit Record:	24 words	punched card or its image in core storage.
Group or "byte":	6 or 8 bits + parity bit	a BCD char on band of a disk surface.
Band:	2,790 char max	usable length of band in disk store.
Record:	1 to 2,790 char	related char in a band.
Record:	1 to N words	related words on mag tape.
Cylinder:	40 bands	addressable group of bands.
File:	1 to N records	mag tape or disk store.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	BCD char on mag tape or disk. card column.
Alphameric char: . . .	BCD char on mag tape or disk. card column. 6 bits of word.
Fixed point number: . .	sign bit plus 35 bits in word.
Floating point number:	sign bit plus 8 bit characteristic plus 27 bit fractional part in word.
Instruction:	1 word.
Data:	1 or 2 words.

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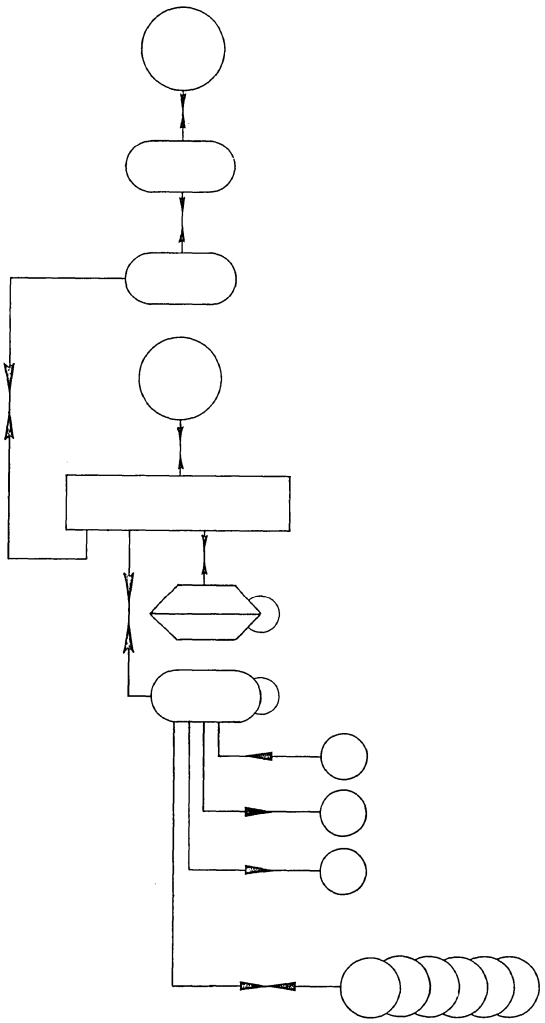
SYSTEM CONFIGURATION

§ 031.

.1 6-TAPE AUXILIARY STORAGE SYSTEM; CONFIGURATION V

Deviations from Standard Configuration: . . . . . card reader slower by 250 cards/min.
printer slower by 350 lines/min.
magnetic tapes faster by 11,700 char/sec.
floating point included.
no typewriter output.

Rental: . . . . . $69,960 per month.



Equipment	Rental
1301 Model 1 Disk Storage: 27,900,000 char.	$ 2,125
7631 Model 2 Disk Storage Control	835
7909 Data Channel	2,800
7302 Core Storage: 32,768 words	17,500
7606 Multiplexor	3,950
7110 Instruction Processing Unit	16,350
7109 Arithmetic Sequence Unit	8,775
7151 Console Control Unit	1,225
7607 Model 1 Data Channel	4,275
7617 Console	225
711 Card Reader: 250 cards/min.	800
721 Card Punch: 100 cards/min.	600
716 Printer: 150 lines/min.	1,200
729 II Magnetic Tape Units (6): 41,700 char/sec.	4,200
Power Supplies	1,600
Total Rental:	$69,960

Optional Features Included: . . . . . Cylinder Mode (Disk Storage).

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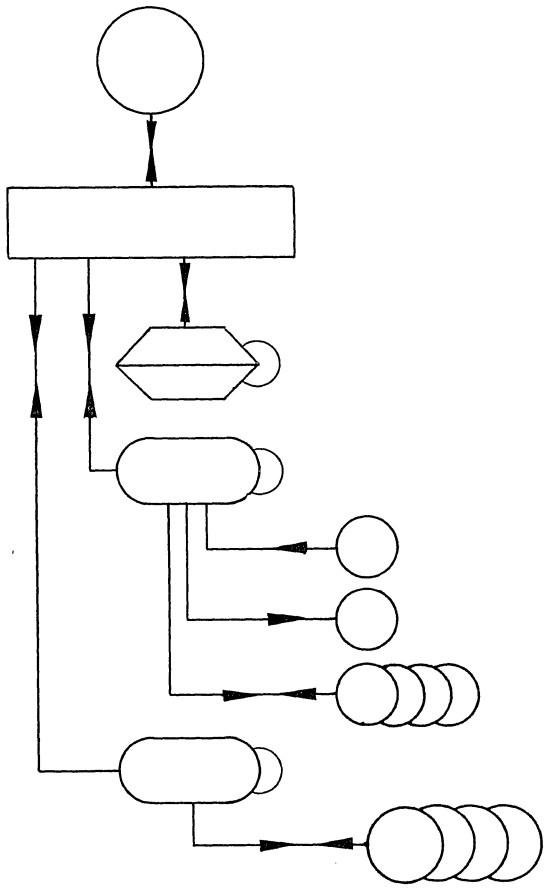
§ 031.

.2 10-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VII B

Main Computer



Equipment	Rental
7302 Core Storage: 32,768 words	$17,500
7606 Multiplexor	3,900
7110 Instruction Processing Unit	16,350
7109 Arithmetic Sequence Unit	8,775
7151 Console Control Unit	1,225
7607 Model 1 Data Channel	4,275
7617 Console	225
711 Card Reader: 250 cards/min.	800
716 Printer: 150 lines/min.	1,200
729 IV Magnetic Tape Units (4): 62,500 char/sec.	3,600
7607 Model 2 Data Channel	3,275
7617 Console	225
729 IV Magnetic Tape Units (4): 62,500 char/sec.	3,600
Power Supplies	1,600
Total Rental:	$66,325

Deviations from Standard Configuration: . . . . . 19,500 words more storage.
printer not required.
card reader 150 cards/min. faster.
no input-output by typewriter.

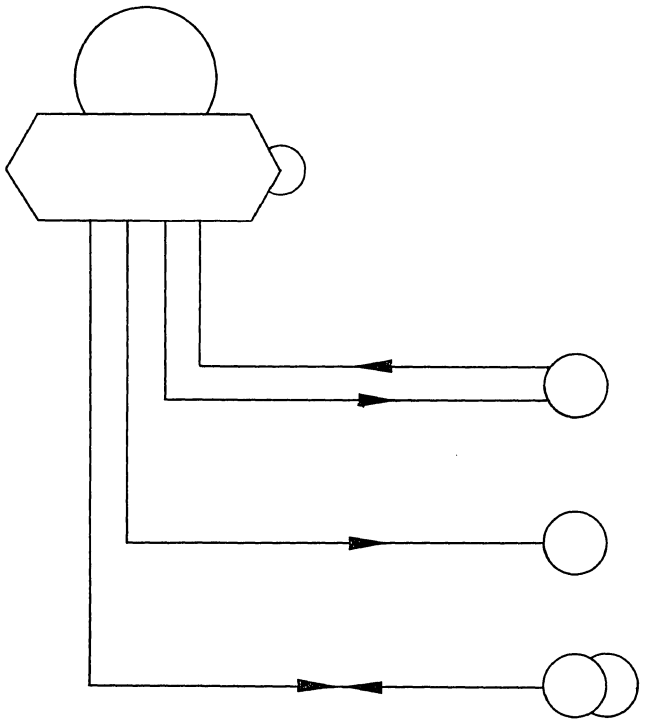
Rental: . . . . . $ 66,325 per month.

Optional Features Included: . . . . . printer (required for operation of card reader).

§ 031.

.2 10-TAPE GENERAL SYSTEM (PAIRED) CONFIGURATION VII B (Contd.)

Auxiliary Computer (IBM 1401)



Equipment	Rental
Core Storage: 4,000 positions	$ - -
Processing Unit: 1401 Model C3 Console	2,680
1402 Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
1403 Printer: 600 lines/min.	835
729 II Magnetic Tape Units (2): 15,000 or 41,667 char/sec.	1,400
Optional Features	605
Total Rental:	$ 6,070

Deviations from Standard Configuration: . . . . . none.

Rental: . . . . . $ 6,070 per month.

Optional Features Included: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Early Card Read.

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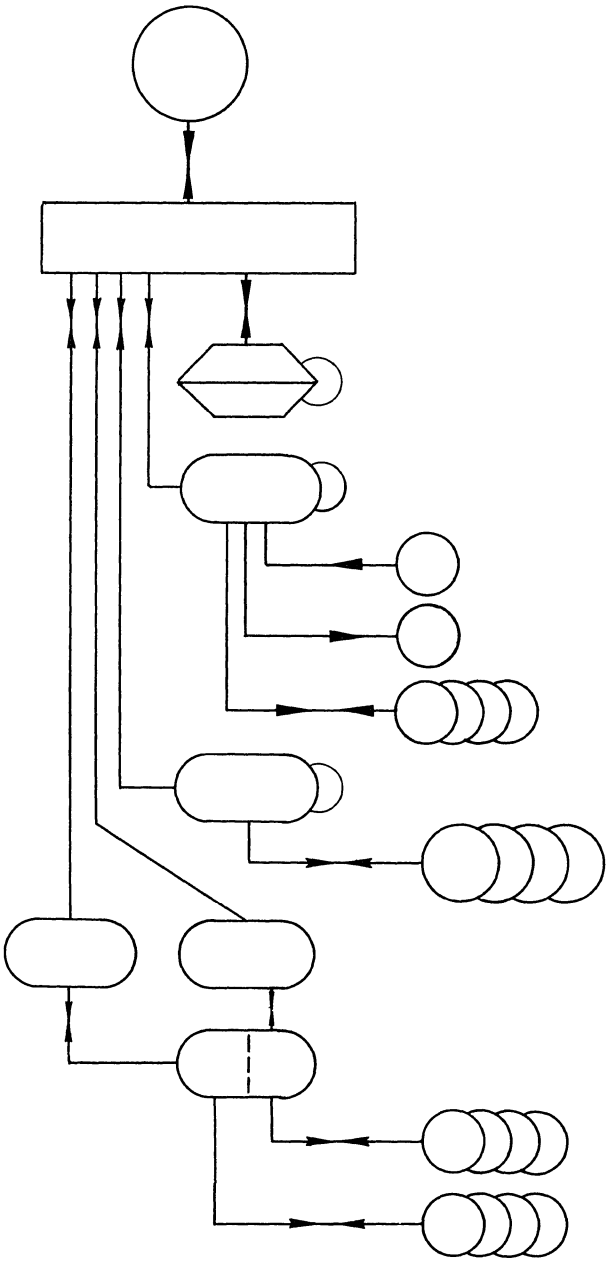
§ 031.

.3 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIII B

Main Computer



Equipment	Rental
7302 Core Storage: 32, 768 words	$17, 500
7606 Multiplexor	3, 900
7110 Instruction Processing Unit	16, 350
7109 Arithmetic Sequence Unit	8, 775
7151 Console Control Unit	1, 225
7607 Model 3 Data Channel	4, 360
7617 Console	225
711 Card Reader: 250 cards/min.	800
716 Printer: 150 lines/min.	1, 200
729 VI Magnetic Tape Units (4): 90, 000 char/sec.	3, 800
7607 Model 4 Data Channel	3, 360
7617 Console	225
729 VI Magnetic Tape Units (4): 90, 000 char/sec.	3, 800
7909 Data Channels (2)	5, 600
7640 Control	3, 400
7340 Hypertape Drives (4): 170, 000 char/sec.	5, 200
7340 Hypertape Drives (4): 170, 000 char/sec.	5, 200
Power Supplies	1, 600
Total Rental	$ 86, 520

Deviations from Standard Configuration: . . . . . 6, 100 words more storage.
printer not required.
card reader 150/cards/min. faster.
3 fewer index registers.
no input-output by typewriter.
8 tapes 30, 000 char/sec. slower.
8 tapes 50, 000 char/sec. faster.

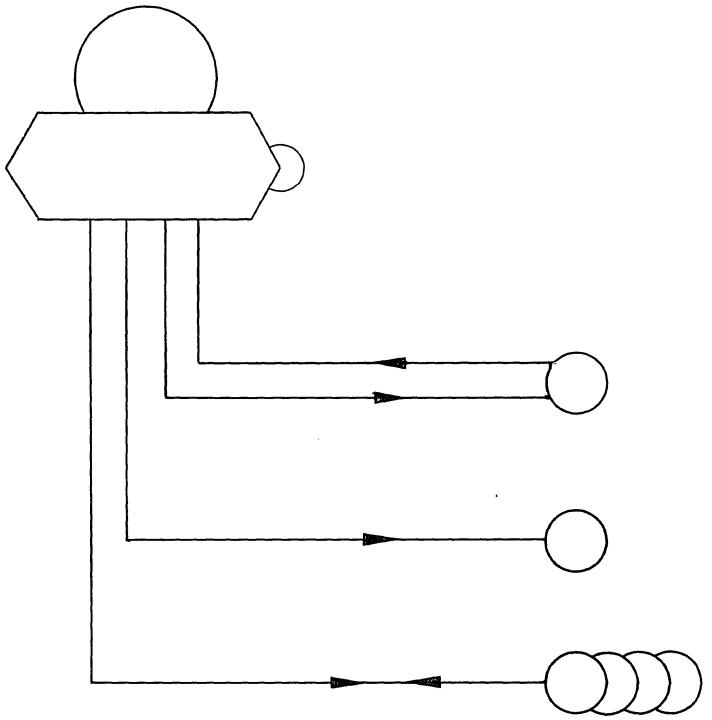
Rental: . . . . . $ 86, 520 per month.

Optional Features Included: . . . . . printer (required for operation of card reader).

§ 031.

.3 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIII B (Contd.)

Auxiliary Computer (IBM 1401)



Equipment	Rental
Core Storage: 8,000 positions	$ 575
Processing Unit: 1401 Model C4 Console	2,730
Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
Printer: 600 lines/min.	835
729 V Magnetic Tape Units (4): 60,000 char/sec.	3,000
Optional Features	855
Total Rental:	$ 8,545

Deviations from Standard Configuration: . . . . . none.

Rental: . . . . . $ 8,545 per month.

Optional Features Included: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Processing Overlap.
Early Card Read.

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INTERNAL STORAGE: 7302 CORE STORAGE

§ 041.

.1 GENERAL

.11 Identity: . . . . . 7302 Core Storage.

.12 Basic Use: . . . . . working storage.

.13 Description

The IBM 7302 storage unit is used with the 7030, 7080, 7090, and 7094 systems. The unit is attached to a 7094 through a 7606 Multiplexor. The 7302 has a capacity of 32, 768 words of 36 bits each. Error or check bits are not used. The unit does, however, contain circuits that may be used for checking or as an aid to servicing.

Data is accessed in the store in 72 data bit groups. In the 7094 system, the Data Channels take two words at a time, and the central processor takes two instructions at a time.

.16 Reserved Storage

Purpose	Number of locations
I/O Control:	6 to 36.
Transfer trapping: . .	3.
Floating point trap: .	2.

.2 PHYSICAL FORM

.21 Storage Medium:. . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter:. . . . 50 mils.
Core bore: . . . . . 30 mils.
Array size:. . . . . 72 bits by 128 bits by 128 bits.
80 inches by 36 inches by 70 inches.

.23 Storage phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . yes.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method:. . . coincident current.
.282 Reading method: . . . . sense wire.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.282 Peak data rates
Cycling rates: . . . . 500, 000 cps.
Unit of data: . . . . . 2 words.
Conversion factor: . . 36 bits/word.
Data rate: . . . . . 36, 000, 000 bits/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage
Identity:	7302.
Words:	32, 768.
Characters:	196, 608.
Instructions:	32, 768.
Modules:	1.

.32 Rules for Combining Modules: . . . . . not permitted.

.4 CONTROLLER

.41 Identity: . . . . . 7606. Multiplexor.

.42 Connection to System

.421 On-line: . . . . . one.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions:. . . . . none.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of stacks: . . . one.

.52 Simultaneous Operations:. . . . . none.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 0.55 μ sec.
Cycle time:. . . . . 2.00 μ sec.
For data unit of: . . . 2 words.

.6 CHANGEABLE STORAGE: . . . . . none.

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.7 PERFORMANCE

.71 Data Transfer

Pair of storage units possible

With Self (Via 7909 Data Channel): . . . . . yes.
With Self (Via 7090 Processor): . . . . . yes.
With Data Channel or Processor: . . . . . yes.

.72 Transfer Load Size

With Self (Via 7909): . . N words.
With Self (Via 7090): . . 2 words.
With Data Channel or Processor: . . . . . 2 words.

.73 Effective Transfer Rate

With Self (Via 7909): . . 4 μ sec per word.
With Self (Via 7090): . . 4 μ sec per 2 words.
With Data Channels or Processor: . . . . . 2 μ sec per 2 words.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	not possible.	
Invalid code:	not possible.	
Receipt of data:	none.	
Recording of data:	none.	
Recovery of data:	none.	
Dispatch of data:	none.	
Timing conflicts:		data is lost, (see 409:111.4).
Reference to locked area:	none	module restricted store size.

CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . Central Processor.
IBM 7094 Models I and II.

IBM 7110, 7111.
Instruction Processing Unit.

IBM 7109.
Arithmetic Sequencing Unit.

.12 Description

The 7094 Central Processor is upwards compatible with the 7090 Central Processor. Its major differences are:

- There are two modes of indexing, with 7 index registers or with 3 index registers (7090 compatible); they are chosen by the use of special instructions.
- Operations are included to transfer complements from index registers.
- New operations are included to transfer double words between the accumulator and core storage.
- Double length floating point operations are provided. Double length operands have an exponent in each part; they must start in even addresses or else a "trap" interrupt occurs when referenced.
- Access to instructions in odd locations can be effectively zero due to double word access, but not for double length operations. (This applies to the 7094 Model I only.)
- Many instruction times have been reduced. Fixed point addition is little altered; multiplication, division and floating point are approximately halved; while the new double length floating point operations are about the same as single precision on the 7090.

7094 Model II

The recently announced 7094 Model II is completely program-compatible with the 7094 Model I. Core storage cycle time has been reduced from 2.0 microseconds to 1.4 microseconds, and the number of cycles required to perform several operations has also been reduced.

The 7094 Model II core storage has been effectively divided into two separate banks (odd and even). This permits the instruction access time, for most instructions in a sequence, to be overlapped with the execution time of the preceding instruction, thereby reducing the total number of cycles required for the

.12 Description (Contd.)

instruction. The maximum amount of time that could be saved through this feature would be all of the instruction access time required for a string of instructions; however, this could only be realized if each referenced operand were in the same bank as the instruction referencing it. Since such an arrangement is almost impossible to achieve, it has been estimated that an average of 40% of the instruction access time will be eliminated by the overlap feature.

To show the overall increase in central processor speed resulting from the decreased cycle time, the reduced number of cycles for certain operations, and the instruction time overlap, a sample problem was run by the manufacturer on the 7094 Model I and Model II. The Model II increased the throughput by a factor of 1.94. The sample problem had 22% of the instructions indexed and had the following distribution of instructions:

38% load and store
13% fixed point arithmetic
15% floating point arithmetic
21% branches
13% other instructions.

Specific comparisons of the internal speeds of the 7094 Model I and Model II are presented in Paragraphs .41 and .42 of this report section.

An existing 7094 Model I system can be field converted to a Model II system in 96 hours with a $6,000 monthly rental increase. An IBM 7090 system can be field converted to a 7094 Model II system in 108 to 120 hours with a $12,000 monthly rental increase.

For a general description see Section 408:051.12 on the 7090 Central Processor.

.13 Availability: . . . . . ?

.14 First Delivery: . . . . October, 1962; field conversion of 7090.

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
211	Fixed point			
	Add-subtract:	automatic	binary	35 bits & sign.
	Multiply			
	Short:	automatic	binary	0 to 35 bits & sign.
	Long:	automatic	binary	35 bits & sign.
	Divide			
	Remainder:	automatic	binary	35 bits & sign.

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.212 Floating point

			Fraction	Characteristic
Add-subtract: ‡	automatic	binary	27 or 54 bits & sign	8 bits.
Multiply: ‡	automatic	binary	27 or 54 bits & sign	8 bits.
Divide: ‡	automatic	binary	27 or 54 bits & sign	8 bits.

‡ Both normalized and unnormalized.

.213 Boolean

AND:	automatic	binary	36 bits.
Inclusive OR:	automatic	binary	36 bits.
Exclusive OR:	automatic	binary	36 bits.
NOT:	automatic	binary	37 bits.

.214 Comparison

Numbers:	automatic	36 bits.
Absolute:	automatic	36 bits.
Letters:	automatic	36 bits.
Mixed:	automatic	36 bits.

.215 Code translation

Provision	From	To	Size
†	any code	any code	six 6-bit char.
Standard subroutine	card image	BCD	36 bits or 6 char.
Standard subroutine	6-bit BCD	card image	36 bits or 6 char.

† Special tables are specified to be used with convert instructions.

.216 Radix conversion

automatic	6-bit BCD	any radix	20 bits.
standard subroutine	any radix	6-bit BCD	36 bits or 6 chars.

† Special tables are specified to be used with convert instructions.

.217 Edit format

	Provision	Comment	Size
Suppress Zero:	semi-automatic	separate sequences using convert instructions and/or logical instructions with appriate tables.	six 6-bit characters.
Round off:	semi-automatic		
Insert point:	semi-automatic		
Insert spaces:	semi-automatic		
Insert character:	semi-automatic		
Float character:	semi-automatic		
Protection:	semi-automatic		

.218 Table look-up: . . . . . none.

.219 Others
Test: . . . . . 1 to 36 bits.

.22 Special Cases of Operands

.221 Negative numbers: . . . binary magnitude and sign.

.222 Zero: . . . . . + or -; may or may not be equal, depends on instructions.

.223 Operand size determination: . . . . 36, 18, 15, 3 or 1 bits; variable 0 to 36 bits in multiply and divide, and also six 6-bit characters.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout

Part	Operations	Flag/Count	Tag	Address
Size (bits)	12	6	3	15

Part	Operation	Flag	Not Used*	Tag	Address
Size (bits)	3	2	4	3	15

Part	Operation	Decrement	Tag	Address
Size (bits)	3	15	3	15

* Not used for most instructions.

.233 Instruction parts

Name	Purpose
Operation:	operation code.
Flag:	indirect addressing specification.
Tag:	index register specification.
Address:	operand address.
Count:	variable length operands and counts.

.234 Basic address structure: 1 address (sequential).

.235 Literals

Arithmetic:	none.
Comparisons and tests:	none.
Incrementing modifiers:	0 to 32,767.
Setting modifiers: . .	0 to 32,767.

.236 Directly addressed operands

.2361 Internal storage

	Minimum size	Maximum size	Volume accessible
Core Storage:	3 bits	entire storage †	entire storage.
Magnetic Disc:	1 word	entire storage ‡	entire storage.

‡ only 2790 unless RC Disc option is included.
† only two words unless 7909 Data Channel included.

.2362 Increased address capacity: . . . . . none.

.237 Address indexing

.2371 Number of methods: . 1.

.2372 Names: . . . . . indexing (can be multiple indexes).

.2373 Indexing rule: . . . . . the contents of the indicated index registers are ORed together then subtracted from the address of the instruction to form the effective address.

.2374 Index specification: . . each of the index bits specifies an index register.

.2375 Number of potential indexers: . . . . . 3.

.2376 Addresses which can be indexed:

Type of address	Application
After ESNT instruction: . . .	0 to 16,383.
After LSNT instruction, normal condition:	0 to 32,767.

.2377 Cumulative indexing: . via indirect addressing and EXC instruction.

§ 051.

.2378 Combined index and step: . . . . . yes.

	IA bits	EXC instructions
.238 Indirect addressing		
.2381 Recursive:	no	yes.
.2382 Designation:	2 bits in the instruction.	operation code EXC with or without IA bits.
.2383 Control:	automatic, one level only.	n level, will not stop until another instruction is encountered.

.2384 Indexing with indirect addressing: yes; possible before and after going to the indrect address.

.239 Stepping: . . . . . index registers.

.2391 Specification of increment: . . . . . in stepping instruction.

.2392 Increment sign: . . . . positive.

.2393 Size of increment: . . 0 to 32, 767.

.2394 End value: . . . . . value of increment.

.2395 Combined step and test: . . . . . yes.

.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in bits	Program usage
Accumulator:	1	38	arithmetic unit.
Multiplier-Quotient:	1	36	arithmetic unit & input-output.
Index:	3	15	address modification.
Program counter:	1	15	specified instruction address.
Sense lights:	4	1	save condition.
Sense switches:	6	1	accept condition.
Storage register:	1	36	buffer with store.
Instructions:	1	18	shift counter, holds instruction.
Indicator:	1	36	save condition.
7151 Console Keys:	1	36	enter data.

.242 Category of storage	Total number of locations	Physical form	Access time, μsec	Cycle time, μsec Model I	Cycle time, μsec Model II
Accumulator:	1	register	0.33	2	1.4.
Multiplier-Quotient:	1	register	0.33	2	1.4.
Index:	3	register	0.33	2	1.4.
Program counter:	1	register	0.33	2	1.4.
Sense lights:	4	flip-flops	0.33	2	1.4.
Sense switches:	6	switch	1.32	-	-
Storage register:	1	register	0.33	2	1.4.
Instruction:	1	register	-	-	-
Indicator:	1	register	0.33	2	1.4.
7151 Console Keys:	1	36 switches	1.32		

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1 sequential.

.314 Special sub-sequence counters
Number: . . . . . 1.
Purpose: . . . . . counts shifts (not accessible by program).

.315 Sequence control step size: . . . . . 1 word.

.316 Accessibility to routines: . . . . . change, save in index, or store.

.317 Permanent or optional modifier: . . . . . none.

.32 Look-Ahead: . . . . . one instruction (40 to 45 per cent of the time is average).

.33 Interruption

.331 Possible causes
In-out units: . . . . . external signal.
tape error.
end-of-file.
704 I/O instruction in copy trap mode.
direct data.
In-out controllers: . . when free.
Storage access: . . . none.
Processor errors: . . floating point underflow; overflow in floating trap mode.
Other: . . . . . on encountering transfer of control instruction while in trapping mode.

.332 Control by routine
Individual control: . . for I/O mask and instruction.
Method: . . . . . request by instruction.
Restriction: . . . . . external signal trap is always active and may cause timing conflicts.
some interrupts use common locations.

.333 Operator control: . . . can clear or set traps manually.

334 Interruption conditions: only when specifically requested (floating point trap mode is normally on).
high to low classes of interrupts; floating point, direct data, external signal, data channel.

.335 Interruption process
Disabling interruption: first interrupt in any class disables all interrupts except higher classes.
Registers saved: . . . program counter.
Destination: . . . . . fixed location, depends on cause.

.336 Control methods
Determine cause: . . indication stored in a particular location.
Enable interruption: . instruction.

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.34 Multi-running

.341 Method of control:	own coding.
.342 Maximum number of programs:	own coding.
.343 Precedence rules:	own coding.
.344 Program protection	
Storage:	words 0 to 16,383 can be used, with words 16,384 to 32,767 unavailable by ESNT instruction.
In-out units:	own coding.
Maximum separate sets:	own coding.

.35 Multi-sequencing: . . . see paragraph .344.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec

411 Fixed point

Model I	
Add-subtract:	4
Multiply:	4 to 10 (10 avg.)
Divide:	6 to 16 (16 avg.)
Model II	
Add-subtract:	2.8
Multiply:	2.8 to 5.6 (5.6 avg.)
Divide:	4.2 to 8.4 (8.4 avg.)

.412 Floating point

Model I	Single Precision	Double Precision
Add-subtract:	4 to 24 (6 avg.)	4 to 26 (8 avg.)
Multiply:	4 to 10 (10 avg.)	4 to 22 (22 avg.)
Divide:	6 to 18 (18 avg.)	6 to 38 (38 avg.)
Model II		
Add-subtract:	2.8 to 16.8 (4.2 avg.)	2.8 to 17.2 (5.6 avg.)
Multiply:	2.8 to 5.6 (5.6 avg.)	2.8 to 12.6 (12.6 avg.)
Divide:	2.8 to 8.4 (8.4 avg.)	2.8 to 18.2 (18.2 avg.)

.413 Additional allowance for

	Model I	Model II
Indexing:	none	none.
Indirect addressing:	2	1.4.
Re-complementing:	none	none.
.414 Control		
Compare:	4	2.8
Branch:	2	1.4
Compare and branch:	4	2.8
.415 Counter control		
Step:	2	1.4
Step and test:	2	1.4
Test:	2	1.4
.416 Edit:	none	none.
.417 Convert:	4 to 16 (16 avg.)	2.8 to 11.2 (11.2 avg.)
.418 Shift:	1 to 7	1.4 to 4.9

.42 Processor Performance in μsec

.421 For random addresses

	Fixed point	Floating point Single precision	Floating point Double precision
Model I			
c = a + b:	10	12	18
b = a + b:	10	12	18
Sum N items:	3N	5N	9N
c = ab:	16	16	32
c = a/b:	20	22	48
Model II			
c = a + b:	7.0	8.4	12.6
b = a + b:	7.0	8.4	12.6
Sum N items:	2.1N	3.5N	6.3N
c = ab:	9.8	11.2	19.6
c = a/b:	14.0	14.0	25.2

.422 For arrays of data

Model I			
$c_i = a_i + b_j$:	12	14	22
$b_j = a_i + b_j$:	12	14	22
Sum N items:	6N	6N	10N
$c = c + a_i b_j$:	24	24	56
Model II			
$c_i = a_i + b_j$:	9.8	11.2	15.4
$b_j = a_i + b_j$:	9.8	11.2	15.4
Sum N items:	4.2N	4.2N	7N
$c = c + a_i b_j$:	14.0	16.8	28.0

.423 Branch based on comparison

	Model I	Model II
Numeric data:	7N	4.9N
Alphabetic data:	7N	4.9N

.424 Switching

Unchecked:	4	2.8
Checked:	6	4.2
List search:	6N	4.2N

.425 Format control per character

	Model I	Model II
Unpack card image to BCD:	7.1	9.7
BCD to binary	8.3	5.8
Compose (without radix conversion):	6.0	4.2

.426 Table look up per comparison

	Model I	Model II
For a match:	12(N + 1)	8.4(N + 1)
For least or greatest:	12(N + 1)	8.4(N + 1)
For interpolation point:	12(N + 1)	8.4(N + 1)

.427 Bit indicators

	Model I	Model II
Set bit in separate location:	2	1.4
Set bit in pattern:	2	1.4
Test bit in separate location:	2	1.4
Test bit in pattern:	4	2.8
Test AND for B bits:	4	2.8
Test OR for B bits:	4	2.8

.428 Moving, N words

Using XMT (Via 7909 Data Channel):	6 + 2N	4.2 + 1.4N
Using 4 instructions:	2 + 5N	1.4 + 3.5N
Using 2N instructions:	4N	2.8N

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.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	sets indicator.
Underflow (float-pt):	check	sets indicator.
Zero divisor:	check	sets indicator and/or stops processor.
Invalid data:	not possible.	
Invalid operation:	none	attempts operation.
Arithmetic error:	none.	
Invalid address:	check	modulo memory size.
Receipt of data:	none.	
Dispatch of data:	none.	

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INPUT-OUTPUT: 729 MAGNETIC TAPE UNITS

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit 729 II, IV, V, VI.

.12 Description

These tape units are used in the IBM 1401, 1410, 7040, 7070 and 7080 series systems as well as in the 709, 7090 and 7094. They use a standard reel and half-inch tape compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are summarized in the following table:

Model	Tape speed, inches/sec	Density char/inch	Peak transfer rate, char/sec
II	75	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

The only differences between the use of these units on the IBM 7090 and 7094 is in the demands made on the storage and simultaneous limitations. See paragraph 409:091.63 and 409:111.4.

Up to ten tape units may be connected to each 7607 Data Channel in a 7094 system. Tape operations may be performed parallel with internal processing; however, in normal operation, tapes attached to a single channel cannot be involved in simultaneous data transmission. Any number of non-data transmitting operations may occur simultaneously. It is usually economical to use the highest density of a given model in order to achieve the maximum transmission rates; however, compatibility with other machines (such as the 704) may dictate the occasional use of lower density settings.

The 7094 input-output command system permits scatter read and gather write capabilities as well as selection or deletion of recorded information. Efficient use of the command system requires a fairly sophisticated level of programming, but the time-sharing of input-output and elementary scatter or gather coding is understood by most programmers and results in a considerable saving on large volume input-output tasks.

.12 Description (Contd.)

In most installations, the 7094 system uses magnetic tape as the primary input-output mode. A smaller computer such as the 1401 is usually used to transcribe information from cards to tape, tape to printer, etc. Usually some formatting is performed by this smaller computer. Normal library and system routines are also held on tape, and one tape station (channel A, Tape 1) is reserved for a system tape.

.13 Availability: . . . . 12 to 15 months.

.14 First Delivery

729 II: . . . . . November, 1959.
729 IV: . . . . . November, 1959.
729 V: . . . . . May, 1962.
729 VI: . . . . . May, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . about 7 feet.
.213 Feed drive: . . . . motor.
.214 Take-up drive: . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . magnetic head.
.222 Sensing system: . . magnetic head.
.223 Common system: . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . multiple copies may be obtained by dialing two or more tapes on a given channel to the same number. This procedure is not recommended.

.24 Arrangement of Heads

Use of station: . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . 7.
Method of use: . . . 1 row at a time.
Use of station: . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . 7.
Method of use: . . . 1 row at a time.

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.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or (models V and VI) 800 rows per inch (see 409:091.431).
.322 Parallel by: . . . . 7 tracks.
.324 Track use
Data: . . . . . 6.
Redundancy check: . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . 1.
Timing: . . . . . 0.
Control signals: . . 0 (record and segment marks are optional).
Unused: . . . . . gaps.
Inter-block gap: . . 0.75 inch.
Inter-file gap: . . 3.75 inch.
Erased gap (to skip flaw area): . . . 5.75 inch.

.33 Coding: . . . . . column binary as in core with odd parity redundancy check.
binary coded decimal (BCD) as in Data Table No. 4 with even parity check.

.34 Format Compatibility

Other device or system	Code translation
727:	matched, low recording density only.
7330:	matched, low recording density only.

.35 Physical Dimensions

.351 Overall width: . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.
Leader: . . . . . 25 feet.
Trailer: . . . . . 25 feet.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel.
7607, Models 1, 2, 3, 4. (Modified)

.42 Connection to System

.421 On-line: . . . . . up to 8 data channels with a maximum of ten tape drives each, (see 409:101.12).
.422 Off-line:
Associated equipment: may be switched to another channel, another computer, or an off-line auxiliary unit either manually or by means of the optional 7830 switching feature and 7155 Switch Control Console.

.43 Connection to Device

.431 Devices per controller
Model 1: . . . . . ten 729 II/IV, one each 711, 716, 712.
Model 2: . . . . . ten 729 II/IV/V/VI, one each 711, 716, 712.
Model 3: . . . . . ten 729 II/IV.
Model 4: . . . . . ten 729 II/IV/V/VI.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N words.
.442 Input-Output areas: . core storage.
.443 Input-Output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . yes; scatter read and gather write, controlled by channel commands.
.446 Synchronization: . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . 1 to N words in block.
1 to N blocks in files.
.512 Block demarcation
Input: . . . . . 0.75 inch inter-record gap.
3.75 inch inter-file gap.
Output: . . . . . 0.75 inch end of transmission.
3.75 inch written by instruction.

.52 Input-Output Operations

.521 Input: . . . . . forward only.
read until either N words or end-of-record or read N words skipping over end-of-record gaps.
end-of-file gap always terminates reading.
.522 Output: . . . . . write N words followed by end-of-record.
erase gap.
write end-of-file gap.
.523 Stepping: . . . . . non-transmit channel commands used to skip N words during reading.
.524 Skipping: . . . . . one block backward.
one block forward.
one file backward.
.525 Marking: . . . . . inter block or inter file gap.
.526 Searching: . . . . none.

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.53 Code Translation: code (binary or BCD) selected by program; translations are automatic.

.54 Format Control

Control:	program.
Format alternatives:	densities (2 or 3)
Rearrangement:	no.
Suppress zeros:	no.
Insert point:	no.
Insert spaces:	no.
Recording density:	yes.
Section sizes:	yes.

.55 Control Operations

Disable:	yes.
Request interrupt:	yes.
Select format:	no.
Select code:	yes.
Rewind:	yes.
Unload:	yes.

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Output lock:	yes.
Nearly exhausted:	yes (25 feet).
Busy controller:	yes.
End of medium marks:	no.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed

Model II:	15,000 or 41,667 char/sec.
Model IV:	22,500 or 62,500 char/sec.
Model V:	15,000, 41,667, or 60,000 char/sec.
Model VI:	22,500, 62,500, or 90,000 char/sec.

.622 Important parameters

Name	Models II	IV	V	VI
Density (char/inch):	200 or 566		200, 556, or 800	
Tape speed inches/sec):	75.	112.5	75.	112.5
Start time (msec)				
read:	10.5	6.7	10.5	6.7
write:	7.5	5.0	7.5	5.0
Stop time (msec)				
read:	2.1	2.1	2.1	2.1
write:	5.1	3.8	5.1	3.8
Full rewind time (min):	1.2	0.9	1.2	0.9
Gaps block (inches):	0.75	0.75	0.75	0.75
Gaps file (inches):	3.75	3.75	3.75	3.75

.623 Overhead

Gap crossing time (msec):	Model II and IV	V and VI
Block:	10.	6.67.
File:	50.	33.33.

.624 Effective speeds

Models II and V

200 char/inch: $\frac{15,000N}{N+150}$ char/sec.

556 char/inch: $\frac{41,667N}{N+417}$ char/sec.

Models IV and VI

200 char/inch: $\frac{22,500N}{N+150}$ char/sec.

556 char/inch: $\frac{62,500N}{N+417}$ char/

Model V

800 char/inch: $\frac{60,000N}{N+600}$ char/sec.

Model VI

800 char/inch: $\frac{90,000N}{N+600}$ char/sec.

.63 Demands on System

Component	Condition	msec per word	Average Percentage
Core storage:	15.0 KC tape	$0.002(0.5+A+C)$	0.178
	22.5 KC tape		0.222
	41.7 KC tape		0.400
	60.0 KC tape		0.556
	62.5 KC tape		0.600
	90.0 KC tape		0.849

Note: A = number of indirect addresses per word transferred (avg 0)
C = number of channel commands per word transferred (small)

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.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (models V and VI only), (see 409:101.12), 200/556, 556/800, 200/800.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	button	lowers tape into reservoirs and rewinds tape to load point.
Unload:	button	removes tape from reservoirs and raises upper portion of head assembly.
File protection:	ring on reel	ring permits writing.

.73 Loading and Unloading

.731 Volume handled

One reel		Density		
Words/record	Records/file	200	556	800
167 (about 1,000 char)	1	751,000 words	1,843,000 words	2,350,000 words.
20	20	384,000 words	498,000 words	548,400 words.
40	20	548,000 words	872,000 words	960,000 words.
20	50	408,000 words	542,000 words	600,000 words.
40	50	572,000 words	926,000 words	1,036,000 words.

Note: 1 word = 6 char.

.732 Replenishment time: . . . . . 1.0 to 1.5 mins. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . 6 min.
Models IV & VI: . . 4 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	not possible.	
Output block size:	not possible.	
Invalid code:	yes	see reading.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	yes	halts tape drive.
Timing conflicts:	interlock	stalls processor.
Recording level:	dual level signal strength check	indicator & alarm.

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INPUT-OUTPUT: HYPERTAPE

§ 092.

.1 GENERAL

.11 Identity: . . . . . Hypertape drive. 7340.

.12 Description

The IBM 7340 Hypertape drive is available for use with the 7074, 7080, 7090 and 7094 systems.

The only difference in the use of these units in the IBM 7094 from their use in the 7090 is in the demands on the storage and simultaneous operations. See paragraphs 409:091.63 and 409:111.4.

Up to 170,000 characters per second may be written on or read from the one-inch wide, 1,800-foot tape, of which 1,750 feet is usable. The effective speed for 1,000 character blocks is 100,000 characters per second. The 7094 may record data on eight of the ten tape tracks at a density of 1,511 characters per inch. Two of the eight used tracks contain codes which automatically correct all single and most double-bit errors. The tape may be read forward or backward (optional feature) at a rate of 112.5 inches per second. Because of a short (0.45 inch) interblock gap, average access time to a block is 4.2 milliseconds compared to 7.3 milliseconds for the 729 IV or VI. Rewinding speed is 225 inches per second but tapes may be dismounted without rewinding.

The Hypertape contains three reflective strips instead of the usual two. Two of these, beginning-of-tape and end-of-tape occur on other IBM tapes; however, it is not possible to cause the Hypertape to move beyond these marks. A third spot, called the end-of-tape warning, occurs 40 feet before the end-of-tape and may be sensed by the 7094 program in either read or write mode.

Another feature of the 7340 which differs from other IBM units is the setting, by program, of a file protect condition. Program removal of file protection is not possible and may only be accomplished with the tape cartridge removed from the unit.

Only tape cartridges can be used with the Hypertape drive. Supply and take-up reels holding 1,800 feet of tape are enclosed in a sealed cartridge that measures about 17 by 10 by 2 inches and weighs about 8 pounds. The operator loads a reel of tape by raising the top cover, sliding the cartridge into place, lowering the cover, and depressing the load-unload button. After the tape reels engage the drive mechanism, the tape is then automatically positioned for use. Unloading is accomplished by reversing the procedure.

.12 Description (Cont'd)

The automatic Cartridge Loader feature can operate under program control. It accommodates one cartridge. When the change tape command is given, the tape cartridge being used is unloaded to a discharge station, then the waiting cartridge is loaded. The operation requires about 30 seconds. This feature helps eliminate operator set-up delays, especially when using an automatic run-scheduling program.

Whenever a tape is rewound, unloaded, or the drive is not ready for use, an "attention indicator" is set. This indicator is program testable (as are many other conditions, e.g., beginning or end of tape). Indicators on each drive can be lit by the program to inform the operator. These are Reserved, Change Cartridge (set automatically after any unload command), File Protect, and the Check light, which is used to call the operator's attention and not to signal hardware errors automatically.

Hypertape drives can be connected to a 7094 through a 7640 Hypertape Control, which is connected to two 7909 Data Channels (or if Data Channel Switches are used, any two switch legs) and thence to the 7606 multiplexer. The 7640 has two separate channels which can each accommodate 10 Hypertape drives. If each 7640 channel is connected to a 7909 Data Channel, it can read tape on one channel and write tape on the other channel. However, read-read or write-write operations are not possible because the 7640 has only one set each of read and write equipment.

Optional Feature

Automatic Cartridge Loader: Reduces time lost during tape changes by automatically unloading one Hypertape cartridge and loading another under manual or program control. Maximum time for a complete unload and load cycle is 30 seconds. The loader is mounted on top of the Hypertape Drive.

Optional features on the 7909 Data Channel (see 408:102) can be provided to enable the use of backward reading, and conversion of 6-bit BCD code.

.14 First Delivery: . . . . 1963.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . non-coated surface of tape is held against single capstan by vacuum action of reservoirs.

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.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum columns.
Capacity: . . . . . about 4 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . two-gap heads provides read-after-write checking.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 10.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 10.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 1,511 rows per inch.
.322 Parallel by: . . . . . 10 tracks.
.323 Bands: . . . . . 1.
.324 Track use
Data: . . . . . 6.
Redundancy check: . . 2.
Timing: . . . . . 0 (self clocking).
Control signals: . . . 0.
Unused: . . . . . 2.
Total: . . . . . 10.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 0.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 0.
Gap: . . . . . 0.45 inch.
Tape mark: . . . . . 3.75 inches.

.33 Coding: . . . . . Binary 6 bit/row as in core.
BCD 6 bit/row as in Data Code Table No. 4 (optional).
Only with Hypertape drives on other IBM 7074, 7080, 7090 and 7094 systems.

.35 Physical Dimensions

.351 Overall width: . . . . . 1.0 inch.
.352 Length: . . . . . 1,800 feet per cartridge.
.353 Maximum margins
Left: . . . . . 25 feet.
Right: . . . . . 25 feet.

.4 CONTROLLER

.41 Identity: . . . . . Hypertape Control. 7640.

.42 Connection to System

.421 On-line: . . . . . one 7640 (containing two tape channels) connected to two 7909s (or two #3224 Data Channel Switches, on one or two 7909 Data Channels) and connected to 7606.
Note: 7909 requires special option to read backwards on Hypertapes.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 20; up to 10 to each 7909 Channel or 3224 Switch.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N words.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . yes, scatter-read and gather-write, with separate channel commands for each field of data (see 408:109).
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to N words.
.512 Block demarcation: . . gap on tape write command.

.52 Input-Output Operations

.521 Input: . . . . . read one block forward or (optional; see 408:109.12) backward into core storage area(s) specified by one or more channel read commands.
.522 Output: . . . . . write one block forward from core storage area(s) specified by one or more channel write commands.

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.523 Stepping: . . . . . step one block forward or backward.
step forward or backward to end-of-file mark.
erase 8 inches (to step over defective tape areas).

.524 Skipping: . . . . . skip N words or records when reading.

.525 Marking: . . . . . inter-block gap.
end-of-file gap.

.526 Searching: . . . . . none.

.53 Code Translation: . . . matched.
automatic with optional BCD feature.

.54 Format Control

Control: . . . . . program.
Format alternatives: . two.
Rearrangement: . . . . yes; scatter-read and gather-write.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes, priority signal.
Select format: . . . . . no.
Select code: . . . . . binary or optional BCD.
Rewind: . . . . . yes.
Unload: . . . . . yes.
Enter file protect status: . . . . . yes.
Change Cartridge: . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . yes.
Nearly exhausted: . . . yes, 40 feet from end-of-tape mark.
Busy controller: . . . . yes.
Beginning of tape mark: yes.
End of tape mark: . . . yes.
Not ready: . . . . . yes.
Not loaded: . . . . . yes.
Correction occurred: . yes.
Uncorrected error: . . yes.
Code check: . . . . . yes.
Write failure: . . . . . yes.
Timing error: . . . . . yes.
Forward or backward: . yes.
Attention required: . . yes.
File protection on: . . . yes.

.62 Speeds

.621 Nominal or peak speed: 170, 000 char/sec.
.622 Important parameters
Recording density: . . 1, 511 rows/inch.
Tape speed: . . . . . 112.5 inches/sec.
Start time: . . . . . 3.0 m.sec maximum.
Stop time: . . . . . 3.0 m.sec maximum.
Full rewind time: . . 1.5 minutes.
Rewind speed: . . . . 225 inches/sec.
Inter-block gap: . . . 0.45 inches/sec.
Tape mark: . . . . . 3.75 inches.

.623 Overhead: . . . . . 4.3 m.sec/block.
.624 Effective speeds: . . . 170, 000N/(N + 714).

.63 Demands on System

Component: . . . . . core storage.
Condition: . . . . . reading or writing.
m.sec per word: . . . . 0.002(0.5 + C + A).
Percentage: . . . . . 5.8 (1 + C + A); (see also 408:111.4).
A: . . . . . number of indirect addresses per word transferred.
C: . . . . . number of commands obeyed in Data Channel per word transferred.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0 through 9.
Start key:	button	makes unit available to computer.
Stop key:	button	removes unit from computer control; stops any operation in progress.
Load-unload button:	button	loads if cartridge in unload status.
Rewind:	button	indicates rewind if tape not in ready (available to computer).

.73 Loading and Unloading

.731 Volumes handled
Storage Capacity
Cartridge: . . . . . 1, 800 feet; for 1, 000 row blocks, 14, 000, 000 characters.
.732 Replenishment time: . . 0.5 to 1.5 min.
tape drive needs to be stopped; however, if cartridge loader is employed, tapes can be placed in loader at any time and changed under program control.
.734 Optimum reloading period: . . . . . 3.1 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	read-after-write dual row parity	indicator.
Reading:	dual-row parity	indicator-error corrected if possible.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	check	indicator.
Exhausted medium:	reflective spots	indicator, inhibit movement passed mark.
Imperfect medium:	check	indicator.
Timing conflicts:	disconnect	indicator.
Excessive skew:	check	indicator.
Circuit failure:	check	indicator.

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INPUT-OUTPUT: 7607 DATA CHANNEL

§ 101.

.1 GENERAL

.11 Identity: . . . . . Data Channel.
7607.
Models 1, 2, 3, and 4.
7617 Data Channel Console.

.12 Description

The 7607 unit provides an independently operating data channel to the core storage for all models of 729 units in any mixture, the 711 Card Reader, 721 Card Punch, and 716 Printer.

The differences in use from the 7090 are the use of 72 bit, two word, transfers to the storage. Data is transferred to core storage in 72 or 36-bit word units as necessary. One access cycle is required for each two words transferred, each instruction selected, and for each indirect address in an instruction. A maximum of three accesses may be required for one word. These parameters affect the actual demands on the core storage. The maximum values affect the safe number of simultaneous transfers (see 409:111.43).

There are four models. They differ in the units that they may control, and the number that may be connected to a system.

Model 1: Up to ten 729 (II or IV), one 711, one 721, one 716.
3: Up to ten 729 (II, IV, V, or VI), one 711, one 721, one 716.
2: Up to ten 729 (II or IV).
4: Up to ten 729 (II, IV, V, or VI).

Models 3 and 4 have a Tape Densities Option Switch to select any one of these density pairs: 200/556, 200/800, or 556/800 characters per inch. The program may choose "high" or "low" density.

Each 7607 has a special 7617 console, which can be used to control the Data Channel and associated units, but not transfers with the core storage.

Every 7090 must have one 7607 model 1 or 3 with both a 711 Card Reader and a 716 Printer. A 721 Card Punch is optional.

There may be a maximum of eight 7607 units in a configuration, but this is substantially restricted when any 7909 are used. A table showing the joint maximum possibilities is in 409:111.41.

.12 Description (Cont'd)

Each Data Channel behaves as a separate control unit in selecting and executing instructions. The Central Processor may execute instructions (see 409:121) to:

- Start in motion a selected unit on a specific channel.
- Start the control unit by specifying the location of the first Data Channel instruction.
- Specify a new location from which the next Data Channel instruction is to be taken, ignoring the remainder of the current sequence.
- Copy the current contents of the Data Channel control registers into core storage without affecting channel operation, including instruction location, word counter, operation control bits.
- Backspace, rewind, unload, set density, or write control marks.

The individual Data Channels may execute instructions (called commands by IBM) (see 409:121) to:

- Copy data controlled by counters or block delimiters.
- Change sequence.
- Disconnect, i.e. execute no more instructions until directed by the Central Processor.
- Sense for control, access, and error indicators.

The individual adapters and controllers for peripheral units can sometimes execute instructions (called orders by IBM).

A Data Channel has a large degree of autonomy and its own sequence of instructions can be interrupted by control and error conditions. The interrupts can be inhibited if required.

Data is transferred between all Data Channels 7909 or 7607 and core storage via the 7606 Multiplexer. The Multiplexer shares the access of all devices to the core storage on a priority basis. To ensure maximum simultaneous operation with no access in conflicts, the Data Channels are connected in the sequence of their peak demands (see 409:111.43).

.13 Availability: . . . . . ?

.14 First Delivery: . . . . November, 1959.

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INPUT-OUTPUT: 7909 DATA CHANNEL

§ 102.

.1 GENERAL

.11 Identity: . . . . . Data Channel. 7909.

.12 Description

The 7909 unit provides an independently operating data channel to the core storage for such units as Hypertape Drives, 1301 Disk Storages, and TELEPROCESSING units.

The differences in use from the 7090 are the use of 72 bit, 2 word, transfers. Data is transferred to core storage in 72 or 36-bit word units as necessary. One access cycle is required for each 2 words transferred, each instruction selected, and for each indirect address in an instruction. A maximum of three accesses may be required for one word. These parameters affect the actual demands on the core storage. The maximum values affect the safe number of simultaneous transfers (see 409:111.43).

A maximum of four 7909 data channels can be used in a system, but the maximum is also affected by the use of 7607 data channels. The table in 408:111.41 shows the maximum combinations.

Only one Hypertape Control 7640, can be connected to a system. It contains two independent input-output highways, and requires two 7909's for full use, or one 7909 for restricted use (see 409:092.4).

Up to two 7631 Disk Storage Controllers can be connected to a system. Each controller requires one 7909 (see 408:042).

Up to two 1414 Synchronizers can be connected to a system. Each controller requires one 7909 (see 408:103).

Each Data Channel behaves as a separate control unit in selecting and executing instructions. The Central Processor may execute instructions (see 409:121) to:

- Start in motion a selected unit on a specific channel.
- Start the control unit by specifying the location of the first Data Channel instruction.
- Specify a new location from which the next Data Channel instruction is to be taken, ignoring the remainder of the current sequence.
- Copy the current contents of the Data Channel control registers into core storage without affecting channel operation, including instruction location, word counter, operation control bits.
- Backspace, rewind, unload, set density, or write control marks.

.12 Description (Contd.)

The individual Data Channels may execute instructions (called commands by IBM) (see 408:121) to:

- Copy data controlled by counters or block delimiters.
- Change sequence.
- Disconnect, i.e., execute no more instructions until directed by the Central Processor.
- Sense for control, access, and error indicators.

The individual adapters and controllers for peripheral units can sometimes execute instructions (called orders by IBM).

A Data Channel has a large degree of autonomy and its own sequence of instructions can be interrupted by control and error conditions. The interrupts can be inhibited if required.

Data is transferred between all Data Channels 7909 or 7607 and core storage via the 7606 Multiplexer. The Multiplexer shares the access of all devices to the core storage on a priority basis. To ensure maximum simultaneous operation with no access conflicts, the Data Channels are connected in the sequence of their peak demands (see 409:111.43).

Optional Features

3224 Data Channel Switch. One manual switch can be fitted to each channel to enable the channel to be switched to one of two devices, selected by a Hypertape Control, a 1301 Disk Control, and a 1414 Teleprocessing Adapter.

1471 BCD Translation. This feature provides a translation between the internal 6-bit binary code of the 7090 (see 409:141), and the 6-bit BCD input-output code, for compatibility with other IBM systems (see 409:144).

5975 Read Backward Character Assembly and Storage. This feature enables the 7640 Hypertape Control read backward feature to be used.

.13 Availability: . . . . . ?

.14 First Delivery: . . . 1963?

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . 7909.
Data Channel.

7607.
Data Channel.

7606.
Multiplexor.

.12 Description

In general, every Data Channel and Central Processor may operate simultaneously. There are three types of limitations: The maximum allowable combinations of channels, the units and channels attached, and the demand limitations on the core storage.

The difference from the 7090 is the reduced access cycle of the storage, and the use of two word transfers.

The Data Channels are described in 409:101 and 409:102. In general, one unit on each Data Channel may be operating (transmitting or receiving data) simultaneously. In fact, each channel acts as a separate control unit, selecting and executing its own sequences of instructions as initiated by the central processor.

In IBM terminology the central processor executes instructions, the data channels execute commands, and the special adapters and controls execute orders. The various groups are all set out in the Instruction List (see 408:121).

.2 CONFIGURATION CONDITIONS

R: . . . . . number of 7909 Data Channels.
S: . . . . . number of 7640 Hypertape Controls.
T: . . . . . number of 7631 Disk Storage Controls.
U: . . . . . number of 1414 Synchronizers.
V: . . . . . number of 7607 Data Channels Model 1.
W: . . . . . number of 7607 Data Channels Model 3.
X: . . . . . number of 7607 Data Channels Model 2.
Y: . . . . . number of 7607 Data Channels Model 4.

.3 CLASSES OF OPERATION

A: . . . . . compute.
B: . . . . . read or write 729 tapes.
C: . . . . . rewind, backspace record or file or skip remainder of a record on 729 tapes, feed remainder of a card or space paper.
D: . . . . . read cards.
E: . . . . . punch cards.
F: . . . . . print.
G: . . . . . read or write Hypertapes.
H: . . . . . rewind, backspace or skip a record on Hypertapes.
I: . . . . . read or write, disc store.
J: . . . . . seek access, disc store.
K: . . . . . 1414 devices input-output.

.4 RULES

.41 Configuration Limitations On Equipment

Class	Possible Sets						
R	4	3	2	2	2	1	0
S	1	1	1	1	0	0	0
T	2	1	0	0	2	1	0
U	2-t	1-t	0	0	2-t	2-t	0
V	1	1	1	0	1	1	1
W	1-v	1-v	0	1	1-v	1 v	1-v
X	0	1	1	2	4	5	7
Y	0	1-x	1-x	2-x	4-x	5-x	7-x

.42 Configuration Limitations On Channels

a	-	at most 1.
b + d + e + f	-	at most V + W + X + Y.
c	-	at most 10(V + W + X) - b.
d + e + f	-	at most V + W.
g	-	at most 25.
h	-	at most 20S - g.
i	-	at most T.
j	-	at most 5 - i.
k	-	at most 6U.
g + i + k	-	at most R.

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§ 111.

.43 Demand Limitations

If the units are assigned to channels such that those with highest weights have priority, the total weight of units operating may not be more than 100. Otherwise, the weight may not be more than 70.

Device	Rate KC	Weight
729 II, V (200)	15	1.9
729 IV, VI (200)	22.5	2.8
729 II, V (556)	41.7	5.2
729 V (800)	60	7.6
7750	71.5	7.6
729 IV, VI (556)	62.5	7.9
1301	90	9.6
1414.6	90	9.7
729 VI (800)	90	11.7
7340	174	23.0

These weights allow for the usual worst case, in which three accesses may be required for each word transferred: the word itself, an instruction to the data channel, and an indirect address.

§ 121. INSTRUCTION LIST

Note: The majority of the IBM 7094 instructions are identical to those for the IBM 7090. Those beginning with the the Double Precision Floating Point instructions are exclusively 7094 instructions.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	Accumulator (AC) bits are called S, Q, P 1 thru 35. Multiplier-Quotient (MQ) called S, 1 thru 35, Q, P, hold overflows, S's sign.
					Fixed Point Arithmetic (AC and MQ use bits S, 1 thru 35 unless overflow in AC, then P and Q).
ADD	X	F	T	Y	(Y) + (AC) → AC
ADM	X	F	T	Y	|(Y)| + (AC) → AC
SUB	X	F	T	Y	(AC) - (Y) → AC
SBM	X	F	T	Y	(AC) - |(Y)| → AC
MPY	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ
MPR	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ, and if $MQ_1 = 1$; AC + 1 → AC
DVH	X	F	T	Y	(MQ ÷ (Y) → MQ (quotient), AC (remainder). If overflow, set divide-check indicator and halt processor.
DVP	X	F	T	Y	Same as for DVH except processor is not halted.
VLM	X	FC	T	Y	(Y) x $(MQ)_{35-0}$ → AC and MQ.
VDH	X	FC	T	Y	(AC) ÷ $(Y)_{1 \text{ to } C}$ → $(MQ)_{35-C \text{ to } 35}$, remainder in AC; If (Y) ≤ (AC), halt processor.
VDP	X	FC	T	Y	(AC) ÷ $(Y)_{1 \text{ to } C}$ → $(MQ)_{35-C \text{ to } 35}$, remainder in AC.
					Floating Point Arithmetic
FAD	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
UFA	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; unnormalized.
FSB	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
UFS	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; unnormalized.
FMP	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ; normalized.
FDH	X	F	T	Y	(AC) ÷ (Y) → MQ (quotient) normalized, AC (remainder). If overflow, set divide-check indicator and halt processor.
FDP	X	F	T	Y	Same as for FDH except processor is not halted.
FAM	X	F	T	Y	|(Y)| + (AC) → AC and MQ, normalized.
UAM	X	F	T	Y	|(Y)| + (AC) → AC and MQ, unnormalized.
FSM	X	F	T	Y	(AC) - |(Y)| → AC and MQ, normalized.
USM	X	F	T	Y	(AC) - |(Y)| → AC and MQ, unnormalized.
FRN	X	F	T	Y	(AC) + $(MQ)_9$ → (AC) normalized.
UFM	X	F	T	Y	(Y) x (MQ) → AC and MQ, unnormalized.
					Data Transfer Arithmetic
LDQ	X	F	T	Y	(Y) → MQ.
STQ	X	F	T	Y	(MQ) → Y.
SLQ	X	F	T	Y	$(MQ)_{S, 1-17}$ → $Y_{S, 1-17}$.
STO	X	F	T	Y	(AC) → Y.
STZ	X	F	T	Y	0 → (Y); sign is plus.
STP	X	F	T	Y	$(AC)_{P, 1, 2}$ → $Y_{S, 1, 2}$
STD	X	F	T	Y	$(AC)_{3-17}$ → Y_{3-17}.
STA	X	F	T	Y	$(AC)_{21-35}$ → Y_{21-35}.
CLA	X	F	T	Y	(Y) → AC.
CLS	X	F	T	Y	(-Y) → AC.
CVA	X	C	X	Y	Y → (SR). $((AC)_{30-35} + (SR)) \rightarrow (SR)$, (AC)/ 64 → (AC), $(SR)_{P-5} \rightarrow (AC)_{P-5}$, C times.
CRQ	X	C	X	Y	Y → (SR). $((MQ)_{S-5} + (SR) \rightarrow (SR)$, (MQ) x 64 → (MQ), $(SR)_{S-5} \rightarrow (MQ)_{30-35}$, C times.
CAQ	X	C	X	Y	Y → (SR). $(MQ)_{S-5} + (SR) \rightarrow (SR)$, RQL 6, (AC) + (SR) → AC, C times.

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INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Data Transfers (Logical)
CAL	X	F	T	Y	(Y) → AC.
SLW	X	F	T	Y	(AC) → Y.
STT	X	F	T	Y	$(AC)_{18-20}$ → Y_{18-20}; remaining positions remain unchanged.
STL	X	F	T	Y	Location of STL instruction + 1 → Y_{21-35}; remaining positions of Y unchanged.
STR	X	X	X	X	Location of STR instruction + 1 → to positions 21-35 of location 0000.
XCA	X	X	X	X	$(AC)_{S,\ 1-35}$ exchanged with $(MQ)_{S,\ 1-35}$; positions P and Q of AC are cleared.
XCL	X	X	X	X	$(AC)_{P,\ 1-35}$ exchanged with $(MQ)_{S,\ 1-35}$; positions S and Q of AC are cleared.
ENK	X	X	T	X	Contents of manual input switches → MQ. (See PSE)
					Logical Operations (AC used P, 1 thru 35 unless overflow in AC, then Q.)
ACL	X	F	T	Y	(Y) + (AC) → AC.
ANA	X	F	T	Y	(AC) "AND" (Y) → AC.
ANS	X	F	T	Y	(AC) "AND" (Y) → Y.
ORA	X	F	T	Y	(AC) "OR" (Y) → AC.
ORS	X	F	T	Y	(AC) "OR" (Y) → Y.
ERA	X	F	T	Y	(AC) 'EXCLUSIVE OR" (Y) → AC (binary half-add).
					Shift Operations (All are modulo 256 places).
ALS	X	X	T	Y	(AC) shifted left Y, sign unchanged.
ARS	X	X	T	Y	(AC) shifted right Y, sign unchanged.
LLS	X	X	T	Y	(AC) and (MQ) shifted left Y, $(MQ)_S$ → AC_S.
LRS	X	X	T	Y	(AC) and (MQ) shifted right Y, $(AC)_S$ → MQ_S.
LGL	X	X	T	Y	(AC) and (MQ) shifted left Y, signs unchanged.
RQL	X	X	T	Y	(MQ) rotated left Y.
LGR	X	X	T	Y	(AC) and (MQ) shifted right Y, signs unchanged.
					Control Operations
NOP	X	X	X	X	Next instruction in sequence is executed.
HPR	X	X	X	X	Halts processor; processor steps to next instruction when Start key is depressed.
HTR	X	F	T	Y	Halts processor; processor steps to instruction in location Y when Start key is depressed.
TRA	X	F	T	Y	Next instruction is taken from location Y.
TZE	X	F	T	Y	If (AC) = 0, next instruction taken from location Y.
TNZ	X	F	T	Y	If (AC) ≠ 0, next instruction taken from location Y.
TPL	X	F	T	Y	If sign bit of AC positive, next instruction taken from location Y. Sign bit negative, next instruction executed.
TMI	X	F	T	Y	If sign bit of AC negative, next instruction taken from location Y. If sign bit positive, next instruction executed.
TOV	X	F	T	Y	If overflow indicator on, it is turned off and processing continues from location Y.
TNO	X	F	T	Y	If overflow indicator off, continue from location Y.
TQP	X	F	T	Y	If sign bit of MQ positive, next instruction taken from location Y.
TQO	X	F	T	Y	If MQ overflow indicator turned off, next instruction taken from location Y.
TLQ	X	F	T	Y	(MQ < (AC) next instruction taken from location Y.
TSX	X	X	T	Y	2's complement of location Y placed in index register T. *
TXI	D	D	T	Y	Adds the value of D to the number in index register T and takes next instruction from Y. *
TXH	D	D	T	Y	If number in index register T greater than value of D, next instruction taken from location Y.

INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Control Operations (Cont'd)
TXL	D	D	T	Y	If number in index register T is less than or equal to the value of D, next instruction taken from location Y.*
TIX	D	D	T	Y	If number in index register T is greater than the value of D, the number in index register T is reduced by the value of D and next instruction is taken from Y.*
TNX	D	D	T	Y	If number in index register T is greater than the value of D, number in index register T is reduced by the value of D and transfers to the next instruction; otherwise the index is unchanged and the next instruction is taken from Y.*
TTR	X	F	T	Y	Processor takes its next instruction from location Y and proceeds whether or not in trapping mode.
CAS	X	F	T	Y	If (Y) < (AC), next instruction is executed. If (Y) = (AC) next instruction is skipped. If (Y) > (AC), next two instructions are skipped.
LXA	X	X	T	Y	Address portion of (Y) replaces number in index register T.*
LXD	X	X	T	Y	Decrement portion of (Y) replaces number in index register T.*
SXD	X	X	T	Y	0 → (Y) and (T) replaces decrement part of location Y.*
PAX	X	X	T	Y	Address part of (AC) replaces the number in the index register T.*
PDX	X	X	T	Y	Decrement part of (AC) replaces the number in the index register T.*
PXD	X	X	T	Y	0 → (AC) and number in index register T is placed in the decrement part of the AC.*
XEC	X	F	T	Y	Execute instruction in location Y.
BTT	X	X	T	Y	Test the status of data channel BOT indicator. Channel specified by value of Y.
ZET	X	F	T	Y	If $(Y)_{1-35} = 0$, next instruction is skipped and processing continues. If $(Y)_{1-35} \neq 0$, next sequential instruction is executed.
NZT	X	F	T	Y	If $(Y)_{1-35} \neq 0$, the next instruction is skipped and processing continues. If $(Y)_{1-35} = 0$, next sequential instruction is executed.
LAS	X	F	T	Y	(AC) compared logically with (Y). If (AC) > (Y), next sequential instruction is executed. If (AC) = (Y), next instruction is skipped and processing continues. If (AC) < (Y), next two instructions are skipped and processing continues.
TCOA	X	F	T	Y	Next instruction taken from location Y if channel A is in operation.
TCNA	X	F	T	Y	Next instruction taken from location if channel A is not in operation.
TRCA	X	F	T	Y	When tape check indicator for channel A is on, next instruction taken from location Y. If indicator is off, next instruction in sequence is executed.
TEFA	X	F	T	Y	When end-of-file indicator for channel A is on, next instruction taken from location Y. If indicator is off, next instruction in sequence is executed.
LAC	X	X	T	Y	$(NOT(Y)_{21-35}) + 1 \rightarrow (T)$.
LDC	X	X	T	Y	$(NOT(Y)_{21-35}) + 1 \rightarrow (T)$.
AXT	X	X	T	Y	$Y \rightarrow (T)$.
AXC	X	X	T	Y	$(NOT\ Y) + 1 \rightarrow (T)$.
PAC	X	X	T	X	$(NOT\ (AC)_{21-35}) + 1 \rightarrow (T)$.
PDC	X	X	T	X	$(NOT\ (AC)_{3-17}) + 1 \rightarrow (T)$.
SXA	X	X	T	Y	$(T) \rightarrow (Y)_{21-35}$.
PXA	X	X	T	Y	$0 \rightarrow AC$; $(T) \rightarrow AC_{21-35}$.

* Not indexable.

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INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Input-Output Operations
RDS	X	X	T	Y	Start the unit specified by Y in the read mode.
WRS	X	X	T	Y	Start the unit specified by Y in the write mode.
BST	X	X	T	Y	Backspace tape designated by Y one record.
WEF	X	X	T	Y	An end-of-file gap and mark and a redundancy character is written on the tape on unit Y.
REW	X	X	Y	Y	Rewind tape unit Y.
LDA	X	F	T	Y	704/709 Input-Output instruction.
CPY	X	X	T	Y	704/709 Input-Output instruction.
PSE †	X	X	T	X	Provides a means for testing the status of sense switches, controlling sense lights, and the sampling of or sending of impulses to the printer and punch. These functions include:
LBT					Low order bit test (AC).
CHS					Change sign (AC).
SSP					Set sign plus (AC).
ENK					(Console Keys) $\rightarrow$ (AC).
IOT					Test for input-output error.
COM					Complement magnitude (AC).
ETM					Enter trapping mode.
RND					Round $(MQ)_1 \times 2^{-35} + (AC) \rightarrow AC$.
SLN					Turn on Sense Light.
BTT					Test for beginning of tape.
DCT					Divide check test.
RCT					Test for tape error.
SLF					Turn off Sense Lights.
CLM					Clear Magnitude (AC).
SWT					Test Sense Switch.
SPU					Send signal to Card Reader.
SPT					Test for Printer signal.
SPR					Send signal to Printer.
RIC					Reset Data Channel.
RDC					Reset and Disconnect Data Channel.
FRN					Floating Point Round.
MSE †	X	X	T	X	Provides a means for testing and turning off the sense lights. These functions include:
PBT					P bit test (AC).
EFTM					Enter floating trap mode.
SSM					Set sign minus.
LFTM					Leave floating trap mode.
ESTM					Enter Storage Nullification Mode.
ECTM					Enter Copy Trap Mode.
LTM					Leave trapping mode.
LSTM					Leave Storage Nullification Mode.
SLT					Test Sense Light and turn it off.
ETT					End of Tape Test.
RTT					704 instruction.
BSF	X	X	T	Y	Selected tape Y is moved backward until end-of-file or load point is reached.
CAD	X	X	T	Y	704/709 input-output instruction.
					Sense Indicator Operations
PAI	X	X	X	X	$(AC)_{P,\ 1\text{-}35} \rightarrow SI$.
PIA	X	X	X	X	$(SI) \rightarrow AC_{P,\ 1\text{-}35}$; 0 $\rightarrow$ positions S and Q.
LDI	X	F	T	Y	$(Y) \rightarrow SI_{0\text{-}35}$.
STI	X	F	T	Y	$(SI) \rightarrow Y$.
OAI	X	X	X	X	(AC) "OR" (SI) $\rightarrow$ SI.
OSI	X	X	T	Y	(Y) "OR" (SI) $\rightarrow$ SI.
SIL	X	X	Y	Y	Y "OR" $(SI)_{0\text{-}17} \rightarrow SI_{0\text{-}17}$.
SIR	X	X	Y	Y	Y "OR" $(SI)_{18\text{-}35} \rightarrow SI_{18\text{-}35}$.
RIA	X	X	X	X	"NOT" (AC) "AND" (SI) $\rightarrow$ SI.

† Note: Except for the sign bit, the first 11 PSE have identical operation codes to the corresponding MSE codes. The particular variation is determined by the indexable address field.

§ 121.

INSTRUCTION LIST (Cont'd)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
RIS	X	F	T	Y	"NOT" (Y) "AND" (SI) → SI.
RIL	X	X	Y	Y	"NOT" (Y) "AND" $(SI)_{0-17} \rightarrow SI_{0-17}$.
ONT	X	F	T	Y	If (Y) "AND" (SI) = (Y), skip next instruction.
OFT	X	F	T	Y	If (Y) "AND NOT" (SI) = (Y), skip next instruction.
LNT	X	X	Y	Y	If Y "AND" $(SI)_{0-17}$ = (Y), skip next instruction.
RNT	X	X	Y	Y	If Y "AND" $(SI)_{18-35}$ = (Y), skip next instruction.
LFT	X	X	Y	Y	If Y "AND NOT" (SI_{0-17}) = (Y), skip next instruction.
RFT	X	X	Y	Y	If Y "AND NOT" (SI_{18-35}) = (Y), skip next instruction.
RIR	X	X	Y	Y	"NOT" Y "AND" $(SI)_{18-35} \rightarrow SI_{18-35}$.
IIA	X	X	X	X	(AC) "EXC. OR" (SI) → SI.
IIS	X	F	T	Y	(Y) "EXC. OR" (SI) → SI.
IIL	X	X	Y	Y	Y "EXC. OR" $(SI)_{0-17} \rightarrow SI_{0-17}$.
IIR	X	X	Y	Y	Y "EXC. OR" $(SI)_{18-35} \rightarrow SI_{18-35}$.
IIO	X	F	T	Y	If (AC) "AND" (SI) = (AC), take next instruction from Y.
TIF	X	F	T	Y	If (AC) "AND NOT" (SI) = (AC), take next instruction from Y.
					Systems Compatibility Operations
ESNT	X	F	T	Y	Half effective storage for 704 simulation transfer to Y - (T).
LSNM	X	X	T	X	Return to normal storage mode.
ESTM	X	X	T	X	Enter select trap mode. Input-output instructions set to cause trapping.
ECTM	X	X	T	X	Enter copy trap mode CPY CAD, and LDA will be trapped.
					Channel Trap Instructions
ENB	X	X	T	Y	Enable from Y. The (Y) determines which channel signals cause a trapping operation.
RCT	X	F	T	Y	Restore channel traps. Allows traps to occur as specified by ENB. Cancels the inhibiting effect of an executed trap.
					Input-Output Transmission Operations
RUN	X	X	T	Y	Rewind and unload tape.
SDN	X	X	X	Y	Set density of designated tape unit.
RDC	X	X	T	Y	Zero all registers and indicators in the designated data channel.
RIC	X	X	T	Y	Reset all conditions in data channel.
SCHA	X	F	T	Y	Store Channel A. (Y) replaced with contents of Channel A.
RCHA	X	F	T	Y	Reset and load Channel A. Channel A is reset and loaded with the (Y).
LCHA	X	F	T	Y	Load Channel A with the (Y).
					Data Channel Commands (7607)
IOCD	C	F	N	Y	Input-Output C words starting at Y and disconnect.
IOCP	C	F	N	Y	Input-Output C words starting at Y and proceed to next channel command.
IORP	C	F	N	Y	Input-Output up to C words of one record starting at Y, then proceed to the next channel command.
IOCT	C	F	N	Y	Input-Output C words of one record starting at Y then accept the waiting LCH instruction or disconnect.
					Data Channel Commands (7607) (Cont'd)
IORT	C	F	N	Y	Input-Output up to C words of one record starting at Y then accept the waiting LCH instruction or disconnect.
IOSP	C	F	N	Y	Input-Output the smaller of 1 record or C words starting at Y, then accept the next channel command.
IOST	C	F	N	Y	Input-Output the smaller of 1 record or C words starting at Y, then accept the waiting LCH instruction or disconnect.
TCH	X	F	X	Y	Take next channel command from Y.

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INSTRUCTION LIST (Cont'd)

§ 121.

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Data Channel Commands (7909)
CTL	X	X	X	Y	Information is sent to the adapters starting with (Y).
CTLR	X	X	X	Y	Prepared to read from the adapter. Must be followed by a copy.
CTLW	X	X	X	Y	Prepare to write to the adapter. Must be followed by a copy.
SNS	X	X	X	X	Prepare to read sense data. Must be followed by a copy.
CPYD	X	CF	X	Y	Transmit C words between the channel and core starting with location Y.
CPYP	X	CF	X	Y	Transmit C words between the channel and core starting with location Y then obtain next sequential command.
LAR	X	F	X	Y	(Y) $\longrightarrow$ (AR).
SAR	X	F	X	Y	(AR) $\longrightarrow$ (Y).
XMT	X	CF	X	Y	(XTM+1), (XTM+2), ..., (XTM+C+1) $\longrightarrow$ (Y+1), (Y+2), ..., (Y+C). Next channel instruction taken from (Y+C+1).
LCC	X	CF	X	X	C $\longrightarrow$ (CC).
TDC	X	F	X	X	If (C) > 0, then (C) - 1 $\longrightarrow$ (C) and next instruction is taken from (Y); if (C) = 0, command is no operation.
ICC	X	C	X	X	If C = 0, SMS indicators $(AR)_{31-36}$. If C = 1 - 6 (CC) $\longrightarrow$ (AR) character C. If C = 7 instruction is no operation.
TCM	X	CFM	X	Y	Transfer on condition met, select a character by: C = 0, use channel check register. C = 1 - 6, use (AR) character C. C = 7, go to Y; if M = 0, next command; otherwise for C $\neq$ 7, go to Y. If character = M and $(TCM)_{11}$ = 0, or if character "AND" M = M and $(TCM)_{11}$ = 1; otherwise use next command in sequence.
SMS	X	F	X	X	Set mode and select; $(SMS)_{30-35}$ $\longrightarrow$ status indicators.
WTR	X	F	X	Y	Wait and transfer; a start channel instruction will cause the next command to be taken from location Y.
TWT	X	F	X	Y	Trap and wait; the channel suspends operation until a start channel instruction is executed. If control word trap is enabled, the CPU traps.
LIP	X	X	X	X	Leave interrupt program, the channel resumes a program that has been interrupted.
LIPT	X	F	X	Y	Leave interrupt program and transfer, the channel enters a non-interrupted condition and takes its next command from location Y.
					Control Orders (Disc)
DNOP					No Operation
DREL					Release
DEBM					Eight-Bit Mode
DSBM					Six-bit Mode
DSEK					Seek
DVSR					Prepare to Verify (single record)
DWRF					Prepare to Write Format
DVTN					Prepare to Verify (track with no addresses)
DVCY					Prepare to Verify (cylinder operation)*
DWRC					Prepare to Write Check
DSAI					Set Access Inoperative
DCTA					Prepare to Verify (track with addresses)
DVHA					Prepare to Verify (home address)

§ 121. INSTRUCTION LIST (Cont'd)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Control Orders (Hypertape)
HNOP					No Operation
HEOS					End of Sequence
HRLF					Reserved Light Off
HRLN					Reserved Light On
HCLN					Check Light On
HSEL					Select
HSBR					Select for Backward Reading
HCCR					Change Cartridge and Rewind
HRWD					Rewind
HRUN					Rewind and Unload Cartridge
HERG					Erase Long Gap
HWTM					Write Tape Mark
HBSR					Backspace
HBSF					Backspace File
HSKR					Space
HSKF					Space File
HCHC					Change Cartridge
HUNL					Unload Cartridge
HFPN					File Protect On

Terms:

C means count value.
D means decrement value.
F means indirect addressing flag.
M means mask character.
N means non-transmit to storage.
T means index register tag.
X means part of the operation code.
Y means the address or value.

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INSTRUCTION LIST (Contd.)

§ 121.

Note: The following instructions are exclusively 7094 instructions.

INSTRUCTION					Additional Instructions to 7090 List OPERATION Where (A, A + 1) appear as operand addresses, A must be an even numbered address, i.e., with a low order address bit set to zero.
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Double Precision Floating Point Arithmetic
DFAD	X	F	T	A	(A, A + 1) + (AC, MQ) → (AC, MQ) in floating point, normalized.
DFAM	X	F	T	A	(AC, MQ) + (A, A + 1) → (AC, MQ) unsigned in normalized floating point.
DFDH	X	F	T	A	(AC, MQ) / (A, A + 1) → (AC, MQ) in normalized floating point. Halt if the Divide Check indicator is set. 0 → sense indicators.
DFDP	X	F	T	A	(AC, MQ) / (A, A + 1) → (AC, MQ) in normalized floating point. 0 → sense indicators.
DFMP	X	F	T	A	(AC, MQ) x (A, A + 1) → (AC, MQ) in normalized floating point.
DFSB	X	F	T	A	(AC, MQ) - (A, A + 1) → (AC, MQ) in normalized floating point.
DFSM	X	F	T	A	(AC, MQ) - (A, A + 1) → (AC, MQ) unsigned in normalized floating point.
DUFA	X	F	T	A	(A, A + 1) + (AC, MQ) → (AC, MQ) in unnormalized floating point.
DUAM	X	F	T	A	(AC, MQ) + (A, A + 1) → (AC, MQ) unsigned in unnormalized floating point.
DUFM	X	F	T	A	(AC, MQ) x (A, A + 1) → (AC, MQ) in unnormalized floating point.
DUFS	X	F	T	A	(AC, MQ) - (A, A + 1) → (AC, MQ) in unnormalized floating point.
DUSM	X	F	T	A	(AC, MQ) - (A, A + 1) → (AC, MQ) unsigned in unnormalized floating point.
					Data Transfer
DLD	X	F	T	A	(A) → AC, (A + 1) → MQ; A must be an even numbered address.
DST	X	F	T	A	(AC) → (A), (MQ) → (A + 1); A must be an even number address.
SCA	X	X	T	A	(T) → (A_{21-25}), ($A_{S,\ 1-20}$) are unchanged.
SCD	X	X	T	A	(T) → (A_{3-17}), ($A_{S,\ 1,\ 2,\ 18-20}$) are unchanged.
PCA	X	X	T	X	Clear the entire (AC) to 0, the twos complement of (T) is inserted in AC_{21-35}. When T = 0, AC is set to zero.
PCD	X	X	T	X	Clear the entire (AC) to 0, the twos complement of (T) is inserted in AC_{3-17}. When T = 0, AC is set to zero.
					Index Control
EMTM	X	X	T	X	Decode Tag bits to indicate one of seven index registers. (A variation of the MSE instruction.)
LMTM	X	X	T	X	Decode Tag bits to indicate any of three index which will be ORed together before use. (A variation of the PSE instruction.)

IBM 7094
SYSTEM PERFORMANCE

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IBM 7094 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration V	Configuration VII B		Configuration VIII B		Reference
1 Input-Output Times	Char/block	(File 1)	1008	1008	4032	1008	4032	4:200.112
	Records/block	K (File 1)	8	8	32	8	32	
	m. sec/block	File 1 = File 2	34	22.6	66	10.1	27.8	
		File 3	13	8.7	22.7†	8.1	17.9†	
		File 4	13	8.7	22.7†	8.1	17.9†	
	m. sec/switch	File 1 = File 2						
		File 3						
		File 4						
	m. sec penalty	File 1 = File 2	0.3	0.2	0.7	0.1	0.2	
		File 3	0.1	0.1	0.2	0.1	0.1	
		File 4	0.1	0.1	0.2	0.1	0.1	
2 Central Processor Times	m. sec/block	a1	0.18	0.18		0.18		4:200.1132
	m. sec/record	a2	0.18	0.18		0.18		
	m. sec/detail	b6	0.13	0.13		0.13		
	m. sec/work	b5 + b9	0.28	0.28		0.28		
	m. sec/report	b7 + b8	4.94	4.94		4.94		
3 Standard Problem A F = 1.0	m. sec. for C. P. and dominant column.	a1	0.2	0.2	0.2	0.2	0.2	4:200.114
		a2 K	1.4	1.4	5.6	1.4	5.6	
		a3 K	42.7	42.7	170.8	42.7	170.8	
		File 1 Master In	0.1 34	0.1 22.6	0.1 66.0	0.1	0.1	
		File 2 Master Out	0.1 34	0.1	0.1	0.1	0.1	
		File 3 Details	0.7 104	0.7 69.6	2.8	0.7 64.8	2.8 143.2	
		File 4 Reports	0.7 104	0.7	2.8	0.7	2.8	
		Total	45.9 276	45.9 92.2	182.4 66.0	45.9 64.8	182.4 143.2	
4 Standard Problem A Space	Unit of measure	(words)						4:200.1151
		Std. routines	620	620	620	620	620	
		Fixed	0	0	0	0	0	
		3 (Blocks 1 to 23)	400	400	450	400	450	
		6 (Blocks 24 to 48)	2,000	2,000	2,000	2,000	2,000	
		Files	756	756	3,360	756	3,360	
		Working	200	200	200	200	200	
		Total	3,976	3,976	6,630	3,976	6,630	

† 8 records per block.

IBM 7094 SYSTEM PERFORMANCE—Contd.

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration V	Configuration VII B	Configuration VIII B	Reference
5	Fixed/Floating point				Floating	Floating	4:200.413
	Unit name		input		729 IV	729 VI	
			output		729 IV	729 VI	
	Size of record		input		90 char	90 char	
			output		120 char	120 char	
Standard Mathematical Problem A	m. sec/block		input T1		8.2	7.7	
			output T2		8.6	8.0	
	m. sec penalty		input T3		0	0	
			output T4		0	0	
	m. sec/record		T5		0.902		
	m. sec/5 loops		T6		1.38		
	m. sec/report		T7		6.36		
7	Unit name				729 IV	Hypertape	4:200.512
	Size of block				9,000	21,000	
	Records/block		B		150	350	
Standard Statistical Problem A	m. sec/block		T1		151	128	
	m. sec. penalty		T3		0	0	
	C. P.	m. sec/block	T5		0.03		
		m. sec/record	T6		0.49		
		m. sec/table	T7		0.04		

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SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

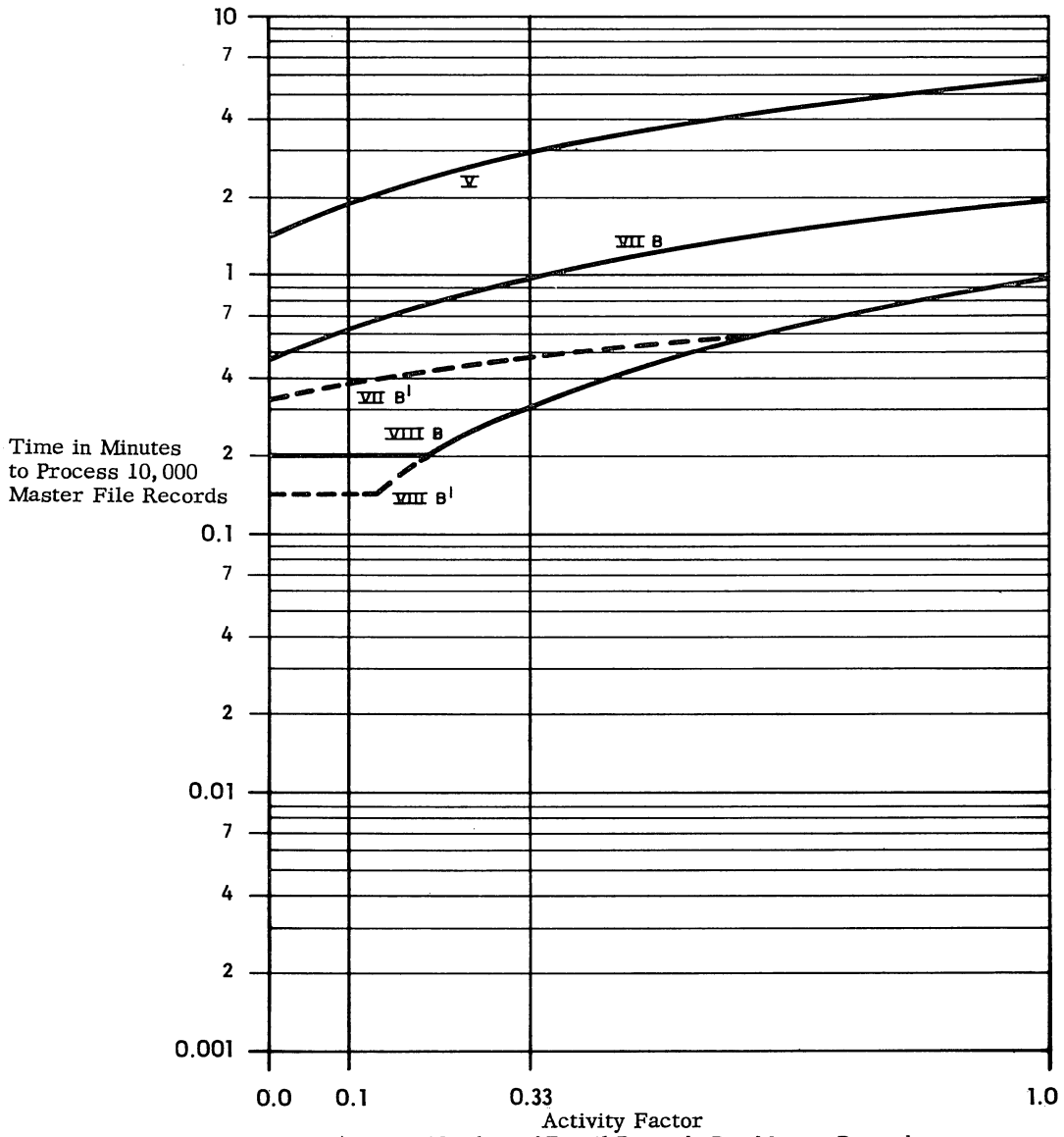
.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.

.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113

.114 Graph: . . . . . see graph below.

.115 Storage space required
Unblocked detail and report files
Configuration V: . . . . . 3,976.
Configuration VII B: . . . . 3,976.
Configuration VIII B: . . . . 3,976.
Blocked detail and report files
Configuration VII B: . . . . 6,630.
Configuration VIII B: . . . . 6,630.



Broken line indicates blocked detail and report files.

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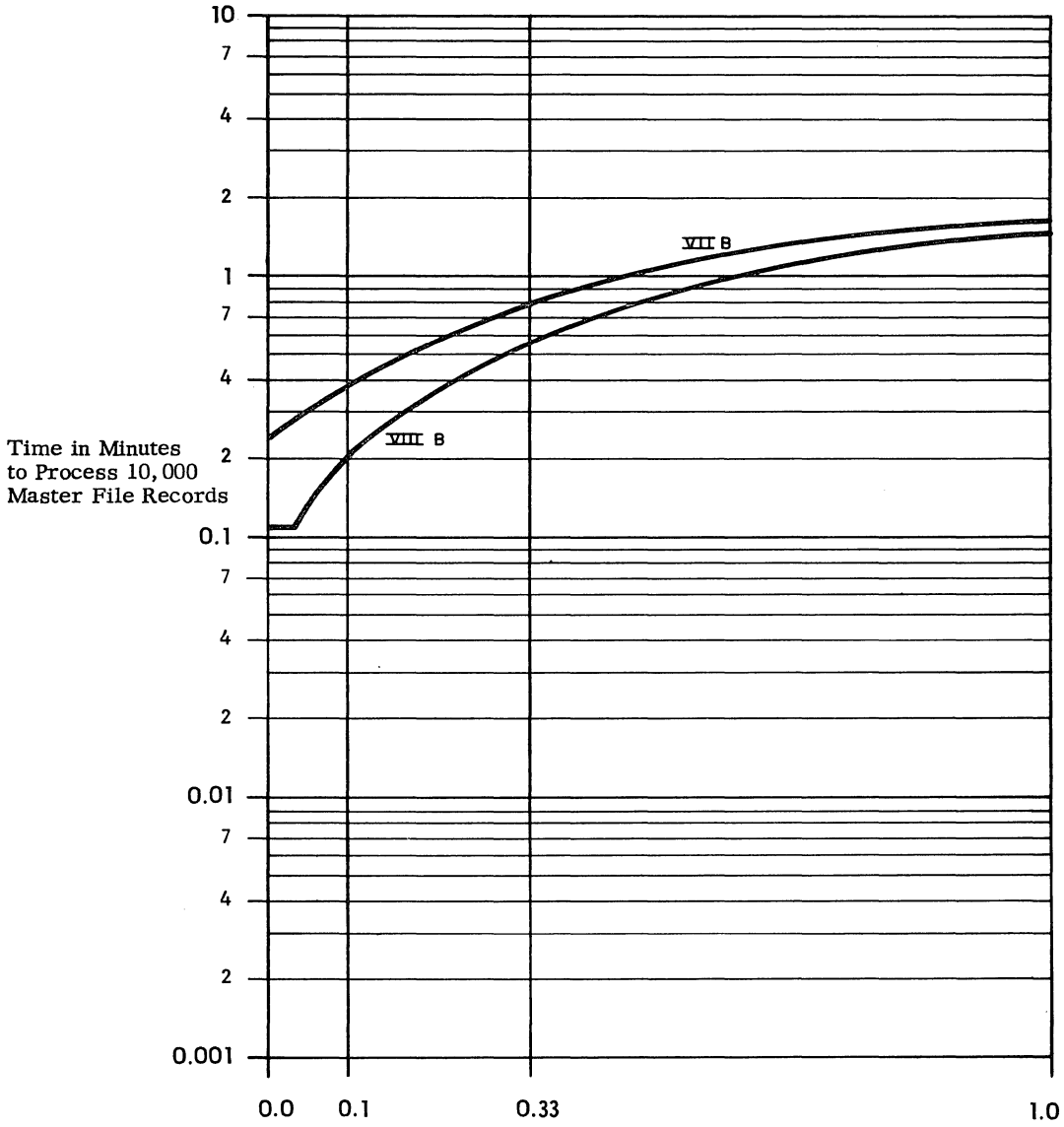
§ 201.

.12 Standard File Problem B

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



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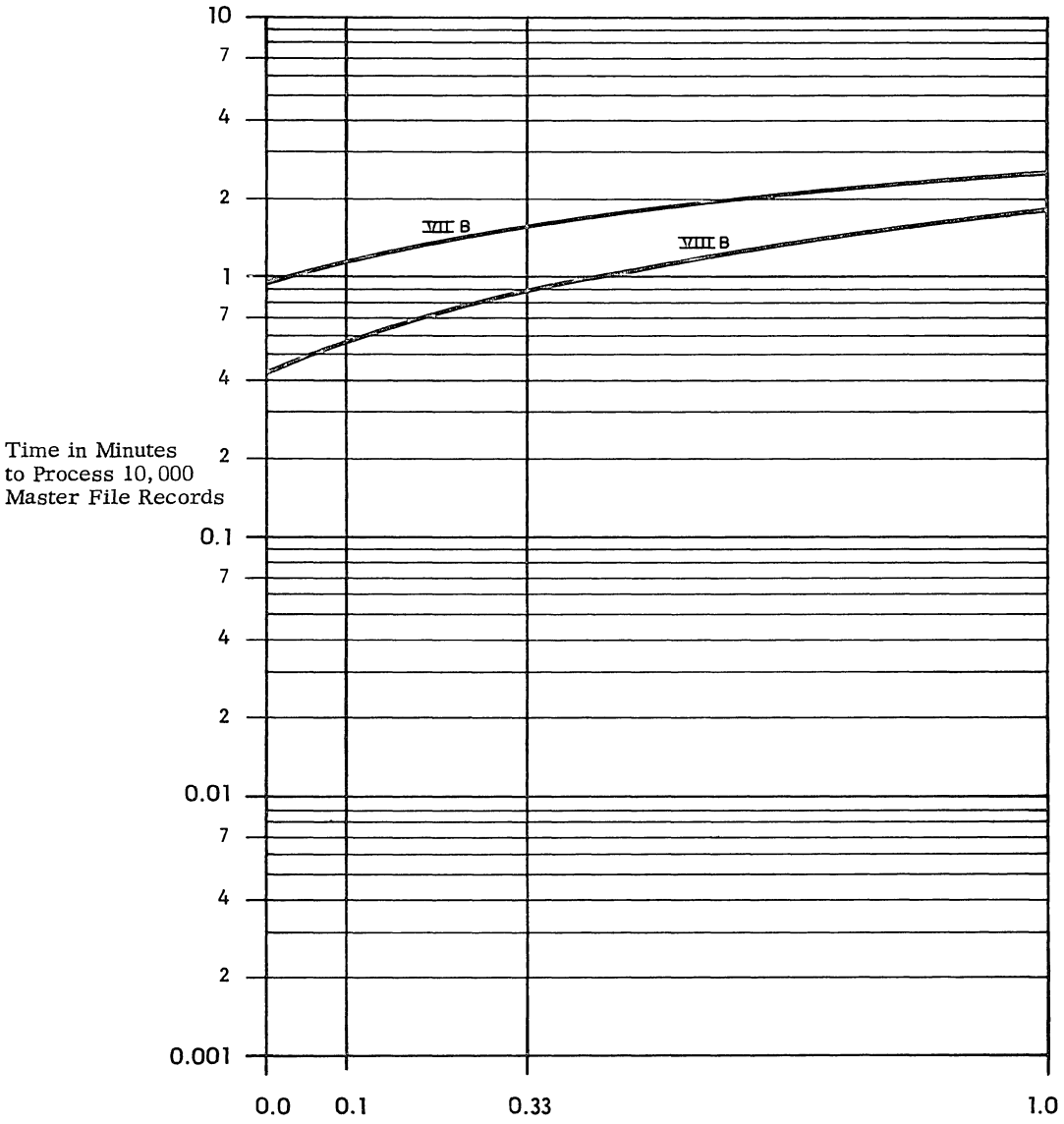
§ 201.

.13 Standard File Problem C

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



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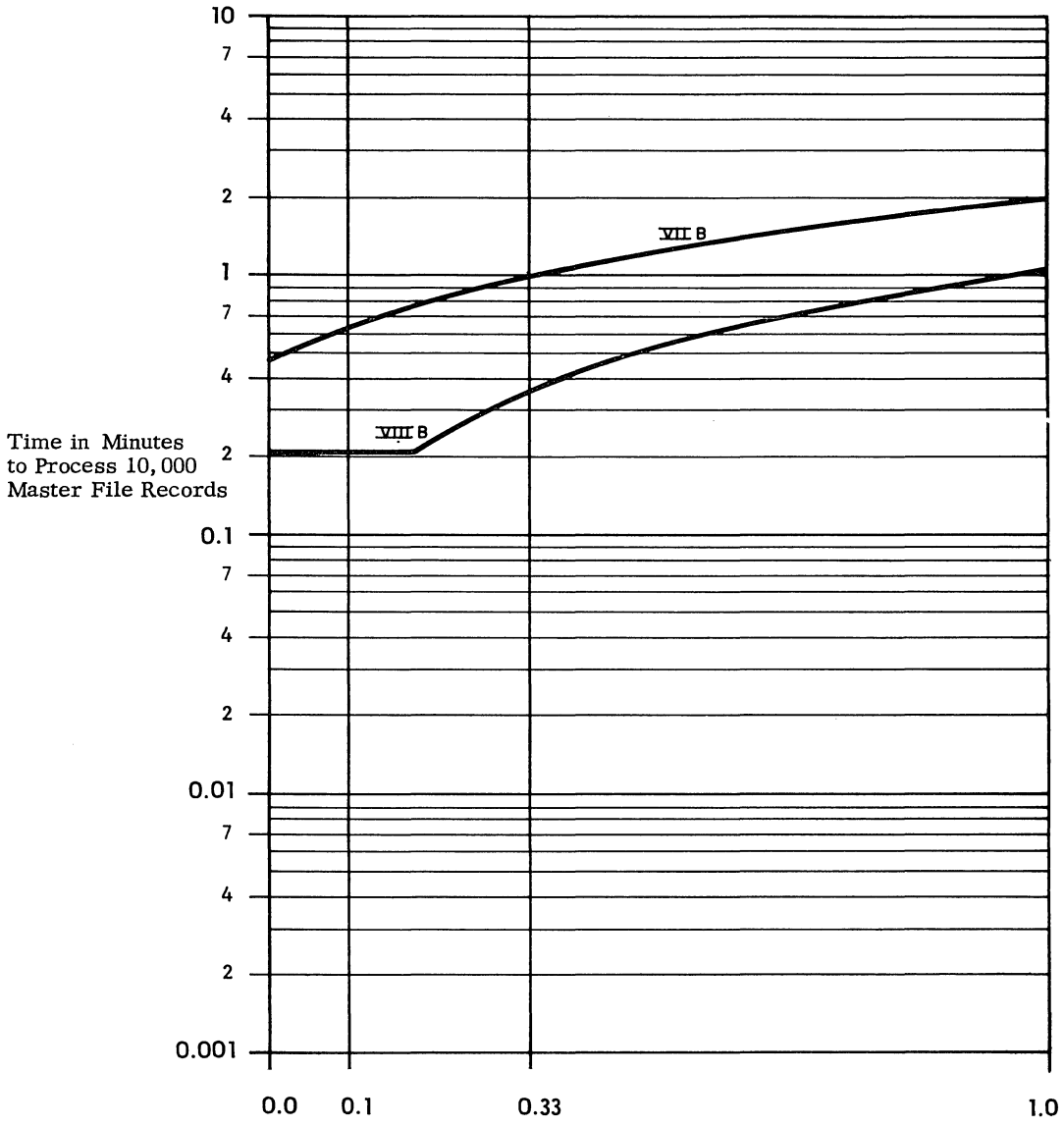
§ 201.

.14 Standard File Problem D

.141 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.14.
.144 Graph: . . . . . see graph below.



§ 201.

.2 SORTING

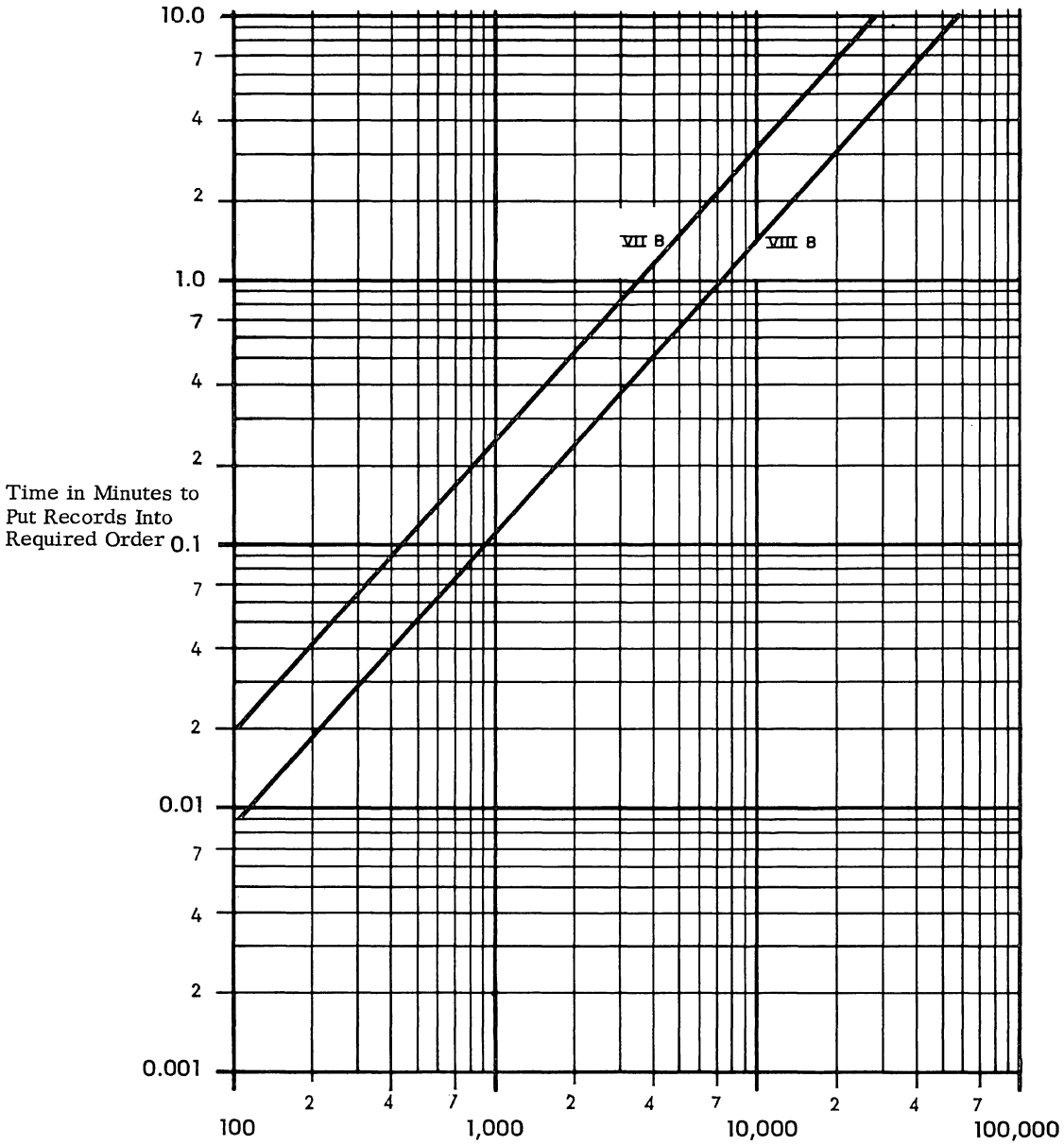
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



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§ 201.

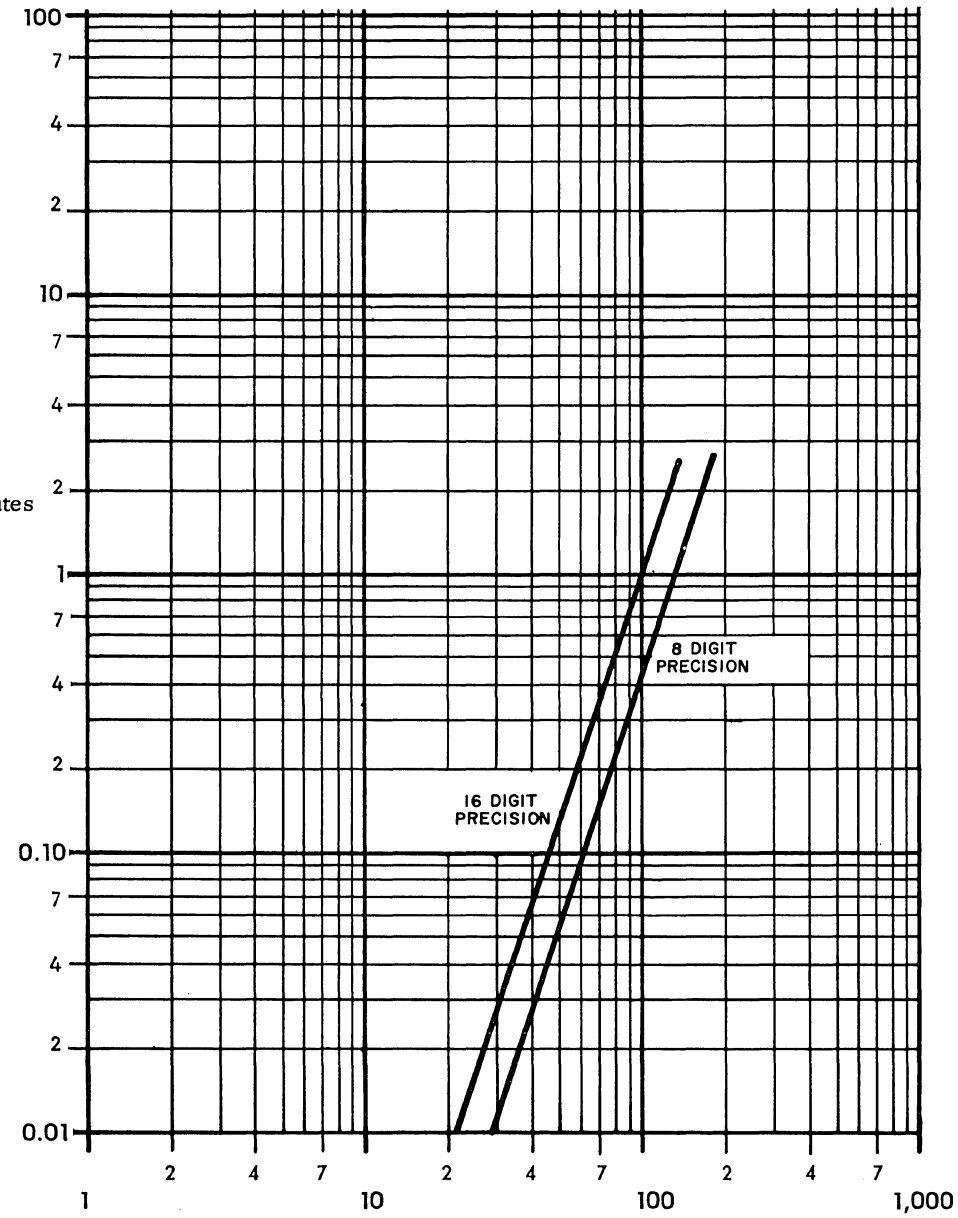
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . . see graph below.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

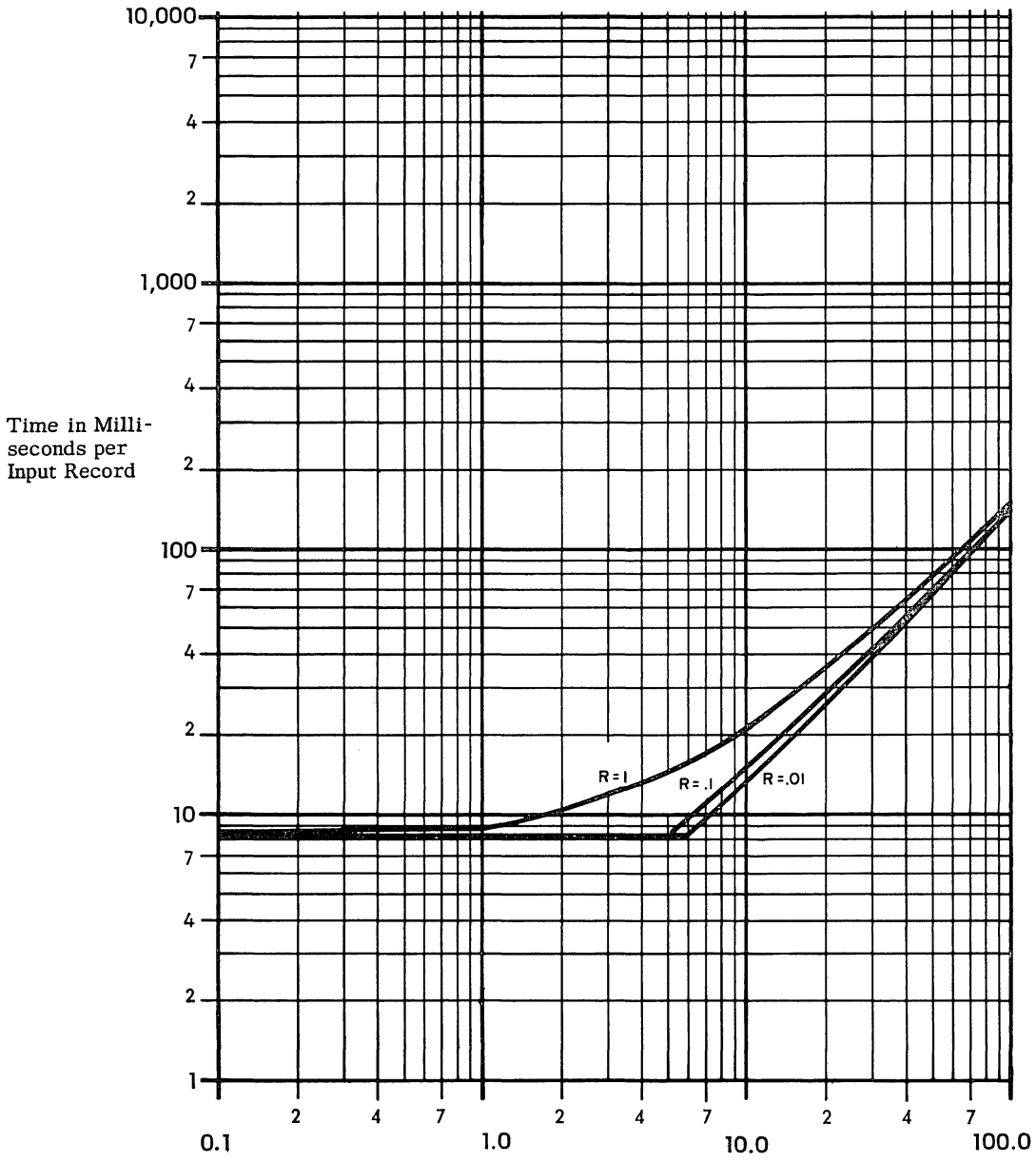
.411 Record sizes: . . . . . 10 signed numbers, avg., size 5 digits, max. size 8 digits.

.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . . see graph below.

CONFIGURATION VII B; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT.
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



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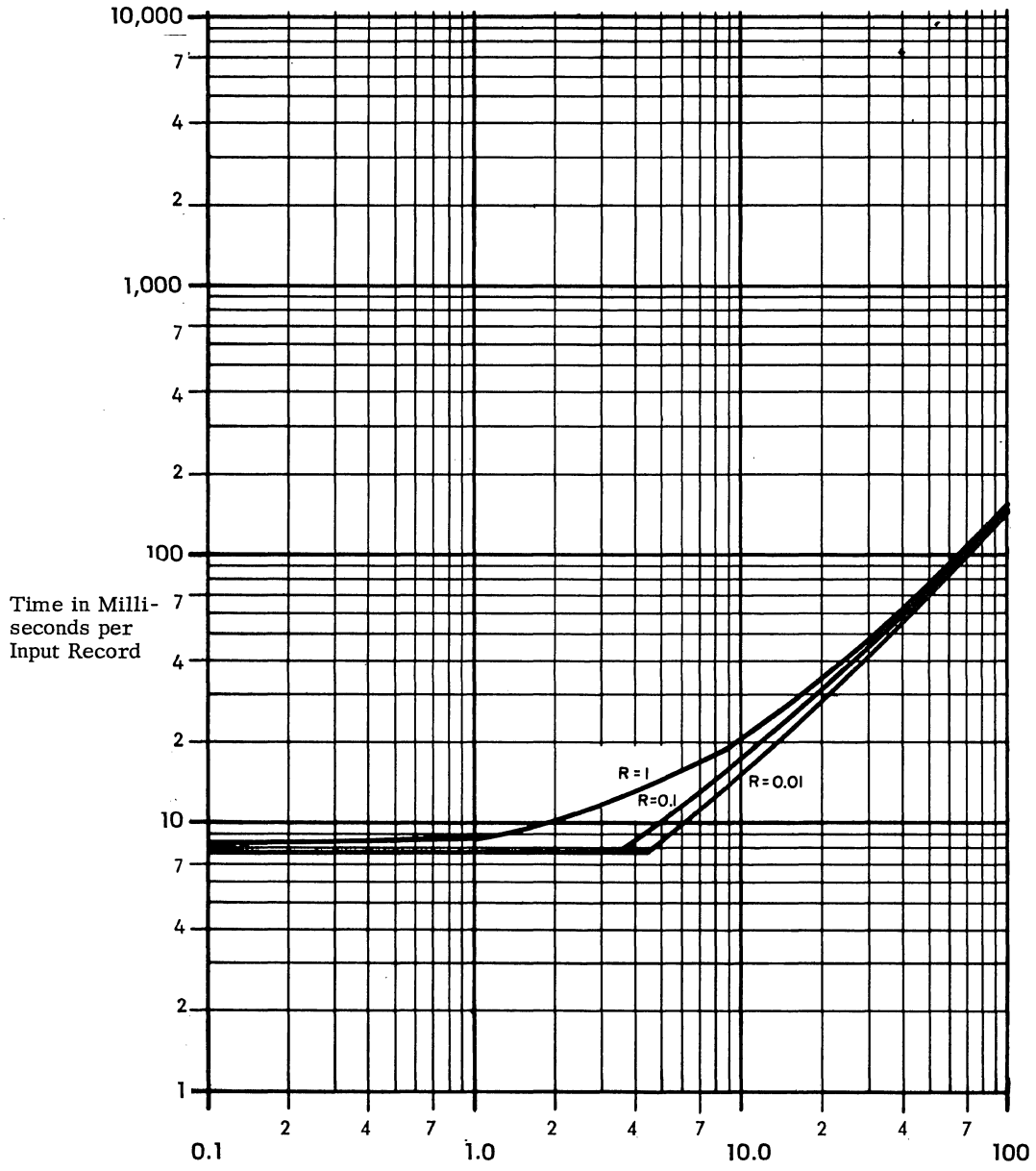
§ 201.

.415 Graph: . . . . . see graph below.

CONFIGURATION VIII; SINGLE LENGTH (8 DIGIT PRECISION); FLOATING POINT.
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

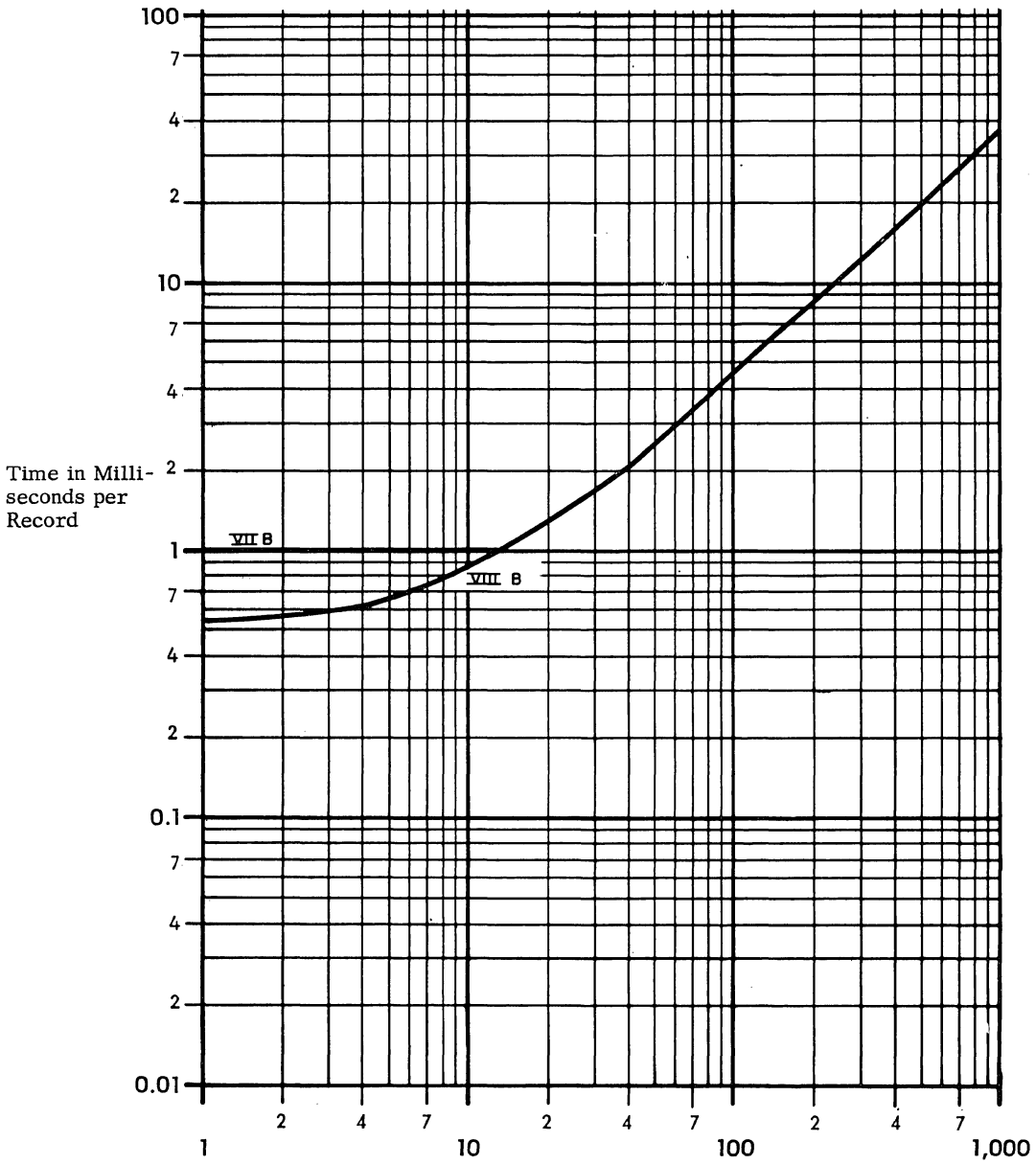
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



Roman numerals denote Standard Configurations

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IBM 7094
PHYSICAL CHARACTERISTICS

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IBM 7094 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Core Storage	Multiplexor	Disk Storage	Disk Storage	Drum Storage	File Control	Instruction Processing Unit
	Model Number		7302-1	7606-1	1301-1	1301-2	7320-1	7631 II/III/IV	7110-1
PHYSICAL	Height × Width × Depth, in.		80X36X70	56×30×69	33×85½×65⅝	33×85½×65⅝	30×29×60	38×32×70	60×28×69
	Weight, lbs.		2,450	1,500	3,625	3,825	850	500	2,335
	Maximum Cable Lengths		From 7618 - 75 ft. From 7606 - 18 ft.	From 7618 - 75 ft. From 7151 - 65 ft.					From 7618 - 75 ft. From 7151 - 65 ft.
ATMOSPHERE	Storage Ranges	Temperature, °F.	98 ± 1						
		Humidity, %	oil immersed						
	Working Ranges	Temperature, °F.	←			50 to 80			→
		Humidity, %	←			20 to 80			→
	Heat Dissipated, BTU/hr.		15,420	1,550	16,700	20,000	2,800	4,800	4,410
	Air Flow, cfm.		1,860	400	---	---	---	---	400
	Internal Filters				Yes	Yes	Yes	Yes	
ELECTRICAL	Voltage	Nominal	208	208	208 or 230	208 or 230	208	208 or 230	208
		Tolerance							
	Cycles	Nominal	←			60			→
		Tolerance							
	Phases and Lines		3-phase, 5-wire	3-phase, 5-wire	3-phase, 4-wire	3-phase, 4-wire	3-phase, 4-wire	1-phase, 3-wire	3-phase, 5-wire
	Load KVA		5.83	0.73	7.5	9.0	1.1	2.7	1.82
NOTES					Max 5 per Model 1 or 2		Max 5 per 7631 Model 2; 10 per system	Max 2	

IBM 7094 PHYSICAL CHARACTERISTICS (Contd.)

			Arithmetic Sequence Unit	Console Control Unit	Card Reader	Card Punch	Printer	Magnetic Tape Units	Hypertape Drive	Hypertape Control	Paper Tape Reader	Data Channel	Data Channel	Input-Output Synchronizer	Data Channel	Data Channel Console	Data Transmission Unit	Remote Inquiry Unit	Switch Control Console	Programmed Transmission Control	Power Converter	Power Control
IDENTITY	Unit Name		Arithmetic Sequence Unit	Console Control Unit	Card Reader	Card Punch	Printer	Magnetic Tape Units	Hypertape Drive	Hypertape Control	Paper Tape Reader	Data Channel	Data Channel	Input-Output Synchronizer	Data Channel	Data Channel Console	Data Transmission Unit	Remote Inquiry Unit	Switch Control Console	Programmed Transmission Control	Power Converter	Power Control
	Model Number		7109-1	7151-2	711-2	721	716-1	729 II, IV, V, VI	7340-1	7640-1	1011-1	7607 1 or 3	7607 2 or 4	1414-6	7909-1	7617-1	1009-1	1014-1	7155 1/2/3/4	7750 I, II or III	7608-1	7816-1
I	Height × Width × Depth, in.		69×60×28	49×60×41	32×32×30	50×40×26	47×59×30	29×34×69	60×48×29	70×74×30	60×32×24	69×56×30	69×56×30	70×73×31	70×38×32	30×30×17	40×29×31	35×24×29	12×8×7	70×181×31	58×61×29	69×56×30
PHYSICAL	Weight, lbs.		2,225	700	560	670	1,910	1,200	1,350	1,000	529	2,290	2,290	1,100	700	110	500	175	10	2,700	1,680	1,150
	Maximum Cable Lengths		From 7618 - 75 ft.	From 7618 - 75 ft. From 7109 - 65 ft.	From 716 - 30 ft.	From 716 - 20 ft.	From 7618 - 75 ft. From 7607 - 35 ft. To 711 - 30 ft. To 721 - 44 ft.	MTU to MTU 60 ft. From 7607 - 60 ft.			From 1414 - 90 ft.	Max combined cable length between 7607 & furthest tape unit - 60 ft. from plug (one per MTU leg) - 14 ft. from 7618 - 75 ft. From 7606 - 100 ft. From 7617 - 50 ft. Between 7607s 100 ft.		Max of 40 ft. from Data Channel.	For 2 channel system 100 ft per signal leg 140 ft to connect signal legs (total 340) Each additional channel reduces total by 40 ft).		From 1414 - 60 ft.	From 1414 - 50 ft.			50 ft. Input 50 ft. Output 50 ft. converter control connected only to 7618	From plug - 14 ft.
ATMOSPHERE	Storage Ranges	Temperature, °F.	←									50 to 110										→
		Humidity, %	←									0 to 80										→
	Working Ranges	Temperature, °F.	←									50 to 80										→
		Humidity, %	←									20 to 80										→
	Heat Dissipated, BTU/hr.		3,620	1,570	2,600	3,070	7,150	3,900	12,000	3,400	4,100	3,590	3,590	4,450	4,000	---	1,000	500	---	26,000 27,000 with TCP*	19,800	500
	Air Flow, cfm.		400	---	---	---	---	550	---	---	---	500	500	---	---	---	---	---	---	---	1,100	---
	Internal Filters				Yes	Yes	Yes	Yes							Yes	Yes			Yes		Yes	Yes
ELECTRICAL	Voltage	Nominal	←		208		→	208 or 230	208	208	208 or 230	208	208	208 or 230	208	208	115, 208, 230	115, 208, 230	208 or 230	208 or 230	208	208
		Tolerance																				
	Cycles	Nominal	←									60										→
		Tolerance																				
	Phases and Lines		3-phase, 5-wire	3-phase, 5-wire	3-phase, 4-wire	3-phase, 4-wire	3-phase, 4-wire	3-phase	3-phase, 4-wire	3-phase	1-phase, 3-wire	3-phase, 5-wire	3-phase, 5-wire	3-phase	3-phase, 4-wire	3-phase, 5-wire	1-phase, 3-wire	1-phase	3-phase	3-phase, 4-wire	3-phase, 5-wire	3-phase, 5-wire
	Load KVA		1.59	0.71	Supplied by 716 0.7	Supplied by 716 3.5	5.4	1.62	4.0	---	1.8	1.53	1.53	1.3	0.62	---	0.3	0.18	---	10.8	8.69	0.20
NOTES			7094 Feature #7146						Max 20	Max 1	Add 13" to depth for reading board.	Model 1 & 2, Max 10 729 II or IVs. Model 3 & 4 Max 10 729 II/IV/V/VIs Model 2 & 3 control a 711, 716 & 721. For additional MTU add up to 7-7607 Models 2 or 4. Each requires a 7617.			Max 4. Addition of 7909 reduces number of additional 7607s	One used with each 7607 in the system.				Max 1 *TCH= Telegraph Converter Base	This unit houses the motor-generator.	This unit houses the motor-generator controls and distribution power cables to the 7151, 7302 7606, 716 7108, 7109, 7909, & 7607s.

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT No.	IDENTITY OF UNIT Name	PRICES Monthly Rental $	PRICES Monthly Maintenance $	PRICES Purchase $
Central Processor (For 7094 Model I)	7109	Arithmetic Sequence Unit	8,675	453.00	368,000
	# 7146	7094 Feature	100	--	4,000
	7110	Instruction Processing Unit	16,350	609.00	693,000
	7151	Console Control Unit	1,325	13.00	66,700
Central Processor (For 7094 Model II)	7109	Arithmetic Sequence Unit	8,675	453.00	368,000
	# 7146	7094 Feature	100	--	4,000
	# 7147	7094 II Feature	--	--	---
	7111	Instruction Processing Unit	20,200	700.00	745,000
	7151	Console Control Unit	1,325	13.00	66,700
Storage (For 7094 Model I)	7606-1	Multiplexor	3,900	146.00	156,000
	# 7146	7094 Feature	50	--	2,000
	7302-1	Core Storage	17,500	580.00	840,000
Storage (For 7094 Model II)	7606-2	Multiplexor	4,600	150.00	184.300
	7302-3	Core Storage	19,000	610.00	880,000
Additional Storage		Disk Storage			
	1301-1	1 disk array (max 5 per system)	2,100	138.00	115,500
	1301-II	2 disk array (max 5 per system)	3,500	238.00	185,500
	763-II	File Control	835	30.00	42,000
	7631-III	File Control (7090 + 1410) (Max 2 attached to 7909s)	1,035	35.00	52,000
	7631-IV	File Control (7090 + other 7000 except 7072) (Max 2 attached to 7909s)	1,035	35.00	52,000
	# 3213	Cylinder Mode (on any 7631)	25	1.00	1,250
Data Channels		Data Channels			
	7607-1	Channel for 729 II/IVs (max 10), 711, 716	4,275	182.00	197,500
	7607-III	Channel for 729 II/IV/V/VIs (max 10), 711, 716	4,360	182.00	200,900
	7607-II	Channel for 719 II/IVs (max 10)	3,275	118.00	159,000
	7607-IV	Channel for 729 II/IV/V/VIs (max 10)	3,360	118.00	162,400
	7617	Data Channel Console (An extra 7617 required for each additional 7607)	225	16.00	10,900
		For 1301s, 7340s, 1410s or 7750			
	7909-1	Data Channel (max 4) optional	2,800	125.00	112,000
	# 1471	BCD Translation	100	1.00	4,200
	3224	Data channel switch (Addition of 7909s reduces number of 7607s possible)	125	1.00	5,000
Input-Output	711-2	Card Reader	800	63.25	32,000
	716	Printer	1,200	116.00	54,200
	721	Card Punch	600	62.25	25,000
	# 2250	Consecutive Number Punching (Optional feature for 721)	35	8.25	2,275
	729 II	Magnetic Tape Unit	700	116.00	36,000
	729 IV	Magnetic Tape Unit	900	128.00	41,250
	729 V	Magnetic Tape Unit	750	122.00	37,200
	729 VI	Magnetic Tape Unit	950	134.00	42,450
		Optional for 729 II/IV/V/VI			
	# 7830	Tape Switching Feature	85	6.50	4,400

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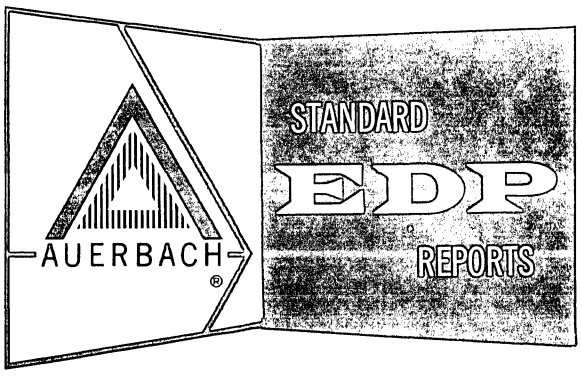
PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
Input-Output (Contd.)	7155	Switch Control Feature (#7830 required on each MTU to be switched)			
	model 1	for up to 2 MTUs	35	5.50	1,775
	model 2	for up to 4 MTUs	55	11.00	2,675
	model 3	for up to 6 MTUs	80	16.50	3,875
	model 4	for up to 8 MTUs	100	22.00	4,775
	7640	Hypertape Control (max 1)	3,400	102.00	218,000
	7340	Hypertape Drive (max 20)	1,300	130.00	78,000
		Optional for 7340 on 7909:			
	# 5975	Read Backward Char Assembly and Store	200	1.50	8,400
		Tele-Processing via:			
	1414-6	I/O Synchronizer	850	12.00	43,350
	# 3238	Data Transmission Unit adaptor for 1009	200	3.50	11,000
	1009	Data Transmission Unit	500	11.50	26,400
	# 5514	Paper Tape Reader adaptor for 1011	100	1.50	3,750
	1011	Paper Tape Reader	500	42.50	22,400
	# 6136	Remote Inquiry Unit adaptor for 1014	200	5.75	11,500
	1014	Remote Inquiry Unit (10 max)	200	12.50	11,000
	# 7864	Telegraph I/O Feature for 7871 and 7875	500	11.00	30,500
	7871	Telegraph Input Feature	110	3.25	6,750
	7875	Telegraph Output Feature	125	3.25	7,750
Power Supplies	7608	Power Converter	700	1.50	25,000
	7618	Power Control	900	5.00	35,000

IBM 7040

International Business Machines Corp.



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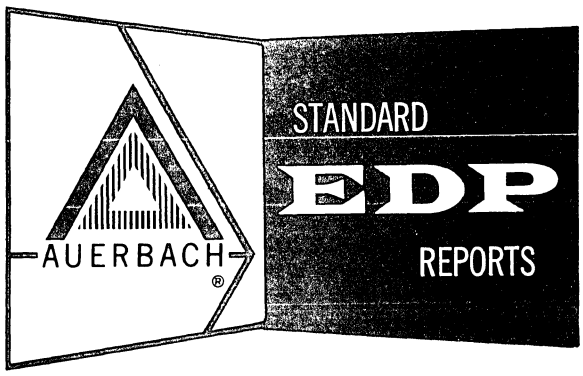
IBM 7040

International Business Machines Corp.



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RIP = Report in process.

§ 011. INTRODUCTION

The 7040 is a medium to large scale, solid-state, general purpose processing system. Unlike other members of the IBM 7090/7094 family, the 7040 (and the faster 7044) can communicate directly, storage-to-storage, with a 1401 and its input-output equipment, as well as with other 7040, 7044, 7090, and 7094 systems. The 7040 and 7044 are the only systems of the 704/709/7090/7094 group that can include high-speed printers and card readers in which all data transfers are parity checked.

The 7106 Central Processor is available in four models which differ only in storage size. Storage sizes are 4,096, 8,192, 16,384, and 32,678 words; each word contains 36 bits plus a parity bit. The basic storage or processor cycle time is 8 microseconds and all data transfers in the processor are performed in parallel. The 7106 is similar to the 704 processor in that it can be used either for processing or as a data channel for input-output transmission. The 7106 can also have four independent 7904 overlapped-transfer data channels connected to it.

The standard 7106 Central Processor has a set of fixed point arithmetic instructions and instructions for data manipulating, control, and input-output, but has no index registers. The Extended Performance option includes three index registers with a set of 20 instructions for using these registers, three single-character-handling instructions, a data block transfer instruction, and several sequence control instructions. Acquiring this option is almost mandatory because the software being written for the 7040 relies on the option for optimum object programs; also, the option can double the system throughput with an increase of five per cent or less in rental or price.

Other options are: Single Precision Floating Point (required for FORTRAN), Double Precision Floating Point (for which the Single Precision Floating Point option is a prerequisite), a Clock and Interval Timer, and a Memory Protect option.

The 7040 system can be programmed so that its programs can also be run on the 7090 and 7094 systems. Running 7090/7094 programs on the 7040 is almost impossible because many 7090/7094 instructions are not in the 7040 repertoire. Recompilation in a compatible language such as FORTRAN or COBOL is the only effective way to run 7090/7094 programs on a 7040. The 7040 software complement will be very similar to that for the 7090 (see 7090, Introduction), but will be restricted in capability and effectiveness on system configurations with smaller storage than the 7090.

The 7040 system has a very extensive interrupt system that provides definitive indications of the reasons for the interrupts, plus links back to the main program and to an interrupt processing routine. The interrupt system grows with the size of the system; with few exceptions, adding any option or piece of equipment adds another source or kind of interrupt. All interrupts can be enabled or disabled individually or in groups.

The input-output equipment is connected in modular fashion. The central processor is connected to 7904 Data Channels B through E by adapters. Since channel A is the central processor, no adapter is required. Next, the data channels are connected to synchronizers by another set of adapters, except in the cases of 7904 Direct Data connections (which connect to "real-time" devices such as radars and Direct Data connections on other systems), and the 1401 system connection on channel A. The synchronizers can be buffered or unbuffered controllers that are connected through a control adapter to the input-output unit or series of units. One data transmission at a time may be in progress on each data channel.

A characteristic of all 7040 terminal units is that parity is checked during data transmission operations at the core store, the data channel, and the terminal unit. Almost all the units have some form of built-in checking in their read or write circuits.

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§ 011. INTRODUCTION (Contd.)

The basic input-output controller in the system is the 1414 Synchronizer. Through these units two 1403 or 1404 Printers and a 1402 Card Read Punch can be connected. The communications equipment that can be connected to a 1414 permits data transmissions with any digital equipment that can use telegraph or telephone lines.

In comparison to other systems in its class, the 7040 appears to operate two to three times faster than the 709 system and at approximately half the speed of a 7090. Ignoring Hypertape units on input-output-limited problems, the 7040 speed should approach that of the 7090 very closely since the same disc storage and magnetic tape units are used with either system. The basic 7040 system rents for approximately one-third and an expanded system for approximately two-thirds that of a comparable 7090 system. The 7040 processor rents for approximately one-fourth that of the 7090 processor, but the input-output equipment costs the same on either system except for the controllers, which rent for somewhat less in the 7040 system.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word position:	36 bits + parity	basic addressable location in core storage.
Row:	6 bits + parity	character on magnetic tape.
Column:	single column code	character on punched cards.
Unit Record:	14, 17, 22 or 24 words	punched card and print image in core storage.
Group or "byte":	6 or 8 bits + parity bit	a BCD char on band of a disk surface.
Band:	2,790 char max	usable length of band in disk store.
Record:	1 to 2,790 char	related char in a band.
Record:	1 to N words	related words on magnetic tape.
Cylinder:	40 bands	addressable group of bands.
File:	1 to N records	magnetic tape or disk store.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	BCD char on magnetic tape or disk. card column.
Alphameric char: . . .	BCD char on magnetic tape or disk. card column. 6 bits of word.
Fixed point number:	sign bit plus 35 bits in word.
Floating point number:	sign bit plus 8 bit characteristic plus 27 bit fractional part in word.
Instruction:	1 word.
Data:	1 word.

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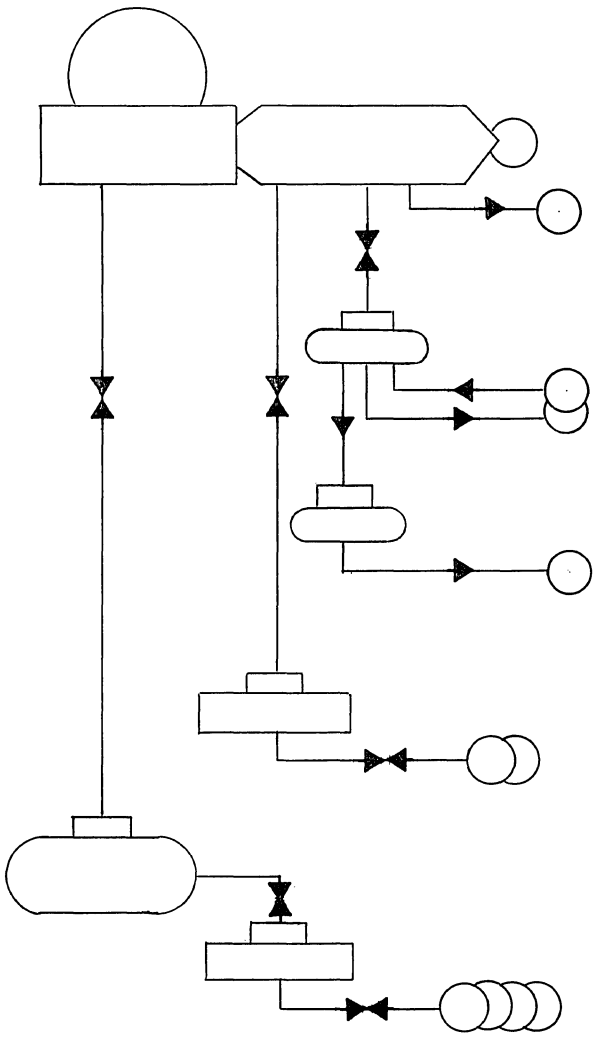
SYSTEM CONFIGURATION

§ 031

.1 6-TAPE BUSINESS/SCIENTIFIC; CONFIGURATION VI

Deviations from Standard Configuration: . . . . . 20% more core storage.
10% longer print line.
20% faster printer.
60% faster card reader.
150% faster card punch.



Equipment	Rental
Core Storage: 16,384 words, 7106 III Central Processor, with Console and Output, Typewriter, 15.5 char/sec.	$ 9,000
Processor Options (see below).	850
#1038 Card Adapter.	80
1414 III Synchronizer.	675
1402 Card Reader-Punch, Reader: 800, Punch: 250 cards/min.	615
#7680 Attachment, 1403.	550
#7681 Additional Synchronizer Storage.	60
1403 II Printer, 600 lines/min.	775
#1040 Tape Adapter.	120
1414 I Synchronizer.	975
729 II Magnetic Tape Units (2), 41,667 char/sec.	1,400
#1845 First Channel Adapter.	250
7904 I Overlapped Data Channel.	1,500
#1040 Tape Adapter.	90
1414 I Synchronizer.	975
729 II Magnetic Tape Units (4), 41,667 char/sec.	2,800
Total Rental:	$ 20,715

Optional Features Included: . . . . . Extended Performance, #3880.
Single Precision Floating Point, #4428.

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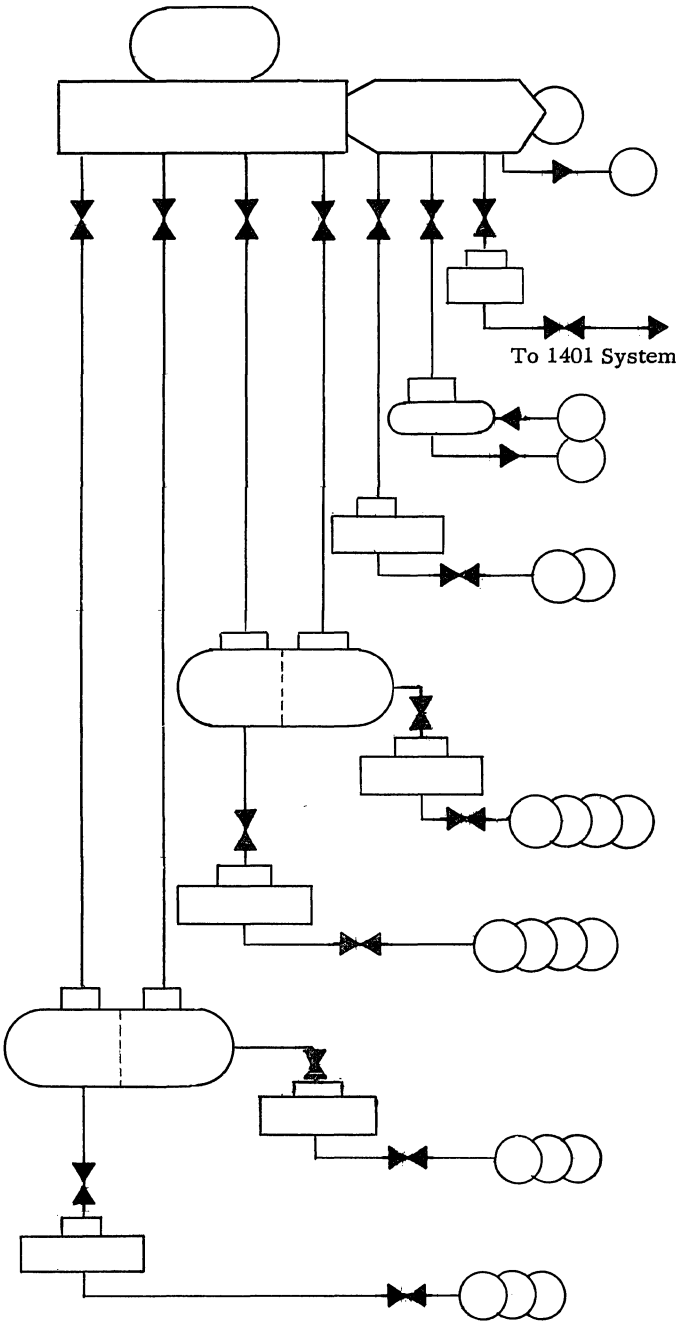
§ 031
.2 20-TAPE GENERAL-PAIRED; CONFIGURATION VIII B.

Deviations from Standard Configuration: . . . . . 23% more core storage.
10% longer print line.
150% faster card reader.
Extra card punch (comes with reader).
25% slower magnetic tapes.
Typewriter is output only.
70% fewer index registers (3 only).
On-line connection to paired system.



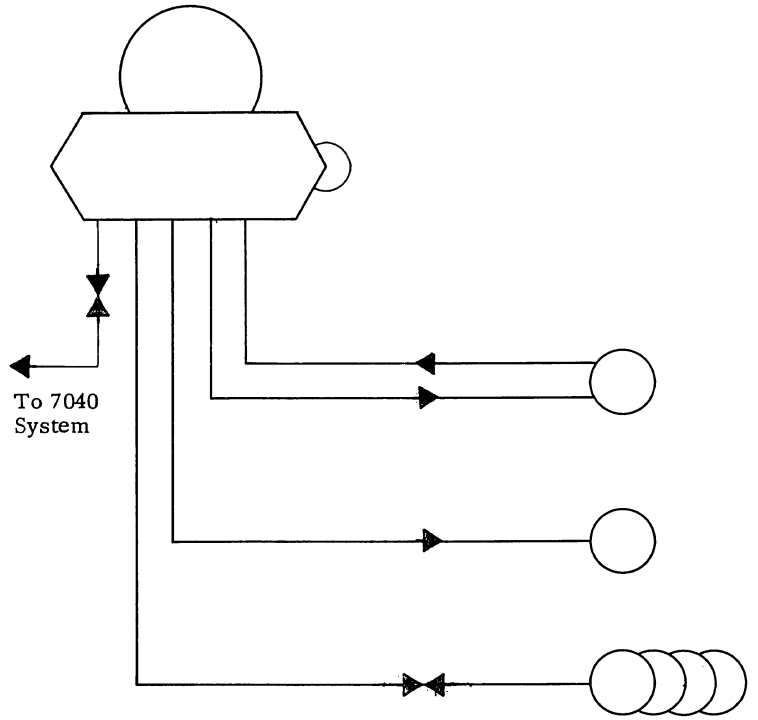
Equipment	Rental
Core Storage: 32,768 words,	$ 11,000
7106 IV Central Processor, with Console and Output	
Typewriter, 15.5 char/sec.	
Processor Options (see below)	985
#1034 Adapter, 1401.	100
#7080 Serial I/O Adapter, 87,000 char/sec.	100
#1046 Adapter, 1622.	95
1622 Card Reader-Punch,	615
Reader: 250, Punch: 100 cards/min.	
#1040 Tape Adapter.	120
1414 VII Synchronizer.	1,125
729 V Magnetic Tape Units (2), 60,000 char/sec.	1,900
#1845 First Channel Adapter.	250
#1846 Additional Channel Adapter.	50
7904 II Overlapped Data Channels (2 controllers)	2,000
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (4), 90,000 char/sec.	3,800
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (4), 90,000 char/sec.	3,800
#1846 Additional Channel Adapters (2).	100
7904 II Overlapped Data Channels (2 controllers).	2,000
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (3), 90,000 char/sec.	2,850
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (3), 90,000 char/sec.	2,850
Total Rental:	$38,600

Optional Features Include: . . . . . Extended Performance, #3880.
Single Precision Floating Point, #4428.
Clock and Interval Timer, #7498.
Memory Protect, #5080.

§ 031.

.2 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIII B (Contd.)

Auxiliary Computer (IBM 1401)



Equipment	Rental
1406 Core Storage: 8, 000 positions	$ 575
Processing Unit: 1401 Model C4	2, 730
Console	
1402 Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
1403 Printer: 600 lines/min.	835
729 V Magnetic Tape Units (4): 60, 000 char/sec.	3, 000
Optional Features	855
Total Rental:	$ 8, 545

Deviations from Standard Configuration . . . . . none.

Rental . . . . . $8, 545 per month.

Optional Features Included: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Processing Overlap.
Early Card Read.

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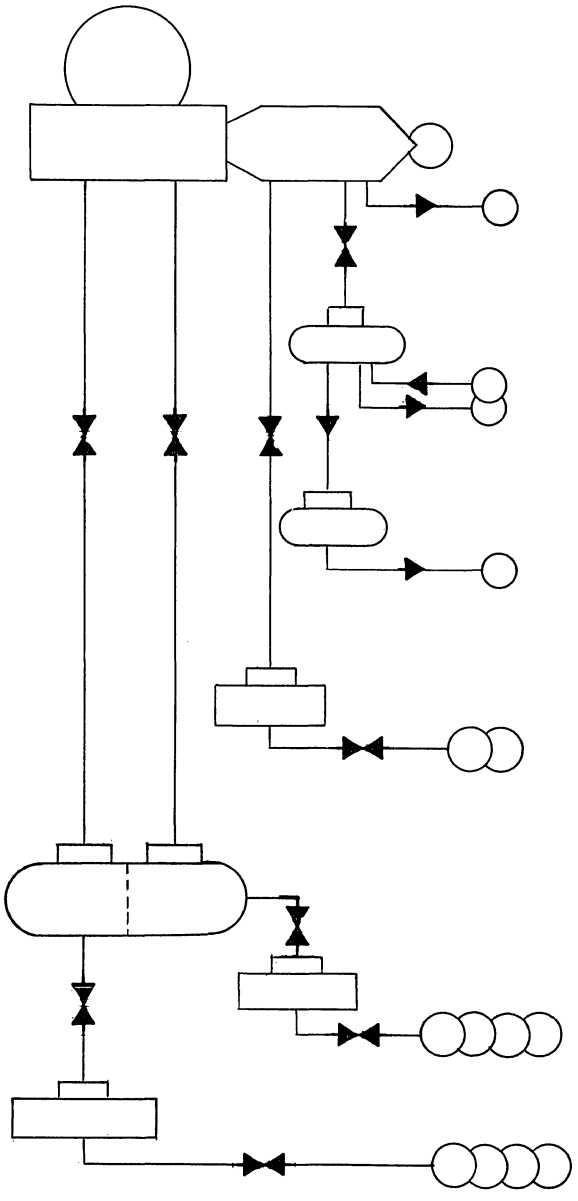
§ 031.

.3 10-TAPE GENERAL-INTEGRATED; CONFIGURATION VII A.

Deviations from Standard Configuration: . . . . . 65% more core storage.
10% longer printer line.
20% faster printer.
60% faster card reader.
150% faster card punch.
Typewriter is output only.
50% fewer index registers (only 3).



Equipment	Rental
Core storage: 32,768 words, 7106 IV Central Processor, with Console and Output Typewriter, 15.5 char/sec.	$ 11,000
Processor Options (see below).	910
#1038 Card Adapter.	80
1414 III Synchronizer.	675
1402 II Card Read-Punch, Reader: 800, Punch: 250 cards/min.	615
#7680 Attachment, 1403.	550
#7681 Additional Synchronizer Storage.	60
1403 II Printer, 600 lines/min.	775
#1040 Tape Adapter.	120
1414 I Synchronizer.	975
729 II Magnetic Tape Units (2), 41,667 char/sec.	1,400
#1845 First Channel Adapter.	250
#1846 Second Channel Adapter.	50
7904 II Overlapped Data Channels (2 controllers).	2,000
#1040 Tape Adapter.	90
1414 I Synchronizer.	975
729 II Magnetic Tape Units (4), 41,667 char/sec.	2,800
#1040 Tape Adapter.	90
1414 I Synchronizer.	975
729 II Magnetic Tape Units (4), 41,667 char/sec.	2,800
Total Rental:	$ 27,190

Optional Features Included: . . . . . Extended Performance, #3880.
Single Precision Floating Point, #4428.
Clock and Interval Timer, #7498

INTERNAL STORAGE: MAGNETIC CORE

§ 041.

.1 GENERAL

.11 Identity: . . . . . 7106 (Processor) Magnetic Core.
Models I, II, III, IV.

.12 Basic Use: . . . . . working storage.

.13 Description

The core storage is physically part of the central processor. The central processor model number is determined by its storage capacity; Models I, II, III, and IV having 4,096, 8,192, 16,384, and 32,768 storage locations, respectively.

A word is represented as 36 bits plus an odd parity bit. Odd parity checking is provided on all data transfers to, or from, the core store. A parity error sets an indicator which can cause an immediate or delayed interrupt of the program. When a parity interrupt occurs, the possibility of additional parity interrupts is automatically inhibited.

This store has a cycle time of eight microseconds, and it can accept or send data at a rate of 125,000 words per second either to the processor or any of the data channels.

A "Memory Protect" option (see Central Processor, 410:051.12) which will prevent the program from changing the contents of a region of storage is available with any of the models. Input-output operations are not inhibited by this option.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter: . . . . ?
Core bore: . . . . . ?

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.282 Reading method: . . . . sense wire.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 125,000 cps.
Unit of data: . . . . . word.
Conversion factor: . . 37 bits/word.
Data rate: . . . . . 125,000 words/second.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage			Maximum Storage
Identity:	7106 I	7106 II	7106 III	7106 IV
Words:	4,096	8,192	16,384	32,768
Characters:	24,576	49,152	98,304	196,608
Instructions:	4,096	8,192	16,384	32,768

.32 Rules for Combining Modules: . . . . . pick only one.

.4 CONTROLLER

.41 Identity: . . . . . central processor.

.42 Connection to System

.421 On-line: . . . . . core store is internal to the processor.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 5 data channels.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to 255 words.
.442 Input-output area: . . . all of storage.
.443 Input-output area access: . . . . . by word.
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . . . automatic.
.446 Synchronizing aids: . . none.
.447 Table control: . . . . . none.
.448 Testable conditions: . . parity error.

.5 ACCESS TIMING

.51 Arrangement of Heads: set of read/write circuits.

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§ 041.

.52 Simultaneous Operations

A: . . . . . Data Channel A.
B: . . . . . Data Channel B.
C: . . . . . Data Channel C.
D: . . . . . Data Channel D.
E: . . . . . Data Channel E.
F: . . . . . Computation.

A + B + C + D + E = 5.
B + C + D + E + F = 5.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 6.4 μ sec.
Cycle time: . . . . . 8.0 μ sec.
For data unit of: . . . 1 word.

.6 CHANGEABLE STORAGE: . . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possible
With self via processor: . . . . . yes.
With data channel: . . yes.

.72 Transfer Load Size

With self via processor: 1 to 255 words.
With data channel: . . . 1 to 32,767 words.

.73 Effective Transfer Rate

With self via processor: 8 + 16 μ sec per word.
With data channel: . . . 16 μ sec per word.

INTERNAL STORAGE: 1301 DISK STORAGE UNIT

§ 042.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit. 1301 Models 1 and 2.

.12 Basic User: . . . . . auxiliary storage.

.13 Description

The 1301 Model 1 Disk Storage Unit can store up to 27,900,000 alphameric characters. Model 2 has two modules on a single vertical shaft and can store up to 55,800,000 characters. Each module contains 25 discs; 40 of the 50 disc surfaces are used for data storage. Each module is served by a comb-like access mechanism. Forty data read-write heads, one for each data surface, move horizontally between the discs. The entire access mechanism moves as one unit, so the horizontal position of all the heads serving a given module is always the same. The 40 bands, one on each disc surface, that can be read or recorded upon when the access mechanism is in any given position are referred to as a "cylinder."

There are 250 bands on each disc surface. The size and number of records stored in each band are variable. Their formats are controlled by a format surface that can be written upon only by a special instruction after manually releasing a write lock. Each of the 250 bands on the format surface controls the record format of the entire cylinder in the corresponding position. A different record format can be used in each of the 250 cylinders in each module.

Data can be recorded in either the 6-bit or 8-bit mode. In the 6-bit mode each band can store up to 2,790 characters. In the 8-bit mode, only 2,160 alphameric characters can be stored in a band, and 6-bit groups are stacked in 8-bit locations. The other 2 bits on the disc are ignored or cleared. When more than one record is stored in a band, the data capacity is reduced by 38 characters for each additional record address. Instructions are provided to read or record a single record, a full band, or, with the optional Read/Write Cylinder feature (RC), a full cylinder of up to 111,600 characters.

Time for access mechanism movement ranges from zero (for a record in a previously-selected cylinder) to 180 milliseconds. Maximum rotation delay time is 34 milliseconds. Total reference cycle time to read a randomly-placed record of 270 characters, update it, re-write it, and execute a programmed write check is 248 milliseconds. If no access motion is required, the total reference cycle time is reduced to 88 milliseconds. Using the Read/Write Cylinder feature, an effective bulk transfer rate of 13,833 words, or 83,000 characters, per second can be achieved in the 6-bit mode.

.13 Description (Cont'd)

Checking features include a storage parity check, a validity check upon data received by the File Control, a comparison of the record address on the disc with the address in the stored program, and checks for illegal operation codes or sequences of instructions. Three check characters are generated and recorded during each write operation. When the record is read, the check characters are automatically generated again and compared with the ones read from the disc. As in the 7300 RAMAC unit, a programmed comparison of data recorded on a disc with data in core storage can be made.

A maximum of five 1301 Disk Storage Units can be connected to one or two 7631 File Controls. Each 7631 is attached to a 7040/44 via 7904 Channels. Two read or write operations can occur simultaneously when two File Controls are used. Every disc storage operation is initiated by a "channel select" instruction, which sends the core storage address of the initial channel command word to the specified Data Channel. Internal processing then continues while the Data Channel independently controls the disc operation. A group of 1301 units can be shared by two IBM 7000 series and/or 1410 systems.

Optional Features

#3213 Cylinder Mode (RC). Enables transfers of data, by one instruction, of a complete cylinder of up to some 18,600 words, or 111,600 characters.

.14 Availability: . . . . 12 to 15 months (**).

.15 First Delivery: . . . July, 1962.

.16 Reserved Storage

Purpose	No. of locations	Locks
Clocking:	1 disc surface	not addressable.
Spares:	6 disc surfaces	not addressable.
	2 disc surfaces	no heads available.
Format:	1 disc surface	manual lock.
Addresses:	31 + 38R char/band, for R records/band	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . multiple magnetic discs.

.22 Physical Dimensions

.222 Disc

Diameter: . . . . . 24 inches.
Thickness: . . . . thin.
Number on shaft: . . Model 1, 25 discs.
Model 2, 50 discs.

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.23 Storage Phenomenon: . magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . yes.
.242 Data regenerated constantly: . . . . no.
.243 Data volatile: . . . . no.
.244 Data permanent: . . . no.
.245 Storage changeable: . . . . no.

.25 Data Volume per Band of 1 Track

	6-bit mode	8-bit mode
Words:	465	360.
Characters:	2,790	2,160.
Digits:	2,790	2,160.
Instructions:	465	360.

Note: These are maximum capacities, based upon 1 record per band; each additional record address requires 38 characters, or 7 words.

.26 Bands per Physical Unit: . . . . . 250 per disc surface.

.27 Interleaving Levels: . 1.

.28 Access Techniques

.281 Recording method: . . magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to selected band: . .	if new band is selected.
Wait for selected record:	if same band was previously selected.
Wait for transfer of data:	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . 1,800 rpm.
Bit rate per track:. . 630,000 bits/sec, including char. gaps.
540,000 bits/sec, data bits only.
Note: based on 6-bit mode.

.292 Peak data rates
Unit of data: . . . . character.
Conversion factor: . 7 or 9 (including space bit).
Gain factor: . . . . 1 track/band.
Data rate
6-bit mode: . . . 90,000 char/sec.
8-bit mode: . . . 70,000 char/sec.
8,750 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	Minimum Storage	1301 Model 1	1301 Model 2	Maximum Storage 5 1301s. Model 2.
Discs:	0	20 data	40 data	200 data.
Words:	0	4,650,000	9,300,000	46,500,000.
Characters:	0	27,900,000	55,800,000	279,000,000.
Instructions:	0	4,650,000	9,300,000	46,500,000
Cylinder char:		111,600	223,200	1,116,000.
Cylinder word:		18,600	37,200	180,000.
Modules:	0	1	2	10.
Basis:	6-bit mode, 1 record/band.			

.32 Rules for Combining Modules: . . . . . up to five 1301s, Model 1 and/or Model 2 in any combination.

.4 CONTROLLER

.41 Identity: . . . . . File Control.
7631 Model 2, 3, or 4.

Data Channel.
7904 (see 410:101.12).
#1074 Channel Adapter.

.42 Connection to System

.421 On-Line: . . . . . one 7631 with one 7904.
.422 Off-Line: . . . . . 7631 Model 3 permits shared use of 1301s with an IBM 1410 system.

7631 Model 4 permits shared use with another 7000 series system (except 7072).

.43 Connection to Device

.431 Devices per controller: . . . . 5.
.432 Restrictions: . . . . maximum of 5 1301s per system, whether 1 or 2 7631s are used.

.44 Data Transfer Control

.441 Size of load: . . . . 1 record of up to 2,790 chars, 1 band of up to 2,790 chars, or (with read/write cylinder option) 1 cylinder of up to 111,600 characters.

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.442 Input-output area: . . . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . . automatic.
.447 Table control: . . . . no.
.448 Testable conditions: . . . . access not ready, access inoperable, and various error conditions are signaled by the File Control in response to a "sense" command.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
Stacks per system: . 40 to 400, data only.
Stacks per module: . 40.
Stacks per yoke: . . 40.
Yokes per module: . 1.
Total per system: . 50 to 500, including spares and control, (see 410:042.16).
.512 Stack movement: . . . horizontal.
.513 Stacks that can access any particular location: . . . . . 1.
.514 Accessible locations
By single stack
With no movement:. 1 band.
With all movement: . . . . . 250 bands.
By all stacks
With no movement: . . . . . 40 bands per module.
40 to 400 bands per system.
.515 Relationship between stacks and locations: . . . . . first 4 digits of 6-digits home address for each band denote head and band number.

.52 Simultaneous Operations

A: . . . . . seeking a specified location.
B: . . . . . reading.
C: . . . . . recording.

a + b + c = at most 1 per DSU module.
b + c = at most 1 per File Control.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, msec.	Example, msec.
Move head to selected band:	0 or 50 to 180	160.0.
Wait for selected record:	0 to 34	17.0.
Read one record:	0.4 to 34	4.0.
Read one band:	34.	
Total:	0.4 to 248	181.0.

.6 CHANGEABLE STORAGE: . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possibilities
With self: . . . . . no.
With core storage: . yes.

.72 Transfer Load Size

With core storage: . . 1 record, 1 band, or (with RC) 1 cylinder.

.73 Effective Transfer Rate

With core storage, using optional RC
6-bit mode: . . . . 83,700 char/sec.
13,950 words/sec.
8-bit mode: . . . . 65,000 char/sec.
10,833 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	indicator.
Invalid code:	check	indicator.
Receipt of data:	parity bit check	indicator.
Recording of data:	programmed write check; generate check characters	indicator.
Dispatch of data:	parity	indicator.
Timing conflicts:	check	indicator.
Physical record missing:	check	indicator.
Reference to locked area:	ignored.	
Access inoperative:	check	indicator.
Circuit failure:	check	indicator.
Illegal instruction sequence:	check	indicator.
Illegal format character:	check	indicator.

Note: These error indications are transmitted from the File Control to the computer in response to a "sense" command.

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CENTRAL PROCESSOR

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.1 GENERAL

.11 Identity: . . . . . 7106 Central Processor.

.12 Description

The 7106 Central Processor is a solid-state, medium to large-scale scientific computer which is available in four models. The models differ only in storage size. The 7106 is similar to the 709, 7090, and 7094 processors in its instruction repertoire, word length (36 bits), register complement, and use of independent simultaneous data channels. Many of the standard features on the 709, 7090, and 7094 processors are optional on the 7106. Like the 704 processor, the 7106 processor can also be used as a data channel (A), but no simultaneous processing can take place.

The basic processor, with no options included, has a standard instruction set, an input-output instruction set, indirect addressing capability, and the capability to be used as data channel A. An output-only IBM Selectric typewriter located on a desk below the processor console is connected to channel A. Index registers are not provided as standard equipment with the basic processor. The 7106 uses single-address one-word instructions which can be executed at a rate of approximately 60,000 instructions per second.

The basic instruction set includes: a full range of binary fixed-point arithmetic instructions; the AND, OR, and NOT logical instructions; a recursive "Execute" instruction; the 7 shift instructions used in the 709, 7090 and 7094; an extensive set of test-accumulator-and-branch instructions; and several other set bit and test instructions. Two new and very useful instructions are a "subroutine-branch" and a "multiply-accumulate". Most of the instructions require 16 microseconds for execution. The notable exceptions are multiplication (40 microseconds) and division (61 microseconds). Indirect addressing requires an additional eight microseconds. The "table look-at" instructions, useful for radix and code conversions in the 7090/94, have not been included in the 7040. However, three character-handling instructions are available in the Extended Performance instruction set (see optional equipment, below).

When the processor is used as data channel A, the accumulator, address, and multiplier-quotient registers are used for the duration of an input-output transfer to or from core storage, thus prohibiting any simultaneous calculations. Because the card reader, card punch, printer, and TELE-PROCESSING* equipment are fully buffered, calculation is

.12 Description (Contd.)

rarely delayed for more than one percent of the total input-output operation. The processor is stalled for less than 0.5 millisecond while the data is being transferred from any buffer to core storage. Magnetic tape start time and the time between single characters typed on the console typewriter can be overlapped with computation time, but the actual data transmissions are non-simultaneous with processing.

The basic input-output instructions are comprehensive, and permit the status-testing of all addressable devices. Two instructions are required to initiate a data transmission input-output operation. The first instruction selects the device, selects either the read or write mode, and ascertains the type of code translation (if any) to be used. The second instruction sets the data channel registers with the word count and the starting address in core from which data transmission will begin. These instruction assignments apply to all input-output data transmission operations, whether performed on a simultaneous 7904 Data Channel or data channel A. The only data channel command is "input-output a record and disconnect," which does not permit scatter-read and gather-write operations.

An extensive interrupt system is provided with the 7040. As the 7040 is expanded by adding options to the processor or adding input-output equipment and data channels, the interrupt system also expands. A direct indication of the cause of an interrupt (called "trap" by IBM) is provided by the system. When an interrupt occurs, the program counter and a detailed indication of the interrupt condition are stored in a location peculiar to the interrupt that caused it. The program counter is then set to the address of the data just stored plus one, where a transfer interrupt routine and interrupt routine should be stored. Thus, both a link to the interrupt routine and a link back to the main program are provided automatically. Interrupts are processed on a fixed priority basis. All interrupts are mutually exclusive, thus making the interrupt program routines straightforward. All interrupts can be enabled or disabled individually, or in groups, under program control.

Compatibility: Consideration has been given to compatibility in transferring 7040 programs to the 7090 or 7094. In the 7090/7094 to 7040 direction, about the only practical approach seems to be recompilation of the source program through a compatible source language translator, such as FORTRAN or COBOL, because many commonly used instructions for the 7090/7094 are not included in the 7040 set. All of the new 7040 instructions that do not exist in the 7090/7094 have been given instruction operation codes that would appear as "store and trap" instructions to the 7090/7094 which provide a

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.12 Description (Cont'd)

link to a 7040 interpretive routine that can perform (or ignore if not possible) the same function in the 7090/7094 instruction complement. A read and a write instruction in this form has been provided in addition to the 7090/7094 read/write operations. If input-output units that are common to both systems use the 7090/7094 instructions, and input-output units peculiar to the 7040 use the new read and write instructions, direct object program compatibility will result. Naturally, the equipment required by the 7040 program (such as double precision floating point hardware) must be available on the system that executes a 7040 program.

Optional Processor Features

Extended Performance, #3880: The Extended Performance option consists of three index registers and 20 instructions to load, unload, test, and change index registers; a load, a store, and a test single-character set of instructions; a test storage word plus or minus; and a move (up to 255 words) instruction. It is anticipated that most users will acquire this option for the following reasons:

(a) All of the major software packages require this option.

(b) The throughput capability of the system can be increased by between two and five times.

(c) It costs less than five percent of the cheapest reasonable system configuration.

(d) Programs written without this option will not be any more efficient if the option is added later. Even with recompilation the result would not be as efficient as a program written with this option, even assuming good software existed for the option.

Single Precision Floating Point Option, #4428: This option is very useful for scientific applications and is required if FORTRAN programs are to be run on the system. It consists of the normalized floating divide, and the unnormalized and normalized add, subtract, and multiply instructions.

Double Precision Floating Point Option, #4429: The #4428 Single Precision Floating Point option is a prerequisite for this option. Double Precision requires the addition of another register which is part of this option. The option is required if the double precision arithmetic statements in FORTRAN programs are to be used.

Clock and Interval Timer Option, #7498: This option enables the time in sixtieths of a second to be stored in location 00005 of core storage. Every 16.667 milliseconds the processor is interrupted and a ONE is added to the low order bit of location 00005. Because of higher priority or previous interrupts this timer interrupt may not be able to occur. If the timer has not been incremented after 33 milliseconds, all data channels will be reset (halting all input-output operations and setting all channel registers and indicators to zero except in the processor) and the timer-reset interrupt procedure allowed to begin. An overflow out of bit position one of the timer location causes a timer overflow interrupt. If this is ignored for 16.667 milliseconds because of higher priority or previous interrupts, the timer reset interrupt occurs as outlined above.

.12 Description (Contd.)

Memory Protect Option, #5080: This option causes storage to be protected in one of two ways, either to restrict the program from storing data in a core storage area or not. When a store instruction references a protected area, a protect interrupt occurs and the protected word is not changed. Input-output transfers are not affected by this option. The area is defined by a "set protect mode" instruction, which gives the seven high order address bits, and a count, which tells how many of the seven bits are to be used. This defines a region as all of the store from the high address down to a particular 256-word area. This instruction also determines whether only the area is protected, or all of the rest of storage is protected, but not the area. When the low order part of storage is protected, every interrupt will cause a protection violation since every interrupt stores indicators in this region at the time of the interrupt. This action causes what is called a pre-interrupt memory-protect trap. This trap links the interrupt routine that caused the interrupt to the memory protect interrupt routine which is, in turn, linked back to the normal program. When the protect mode is on, a "set protect mode" instruction will cause a protection interrupt as will any occurrence of a "release protect mode" instruction.

.13 Availability: . . . . . ?

.14 First Delivery: . . . ?

.2 PROCESSING FACILITIES

.21 Operations and Operands

	Operation and Variation	Provision	Radix	Size
.211	Fixed point			
	Add-Subtract:	automatic	binary	35 bits + sign + 2 overflow.
	Multiply			
	Short:	automatic	binary	0-35 bits + sign.
	Long:	automatic	binary	35 bits + sign.
	Divide			
	No remainder:	none.		
	Remainder:	automatic	binary	35 bits + sign.
.212	Floating point			Fraction Characteristic
	Single length			
	optional set:	automatic	binary	27 & 8.
	Add-Subtract:	automatic	binary	27 & 8.
	Multiply:	automatic	binary	27 & 8.
	Double length			
	optional set:	automatic	binary	54 & 8.
	Add-Subtract:	automatic	binary	54 & 8.
	Multiply:	automatic	binary	54 & 8.
	Divide:	automatic	binary	54 & 8.
.213	Boolean			
	AND:	automatic		36 bits.
	Inclusive OR:	automatic	binary	36 bits.
	NOT:	automatic		37 bits.

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.214 Comparison

Numbers:	automatic	35 bits + sign.
Absolute:	none.	
Letters:	automatic	36 bits.
Mixed:	same as letters	36 bits.

Collating sequence: . . . see Data Code Table No. 4, 410:144.

.215 Code translation: . . . none.

.216 Radix conversion: . . . none.

.217 Edit format

Alter size:	none.	
Suppress zero:	none.	
Round off:	none.	
Insert point:	see Boolean	36 bits.
Insert spaces:	see Boolean	36 bits.
Insert character:	see Boolean	6 or 36 bits.
Floating character:	none.	
Protection:	see Boolean	36 bits.

.218 Table look-up: . . . . . none.

.219 Others

Test:	automatic	1 to 36 bits.
Move:	optional	0 to 255 words.

.22 Special Cases of Operands

.221 Negative numbers: . . . binary magnitude and sign.

.222 Zero: . . . . . + or -; may or may not be equal; depends on instructions.

.223 Operand size determination: . . . . 36, 18, 15, or 1 bits; variable 0 to 36 bits in multiply and divide; 6 bit char in extended performance set.

.23 Instruction Formats

.231 Instruction structure: . 1 word.

.232 Instruction layout:

Variable:

Part	Operation	Flag/Count	Tag	Address
Size (bits)	12	6	3	15

Arithmetic and Data Transfer:

Part	Operation	Flag	Not Used†	Tag	Address
Size (bits)	12	2	4	3	15

Indexing‡:

Part	Operation	Decrement	Tag	Address
Size (bits)	3	15	3	15

† Not used for most instructions.
‡ Optional.

.233 Instruction parts

Name	Purpose
Operation:	operation code.
Flag:	indirect addressing.
Tag:	index register specification.
Address:	operand address.
Count:	counts and variable length operands.
Decrements:	index limits and modification values.

.234 Basic address structure: 1 + 0, sequential.

.235 Literals

Arithmetic:	none.
Comparisons and tests:	none.
Incrementing modifiers:	0 to 32,767.

.236 Directly addressed operands

.2361 Internal storage type	Minimum size	Maximum size	Volume accessible
Magnetic core:	1 bit	255 words †	entire storage.
Magnetic disc:	1 word	18,600 words ‡	entire storage.

† One word without extended performance instructions.
‡ 456 words without R/C option (see :042.013).

.2362 Increased address capacity: . . . . . none.

.237 Address indexing: . . . optional.

.2371 Number of methods: . 1.

.2372 Names: . . . . . indexing (can be multiple indexes.)

.2373 Indexing rule: . . . . . the contents of the indicated index registers are "ORed" together, then subtracted from the address of the instruction to form the effective instruction.

.2374 Index specification: . . each of the index bits specifies an index register.

.2375 Number of potential indexers: . . . . . 3.

.2376 Addresses which can be indexed: . . . all.

.2378 Combined index and step: . . . . . via indirect addressing or the EXC instruction.

.238 Indirect addressing	IA Bits	EXC Instruction
.2381 Recursive:	no.	yes.
.2382 Designation:	2 bits in the instruction	operation code EXC with or without the I A bits.
.2383 Control:	automatic, one level only	n-level; will not stop until another instruction other than EXC is encountered.

.2384 Indexing with indirect addressing: yes; possible before and after going to the indirect address.

.239 Stepping

.2391 Specification of increment: . . . . . in stepping instruction.

.2392 Increment sign: . . . . positive.

.2393 Size of increment: . . 0 to 32,767.

.2394 End value: . . . . . value of increment.

.2395 Combined step and test: . . . . . yes.

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.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in bits	Program usage
Accumulator:	1	38	arithmetic unit.
Address:	1	15	address storage.
Count†:	1	4	memory protection.
Double Precision Floating Point‡:	1	27	double precision add, subtract, multiply and divide.
Field†:	1	7	memory protection.
Index*:	3	15	address modification.
Instruction:	1	10	hold instruction during execution.
Multiplier-Quotient:	1	36 + check bit	low order bits of product, input-output, hold multiplier and quotient.
Position:	1	6	indirect address bit, operation code, character address of instruction being executed.
Program Counter:	1	15	address of next instruction.
Sense Switch:	6	1	accept condition.
Shift Counter:	1	8	counter for multiply, divide, input-output moves.
Storage:	1	36 + memory parity bit	buffer with core store.
Tag:	1	3	index(s) to be used to modify address.

† Requires memory protect option.
‡ Requires single and double precision floating point option.
* Requires Extended Performance Instruction Set.

.242 Category of storage	Total number of locations	Physical form	Access time, μ sec.	Cycle time, μ sec.
Accumulator:	1	register	1.33	8.
Address:	1	register	1.33	8.
Count†:	1	register	1.33	8.
Double-Precision Floating Point‡:	1	register	1.33	8.
Field†:	1	register	1.33	8.
Index*:	3	register	1.33	8.
Instruction:	1	register	1.33	8.
Multiplier-Quotient:	1	register	1.33	8.
Position:	1	register	1.33	8.
Program Counter:	1	register	1.33	8.
Sense Switch:	6	switches	2.66	--
Shift Counter:	1	register	1.33	8.
Storage:	1	register	1.33	8.
Tag:	1	register	1.33	8.

† Requires memory protect option.
‡ Requires single and double precision floating point option.
* Requires Extended Performance Instruction Set.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1 sequential.

.314 Special sub-sequence counters

Number	Purpose
Shift Counter:	counts shifts (not accessible by program)

.315 Sequence control step size: . . . . . 1 word.

.316 Accessibility to routines: . . . . . store; store and change; trap; store in index and change.

.317 Permanent or optional modifier: . . none.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes

In-out units:	parity error, end of file, incomplete word on tape, redundancy check, 1401 Attention, Direct Data.
In-out controllers: . .	adapter attention. Tele-Processing. free.
Storage access: . . .	Memory Protection violation. read core parity. write to core from input-output parity. release Memory Protection instruction. set Memory Protection instruction when Memory Protection is in use.
Processor errors: . .	floating point overflow or underflow. STR instruction. double precision floating point operand address.
Other:	Interval Timer Reset.

.332 Control by routine

Individual control: . .	mask for input-output units.
Method:	interrupts activated by instruction; some are disabled by the occurrence of other interrupts.
Restriction:	floating point, disallowed Memory Protect instruction, and STR traps always occur.

.333 Operator control: . . . can activate or deactivate all traps.

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.334 Interrupt conditions

INTERRUPT (TRAP) INTERACTIONS

If this action occurs / Then the trap status is	Interval Timer Reset	Memory Protect Violation	Parity Error	Pre-interrupt Memory Protect	Direct Data	Data Channel	ICT Instruction	Reset Button	Instruction			
									ENB/RCT	TRP	SPM	TRT
Memory Protect Violation	Off		Off					On		On		On
		Off		Off				Off			On	
								On				
Parity Error	Off		Off					On		On		On
			Off					On		On		
Pre-Interrupt Memory Protect	Off		Off					On		On		On
		Off		Off				Off			On	
Interval Timer Overflow	Off		Off					On		On		On
Direct Data	Off		Off					On		On		On
					Off	Off	Off	Off	On			
Data Channel	Off		Off					On		On		On
					Off	Off	Off	Off	On			

.335 Interruption process
Disabling interruption: The highest priority interrupt takes precedence except when the interrupt locations are Memory Protected. In the latter case a "pre-interrupt" causes an error indication, the program counter is saved*, Memory Protection is disabled, and then the interrupt that caused the pre-interrupt is executed.
Registers saved: . . . program counter is saved.

.336 Control methods
Determine cause: . . first of two words contains an error indication.
Enable interruption: . by instruction.

.337 Interrupt interaction: . not all interrupts interact (see .334).

.34 Multi-running

.341 Method of control: . . . own coding.

.342 Maximum number of programs: . . . . . own coding.

.343 Precedence rules: . . . own coding.

.344 Program protection
Storage: . . . . . Memory Protect option restricts to or from writing into an area except by an input-output unit.
In-out units: . . . . . none.
Maximum separate sets: . . . . . own coding.

* The program counter is set to the Memory Protect Interrupt Location.

.35 Multi-sequencing: . . . the 7040 can be used to communicate with an IBM 1401 system attached to channel A; the instantaneous peak transmission speed is 87,827 characters per second. Each of four 7904 Data Channels that can be attached to a 7040 can have a Direct Data Connection. This option can be used for online, "real-time" data communication between other IBM computers that have this option (can include the 7090 and 7094). The instantaneous peak transmission speed can be as high as 375,000 characters per second.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μ sec

.411 Fixed point
Add-subtract: . . . . 16.
Multiply: . . . . . 40 avg.
Divide: . . . . . 62 avg.

.412 Floating point

	single precision	double precision
Add-subtract:	24 avg.	36 avg.
Multiply:	35 avg.	96 avg.
Divide:	56 avg.	142 avg.

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.413 Additional allowance for
- Indexing: . . . . . none.
- Indirect addressing: . 8.
- Re-complementing: . none.

.414 Control
- Compare:. . . . . none.
- Branch: . . . . . 8.
- Compare and branch: 16.

.415 Counter control	With index option	Without index option
Step:	8	48.
Step and test:.	8	56.
Test:	8	16.

.416 Edit: . . . . . none.

.417 Convert: . . . . . none.

.418 Shift: . . . . . $16 + \frac{4 (\text{bits} - 6)}{3}$

.42 Processor Performance in μ sec

	Fixed point †	Fixed point *	Floating Point Single precision †	Floating Point Single precision *	Floating Point Double precision †	Floating Point Double precision *
.421 For random address						
c = a + b:	48		56		100.	
b = a + b:	48		56		100.	
Sum N items:	16N		24N		36N.	
c = ab:	72		67		160.	
c = a/b:	94		88		206.	
.422 For arrays of data	†	*	†	*	†	*
$c_i = a_i + b_j$:	136	56	144	64	194	106.
$b_j = a_i + b_j$:	136	56	144	64	194	106.
Sum N items:	112N	24N	120N	32N	148N	42N.
$c = c + a_i b_j$:	208	72	211	91	340	212.

† Without optional index registers.
* With optional index registers.

.423 Branch based on comparison	Without index option	With index option
Numeric data:	8 + 144N	32.
Alphabetic data: . . .	64 + 144 N	32.

.424 Switching		
Unchecked:	64	32.
Checked:	112	40.
List search:	88N	32N.
.425 Format control per character		
Unpack:.	200	43.
Compose:.	1,019	219.
.426 Table look-up per comparison		
For a match:	104N	40.
For least or greatest:	128N	48.
For interpolation point:	104N	40.
.427 Bit indicators		
Set bit in separate location:	32.	
Set bit in pattern: . .	32.	
Test bit in separate location:	32.	
Test bit in pattern:. .	48.	
Test AND for B bits: .	48.	
Test OR for B bits:. .	48.	

.428 Moving: . . . . . 8 + 16 per word (word is 6 char).

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator.
Underflow:	check	interrupt.
Zero divisor:	check	set indicator.
Invalid data:	not possible.	
Invalid operation:	none.	
Arithmetic error:	none.	
Invalid address:	not possible.	
Receipt of data:	check	interrupt.
Dispatch of data:	check	interrupt.
Protected address:*	check	interrupt.

* Optional feature.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . Console panel and desk, a part of the central processor.

.12 Description

The Console provides operator controls and displays of the registers and indicators of the system. The displays can be of use to the operator, the programmer, and to the customer engineer. Two notable additions have been made on the 7040/7044 console as contrasted with the rest of the 7000 scientific processors. First, the rocker switches have been replaced by arrays of pushbuttons representing octal codes: a set of six pushbuttons for the Sense Switches, an 8 by 12 pushbutton array for data entry, and an 8 by 5 array for the location pushbuttons. Secondly, location pushbuttons also have been added. This permits entering data set up on the 8 by 12 pushbutton array directly into storage as addressed by the location pushbuttons. This replaces the more cumbersome two-stage procedure of entering the data into the MQ register, resetting the switches, then storing the data. Visual checking is also made easier.

Another convenience of this console is the load button, which starts loading data at location 100 rather than at location zero. This preserves the data and program that may be held in the interrupt locations which are located in the first octal 100 locations of the store. The other 700 and 7000 scientific systems always cause the low-order three storage locations at least to be altered. The only drawback is that the "Read-Select" instruction must be set up on the data entry keys. This function is performed automatically in the other systems.

The console desk, which is located under the console panel, holds the output-only typewriter, and provides adequate desk space.

.2 CONTROLS

.21 Power

Name	Form	Comment
Master Power Connect:	switch	turns on power for on-off sequencing controls; activates power on and power off switches; lights when on.
Master Power Disconnect:	switch	turns off power for on-off sequencing controls; deactivates power on and power off switches; turns off light in master power connect switch.

.21 Power (Contd.)

Name	Form	Comment
Normal Power On:	switch	starts power on sequence for the CPU and auxiliary equipment under control of the power distribution unit.
Normal Power Off:	switch	starts power off sequence for the CPU and auxiliary equipment under control of the power distribution unit.
Emergency Power Off:	pull-type switch	when activated, all system power and all auxiliary power are immediately removed.

.22 Connections

Name	Form	Comment
Channel Bit Density:	switch	5 density switches, one for each possible data channel, are used to select magnetic tape density pairs; each switch has three positions 566/200, 800/200, and 800/556.

.23 Stops and restarts

Name	Form	Comment
Start:	button	starts operation after a program stop or after the CPU has been returned from manual to automatic status.
Automatic/ Manual:	switch	stops computer when set to Manual after it has completed the execution of the current instructions unless an I/O device is in use. In this case, the computer continues execution of instructions and remains in automatic until all I/O devices are disconnected from program control. The storage clock does not stop when the computer is in Manual mode. The switch is lit when the computer is in automatic.

.24 Stepping

Name	Form	Comment
Step Mode Selector:	switch	controls the operation mode when single or multiple step keys are depressed. The three positions are INSTRUCTION, CYCLE, and PULSE. INSTRUCTION is the normal setting, with the other two positions serving primarily as customer engineering aids.

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.24 Stepping (Contd.)

Name	Form	Comment
Single Step:	button	used only in manual mode to execute a program one instruction at a time. When input-output instructions are executed, the computer operates in automatic until all input-output devices are disconnected.
Multiple Step:	button	used only in manual mode to execute a program at a slow speed. The computer enters automatic for input-output (see single step).

.25 Resets

Name	Form	Comment
Clear:	button	stores zeros in all core storage locations and resets all CPU registers; inoperative when the computer is in true manual status.
Reset:	button	resets all registers and indicators in the logic section of the processing unit.

.26 Loading

Name	Form	Comment
Load:	button	when depressed, a read select instruction is taken from the entry keys. One record is read from the indicated device (a tape unit, card reader, or on-line 1401) into core storage starting from location 00100. After the unit is disconnected, the computer takes its next instruction from location 00101.

.27 Special

Name	Form	Comment
Display Storage:	button	displays contents of core storage location addressed by the entry keys; if storage clock is running, the displayed word will not be maintained in the storage register. Operates only when the CPU is in manual.
Enter Storage:	button	copies word from the word bank of the entry keys into core storage location indicated by the location bank of the entry keys; operates only when CPU is in manual.
Enter Instruction:	button	pressing this button executes the instruction set up in the word bank of the entry keys; CPU must be in manual status.
Sense:	switches	six switches; settings may be tested by the program.
Entry Switches:	buttons	an 8 by 5 matrix used as a location bank, and an 8 by 12 matrix used as a word bank; data is placed in the entry switches as octal numbers.

.27 Special (Contd.)

Name	Form	Comment
I/O Interlock Control:	switch	when on computer remains in manual whenever an I/O unit is selected; switch lights when it is on.
Continuous Enter Instruction:	switch	causes CPU to execute the instruction set up in the entry keys continuously if the CPU is placed in automatic and the start key is depressed; lights when on; an engineering aid.
Storage Clock:	switch	with the ON position, location 00005 is incremented 60 times per second; incrementing stopped by switching OFF position.

.3 DISPLAY

.31 Alarms

Name	Form	Comment
C B Thermal:	light	on whenever a circuit breaker, fuse, thermal, or airflow switch in the basic system or auxiliary equipment opens.

.32 Conditions

Name	Form	Comment
Master Stop:	light	on whenever the master stop trigger is on.
Program Stop:	light	on whenever the master stop trigger is on.
Program Stop:	light	on whenever the computer executes a halt instruction.
Ready:	light	off when the computer is in automatic status and the continuous interinstruction switch is on or the I/O interlock is in manual; otherwise, the light is on whenever the circuits have reached their operating level.
Channel in Use:	lights	five lights, one for each channel; on whenever the corresponding channel is in operation.
Redundancy Check:	lights	five lights, one for each channel; on when a redundancy is detected.
Input-Output Check:	light	the I/O check light is turned on by an irregular input-output event.
Position Register:	lights	five lights reflecting the contents of the indirect address trigger and positions 14 to 17 of the instruction being executed; positions 15 to 17 indicate which adapter is being used on a select instruction and the selected character on character-handling instructions.
Cycle Timer:	lights	six lights which reflect the current machine cycle; an engineering aid.
Clock Pulses:	lights	reflect the state of the timing ring; an engineering aid.
Tally Counter:	lights	indicate cycles of floating point instructions; an engineering aid.
FP1 and FP2	lights	reflect the condition of floating point triggers; customer engineering aids.

§ 061.

.32 Conditions (Cont'd.)

Name	Form	Comment
Parity Inhibit:	light	when on, parity traps are inhibited as a result of a previous parity trap.
Trap Inhibit:	light	when on, all traps are inhibited as a result of a parity or interval timer reset trap.
Channel Trap Control:	light	off when channel traps are inhibited as a result of a trap, ICT instruction or a machine reset.
Memory Protect:	light	on whenever the machine is operating in the memory protect mode.
AC Overflow:	light	on whenever any fixed-point or shifting operation yields a carry out of position 1 of the accumulator.
Divide Check:	light	on in fixed-point division if the dividend is greater than or equal to the divisor. In floating point, the light is turned on if the magnitude of the fraction of the dividend is greater than or equal to twice the magnitude of the divisor fraction.
Parity Check:	light	on when the parity circuits detect an error.
Q Carry:	light	on whenever a carry out of adder position Q occurs, an engineering aid.
X Carry:	light	on as a result of a carry out of adder position 21; an engineering aid.
9 Carry:	light	on whenever a carry occurs out of adder position 9; an engineering aid.
9 Overflow:	light	on whenever accumulator position 9 equals 1 in an accumulator left shift or during a 9-carry in an adder to accumulator operation; an engineering aid.

.33 Control Registers

Name	Form	Comment
Instruction Counter:	lights	fifteen lights which reflect the contents of the instruction counter.
Index A, B, and C:	lights	three sets of 15 lights, each of which displays the contents of the index registers.

.33 Control Registers (Contd.)

Name	Form	Comment
Instruction:	lights	nine lights which display the contents of the instruction register.
Shift Counter:	lights	eight lights which display the contents of the shift counter.
Tag:	lights	three lights which display the contents of the tag register.
Address:	lights	fifteen lights which display the contents of the address counter.
Storage:	lights	thirty seven lights which display the storage register sign, bits 1-35, and parity.
Accumulator:	lights	thirty-eight lights which display the accumulator sign, Q-bit, P-bit, and positions 1 to 35.
MQ	lights	thirty-seven lights displaying the MQ sign, positions 1 to 35 and parity.

.4 ENTRY OF DATA

.41 Into Registers: . . . . instruction may be entered when the machine is in manual. The desired instruction is set up in the entry switches and the enter instruction button pushed.

.42 Into Storage: . . . . . when the machine is in manual, one core storage location may be written into by pressing the enter storage button. The word and the desired location are obtained by setting the entry switches.

.5 CONVENIENCE

.51 Communication: . . . for engineers.

.52 Clock: . . . . . optional.

.53 Desk Space: . . . . . 40 x 20 inches.

.54 View: . . . . . when operator is at the console, all the equipment can be easily seen if it is conveniently placed.

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INPUT-OUTPUT: CARD READ-PUNCH (READER)

§ 071.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch, (Reader only). 1402 Model II.

.12 Description:

While the 1402 consists of a card reader and punch housed in the same cabinet, the two units are completely independent of one another from the user's viewpoint and are covered in separate sections of this report.

The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Conversion from the card column code to internal BCD code is automatic. A hole-count check is made on each column at a second reading station, and the bit configuration of each character is checked for validity as it is transferred into core storage. A hopper with a 3,000-card capacity and stacker with 1,000-card capacity can be loaded and unloaded without stopping the reader.

The 1402 can only be connected to data channel A via a 1414 III or IV Synchronizer. The channel, i.e., the central processor, is delayed only for the time of the actual data transfer; about 0.272 milliseconds. The 1414 acts as a buffer which is always loaded with the next card to be read. The data that is read contains 80 characters which are stored 6 characters to a word; the first 78 are stored in 13 words, and the last two characters are stored in the high order 12 bits of the fourteenth word. The remainder of the fourteenth word is set to zero. If less than fourteen words are requested in the read instruction, the last part of the card is ignored.

Optional Features

Read and Punch Column Binary, #6025: This option can only be used on a 1414 IV Synchronizer. It uses two of the six available 80-character buffers; one for the read section and one for the punch. No validity checking is possible but parity bits are used for Central Processor - 1414 data transfers. It is activated whenever 7 and 9 punches occur in column 1 of a card.

Interchangeable Feed, #4051: This option permits the reading of either 80- or 51-column cards by interchanging hardware, and reduces stacker capacity to 800 cards.

.13 Availability: . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . September, 1960

.2 PHYSICAL FORM

.21 Drive Mechanism

.211	Drive past the head:	clutch driven rollers.
.212	Reservoirs:	none.

.22 Sensing and Recording Systems

.221	Recording system: . .	none.
.222	Sensing system: . . .	brush.
.223	Common system: . .	no.

.23 Multiple copies: . . . none.

.24 Arrangement of Heads

Use of station: . . .	reading.
Stacks:	1.
Heads/stack:	80.
Method of use: . . .	one row at a time.
Use of station: . . .	checking.
Distance:	1 card.
Stacks:	1.
Heads/stack:	80.
Method of use: . . .	one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311	Medium:	standard 80-column cards (51-column cards with optional IF).
.312	Phenomenon:	rectangular holes.

.32 Positional Arrangement

.321	Serial by:	12 rows at standard spacing.
.322	Parallel by:	80 columns of standard spacing.
.324	Track use	
	Data:	80.
	Total:	80.
.325	Row use	
	Data:	12.

.33 Coding: . . . . . column code as in table 3, or binary pattern of holes in each column.

.34 Format Compatibility

Other device or system	Code translation
All devices using std. 80-column cards: .	not required.

.35 Physical Dimensions: . standard 80-column cards.

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.4 CONTROLLER

.41	Identity:	Channel A only. #1038 Adapter. 1414 III or IV Synchronizer.

.42 Connection to System

.421	On-line:	1.
.422	Off-line:	none.

.43 Connection to Device

.431	Devices per controller:	1.
.432	Restrictions:	1622 Read-Punch cannot be connected.

.44 Data Transfer Control

.441	Size of load:	1 card of 80 characters.
.442	Input-output areas: . .	core storage.
.443	Input-output area access:	1 word.
.444	Input-output area lockout:	none.
.445	Table control: . . .	none.
.446	Synchronization: . .	automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511	Size of block:	1 card.
.512	Block demarcation Input:	fixed.

.52 Input-Output Operations

.521	Input:	1 card forward.
.522	Output:	none.
.523	Stepping:	none.
.524	Skipping:	none.
.525	Marking:	none.
.526	Searching:	none.

.53	Code Translation . .	automatic by 1414 Synchronizer.
.54	Format Control: . . .	none.

.55 Control Operations

Disable:	no.
Request interrupt: . .	yes.
Offset card:	no.
Select stacker: . . .	no.
Select format:	no.
Select code:	with #6025 Read-Punch column binary.
Unload:	no.

.56 Testable Conditions

Disabled:	yes.
Busy device:	yes.
Nearly exhausted: . .	no.
Busy controller: . . .	yes.
End of medium marks:	no.
Exhausted:	yes.
Full stacker:	yes.

.6 PERFORMANCE

.61	Conditions:	none.

.62 Speeds

.621	Nominal or peak speed:	800 cards/min, all cases.
.622	Important parameters	
	Name:	read time in msec.
	Value:	0.272 (BCD), 0.496 (column binary).
.623	Overhead:	read time 2.5 msec (column binary).
.624	Effective speeds: . .	800 cards/min.

.63 Demands on System

Component:	processing unit.	
Condition:	read BCD	read column binary
Msec per card: . . .	0.272	0.496
or		
Percentage:	0.4	0.7

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Card width:	interchange of hardware.

.72 Other Controls

Function	Form	Comment
Load:	key	starts loading cards.
Check reset:	key	resets read error indicators.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	3,000 cards.
Stackers:	1,000 cards.

.732	Replenishment time: .	0.25 to 0.50 mins.
.733	Adjustment time (80- to 51-column cards):	10 to 15 mins.
.734	Optimum reloading period:	1.25 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	indicator and alarm.
Input area overflow:	cannot occur.	
Invalid code:	check	indicator and alarm.
Exhausted medium:	check	indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or indicator.
Feed jam:	check	stop and indicator.
Stacker full:	check	stop and indicator.

INPUT-OUTPUT: CARD READ-PUNCH (PUNCH)

§ 072.

.1 GENERAL

.11 Identity: . . . . Card Read-Punch, (Punch only). 1402 Model II.

.12 Description

Housed in the same cabinet as the card reader, this unit punches standard 80-column cards at a peak speed of 250 cards per minute. Conversion from internal BCD representation to the column card code is automatic. A reading station makes a hole-count check on each column. The 1,200-card feed hopper and three 1,000-card stackers can be loaded and unloaded without stopping the punch.

The 1402 can only be connected to data channel A via a 1414 III or IV Synchronizer. The channel, i.e., the central processor, is used for only the time for the actual data transfer of about 0.272 milliseconds. If less than 80 characters are transferred to the 1414, BCD blanks or binary zeros are punched depending on the selected mode. The 1414 is the buffer for the punch. The data that is to be punched is contained in 80 characters which are stored 6 characters to a word; the first 78 are stored in 13 words, and the last two characters are stored in the high order 12 bits of the fourteenth word. The remainder of the fourteenth word is ignored.

Optional Features

Read and Punch Column Binary, #6025: This option can only be used on a 1414 IV Synchronizer. It uses two of the six available 80 character buffers; one for the read section and one for the punch. Parity bits are used for central processor-1414 data transfers.

.13 Availability: . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punches.
.222 Sensing system: . . . brush.
.223 Common system: . . no.

.23 Multiple Copies: . . none.

.24 Arrangement of Heads

Use of station: . . .	punching.
Stacks:	1.
Heads/stack:	80.
Method of use: . . .	one row at a time.
Use of station:	checking.
Distance:	1 card.
Stacks:	1.
Heads/stack:	80.
Method of use: . . .	one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium:	standard 80-column cards.
.312 Phenomenon:	rectangular holes.

.32 Positional Arrangement

.321 Serial by:	12 rows at standard spacing.
.322 Parallel by:	80 columns at standard spacing.
.324 Track use	
Data:	80.
Total:	80.
.325 Row use	
Data:	12.
.33 Coding:	BCD or binary pattern of holes in each column.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity:	Channel A only. #1038 Adapter. 1414 III or IV Synchronizer.
.42 Connection to System	
.421 On-line:	one.
.422 Off-line:	none.
.43 Connection to Device	
.431 Devices per controller:	one.
.432 Restrictions:	none.

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.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 columns.
.442 Input-output areas: . . Core storage.
.443 Input-output area acess: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 1 card.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 card forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic, by processor.

.54 Format Control: . . . none.

.55 Control Operations

Disabled: . . . . . no.
Request interrupt: . . yes.
Offset card: . . . . . no.
Select stacker: . . . yes, one of 3.
Select format: . . . . no.
Select code: . . . . . BCD or column binary.
Unload: . . . . . no.

.56 Testable Conditions

Disable: . . . . . no.
Busy device: . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . no.
Busy controller: . . . yes.
End of medium marks: no.
Hopper empty: . . . yes.
Stacker full: . . . . . yes.

.6 PERFORMANCE

.61 Conditions . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 250 cards/min, (all cases).
.622 Important parameters

Name	Value
Load buffer BCD: .	0.272 msec.
Load buffer binary:	0.496 msec.

.623 Overhead: . . . . . load buffer time.
.624 Effective speeds: . . 250 cards/min.

.63 Demands on System

Component	Condition	msec. per card	or	Percentage
Processing Unit:	Punching BCD	0.272	or	0.3.
	Punching binary	0.496	or	0.6.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets punch error indicators.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stackers:	1,000 cards each.

.732 Replenishment time: . 0.25 to 0.50 mins. Punch does not need to be stopped.
.734 Optimum reloading period: . . . . . 4.0 mins.

.8 ERRORS, CHECKS AND ACTION

Errors	Check or Interlock	Action
Recording:	hole count	indicator and alarm.
Output block size:	fixed.	
Invalid code:	check	indicator and alarm.
Exhausted medium:	check	stop and indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or indicator.
Feed jam:	check	stop and indicator.
Stacker full:	check	stop and indicator.

INPUT-OUTPUT: CARD READ-PUNCH (READER)

§ 073.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch. (Reader only). 1622.

.12 Description

The Model 1622 Card Read-Punch can provide punched card input and output for channel A only on the 7040 system. The reader and punch feed units are separate and functionally independent. They contain their own switches, lights, checking circuits, and buffer storage. Nominal reading speed is 250 cards per minute, and almost all of card reading time is available for internal processing by the computer. Card hoppers have a capacity of 1,200 cards.

When a 1622 is attached to a 7040 system, no 1414 III, IV, or V Synchronizer may be attached. As a result this eliminates the possible use of 1403 or 1404 printers with the system. It also eliminates the possibility of attaching communications equipment to channel A. Communications equipment, however, may be attached to a 1414 VI Synchronizer via a 7904 Data Channel (B through E).

The reader has an 80-character buffer which stores the data in BCD code from one card. A read command from the processor transfers the buffer contents into core storage in 0.272 milliseconds and initiates the refilling of the buffer from the next card. A second sensing station reads each card and compares its data to the buffer contents. If an error is detected, card feeding stops. In addition, the 7040 checks parity of data received from the buffer; an error causes an indicator to be set which may be used by the program to transfer to error-handling subroutines.

The Model 1622 Card Read-Punch may also be used with the IBM 1620 I and II systems.

Optional Features

Read Octal/Binary, M01377: This feature permits the 1622 to read column binary images from cards. It consists of an 80 character buffer plus associated controls. A 7-9 punch in column one of a card causes this feature to be activated.

Read 800 CPM, M03473: This feature permits the 1622 to read cards as fast as a 1402 reader.

Read 500 CPM, M03474: Doubling of the normal card reading speed of the 1622 is provided by this feature.

File Feed, M00711: This feature permits placing as many as 300 cards in the hopper.

.13 Availability: . . . . 3 to 4 months.

.14 First Delivery: . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . rollers.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . none in Reader.
.222 Sensing system: . . . brush.
.223 Common system: . . no.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . 80.
Method of use: . . . 1 row at a time.

Use of station: . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . 80.
Method of use: . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . rectangular punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . BCD or binary.

.34 Format Compatibility: . . . all devices using standard 80-column cards.

.35 Physical Dimensions: standard 80 column cards.

.4 CONTROLLER

.41 Identity: . . . . . 1622 Adapter #1064.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

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.43 Connection to Device

.431 Devices per controller: One 1622 Card Read Punch.
.432 Restrictions: . . . . A 1414 III, IV, or V Synchronizer can not be used with the system.

.44 Data Transfer Control

.441 Size of load: . . . . 80 columns.
.442 Input-output areas: . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output lockout: . . . . . no.
.445 Table control: . . . no.
.446 Synchronization: . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . 80 columns.
.512 Block demarcation Input: . . . . . The smaller of the word count or 80 columns.

.52 Input-Output Operations

.521 Input: . . . . . read 80 char from reader buffer into core storage and initiate reading of 1 card.
.522 Output: . . . . . see Section :074.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic.

.54 Format Control

Control: . . . . . program.
Format alternatives: . 2 (BCD or binary).
Rearrangement: . . . no.
Insert spaces: . . . no.
Section sizes: . . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . yes.
Offset card: . . . . no.
Select stacker: . . . no.
Select format: . . . yes (BCD or column binary).
Select code: . . . . see format.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . no.
Busy controller: . . yes.
Hopper empty: . . . yes (last card read).
Stacker full: . . . . yes.
Read data transfer error: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 250 cards/minute.
.622 Important parameters
Buffer unload time
BCD: . . . . . 0.272 msec.
Binary: . . . . . 0.496 msec.
.623 Overhead: . . . . . buffer load time.
.624 Effective speeds: . . 250 cards/minute if processing time per card does not exceed approximately 237 msec.

.63 Demands on System

Component	msec per card	Percentage
Processor		
BCD:	0.272	0.2.
Binary:	0.496	0.7.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none.

.72 Other Controls

Function	Form	Comment
Restore ready status:	momentary switch	Start key; does not actually start reader.
Remove ready status and stop reader:	momentary switch	Stop key; computer stops at next read command.
Read 1 card into storage and refill buffer:	momentary switch	Load key.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stacker:	1,000 cards.

.732 Replenishment time: . . . . . 0.5 minute; device does not need to be stopped.
.733 Adjustment time: . . none.
.734 Optimum reloading period: 4.8 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity and data comparison with check station	stop, set indicator; terminate ready status.
Input area overflow:	none.	
Invalid code:	parity check only.	
Exhausted medium:	interlock	set alarm, indicator.
Imperfect medium:	see reading errors.	
Timing conflicts:	interlock	wait, or indicator.
Misfeed or jam:	interlock	ready status removed, set indicator.
Dispatch of data:	parity check at 7040	set alarm, indicator.

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INPUT-OUTPUT: CARD READ PUNCH (PUNCH)

§ 074.

.1 GENERAL

.11 Identity: . . . . . Card Read Punch. (Punch only). 1622.

.12 Description

The Model 1622 Card Read-Punch can provide punched card input and output for channel A only on the 7040 system. The reader and punch feeds are separate and functionally independent, and contain their own switches, lights, checking circuits, and buffer storage. Nominal punching speed is 125 cards per minute, and almost all of card punching time is available for internal processing by the computer. Card hoppers have a capacity of 1,200 cards.

When a 1622 is attached to a 7040 system, no 1414 III, IV, V Synchronizer may be attached. This eliminates the use of a 1403 or 1404 printer with the system. It also eliminates the possibility of attaching communication equipment on Channel A although it can be attached to a 1414 VI Synchronizer via a 7904 Data Channel (B through E).

The punch has an 80-character buffer which stores the data for one card. A punch command from the processor transfers data for one card to the buffer in 0.272 milliseconds. The processor checks parity of the data sent to the punch buffer and sets a testable indicator if an error occurs, and inhibits punching of the card.

The data is punched, the punch buffer contents are parity checked, and the card is read at a checking station for agreement with the punch buffer contents. Failure of the parity check or checking station comparison halts the punch and sets an indicator. Also the program can select a stacker.

The Model 1622 Card Read-Punch may also be used with the IBM 1620 I and II systems.

Optional Features

Punch Octal/Binary, M01376: Permits the 1622 to punch column binary images into cards. The feature consists of an 80-character buffer plus associated controls.

Punch 250 CPM, M99145: This feature doubles the normal punching speed of the unit making it as fast as the 1402 punch.

.13 Availability: . . . . . 3 to 4 months.

.14 First Delivery: . . . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . die punches.
.222 Sensing system: . . . . brush.
.223 Common system: . . . . no.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . checking.
Distance: . . . . . ?
Stacks: . . . . . 1.
Head/stack: . . . . . 80.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . BCD and Binary.

.34 Format Compatibility: . all devices using standard 80-column cards.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . 1622 Adapter #1046.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

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.43 Connection to Device

.431 Devices per controller: 1 1622 Card Read Punch.
.432 Restrictions: . . . . . a 1414 III, IV, or V Synchronizer cannot be used with the system.

.44 Data Transfer Control

.441 Size of load: . . . . . 80 card columns.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . no.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 80 card columns.
.512 Block demarcation Output: . . . . . the smaller or the word count or 80 card columns.

.52 Input-Output Operations

.521 Input: . . . . . see Section :073.
.522 Output: . . . . . transfer 80 columns from core storage to punch buffer and initiate punching of 1 card.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control

Control: . . . . . program selection of mode.
Format alternatives: . . 2, BCD or binary.
Rearrangement: . . . . no.
Insert spaces: . . . . . rightmost columns are left blank if count is 13 or less.
Section sizes: . . . . . see insert spaces.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . no.
Offset card: . . . . . no.
Select stacker: . . . . . yes.
Select format: . . . . . yes, BCD or binary.
Select code: . . . . . see format.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
Hopper empty: . . . . . yes.
Stacker full: . . . . . yes.
Write data transfer error: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 125 cards/minute.
.622 Important parameters
Buffer load time: . . . BCD 0.272 msec.
binary 0.496 msec.
.623 Overhead: . . . . . buffer load time.
.624 Effective speeds: . . . . 125 cards/minute if processing time per card does not exceed approximately 477 msec.

.63 Demands on System

Component	msec per card	Percentage
Processor BCD punching:	0.272	0.1
Binary punching:	0.496	0.2

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . none.

.72 Other Controls

Function	Form	Comment
Restore ready status:	momentary switch	start key; does not actually start punch.
Stop punch unit on 1622 error:	2-position switch	Stop/N-Stop switch.
Remove ready status and stop punch:	momentary switch	stop key.

.73 Loading and Unloading

.731 Volumes handled
Storage Capacity
Hopper: . . . . . 1,200 cards.
Stacker: . . . . . 1,000 cards.
.732 Replenishment time: . . 0.5 minutes; unit does not need to be stopped.
.733 Adjustment time: . . . . none.
.734 Optimum reloading period: . . . . . 9.6 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Data transmission:	parity check at 1620	set indicator and alarm.
Recording:	parity check on buffer	halt before punching if Stop/N-Stop switch on Stop.
	check station comparison with buffer	send card to error stacker. Stop, set alarm if Stop/N-Stop switch on Stop.
Output block size:	none.	
Invalid code:	parity check only.	
Exhausted medium:	interlock	ready status removed.
Imperfect medium:	see recording errors.	
Timing conflicts:	interlock	wait or indicator.
Misfeed or jam:	interlock	ready status removed, set indicator.

INPUT-OUTPUT: PAPER TAPE READER

§ 075.

.1 GENERAL

.11 Identity: . . . . . Paper Tape Reader. 1011.

.12 Description:

The 1011 Paper Tape Reader can be connected to a 7040 system through data channel A via a 1414 IV or V Synchronizer, or on any of the 7904 Data Channels via a 1414 VI Synchronizer only. Only one 1011 can be attached to each 1414.

The paper-tape reader can accommodate any 5, 6, 7, or 8-track tape, chad or chadless (in good condition). The tape width can be either 11/16, 7/8 or 1 inch. Data can be read from reels, center-feed rolls, or strips, at a peak speed of 500 characters-per-second. Since the maximum block size is 80 characters (restricted by the 1414 buffer size), the effective speed is about 467 characters-per-second.

The 1011 Paper Tape Reader uses a plugboard to transmit its output to the 1414. The plugboard permits the rearrangement of up to four tracks, character deletion, and code translation. The inputs from the photoelectric heads are connected from tape channel hubs to the decoder network. The 67 possible outputs of the decoder and a parity error output can be wired to any of the 64 encoder inputs permitting any 6-bit code to be generated. The output of the encoder, which is sent to the 1414 Synchronizer, is the 1400 series 6-bit BCD code plus an odd parity bit. An end-of-record input is also available which causes reading to terminate and the remainder of the 80-character block to be filled by a character selected from the encoder.

When 5-channel Teletype code is used, a switch can be wired which causes the letter and figure shift character to be suppressed and to set the decoder to the correct shift. The output of the decoder then contains all 58 telegraphic codes including blank.

.13 Availability: . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211	Drive past the head: .	sprocket drive.
.212	Reservoirs	
	Number:	2.
	Form:	swinging arm.
	Capacity:	about 2 feet.
.213	Feed drive:	motor.
.214	Take-up drive: . . .	motor.

.22 Sensing and Recording Systems

.222	Sensing system: . . .	photoelectric.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

	Use of station: . . .	reading.
	Stacks:	1.
	Heads/stack:	8.
	Method of use: . . .	reads one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311	Medium:	paper tape.
.312	Phenomenon:	punched holes (chad or chadless type).

.32 Positional Arrangement

.321	Serial by:	1 to N rows at 10 per inch.
.322	Parallel by:	5 to 8 tracks at standard spacing.
.324	Track use	
	Data:	6 or 5.
	Redundancy check: .	1 or 0.
	Timing:	1 (sprocket track).
	Control signals: . .	1 or 0.
	Unused:	0.
	Total:	8 to 5 (plus sprocket track).
.325	Row use	
	Data:	variable.
	Redundancy check: .	0.
	Timing:	0.
	Control signals: . .	1 (end-or-record; optional).
	Unused:	0.
	Gap: (if calibrated) .	2.

.33 Coding: . . . . . normally 5-track telegraphic or 8-track IBM coding; most 5, 6, 7, or 8-track codes can be translated by plugboard wiring to any 6-bit code.

.34 Format Compatibility

Other device or system	Code translation
Most devices using 5, 6, 7, or 8-track paper tape:	plugboard wiring.

.35 Physical Dimensions

.351	Over-all width: . . .	11/16, 7/8, or 1 inch.
.352	Length	
	Strip:	20 to 240 inches.
	Roll (inside feeding):	5 to 400 feet.
	Reel (outside feeding):	5 to 1,000 feet.

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.4 CONTROLLER

.41 Identity: . . . . . 1414 IV, V, or VI, Synchronizer.
no separate controller.
#5514 Paper Tape Reader Adapter.

.42 Connection to System

.421 On-line: . . . . . 1 per 1414 Synchronizer.
Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . requires 1 of the 6 1414 Synchronizer 80-char buffers.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to N characters, where N is limited by available core storage.
.442 Input-output areas: . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . none.
.446 Synchronization: . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 1 to 80 characters.
.512 Block demarcation Input: . . . . . end-of-record character on tape, or physical end of tape, or 80 characters.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . plugboard wiring.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . undefined.
Rearrangement: . . . no.
Suppress zeros: . . . yes.
Insert point: . . . . . no.
Insert spaces: . . . . no.
Section sizes: . . . . no.
Omit unwanted characters: . . . . yes.
Assign several tape codes to one character: yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . yes.
Select format: . . . no.
Select code: . . . . no.
Rewind: . . . . . no.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . yes.
Nearly exhausted: . . no.
Busy controller: . . . yes.
End of medium marks: . . . . . yes.
Exhausted: . . . . . yes.
Buffer being filled: . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 500 char/sec.
.622 Important parameters

Name	Value
Tape speed:	50.0 inches/sec.
Start time (to full speed):	2.5 m. sec average, 9.0 m. sec max.
Stop distance: . . .	1.5 rows average, 2.0 rows max.

.623 Buffer unload time Overhead: . . . . . 0.272 msec/block
.624 Effective speeds: . . 500 N/ (N + 4) char/sec., where N = number of char/block.

.63 Demands on System

Component: . . . . . Processing Unit.
Condition: . . . . . buffer unloading.
Msec per block: . . . 0.272.
or
Percentage: . . . . . 0.1.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustments	Method
Tape width:	change reels.
Tape code:	change plugboard panels.

.72 Other Controls

Function	Form
Reset alarm circuits: .	key.
Reel/strip selector: .	2-position switch.

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.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Supply & take-up reels:	1,000 feet.
Center-roll feed: . .	400 feet.

.732 Replenishment time: . 0.3 to 0.5 mins. for strips.
1.0 to 2.0 mins for reels.

.733 Adjustment time: . . 2.0 to 3.0 mins.

.734 Optimum reloading period: 4.0 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check*	set indicator.
Input area overflow:	none.	
Invalid code:	plugboard wiring	as wired.
Exhausted medium:	check	stop, set indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait, or set indicator.
Excessive stop distance:	check	set indicator.
Photocell failure:	check	stop; alarm.

* No parity check on 5-track tape.

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INPUT-OUTPUT: PRINTER

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.1 GENERAL

.11 Identity: . . . . . Printer.
1403, Models 1 and 2.
PR

.12 Description

The 1403 is a line printer with horizontal-chain printing mechanism, tape controlled carriage, and feeding and stacking system for continuous forms. Each character is printed as it is positioned opposite a magnet-driven hammer that presses the form against the moving chain at the correct printing position. Peak speed is 600 lines per minute at single spacing and 480 lines per minute at an average spacing of one inch. Model 1 has 100 printing positions and Model 2 has 132; they are identical in all other respects. The Model 2 Printer requires the additional Synchronizer Storage option (see below) for the 1414.

The 1403 can only be connected to data channel A via a 1414 III or IV Synchronizer. The channel, i.e., the central processor, is used for only the time for the actual data transfer of about 0.320 or 0.384 milliseconds for models 1 and 2 respectively. The 1414 acts as a buffer between the processor and the printer. The data to be printed consists of either 100 or 132 characters which are stored 6 characters to a word. Only the first 100 (or 132) are transferred to the buffer if the word count in the print instruction is greater than 16 (or 22). When the word count is smaller, the remainder of the line to be printed is filled with blanks.

Optional Features

Additional Synchronizer Storage, Printer #7680: This option must be added to a 1414 III or IV Synchronizer when a 1403 II is used.

Interchangeable Chain Cartridge Adapter, #4740: This option can be added to a 1403 if more than one type font or the numeric font is required.

Numerical Print Feature, #5381: Option #4740 is also required for this feature which permits printing the characters 0 through 9, plus six special characters, at a rate of 1285 lines per minute. Two sets of numerical type are available (#9485 and #9484).

Special Print Chain, #5530: Several special character sets and fonts are available. This feature requires option #4740.

Selective Tape Listing Feature, #6411: Eight 1.5 inch or four 3.1 inch tapes can be printed and spaced separately. A 1403 Model II is required to make full use of this option.

.13 Availability: . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . sprocket drive push and pull, paper punched on both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . magnet-driven hammer presses form against moving horizontal chain.

.222 Sensing system: . . . echo check on hammer magnet.

.223 Common system: . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . 6.

.232 Types of master
Multilith: . . . . . yes, with special ribbon.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . 100 or 132.
Method of use: . . . one line at a time.

.25 Range of Symbols

Standard Set

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	12	&, □ - $ * / % # @ ÷ .
Alternatives:		by special request.
FORTRAN set: . . .		alternative Print Set F.
Basic COBOL set: . .		no.
Total:	48 and blank.	

Numeric Set (NP)

Numerals:	10	0-9.
Letters:	0	
Special:	6	$. , * - □ .
FORTRAN set: . . .		no.
Req. COBOL set: . .		no.
Total:	16 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

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.311 Medium: . . . . . continuous fanfold sprocket punched stationery.
.312 Phenomenon: . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 line at 6 or 8 per inch.
.322 Parallel by: . . . . . 100 or 132 characters at 10 per inch.
.324 Track use
Data: . . . . . 100 or 132.
Total: . . . . . 100 or 132.
.325 Row use
Data: . . . . . all.

.33 Coding: . . . . . engraved character font (Internal coding as in Data Code Table No. 4).

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Over-all width: 3.50 to 18.75 in. by vernier.
.352 Length:
Forms: . . . . . 1 to 22.0 by 1/6 inch at 6 lines/in.
1 to 16.5 by 1/8 inch at 8 lines/in.
1 to 17.0 inches (recommended maximum for proper stacking).
continuous roll or fanfold.
.353 Maximum margins:
Left: . . . . . 3.0 inch.
Right, Model 1: . . 6.2 inch.
Model 2: . . 3.0 inch.

.4 CONTROLLER

.41 Identity: . . . . . #1038 Adapter.
1414 III or IV Synchronizer.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: . . . . . 1.
.432 Restrictions: . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . 1 line of 100 or 132 characters in multiple of 6.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: no.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 100 or 132 char per line.
.512 Block demarcation
Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 line forward with single step.
.523 Stepping: . . . . . step 1, 2, or 3 lines as separate operation, or as combined "print then step".
.524 Skipping: . . . . . skip to one of 12 channels on paper tape loop; may be combined in "print then skip".
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic, by processor.

.54 Format Control

Control: . . . . . program.
Format alternatives: . none.
Rearrangement: . . . no.
Suppress zeros: . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . no.
Section sizes: . . . . no.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . yes.
Select format: . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . no.
Busy controller: . . . yes.
End of medium marks: no.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard character set, Model I.
II: . . . . . standard character set, Model II.
III: . . . . . numeric set (NP), Model I.
IV: . . . . . numeric set, Model II.

.62 Speeds

.621 Nominal or peak speed: I & II, 600 lines/minute.
III & IV, 1285 lines/minute.
.622 Important parameters

Name	Value
Print 1 line, I & II:	100.0 m. sec.
Print 1 line, III & IV:	46.7 m. sec.
Skipping speed: . .	33.0 in/sec for skips of 8 lines or less. 75.0 in/sec for skips of more than 8 lines.

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.623 Overhead

Step 1 line:	20 m. sec.
Step 2 lines:	25 m. sec.
Step 3 lines:	30 m. sec.
Independent skip N lines:	15 + 5N m. sec. (N < 9). 37.4 + 2.2N m. sec. (N ≥ 9, all others).
Print & skip N lines, I & II:	as above + 80.0 m. sec.
Print & skip N lines, III & IV:	as above + 26.7 m. sec.

.624 Effective speeds:

Average line feed, inches	Lines/min., I & II	Lines/min., III & IV
1/6:	600	1,285
2/6:	572	1,160
3/6:	545	1,059
1:	480	838
2:	418	664
4:	353	514

(See graph)

.63 Demands on System

Component	Condition	m.sec per line,	or	Percentage*
Processing Unit:	I	0.320	or	0.3
	II	0.384	or	0.4
	III	0.320	or	0.6
	IV	0.384	or	0.7

* At single spacing.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knobs.	
Horizontal alignment:	knobs.	
Form width:	sliding forms tractors.	
Printing quality:	graduated dial.	
Form thickness:	graduated lever.	
Line pitch:	switch	6 or 8 lines/in.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets printer error indications.
Carriage restore:	key	positions carriage at channel 1 on tape loop.
Single cycle:	key	initiates one print cycle.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	20 inch stack.
Stacker:	20 inch stack.

.732 Replenishment time: . . . . . 1 to 2 mins. printer needs to be stopped.

.733 Adjustment time: . . . . . 2 to 3 mins. printer needs to be stopped.

.734 Optimum reloading period

I & II:	56 mins.
III & IV:	35 mins.
Basis:	2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	indicator.
Input area overflow:	none.	
Invalid code:	check	indicator.
Exhausted medium:	check	stop and indicator.
Imprefect medium:	none.	
Timing conflicts:	interlock	wait or indicator.
Feed jam:	check	stop indicator.
Parity:	check	indicator.

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INPUT-OUTPUT: OUTPUT TYPEWRITER

§ 083.

.1 GENERAL

.11 Identity: . . . . . Output Typewriter. Part of the Console.

.12 Description

The Output Typewriter is a standard part of a 7040 system. It is essentially an IBM Selectric typewriter, but it has been modified to decode 64-bit configurations into positioning coordinates for the print-ball mechanism. The print-ball is an oblate sphere that has the raised letter font in tiers around its circumference. It swivels and tilts in order to position a character for printing. The print-ball is mounted on a carriage that advances across the fixed platen as each character is printed.

The Typewriter is connected to Data Channel A. It can be operated in a record or a character mode. In the record mode the Data Channel (processor) is engaged until every character of every word specified by the channel command word has been printed. In the character mode the Data Channel (processor) is tied up only until one character addressed by the channel control word has been transferred to the typewriter buffer. This represents about a 42 per cent overlapping of the typing with processing.

Parity is checked both at core storage and at the typewriter. Up to 15 characters a second can be typed when operating at full speed. Two print-balls with the "Report" and "Programming" fonts are standard. Most of the unusual special characters are in upper case shift. Since changing shift requires one character time, this delay is minimized.

Because of its slow speed and the tying up of the processor, it is best used for the purposes of logging and notes to the operator. In these situations the processor is generally not needed, or operator intervention is required before processing may resume. Compared with operator reaction time, the typing time should be negligible.

.13 Availability: . . . . . 12 to 15 months (**).

.14 First Delivery: . . . . . March, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . feed platen.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . . engraved hammers.
.222 Sensing system: . . . . none.
.223 Common system: . . . . no.

.23 Multiple Copies

.231 Maximum number: . . . depends on stationery.
.232 Types of master
Multilith: . . . . . no.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . . one character at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	18	see Data Code Tables 1 and 2.
Alternatives:		
FORTRAN set:		yes.
Req. COBOL set:		yes.
Total:	64	and blank.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon
Output: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use
Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: . none.

.35 Physical Dimensions

.351 Overall width: . . . . . 8.875 inches.
.352 Length: . . . . . no limit.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel A.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . none.

(**) Estimate by editorial staff.

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.44 Data Transfer Control

.441 Size of load
Input: . . . . . 1 word or character.
Output: . . . . . limited only by capacity of core storage.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word or character.
.444 Input-output area lockout: . . . . . processing is inhibited during data transfers between core storage and synchronizer register.
.445 Table control: . . . . . yes, for output.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block
Output: . . . . . 1 character to 32,767 words.
.512 Block demarcation
Output: . . . . . zero count in channel control word.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . type 1 block forward; data is transferred from core storage to typewriter via the MQ register.
.523 Stepping: . . . . . carriage return at the end of a line or when count in channel control word is zero.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control: . . . . fixed format; automatic carriage return after each line.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.

.56 Testable Conditions

Disabled: . . . . . no.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: . no.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . I : single character
II : a record of N words (6N char.)

.62 Speeds

.621 Nominal or peak speed: 15 char/second for output.
.624 Effective speeds: . . . . same as peak speeds, less allowance for carriage returns.

.63 Demands on System

Component	msec per char	or	Percentage
Processor I:	38.6		58.2.
Processor II:	66.6		100.0.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . typical typewriter adjustments.

.72 Other Controls: . . . . none.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	parity check	set indicator and no print.
Output block size:	none.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or set indicator.

INPUT-OUTPUT: 729 MAGNETIC TAPE UNITS

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit 729 II, IV, V, VI.

.12 Description

These tape units are used in the IBM 1401, 1410, 7040, 7070 and 7080 series systems as well as in the 709, 7090 and 7094. They use a standard reel and half-inch tape compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are summarized in the following table:

Model	Tape speed, inches/sec	Density char/inch	Peak transfer rate, char/sec
II	75	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

Up to ten tape units may be connected to each Data Channel in a 7040 system. Tape operations may be performed parallel with internal processing except on Channel A. However, in normal operation, tapes attached to a single channel cannot be involved in simultaneous data transmission. Any number of non-data transmitting operations may occur simultaneously. It is usually economical to use the highest density of a given model in order to achieve the maximum transmission rates; however, compatibility with other machines (such as the 704) may dictate the occasional use of lower density settings.

.13 Availability: . . . . . 12 to 15 months.

.14 First Delivery

729 II: . . . . . November, 1959.
729 IV: . . . . . November, 1959.
729 V: . . . . . May, 1962.
729 VI: . . . . . May, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.

.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . multiple copies may be obtained by dialing two or more tapes on a given channel to the same number. This procedure is not recommended.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

Use of station: . . . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200, 556, or (models V and VI) 800 rows per inch (see 408:091.431).
.322 Parallel by: . . . . . 7 tracks.
.324 Track use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . . 0 (record and segment marks are optional).

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.325 Row use (Cont'd)
Unused: . . . . . gaps.
Inter-block gap: . . . 0.75 inch.
Inter-file gap: . . . . 3.75 inch.
Erased gap (to skip flaw area): . . . . . 3.75 inch.

.33 Coding: . . . . . column binary as in core with odd parity redundancy check.
binary coded decimal (BCD) as in Data Table No. 4 with even parity check.

.34 Format Compatibility

Other device or system	Code translation
727:	matched, low recording density only.
7330:	matched, low recording density only.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.
Leader: . . . . . 25 feet.
Trailer: . . . . . 25 feet.

.4 CONTROLLER

.41 Identity: . . . . . #1040 Tape Adapter.
1414 I, II, III Synchronizer.
#3585 800 cpi required on 1414 for 729 II and VI 800 cpi operation.

.42 Connection to System

.421 On-line: . . . . . up to four 7904 Channels plus Data Channel A with a maximum of ten tape drives each.
.422 Off-line
Associated equipment: may be switched to another channel, another computer, or an off-line auxiliary unit either manually or by means of the optional 7830 switching feature and 7155 Switch Control Console.

.43 Connection to Device

.431 Devices per controller: 10.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . . no.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 32,767 words in block.
1 to N blocks in files.
.512 Block demarcation
Input: . . . . . 0.75 inch inter-record gap.
3.75 inch inter-file gap.
Output: . . . . . 0.75 inch end of transmission.
3.75 inch gap written by instruction.

.52 Input-Output Operations

.521 Input: . . . . . forward only.
read until either N words or end-of-record.
end-of-file gap always terminates reading.
.522 Output: . . . . . write N words followed by end-of-record.
erase gap.
write end-of-file gap.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . one block backward.
one block forward.
one file backward.
.525 Marking: . . . . . inter block or inter file gap.
.526 Searching: . . . . . none.

.53 Code Translation: . . . code (binary or BCD) selected by program - translations are automatic.

.54 Format Control

Control: . . . . . program.
Format alternatives: . . densities (2 or 3).
Rearrangement: . . . . no.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Recording density: . . . no.
Section sizes: . . . . . yes.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . . yes.
Select format: . . . . . no.
Select code: . . . . . yes, binary or BCD.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . yes (25 feet).
Busy controller: . . . . yes.
End of medium marks: . yes.
Beginning of tape: . . . . yes.

§ 091.

.6 PERFORMANCE

.62 Speeds

.621 Nominal or peak speed

Model II: . . . . . 15,000 or 41,667 char/sec.
Model IV: . . . . . 22,500 or 62,500 char/sec.
Model V: . . . . . 15,000, 41,667, or 60,000 char/sec.
Model VI: . . . . . 22,500, 62,500 or 90,000 char/sec.

.622 Important parameters

Name	Models II	IV	V	VI
Density (char/inch):	200 or 556		200, 556 or 800	
Tape speed (inches/sec):	75.	112.5	75.	112.5
Start time (msec)				
read:	10.5	6.7	10.5	6.7
write:	7.5	5.0	7.5	5.0
Stop time (msec)				
read:	2.1	2.1	2.1	2.1
write:	5.1	3.8	5.1	3.8
Full rewind time (min):	1.2	0.9	1.2	0.9
Gaps block (inches):	0.75	0.75	0.75	0.75
file (inches):	3.75	3.75	3.75	3.75

.623 Overhead:

Gap crossing time (msec)

	Model II and IV	V and VI
Block:	10	6.67.
File:	50	33.33.

.624 Effective speeds

Models II and V
200 char/inch: . . . 15,000N/(N+150) char/sec.
556 char/inch: . . . 41,667N/(N+417) char/sec.
Models IV and VI
200 char/inch: . . . 22,500N/(N+150) char/sec.
556 char/inch: . . . 62,500N/(N+417) char/sec.
Model V
800 char/inch: . . . 60,000N/(N+600) char/sec.
Model VI
800 char/inch: . . . 90,000N/(N+600) char/sec.

.63 Demands on System

Component	Condition	msec per word	Percentage
Core Storage:	15,000 char/sec	0.016	4.3.
	22,500 char/sec	0.016	6.0.
	41,667 char/sec	0.016	11.3.
	60,000 char/sec	0.016	16.0.
	62,500 char/sec	0.016	17.1.
	90,000 char/sec	0.016	24.0.
Channel A Central Processor:	15,000 char/sec	0.400 plus	100.
	22,500 char/sec	0.267 start	100.
	41,667 char/sec	0.143 time	100.
	60,000 char/sec	0.100 not	100.
	62,500 char/sec	0.096 over-	100.
	90,000 char/sec	0.067 lapped	100.

	msec per block	Percentage
Start time not overlapped:		
Models II, V		
read	6.5	100.
write	1.0	100.
Models IV, VI		
read	5.2	100.
write	1.0	100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (models V and VI only), 200/556, 556/800, 200/800.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	button	lowers tape into reservoirs and rewinds tape to load point.
Unload:	button	removes tape from reservoirs and raises upper portion of head assembly.
File protection:	ring on reel	ring permits writing.

.73 Loading and Unloading

.731 Volume handled

Data format: Words/record	Records/file	Words per reel at Density (cpi): 200	556	800
20	20	384,000	498,000	548,000
40	20	548,000	872,200	960,000
20	50	408,000	542,000	600,000
40	50	572,000	926,000	1,036,000
167 (1,000 char.)	all	752,000	1,845,000	2,350,000

Note: 1 word = 6 char.

.732 Replenishment time: . 1.0 to 1.5 mins. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . 6. mins.
Models IV & VI: . . . 4 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none - not possible.	
Output block size:	none - not possible.	
Invalid code:	yes	see reading.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	yes	halts tape drive.
Timing conflicts:	interlock	stalls processor.
Recording level:	dual level signal strength check	indicator & alarm.

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INPUT-OUTPUT: 7330 MAGNETIC TAPE UNIT

§ 092.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit.
7330 Model 1.
MT.

.12 Description

The 7330 Magnetic Tape Unit is slower, simpler, and less expensive than the 729 Tape Unit, but the two are completely compatible. Tape speed is 36 inches per second, and peak transfer rate is either 7,200 or 20,016 characters per second, depending upon the recording density selected. Lateral and longitudinal parity checks are made on both reading and recording.

The throughput of the 7330 can be limited by two restrictions that should be considered:

(1) High speed rewind, which requires 2.2 minutes per full reel, is always terminated by unloading of the tape from the vacuum columns and read-record head. Rewinding without unloading requires 13.3 minutes.
(2) To switch the unit from read to write status, it must be programmed to backspace over the last record read and then rewrite it; such switching between reading and recording will be infrequent in normal applications.

.13 Availability: . . . . . 16 months.

.14 First Delivery: . . . . . October, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 1.5 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . one row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to 32,767 rows at 200 or 556 char/inch.
.322 Parallel by: . . . . . 7 tracks.
.324 Track Use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 0.
Gap: . . . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 1.

.34 Format Compatibility

Other device or system	Code translation
IBM 729, 727 tape units:	not required.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . #1040 Tape Adapter, plus either a 1414 II Synchronizer, a 1414 I or VII Synchronizer with a #7184 Tape Intermix feature.

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§ 092.

.42 Connection to System

.421 On-line: . . . . . 1 per data channel.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 10.
.432 Restrictions: . . . . . when using a 1414 I or VII Synchronizer, the total number of 7330 and 729 Tape Units is 10.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 32,767 words.
.512 Block demarcation
Input: . . . . . the smaller of the words between gaps on tape or word count in data channel.
Output: . . . . . word count in data channel.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1 block backward (backspace). 3.5 inches forward (to skip defective tape areas).
.525 Marking: . . . . . inter-block gap, or end-of-file gap.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes.
Select format: . . . . . no.
Select code: . . . . . binary or BCD.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . yes, 15 feet remaining.
Busy controller: . . . . yes.

.56 Testable Conditions (Cont'd)

End of medium marks: . yes.
Beginning of tape: . . . . yes.
End-of-file: . . . . . yes.
End-of-operation: . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . Data Channel A.
II: . . . . . 7904 Data Channel.

.62 Speeds

.621 Nominal or peak speed: 7,200 or 20,016 char/sec.
.622 Important parameters

Name	Value
Density:	200 or 556 char/inch.
Tape speed:	36.0 inches/sec.
Inter-block gap:	0.75 inch.
Start time (can be overlapped with processing on channel A).	
Read:	7.6 msec.
Write:	20.4 msec.
Stop time	
Read:	12.9 msec.
Write:	15.3 msec.

.623 Overhead: . . . . . start time.
.624 Effective speeds
At 200 char/inch: . . . 7,200 N/(N+147)char/sec.
At 556 char/inch: . . . 20,016 N/(N+408) char/sec. (see graph).
where N = char/block
6 char = 1 word.

.63 Demands on System

Component	Condition	msec per block or		Percentage
Processing Unit:	I; Data Channel A			
	200 char/inch	0.837N	plus start time	100.0.
	556 char/inch	0.300N	plus start time	100.0.
	Start time (not overlapped)			
	Read	0.6		100.0.
	Write	7.4		100.0.
Core Storage:	II; 7904 Data Channel			
	Read or write			
	200 char/inch	0.016N		2.2.
	556 char/inch	0.016N		5.3.

where N is number of words per block.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	200 or 556 char/in.

.72 Other Controls

Function	Form	Comment
Address selection:	dial.	
Load rewind:	key	loads tape into reservoirs.
Unload:	key.	
File protection:	ring on spool	ring permits writing.

§ 092.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Spool:	2,400 feet; for 1,000-char blocks, 5,000,000 char at 200 char/inch, 11,300,000 char at 556 char/inch.

.732 Replenishment time: . . 1.0 to 1.5 mins. tape unit needs to be stopped.

.734 Optimum reloading period: . . . . . 13 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral & longitudinal parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	all codes acceptable	
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing Conflicts:	interlock	indicator.
Recording level:	signal strength check	indicator & alarm.

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INPUT-OUTPUT: OTHER

§ 101.

.1 GENERAL

.11 Identity: . . . . . 7904 I, II, Data Channels.

.12 Description

The 7904 data channel is optional equipment for the 7040 and 7044 systems. A system may have as many as four such channels, which are designed B through E. Each 7904 permits simultaneous input-output operation with computing and other data channels.

Connected to each 7904 may be a DIRECT DATA device, a 1414 I, II or VII Synchronizer and either a 7631 File Control, a 1414 VI Synchronizer, or a 7750 Transmission Control Unit.

A DIRECT DATA connection uses 36 data transfer lines, two parity lines, 20 sense lines, and necessary control lines. An interrupt transfer to central processor address 00004 is used to synchronize the connection. Data may be transmitted at rates up to 62,500 (7040) or 133,333 (7044) words per second; however, high data transfer rates require a curtailment of other data channel operations.

The 1414 I, II or VII is used to connect magnetic tape units to the system, whereas the 1414 VI is used to connect communications equipment.

The 7631 File Control provides a connection between the central processor and 1301 disk storage units. Up to five 1301-1 or 1301-2 storage units may be attached to the system through one or more 7631 control units attached to different 7904 channels.

The 7750 Transmission Control Unit is a special-purpose computer system designed to multiplex a number of communication devices. Its stored program may be used for formatting, editing, trunk assignment, and routine record keeping.

The operation of 7904 data channel is as follows: The input-output operation is initiated by executing a select I/O unit instruction in the central processor. If the unit is busy, the instruction is held up until the I/O unit is available. Once the unit is available and ready, a data transfer command is sent to the data channel. The data channel decodes the command and sets up the channel circuitry accordingly (i.e., mode of operation, starting address, and word count). After this operation has been completed, the word counter in the data channel is checked for zero. If the counter contains a zero, the channel terminates its operation and disconnects the I/O unit. If the counter does not contain a zero, the channel continues with its operation in the mode selected (read or write).

.12 Description (Contd.)

During a read operation (input), the selected I/O device serially transfers a 7-bit byte (6 data bits plus parity). The bytes are parity checked and the data bits transferred to the Assembly Register. After a 36-bit word is assembled, the word is then sent to the Channel Data Register for transfer to core storage. The core storage location is specified by the contents of the Channel Address Counter. After a complete word is assembled and transferred to core storage, the word counter is decremented and the address counter incremented, and the data transfer operation repeated until the word count reaches zero. However, should an end-of-record signal be received from the device, the operation is terminated immediately.

In the write mode (output operation), the Channel Address Counter specifies the core storage location form which a 36-bit word is to be transferred to the channel. The word is divided into six 6-bit data portions and parity added to each portion before being sent to the selected device. The word counter and address counter are decremented and incremented respectively after each word transfer.

The foregoing procedures are essentially the same as the "Input-output a record and disconnect" channel command (IORD) in the 7090/7094.

An I/O transfer error on the 7904 turns on an indicator which can cause an interrupt. If interrupts are enabled and the processor is not executing a "Reset and Load Channel A" (RCHA) instruction, the processor can respond to the interrupt immediately. When this is done, it is possible to interrogate the channel to ascertain which word was transferred in error.

The 7904 Data Channel can sense and store many error and conditional indicators. These indicators can be used to interrupt the program provided they are enabled. Under these conditions the program counter in the processor is stored with the interrupt indicators in the appropriate interrupt location and the program counter set to the next address, as soon as one of the indicators is set. However, when the processor is acting as data channel A by executing an RCHA instruction, the program counter is not used to access another instruction until the RCHA instruction terminates. Therefore, the reaction to an interrupt is delayed until an input-output operation on channel A is completed. This must be considered when "real-time" devices are to be controlled by the system. Interrupts from many input "real-time" devices are notification that they must be serviced within a prescribed time. If these interrupts are ignored, the "real-time" units may become overloaded and as a result, lose data.

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INPUT-OUTPUT: DATA CHANNEL A

§ 102.

.1 GENERAL

.11 Identity: . . . . . Data Channel A, a part of the Central Processor.

.12 Description

The basic 7040 and 7044 systems include one input-output channel, called data channel A, whose operation is not overlapped with that of the processing unit. Attached to the channel may be a console typewriter (which is standard on the 7040/7044 systems); a 1401; a 1414 Model I, II, or III Synchronizer; and either a 1622 Card Read-Punch or a 1414 Model III, IV, or V Synchronizer. Up to ten magnetic tape units may be attached by means of a 1414 Model I, II, or III. With the exception of the console typewriter, all channel A attachments require adapter units to connect them to the processor.

Data channel A is the only channel in the system that can accommodate a 1414 Model III, IV, or V Synchronizer. These units permit the attaching of a 1402 Card Read-Punch, 1403 and 1404 Printers, a 1011 Paper Tape Reader, telegraph units, 1014 Inquiry Stations, and 1009 Data Transmission Units. Channel A is also the only data channel in the system to which the 1401, 1402, 1403, and 1404 units can be attached.

The 1401 attachment permits the 7040 to transmit and receive data from a 1401 and its connected input-output units at a maximum speed of 87,000 characters per second. The programs of both machines must make periodic checks to ascertain whether the other machine is requesting to transmit data. Data transfers take place between the core stores.

Two way communication can be programmed. The 7040 assumes the role of master and the 1401 the slave, since the 7040 can initiate data transfers in either direction. When 1401 input equipment is to be used, the 1401 must read the data before it can be transmitted to the 7040. Conversely, when using 1401 output equipment, the 1401 must accept the data in its core store before transferring it to the output unit.

Input-output instructions for channel A are performed as follows: First the channel and unit are tested for availability. Even though the processor is serving as channel A, the "channel A in use" indicator may still be on from a previous operation. Next a "Select Read" or "Select Write" instruction

.12 Description (Contd.)

is given, which selects channel A, adapter unit, and code translation mode. If either the unit or channel selected is busy, this instruction will stall the processor until it is free. A "Reset and Load Channel A" instruction is then given that causes a control word to be sent to the accumulator. The control word contains the word count, which is the number of words to be transferred, and the location in storage of the first word to be stored.

The operation of channel A is as follows: The word count in the accumulator is tested for zero. If it is zero the transfer is terminated and the unit disconnected. If not, the operation proceeds. Six characters are accepted, one by one, checked for correct parity, and placed in the 36-bit plus parity multiplier-quotient register. The contents of the multiplier-quotient register are stored in core storage at the address specified by the contents of the accumulator. After a 36-bit word is transferred, the word count is reduced by one and the address count incremented by one. If an end-of-record signal is received from the selected unit, the operation is terminated. This procedure is essentially the same as the "input-output a record and disconnect (IORD)" channel command in the 7090/7094. As in IORD execution, the above sequence is continued until one of the terminal conditions is encountered.

Write operations occur in the same manner with respect to storage addressing and termination conditions, but with the data flow operation reversed.

An I/O transmission error turns on a check light. However, since the central processor is delayed until the completion of the transmission, the word associated with the error is undetermined.

Channel A, like the 7904 Data Channels, can sense and store many error and condition indicators. These indicators can be used to interrupt the program, provided they are enabled. Under these conditions the program counter in the processor is stored with the interrupt indicators in the appropriate interrupt location, and the program counter is set to the next address as soon as one of the indicators is set. Because the RCHA instruction occupies the processor until the input-output operation is terminated, the program counter is not used during this time. Therefore, the reaction to the interrupt is delayed until an input-output operation on channel A is completed. This must be considered when "real-time" devices are being controlled by the system.

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INPUT-OUTPUT, OTHER: 1414 SYNCHRONIZER

§ 103.

.1 GENERAL

.11 Identity: . . . . . 1414 Synchronizer Models I through VII.

.12 Description

The 1414 Synchronizer is a controller used to monitor and direct the operations of the input-output units attached to it. There are two basic forms of the 1414: the unbuffered models I, II, and VII which control magnetic tapes; and the buffered models III, IV, V, and VI which control unit record equipment and/or communication equipment.

The unbuffered 1414 models I, II, and VII are essentially control units. They differ only in the type of magnetic tape unit that can be attached to them. The instructions to a magnetic tape unit are interpreted, initiated, and controlled by the 1414 units. These units have no data storage capacity as such; they provide only control and a character data path between the tape unit and the data channel. The data channel provides storage addressing, count control

.12 Description (Contd.)

(which can limit the amount of data read and always defines the amount to be written) and assembling (or disassembling) of words from characters received (or written).

The buffered 1414 Synchronizers contain 80-character buffers which are used to store input and output records between the data channel and the unit. Model III and IV can have a 1402 Read-Punch, and a 1403 or 1404 Printer attached. Models IV, V, and VI can have communications equipment attached to six 80-character communication buffers. The 1014 Inquiry Stations, telegraph terminals, 1009 Data Transmission Units, and 1011 Paper Tape Readers are considered communications equipment.

With the buffered 1414, input-output operations proceed in much the same manner as an unbuffered 1414 except that all data transfers utilize the data channel only long enough to load or unload the buffers from or to core storage. Adapters between the buffer and the input-output units control data transmission to or from the devices. The table below shows the connections of units to a 1414 Synchronizer and a 7040 system.

1414 Model	729 II	729 IV	729 V	729 VI	7330	Communications Devices	Unit Record	Column Binary	Data Channel A	7904 Data Channel
1	x	x	x (note 1)		x (note 2)				x	x
2					x				x	x
3							x		x	
4						x	x	x	x	
5						x			x	
6						x				x
7	x	x	x	x	x (note 2)				x	x

Note 1. With 800 cpi feature.
Note 2. With intermix feature.

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DATA TRANSMISSION UNIT

§ 104.

.1 GENERAL

.11 Identity: . . . . . Data Transmission Unit. 1009 Model 1.

.12 Description

This unit enables the 7040 system to transmit and receive data, via a 1414 Synchronizer, at speeds up to 300 characters-per-second over public or private telephone or telegraph lines. The unit at the other end of the line may be a similarly equipped 1401, 1410, 7040, or 7750 system; an IBM 7701 or 7702 Magnetic Tape Transmission Terminal; or an IBM 1013 Card Transmission Terminal. A specially equipped telephone and a serial data set, supplied by the communications company, are also required at each terminal.

Data from core storage of the transmitting 7040 is transferred to the 1414 Synchronizer in fixed length loads of 80 characters. This transfer requires 0.272 milliseconds, after which the processing unit is free to perform other operations. From the synchronizer, the data is sent to the 1009 DTU. There it is converted from BCD form to a special serial-by-bit, 4-of-8 transmission code in which each character code consists of four "1" bits and four "0" bits as sent over the communications line.

The 1009 at the receiving terminal reconverts the data to the internal BCD form. Validity checks

.12 Description (Cont'd)

insure that each character received contains exactly 4 out of 8 bits, and a longitudinal parity check detects most errors resulting from compensating error bits. Data from the receiving 1009 is transferred to a 1414 Synchronizer and from there to 7040 core storage. Input messages may be of any length and are terminated by an end-of-message signal.

When a 1009 input buffer is filled in a 1414 Synchronizer, the 1009 "Attention" indicator is set in the data channel which will cause an interrupt when interrupts are enabled. Data may be lost if a full input buffer is not emptied into the core store within 1,042,042,521,316, or 260 milliseconds when the transmission speed is 75, 150, 250, or 300 characters-per-second, respectively.

Either a #1038 Card 1414 Adapter with a 1414 IV or V Synchronizer on data channel A, or #1074 Control Adapter with a 1414 VI Synchronizer on 7904 data channels B through E is required for this feature. A #3238 Adapter connects the 1009 to the 1414. Two of the six 80-character buffers present in the 1414 are required for this function.

.13 Availability: . . . . . 14 months as of February 1962.

.14 First Delivery: . . . . October, 1961.

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INPUT-OUTPUT: REMOTE INQUIRY UNIT

§ 105.

.1 GENERAL

.11 Identity: . . . . . Remote Inquiry Unit.
1014 Model 1.
RIU.

.12 Description:

The Remote Inquiry Unit is a modified IBM Selectric typewriter with control circuits and indicator lights, mounted on a 29- by 24-inch work table. It is used for interrogating and printing replies from a 7040 system, and is connected to the system by a 4-wire cable which may be up to eight miles long. The user is responsible for the installation and maintenance of cable runs over fifty feet in length. Up to 20 Remote Inquiry Units can be connected to a 1414 IV or V Synchronizer on data channel A, or a 1414 VI Synchronizer on data channels B through E. An automatic sequencing device controls the order of acceptance of inquiry requests when more than one unit is connected.

When an inquiry is to be made, the Request key on the Remote Inquiry Unit is depressed. This signals the #6136 Remote Inquiry Unit Adapter on the 1414 Synchronizer. As soon as the adapter is not busy with another inquiry operation, the Proceed status light on the Remote Inquiry Unit is turned on. The inquiry unit number (0 to 9) is automatically sent as the first character of the message followed by up to 78 characters of text as typed on the Selectric. Depressing the Release key causes the character after the last one in the text to be a group-mark character. If there are less than 78 characters of text, the remainder of the line is filled with blanks. When the 1414 buffer has been filled the adapter sends a carriage-return signal to the inquiry unit (this unit does not have a carriage-return key on its keyboard) and clears the proceed status of the unit as an acknowledgment. The "Attention" indicator is set in the data channel, which will cause an interrupt if the interrupt is enabled. The 80 character message can then be transmitted to the core store in 0.272 milliseconds when the processor executes the proper read instruction.

If the Cancel key rather than the Release key is depressed, the adapter sends a carriage-return to the inquiry unit, clears its proceed status, and looks for another inquiry unit requesting service. Typing messages faster than 12.5 characters per second causes the inquiry unit to halt. It can only be restarted by cancelling the request. An automatic cancel is caused by not typing for a 20-second period during a proceed status.

The reply message is set up in core storage with the address of the receiving inquiry unit in the first position. It is transferred to the output synchronizer buffer in 0.272 milliseconds, and from there to

.12 Description (Cont'd.)

the inquiry typewriter at 15.5 characters per second. Each reply message is limited to the unit number plus up to 78 characters, terminated by a group mark, and followed by an automatic carriage return generated by the adapter.

Optional Feature

Third Inquiry Adapter, #882017: This feature permits attaching 10 more inquiry units to a 1414 Synchronizer.

.13 Availability: . . . . 14 months as of February, 1962.

.14 First Delivery: . . . July, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . sprocket drive - paper punched both sides.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . engraved hammers.
.222 Sensing system: . . . typewriter keyboard.
.223 Common system: . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . depends on stationery.
.233 Types of master
Multilith: . . . . . no.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . 1.
Method of use: . . . one character at a time.

Use of station: . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . 44 keys.
Method of use: . . . one character at a time.

.25 Range of Symbols

Numerals:	10	0-9.
Letters:	26	A-Z.
Special:	8	&. - $ *, # / (All other special characters print as #).
Alternatives:		none.
FORTRAN set:		no.
Req. COBOL set:		no.
Total:	44 plus space.	

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§ 105.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon: . . . . input - key depression. output- printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use
Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Overall width: . . . . 9.75 inches.
.352 Length: . . . . . up to 11 inches per sheet.
.353 Maximum margins: . no limitations.

.4 CONTROLLER

.41 Identity: . . . . . Synchronizer 1414 Model IV, V, or VI.

Remote Inquiry Unit Adapter.
#6136.

(Both units are required.)

.42 Connection to System

.421 On-line: . . . . . one 1414 Model 4 or 5 on data channel A or a 1414 Model 6 on data channels B thru E plus one #6136 adapters per set of inquiry stations.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 10 per #6136 adapter.
.432 Restrictions: . . . . maximum of 6 buffers in 1414 Model 4 or 5; each #6136 adapter requires 2 buffers.

.44 Data Transfer Control

.441 Size of load: . . . . 1 to 78 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area
access: . . . . . each word.
.444 Input-output area
lockout: . . . . . no.
.445 Table control: . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 1 to 78 characters per inquiry (input) or reply (output).

.512 Block demarcation
Input: . . . . . Release key.
Output: . . . . . group mark in core storage.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . step 1 line.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic.

.54 Format Control: . . . contained in data.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . yes.
Select format: . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . yes.
Busy controller: . . . yes.
End of medium marks: yes.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: input--manual typing speed, less than 12.5 char/sec. output--15.5 char/sec.
.624 Effective speeds: . . same as peak speeds, less allowance for carriage returns.

.63 Demands on System

Component	msec per block	Percentage
Processing Unit:	0.272	0.0.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . typical typewriter adjustments.

.72 Other Controls

Function	Form	Comment
Inquiry request:	key	signals adapter that an inquiry is to be made.
Inquiry release:	key	signals end of message and sets Inquiry Request indicator.
Inquiry cancel:	key	terminates inquiry without a reply.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Recording:	parity	indicator & alarm.
Reading:	parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	check	indicator & alarm.
Invalid code:	none.	
Exhausted medium:	check	alarm.
Imperfect medium:	none.	
Timing conflicts:	checks	alarm if input typing speed exceeds 12.5 char/sec.; wait for Proceed light if RIU adapter is serving another Inquiry Unit.

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SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . 7904 Data Channels
1414 III, IV, V
Synchronizer.

.12 Description

The IBM 7040 system can have a maximum of four time-shared 7904 Data Channels that delay processing only when the data channels and the 7106 central processor simultaneously request storage accesses. The processor can also be used as a data channel, which is referred to as Data Channel A. Data Channel A operates in two different modes with respect to simultaneous operation. When accessing communications equipment, inquiry stations, punched tape readers, card reader/punches, and printers, the central processor is not delayed by Data Channel A for appreciably longer than any other data channel, because all of these units are fully buffered by a 1414 III, IV, or V Synchronizer and processing is delayed for only the time required to load or unload the 1414 buffer, provided that the input-output unit involved is ready for operation.

When a magnetic tape unit or an IBM 1401 system is involved in a data transfer through Data Channel A,

.12 Description (Contd.)

the operation is not buffered with central processor operation, and proceeds at the speed characteristic of the input-output unit.

An IBM 1401 system, which can be connected only to Data Channel A, sends or receives data at approximately the same rate as a 729 VI Magnetic Tape Unit reading 800 characters per inch (i.e., 90,000 characters per second nominally). The start time for magnetic tape units connected to the Data Channel A and the time to establish a data transfer with a 1401 system only partially overlap. Because of these delays, data transfers through Data Channel A delay central processor operation for nearly the total time required to activate and operate a particular device.

.2 RESTRICTIONS

Only one input-output unit can transfer data through a Data Channel (including Data Channel A) at any given time. Since there can be a maximum of five simultaneous transfers plus processing in operation at any given time, the combined input-output rate cannot exceed 375,000 characters per second.

.3 POSSIBLE SIMULTANEOUS OPERATIONS

Operations	Max. No. of Units Operating	Max. No. of Data Transfers to and from Core Storage	Restrictions
Punch cards	1	1	A, B
Read cards	1	1	A, B
Read Punched Tape	5	5	B
Print or Skip lines on printer	2	1	A, B
Read or Write to Inquiry Station	100	5	B
Read or Write to Teleprocessing equipment	20	5	B
Read, Write, Backspace Magnetic Tape Unit	5	5	C
Read or Write Through Direct Data Connection	4	4	
Read, Write, or Seek Magnetic Disk Storage	2	2	
Read or Write "Real-Time Equipment"	4	4	
Read or Write to 1401 system	1	1	A, C
Print on Output Typewriter	1	1	A, C or D
Rewind Magnetic Tape Unit	50	0	

Key:

A. Data Channel A only.
B. Data Channel A (i.e., the processor) stalled for data transfer only.
C. Data Channel A (i.e., the processor) stalled for the entire operation.
D. Data Channel A (i.e., the processor) stalled for about half of the operation.

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§ 121. INSTRUCTION LIST

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Fixed Point Arithmetic
ADD	X	F	T	Y	(Y) + (AC) → AC
DVP	X	F	T	Y	(MQ) ÷ (Y) → MQ (quotient), AC (remainder). If overflow set divide - check indicator.
MPY	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ.
SUB	X	F	T	Y	(AC) - (Y) → AC.
VDP	X	F C	T	Y	(AC) ÷ $(Y)_{1-C}$ → $(MQ)_{35-C \text{ to } 35}$; remainder in AC.
VLM	X	F C	T	Y	(Y) x $(MQ)_{35-C \text{ to } 35}$ → AC and $(MQ)_{1 \text{ to } C}$.
VMA	X	F C	T	Y	(AC) + (Y) x $(MQ)_{35-C \text{ to } 35}$ → AC and $(MQ)_{1-C}$.
					Floating Point Arithmetic
*FAD	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
*FDP	X	F	T	Y	(AC) ÷ (Y) → MQ (quotient) normalized, AC (remainder); if overflow, set divide - check indicator.
*FMP	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ; normalized.
*FSB	X	F	T	Y	(AC) - (Y) → (MSB)AC, (LSB)MQ; normalized.
*UFA	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
*UFM	X	F	T	Y	(Y) x (MQ) → AC and MQ unnormalized.
*UFS	X	F	T	Y	(AC) - (Y) → (MSB)AC, (LSB)MQ; unnormalized.
*DFAD	X	F	T	2Y	(2Y, 2Y + 1) + (AC, MQ) → (AC, MQ); normalized.
*DFDP	X	F	T	2Y	(AC, MQ) ÷ (2Y, 2Y + 1) → (AC, MQ); normalized.
*DFMP	X	E	T	2Y	(2Y, 2Y + 1) x (AC, MQ) → (AC, MQ); normalized.
*DFSB	X	F	T	2Y	(AC, MQ) - (2Y, 2Y + 1) → (AC, MQ); normalized.
					Arithmetic Data Transfer
CLA	X	F	T	Y	(Y) → AC.
CLS	X	F	T	Y	-(Y) → AC.
LDQ	X	F	T	Y	(Y) → MQ.
STO	X	F	T	Y	(AC) → Y.
STQ	X	F	T	Y	(MQ) → Y.
STZ	X	F	T	Y	0 → Y; sign is plus.
*TMT	X	X	T	Y	C = Y(mod 256), C words are moved from $((AC)_{3-17} + i)$ to $((AC)_{21-35} + i)$; i = 0, 1, . . . , C-1.
					Logical Data Transfer
CAL	X	F	T	Y	(Y) → $AC_{P, 1-35}$.
*PCS	X	F C	T	Y	character C of (Y) → AC_{30-35}.
*SAC	X	F C	T	Y	$(AC)_{30-35}$ → Y character position C.
SLW	X	F	T	Y	$(AC)_{P, 1-35}$ → Y.
STA	X	F	T	Y	$(AC)_{21-35}$ → Y_{21-35}.
STD	X	F	T	Y	$(AC)_{3-17}$ → Y_{3-17}.
STL	X	F	T	Y	Location of STL instruction + 1 → Y_{21-35}; remainder of Y unchanged.

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§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Logical Operations
ACL	X	F	T	Y	(Y) + (AC) → AC added as 36 bit unsigned quantities with end-around carry from AC_P.
ANA	X	F	T	Y	(AC) "AND" (Y) → AC.
CHS	X	X	X	X	change sign of AC.
COM	X	X	X	X	"NOT" $(AC)_{P,\ 1-35}$ → $(AC)_{P,\ 1-35}$.
*MSM	X	F	T	Y	1 → $(Y)_S$.
*MSP	X	F	T	Y	0 → $(Y)_S$.
ORA	X	F	T	Y	(AC) "OR" (Y) → AC.
SLW	X	F	T	Y	$(AC)_{P,\ 1-35}$ → Y.
SSP	X	X	X	X	0 → AC_S.
					Shifting Operations
ALS	X	X	T	Y	(AC) shifted left Y, sign unchanged.
ARS	X	X	T	Y	(AC) shifted right Y, sign unchanged.
LGL	X	X	T	Y	$(AC)_{Q,P,\ 1-35}$ and $(MQ)_{S,\ 1-35}$ shifted left Y (mod 256).
LGR	X	X	T	Y	$(AC)_{Q,P,\ 1-35}$ and $(MQ)_{S,\ 1-35}$ shifted right Y (mod 256).
LLS	X	X	T	Y	$(AC)_{Q,P,\ 1-35}$ and $(MQ)_{1-35}$ shifted left Y (mod 256), MQ_S → AC_S.
LRS	X	X	T	Y	$(AC)_{P,Q,\ 1-35}$ and $(MQ)_{1-35}$ shifted right Y (mod 256), $(AC)_S$ → $(MQ)_S$.
ROL	X	X	T	Y	(MQ) rotated left Y (mod 256).
					Control Operations
*AXT	X	X	T	Y	Y → (T).

CAS	X	F	T	Y	If (AC) > (Y), go to next instruction.
					If (AC) = (Y), skip next instruction.
					If (AC) < (Y), skip two instructions.

*CCS	X	F C	T	Y	Character C of (Y) is compared with $(AC)_{30-35}$; If $(AC)_{30-35}$ > $(Y)_{6C\ to\ 6C+5}$, go to next instruction. If $(AC)_{30-35}$ = $(Y)_{6C\ to\ 6C+5}$, skip next instruction. If $(AC)_{30-35}$ < $(Y)_{6C\ to\ 6C+5}$, skip next two instructions.
DCT	X	X	X	X	If divide-check indicator on, turn it off; otherwise, skip next instruction.
HPR	X	X	X	X	Halts processor; processor steps to next instruction when Start key is depressed. Traps cause the location of the next instruction to be stored, and as a result, normally causes computation to resume.
*LAC	X	X	T	Y	32,768 - $(Y)_{21-35}$ → (T).
LAS	X	F	T	Y	If $(AC)_{Q,P,\ 1-35}$ < (Y), go to next instruction. If $(AC)_{Q,P,\ 1-35}$ = (Y), skip next instruction. If $(AC)_{Q,P,\ 1-35}$ > (Y), skip next two instructions.
LBT	X	X	X	X	Skip next instruction if $(AC)_{35}$ = 1.
*LDC	X	X	T	Y	32,768 - $(Y)_{3-17}$ → (T).
*LXA	X	X	T	Y	$(Y)_{21-35}$ → (T).
*LXD	X	X	T	Y	$(Y)_{3-17}$ → (T).
*MIT	X	F	T	Y	Skip next instruction if $(Y)_S$ = 1.
*PAC	X	X	T	X	32,768 - $(AC)_{21-35}$ → (T).
*PAX	X	X	T	X	$(AC)_{21-35}$ → (T).
PBT	X	X	X	X	Skip next instruction if $(AC)_P$ = 1.
*PDC	X	X	T	X	32,768 - $(AC)_{3-17}$ → (T).

§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Control Operations (Cont'd)
*PDX	X	X	T	X	$(AC)_{3-17} \rightarrow (T)$.
*PLT	X	F	T	Y	Skip next instruction if $(Y)_S = 0$.
*PXA	X	X	T	X	$(T) \rightarrow (AC)_{21-35}$.
*PXD	X	X	T	X	$(T) \rightarrow (AC)_{3-17}$.
*RPM	X	X	X	X	Release memory protect. Store location counter in address 32 and trap to address 33.
*SPM	X	F C	T	Y	Set memory protect; $(Y)_{21-27} \rightarrow$ field register; $(Y)_{35-35} \rightarrow$ count register; $(Y)_{32}$ sets mode 0 = trap on equal, 1 = trap on unequal.
*SXA	X	X	T	Y	$(T) \rightarrow (Y)_{21-35}$.
*SXD	X	X	T	Y	$(T) \rightarrow (Y)_{3-17}$.
*TIX	D	D	T	Y	If the number in index T is greater than D, (T) - D → (T) and the next instruction is then from Y.
TMI	X	F	T	Y	Branch to Y if (AC) minus.
*TNX	D	D	T	Y	If (T) > D set (T) = (T) - D; otherwise, go to Y.
TNZ	X	F	T	Y	Branch to Y if (AC) $\neq 0$.
TOV	X	F	T	Y	If overflow indicator is on, turn it off and branch to Y.
TPL	X	F	T	Y	Branch to Y if $(AC)_S = 0$.
TRA	X	F	T	Y	Transfer to Y.
TRP	X	F	T	Y	Parity and trap inhibits are turned off; control goes Y.
TRT	X	F	T	Y	Trap inhibit is turned off; control goes to Y.
TSL	X	F	T	Y	This location plus one → $(Y)_{21-35}$; control goes to Y + 1.
*TSX	X	X	T	Y	2's complement of the address of this instruction replaces (T); control goes to Y.
*TXH	D	D	T	Y	If (T) > D, go to Y.
*TXI	D	D	T	Y	(T) + D → (T); control goes to Y.
*TXL	D	D	T	Y	If (T) < D, go to Y.
TZE	X	F	T	Y	Branch to Y if (AC) = 0.
XEC	X	F	T	Y	Execute instruction in location Y.
					Input-Output Instructions
BSR	X	I	T	Y	Backspace tape designated by I and Y one record.
CTR	X	I	T	Y	Prepare to send control data to device designated by Y and I.
ENB	X	F	T	Y	Enable from Y; the (Y) determine which traps will be permitted.
ETT	X	X	T	Y	End-of-tape test; skip next instruction if end-of-tape indicator for channel indicated by (Y) is not on.
ICT	X	X	T	X	Inhibit channel and direct data traps.
IOT	X	X	T	X	Skip next instruction if I/O check indicator is off; otherwise turn it off.
PRD	X	I	T	Y	Equivalent to read select but will cause trapping on 7090/7094.
*PSL	X	F	T	Y	$(Y)_{8-17}$ are sent to the direct data lines.
PWR	X	I	T	Y	Equivalent to write select but will cause trapping on 7090/7094.
RCH	X	F	T	Y	(Y) sent to the channel as a command word.
RCT	X	X	T	X	Restore channel traps.
RDC	X	X	T	X	Reset data channel.
RDS	X	I	T	Y	Prepare to read from I/O device specified by I and Y.

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§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Input-Output Instructions (Cont'd)
RUN	X	I	T	Y	Rewind and unload the tape specified by I and Y.
SEN	X	I	T	Y	Prepare to read status data from the device specified by Y and I.
*SSL	X	F	T	Y	The static sense line contents from the direct data device $\rightarrow (Y)_{8-17}$.
TCO	X	F	T	Y	If channel-in-use indicator is on, go to location Y.
SCH	X	F	T	Y	Store channel registers in Y.
TEF	X	F	T	Y	Branch to Y if the end-of-file indicator for the specified channel is on.
TRC	X	F	T	Y	If the specified redundancy indicator is on, turn it off and branch to Y.
WBT	X	I	T	Y	Write blank tape (used to skip over bad spots).
WEF	X	I	T	Y	Write end-of-file on tape designated by Y and I.
WRS	X	I	T	Y	Prepare to write to device designated by I and Y.

Terms:

C means count value.
D means decrement value.
F means indirect addressing flag.
T means index register tag.
X means part of the operation code.
Y means the address or value.
* means optional instruction.

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . report writing graphics console typewriter font.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: . . . . . 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: . . . . . 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	0	8	&	H	-	Q	blank	Y
1	1	9	A	I	J	R	/	Z
2	2	b	B	?	K	!	S	ǂ
3	3	⁂	C	.	L	$	T	,
4	4	@	D	□	M	*	U	%
5	5	:	E	⊏	N	⊐	V	⌜
6	6	>	F	<	O	;	W	\
7	7	√	G	†	P	Δ	X	⫩

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . programming language graphics, console typewriter font.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: . . . . . 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: . . . . . 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	0	8	+	H	-	Q	Blank	Y
1	1	9	A	I	J	R	/	Z
2	2	⌀	B	?	K	!	S	≠
3	3	=	C	.	L	$	T	,
4	4	'	D	)	M	*	U	(
5	5	:	E	[	N	]	V	⌒
6	6	>	F	<	Ø	;	W	\
7	7	√‾	G	≠	P	Δ	X	⧺

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . Hollerith Card Code.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	&	-	0
12	&	&		?
11	-		-	!
0	0	?	!	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2	b			≠
8-3	#	.	$	,
8-4	@	□	*	%
8-5	:	[	]	¬
8-6	>	<	;	\
8-7	√	≠	Δ	⧺

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DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . Internal and binary magnetic tape code.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: 3 bits: value from low to high order; 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	0	8	&	H	-	Q	blank	Y
1	1	9	A	I	J	R	/	Z
2	2	b	B	?	K	!	S	≠
3	3	#	C	.	L	$	T	,
4	4	@	D	□	M	*	U	%
5	5	:	E	[	N	]	V	⌒
6	6	>	F	<	O	;	W	\
7	7	√	G	≡	P	Δ	X	⊞

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DATA CODE TABLE NO. 5

§ 145.

.1 USE OF CODE: . . . BCD code on magnetic tape.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0		8	blank	Y	-	Q	&	H
1	1	9	/	Z	J	R	A	I
2	2	0	S		K	!	B	?
3	3	#	T	,	L	$	C	.
4	4	@	U	%	M	*	D	□
5	5	:	V	‿	N	]	E	[
6	6	>	W	\	O	;	F	<
7	7	√‾	X	⫩	P	Δ	G	≠

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DATA CODE TABLE NO. 6

§ 146.

.1 USE OF CODE: . . . 1400 series code to 1401 processor.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (show below as two octal digits).

.22 Character Structure

.221 More significant pattern: 3 bits; value from low to high order: 8, 16, 32.

.222 Less significant pattern: 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	Blank	8	b	Y	-	Q	&	H
1	1	9	/	Z	J	R	A	I
2	2	0	S	÷	K	!	B	?
3	3	#	T	,	L	$	C	.
4	4	@	U	%	M	*	D	□
5	5	:	V	‿	N	]	E	[
6	6	>	W	\	O	;	F	<
7	7	√	X	≠	P	Δ	G	≒

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IBM 7040
SYSTEM PERFORMANCE

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IBM 7040 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration VI	VII A	VII A′	VIII B	VIII B′	Reference
1 Input-Output Times	Char/block	(File 1)	1,008	1,008	4,032	1,008	4,032	4:200.112
	Records/block	K (File 1)	8	8	32	8	32	
	msec/block	File 1 = File 2	34.2	34.2	106.8	17.8	51.5	
		File 3	100	13.2	34.2†	8.1	17.8†	
		File 4	125	12.9	34.1†	8.1	17.8†	
	msec/switch	File 1 = File 2	---	---	---	---	---	
		File 3	---	---	---	---	---	
		File 4	---	---	---	---	---	
	msec penalty	File 1 = File 2	2.8	2.08	8.06	2.08	8.06	
		File 3	0.272	.27	2.08	0.35	2.08	
		File 4	0.320	.26	2.02	0.33	2.02	
2 Central Processor Times	msec/block	a1	0.760	0.760	0.760	0.760	0.760	4:200.1132
	msec/record	a2	1.560	1.560	1.560	1.560	1.560	
	msec/detail	b6	1.288	1.288	1.288	1.288	1.288	
	msec/work	b5 + b9	1.728	1.728	1.728	1.728	1.728	
	msec/report	b7 + b8	26.792	26.792	26.792	26.792	26.792	
3 Standard Problem A F = 1.0	msec/block for C.P. and dominant column.	a1	0.8	0.8	0.8	0.8	0.8	4:200.114
		a2 K	12.5	12.5	50.0	12.5	12.5	
		a3 K	238.5	238.5	953.9	238.5	238.5	
		File 1 Master In	2.2	2.2	8.1	2.2	2.2	
		File 2 Master Out	2.2	2.2 34.2	8.1 106.3	2.2	2.2	
		File 3 Details	2.2	2.8 103.2	8.1 136.4	2.8 64.8	2.8 71.2	
		File 4 Reports	2.2 1,000	2.6	8.0	2.6	2.6	
		Total	260.6 1,000	261.6 137.4	1,037.0 242.7	261.6 64.8	261.6 71.2	
4 Standard Problem A Space	Unit of measure	(word)						4:200.1151
		Std. routines	650	650	650	650	650	
		Fixed	0	0	0	0	0	
		3 (Blocks 1 to 23)	425	425	460	425	460	
		6 (Blocks 24 to 48)	2,020	2,020	2,020	2,020	2,020	
		Files	756	756	3,360	756	756	
		Working	325	325	325	325	325	
		Total	4,176	4,176	6,815	4,176	6,815	

† 8 records per block.

IBM 7040 SYSTEM PERFORMANCE (Contd.)

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration VI	Configuration VII A	Configuration VIII B	Reference
5 Standard Mathematical Problem A	Fixed/Floating point			Floating	Floating	Floating	4:200.413
	Unit name	input		1402 II	729 II	729 VI	
		output		1403 III	729 II	729 VI	
	Size of record	input		80 characters	80 characters	80 characters	
		output		120 characters	120 characters	120 characters	
	msec/block	input	T1	100	12.16	7.56	
		output	T2	75	12.88	8	
	msec penalty	input	T3	1.36	0.11	0.11	
		output	T4	2.19	0.16	0.16	
	msec/record		T5	0.10	0.10	0.10	
	msec/5 loops		T6	12.77	12.77	12.77	
	msec/report		T7	26.30	26.30	26.30	
7 Standard Statistical Problem A	Unit name			1402 Card Reader	729 II	729 VI	4:200.512
	Size of block			10 words	3,500 words	3,500 words	
	Records/block		B	1	350	350	
	msec/block		T1	100	514	240	
	msec penalty		T3	1.33	28.0	28.0	
	C.P.	msec/block	T5	0.152	0.152	0.152	
		msec/record	T6	4.256	4.256	4.256	
		msec/table	T7	0.216	0.216	0.216	

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SYSTEM PERFORMANCE

§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

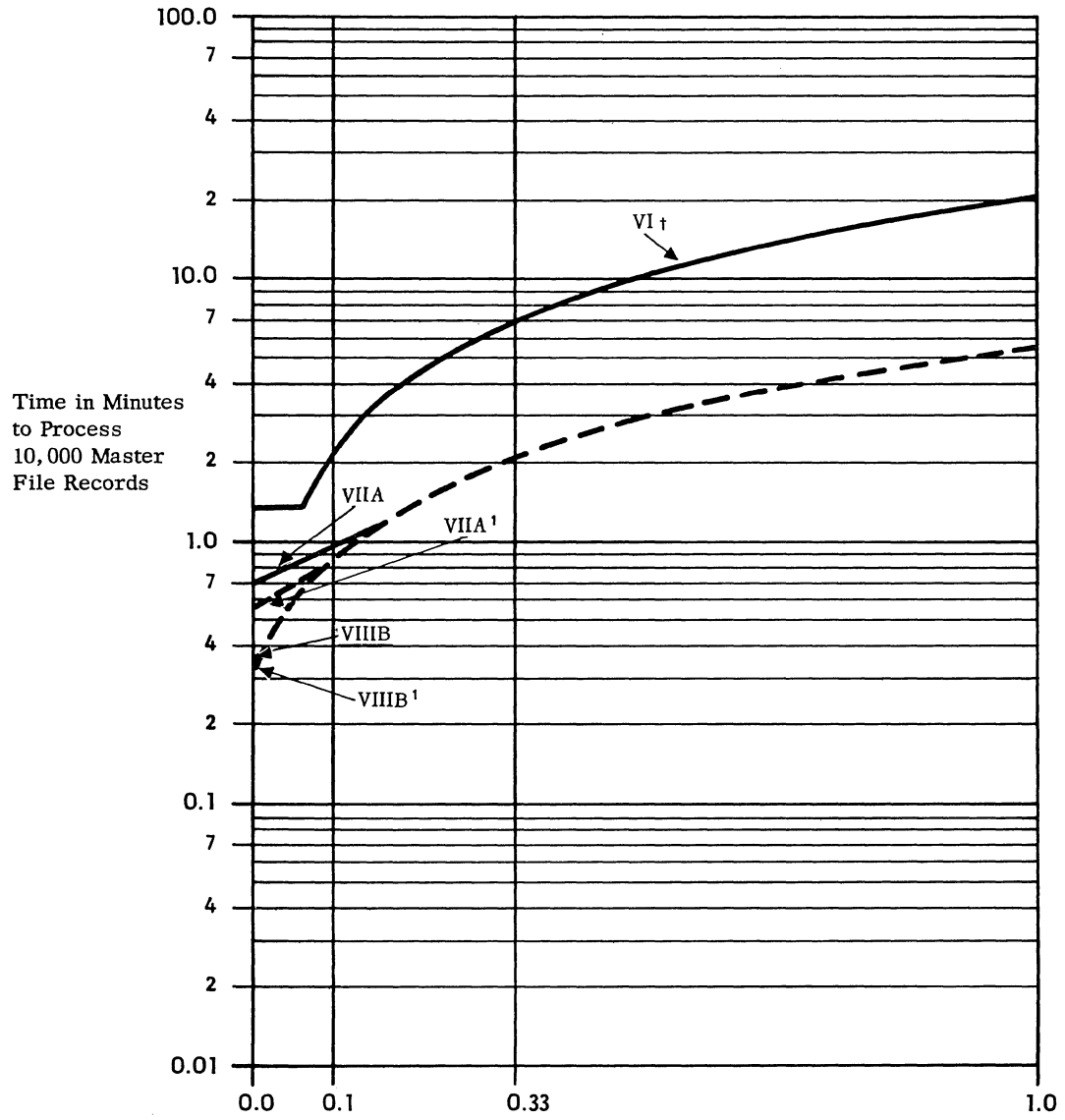
.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.

.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.

.114 Graph: . . . . . see graph below.

.115 Storage space required
Configuration VI. . . . 4,176 words.
Configuration VII A . . 4,176 words.
Configuration VII A[1] . 6,815 words.
Configuration VIII B . . 4,176 words.
Configuration VIII B[1] . 6,815 words.



† And all configurations using an on-line printer.

Broken lines indicates blocked detail and report files.

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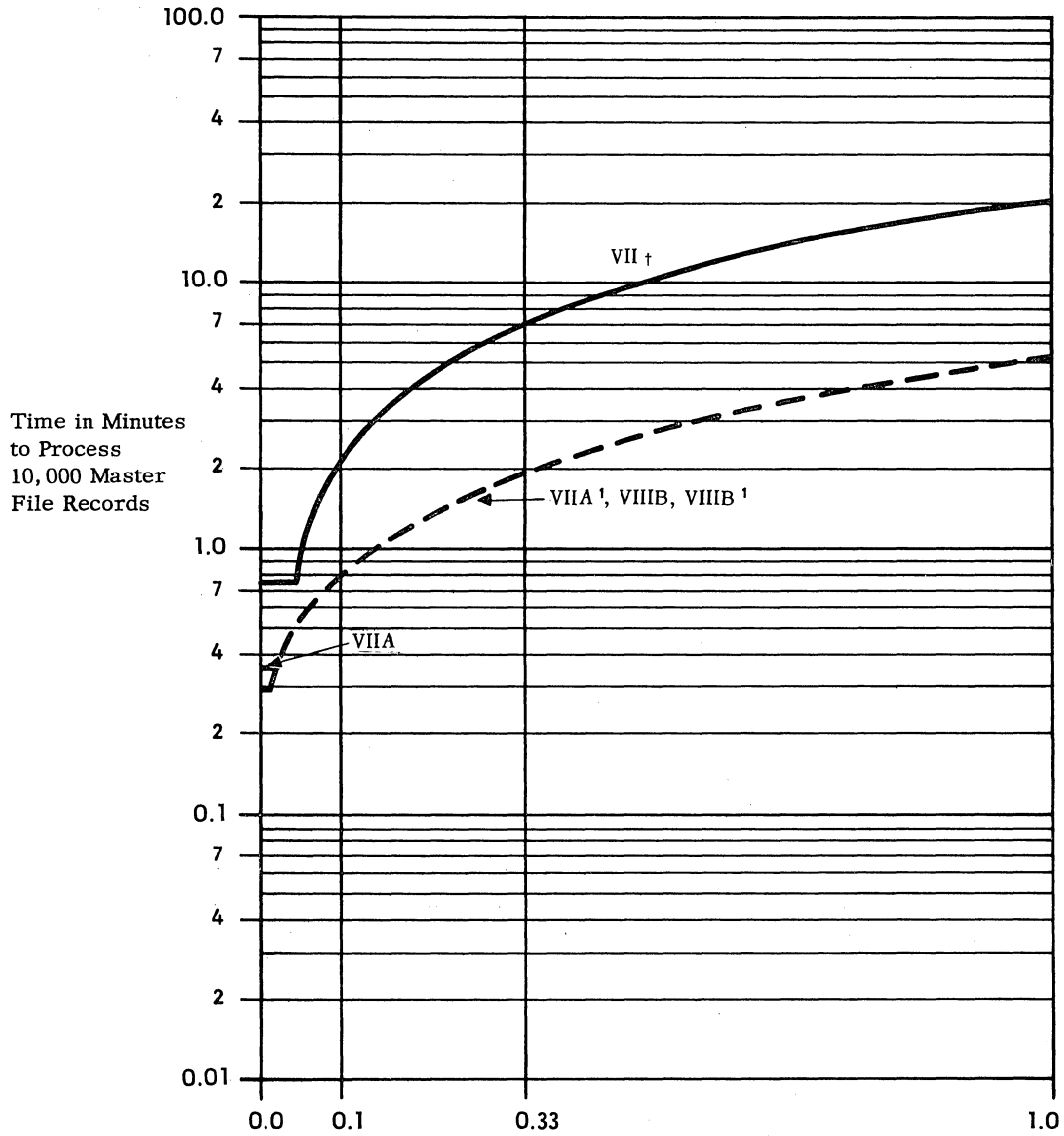
§ 201.

.12 Standard File Problem B

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



† And all configurations using an on-line printer.

Broken lines indicates blocked detail and report files.

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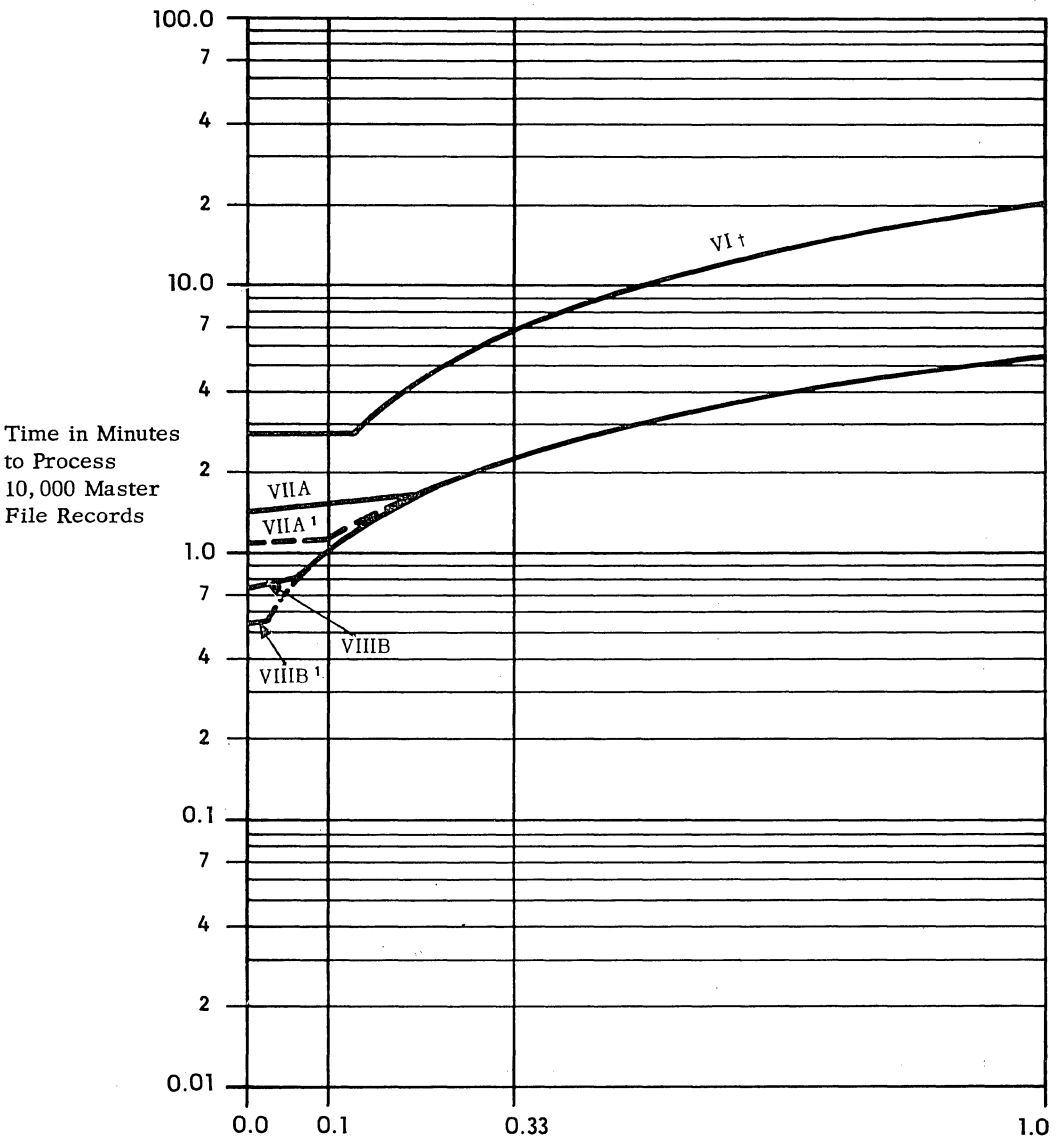
§ 201.

.13 Standard File Problem C

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



† And all configurations using an on-line printer.

Broken lines indicates blocked detail and report files.

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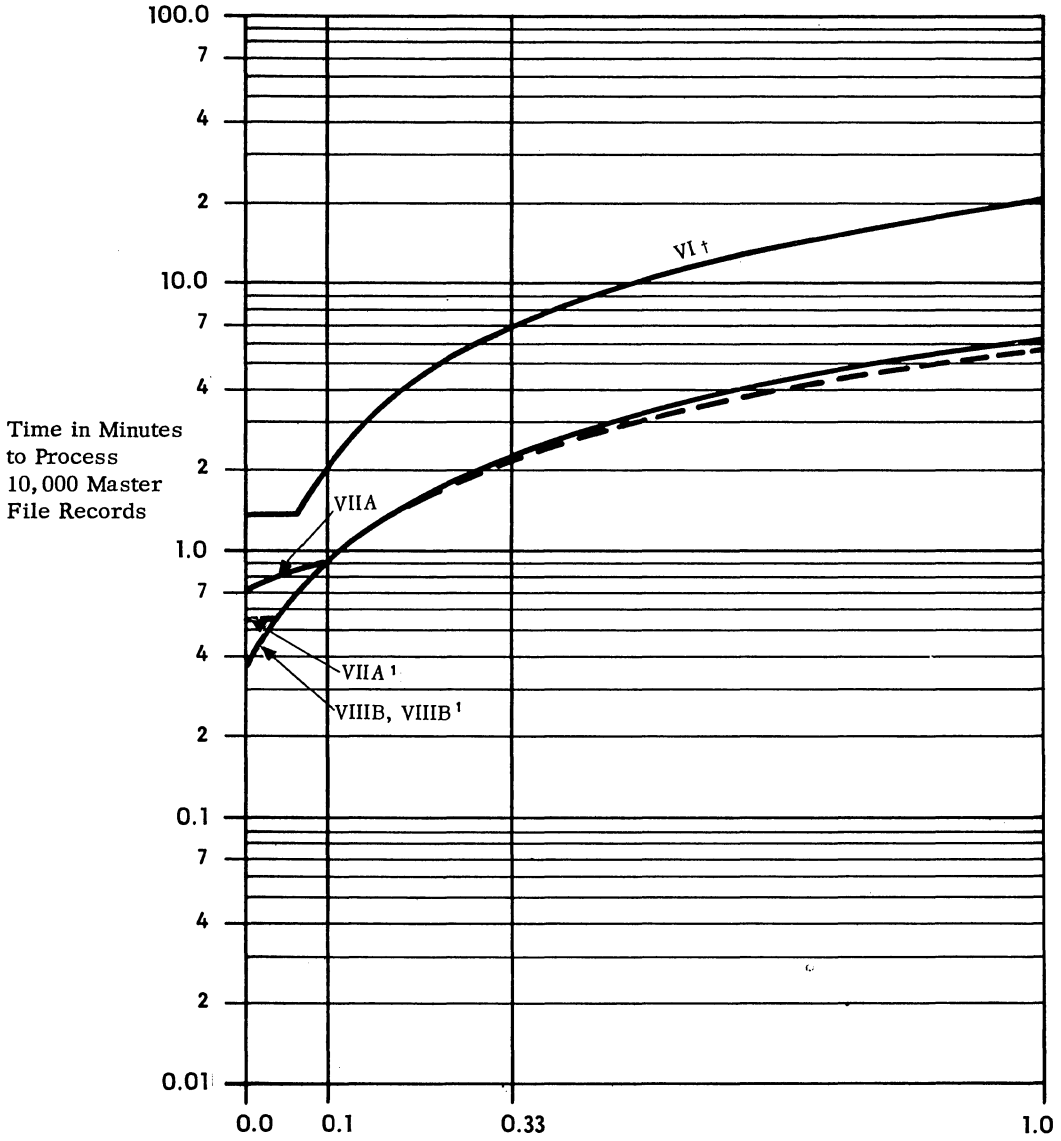
§ 201.

.14 Standard File Problem D

.141 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.144 Graph: . . . . . see graph below.



† And all configurations using an on-line printer.

Broken lines indicates blocked detail and report files.

§ 201.

.2 SORTING

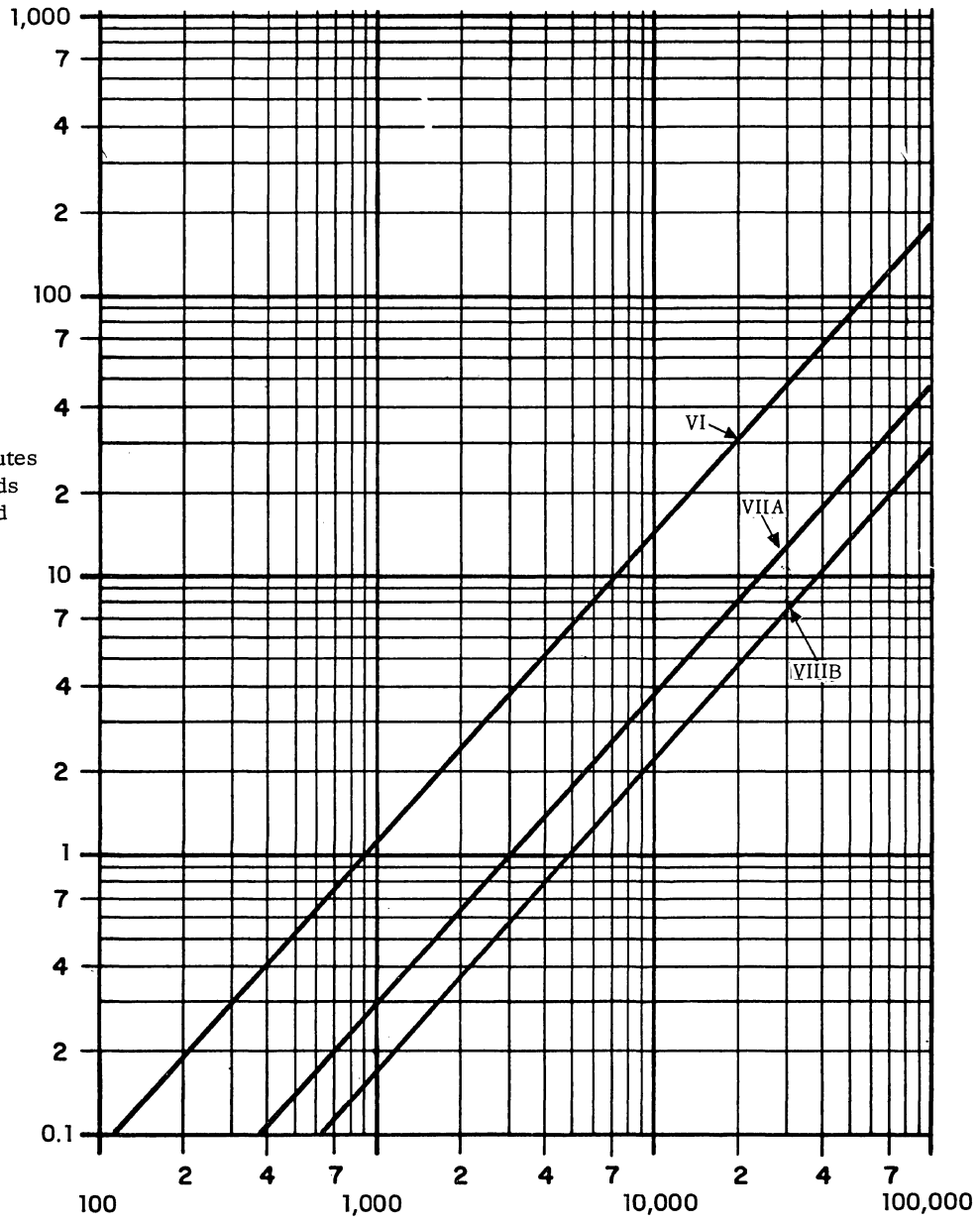
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph:. . . . . see graph below.



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§ 201.

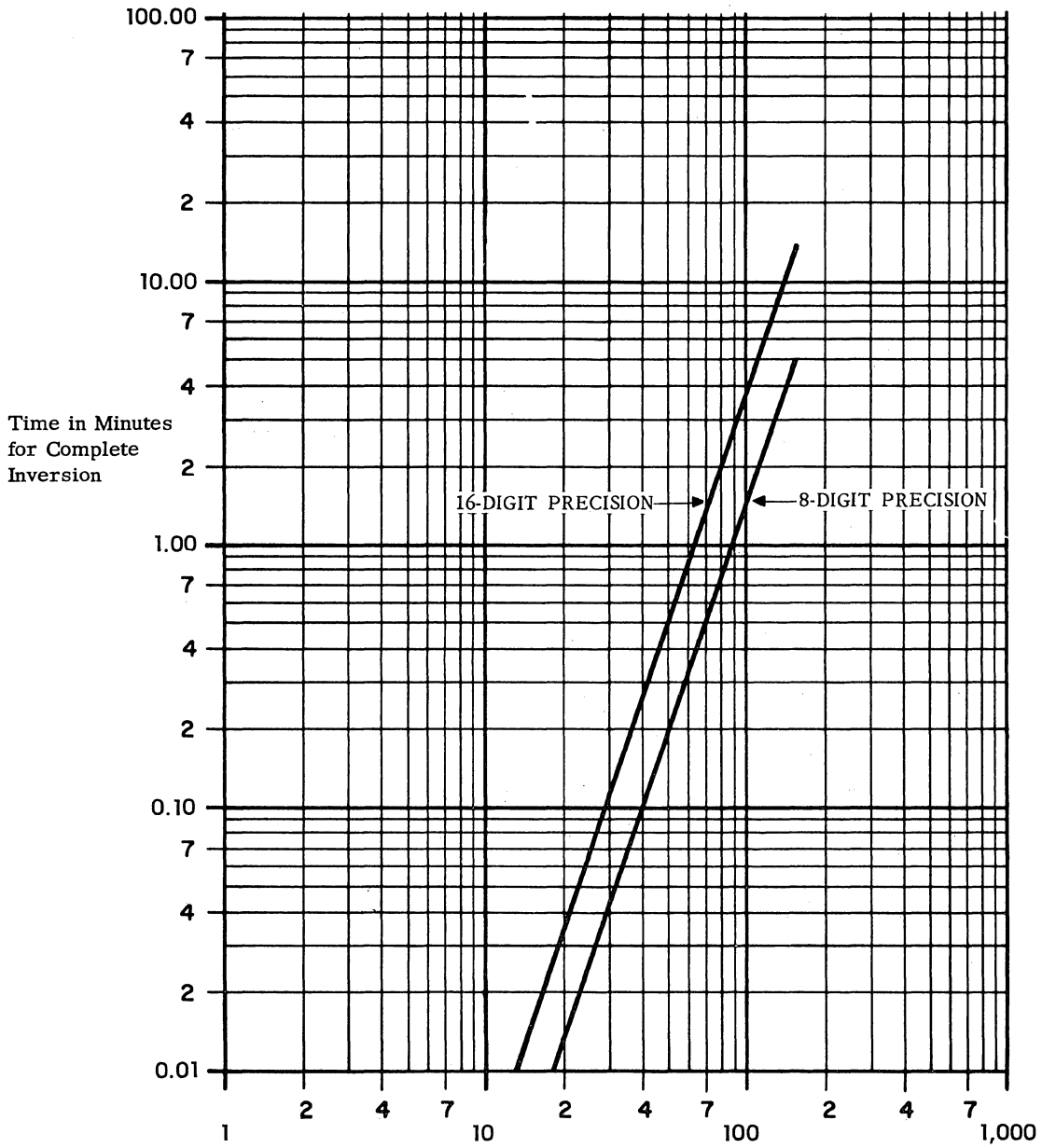
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . . general, non-symmetric matrices, using floating point to at least 8 decimal digits using single precision floating point option, 16 digit precision using double precision floating point option.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . . see graph below.



§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

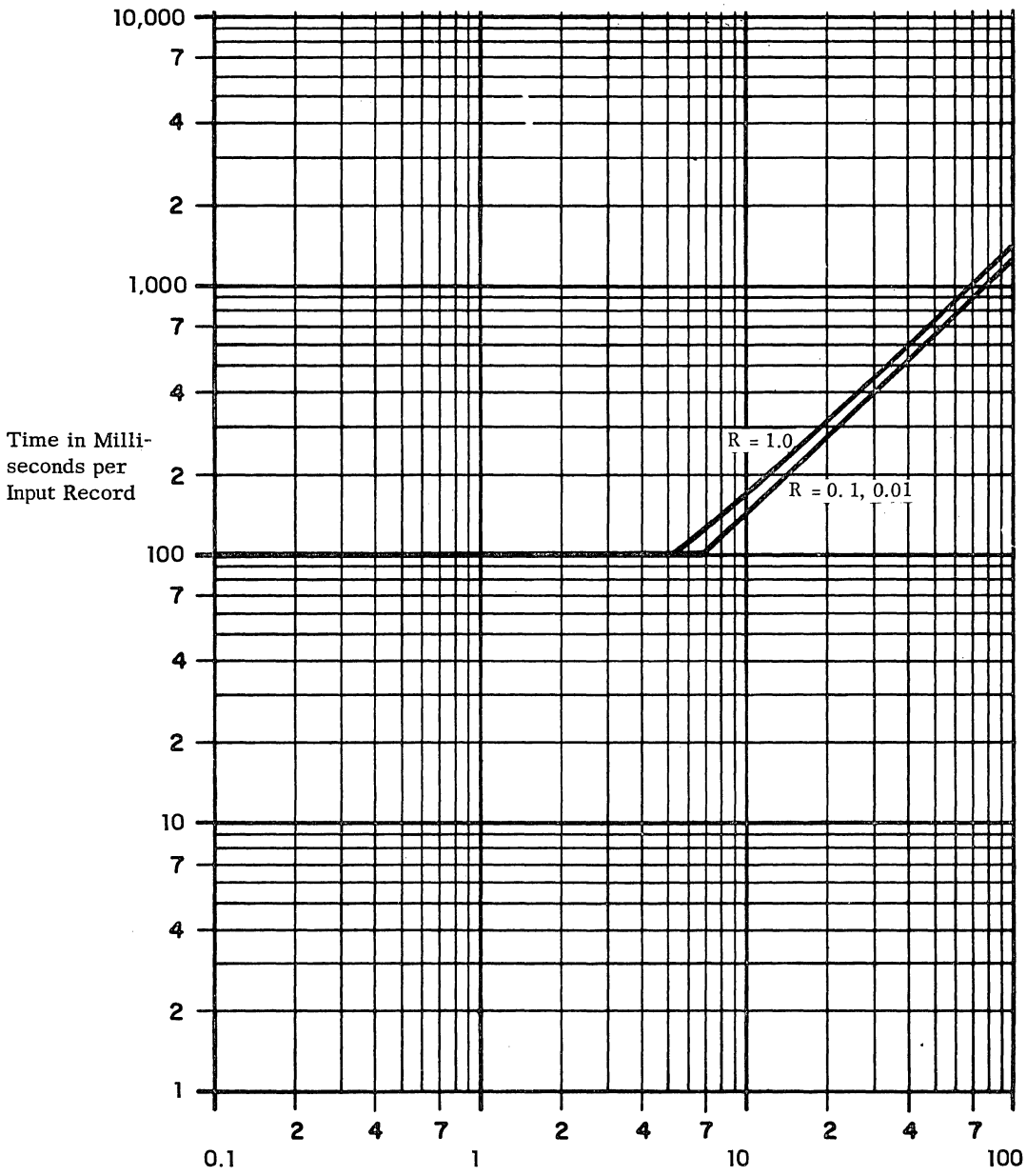
.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . . see graph below.

CONFIGURATION VI OR ANY CONFIGURATION USING ONE PRINTER ON-LINE, LENGTH (8 DIGIT PRECISION); FLOATING POINT

R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



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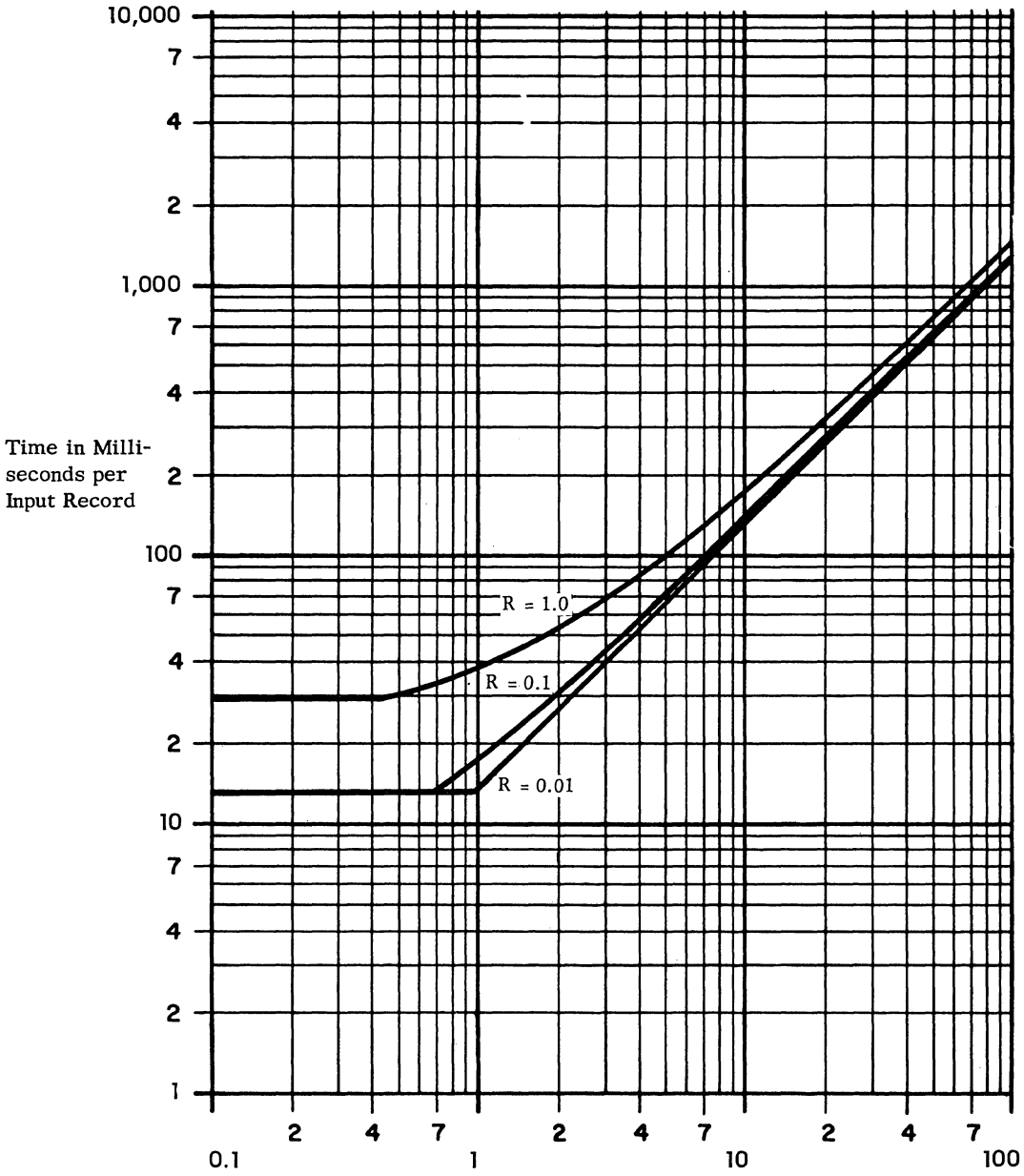
.415 Graph: . . . . . see graph below.

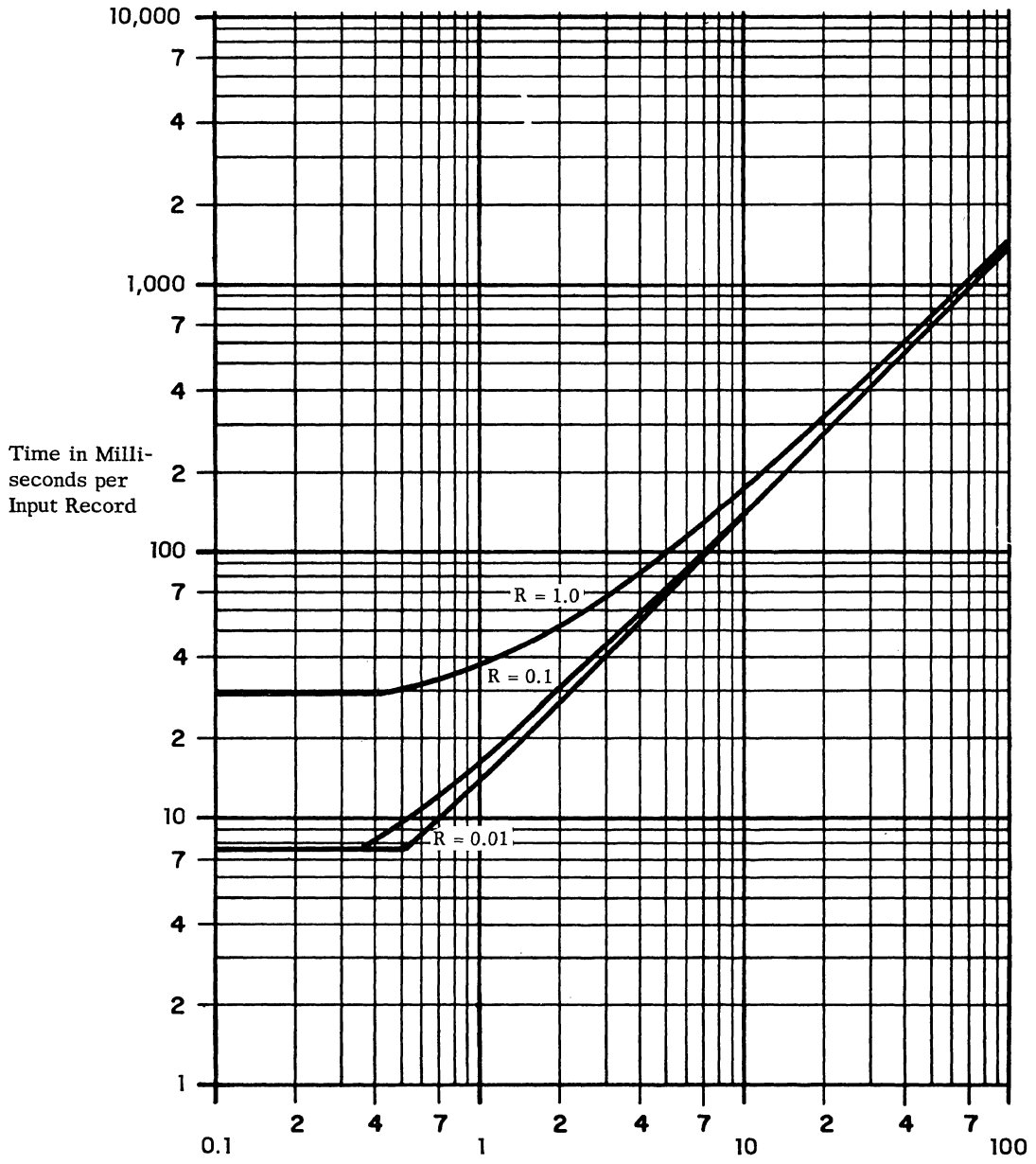
CONFIGURATION VII A LENGTH (8 DIGIT PRECISION); FLOATING POINT
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



§ 201.

.416 Graph: . . . . . see graph below.

CONFIGURATION VIII B LENGTH (8 DIGIT PRECISION); FLOATING POINT
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



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§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

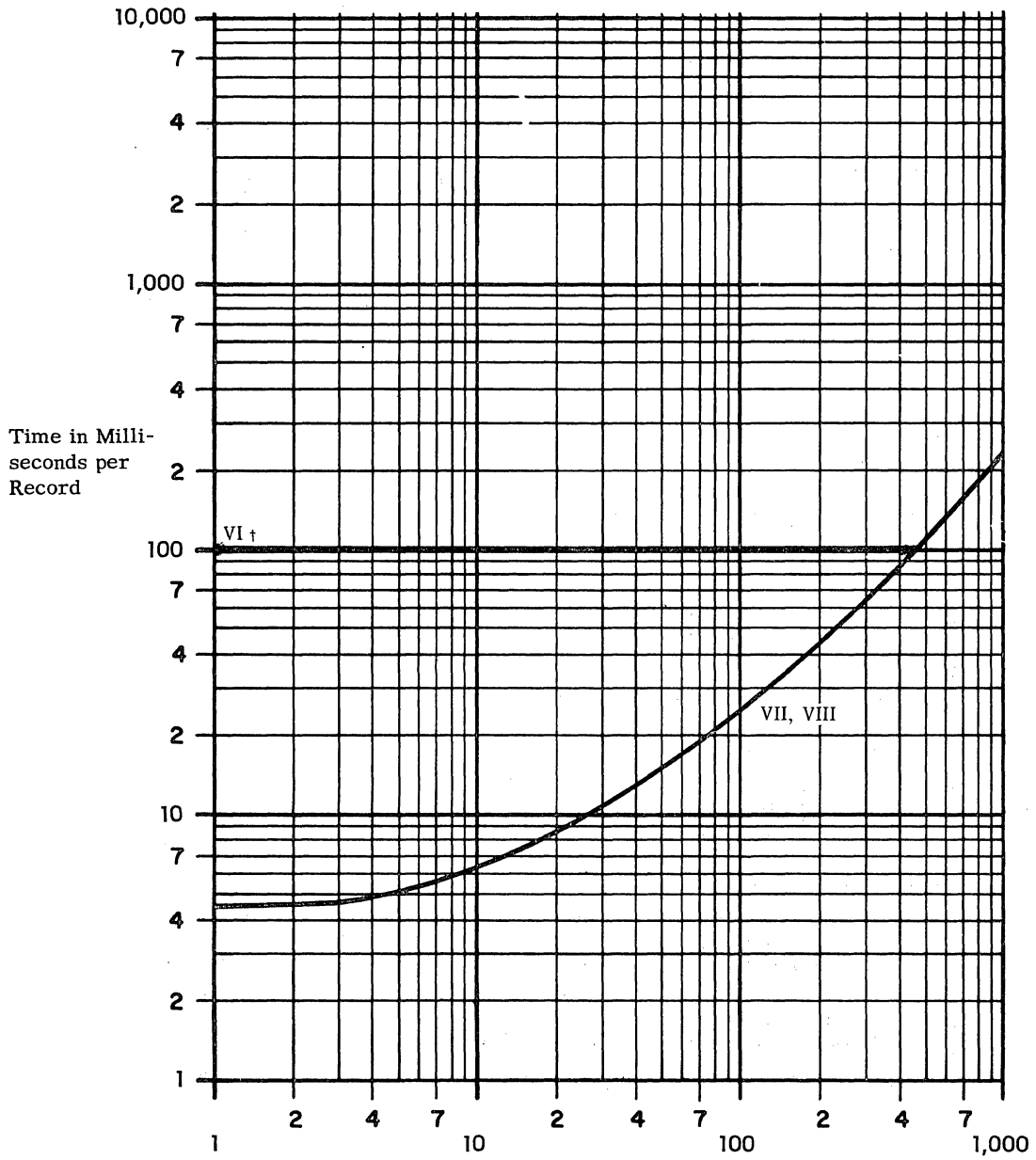
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



Roman numerals denote Standard Configurations

† And all configurations using one card-reader on-line without pre-editing.

IBM 7040
PHYSICAL CHARACTERISTICS

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IBM 7040 PHYSICAL CHARACTERISTICS

IDENTITY	Unit Name		Processing Unit	Processing Unit	Processing Unit	Processing Unit	Disk Storage	Disk Storage	Switch Control Console	File Control	Card Read-Punch
	Model Number		7106-I	7106-II	7106-III	7106-IV	1301-I	1301-II	7155 I,II,III or IV	7631 II, III or IV	1402-II
PHYSICAL	Height × Width × Depth, in.		70×208×31	70×208×31	70×208×31	70×208×31	69×86×33	69×86×33	12×9×7	70×38×32	10×58×30
	Weight, lbs.		4,200	4,200	4,200	4,200	3,625	3,825	10	500	1,400
	Maximum Cable Lengths									To 7904—50 ft.	
ATMOSPHERE	Storage Ranges	Temperature, °F.	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110
		Humidity, %	20 to 80	20 to 80	20 to 80	20 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80
	Working Ranges	Temperature, °F.	60 to 90	60 to 90	60 to 90	60 to 90	65 to 90	65 to 90	60 to 90	60 to 90	60 to 90
		Humidity, %	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80
	Heat Dissipated, BTU/hr.		26,000	27,000	27,000	27,000	16,700	20,000		4,800	4,400
	Air Flow, cfm.		4,015	4,015	4,015	4,015	1,800	1,800		400	290
	Internal Filters		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230
		Tolerance	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%
	Cycles	Nominal	60	60	60	60	60	60	60	60	60
		Tolerance	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
	Phases and Lines		3ϕ 4 wire	3ϕ 4 wire	3ϕ 4 wire	3ϕ 4 wire	3ϕ 4 wire	3ϕ 4 wire	3ϕ 4 wire	1ϕ 3 wire	1ϕ 3 wire
	Load KVA		11.3	11.6	11.6	11.6	7.5	9.0		2.7	1.6
NOTES			Console table expands 20" right or left of frame.	See Model I.	See Model I.	See Model I.	Maximum 5 units per system.		Controls a maximum of 8 tape units.	Requires 1414 VI.	One can be attached to the basic (A) channel of the system. Requires a 1414 Model 3 or 4.

IBM 7040 PHYSICAL CHARACTERISTICS (Contd.)

IDENTITY	Unit Name		I/O Synchronizer	I/O Synchronizer	I/O Synchronizer	I/O Synchronizer	I/O Synchronizer	I/O Synchronizer	I/O Synchronizer	Card Read-Punch	Paper Tape Reader	Printer	Magnetic Tape Unit	Magnetic Tape Unit	Programmed Transmission Control	Data Channel	Data Channel	Data Transmission Unit	Remote Inquiry Unit	Data Processing System
	Model Number		1414-I	1414-II	1414-III	1414-IV	1414-V	1414-VI	1414-VII	1622 I, II	1011-I	1403 I, II	729 All Models	7330-I	7750 I, II or III	7904-I	7904-II	1009-I	1014-I	1401 Models B-F
PHYSICAL	Height × Width × Depth, in.		70×38×32	70×38×32	70×38×32	70×38×32	70×74×32	70×74×32	70×38×32	46×58×30	60×32×36	53×48×29	69×29×34	38×29×31	70×181×31	70×37×31	70×37×31	40×29×31	35×29×24	
	Weight, lbs.		500	500	500	1,000	1,100	1,100	500	1,350	529	750	1,200 (max)	650	2,700 (approx)	660	750	500	175	
	Maximum Cable Lengths		To 7106—50' To 7904 Channel D —40' To 7106 Module A—75'	To 7106—50' To 7904 Channel D —40' To 7106 Module A—75'	To 7106—50'	To 7106—50'			To 7106—50' To 7904 Channel A —40' To 7106 Module A—75'	To 7106—20'			Maximum total length of a power leg is 100'	Maximum total length of a power leg is 80'		To 7106—50' To Direct Data—150'	To 7106—50'			To 7106—60'
ATMOSPHERE	Storage Ranges	Temperature, °F.	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110	50 to 110
		Humidity, %	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80	0 to 80
	Working Ranges	Temperature, °F.	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90	60 to 90
		Humidity, %	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80
	Heat Dissipated, BTU/hr.		1,400	1,400	2,120	5,000	4,050	4,450	1,400	5,500	4,100	3,000	3,900	3,415	26,000 *	3,260	6,040	1,000	500	
	Air Flow, cfm.		500	500	500	1,000	1,000	1,000	500	280	150	310	550	150	?	710	710	120	— — —	
	Internal Filters		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
ELECTRICAL	Voltage	Nominal	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	208 or 230	115, 208 or 230	115, 208 or 230	
		Tolerance	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	±8%	
	Cycles	Nominal	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	
		Tolerance	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	
	Phases and Lines		3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	1φ 3 wire	1φ 3 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	3φ 4 wire	1φ 3 wire	1φ 3 wire	
	Load KVA		0.5	0.5	0.8	1.8	1.2	1.3	0.5	1.46	1.8	— — —	1.6	1.1	10.8	1.6	2.6	0.3	0.18	
NOTES			One Model 1, 2, or 7 can be attached to each channel.	See Model I.	One Model 1414 III, IV or V can be attached to the basic (A) channel.			One Model 6 can be attached to each additional channel (B, C, D or E). Maximum, 4 per system.	See Model I.	Either model can be attached to a 7106.	On 1414 models 4, 5 or 6.	Either model can be attached to the basic (A) channel of the system. Requires a 1414 model 3 or 4.		Requires 1414 model 1, 2 or 7.	Only 1 per system. *(27,000 with Telegraph Converter Base)	Either model. One per channel. Four per system.		On 1414 Models 4, 5 or 6.	On 1414 Models 4, 5 or 6.	See 1401.

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT No.	IDENTITY OF UNIT Name	PRICES Monthly Rental $	PRICES Monthly Maintenance $	PRICES Purchase $
CENTRAL PROCESSOR	7106	Central Processor Standard Equipment			
	Model I	4,096 words of storage	7,500	175.00	485,000
	II	8,192 words of storage	8,000	185.00	510.000
	III	16,384 words of storage	9,000	200.00	560,000
	IV	32,768 words of core storage 1 Output Typewriter Data Channel A	11,000	245.00	660,000
		Optional Features			
	#3880	Extended Performance	500	11.25	15,000
	#4428	Floating Point Arithmetic Single Precision	350	6.25	10,000
	#4429	Floating Point Arithmetic Double Precision	550	17.25	18,000
	#5080	Memory Protection	75	2.25	3,000
	#7498	Storage Block Internal Time	60	2.25	2,400
STORAGE	1301	Disc Store (5 Max.)			
	Model I	28 million characters	2,100	138.00	115,500
	Model II	56 million characters	3,500	238.00	185,500
		Optional Feature			
	#3213	Cylinder Mode	25	1.00	1,250
		Prerequisite Equipment			
	7631	File Control (2 max.)			
	Model I	Unshared	835	30.00	42,000
	Model II	Shared with 1410 or 7010	1,035	35.00	52,000
	Model III	Shared with 7000 series system	1,035	35.00	52,000
	#1074	Control Adapter	225	3.25	8,000
	7094 I or II	Data Channel (see I/O)			
	#1845 or	Data Channel B Adapter	250	6.75	11,000
	#1846	Adapter for Data Channel C, D, and E (1 each)	50	1.00	1,800
INPUT-OUTPUT DATA CHANNELS	7904 I	Data Channel B or D	1,500	33.50	95,000
	7904 II	Data Channel C or E	2,000	57.00	118,000
		Optional Equipment			
	#1040	Adapter, Tape 1414 (1 max. per channel)	90	2.25	4,200
	#1074	Adapter, Control (1 max. per channel) to attach a 7631, 1414 VI, or 7750.	225	3.25	8,000
	#1080	Adapter, Direct Data or Non-IBM devices (1 max. per channel)	300	4.25	2,000
		Prerequisite Equipment			
	#1845	Data Channel B Adapter	250	6.75	11,000
	#1846	Adapter for Data Channel C and D and E (1 each).	50	1.00	1,800

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PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
	7106 I II, III, and IV	Data Channel A (processor)	see	central	processor
		Optional Equipment			
		Adapter, Card 1414 (1 max., none with #1046).	80	3.25	3,600
	#1046	Adapter, 1622 (1 max., none with #1038	95	2.25	4,700
	#1040	Adapter, Tape 1414 (1 max.)	120	4.25	5,500
	#1034	Adapter, 1401 (1 max., requires #7080)	100	2.25	3,800
	#7080	Serial Input-Output Adapter	100	1.50	3,750
INPUT-OUTPUT CONTROLLERS	7631 II	File Control for 1301 DSU	835	30.00	42,000
	III	File Control for 1301 DSU	1,035	35.00	52,000
	IV	File Control for 1301 DSU	1,035	35.00	52,000
		Prerequisite Equipment			
		See Storage, 1301			
		Optional Features			
		See Storage, 1301			
	1414 I	I/O Synchronizer Tape, 729 II, IV, V	975		
	1414 II	I/O Synchronizer Tape, 7330	500		
	1414 III	I/O Synchronizer Unit record	675		
	1414 IV	I/O Synchronizer Unit record and communications	775		
	1414 V	I/O Synchronizer Communications	?		
	1414 VI	I/O Synchronizer Communications	850	12.00	43,350
	1414 VII	I/O Synchronizer Tape, 729 II, IV, V, VI	1,125		
		Prerequisite Equipment			
		See Input-Output, Data Channels.			
		Optional Features			
	#3585	Model I 800 CPI for 729 V			
	F92950	Model I Tape, Read Gapless	270		
	W99187	Model III Printer, 1404 with compare	580		
	E10112	Model III & IV Printer, 1404 attachment without compare	90		
	#7680	Model III & IV Printer, 1403 II attachment	550		
	#7681	Model III & IV Printer, 1403 II Additional Synchronizer Storage	60		
	#6024	Model IV Read/Punch, 1402 Read/Punch Column Binary	?		
	M04578	Model IV Trans. Remote to 1001	260		
	882017	Model IV Inquiry Adapter, Indicator	10		
	M00447	Model IV 2nd Buffer 1403 - channel 1	630		
	730631	Model IV Reader 2nd 1011 Paper Tape	45		
	#7184	Model I & VII Tape Intermix for 7330s	45		2,250

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT UNITS	729 II	Magnetic Tape Unit	700	116.00	36,000
	729 IV	Magnetic Tape Unit Maximum	900	128.00	41,250
	729 V	Magnetic Tape Unit 10 per	750	122.00	37,200
	729 VI	Magnetic Tape Unit Channel	950	134.00	42,450
	7330	Magnetic Tape Unit	450	52.25	22,000
For prerequisite equipment see appropriate 1414 or Data Channel.		Optional Equipment			
	#7830	Tape Switching Feature for 729 MTUs attached to a 7155	85	6.50	4,400
	E03378	Required for each 7330 MTU attached to a 7155	125		
	7155	Switch Control Console			
	Model I	2 tapes	35	5.50	1,775
	Model II	4 tapes	55	11.00	2,675
	Model III	6 tapes	80	16.50	3,875
	Model IV	8 tapes	100	22.00	4,775
	1009	Data Transmission Unit (1 max per 1414 IV, V, VI)	500	11.50	26,400
	1011	Punched Tape Reader (1 max per 1414 IV, V, VI)	500	42.50	22,400
	1014	Inquiry Station (20 max per 1414 IV, V, VI)	200	12.50	11,000
	1402 II	Card Read/Punch (requires 1414 III, IV)	615		
	1403 I	Printer (requires #7680)	725	172.00	32,900
	1403 II	Printer (requires #7680 and 7681)	775		
	1404 II	Printer (requires E10112)			
	1622	Card Read/Punch	615		
		Optional Features:			
	M01376	Punch Octal/binary	160		
	M01377	Read Octal/binary	140		
	M99145	Punch 250 cpm	170		
	M03473	Read 800 cpm	75		
	M03747	Read 500 cpm	65		
	M00711	File Feed	35		

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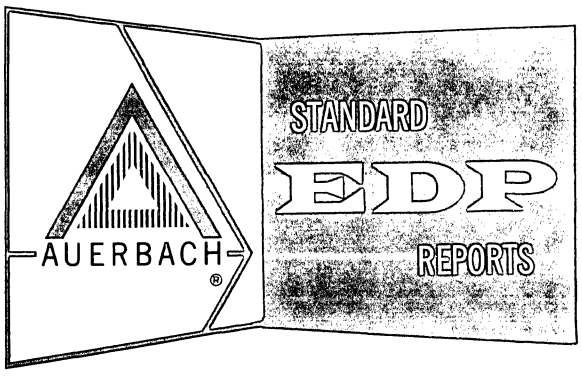
IBM 7044

International Business Machines Corp.



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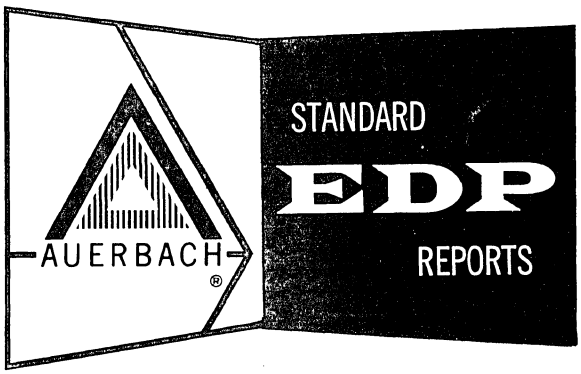
IBM 7044

International Business Machines Corp.



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RIP = Report in Process

INTRODUCTION

§ 011.

The IBM 7044 is a medium to large scale, solid-state, general purpose processing system. Unlike other members of the IBM 7090/7094 family, the 7044 (and the slower 7040) can communicate directly, storage-to-storage, with an IBM 1401 and its input-output equipment, as well as with other 7040, 7044, 7090, and 7094 systems. The 7040 and 7044 are the only systems of the 704/709/7090/7094 group that can include high-speed printers and card readers in which all data transfers are parity checked.

The 7107 Central Processor is available in three models which differ only in storage size. Storage sizes are 8,192, 16,384 and 32,678 words; each word contains 36 bits plus a parity bit. The basic storage or processor cycle time is 8 microseconds and all data transfers in the processor are performed in parallel. The 7107 is similar to the 704 and 7106 processors in that it can be used either for processing or as a data channel for input-output transmission. The 7107 can also have four independent 7904 overlapped-transfer data channels connected to it.

Like the 7040, the standard 7107 Central Processor has a set of fixed point arithmetic instructions and instructions for data manipulating, control and input-output, but has no index registers. The Extended Performance option includes 3 index registers with a set of 20 instructions for using these registers, 3 single-character-handling instructions, a data block transfer instruction, and several sequence control instructions. Acquiring this option is almost mandatory because the software being written for the 7044 relies on the option for optimum object programs; also, the option can double the system throughput with an increase of five per cent or less in rental or price. The 7044 without the Extended Performance option is about as fast as a 7040 with the option. The 7044 can outperform its equivalent 7040 system by only a factor of approximately two. The increase of three-fold in the cycle-time is partially negated by the use of more word cycles to execute many 7044 instructions than the number of comparable word cycles in the 7040.

Other options for the 7044 are: Single Precision Floating Point (required for FORTRAN), Double Precision Floating Point (for which the Single Precision Floating Point option is a prerequisite), a Clock and Interval Timer, and a Memory Protect option.

The 7044 system can be programmed so that its programs can also be run on the 7090 and 7094 systems. Running 7090/7094 programs on the 7044 is almost impossible because many 7090/7094 instructions are not in the 7044 repertoire. Recompilation in a compatible language such as FORTRAN or COBOL is the only effective way to run 7090/7094 programs on a 7044. The 7040 software complement will be very similar to that for the 7090 (see 7090, Introduction), but will be restricted in capability and effectiveness on system configurations with smaller storage than the 7090. Programs for the 7040 and 7044 are completely interchangeable, except where timing problems exist.

The 7044 system has a very extensive interrupt system that provides definitive indications of the reasons for the interrupts, in addition to links back to the main program and to an interrupt processing routine. The interrupt system grows with the size of the system; with few exceptions, adding any option or piece of equipment adds another source or kind of interrupt. All interrupts can be enabled or disabled individually or in groups.

The input-output equipment is connected in modular fashion. The central processor is connected to 7904 Data Channels B through E by adapters. Since channel A is the central processor, no adapter is required. The data channels are connected to synchronizers by another set of adapters, except in the cases of 7904 Direct Data connections (which connect to "real-time" devices such as radars and Direct Data connections on other systems), and the 1401 system connections on channel A. The synchronizers can be buffered or unbuffered

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§ 011. INTRODUCTION (Contd.)

controllers that are connected through a control adapter to the input-output unit or series of units. One data transmission at a time may be in progress on each data channel.

A characteristic of all 7044 terminal units is that parity is checked during data transmission operations at the core store, the data channel, and the terminal unit. Almost all the units have some form of built-in checking in their read or write equipment.

The basic input-output controller in the system is the 1414 Synchronizer. Through these units two 1403 or 1404 Printers and a 1402 Card Read Punch can be connected. The communications equipment that can be connected to a 1414 permits data transmissions with any digital equipment that can use telegraph or telephone lines.

In comparison to other systems in its class, the 7044 appears to operate twice as fast as a 7040, five times faster than the 709 system and very slightly slower than a 7090. Ignoring Hypertape units on input-output-limited problems, the 7044 speed should equal that of the 7090 very closely, since the same disc storage and magnetic tape units are used with either system. The basic 7044 system rents for approximately one-half and an expanded system for approximately three-fourths that of a comparable 7090 system. The 7044 processor rents for approximately one-half that of the 7090 processor, but the input-output equipment costs the same on either system except for the controllers, which rent for somewhat less in the 7044 system.

DATA STRUCTURE

§ 021.

.1 STORAGE LOCATIONS

Name of Location	Size	Purpose or Use
Word position:	36 bits + parity	basic addressable location in core storage.
Row:	6 bits + parity	character on magnetic tape.
Column:	single column code	character on punched cards.
Unit Record:	14, 17, 22, 24, or 28 words	punched card and print image in core storage.
Group or "byte":	6 or 8 bits + parity bit	a BCD char on band of a disk surface.
Band:	2,790 char max	usable length of band in disk store.
Record:	1 to 2,790 char	related char in a band.
Record:	1 to N words	related words on magnetic tape.
Cylinder:	40 bands	addressable group of bands.
File:	1 to N records	magnetic tape or disk store.

.2 INFORMATION FORMATS

Type of Information	Representation
Numeral:	BCD char on magnetic tape or disk. card column.
Alphameric char: . . .	BCD char on magnetic tape or disk. card column. 6 bits of word.
Fixed point number:	sign bit plus 35 bits in word.
Floating point number:	sign bit plus 8-bit characteristic plus 27-bit fractional part in word.
Instruction:	1 word.
Data:	1 word.

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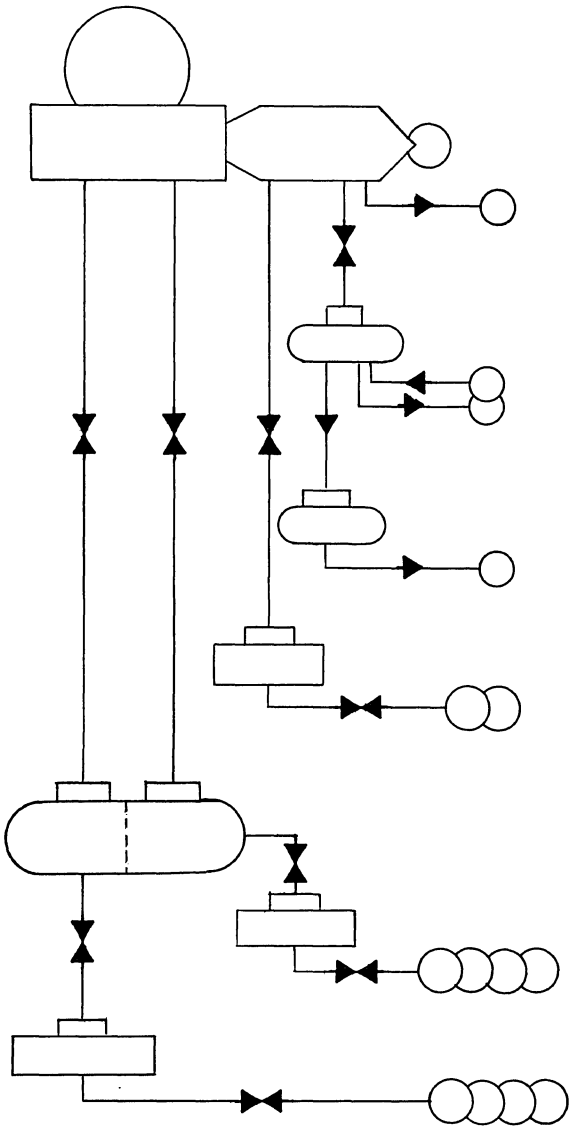
SYSTEM CONFIGURATION

§ 031.

.1 10-TAPE GENERAL-INTEGRATED; CONFIGURATION VII A.

Deviations from Standard Configuration: . . . . . 65% more core storage.
10% longer printer line.
20% faster printer.
60% faster card reader.
150% faster card punch.
Typewriter is output only.
50% fewer index registers (only 3).



Equipment	Rental
Core storage: 32,768 words, 7107 III Central Processor, with Console and Output Typewriter, 15.5 char/sec.	$ 20,500
Processor Options (see below).	910
#1038 Card Adapter.	80
1414 III Synchronizer.	675
1402 II Card Read-Punch, Reader: 800, Punch: 250 cards/min.	615
#7680 Attachment, 1403.	550
#7681 Additional Synchronizer Storage.	60
1403 II Printer, 600 lines/min.	775
#1040 Tape Adapter.	120
1414 I Synchronizer.	975
729 II Magnetic Tape Units (2), 41,667 char/sec.	1,400
#1845 First Channel Adapter.	250
#1846 Second Channel Adapter.	50
7904 II Overlapped Data Channels (2 controllers).	2,000
#1040 Tape Adapter.	90
1414 I Synchronizer.	975
729 II Magnetic Tape Units (4), 41,667 char/sec.	2,800
#1040 Tape Adapter.	90
1414 I Synchronizer.	975
729 II Magnetic Tape Units (4), 41,667 char/sec.	2,800
Total Rental:	$ 36,690

Optional Features Included: . . . . . Extended Performance, #3880.
Single Precision Floating Point, #4428.
Clock and Interval Timer, #7498

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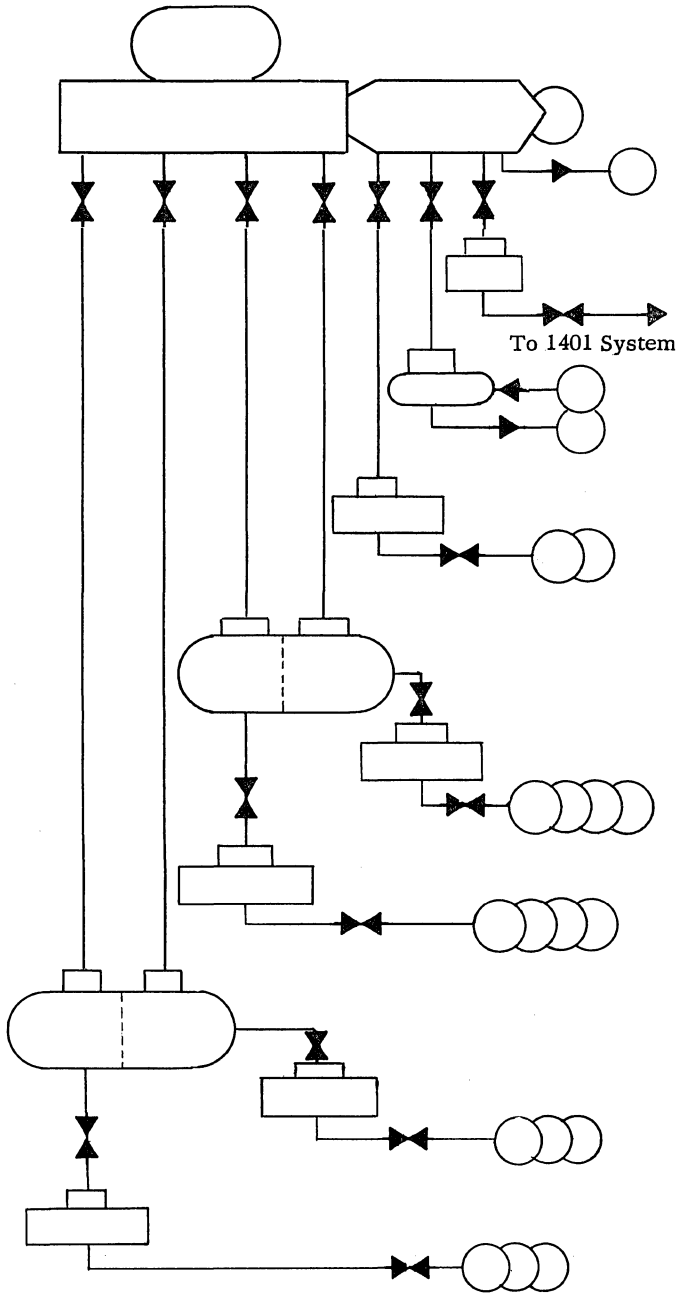
.2 20-TAPE GENERAL-PAIRED; CONFIGURATION VIII B.

Deviations from Standard Configuration: . . . . . 23% more core storage.
10% longer print line.
150% faster card reader.
Extra card punch (comes with reader).
25% slower magnetic tapes.
Typewriter is output only.
70% fewer index registers (3 only).
On-line connection to paired system.



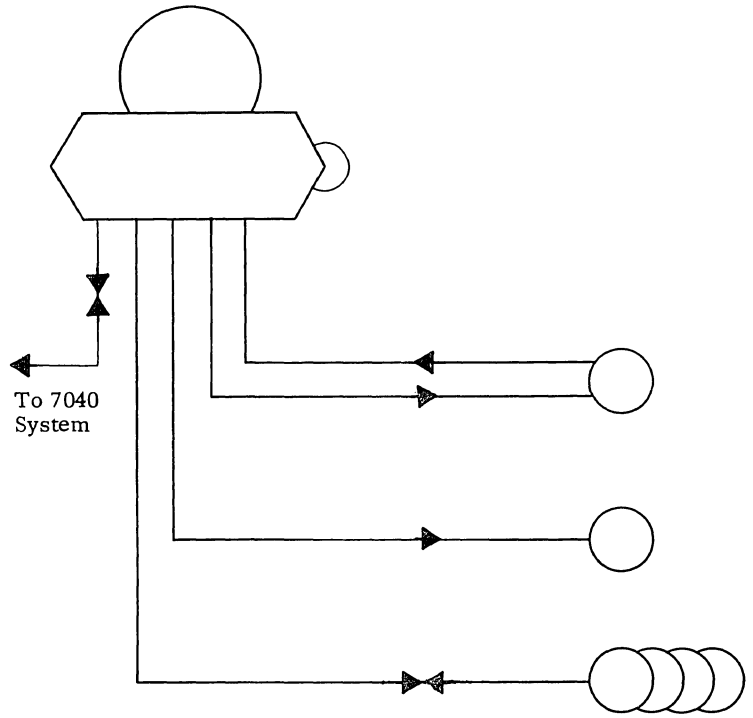
Equipment	Rental
Core Storage: 32,768 words,	$ 20,500
7107 III Central Processor, with Console and Output Typewriter, 15.5 char/sec.	
Processor Options (see below)	985
#1034 Adapter, 1401.	100
#7080 Serial I/O Adapter, 87,000 char/sec.	100
#1046 Adapter, 1622.	95
1622 Card Reader-Punch, Reader: 250, Punch: 100 cards/min.	615
#1040 Tape Adapter.	120
1414 VII Synchronizer.	1,125
729 V Magnetic Tape Units (2), 60,000 char/sec.	1,900
#1845 First Channel Adapter.	250
#1846 Additional Channel Adapter.	50
7904 II Overlapped Data Channels (2 controllers)	2,000
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (4), 90,000 char/sec.	3,800
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (4), 90,000 char/sec.	3,800
#1846 Additional Channel Adapters (2).	100
7904 II Overlapped Data Channels (2 controllers).	2,000
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (3), 90,000 char/sec.	2,850
#1040 Tape Adapter.	90
1414 VII Synchronizer.	1,125
729 VI Magnetic Tape Units (3), 90,000 char/sec.	2,850
Total Rental:	$ 48,100

Optional Features Include: . . . . . Extended Performance, #3880.
Single Precision Floating Point, #4428.
Clock and Interval Timer, #7498.
Memory Protect, #5080.

§ 031.

.2 20-TAPE GENERAL SYSTEM (PAIRED); CONFIGURATION VIII B (Contd.)

Auxiliary Computer (IBM 1401)



Equipment	Rental
1406 Core Storage: 8,000 positions	$ 575
Processing Unit: 1401 Model C4 Console	2,730
1402 Card Read-Punch Reads: 800 cards/min. Punches: 250 cards/min.	550
1403 Printer: 600 lines/min.	835
729 V Magnetic Tape Units (4): 60,000 char/sec.	3,000
Optional Features	855
Total Rental:	$ 8,545

Deviations from Standard Configuration . . . . . none.

Rental . . . . . $8,545 per month.

Optional Features Included: . . . . . High-Low-Equal Compare.
Advanced Programming.
Read Punch Release.
Sense Switches.
Print Storage.
Processing Overlap.
Early Card Read.

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INTERNAL STORAGE: MAGNETIC CORE

§ 041.

.1 GENERAL

.11 Identity: . . . . . 7107 (Processor) Magnetic Core.
Models I, II, III.

.12 Basic Use: . . . . . working storage.

.13 Description

The core storage is physically part of the central processor. The central processor model number is determined by its storage capacity; Models I, II, and III having 8,192, 16,384, and 32,768 storage locations, respectively.

A word is represented as 36 bits plus an odd parity bit. Odd parity checking is provided on all data transfers to or from the core store. A parity error sets an indicator which can cause an immediate or delayed interrupt of the program. When a parity interrupt occurs, the possibility of additional parity interrupts is automatically inhibited.

This store has a cycle time of 2.5 microseconds, and it can accept or send data at a rate of 400,000 words per second to the processor or any of the data channels.

A "Memory Protect" option (see Central Processor, 411:051.12) which will prevent the program from changing the contents of a region of storage is available with any of the models. Input-output operations are not inhibited by this option.

.16 Reserved Storage: . . . none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . magnetic core.

.22 Physical Dimensions

.221 Magnetic core type storage
Core diameter: . . . . ?
Core bore: . . . . . ?

.23 Storage Phenomenon: . direction of magnetization.

.24 Recording Permanence

.241 Data erasable by instructions: . . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . . no.
.245 Storage changeable: . . no.

.28 Access Techniques

.281 Recording method: . . . coincident current.
.282 Reading method: . . . . sense wire.
.283 Type of access: . . . . uniform.

.29 Potential Transfer Rates

.292 Peak data rates
Cycling rates: . . . . 400,000 cps.
Unit of data: . . . . . word.
Conversion factor: . . 37 bits/word.
Data rate: . . . . . 400,000 words/second.

.3 DATA CAPACITY

.31 Module and System Sizes

	Minimum Storage		Maximum Storage
Identity:	7107 I	7107 II	7107 III
Words:	8,192	16,384	32,768
Characters:	49,152	98,304	196,608
Instructions:	8,192	16,384	32,768

.32 Rules for Combining Modules: . . . . . pick only one.

.4 CONTROLLER

.41 Identity: . . . . . central processor.

.42 Connection to System

.421 On-line: . . . . . core store is internal to the processor.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 5 data channels.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to 255 words.
.442 Input-output area: . . . all of storage.
.443 Input-output area access: . . . . . by word.
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . . . automatic.
.446 Synchronizing aids: . . none.
.447 Table control: . . . . . none.
.448 Testable conditions: . . parity error.

.5 ACCESS TIMING

.51 Arrangement of Heads: set of read/write circuits.

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.52 Simultaneous Operations

A: . . . . . Data Channel A.
B: . . . . . Data Channel B.
C: . . . . . Data Channel C.
D: . . . . . Data Channel D.
E: . . . . . Data Channel E.
F: . . . . . Computation.

A + B + C + D + E = 5.
B + C + D + E + F = 5.

.53 Access Time Parameters and Variations

.531 For uniform access
Access time: . . . . . 2.0 μsec.
Cycle time: . . . . . 2.5 μsec.
For data unit of: . . . 1 word.

.6 CHANGEABLE STORAGE: . . . . . none.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pair of storage units possible
With self via processor: . . . . yes.
With data channel: . . yes.

.72 Transfer Load Size

With self via processor: 1 to 255 words.
With data channel: . . . 1 to 32,767 words.

.73 Effective Transfer Rate

With self via processor: 5 + 5 μsec per word.
With data channel: . . . 5 μsec per word.

INTERNAL STORAGE: 1301 DISK STORAGE UNIT

§ 042.

.1 GENERAL

.11 Identity: . . . . . Disk Storage Unit. 1301 Models 1 and 2.

.12 Basic User: . . . . . auxiliary storage.

.13 Description

The 1301 Model 1 Disk Storage Unit can store up to 27,900,000 alphameric characters. The Model 2 has two modules on a single vertical shaft and can store up to 55,800,000 characters. Each module contains 25 discs; 40 of the 50 disc surfaces are used for data storage. Each module is served by a comb-like access mechanism. Forty data read-write heads, one for each data surface, move horizontally between the discs. The entire access mechanism moves as one unit, so the horizontal position of all the heads serving a given module is always the same. The 40 bands, 1 on each disc surface, that can be read or recorded upon when the access mechanism is in any given position are referred to as a "cylinder."

There are 250 bands on each disc surface. The size and number of records stored in each band are variable. Their formats are controlled by a format surface that can be written upon only by a special instruction after manually releasing a write lock. Each of the 250 bands on the format surface controls the record format of the entire cylinder in the corresponding position. A different record format can be used in each of the 250 cylinders in each module.

Data can be recorded in either the 6-bit or 8-bit mode. In the 6-bit mode each band can store up to 2,790 characters. In the 8-bit mode, only 2,160 alphameric characters can be stored in a band, and 6-bit groups are stacked in 8-bit locations. The other two bits on the disc are ignored or cleared. When more than 1 record is stored in a band, the data capacity is reduced by 38 characters for each additional record address. Instructions are provided to read or record a single record, a full band, or, with the optional Read/Write Cylinder feature (RC), a full cylinder of up to 111,600 characters.

Time for access mechanism movement ranges from zero (for a record in a previously selected cylinder) to 180 milliseconds. Maximum rotation delay time is 34 milliseconds. Total reference cycle time to read a randomly placed record of 270 characters, update it, rewrite it, and execute a programmed write check is 248 milliseconds. If no access motion is required, the total reference cycle time is reduced to 88 milliseconds. Using the Read/Write Cylinder feature, an effective bulk transfer rate of 13,833 words, or 83,000 characters, per second can be achieved in the 6-bit mode

.13 Description (Contd.)

Checking features include a storage parity check, a validity check upon data received by the File Control, a comparison of the record address on the disc with the address in the stored program, and checks for illegal operation codes or sequences of instructions. Three check characters are generated and recorded during each write operation. When the record is read, the check characters are automatically generated again and compared with the ones read from the disc. As in the 7300 RAMAC unit, a programmed comparison of data recorded on a disc with data in core storage can be made.

A maximum of five 1301 Disk Storage Units can be connected to one or two 7631 File Controls. Each 7631 is attached to a 7040/44 via 7904 Channels. Two read or write operations can occur simultaneously when two File Controls are used. Every disc storage operation is initiated by a "channel select" instruction, which sends the core storage address of the initial channel command word to the specified Data Channel. Internal processing then continues while the Data Channel independently controls the disc operation. A group of 1301 units can be shared by two IBM 7000 series and/or 1410 systems.

Optional Features

#3213 Cylinder Mode (RC). Enables transfers of data, by one instruction, of a complete cylinder of up to some 18,600 words, or 111,600 characters.

.14 Availability: . . . . . 12 to 15 months (**).

.15 First Delivery: . . . . July, 1962.

.16 Reserved Storage

Purpose	Number of locations	Locks
Clocking:	1 disc surface	not addressable.
Spares:	6 disc surfaces	not addressable.
	2 disc surfaces	no heads available.
Format:	1 disc surface	manual lock.
Addresses:	31 + 38R char/band, for R records/band	none.

.2 PHYSICAL FORM

.21 Storage Medium: . . . . multiple magnetic disc.

.22 Physical Dimensions

.222 Disc
Diameter: . . . . . 24 inches.
Thickness: . . . . . thin.
Number on shaft: . . Model 1, 25 discs.
Model 2, 50 discs.

(**) Estimate. See 1:010.400.

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.23 Storage Phenomenon: magnetization.

.24 Recording Permanence

.241 Data erasable by instructions:. . . . . yes.
.242 Data regenerated constantly: . . . . . no.
.243 Data volatile: . . . . . no.
.244 Data permanent: . . . no.
.245 Storage changeable: . . . . . no.

.25 Data Volume per Band of 1 Track

	6-bit mode	8-bit mode
Words:	465	360.
Characters:	2,790	2,160.
Digits:	2,790	2,160.
Instructions:	465	360.

Note: These are maximum capacities, based upon 1 record per band; each additional record address requires 38 characters, or 7 words.

.26 Bands per Physical Unit: . . . . . 250 per disc surface.

.27 Interleaving Levels: . . 1.

.28 Access Techniques

.281 Recording method: . . magnetic heads on access arms which move horizontally in unison.

.283 Type of access

Description of stage	Possible starting stage
Move heads to selected band:. . .	if new band is selected.
Wait for selected record:	if same band was previously selected.
Wait for transfer of data:.	no.

.29 Potential Transfer Rates

.291 Peak bit rates
Cycling rates: . . . . 1,800 rpm.
Bit rate per track: . . 630,000 bits/sec including char gaps.
540,000 bits/sec, data bits only.
Note: based on 6-bit mode.

.292 Peak data rates
Unit of data:. . . . . character.
Conversion factor: . . 7 or 9 (including space bit).
Gain factor: . . . . . 1 track/band.
Data rate
6-bit mode: . . . . 90,000 char/sec.
8-bit mode: . . . . 70,000 char/sec.
8,750 words/sec.

.3 DATA CAPACITY

.31 Module and System Sizes

Identity:	Minimum Storage	1301 Model 1	1301 Model 2	Maximum Storage 5 1301s. Model 2.
Discs:	0	20 data	40 data	200 data.
Words:	0	4,650,000	9,300,000	46,500,000.
Characters:	0	27,900,000	55,800,000	279,000,000.
Instructions:	0	4,650,000	9,300,000	46,500,000.
Cylinder char:		111,600	223,200	1,116,000.
Cylinder word:		18,600	37,200	180,000.
Modules:	0	1	2	10.
Basis:	6-bit mode, 1 record/band.			

.32 Rules for Combining Modules: . . . . . up to five 1301s, Model 1 and/or Model 2 in any combination.

.4 CONTROLLER

.41 Identity: . . . . . File Control.
7631 Model 2, 3, or 4.

Data Channel.
7904 (see 411:101.12).
#1074 Channel Adapter.

.42 Connection to System

.421 On-Line: . . . . . one 7631 with one 7904.
.422 Off-Line:. . . . . 7631 Model 3 permits shared use of 1301s with an IBM-1410 system.

7631 Model 4 permits shared use with another 7000 series system (except 7072).

.43 Connection to Device

.431 Devices per controller: . . . . . 5.
.432 Restrictions: . . . . . maximum of five 1301s per system, whether 1 or 2 7631s are used.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 record of up to 2,790 chars, 1 band of up to 2,790 chars, or (with read/write cylinder option) 1 cylinder of up to 111,600 characters.

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.442 Input-output area: . . . . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Synchronization: . . . automatic.
.447 Table control:. . . . . no.
.448 Testable conditions: . . . . . access not ready, access inoperable, and various error conditions are signaled by the File Control in response to a "sense" command.

.5 ACCESS TIMING

.51 Arrangement of Heads

.511 Number of Stacks
Stacks per system: . . 40 to 400, data only.
Stacks per module: . . 40.
Stacks per yoke: . . . 40.
Yokes per Module: . . 1.
Total per system: . . 50 to 500, including spares and control (see 410:041.16).
.512 Stack movement: . . . horizontal.
.513 Stacks that can access any particular location: . . . . . 1.
.514 Accessible locations
By single stack
With no movement: . 1 band.
With all movement: . . . . . 250 bands.
By all stacks
With no movement: . . . . . 40 bands per module. 40 to 400 bands per system.
.515 Relationship between stacks and locations: . . . . . first 4 digits of 6-digit home address for each band denote head and band number.

.52 Simultaneous Operations

A: . . . . . seeking a specified location.
B: . . . . . reading.
C: . . . . . recording.

a + b + c = at most 1 per DSU module.
b + c = at most 1 per File Control.

.53 Access Time Parameters and Variations

.532 Variation in access time

Stage	Variation, msec.	Example, msec.
Move head to selected band:	0 or 50 to 180	160.0.
Wait for selected record:	0 to 34	17.0.
Read one record:	0.4 to 34	4.0.
Read one band:	34.	
Total:	0.4 to 248	181.0.

.6 CHANGEABLE STORAGE: . . . . . no.

.7 AUXILIARY STORAGE PERFORMANCE

.71 Data Transfer

Pairs of storage units possibilities
With self: . . . . . no.
With core storage: . . yes.

.72 Transfer Load Size

With core storage:. . . 1 record, 1 band, or (with RC) 1 cylinder.

.73 Effective Transfer Rate

With Core storage, using optional RC
6-bit mode: . . . . . 83,700 char/sec.
13,950 words/sec.
8-bit mode: . . . . . 65,000 char/sec.
10,833 words/sec.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Invalid address:	check	indicator.
Invalid code:	check	indicator.
Receipt of data:	parity bit check	indicator.
Recording of data:	programmed write check; generate check characters	indicator.
Dispatch of data:	parity	indicator.
Timing conflicts:	check	indicator.
Physical record missing:	check	indicator.
Reference to locked area:	ignored.	
Access inoperative	check	indicator.
Circuit failure:	check	indicator.
Illegal instruction sequence:	check	indicator.
Illegal format character:	check	indicator.

Note: These error indications are transmitted from the File Control to the computer in response to a "sense" command.

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CENTRAL PROCESSOR

§ 051.

.1 GENERAL

.11 Identity: . . . . . 7107 Central Processor.

.12 Description

The 7107 Central Processor is a solid-state, medium-to-large-scale scientific computer which is available in three models. The models differ only in storage size. The 7107 is similar to the 709, 7090, and 7094 processors in its instruction repertoire, word length (36 bits), register complement, and use of independent simultaneous data channels. Many of the standard features on the 709, 7090, and 7094 processors are optional on the 7107. Like the 704 and 7106 processors, the 7107 processor can also be used as data channel A, but no simultaneous processing can take place.

The basic processor with no options included has a standard instruction set, an input-output instruction set, indirect addressing capability, and the capability to be used as data channel A. An output-only IBM Selectric typewriter located on a desk below the processor console is connected to channel A. Index registers are not provided as standard equipment with the basic processor. The 7107 uses single-address one-word instructions which can be executed at a rate of approximately 120,000 instructions per second, or about twice as fast as the 7040 processor. The increase of three-fold in the cycle-time is partially negated by more word cycles to execute many 7044 instructions than the comparable number of word cycles used in the 7040.

The basic instruction set is the same as the 7040 set and includes: a full range of binary fixed-point arithmetic instructions; the AND, OR, and NOT logical instructions; a recursive "Execute" instruction; the seven shift instructions used in the 709, 7090, and 7094; an extensive set of test-accumulator-and-branch instructions; and several other set bit and test instructions. Two new and very useful instructions are a "subroutine-branch" and a "multiply-accumulate". Most of the instructions require 5 microseconds for execution. The notable exceptions are multiplication (30 microseconds) and division (50 microseconds). Indirect addressing requires an additional 25 microseconds. The "table look-at" instructions, useful for radix and code conversions in the 7070/7094, have not been included in the 7044. However, three character-handling instructions are available in the Extended Performance instruction set (see optional equipment, below).

When the processor is used as data channel A, the accumulator, address, and multiplier-quotient registers are used for the duration of an input-output transfer to or from core storage, thus prohibiting any simultaneous calculations. Because the card reader, card punch, printer, and TELE-PROCESSING* equipment are fully buffered, calculation is rarely delayed for more than one per cent of the total input-output operation. The processor is stalled for less than 0.15 millisecond while the data is being transferred from any buffer to core storage. Magnetic tape start time and the time between single characters typed on the console typewriter can be overlapped with computation time, but the actual data transmissions are non-simultaneous with processing.

.12 Description (Contd.)

The basic input-output instructions are comprehensive, and permit the status-testing of all addressable devices. Two instructions are required to initiate a data transmission input-output operation. The first instruction selects the device, selects either the read or write mode, and ascertains the type of code translation (if any) to be used. The second instruction sets the data channel registers with the word count and the starting address in core from which data transmission will begin. These instruction assignments apply to all input-output data transmission operations, whether performed on a simultaneous 7904 Data Channel or data channel A. The only data channel command is "input-output a record and disconnect," which does not permit scatter-read and gather-write operations.

An extensive interrupt system is provided with the 7044. As the 7044 is expanded by adding options to the processor or adding input-output equipment and data channels, the interrupt system also expands. A direct indication of the cause of an interrupt (called "trap" by IBM) is provided by the system. When an interrupt occurs, the program counter and a detailed indication of the interrupt condition are stored in a location peculiar to the interrupt that caused it. The program counter is then set to the address of the data just stored plus one, where a transfer interrupt routine and interrupt routine should be stored. Thus, both a link to the interrupt routine and a link back to the main program are provided automatically. Interrupts are processed on a fixed priority basis. All interrupts are mutually exclusive, thus making the interrupt program routines straightforward. All interrupts can be enabled or disabled individually, or in groups, under program control.

Compatibility: Consideration has been given to compatibility in transferring 7044 programs to the 7040, 7090, or 7094. In the 7090/7094 to 7044 direction, the only practical approach seems to be recompilation of the source program through a compatible source language translator, such as FORTRAN or COBOL, because many commonly used instructions for the 7090/7094 are not included in the 7044 set. All the new 7044 instructions that do not exist in the

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.12 Description (Contd.)

7090/7094 have been given instruction operation codes that would appear as "store and trap" instructions to the 7090/7094, which provide a link to a 7044 interpretive routine that can perform (or ignore, if not possible) the same function in the 7090/7094 instruction complement. A read and a write instruction in this form have been provided in addition to the 7090/7094 read/write operations. If input-output units that are common to both systems use the 7090/7094 instructions, and input-output units peculiar to the 7044 use the new read and write instructions, direct object program compatibility will result. Naturally, the equipment required by the 7044 program (such as double precision floating point hardware) must be available on the system that executes a 7044 program.

Optional Processor Features

Extended Performance, #3880: The Extended Performance option consists of three index registers and 20 instructions to load, unload, test, and change index registers; a load, a store, and a test single-character set of instructions; a test storage word plus or minus; and a move (up to 255 words) instruction. The 7044 without this option is about as fast as the 7040 with the option. It is anticipated that most users will acquire the Extended Performance option for the following reasons:

(a) All of the major software packages require this option.

(b) The throughput capability of the system can be increased by two to five times.

(c) It costs less than three per cent of the cheapest system configuration likely to be used.

(d) Programs written without this option will not be any more efficient if the option is added later. Even with recompilation the result would not be as efficient as a program written with this option, even assuming good software existed for the option.

Single Precision Floating Point Option, #4428: This option is very useful for scientific applications, and is required if FORTRAN programs are to be run on the system. The option consists of the normalized floating divide, and the unnormalized and normalized add, subtract, and multiply instructions.

Double Precision Floating Point Option, #4429: The #4428 Single Precision Floating Point option is a prerequisite for this option. Double Precision requires the addition of another register which is part of this option. The option is required if the double precision arithmetic statements in FORTRAN programs are to be used.

Clock and Interval Timer Option, #7498: This option enables the time in sixtieths of a second to be stored in location 00005 of core storage. Every 16.667 milliseconds the processor is interrupted and a "1" is added to the low order bit of location 00005. Because of higher priority or previous interrupts this timer interrupt may not be able to occur. If the timer has not been incremented after 33 milliseconds, all data channels will be reset (halting all input-output operations and setting all channel registers and indicators to zero except in the processor) and the timer-reset interrupt procedure allowed to begin. An overflow out of bit position 1 of the timer location causes a timer overflow interrupt. If this interrupt is ignored for 16.667 milliseconds because of higher priority or previous interrupts, the timer reset interrupt occurs as outlined above.

.12 Description (Contd.)

Memory Protect Option, #5080: This option causes storage to be protected in one of two ways, either to restrict the program from storing data in a core storage area or not. When a store instruction references a protected area, a protect interrupt occurs and the protected word is not changed. Input-output transfers are not affected by this option. The area is defined by a "set protect mode" instruction which gives the seven high order address bits, and a count which tells how many of the seven bits are to be used. This instruction defines a region as all of the store from the high address down to a particular 256-word area. The instruction also determines whether only the area is protected, or all of the rest of storage is protected, but not the area. When the low order part of storage is protected, every interrupt causes a protection violation because every interrupt stores indicators in this region at the time of the interrupt. This action causes what is called a pre-interrupt memory-protect trap. This trap links the interrupt routine that caused the interrupt to the memory protect interrupt routine, which is in turn linked back to the normal program. When the protect mode is on, a "set protect mode" instruction causes a protection interrupt as well as any occurrence of a "release protect mode" instruction.

.2 PROCESSING FACILITIES

.21 Operations and Operands

Operation and Variation	Provision	Radix	Size
.211 Fixed point			
Add-Subtract:	automatic	binary	35 bits + sign + 2 overflow.
Multiply			
Short:	automatic	binary	0-35 bits + sign.
Long:	automatic	binary	35 bits + sign.
Divide			
No remainder:	none.		
Remainder:	automatic	binary	35 bits + sign.
.212 Floating point			Fraction Characteristic
Single length optional set:	automatic	binary	27 & 8.
Add-Subtract:	automatic	binary	27 & 8.
Multiply:	automatic	binary	27 & 8.
Double length optional set:	automatic	binary	54 & 8.
Add-Subtract:	automatic	binary	54 & 8.
Multiply:	automatic	binary	54 & 8.
Divide:	automatic	binary	54 & 8.
.213 Boolean			
AND:	automatic		36 bits.
Inclusive OR:	automatic	binary	36 bits.
NOT:	automatic		37 bits.

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.21 Operations and Operands (Contd.)

Operation and Variation	Provision	Size
.214 Comparison		
Numbers:	automatic	35 bits + sign.
Absolute:	none.	
Letters:	automatic	36 bits.
Mixed:	same as letters	36 bits.
Collating sequence: . . .	see Data Code Table No. 4, 410:144.	
.215 Code translation: . . .	none.	
.216 Radix conversion: . . .	none.	
.217 Edit format		
Alter size:	none.	
Suppress zero:	none.	
Round off:	none.	
Insert point:	see Boolean	36 bits.
Insert spaces:	see Boolean	36 bits.
Insert character:	see Boolean	6 or 36 bits.
Floating character:	none.	
Protection:	see Boolean	36 bits.
.218 Table look-up:	none.	
.219 Others		
Test:	automatic	1 to 36 bits.
Move:	optional	0 to 255 words.

.22 Special Cases of Operands

.221 Negative numbers: . . . binary magnitude and sign.
.222 Zero: . . . . . + or -; may or may not be equal; depends on instructions.
.223 Operand size determination: . . . . 36, 18, 15, or 1 bits; variable 0 to 36 bits in multiply and divide; 6-bit char in extended performance set.

.23 Instruction Formats

.231 Instruction structure: . 1 word.
.232 Instruction layout:

Variable:

Part	Operation	Flag/Count	Tag	Address
Size (bits)	12	6	3	15

Arithmetic and Data Transfer:

Part	Operation	Flag	Not Used †	Tag	Address
Size (bits)	12	2	4	3	15

Indexing ‡:

Part	Operation	Decrement	Tag	Address
Size (bits)	3	15	3	15

† Not used for most instructions.
‡ Optional.

.233 Instruction parts

Name	Purpose
Operation:	operation code.
Flag:	indirect addressing.
Tag:	index register specification.
Address:	operand address.

.233 Instruction parts (Contd.)

Name	Purpose
Count:	counts and variable length operands.
Decrements: . . .	index limits and modification values.

.234 Basic address structure: 1 + 0, sequential.
.235 Literals

Arithmetic:	none.
Comparisons and tests:	none.
Incrementing modifiers:	0 to 32,767.

.236 Directly addressed operands

	Minimum size	Maximum size	Volume accessible
.2361 Internal storage type			
Magnetic core:	1 bit	255 words †	entire storage.
Magnetic disc:	1 word	18,600 words ‡	entire storage.

† One word without extended performance instructions.
‡ 456 words without R/C option (see :042.013).

.2362 Increased address capacity: . . . . . none.
.237 Address indexing: . . . optional.
.2371 Number of methods: . 1.
.2372 Names: . . . . . indexing (can be multiple indexes.)
.2373 Indexing rule: . . . . . the contents of the indicated index registers are "ORed" together, then subtracted from the address of the instruction to form the effective instruction.
.2374 Index specification: . . each of the index bits specifies an index register.
.2375 Number of potential indexers: . . . . . 3.
.2376 Addresses which can be indexed: . . . all.
.2378 Combined index and step: . . . . . via indirect addressing or the EXC instruction.

Indirect addressing	I A Bits	EXC Instruction
.2381 Recursive:	no.	yes.
.2382 Designation: . . .	2 bits in the instruction	operation code EXC with or without the IA bits.
.2383 Control:	automatic, one level only	n-level; will not stop until another instruction other than EXC is encountered.

.2384 Indexing with indirect addressing: yes; possible before and after going to the indirect address.
.239 Stepping

.2391 Specification of increment:	in stepping instruction.
.2392 Increment sign:	positive.
.2393 Size of increment: . .	0 to 32,767.
.2394 End value:	value of increment.
.2395 Combined step and test:	yes.

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.24 Special Processor Storage

.241 Category of storage	Number of locations	Size in bits	Program usage
Accumulator:	1	38	arithmetic unit.
Address:	1	15	address storage.
Count †:	1	4	memory protection.
Double Precision Floating Point ‡:	1	27	double precision add, subtract, multiply and divide.
Field †:	1	7	memory protection.
Index ⧺:	3	15	address modification.
Instruction:	1	10	hold instruction during execution.
Multiplier-Quotient:	1	36 + check bit	low order bits of product, input-output, hold multiplier and quotient.
Position:	1	6	indirect address bit, operation code, character address of instruction being executed.
Program Counter:	1	15	address of next instruction.
Sense Switch:	6	1	accept condition.
Shift Counter:	1	8	counter for multiply, divide, input-output moves.
Storage:	1	36 + memory parity bit	buffer with core store.
Tag:	1	3	index(s) to be used to modify address.

† Requires memory protect option.
‡ Requires single and double precision floating point option.
⧺ Requires Extended Performance Instruction Set.

.242 Category of storage	Total number of locations	Physical form	Access time, μsec.	Cycle time, μsec.
Accumulator:	1	register	0.42	2.50
Address:	1	register	0.42	2.50
Count †:	1	register	0.42	2.50
Double-Precision Floating Point ‡:	1	register	0.42	2.50
Field †:	1	register	0.42	2.50
Index ⧺:	3	register	0.42	2.50
Instruction:	1	register	0.42	2.50
Multiplier-Quotient	1	register	0.42	2.50
Position:	1	register	0.42	2.50
Program Counter:	1	register	0.42	2.50
Sense Switch:	6	switches	0.83	--
Shift Counter:	1	register	0.42	2.50
Storage:	1	register	0.42	2.50
Tag:	1	register	0.42	2.50

† Requires memory protect option.
‡ Requires single and double precision floating point option.
⧺ Requires Extended Performance Instruction Set.

.3 SEQUENCE CONTROL FEATURES

.31 Instruction Sequencing

.311 Number of sequence control facilities: . . 1 sequential.

.314 Special sub-sequence counters

Number	Purpose
Shift Counter:	counts shifts (not accessible by program).

.315 Sequence control step size: . . . . . 1 word.

.316 Accessibility to routines: . . . . . store; store and change; trap; store in index and change.

.317 Permanent or optional modifier: . . . . . none.

.32 Look-Ahead: . . . . . none.

.33 Interruption

.331 Possible causes

In-out units:	parity error, end of file, incomplete word on tape, redundancy check, 1401 Attention, Direct Data
In-out controllers: . .	adapter attention.
	Tele-Processing.
	free.
Storage access: . . .	Memory Protection violation.
	read core parity.
	write to core from input-output parity.
	release Memory Protection instruction.
	set Memory Protection instruction when Memory Protection is in use.
Processor errors: . .	floating point overflow or underflow.
	STR instruction.
	add double precision floating point operand address.
Other:	Interval Timer Reset.

.332 Control by routine

Individual control: . .	mask for input-output units.
Method:	interrupts activated by instruction; some are disabled by the occurrence of other interrupts.
Restriction:	floating point, disallowed Memory Protect instruction, and STR traps always occur.

.333 Operator control: . . . can activate or deactivate all traps.

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.334 Interrupt conditions

INTERRUPT (TRAP) INTERACTIONS

If this action occurs / Then the trap status is	Interval Timer Reset	Memory Protect Violation	Parity Error	Pre-interrupt Memory Protect	Direct Data	Data Channel	ICT Instruction	Reset Button	Instruction ENB/RCT	Instruction TRP	Instruction SPM	Instruction TRT
Memory Protect Violation	Off		Off					On		On		On
		Off		Off				Off			On	
								On				
Parity Error	Off		Off					On		On		On
			Off					On		On		
Pre-Interrupt Memory Protect	Off		Off					On		On		On
		Off		Off				Off			On	
Interval Timer Overflow	Off		Off					On		On		On
Direct Data	Off		Off					On		On		On
					Off	Off	Off	Off	On			
Data Channel	Off		Off					On		On		On
					Off	Off	Off	Off	On			

.335 Interruption process

Disabling interruption: The highest priority interrupt takes precedence except when the interrupt locations are Memory Protected. In the latter case a "pre-interrupt" causes an error indication, the program counter is saved*, Memory Protection is disabled, and then the interrupt that caused the pre-interrupt is executed.

Registers saved:. . . program counter is saved.

.336 Control methods

Determine cause: . . first of two words contains an error indication.

Enable interruption: . by instruction.

.337 Interrupt interaction: . not all interrupts interact. (see.. 334).

.34 Multi-running

.341 Method of control: . . . own coding.

.342 Maximum number of programs: . . . . . own coding.

.343 Precedence rules: . . . own coding.

.344 Program protection

Storage: . . . . . Memory Protect option restricts to or from writing into an area except by an input-output unit.

In-out units: . . . . . none.

Maximum separate sets: . . . . . own coding.

* The program counter is set to the Memory Protect Interrupt Location.

.35 Multi-sequencing: . . . the 7044 can be used to communicate with an IBM 1401 system attached to channel A; the instantaneous peak transmission speed is 87,827 characters per second. Each of four 7904 Data Channels that can be attached to a 7044 can have a Direct Data Connection. This option can be used for on-line, "real-time" data communication between other IBM computers that have this option (can include the 7090 and 7094). The instantaneous peak transmission speed can be as high as 1,000,000 characters per second.

.4 PROCESSOR SPEEDS

.41 Instruction Times in μsec

.411 Fixed point

Add-subtract: . . . . 5.
Multiply: . . . . . 30 avg.
Divide: . . . . . 50 avg.

.412 Floating point

	single precision	double precision
Add-subtract:	14 avg.	21 avg.
Multiply:	25 avg.	78 avg.
Divide:	45 avg.	120 avg.

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.413 Additional allowance for
- Indexing: . . . . . none.
- Indirect addressing: . 2.5
- Re-complementing: . none.

.414 Control
- Compare: . . . . . none.
- Branch: 2.5
- Compare and branch: 7.5

.415 Counter control	With index option	Without index option
Step:	5	15.
Step and test:	5	17.5
Test:	5	7.5

.416 Edit: . . . . . none.

.417 Convert: . . . . . none.

.418 Shift: . . . . . $5 + \frac{2.5 \text{ (bits - 6)}}{6}$

.42 Processor Performance in μsec

	Fixed Point	Floating Point Single Precision	Floating Point Double Precision
.421 For random access			
c = a + b:	15	24	41
b = a + b:	15	24	41
Sum N items:	5N	4N	78N
c = ab:	40	35	98
c = a/b:	60	55	140

.422 For arrays of data	†	*	†	*	†	*
$c_i = a_i + b_j$:	46	20	54	29	69	46
$b_j = a_i + b_j$:	46	20	54	29	69	46
Sum N items:	38N	10N	50N	19N	57N	26N
$c = c + a_i b_j$:	89	41	92	59	153	129

† Without optional index registers.
* With optional index registers.

.423 Branch based on comparison	Without index option	With index option
Numeric data:	25 + 44N	12.5
Alphabetic data: . . .	20 + 44N	12.5

.424 Switching		
Unchecked:	20	12.5
Checked:	35	15.0
List search:	27.5N	12.5
.425 Format control per character		
Unpack:	95	21
Compose:	486	104
.426 Table look-up per comparison		
For a match:	32.5N	15.0N
For least or greatest:	40N	17.5N
For interpolation point:	32.5N	12.5N
.427 Bit indicators		
Set bit in separate location:	10.	
Set bit in pattern: . .	10.	
Test bit in separate location:	5.	
Test bit in pattern: . .	15.	
Test AND for B bits: .	15.	
Test OR for B bits: . .	15.	

.428 Moving: . . . . . 5 + 5 per word (word is 6 char).

.5 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Overflow:	check	set indicator
Underflow:	check	interrupt.
Zero divisor:	check	set indicator.
Invalid data:	not possible.	
Invalid operation:	none.	
Arithmetic error:	none.	
Invalid address:	not possible.	
Receipt of data:	check	interrupt.
Dispatch of data:	check	interrupt.
Protected address:*	check	interrupt.

* Optional feature.

CONSOLE

§ 061.

.1 GENERAL

.11 Identity: . . . . . Console panel and desk, a part of the central processor.

.12 Description

The Console provides operator controls and displays of the registers and indicators of the system. The displays can be of use to the operator, the programmer, and to the customer engineer. Two notable additions have been made on the 7040/7044 console as contrasted with the rest of the 7000 scientific processors. First, the rocker switches have been replaced by arrays of pushbuttons representing octal codes: a set of six pushbuttons for the Sense Switches, an 8 by 12 pushbutton array for data entry, and an 8 by 5 array for the location pushbuttons. Secondly, location pushbuttons also have been added. This permits entering data set up on the 8 by 12 pushbuttons array directly into storage as addressed by the location pushbuttons. This replaces the more cumbersome two-stage procedure of entering the data into the MQ register, resetting the switches, then storing the data. Visual checking is also made easier.

Another convenience of this console is the load button, which starts loading data at location 100 rather than at location zero. This preserves the data and program that may be held in the interrupt locations which are located in the first octal 100 locations of the store. The other 700 and 7000 scientific systems always cause the low-order three storage locations at least to be altered. The only drawback is that the "Read-Select" instruction must be set up on the data entry keys. This function is performed automatically in the other systems.

The console desk, which is located under the console panel, holds the output-only typewriter, and provides adequate desk space.

.2 CONTROLS

.21 Power

Name	Form	Comment
Master Power Connect:	switch	turns on power for on-off sequencing controls; activates power on and power off switches; lights when on.
Master Power Disconnect:	switch	turns off power for on-off sequencing controls; deactivates power on and power off switches; turns off light in master power connect switch.

.2 CONTROLS (Contd.)

.21 Power (Contd.)

Name	Form	Comment
Normal Power On:	switch	starts power on sequence for the CPU and auxiliary equipment under control of the power distribution unit.
Normal Power Off:	switch	starts power off sequence for the CPU and auxiliary equipment under control of the power distribution unit.
Emergency Power Off:	pull-type switch	when activated, all system power and all auxiliary power are immediately removed.

.22 Connections

Name	Form	Comment
Channel Bit Density:	switch	five density switches, one for each possible data channel, are used to select magnetic tape density pairs; each switch has three positions 566/200, 800/200, and 800/556.

.23 Stops and Restarts

Name	Form	Comment
Start:	button	starts operation after a program stop or after the CPU has been returned from manual to automatic status.
Automatic/ Manual:	switch	stops computer when set to Manual after it has completed the execution of the current instructions unless an I/O device is in use. In this case, the computer continues execution of instructions and remains in automatic until all I/O devices are disconnected from program control. The storage clock does not stop when the computer is in Manual mode. The switch is lit when the computer is in automatic.

.24 Stepping

Name	Form	Comment
Step Mode Selector:	switch	controls the operation mode when single or multiple step keys are depressed. The three positions are INSTRUCTION, CYCLE, and PULSE. INSTRUCTION is the normal setting with the other two positions serving primarily as customer engineering aids.

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.24 Stepping (Contd.)

Name	Form	Comment
Single Step:	button	used only in manual mode to execute a program one instruction at a time. When input-output instructions are executed, the computer operates in automatic until all input-output devices are disconnected.
Multiple Step:	button	used only in manual mode to execute a program at a slow speed. The computer enters automatic for input-output (see single step).

.25 Resets

Name	Form	Comment
Clear:	button	stores zeros in all core storage locations and resets all CPU registers; inoperative when the computer is in true manual status.
Reset:	button	resets all registers and indicators in the logic section of the processing unit.

.26 Loading

Name	Form	Comment
Load:	button	when depressed, a read select instruction is taken from the entry keys. One record is read from the indicated device (a tape unit, card reader, or on-line 1401) into core storage starting from location 00100. After the unit is disconnected, the computer takes its next instructions from location 00101.

.27 Special

Name	Form	Comment
Display Storage:	button	displays contents of core storage location addressed by the entry keys; if storage clock is running, the displayed word will not be maintained in the storage register. Operates only when the CPU is in manual.
Enter Storage:	button	copies word from the word bank of the entry keys into core storage location indicated by the location bank of the entry keys; operates only when CPU is in manual.
Enter Instruction:	button	pressing this button executes the instruction set up in the word bank of the entry keys; CPU must be in manual status.
Sense:	switches	six switches; settings may be tested by the program.
Entry Switches:	buttons	an 8 by 5 matrix used as a location bank, and an 8 by 12 matrix used as a word bank; data is placed in the entry switches as octal numbers.

.27 Special Contd.)

Name	Form	Comment
I/O Interlock Control:	switch	when on computer remains in manual whenever an I/O unit is selected; switch lights when it is on.
Continuous Enter Instruction:	switch	causes CPU to execute the instruction set up in the entry keys continuously if the CPU is placed in automatic and the start key is depressed; lights when on; an engineering aid.
Storage Clock:	switch	with the ON position, location 00005 is incremented 60 times per second; incrementing stopped by switching OFF position.

.3 DISPLAY

.31 Alarms

Name	Form	Comment
C B Thermal:	light	on whenever a circuit breaker, fuse, thermal, or airflow switch in the basic system or auxiliary equipment opens.

.32 Conditions

Name	Form	Comment
Master Stop:	light	on whenever the master stop trigger is on.
Program Stop:	light	on whenever the master stop trigger is on.
Program Stop:	light	on whenever the computer executes a halt instruction.
Ready:	light	off when the computer is in automatic status and the continuous interinstruction switch is on or the I/O interlock is in manual; otherwise, the light is on whenever the circuits have reached their operating level.
Channel in Use:	lights	five lights, one for each channel; on whenever the corresponding channel is in operation.
Redundancy Check:	lights	five lights, one for each channel; on when a redundancy is detected.
Input-Output Check:	light	the I/O check light is turned on by an irregular input-output event.
Position Register:	lights	five lights reflecting the contents of the indirect address trigger and positions 14 to 17 of the instruction being executed; positions 15 to 17 indicate which adapter is being used on a select instruction and the selected character on character-handling instructions.
Cycle Timer:	lights	six lights which reflect the current machine cycle; an engineering aid.
Clock Pulses:	lights	reflect the state of the timing ring; an engineering aid.
Tally Counter:	lights	indicate cycles of floating point instructions; an engineering aid.
FP1 and FP2:	lights	reflect the condition of floating point triggers; customer engineering aids.

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.32 Conditions (Contd.)

Name	Form	Comment
Parity Inhibit:	light	when on, parity traps are inhibited as a result of a previous parity trap.
Trap Inhibit:	light	when on, all traps are inhibited as a result of a parity or interval timer reset trap.
Channel Trap Control:	light	off when channel traps are inhibited as a result of a trap, ICT instruction or a machine reset.
Memory Protect:	light	on whenever the machine is operating in the memory protect mode.
AC Overflow:	light	on whenever any fixed-point or shifting operation yields a carry out of position 1 of the accumulator.
Divide Check:	light	on in fixed-point division if the dividend is greater than or equal to the divisor. In floating point, the light is turned on if the magnitude of the fraction of the dividend is greater than or equal to twice the magnitude of the divisor fraction.
Parity Check:	light	on when the parity circuits detect an error.
Q Carry:	light	on whenever a carry out of adder position Q occurs, an engineering aid.
X Carry:	light	on as a result of a carry out of adder position 21; an engineering aid.
9 Carry:	light	on whenever a carry occurs out of adder position 9; an engineering aid.
9 Overflow:	light	on whenever accumulator position 9 equals 1 in an accumulator left shift or during a 9-carry in an adder to accumulator operation; an engineering aid.

.33 Control Registers

Name	Form	Comment
Instruction Counter:	lights	fifteen lights which reflect the contents of the instruction counter.
Index A, B, and C:	lights	three sets of 15 lights, each of which displays the contents of the index registers.

.33 Control Registers (Contd.)

Name	Form	Comment
Instruction:	lights	nine lights which display the contents of the instruction register.
Shift Counter:	lights	eight lights which display the contents of the shift counter.
Tag:	lights	three lights which display the contents of the tag register.
Address:	lights	fifteen lights which display the contents of the address counter.
Storage:	lights	thirty-seven lights which display the storage register sign, bits 1-35, and parity.
Accumulator:	lights	thirty-eight lights which display the accumulator sign, Q-bit, P-bit, and positions 1 to 35.
MQ	lights	thirty seven lights displaying the MQ sign, positions 1 to 35 and parity.

.4 ENTRY OF DATA

.41 Into Registers: . . . . . instruction may be entered when the machine is in manual. The desired instruction is set up in the entry switches and the enter instruction button pushed.

.42 Into Storage: . . . . . when the machine is in manual, one core storage location may be written into by pressing the enter storage button. The word and the desired location are obtained by setting the entry switches.

.5 CONVENIENCE

.51 Communication: . . . . for engineers.

.52 Clock: . . . . . optional.

.53 Desk Space: . . . . . 40 x 20 inches.

.54 View: . . . . . when operator is at the console, all the equipment can be easily seen if it is conveniently placed.

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INPUT-OUTPUT: CARD READ-PUNCH (READER)

§ 071.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch, (Reader only). 1402 Model II.

.12 Description:

While the 1402 consists of a card reader and punch housed in the same cabinet, the two units are completely independent of one another from the user's viewpoint and are covered in separate sections of this report.

The reader reads standard 80-column cards at a peak speed of 800 cards per minute. Conversion from the card column code to internal BCD code is automatic. A hole-count check is made on each column at a second reading station, and the bit configuration of each character is checked for validity as it is transferred into core storage. A hopper with a 3,000-card capacity and stacker with 1,000-card capacity can be loaded and unloaded without stopping the reader.

The 1402 can be connected only to data channel A via a 1414 III or IV Synchronizer. The channel, i.e., the central processor, is delayed only for the time of the actual data transfer, about 0.085 millisecond. The 1414 acts as a buffer which is always loaded with the next card to be read. The data that is read contains 80 characters which are stored 6 characters to a word; the first 78 are stored in 13 words, and the last 2 characters are stored in the high order 12 bits of the fourteenth word. The remainder of the fourteenth word is set to zero. If less than 14 words are requested in the read instruction, the last part of the card is ignored.

Optional Features

Read and Punch Column Binary, #6025: This option can only be used on a 1414 IV Synchronizer. It uses two of the six available 80-character buffers; one for the read section and one for the punch. No validity checking is possible but parity bits are used for Central Processor - 1414 data transfers. It is activated whenever 7 and 9 punches occur in column 1 of a card.

Interchangeable Feed, #4051: This option permits the reading of either 80- or 51-column cards by interchanging hardware, and reduces stacker capacity to 800 cards.

.13 Availability: . . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . September, 1960

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . . . . clutch driven rollers.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . none.
.222 Sensing system: . . . . brush.
.223 Common system: . . . no.

.23 Multiple copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . reading.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards (51-column cards with optional IF).
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns of standard spacing.
.324 Track use
Data: . . . . . 80.
Total: . . . . . 80.
.325 Row use
Data: . . . . . 12.

.33 Coding: . . . . . column code as in Table 3, or binary pattern of holes in each column.

.34 Format Compatibility

Other device or system	Code translation
All devices using std. 80-column cards: . .	not required.

.35 Physical Dimensions: . standard 80-column cards.

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.4 CONTROLLER

.41 Identity: . . . . . Channel A only. #1038 Adapter. 1414 III or IV Synchronizer.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . . 1622 read-punch cannot be connected.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . 1 word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation Input: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . 1 card forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic by 1414 Synchronizer.

.54 Format Control: . . . none.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . no.
Select code: . . . . . with #6025 Read-Punch column binary.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: no.
Exhausted: . . . . . yes.
Full stacker: . . . . . yes.

.6 PERFORMANCE

.61 Conditions . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 800 cards/min, all cases.
.622 Important parameters
Name: . . . . . read time in msec.
Value: . . . . . 0.085 (BCD), 0.155 (column binary).
.623 Overhead: . . . . . read time.
.624 Effective speeds: . . . 800 cards/min.

.63 Demands on System

Component:	processing unit.	
Condition:	read BCD	read column binary
Msec per card:	0.085	0.155
or		
Percentage:	0.11	0.21

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method
Card width:	interchange of hardware.

.72 Other Controls

Function	Form	Comment
Load:	key	starts loading cards.
Check reset:	key	resets read error indicators.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	3,000 cards.
Stackers:	1,000 cards.

.732 Replenishment time: . . 0.25 to 0.50 minute.
.733 Adjustment time (80- to 51-column cards): . . . . . 10 to 15 minutes.
.734 Optimum reloading period: . . . . . 1.25 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	hole count	indicator and alarm.
Input area overflow:	cannot occur.	
Invalid code:	check	indicator and alarm.
Exhausted medium:	check	indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or indicator.
Feed jam:	check	stop and indicator.
Stacker full:	check	stop and indicator.

INPUT-OUTPUT: CARD READ-PUNCH (PUNCH)

§ 072.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch, (punch only). 1402 Model II.

.12 Description

Housed in the same cabinet as the card reader, this unit punches standard 80-column cards at a peak speed of 250 cards per minute. Conversion from internal BCD representation to the column card code is automatic. A reading station makes a hole-count check on each column. The 1,200-card feed hopper and three 1,000-card stackers can be loaded and unloaded without stopping the punch.

The 1402 can be connected only to data channel A via a 1414 III or IV Synchronizer. The channel, i.e., the central processor, is used for only the time for the actual data transfer of about 0.085 millisecond. If fewer than 80 characters are transferred to the 1414, BCD blanks or binary zeros are punched depending on the selected mode. The 1414 is the buffer for the punch. The data that is to be punched is contained in 80 characters which are stored 6 characters to a word; the first 78 are stored in 13 words, and the last 2 characters are stored in the high order 12 bits of the fourteenth word. The remainder of the fourteenth word is ignored.

Optional Features

Read and Punch Column Binary, #6025: This option can only be used on a 1414 IV Synchronizer. It uses 2 of the 6 available 80 character buffers; 1 for the read section and 1 for the punch. Parity bits are used for central process or-1414 data transfers.

.13 Availability: . . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . clutch driven rollers
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punches.
.222 Sensing system: . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . punching.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.

.324 Track use
Data: . . . . . 80.
Total: . . . . . 80.
.325 Row use
Data: . . . . . 12.

.33 Coding : . . . . . BCD or binary pattern of holes in each column.

.34 Format Compatibility

Other device or system	Code translation
All devices using standard 80-column cards:	not required.

.35 Physical Dimensions: standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . Channel A only. #1038 Adapter. 1414 III or IV Synchronizer.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . none.

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.44 Data Transfer Control

.441 Size of load: . . . . . 1 card of 80 columns.
.442 Input-output areas: Core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 card.
.512 Block demarcation Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . 1 card forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control: . . . none.

.55 Control Operations

Disabled: . . . . . no.
Request interrupt: . . yes.
Offset card: . . . . . no.
Select stacker: . . . . yes, one of 3.
Select format: . . . . no.
Select code: . . . . . BCD or column binary.
Unload: . . . . . no.

.56 Testable Conditions

Disable: . . . . . no.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . no.
Busy controller: . . . yes.
End of medium marks: no.
Hopper empty: . . . yes.
Stacker full: . . . . . yes.

.6 PERFORMANCE

.61 Conditions . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 250 cards/min, (all cases).
.622 Important parameters

Name	Value
Load buffer BCD:	0.085 msec.
Load buffer binary:	0.155 msec.

.623 Overhead: . . . . . load buffer time.
.624 Effective speeds: . . . 250 cards/min.

.63 Demands on System

Component	Condition	msec. per card	or	Percentage
Processing Unit:	Punching BCD	0.085	or	0.03
	Punching binary	0.155	or	0.06

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets punch error indicators

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards
Stackers:	1,000 cards each.

.732 Replenishment time: . 0.25 to 0.50 minute. Punch does not need to be stopped.
.734 Optimum reloading period: . . . . . 4.0 minutes.

.8 ERRORS, CHECKS AND ACTION

Errors	Check or Interlock	Action
Recording:	hole count	indicator and alarm.
Output block size:	fixed.	
Invalid code:	check	indicator and alarm.
Exhausted medium:	check	stop and indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or indicator.
Feed jam:	check	stop and indicator.
Stacker full:	check	stop and indicator.

INPUT-OUTPUT: CARD READ PUNCH (READER)

§ 073.

.1 GENERAL

.11 Identity: . . . . . Card Read-Punch. (Reader only). 1622.

.12 Description

The Model 1622 Card Read-Punch can provide punched card input and output for channel A only on the 7044 system. The reader and punch feed units are separate and functionally independent. They contain their own switches, lights, checking circuits, and buffer storage. Nominal reading speed is 250 cards per minute, and almost all of card reading time is available for internal processing by the computer. Card hoppers have a capacity of 1,200 cards.

When a 1622 is attached to a 7044 system, no 1414 III, IV, or V Synchronizer may be connected. As a result this eliminates the possible use of 1403 or 1404 printers with the system. It also eliminates the possibility of attaching communications equipment to channel A. Communications equipment, however, may be attached to a 1414 VI Synchronizer via a 7904 Data Channel (B through E).

The reader has an 80-character buffer which stores the data in BCD code from one card. A read command from the processor transfers the buffer contents into core storage in 0.085 millisecond and initiates the refilling of the buffer from the next card. A second sensing station reads each card and compares its data to the buffer contents. If an error is detected, card feeding stops. In addition, the 7044 checks parity of data received from the buffer; an error causes an indicator to be set which may be used by the program to transfer to error-handling subroutines.

The Model 1622 Card Read-Punch may also be used with the IBM 1620 I and II systems.

Optional Features

Read Octal/Binary, M01377: This feature permits the 1622 to read column binary images from cards. It consists of an 80-character buffer plus associated controls. A 7-9 punch in column one of a card causes this feature to be activated.

Read 800 CPM, M03473: This feature permits the 1622 to read cards as fast as a 1402 reader.

Read 500 CPM, M03474: Doubling of the normal card reading speed of the 1622 is provided by this feature.

File Feed, M00711: This feature permits placing as many as 3,000 cards in the hopper.

.13 Availability: . . . . . 3 to 4 months.

.14 First Delivery: . . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: roller.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . none in Reader.
.222 Sensing system: . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . checking.
Distance: . . . . . 1 card.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . BCD or binary.

.34 Format Compatibility: . . . all devices using standard 80-column cards.

.35 Physical Dimensions: standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . 1622 Adapter #1064.
.42 Connection to System:

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

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§ 073.

.43 Connection to Device

.431 Devices per controller: One 1622 Card Read Punch.
.432 Restrictions: . . . . A 1414 III, IV, or V Synchronizer can not be used with the system.

.44 Data Transfer Control

.441 Size of load: . . . . . 80 columns.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
input-output lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . 80 columns.
.512 Block demarcation Input: . . . . . The smaller of the word count or 80 columns.

.52 Input-Output Operations

.521 Input: . . . . . read 80 char from reader buffer into core storage and initiate reading of 1 card.
.522 Output: . . . . . see Section :074.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic.

.54 Format Control

Control: . . . . . program.
Format alternatives: . 2 (BCD or binary).
Rearrangement: . . . no.
Insert spaces: . . . . no.
Section sizes: . . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Offset card: . . . . . no.
Select stacker: . . . . no.
Select format: . . . . yes (BCD or column binary).
Select code: . . . . . see format.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . no.
Busy controller: . . . yes.
Hopper empty: . . . . yes (last card read).
Stacker full: . . . . . yes.
Read data transfer error: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 250 cards/minute.
.622 Important parameters
Buffer unload time
BCD: . . . . . 0.085 msec.
Binary: . . . . . 0.155 msec.
.623 Overhead: . . . . . buffer load time.
.624 Effective speeds: . . . 250 cards/minute if processing time per card does not exceed approximately 237 msec.

.63 Demands on System

Component	msec per card	Percentage
Processor		
BCD:	0.085	0.03
Binary:	0.115	0.06

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none.

.72 Other Controls

Function	Form	Comment
Restore ready status:	momentary switch	Start key; does not actually start reader.
Remove ready status and stop reader:	momentary switch	Stop key; computer stops at next read command.
Read 1 card into storage and refill buffer:	momentary switch	Load key.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stacker:	1,000 cards.

.732 Replenishment time: . . . . . 0.5 minute; device does not need to be stopped.
.733 Adjustment time: . . . none.
.734 Optimum reloading period: . . . . . 4.8 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity and data comparison with check station	stop, set indicator; terminate ready status.
Input area overflow:	none.	
Invalid code:	parity check only.	
Exhausted medium:	interlock	set alarm, indicator.
Imperfect medium:	see reading errors.	
Timing conflicts:	interlock	wait, or indicator.
Misfeed or jam:	interlock	ready status removed, set indicator.
Dispatch of data:	parity check at 7044	set alarm, indicator.

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INPUT-OUTPUT: CARD READ PUNCH (PUNCH)

§ 074.

.1 GENERAL

.11 Identity: . . . . . Card Read Punch. (Punch only). 1622.

.12 Description

The Model 1622 Card Read-Punch can provide punched card input and output for channel A only on the 7044 system. The reader and punch feeds are separate and functionally independent, and contain their own switches, lights, checking circuits, and buffer storage. Nominal punching speed is 125 cards per minute, and almost all of card punching time is available for internal processing by the computer. Card hoppers have a capacity of 1,200 cards.

When a 1622 is attached to a 7044 system, no 1414 III,IV, V Synchronizer may be attached. This eliminates the use of a 1403 or 1404 printer with the system. It also eliminates the possibility of attaching communication equipment on Channel A although it can be attached to a 1414 VI Synchronizer via a 7904 Data Channel (B through E).

The punch has an 80-character buffer which stores the data for one card. A punch command from the processor transfers data for one card to the buffer in 0.085 milliseconds. The processor checks parity of the data sent to the punch buffer and sets a testable indicator if an error occurs, and inhibits punching of the card.

The data is punched, the punch buffer contents are parity checked, and the card is read at a checking station for agreement with the punch buffer contents. Failure of the parity check or checking station comparison halts the punch and sets an indicator. Also the program can select a stacker.

The Model 1622 Card Read-Punch may also be used with the IBM 1620 I and II systems.

Optional Features

Punch Octal/Binary, M01376: Permits the 1622 to punch column binary images into cards. The feature consists of an 80-character buffer plus associated controls.

Punch 250 CPM, M99145: This feature doubles the normal punching speed of the unit making it as fast as the 1402 punch.

.13 Availability: . . . . 3 to 4 months.

.14 First Delivery: . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . rollers.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . die punches.
.222 Sensing system: . . . brush.
.223 Common system: . . . no.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

Use of station: . . . . checking.
Distance: . . . . . ?
Stacks: . . . . . 1.
Head/stack: . . . . . 80.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . standard 80-column cards.
.312 Phenomenon: . . . . . rectangular punched holes.

.32 Positional Arrangement

.321 Serial by: . . . . . 12 rows at standard spacing.
.322 Parallel by: . . . . . 80 columns at standard spacing.
.324 Track use: . . . . . all for data.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . BCD and Binary.

.34 Format Compatibility: . all devices using standard 80-column cards.

.35 Physical Dimensions: . standard 80-column cards.

.4 CONTROLLER

.41 Identity: . . . . . 1622 Adapter #1046.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

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074.

.43 Connection to Device

.431 Devices per controller: 1 1622 Card Read Punch.
.432 Restrictions: . . . . . a 1414 III, IV, or V Synchronizer cannot be used with the system.

.44 Data Transfer Control

.441 Size of load: . . . . . 80 card columns.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 80 card columns.
.512 Block demarcation Output: . . . . . the smaller or the word count or 80 card columns.

.52 Input-Output Operations

.521 Input: . . . . . see Section :073.
.522 Output: . . . . . transfer 80 columns from core storage to punch buffer and initiate punching of 1 card.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic.

.54 Format Control

Control: . . . . . program selection of mode.
Format alternatives: 2 BCD or binary.
Rearrangement: . . . no.
Insert spaces: . . . . rightmost columns are left blank if count is 13 or less.
Section sizes: . . . . see insert spaces.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . no.
Offset card: . . . . . no.
Select stacker: . . . . yes.
Select format: . . . . yes, BCD or binary.
Select code: . . . . . see format.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . no.
Busy controller: . . . yes.
Hopper empty: . . . . yes.
Stacker full: . . . . . yes.
Write data transfer error: . . . . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: 125 cards/minute.
.622 Important parameters
Buffer load time: . . BCD 0.085 msec.
binary 0.155 msec.
.623 Overhead: . . . . . buffer load time.
.624 Effective speeds: . . . 125 cards/minute if processing time per card does not exceed approximately 477 msec.

.63 Demands on System

Component	msec per card	Percentage
Processor BCD punching:	0.085	0.02
Binary punching:	0.155	0.03

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . none.

.72 Other Controls

Function	Form	Comment
Restore ready status:	momentary switch	start key; does not actually start punch.
Stop punch unit on 1622 error:	2-position switch	Stop/N-Stop switch.
Remove ready status and stop punch:	momentary switch	stop key.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	1,200 cards.
Stacker:	1,000 cards.

.732 Replenishment time: 0.5 minutes; unit does not need to be stopped.
.733 Adjustment time: . . . none.
.734 Optimum reloading period: . . . . . 9.6 mins.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Data transmission:	parity check at 1620	set indicator and alarm.
Recording:	parity check on buffer	halt before punching if Stop/N-Stop switch on Stop.
	check station comparison with buffer	send card to error stacker. Stop, set alarm if Stop/N-Stop switch on Stop.
Output block size:	none.	
Invalid code:	parity check only.	
Exhausted medium:	interlock	ready status removed.
Imperfect medium:	see recording errors.	
Timing conflicts:	interlock	wait or indicator.
Misfeed or jam:	interlock	ready status removed. set indicator.

INPUT-OUTPUT: PAPER TAPE READER

§ 075.

.1 GENERAL

.11 Identity: . . . . . Paper Tape Reader. 1011.

.12 Description:

The 1011 Paper Tape Reader can be connected to a 7044 system through data channel A via a 1414 IV or V Synchronizer, or on any of the 7904 Data Channels via a 1414 VI Synchronizer only. Only one 1011 can be attached to each 1414.

The paper-tape reader can accommodate any 5-, 6-, 7-, or 8-track tape, chad or chadless (in good condition). The tape width can be either 11/16, 7/8 or 1 inch. Data can be read from reels, center-feed rolls, or strips, at a peak speed of 500 characters-per-second. Since the maximum block size is 80 characters (restricted by the 1414 buffer size), the effective speed is about 467 characters-per-second.

The 1011 Paper Tape Reader uses a plugboard to transmit its output to the 1414. The plugboard permits the rearrangement of up to four tracks, character deletion, and code translation. The inputs from the photoelectric heads are connected from tape channel hubs to the decoder network. The 67 possible outputs of the decoder and a parity error output can be wired to any of the 64 encoder inputs permitting any 6-bit code to be generated. The output of the encoder, which is sent to the 1414 Synchronizer, is the 1400 series 6-bit BCD code plus an odd parity bit. An end-of-record input is also available which causes reading to terminate and the remainder of the 80-character block to be filled by a character selected from the encoder.

When 5-channel Teletype code is used, a switch can be wired which causes the letter and figure shift character to be suppressed and to set the decoder to the correct shift. The output of the decoder then contains all 58 telegraphic codes, including blank.

.13 Availability: . . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . . June, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . swinging arm.
Capacity: . . . . . about 2 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.222 Sensing system: . . . . photoelectric.

.23 Multiple Copies: . . . none.

.24 Arrangement of Heads

Use of station: . . . . reading.
Stacks: . . . . . 1.
Heads/stack . . . . . 8.
Method of use: . . . . reads 1 row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . paper tape.
.312 Phenomenon: . . . . . punched holes (chad or chadless type).

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 10 per inch.
.322 Parallel by: . . . . . 5 to 8 tracks at standard spacing.
.324 Track use
Data: . . . . . 6 or 5.
Redundancy check: . . 1 or 0.
Timing: . . . . . 1 (sprocket track).
Control signals: . . . 1 or 0.
Unused: . . . . . 0.
Total: . . . . . 8 to 5 (plus sprocket track).
.325 Row use
Data: . . . . . variable.
Redundancy check: . . 0.
Timing: . . . . . 0.
Control signals: . . . 1 (end-or-record; optional).
Unused: . . . . . 0.
Gap: (if calibrated) . 2.

.33 Coding: . . . . . normally 5-track telegraphic or 8-track IBM coding; most 5, 6, 7, or 8-track codes can be translated by plugboard wiring to any 6-bit code.

.34 Format Compatibility

Other device or system	Code translation
Most devices using 5, 6, 7, or 8-track paper tape:	plugboard wiring.

.35 Physical Dimensions

.351 Over-all width: . . . . 11/16, 7/8, or 1 inch.
.352 Length
Strip: . . . . . 20 to 240 inches.
Roll (inside feeding): . 5 to 400 feet.
Reel (outside feeding): . 5 to 1,000 feet.

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§ 075.

.4 CONTROLLER

.41 Identity: . . . . . .1414 IV, V, or VI Synchronizer # 5514 Paper Tape Reader Adapter.

.42 Connection to System

.421 On-line: . . . . . 1 per 1414 Synchronizer.
Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per Controller: . . . . . 1.
.432 Restrictions: . . . . . requires one of the six 1414 Synchronizer 80 character buffers.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 to N characters, where N is limited by available core storage.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 80 characters.
.512 Block demarcation Input: . . . . . end-of-record character on tape, or physical end of tape, or 80 characters.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . none.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . plugboard wiring.

.54 Format Control

Control: . . . . . plugboard.
Format alternatives: . . undefined.
Rearrangement: . . . . no.
Suppress zeros: . . . . yes.
Insert point: . . . . . no.
Insert spaces: . . . . . no.
Section sizes: . . . . . no.
Omit unwanted characters: . . . . . yes.
Asign several tape codes to one character: . . . yes.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Select format: . . . . no.
Select code: . . . . . no.
Rewind: . . . . . no.
Unload: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: . . . . . yes.
Exhausted: . . . . . yes.
Buffer being filled: . . yes.

.6 PERFORMANCE

.61 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: . . . . . 500 char/sec.
.622 Important parameters

Name	Value
Tape speed:	50.0 inches/sec.
Start time (to full speed):	2.5 msec average, 9.0 msec max.
Stop distance:	1.5 rows average, 2.0 rows max.

.623 Buffer unload time Overhead: . . . . . 0.085 msec/block
.624 Effective speeds: . . . 500 N/ (N + 4) char/sec., where N = number of char/block.

.63 Demands on System

Component: . . . . . Processing Unit.
Condition: . . . . . buffer unloading.
Msec per block: . . . . 0.085.
or
Percentage: . . . . . 0.05.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustments	Method
Tape width:	change reels.
Tape code:	change plugboard panels.

.72 Other Controls

Function	Form
Reset alarm circuits: .	key.
Reel/strip selector: . .	2-position switch.

§ 075.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Supply & take-up reels	1,000 feet.
Center-roll feed	400 feet.

.732 Replenishment time: 0.3 to 0.5 min. for strips.
1.0 to 2.0 min. for reels.

.733 Adjustment time: 2.0 to 3.0 min.

.734 Optimum reloading period: 4.0 min.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Reading:	parity check*	set indicator.
Input area overflow:	none.	
Invalid code:	plugboard wiring	as wired.
Exhausted medium:	check	stop, set indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait, or set indicator.
Excessive stop distance:	check	set indicator.
Photocell failure:	check	stop; alarm.

* No parity check on 5-track tape.

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INPUT-OUTPUT: PRINTER

§ 081.

.1 GENERAL

.11 Identity: . . . . . Printer.
1403, Models 1 and 2.
PR.

.12 Description

The 1403 is a line printer with horizontal-chain printing mechanism, tape-controlled carriage, and feeding and stacking system for continuous forms. Each character is printed as it is positioned opposite a magnet-driven hammer that presses the form against the moving chain at the correct printing position. Peak speed is 600 lines per minute at single spacing and 480 lines per minute at an average spacing of one inch. Model 1 has 100 printing positions and Model 2 has 132; they are identical in all other respects. The Model 2 Printer requires the additional Synchronizer Storage option (see below) for the 1414.

The 1403 can only be connected to data channel A via a 1414 III or IV Synchronizer. The channel, i.e., the central processor, is used for only the time for the actual data transfer of about 0.100 or 0.125 millisecond for models 1 and 2 respectively. The 1414 acts as a buffer between the processor and the printer. The data to be printed consists of either 100 or 132 characters which are stored 6 characters to a word. Only the first 100 (or 132) are transferred to the buffer if the word count in the print instruction is greater than 16 (or 22). When the word count is smaller, the remainder of the line to be printed is filled with blanks.

Optional Features

Additional Synchronizer Storage Printer #7680: This option must be added to a 1414 III or IV Synchronizer when a 1403 II is used.

Interchangeable Chain Cartridge Adapter, #4740: This option can be added to a 1403 if more than one type font or the numeric font is required.

Numerical Print Feature, #5381: Option #4740 is also required for this feature which permits printing the characters 0 through 9, plus 6 special characters, at a rate of 1285 lines per minute. Two sets of numerical type are available (#9485 and #9484).

Special Print Chain, #5530: Several special character sets and fonts are available. This feature requires option #4740.

Selective Tape Listing Feature, #6411: Eight 1.5-inch or four 3.1-inch tapes can be printed and spaced separately. A 1403 Model II is required to make full use of this option.

.13 Availability: . . . . . 16 months, as of January, 1962.

.14 First Delivery: . . . . September, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive push and pull, paper punched on both sides.

.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . magnet-driven hammer presses form against moving horizontal chain.

.222 Sensing system: . . . . echo check on hammer magnet.

.223 Common system: . . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . 6.

.232 Types of master
Multilith: . . . . . yes, with special ribbon.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 100 or 132.
Method of use: . . . . 1 line at a time.

.25 Range of Symbols

	Standard Set
Numerals:	10 0-9.
Letters:	26 A-Z.
Special:	12 &, □ - $. * / % # @ ≠.
Alternatives:	by special request.
FORTRAN set:	alternative Print Set F.
Basic COBOL set: . . .	no.
Total:	48 and blank.

	Numeric Set (NP)
Numerals:	10 0-9.
Letters:	0.
Special:	6 $. , * - □ .
FORTRAN set:	no.
Req. COBOL set: . . .	no.
Total:	16 and blank.

.3 EXTERNAL STORAGE

.31 Form of Storage

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.311 Medium: . . . . . continuous fanfold sprocket punched stationery.
.312 Phenomenon: . . . . . printing.

.32 Positional Arrangement

.321 Serial by:. . . . . 1 line at 6 or 8 per inch.
.322 Parallel by: . . . . . 100 or 132 characters at 10 per inch.
.324 Track use
Data: . . . . . 100 or 132.
Total: . . . . . 100 or 132.
.325 Row use
Data: . . . . . all.

.33 Coding: . . . . . engraved character font (Internal coding as in Data Code Table No. 4).

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Over-all width: . . . . 3.50 to 18.75 in. by vernier.
.352 Length:
Forms: . . . . . 1 to 22.0 by 1/6 inch at 6 lines/inch.
1 to 16.5 by 1/8 inch at 8 lines/inch.
1 to 17.0 inches (recommended maximum for proper stacking).
continuous roll or fold.
.353 Maximum margins:
Left: . . . . . 3.0 inch.
Right, Model 1: . . . 6.2 inch.
Model 2: . . . 3.0 inch.

.4 CONTROLLER

.41 Identity: . . . . . #1038 Adapter.
1414 III or IV Synchronizer.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller:. . . . . 1.
.432 Restrictions: . . . . . none.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 line of 100 or 132 characters in multiples of 6.
.442 Input-output areas: . . core storage
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout:. . . . . no.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 100 or 132 char per line.
.512 Block demarcation
Output: . . . . . fixed.

.52 Input-Output Operations

.521 Input:. . . . . none.
.522 Output: . . . . . 1 line forward with single step.
.523 Stepping: . . . . . step 1, 2, or 3 lines as separate operation, or as combined "print then step".
.524 Skipping: . . . . . skip to one of 12 channels on paper tape loop; may be combined in "print then skip".
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic, by processor.

.54 Format Control

Control: . . . . . program.
Format alternatives: . none.
Rearrangement: . . . . no.
Suppress zeros: . . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . no.
Section sizes: . . . . . no.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . . yes.
Select format:. . . . . no.
Select code: . . . . . no.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . no.
Busy controller: . . . . yes.
End of medium marks: no.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . standard character set, Model I.
II: . . . . . standard character set, Model II.
III: . . . . . numeric set (NP), Model I.
IV: . . . . . numeric set, Model II.

.62 Speeds

.621 Nominal or peak speed: I & II 600 lines/minute.
III & IV, 1285 lines/minute.

.622 Important parameters

Name	Value
Print 1 line, I & II: .	100.0 msec.
Print 1 line, III & IV:	46.7 msec.

§ 081.

.622 Important parameters (Contd.)

Name	Value
Skipping speed:	33.0 in/sec for skips of 8 lines or less. 75.0 in/sec for skips of more than 8 lines.

.623 Overhead

Step 1 line:	20 msec.
Step 2 lines:	25 msec.
Step 3 lines:	30 msec.
Independent skip N lines:	15 + 5N msec. (N < 9). 37.4 + 2.2N msec. (N ≥ 9, all others).
Print & skip N lines, I & II:	as above + 80.0 msec.
Print & skip N lines, III & IV:	as above + 26.7 msec.

.624 Effective speeds:

Average line feed, inches	Lines/min., I & II	Lines/min., III & IV
1/6:	600	1,285
2/6:	572	1,160
3/6:	545	1,059
1:	480	838
2:	418	664
4:	353	514

(See graph)

.63 Demands on System

Component	Condition	msec per line *	or	Percentage*
Processing Unit:	I	0.100	or	0.10
	II	0.125	or	0.13
	III	0.100	or	0.21
	IV	0.125	or	0.27

* At single spacing.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Vertical alignment:	knobs.	
Horizontal alignment:	knobs.	
Form width:	sliding forms tractors.	
Printing quality:	graduated dial.	
Form thickness:	graduated lever.	
Line pitch:	switch	6 or 8 lines/in.

.72 Other Controls

Function	Form	Comment
Check reset:	key	resets printer error indications.
Carriage restore:	key	positions carriage at channel 1 on tape loop.
Single cycle:	key	initiates one print cycle.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Hopper:	20-inch stack.
Stacker:	20-inch stack.

.732 Replenishment time: 1 to 2 minutes. printer needs to be stopped.

.733 Adjustment time: 2 to 3 minutes. printer needs to be stopped.

.734 Optimum reloading period

1 & II	56 minutes.
III & IV	35 minutes.
Basis:	2-part sets, 17 inches long, at 1-inch line spacing.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	echo check	indicator.
Input area overflow:	none.	
Invalid code:	check	indicator.
Exhausted medium:	check	stop and indicator.
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or indicator.
Feed jam:	check	stop indicator.
Parity:	check	indicator.

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INPUT-OUTPUT: OUTPUT TYPEWRITER

§ 083.

.1 GENERAL

.11 Identity: . . . . . Output Typewriter. Part of the Console.

.12 Description

The Output Typewriter is a standard part of a 7044 system. It is essentially an IBM Selectric typewriter, but it has been modified to decode 64-bit configurations into positioning coordinates for the print-ball mechanism. The print-ball is an oblate sphere that has the raised letter font in tiers around its circumference. It swivels and tilts in order to position a character for printing. The print-ball is mounted on a carriage that advances across the fixed platen as each character is printed.

The Typewriter is connected to Data Channel A. It can be operated in a record or a character mode. In the record mode the Data Channel (processor) is engaged until every character of every word specified by the channel command word has been printed. In the character mode the Data Channel (processor) is tied up only until one character addressed by the channel control word has been transferred to the typewriter buffer. This represents about a 42 per cent overlapping of the typing with processing.

Parity is checked both at core storage and at the typewriter. Up to 15 characters a second can be typed when operating at full speed. Two print-balls with the "Report" and "Programming" fonts are standard. Most of the unusual special characters are in upper case shift. Since changing shift requires one character time, this delay is minimized.

Because of its slow speed and the tying up of the processor, it is best used for the purposes of logging and notes to the operator. In these situations the processor is generally not needed, or operator intervention is required before processing may resume. Compared with operator reaction time, the typing time should be negligible.

.13 Availability: . . . . 12 to 15 months (**).

.14 First Delivery: . . . March, 1960.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . feed platen.
.212 Reservoirs: . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . engraved hammers.

(**) Estimate by editorial staff. See 1:010.400.

.222 Sensing system: . . . none.
.223 Common system: . . . no.

.23 Multiple Copies

.231 Maximum number: . . depends on stationery.
.232 Types of master
Multilith: . . . . . no.
Xerox: . . . . . yes.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . one character at a time.

.25 Range of Symbols

Numerals:	10	0 - 9.
Letters:	26	A - Z.
Special:	18	see Data Code Tables
Alternatives:		1 and 2.
FORTRAN set:		yes.
Req. COBOL set: . . .		yes.
Total:	64 and blank.	

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon
Output: . . . . . printing.

.32 Positional Arrangement

.321 Serial by: . . . . . character at 10 per inch.
.324 Track use
Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Overall width: . . . 8.875 inches.
.352 Length: . . . . . no limit.

.4 CONTROLLER

.41 Identity: . . . . . Data Channel A.

.42 Connection to System

.421 On-line: . . . . . 1.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 1.
.432 Restrictions: . . . . none.

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.44 Data Transfer Control

.441 Size of load
Input: . . . . . 1 word or character.
Output: . . . . . limited only by capacity of core storage.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word or character.
.444 Input-output area lockout: . . . . . processing is inhibited during data transfers between core storage and synchronizer register.
.445 Table control: . . . . yes, for output.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block
Output: . . . . . 1 character to 32,767 words.
.512 Block demarcation
Output: . . . . . zero count in channel control word.

.52 Input-Output Operations

.521 Input: . . . . . none.
.522 Output: . . . . . type 1 block forward; data is transferred from core storage to typewriter via the MQ register.
.523 Stepping: . . . . . carriage return at the end of a line or when count in channel control word is zero.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . automatic.

.54 Format Control: . . . fixed format; automatic carriage return after each line.

.55 Control Operations

Disable: . . . . . no.
Request interrupt: . . yes.

.56 Testable Conditions

Disabled: . . . . . no
Busy device: . . . . . yes.
Nearly exhausted: . . . no.
Busy controller: . . . . no.
End of medium marks: no.
Exhausted: . . . . . no.

.6 PERFORMANCE

.61 Conditions: . . . . . I : single character
II : a record of N words (6N char.)

.62 Speeds

.621 Nominal or peak speed: 15 char/second for output.
.624 Effective speeds: . . . same as peak speeds, less allowance for carriage returns.

.63 Demands on System

Component	msec per char	or	Percentage
Processor I:	38.6		58.2.
Processor II:	66.6		100.0.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . typical typewriter adjustments.

.72 Other Controls: . . . none.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	parity check	set indicator and no print.
Output block size:	none.	
Exhausted medium:	none.	
Imperfect medium:	none.	
Timing conflicts:	interlock	wait or set indicator.

AUERBACH / BNA

INPUT-OUTPUT: 729 MAGNETIC TAPE UNITS

§ 091.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit 729 II, IV, V, VI.

.12 Description

These tape units are used in the IBM 1401, 1410, 7040, 7044, 7070 and 7080 series systems as well as in the 709, 7090 and 7094. They use a standard reel and half-inch tape compatible with the 7330 and 727 tape units. The only significant differences among the four models are in recording densities and tape speeds. These are summarized in the following table:

Model	Tape speed, inches/sec	Density char/inch	Peak transfer rate, char/sec
II	75	200	15,000
		556	41,667
IV	112.5	200	22,500
		556	62,500
V	75	200	15,000
		556	41,667
		800	60,000
VI	112.5	200	22,500
		556	62,500
		800	90,000

Up to ten tape units may be connected to each Data Channel in a 7044 system. Tape operations may be performed parallel with internal processing; however, in normal operation, tapes attached to a single channel cannot be involved in simultaneous data transmission. Any number of non-data transmitting operations may occur simultaneously. It is usually economical to use the highest density of a given model in order to achieve the maximum transmission rates; however, compatibility with other machines (such as the 704) may dictate the occasional use of lower density settings.

.13 Availability: . . . . 12 to 15 months.

.14 First Delivery

729 II: . . . . . November, 1959.
729 IV: . . . . . November, 1959.
729 V: . . . . . May, 1962.
729 VI: . . . . . May, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: pinch roller friction.

.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 7 feet.

.213 Feed drive: . . . . . motor.

.214 Take-up drive: . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . magnetic head.

.222 Sensing system: . . . magnetic head.

.223 Common system: . . . 2-gap head provides read-after-write checking.

.23 Multiple Copies: . . . multiple copies may be obtained by dialing 2 or more tapes on a given channel to the same number. This procedure is not recommended.

.24 Arrangement of Heads

Use of station: . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . 1 row at a time.

Use of station: . . . . sensing.
Distance: . . . . . 0.3 inch.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . 1 row at a time.

.3 EXTERNAL STORAGE

.311 Medium: . . . . . plastic tape with magnetizable surface.

.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to N rows at 200,556, or (models V and VI) 800 rows per inch (see 408:091.431).

.322 Parallel by: . . . . . 7 tracks.

.324 Track use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.

.325 Row use
Data: . . . . . 1 to N.
Redundancy check: 1.
Timing: . . . . . 0.
Control signals: . . . 0 (record and segment marks are optional).

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.325 Row use (Cont'd)
Unused: . . . . . gaps.
Inter-block gap: . . . 0.75 inch.
Inter-file gap: . . . . 3.75 inches.
Erased gap (to skip flaw area): . . . . 3.75 inches.

.33 Coding: . . . . . column binary as in core with odd parity redundancy check.
binary coded decimal (BCD) as in Data Table No. 4 with even parity check.

.34 Format Compatibility

Other device or system	Code translation
727:	matched, low recording density only.
7330:	matched, low recording density only.

.35 Physical Dimensions

.351 Overall width: . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.
Leader: . . . . . 25 feet.
Trailer: . . . . . 25 feet.

.4 CONTROLLER

.41 Identity: . . . . . #1040 Tape Adapter.
1414 I, II, III Synchronizer.
#3585 800 cpi required on 1414 for 729 II and VI 800 cpi operation.

.42 Connection to System

.421 On-line: . . . . . up to four 7904 Channels plus Data Channel A with a maximum of 10 tape drives each.

.422 Off-line
Associated equipment: may be switched to another channel, another computer, or an off-line auxiliary unit either manually or by means of the optional 7830 switching feature and 7155 Switch Control Console.

.43 Connection to Device

.431 Devices per controller: 10.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . none.
.445 Table control: . . . . no.
.446 Synchronization: . . . automatic

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . 1 to 32,767 words in block.
1 to N blocks in files.

.521 Block demarcation
Input: . . . . . 0.75-inch inter-record gap.
3.75-inch inter-file gap.
Output: . . . . . 0.75-inch end of transmission.
3.75-inch gap written by instruction.

.52 Input-Output Operations

.521 Input: . . . . . forward only.
read until either N words or end-of-record.
end-of-file gap always terminates reading.
.522 Output: . . . . . write N words followed by end-of-record.
erase gap.
write end-of-file gap.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1 block backward.
1 block forward.
1 file backward.
.525 Marking: . . . . . inter block or inter file gap.
.526 Searching: . . . . . none.

.53 Code translation: . . . code (binary or BCD) selected by program - translations are automatic.

.54 Format Control

Control: . . . . . program.
Format alternatives: densities (2 or 3).
Rearrangement: . . . no.
Suppress zeros: . . . no.
Insert point: . . . . . no.
Insert spaces: . . . . no.
Recording density: . . no.
Section sizes: . . . . yes.

.55 Control Operations

Disable: . . . . . yes.
Request interrupt: . . yes.
Select format: . . . . no.
Select code: . . . . . yes, binary or BCD.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . yes (25 feet).
Busy controller: . . . yes.
End of medium marks: yes.
Beginning of tape: . . . yes.

.6 PERFORMANCE

.62 Speeds

§091.

.621 Nominal or peak speed

Model II: . . . . . 15,000 or 41,667 char/sec.
Model IV: . . . . . 22,500 or 62,500 char/sec.
Model V: . . . . . 15,000, 41,667, or 60,000 char/sec.
Model VI: . . . . . 22,500, 62,500 or 90,000 char/sec.

.622 Important parameters

Name	Models II	IV	V	VI
Density (char/inch):	200 or 556		200, 556 or 800	
Tape speed (inches/sec):	75.	112.5	75.	112.5
Start time (msec)				
read:	10.5	6.7	10.5	6.7
write:	7.5	5.0	7.5	5.0
Stop time (msec)				
read:	2.1	2.1	2.1	2.1
write:	5.1	3.8	5.1	3.8
Full rewind time (min):	1.2	0.9	1.2	0.9
Gaps block (inches):	0.75	0.75	0.75	0.75
file (inches):	3.75	3.75	3.75	3.75

.623 Overhead:

Gap crossing time (msec)

	Model II and IV	V and VI
Block:	10	6.67.
File:	50	33.33.

.624 Effective speeds

Models II and V
200 char/inch: . . 15,000N/(N+150) char/sec.
556 char/inch: . . 41,667N/(N+417) char/sec.
Models IV and VI
200 char/inch: . . 22,500N/(N+150) char/sec.
556 char/inch: . . 62,500N/(N+417) char/sec.
Model V
800 char/inch: . . 60,000N/(N+600) char/sec.
Model VI
800 char/inch: . . 90,000N/(N+600) char/sec.

.63 Demands on System

Component	Condition	msec per word		Percentage
Core Storage:	15,000 char/sec	0.005		1.3
	22,500 char/sec	0.005		1.9
	41,667 char/sec	0.005		3.5
	60,000 char/sec	0.005		5.0
	62,500 char/sec	0.005		5.3
	90,000 char/sec	0.005		7.6
Channel A Central Processor	15,000 char/sec	0.400	plus	100.
	22,500 char/sec	0.267	start	100.
	41,667 char/sec	0.143	time	100.
	60,000 char/sec	0.100	not	100.
	62,500 char/sec	0.096	over-	100.
	90,000 char/sec	0.067	lapped	100.

	msec per block	Percentage
Start time not overlapped:		
Models II, V		
read	6.5	100.
write	1.0	100.
Models IV, VI		
read	5.2	100.
write	1.0	100.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	selects 1 of 2 densities.
Densities option:	switch	selects any pair of densities (models V and VI only), 200/556, 556/800, 200/800.

.72 Other Controls

Function	Form	Comment
Address selection:	dial	selects unit address 0-9.
Load rewind:	button	lowers tape into reservoirs and rewinds tape to load point.
Unload:	button	removes tape from reservoirs and raises upper portion of head assembly.
File protection:	ring on reel	ring permits writing.

.73 Loading and Unloading

.731 Volume handled

Data format: Words/ record	Records/ file	Words per reel at Density (cpi): 200	556	800
20	20	384,000	498,000	548,000
40	20	548,000	872,200	960,000
20	50	408,000	542,000	600,000
40	50	572,000	926,000	1,036,000
167 (1,000 char.)	All	752,000	1,854,000	2,350,000

Note: 1 word = 6 char.

.732 Replenishment time: 1.0 to 1.5 minutes. tape unit needs to be stopped.

.734 Optimum reloading period
Models II & V: . . . 6 minutes.
Models IV & VI: . . . 4 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none-not possible.	
Output block size:	none-not possible.	
Invalid code:	yes	see reading.
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	yes	halts tape drive.
Timing conflicts:	interlock	stalls processor.
Recording level:	dual level signal strength check	indicator & alarm.

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INPUT-OUTPUT: 7330 MAGNETIC TAPE UNIT

§ 092.

.1 GENERAL

.11 Identity: . . . . . Magnetic Tape Unit.
7330 Model 1.
MT.

.12 Description

The 7330 Magnetic Tape Unit is slower, simpler, and less expensive than the 729 Tape Unit, but the two are completely compatible. Tape speed is 36 inches per second, and peak transfer rate is either 7,200 or 20,016 characters per second, depending upon the recording density selected. Lateral and longitudinal parity checks are made on both reading and recording.

The throughput of the 7330 can be limited by two restrictions that should be considered:

(1) High speed rewind, which requires 2.2 minutes per full reel, is always terminated by unloading of the tape from the vacuum columns and read-record head. Rewinding without unloading requires 13.3 minutes.

(2) To switch the unit from read to write status, it must be programmed to backspace over the last record read and then rewrite it; such switching between reading and recording will be infrequent in normal applications.

.13 Availability: . . . . . 16 months.

.14 First Delivery: . . . . October, 1961.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . pinch roller friction.
.212 Reservoirs
Number: . . . . . 2.
Form: . . . . . vacuum.
Capacity: . . . . . about 1.5 feet.
.213 Feed drive: . . . . . motor.
.214 Take-up drive: . . . . . motor.

.22 Sensing and Recording Systems

.221 Recording system: . . . magnetic head.
.222 Sensing system: . . . . magnetic head.
.223 Common system: . . . two-gap head provides read-after-write checking.

.23 Multiple Copies: . . . . none.

.24 Arrangement of Heads

Use of station: . . . . . recording.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . one row at a time.

Use of station: . . . . . sensing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 7.
Method of use: . . . . . one row at a time.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . plastic tape with magnetizable surface.
.312 Phenomenon: . . . . . magnetization.

.32 Positional Arrangement

.321 Serial by: . . . . . 1 to 32,767 rows at 200 or 556 char/inch.
.322 Parallel by: . . . . . 7 tracks.
.324 Track Use
Data: . . . . . 6.
Redundancy check: . . 1.
Timing: . . . . . 0 (self-clocking).
Control signals: . . . 0.
Unused: . . . . . 0.
Total: . . . . . 7.
.325 Row use
Data: . . . . . 1 to N.
Redundancy check: . . 1.
Timing: . . . . . 0.
Control signals: . . . 0.
Unused: . . . . . 0.
Gap: . . . . . 0.75 inch.

.33 Coding: . . . . . as in Data Code Table No. 1.

.34 Format Compatibility

Other device or system — Code translation
IBM 729, 727 tape units: . . . . . not required.

.35 Physical Dimensions

.351 Overall width: . . . . . 0.50 inch.
.352 Length: . . . . . 2,400 feet per reel.

.4 CONTROLLER

.41 Identity: . . . . . #1040 Tape Adapter, plus either a 1414 II Synchronizer, a 1414 I or VII Synchronizer with a #7184 Tape Intermix feature.

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§ 092.

.42 Connection to System

.421 On-line: . . . . . 1 per data channel.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 10.
.432 Restrictions: . . . . . when using a 1414 I or VII Synchronizer, the total number of 7330 and 729 Tape Units is 10.

.44 Data Transfer Control

.441 Size of load: . . . . . 1 word.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . . none.
.446 Synchronization: . . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 32,767 words.
.512 Block demarcation
Input: . . . . . the smaller of the words between gaps on tape or word count in the data channel.
Output: . . . . . word count in data channel.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output: . . . . . 1 block forward.
.523 Stepping: . . . . . none.
.524 Skipping: . . . . . 1 block backward (backspace). 3.5 inches forward (to skip defective tape areas).
.525 Marking: . . . . . inter-block gap, or end-of-file gap.
.526 Searching: . . . . . none.

.53 Code Translation: . . . matched codes.

.54 Format Control: . . . . none.

.55 Control Operations

Disable: . . . . . disabled after unloading.
Request interrupt: . . . yes.
Select format: . . . . . no.
Select code: . . . . . binary or BCD.
Rewind: . . . . . yes.
Unload: . . . . . yes.

.56 Testable Conditions

Disabled: . . . . . yes.
Busy device: . . . . . yes.
Output lock: . . . . . no.
Nearly exhausted: . . . yes, 15 feet remaining.
Busy controller: . . . . yes.

.56 Testable Conditions (Contd.)

End of medium marks: yes.
Beginning of tape: . . . yes.
End-of-file: . . . . . yes.
End-of-operation: . . . yes.

.6 PERFORMANCE

.61 Conditions

I: . . . . . Data Channel A.
II: . . . . . 7904 Data Channel.

.62 Speeds

.621 Nominal or peak speed: 7,200 or 20,016 char/sec.
.622 Important parameters

Name	Value
Density:	200 or 556 char/inch.
Tape speed:	36.0 inches/sec.
Inter-block gap:	0.75 inch.
Start time (can be overlapped with processing on channel A)	
Read:	7.6 msec.
Write:	20.4 msec.
Stop time	
Read:	12.9 msec.
Write:	15.3 msec.

.623 Overhead: . . . . . start time.
.624 Effective speeds
At 200 char/inch: . . 7,200N/(N + 147) char/sec.
At 556 char/inch: . . 20,016N/(N+408) char/sec. (see graph).
where N = char/block
6 char = 1 word.

.63 Demands on System

Component	Condition	msec per block		or Percentage
Processing Unit:	I; Data Channel A			
	200 char/inch	0.837N	plus start time	100.0
	556 char/inch	0.300N	plus start time	100.0
	Start time (not overlapped)			
	Read	0.6		100.0
	Write	7.4		100.0
Core Storage:	II; 7904 Data Channel			
	Read or write			
	200 char/inch	0.005N		0.59
	556 char/inch	0.005N		1.66

where N is number of words per block.

.7 EXTERNAL FACILITIES

.71 Adjustments

Adjustment	Method	Comment
Recording density:	switch	200 or 556 char/in.

.72 Other Controls

Function	Form	Comment
Address selection:	dial.	
Load rewind:	key	loads tape into reservoirs.
Unload:	key.	
File protection:	ring on spool	ring permits writing.

§ 092.

.73 Loading and Unloading

.731 Volumes handled

Storage	Capacity
Spool:	2,400 feet; for 1,000-char blocks, 5,000,000 char at 200 char/inch, 11,300,000 char at 556 char/inch.

.732 Replenishment time: . . 1.0 to 1.5 minutes. tape unit needs to be stopped.

.734 Optimum reloading period: . . . 13 minutes.

.8 ERRORS, CHECKS AND ACTION

Error	Check or Interlock	Action
Recording:	lateral & longitudinal parity	indicator & alarm.
Reading:	lateral & longitudinal parity	indicator & alarm.
Input area overflow:	none.	
Output block size:	none.	
Invalid code:	all codes acceptable.	
Exhausted medium:	reflective spot or tape mark	indicator.
Imperfect medium:	none.	
Timing Conflicts:	interlock	indicator.
Recording level:	signal strength check	indicator & alarm.

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INPUT-OUTPUT: OTHER

§ 101.

.1 GENERAL

.11 Identity: . . . . . 7904 I, II, Data Channels.

.12 Description

The 7904 data channel is optional equipment for the 7040 and 7044 systems. A system may have as many as four such channels which are designated B through E. Each 7904 permits simultaneous input-output operation with computing and other data channels.

Connected to each 7904 may be a Direct Data device, a 1414 I, II or VII Synchronizer and either a 7631 File Control, a 1414 VI Synchronizer, or a 7750 Transmission Control Unit.

A Direct Data connection uses 36 data transfer lines, 2 parity lines, 20 sense lines, and necessary control lines. An interrupt transfer to central processor address 00004 is used to synchronize the connection. Data may be transmitted at rates up to 62,500 (7040) or 133,333 (7044) words per second; however, high data transfer rates require a curtailment of other data channel operations.

The 1414 I, II or VII is used to connect magnetic tape units to the system, whereas the 1414 VI is used to connect communications equipment.

The 7631 File Control provides a connection between the central processor and 1301 disk storage units. Up to five 1301-1 or 1301-2 storage units may be attached to the system through one or more 7631 control units attached to different 7904 channels.

The 7750 Transmission Control Unit is a special-purpose computer system designed to multiplex a number of communication devices. Its stored program may be used for formatting, editing, trunk assignment, and routine record keeping.

The operation of 7904 data channel is as follows: The input-output operation is initiated by executing a select I/O unit instruction in the central processor. If the unit is busy, the instruction is held up until the I/O unit is available. Once the unit is available and ready, a data transfer command is sent to the data channel. The data channel decodes the command and sets up the channel circuitry accordingly (i.e., mode of operation, starting address, and word count). After this operation has been completed, the word counter in the data channel is checked for zero. If the counter contains a zero, the channel terminates its operation and disconnects the I/O unit. If the counter does not contain a zero, the channel continues with its operation in the mode selected (read or write).

.12 Description (Contd.)

During a read operation (input), the selected I/O device serially transfers a 7-bit byte (6 data bits plus parity). The bytes are parity checked and the data bits transferred to the Assembly Register. After a 36-bit word is assembled, the word is then sent to the Channel Data Register for transfer to core storage. The core storage location is specified by the contents of the Channel Address Counter. After a complete word is assembled and transferred to core storage, the word counter is decremented and the address counter incremented, and the data transfer operation repeated until the word count reaches zero. However, should an end-of-record signal be received from the device, the operation is terminated immediately.

In the write mode (output operation), the Channel Address Counter specifies the core storage location from which a 36-bit word is to be transferred to the channel. The word is divided into six 6-bit data portions and parity added to each portion before being sent to the selected device. The word counter and address counter are decremented and incremented respectively after each word transfer.

The foregoing procedures are essentially the same as the "input-output a record and disconnect" channel command (IORD) in the 7090/7094.

An I/O transfer error on the 7904 turns on an indicator which can cause an interrupt. If interrupts are enabled and the processor is not executing a "Reset and Load Channel A" (RCHA) instruction, the processor can respond to the interrupt immediately. When this is done, it is possible to interrogate the channel to ascertain which word was transferred in error.

The 7904 Data Channel can sense and store many error and conditional indicators. These indicators can be used to interrupt the program provided they are enabled. Under these conditions the program counter in the processor is stored with the interrupt indicators in the appropriate interrupt location and the program counter set to the next address as soon as one of the indicators is set. However, when the processor is acting as data channel A by executing an RCHA instruction, the program counter is not used to access another instruction until the RCHA instruction terminates. Therefore, the reaction to an interrupt is delayed until an input-output operation on channel A is completed. This must be considered when "real-time" devices are to be controlled by the system. Interrupts from many input "real-time" devices are notification that they must be serviced within a prescribed time. If these interrupts are ignored, the "real-time" units may become overloaded and as a result, lose data.

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INPUT-OUTPUT: DATA CHANNEL A

§ 102.

.1 GENERAL

.11 Identity: . . . . . Data Channel A, a part of the Central Processor.

.12 Description

The basic 7040 and 7044 system includes one input-output channel, called data channel A, whose operation is not overlapped with that of the processing unit. Attached to the channel may be a console typewriter (which is standard on the 7040/7044 systems); a 1401; a 1414 Model I, II, or III Synchronizer; and either a 1622 Card Read-Punch or a 1414 Model III, IV, or V Synchronizer. Up to 10 magnetic tape units may be attached by means of a Model I, II, or III. With the exception of the console typewriter, all channel A attachments require adapter units to connect them to the processor.

Data channel A is the only channel in the system that can accomodate a 1414 Model III, IV, or V Synchronizer. These units permit the attaching of a 1402 Card Read-Punch, 1403 and 1404 Printers, a 1011 Paper Tape Reader, telegraph units, 1014 Inquiry Stations, and 1009 Data Transmission Units. Channel A is also the only data channel in the system to which the 1401, 1402, 1403, and 1404 units can be attached.

The 1401 attachment permits the 7044 to transmit and receive data from a 1401 and its connected input-output units at a maximum speed of 87,000 characters per second. The programs of both machines must make periodic checks to ascertain whether the other machine is requesting to transmit data. Data transfers take place between the core stores.

Two way communication can be programmed. The 7044 assumes the role of master and the 1401 the slave, since the 7040 can initiate data transfers in either direction. When 1401 input equipment is to be used, the 1401 must read the data before it can be transmitted to the 7044. Conversely, when using 1401 output equipment, the 1401 must accept the data in its core store before transferring it to the output unit.

Input-output instructions for channel A are performed as follows: First the channel and unit are tested for availability. Even though the processor is serving as channel A, the "channel A in use" indicator may still be on from a previous operation. Next a "Select Read" or "Select Write" instruction

.12 Description (Contd.)

is given which selects channel A, adapter unit, and code translation mode. If either the unit or channel selected is busy, this instruction will stall the processor until it is free. A "Reset and Load Channel A" instruction is then given that causes a control word to be sent to the accumulator. The control word contains the word count, which is the number of words to be transferred, and the location in storage of the first word to be stored.

The operation of channel A is as follows: The word count in the accumulator is tested for zero. If it is zero, the transfer is terminated and the unit disconnected. If not, the operation proceeds. Six characters are accepted, one by one, checked for correct parity, and placed in the 36-bit plus parity multiplier-quotient register. The contents of the multiplier-quotient register are stored in core storage at the address specified by the contents of the accumulator. After a 36-bit word is transferred, the word count is reduced by one and the address count incremented by one. If an end-of-record signal is received from the selected unit, the operation is terminated. This procedure is essentially the same as the "input-output a record and disconnect (IORD)" channel command in the 7090/7094. As in IORD execution, the above sequence is continued until one of the terminal conditions is encountered.

Write operations occur in the same manner with respect to storage addressing and termination conditions, but with the data flow operation reversed.

An I/O transmission error turns on a check light. However, since the CPU is delayed until the completion of the transmission, the word associated with the error is undetermined.

Channel A, like the 7904 Data Channels, can sense and store many error and condition indicators. These indicators can be used to interrupt the program, provided they are enabled. Under these conditions the program counter in the processor is stored with the interrupt indicators in the appropriate interrupt location, and the program counter is set to the next address as soon as one of the indicators is set. Because the RCHA instruction occupies the processor until the input-output operation is terminated, the program counter is not used during this time. Therefore, the reaction to the interrupt is delayed until an input-output operation on channel A is completed. This must be considered when "real-time" devices are being controlled by the system.

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INPUT-OUTPUT, OTHER: 1414 SYNCHRONIZER

§ 103.

.1 GENERAL

.11 Identity: . . . . . 1414 Synchronizer Models I through VII.

.12 Description

The 1414 Synchronizer is a controller used to monitor and direct the operations of the input-output units attached to it. There are two basic forms of the 1414: the unbuffered models I, II, and VII which control magnetic tapes; and the buffered models III, IV, V, and VI which control unit record equipment and/or communication equipment.

The unbuffered 1414 models I, II, and VII are essentially control units. They differ only in the type of magnetic tape unit that can be connected to them. The instructions to a magnetic tape unit are interpreted, initiated, and controlled by the 1414 units. These units have no data storage capacity as such; they provide only control and a character data path between the tape unit and the data channel. The data channel provides storage addressing, count control (which can limit the amount of data read and always defines the amount to be written) and assembling (or disassembling) of words from characters received (or written).

.12 Description (Contd.)

The buffered 1414 Synchronizers contain 80-character buffers which are used to store input and output records between the data channel and the unit. Model III and IV can have a 1402 Read-Punch, and a 1403 or 1404 Printer attached. Models IV, V, and VI can have communications equipment attached to six 80-character communication buffers. The 1014 Inquiry Stations, telegraph terminals, 1009 Data Transmission Units, and 1011 Paper Tape Readers are considered communications equipment.

With the buffered 1414, input-output operations proceed in much the same manner as an unbuffered 1414 except that all data transfers utilize the data channel only long enough to load or unload the buffers from or to core storage. Adapters between the buffer and the input-output units control data transmission to or from the devices. The table below shows the connections of units to a 1414 Synchronizer and a 7044 system.

1414 Model	729 II	729 IV	729 V	729 VI	7330	Communications Devices	Unit Record	Column Binary	Data Channel A	7904 Data Channel
1	x	x	x (Note 1)		x (Note 2)				x	x
2					x				x	x
3							x		x	
4						x	x	x	x	
5						x			x	
6						x				x
7	x	x	x	x	x (Note 2)				x	x

Note 1. With 800 characters-per-inch feature.
Note 2. With intermix feature.

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INPUT-OUTPUT: DATA TRANSMISSION UNIT

§ 104.

.1 GENERAL

.11 Identity: . . . . . Data Transmission Unit. 1099 Model 1.

.12 Description

This unit enables the 7044 system to transmit and receive data, via a 1414 Synchronizer, at speeds up to 300 characters-per-second over public or private telephone or telegraph lines. The unit at the other end of the line may be a similarly equipped 1401, 1410, 7040, or 7750 system; an IBM 7701 or 7702 Magnetic Tape Transmission Terminal; or an IBM 1013 Card Transmission Terminal. A specially equipped telephone and a serial data set, supplied by the communications company, are also required at each terminal.

Data from core storage of the transmitting 7044 is transferred to the 1414 Synchronizer in fixed length loads of 80 characters. This transfer requires 0.085 millisecond, after which the processing unit is free to perform other operations. From the synchronizer, the data is sent to the 1009 DTU. There it is converted from BCD form to a special serial-by-bit, 4-of-8 transmission code in which each character code consists of four "1" bits and four "0" bits as sent over the communications line.

The 1009 at the receiving terminal reconverts the data to the internal BCD form. Validity checks

.12 Description (Contd.)

insure that each character received contains exactly 4 out of 8 bits, and a longitudinal parity check detects most errors resulting from compensating error bits. Data from the receiving 1009 is transferred to a 1414 Synchronizer and from there to 7044 core storage. Input messages may be of any length and are terminated by an end-of-message signal.

When a 1009 input buffer is filled in a 1414 Synchronizer, the 1009 "Attention" indicator is set in the data channel which will cause an interrupt when interrupts are enabled. Data may be lost if a full input buffer is not emptied into the core store within 1,042, 042, 521, 316, or 260 milliseconds when the transmission speed is 75, 150, 250, or 300 characters per second, respectively.

Either a #1038 Card 1414 Adapter with a 1414 IV or V Synchronizer on data channel A, or #1074 Control Adapter with a 1414 VI Synchronizer on 7904 data channels B through E is required for this feature. A #3238 Adapter connects the 1009 to the 1414. Two of the six 80-character buffers present in the 1414 are required for this function.

.13 Availability: . . . . . 14 months as of February 1962.

.14 First Delivery: . . . . October, 1961.

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INPUT-OUTPUT: REMOTE INQUIRY UNIT

§ 105.

.1 GENERAL

.11 Identity: . . . . . Remote Inquiry Unit.
1014 Model 1.
RIU.

.12 Description:

The Remote Inquiry Unit is a modified IBM Selectric typewriter with control circuits and indicator lights, mounted on a 29- by 24-inch work table. It is used for interrogating and printing replies from a 7044 system, and is connected to the system by a 4-wire cable which may be up to 8 miles long. The user is responsible for the installation and maintenance of cable runs over fifty feet in length. Up to 20 Remote Inquiry Units can be connected to a 1414 IV or V Synchronizer on data channel A, or a 1414 VI Synchronizer on data channels B through E. An automatic sequencing device controls the order of acceptance of inquiry requests when more than one unit is connected.

When an inquiry is to be made, the Request key on the Remote Inquiry Unit is depressed. This signals the #6136 Remote Inquiry Unit Adapter on the 1414 Synchronizer. As soon as the adapter is not busy with another inquiry operation, the Proceed status light on the Remote Inquiry Unit is turned on. The inquiry unit number (0 to 9) is automatically sent as the first character of the message followed by up to 78 characters of text as typed on the Selectric. Depressing the Release key causes the character after the last one in the text to be a group-mark character. If there are less than 78 characters of text, the remainder of the line is filled with blanks. When the 1414 buffer has been filled the adapter sends a carriage-return signal to the inquiry unit (this unit does not have a carriage-return key on its keyboard) and clears the proceed status of the unit as an acknowledgment. The "Attention" indicator is set in the data channel, which causes an interrupt if the interrupt is enabled. The 80 character message can then be transmitted to the core store in 0.085 milliseconds when the processor executes the proper read instruction.

If the Cancel key rather than the Release Key is depressed, the adapter sends a carriage-return to the inquiry unit, clears its proceed status, and looks for another inquiry unit requesting service. Typing messages faster than 12.5 characters per second causes the inquiry unit to halt. It can only be restarted by cancelling the request. An automatic cancel is caused by not typing for a 20-second period during a proceed status.

The reply message is set up in core storage with the address of the receiving inquiry unit in the first position. It is transferred to the output synchronizer buffer in 0.85 millisecond, and from there to

.12 Description (Contd.)

the inquiry typewriter at 15.5 characters per second. Each reply message is limited to the unit number plus up to 78 characters, terminated by a group mark, and followed by an automatic carriage return generated by the adapter.

Optional Feature

Third Inquiry Adapter, #882017: This feature permits attaching 10 more inquiry units to a 1414 Synchronizer.

.13 Availability: . . . . . 14 months as of February. 1962.

.14 First Delivery: . . . . July, 1962.

.2 PHYSICAL FORM

.21 Drive Mechanism

.211 Drive past the head: . . sprocket drive-paper punched both sides.
.212 Reservoirs: . . . . . none.

.22 Sensing and Recording Systems

.221 Recording system: . . engraved hammers.
.222 Sensing system: . . . . typewriter keyboard.
.223 Common system: . . . no.

.23 Multiple Copies

.231 Maximum number Interleaved carbon: . depends on stationery.
.233 Types of master
Multilith: . . . . . no.
Spirit: . . . . . yes.

.24 Arrangement of Heads

Use of station: . . . . printing.
Stacks: . . . . . 1.
Heads/stack: . . . . . 1.
Method of use: . . . . 1 character at a time.

Use of station: . . . . keyboard input.
Stacks: . . . . . 1.
Heads/stack: . . . . . 44 keys.
Method of use: . . . . 1 character at a time.

.25 Range of Symbols

Numerals: . . .	10	0-9.
Letters:	26	A-Z.
Special:	8	&. - $ * , # / (All other special characters print as #).

Alternatives: . . . . . none.
FORTRAN set: . . . . no.
Req. COBOL set: . . . no.
Total: . . . . . 44 plus space.

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§ 105.

.3 EXTERNAL STORAGE

.31 Form of Storage

.311 Medium: . . . . . continuous fanfold stationery.
.312 Phenomenon: . . . . . input-key depression. output-printing.

.32 Positional Arrangement

.321 Serial by:. . . . . character at 10 per inch.
.324 Track use
Data: . . . . . 85 print positions.
.325 Row use: . . . . . all for data.

.33 Coding: . . . . . engraved character font.

.34 Format Compatibility: none.

.35 Physical Dimensions

.351 Overall width:. . . . . 9.75 inches.
.352 Length: . . . . . up to 11 inches per sheet.
.353 Maximum margins: . . no limitations.

.4 CONTROLLER

.41 Identity: . . . . . Synchronizer 1414 Model IV, V, or VI.
Remote Inquiry Unit Adapter.
#6136.
(Both units are required.)

.42 Connection to System

.421 On-line: . . . . . one 1414 Model 4 or 5 on data channel A or a 1414 Model 6 on data channels B thru E plus one #6136 adapters per set of inquiry stations.
.422 Off-line: . . . . . none.

.43 Connection to Device

.431 Devices per controller: 10 per #6136 adapter.
.432 Restrictions: . . . . . maximum of 6 buffers in 1414 Model 4 or 5; each #6136 adapter requires 2 buffers

.44 Data Transfer Control

.441 Size of load:. . . . . 1 to 78 characters.
.442 Input-output areas: . . core storage.
.443 Input-output area access: . . . . . each word.
.444 Input-output area lockout: . . . . . no.
.445 Table control: . . . . none.
.446 Synchronization: . . . automatic.

.5 PROGRAM FACILITIES AVAILABLE

.51 Blocks

.511 Size of block: . . . . . 1 to 78 characters per inquiry (input) or reply (output).
.512 Block demarcation
Input:. . . . . Release key.
Output: . . . . . group mark in core storage.

.52 Input-Output Operations

.521 Input: . . . . . 1 block forward.
.522 Output:. . . . . 1 block forward.
.523 Stepping: . . . . . step 1 line.
.524 Skipping: . . . . . none.
.525 Marking: . . . . . none.
.526 Searching: . . . . . none.

.53 Code Translation: . . . automatic.

.54 Format Control: . . . contained in data.

.55 Control Operations

Disable: . . . . . no.
Request interrupt:. . . yes.
Select format: . . . . no.
Select code:. . . . . no.

.56 Testable Conditions

Disabled:. . . . . yes.
Busy device: . . . . . yes.
Nearly exhausted: . . . yes.
Busy controller:. . . . yes.
End of medium marks: yes.
Exhausted: . . . . . yes.

.6 PERFORMANCE

.62 Conditions: . . . . . none.

.62 Speeds

.621 Nominal or peak speed: input--manual typing speed, less than 12.5 char/sec. output--15.5 char/sec.
.624 Effective speeds: same as peak speeds, less allowance for carriage returns.

.63 Demands on System

Component	msec per block	Percentage
Processing Unit: . . .	0.085	0.0.

.7 EXTERNAL FACILITIES

.71 Adjustments: . . . . . typical typewriter adjustments.

.72 Other Controls

Function	Form	Comment
Inquiry request:	key	signals adapter that an inquiry is to be made.
Inquiry release:	key	signals end of message and sets Inquiry Request indicator.
Inquiry cancel:	key	terminates inquiry without a reply.

.8 ERRORS, CHECKS, AND ACTION

Error	Check or Interlock	Action
Recording:	parity	indicator & alarm.
Reading:	parity	indicator & alarm.
Input area overflow	none.	
Output block size:	check	indicator & alarm.
Invalid code:	none.	
Exhausted medium:	check	alarm.
Imperfect medium:	none.	
Timing conflicts:	checks	alarm if input typing speed exceeds 12.5 char/sec.; wait for Proceed light if RIU adapter is serving another inquiry Unit.

SIMULTANEOUS OPERATIONS

§ 111.

.1 SPECIAL UNITS

.11 Identity: . . . . . 7904 Data Channels
1414 III, IV, V
Synchronizer.

.12 Description

The IBM 7044 system can have a maximum of four time-shared 7904 Data Channels that delay processing only when the data channels and the 7107 central processor simultaneously request storage accesses. The processor can also be used as a data channel, which is referred to as Data Channel A. Data Channel A operates in two different modes with respect to simultaneous operation. When accessing communications equipment, inquiry stations, punched tape readers, card reader/punches, and printers, the central processor is not delayed by Data Channel A for appreciably longer than any other data channel, because all of these units are fully buffered by a 1414 III, IV, or V Synchronizer and processing is delayed for only the time required to load or unload the 1414 buffer, provided that the input-output unit involved is ready for operation.

.12 Description (Contd.)

When a magnetic tape unit or an IBM 1401 system is involved in a data transfer through Data Channel A, the operation is not buffered with central processor operation, and proceeds at the speed characteristic of the input-output unit.

An IBM 1401 system, which can be connected only to Data Channel A, sends or receives data at approximately the same rate as a 729 VI Magnetic Tape Unit reading 800 characters per inch (i.e., 90,000 characters per second nominally). The start time for magnetic tape units connected to the Data Channel A and the time to establish a data transfer with a 1401 system only partially overlap. Because of these delays, data transfers through Data Channel A delay central processor operation for nearly the total time required to activate and operate a particular device.

.2 RESTRICTIONS

Only one input-output unit can transfer data through a Data Channel (including Data Channel A) at any given time. Since there can be a maximum of five simultaneous transfers plus processing in operation at any given time, the combined input-output rate cannot exceed 800,000 characters per second.

.3 POSSIBLE SIMULTANEOUS OPERATIONS

	Max. No. of Units Operating	Max. No. of Data Transfers to and from Core Storage	Restrictions
Punch cards	1	1	A, B
Read cards	1	1	A, B
Read Punched Tape	5	5	B
Print or Skip lines on printer	2	1	A, B
Read or Write to Inquiry Station	100	5	B
Read or Write to Teleprocessing equipment	20	5	B
Read, Write, Backspace Magnetic Tape Unit	5	5	C
Read or Write Through Direct Data Connection	4	4	
Read, Write, or Seek Magnetic Disk Storage	2	2	
Read or Write "Real-Time Equipment"	4	4	
Read or Write to 1401 system	1	1	A, C
Print on Output Typewriter	1	1	A, C or D
Rewind Magnetic Tape Unit	50	0	

Key:
A. Data Channel A only.
B. Data Channel A (i.e., the processor) stalled for data transfer only.
C. Data Channel A (i.e., the processor) stalled for the entire operation.
D. Data Channel A (i.e., the processor) stalled for about half of the operation.

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§ 121. INSTRUCTION LIST

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Fixed Point Arithmetic
ADD	X	F	T	Y	(Y) + (AC) → AC
DVP	X	F	T	Y	(MQ) ÷ (Y) → MQ (quotient), AC (remainder). If overflow set divide - check indicator.
MPY	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ.
SUB	X	F	T	Y	(AC) - (Y) → AC.
VDP	X	F C	T	Y	(AC) ÷ $(Y)_{1-C}$ → $(MQ)_{35-C \text{ to } 35}$; remainder in AC.
VLM	X	F C	T	Y	(Y) x $(MQ)_{35-C \text{ to } 35}$ → AC and $(MQ)_{1 \text{ to } C}$.
VMA	X	F C	T	Y	(AC) + (Y) x $(MQ)_{35-C \text{ to } 35}$ → AC and $(MQ)_{1-C}$.
					Floating Point Arithmetic
*FAD	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
*FDP	X	F	T	Y	(AC) ÷ (Y) → MQ (quotient) normalized, AC (remainder); if overflow, set divide - check indicator.
*FMP	X	F	T	Y	(Y) x (MQ) → (MSB)AC, (LSB)MQ; normalized.
*FSB	X	F	T	Y	(AC) - (Y) → (MSB)AC, (LSB)MQ; normalized.
*UFA	X	F	T	Y	(Y) + (AC) → (MSB)AC, (LSB)MQ; normalized.
*UFM	X	F	T	Y	(Y) x (MQ) → AC and MQ unnormalized.
*UFS	X	F	T	Y	(AC) - (Y) → (MSB)AC, (LSB)MQ; unnormalized.
*DFAD	X	F	T	2Y	(2Y, 2Y + 1) + (AC, MQ) → (AC, MQ); normalized.
*DFDP	X	F	T	2Y	(AC, MQ) ÷ (2Y, 2Y + 1) → (AC, MQ); normalized.
*DFMP	X	E	T	2Y	(2Y, 2Y + 1) x (AC, MQ) → (AC, MQ); normalized.
*DFSB	X	F	T	2Y	(AC, MQ) - (2Y, 2Y + 1) → (AC, MQ); normalized.
					Arithmetic Data Transfer
CLA	X	F	T	Y	(Y) → AC.
CLS	X	F	T	Y	-(Y) → AC.
LDQ	X	F	T	Y	(Y) → MQ.
STO	X	F	T	Y	(AC) → Y.
STQ	X	F	T	Y	(MQ) → Y.
STZ	X	F	T	Y	0 → Y; sign is plus.
*TMT	X	X	T	Y	C = Y(mod 256), C words are moved from $((AC)_{3-17} + i)$ to $((AC)_{21-35} + i)$; i = 0, 1, . . . , C-1.
					Logical Data Transfer
CAL	X	F	T	Y	(Y) → $AC_{P, 1-35}$.
*PCS	X	F C	T	Y	character C of (Y) → AC_{30-35}.
*SAC	X	F C	T	Y	$(AC)_{30-35}$ → Y character position C.
SLW	X	F	T	Y	$(AC)_{P, 1-35}$ → Y.
STA	X	F	T	Y	$(AC)_{21-35}$ → Y_{21-35}.
STD	X	F	T	Y	$(AC)_{3-17}$ → Y_{3-17}.
STL	X	F	T	Y	Location of STL instruction + 1 → Y_{21-35}; remainder of Y unchanged.

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§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Logical Operations
ACL	X	F	T	Y	(Y) + (AC) → AC added as 36 bit unsigned quantities with end-around carry from AC_P.
ANA	X	F	T	Y	(AC) "AND" (Y) → AC.
CHS	X	X	X	X	change sign of AC.
COM	X	X	X	X	"NOT" $(AC)_{P,\ 1-35}$ → $(AC)_{P,\ 1-35}$.
*MSM	X	F	T	Y	1 → $(Y)_S$.
*MSP	X	F	T	Y	0 → $(Y)_S$.
ORA	X	F	T	Y	(AC) "OR" (Y) → AC.
SLW	X	F	T	Y	$(AC)_{P,\ 1-35}$ → Y.
SSP	X	X	X	X	0 → AC_S.
					Shifting Operations
ALS	X	X	T	Y	(AC) shifted left Y, sign unchanged.
ARS	X	X	T	Y	(AC) shifted right Y, sign unchanged.
LGL	X	X	T	Y	$(AC)_{Q,P,\ 1-35}$ and $(MQ)_{S,\ 1-35}$ shifted left Y (mod 256).
LGR	X	X	T	Y	$(AC)_{Q,P,\ 1-35}$ and $(MQ)_{S,\ 1-35}$ shifted right Y (mod 256).
LLS	X	X	T	Y	$(AC)_{Q,P,\ 1-35}$ and $(MQ)_{1-35}$ shifted left Y (mod 256), MQ_S → AC_S.
LRS	X	X	T	Y	$(AC)_{P,Q,\ 1-35}$ and $(MQ)_{1-35}$ shifted right Y (mod 256), $(AC)_S$ → $(MQ)_S$.
RQL	X	X	T	Y	(MQ) rotated left Y (mod 256).
					Control Operations
*AXT	X	X	T	Y	Y → (T).

CAS	X	F	T	Y	If (AC) > (Y), go to next instruction.
					If (AC) = (Y), skip next instruction.
					If (AC) < (Y), skip two instructions.

*CCS	X	F C	T	Y	Character C of (Y) is compared with $(AC)_{30-35}$; If $(AC)_{30-35} > (Y)_{6C \text{ to } 6C+5}$, go to next instruction. If $(AC)_{30-35} = (Y)_{6C \text{ to } 6C+5}$, skip next instruction. If $(AC)_{30-35} < (Y)_{6C \text{ to } 6C+5}$, skip next two instructions.
DCT	X	X	X	X	If divide-check indicator on, turn it off; otherwise, skip next instruction.
HPR	X	X	X	X	Halts processor; processor steps to next instruction when Start key is depressed. Traps cause the location of the next instruction to be stored, and as a result, normally causes computation to resume.
*LAC	X	X	T	Y	32,768 - $(Y)_{21-35}$ → (T).
LAS	X	F	T	Y	If $(AC)_{Q,P,\ 1-35} < (Y)$, go to next instruction. If $(AC)_{Q,P,\ 1-35} = (Y)$, skip next instruction. If $(AC)_{Q,P,\ 1-35} > (Y)$, skip next two instructions.
LBT	X	X	X	X	Skip next instruction if $(AC)_{35} = 1$.
*LDC	X	X	T	Y	32,768 - $(Y)_{3-17}$ → (T).
*LXA	X	X	T	Y	$(Y)_{21-35}$ → (T).
*LXD	X	X	T	Y	$(Y)_{3-17}$ → (T).
*MIT	X	F	T	Y	Skip next instruction if $(Y)_S = 1$.
*PAC	X	X	T	X	32,768 - $(AC)_{21-35}$ → (T).
*PAX	X	X	T	X	$(AC)_{21-35}$ → (T).
PBT	X	X	X	X	Skip next instruction if $(AC)_P = 1$.
*PDC	X	X	T	X	32,768 - $(AC)_{3-17}$ → (T).

§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Control Operations (Cont'd)
*PDX	X	X	T	X	$(AC)_{3-17} \rightarrow (T)$.
*PLT	X	F	T	Y	Skip next instruction if $(Y)_S = 0$.
*PXA	X	X	T	X	$(T) \rightarrow (AC)_{21-35}$.
*PXD	X	X	T	X	$(T) \rightarrow (AC)_{3-17}$.
*RPM	X	X	X	X	Release memory protect. Store location counter in address 32 and trap to address 33.
*SPM	X	F C	T	Y	Set memory protect; $(Y)_{21-27} \rightarrow$ field register; $(Y)_{35-35} \rightarrow$ count register; $(Y)_{32}$ sets mode 0 = trap on equal, 1 = trap on unequal.
*SXA	X	X	T	Y	$(T) \rightarrow (Y)_{21-35}$.
*SXD	X	X	T	Y	$(T) \rightarrow (Y)_{3-17}$.
*TIX	D	D	T	Y	If the number in index T is greater than D, (T) - D → (T) and the next instruction is then from Y.
TMI	X	F	T	Y	Branch to Y if (AC) minus.
*TNX	D	D	T	Y	If (T) > D set (T) = (T) - D; otherwise, go to Y.
TNZ	X	F	T	Y	Branch to Y if $(AC) \neq 0$.
TOV	X	F	T	Y	If overflow indicator is on, turn it off and branch to Y.
TPL	X	F	T	Y	Branch to Y if $(AC)_S = 0$.
TRA	X	F	T	Y	Transfer to Y.
TRP	X	F	T	Y	Parity and trap inhibits are turned off; control goes Y.
TRT	X	F	T	Y	Trap inhibit is turned off; control goes to Y.
TSL	X	F	T	Y	This location plus one $\rightarrow (Y)_{21-35}$; control goes to Y + 1.
*TSX	X	X	T	Y	2's complement of the address of this instruction replaces (T); control goes to Y.
*TXH	D	D	T	Y	If (T) > D, go to Y.
*TXI	D	D	T	Y	(T) + D → (T); control goes to Y.
*TXL	D	D	T	Y	If (T) < D, go to Y.
TZE	X	F	T	Y	Branch to Y if (AC) = 0.
XEC	X	F	T	Y	Execute instruction in location Y.
					Input-Output Instructions
BSR	X	I	T	Y	Backspace tape designated by I and Y one record.
CTR	X	I	T	Y	Prepare to send control data to device designated by Y and I.
ENB	X	F	T	Y	Enable from Y; the (Y) determine which traps will be permitted.
ETT	X	X	T	Y	End-of-tape test; skip next instruction if end-of-tape indicator for channel indicated by (Y) is not on.
ICT	X	X	T	X	Inhibit channel and direct data traps.
IOT	X	X	T	X	Skip next instruction if I/O check indicator is off; otherwise turn it off.
PRD	X	I	T	Y	Equivalent to read select but will cause trapping on 7090/7094.
*PSL	X	F	T	Y	$(Y)_{8-17}$ are sent to the direct data lines.
PWR	X	I	T	Y	Equivalent to write select but will cause trapping on 7090/7094.
RCH	X	F	T	Y	(Y) sent to the channel as a command word.
RCT	X	X	T	X	Restore channel traps.
RDC	X	X	T	X	Reset data channel.
RDS	X	I	T	Y	Prepare to read from I/O device specified by I and Y.

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§ 121. INSTRUCTION LIST (Contd.)

INSTRUCTION					OPERATION
Mnemonic Code	Decrement	Flag or Count	Tag	Address	
					Input-Output Instructions (Cont'd)
RUN	X	I	T	Y	Rewind and unload the tape specified by I and Y.
SEN	X	I	T	Y	Prepare to read status data from the device specified by Y and I.
*SSL	X	F	T	Y	The static sense line contents from the direct data device $\longrightarrow (Y)_{8-17}$.
TCO	X	F	T	Y	If channel-in-use indicator is on, go to location Y.
SCH	X	F	T	Y	Store channel registers in Y.
TEF	X	F	T	Y	Branch to Y if the end-of-file indicator for the specified channel is on.
TRC	X	F	T	Y	If the specified redundancy indicator is on, turn it off and branch to Y.
WBT	X	I	T	Y	Write blank tape (used to skip over bad spots).
WEF	X	I	T	Y	Write end-of-file on tape designated by Y and I.
WRS	X	I	T	Y	Prepare to write to device designated by I and Y.

Terms:

C means count value.
D means decrement value.
F means indirect addressing flag.
T means index register tag.
X means part of the operation code.
Y means the address or value.
* means optional instruction.

DATA CODE TABLE NO. 1

§ 141.

.1 USE OF CODE: . . . report writing graphics console typewriter font.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: . . . . . 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: . . . . . 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	0	8	&	H	-	Q	blank	Y
1	1	9	A	I	J	R	/	Z
2	2	b	B	?	K	!	S	ǂ
3	3	⁂	C	.	L	$	T	,
4	4	@	D	□	M	*	U	%
5	5	:	E	⊏	N	⊐	V	⌒
6	6	>	F	<	O	;	W	\
7	7	√	G	ǂ	P	Δ	X	⫩

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DATA CODE TABLE NO. 2

§ 142.

.1 USE OF CODE: . . . programming language graphics, console typewriter font.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: . . . . . 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: . . . . . 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	0	8	+	H	-	Q	Blank	Y
1	1	9	A	I	J	R	/	Z
2	2	≠	B	?	K	!	S	≠
3	3	=	C	.	L	$	T	,
4	4	'	D	)	M	*	U	(
5	5	:	E	[	N	]	V	⌢
6	6	>	F	<	Ø	;	W	\
7	7	√‾	G	≢	P	Δ	X	≠

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DATA CODE TABLE NO. 3

§ 143.

.1 USE OF CODE: . . . Hollerith Card Code.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 1 card column.

.23 Character Codes

UNDERPUNCH	OVERPUNCH			
	None	12	11	0
None	Blank	&	-	0
12	&	&		?
11	-		-	!
0	0	?	!	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-2	b			≠
8-3	#	.	$	,
8-4	@	□	*	%
8-5	:	[	]	¬
8-6	>	<	;	\
8-7	√	≠	Δ	≠

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DATA CODE TABLE NO. 4

§ 144.

.1 USE OF CODE: . . . . internal and binary magnetic tape code.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: 3 bits: value from low to high order; 1, 2, 4.

23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	0	8	&	H	-	Q	blank	Y
1	1	9	A	I	J	R	/	Z
2	2	b	B	?	K	!	S	≠
3	3	#	C	.	L	$	T	,
4	4	@	D	□	M	*	U	%
5	5	:	E	[	N	]	V	⌒
6	6	>	F	<	O	;	W	\
7	7	√‾	G	≢	P	Δ	X	⧺

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IBM 7044
Data Code Table
BCD Code

DATA CODE TABLE NO. 5

§ 145.

.1 USE OF CODE: . . . BCD code on magnetic tape.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (shown below as two octal digits).

.22 Character Structure

.221 More significant pattern: 3 bits; value from low to high order: 8, 16, and 32.

.222 Less significant pattern: 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0		8	blank	Y	-	Q	&	H
1	1	9	/	Z	J	R	A	I
2	2	0	S		K	!	B	?
3	3	#	T	,	L	$	C	.
4	4	@	U	%	M	*	D	□
5	5	:	V	‿	N	]	E	[
6	6	>	W	\	O	;	F	<
7	7	√‾	X	≠	P	Δ	G	≠

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STANDARD EDP REPORTS

IBM 7044
Data Code Table
1400 Series

DATA CODE TABLE NO. 6

§ 146.

.1 USE OF CODE: . . . 1400 series code to 1401 processor.

.2 STRUCTURE OF CODE

.21 Character Size: . . . 6 bits (show below as two octal digits).

.22 Character Structure

.221 More significant pattern: 3 bits; value from low to high order: 8, 16, 32.

.222 Less significant pattern: 3 bits; value from low to high order: 1, 2, 4.

.23 Character Codes

LESS SIGNIFICANT PATTERN	MORE SIGNIFICANT PATTERN							
	0	1	2	3	4	5	6	7
0	Blank	8	b	Y	-	Q	&	H
1	1	9	/	Z	J	R	A	I
2	2	0	S	+	K	!	B	?
3	3	#	T	,	L	$	C	.
4	4	@	U	%	M	*	D	□
5	5	:	V	‿	N	]	E	[
6	6	>	W	\	O	;	F	<
7	7	√	X	≠	P	Δ	G	≡

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IBM 7044
SYSTEM PERFORMANCE

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IBM 7044 SYSTEM PERFORMANCE

WORKSHEET DATA TABLE 1

Worksheet	Item		Configuration				Reference
			VII A	VII A2	VIII B	VIII B2	
1 Input-Output Times	Char/block	(File 1)	1,008	4,032	1,008	4,032	4:200.112
	Records/block	K (File 1)	8	32	8	32	
	msec/block	File 1 = File 2	26.8	77.2	17.8	51.5	
		File 3	14.1	26.8	8.1	17.8	
		File 4	14.0	26.0	8.0	17.3	
	msec/switch	File 1 = File 2	---	---	---	---	
		File 3	---	---	---	---	
		File 4	---	---	---	---	
	msec penalty	File 1 = File 2	0.84	3.36	0.84	3.36	
		File 3	0.11	0.84	0.11	0.84	
		File 4	0.10	0.80	0.10	0.80	
2 Central Processor Times	msec/block	a1	305				4:200.1132
	msec/record	a2	525				
	msec/detail	b6	447.5				
	msec/work	b5 + b9	630				
	msec/report	b7 + b8	9,094.5				
3 Standard Problem A F=1.0	msec for C.P. and dominant column.	a1	0.3		0.3		0.3		0.3		4:200.114
		a2 K	4.2		16.8		4.2		16.8		
		a3 K	81.4		325.4		81.4		325.4		
		File 1 Master In	0.8		3.4		0.8		3.4		
		File 2 Master Out	0.9	26.8	3.4	77.2	0.9		3.4		
		File 3 Details	0.9	112.8	3.4	107.2	0.9	64.8	3.4	71.2	
		File 4 Reports	0.8		3.2		0.8		3.2		
		Total	89.3	139.6	355.9	184.4	89.3	64.8	355.9	71.2	
4 Standard Problem A Space	Unit of measure	(word)									4:200.1151
		Std. routines	650		650		650		650		
		Fixed	---		---		---		---		
		3 (Blocks 1 to 23)	425		460		425		460		
		6 (Blocks 24 to 48)	2,020		2,020		2,020		2,020		
		Files	756		3,360		756		3,360		
		Working	325		325		325		325		
		Total	4,176		6,815		4,176		6,815		

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IBM 7044 SYSTEM PERFORMANCE (Contd.)

WORKSHEET DATA TABLE 2

Worksheet	Item			Configuration VII A	Configuration VIII B	Configuration	Reference
5	Fixed/Floating point			Floating	Floating		
	Unit name	input		729 V	729 VI		
		output		729 V	729 VI		
	Size of record	input		80	80		
		output		120	120		
Standard Mathematical Problem A	msec/block	input	T1	12.6	7.56		4:200.413
		output	T2	14.0	8.00		
	msec/penalty	input	T3	0.0	0.1		
		output	T4	0.1	0.1		
	msec/record		T5	0.035	0.035		
	msec/loops		T6	4,595	4,595		
	msec/report		T7	9,113	9,113		
7	Unit name			729 V	729 VI		
	Size of block			3,500 words	3,500 words		
	Records/block		B	350	350		
Standard Statistical Problem A	msec/block		T1	350	240		4:200.512
	msec/penalty		T3	17.5	17.5		
	C.P.	msec/block	T5	0.053	0.053		
		msec/record	T6	1.398	1.398		
		msec/table	T7	0.083	0.083		

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SYSTEM PERFORMANCE

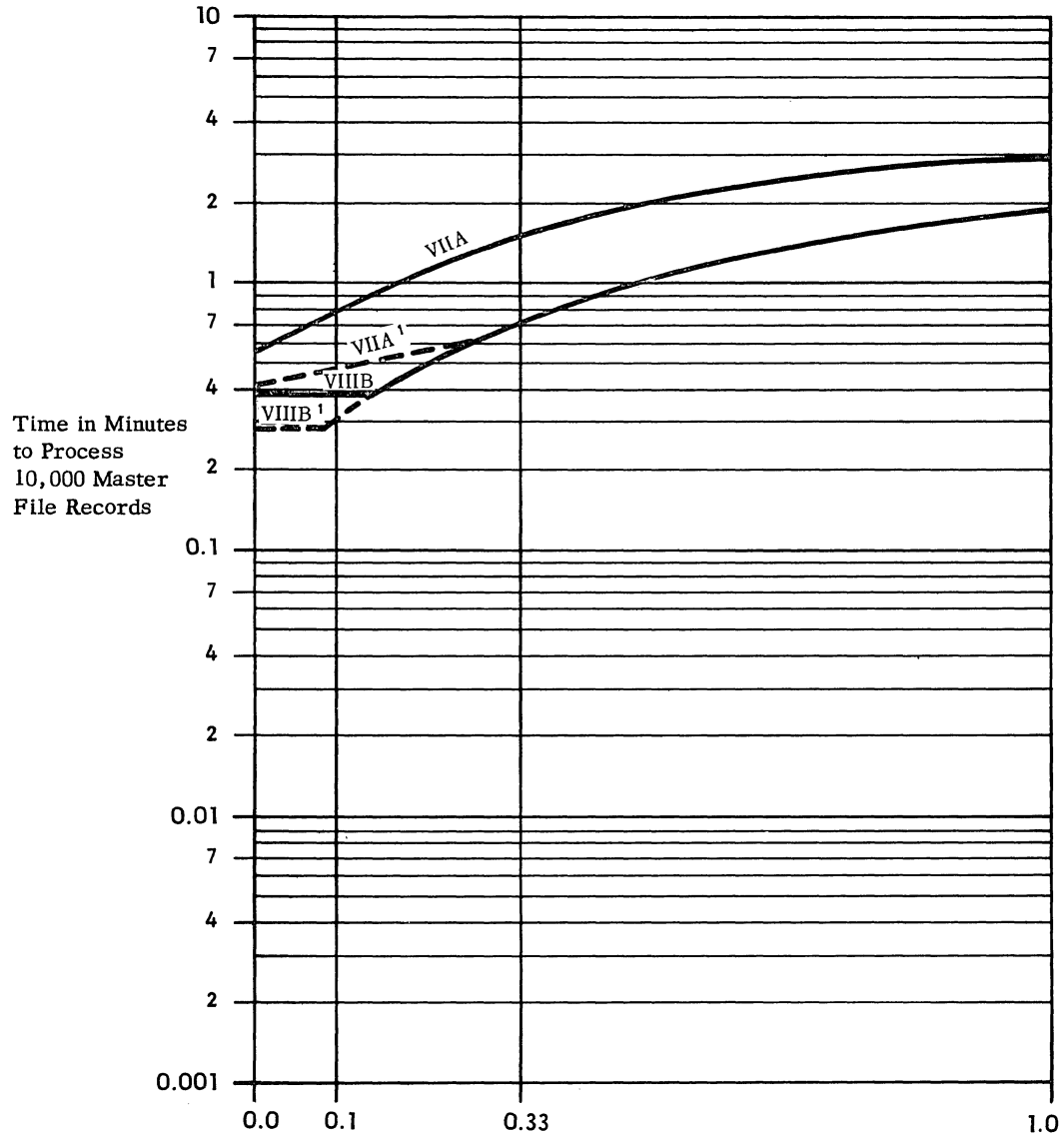
§ 201.

.1 GENERALIZED FILE PROCESSING

.11 Standard File Problem A

.111 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.112 Computation: . . . . . standard.
.113 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.113.
.114 Graph: . . . . . see graph below.
.115 Storage space required
Configuration VIIA . .
Configuration VIIA[1] . .
Configuration VIIIB . .
Configuration VIIIB[1] . .



Activity Factor
Average Number of Detail Records Per Master Record

Broken lines indicates blocked detail and report files.

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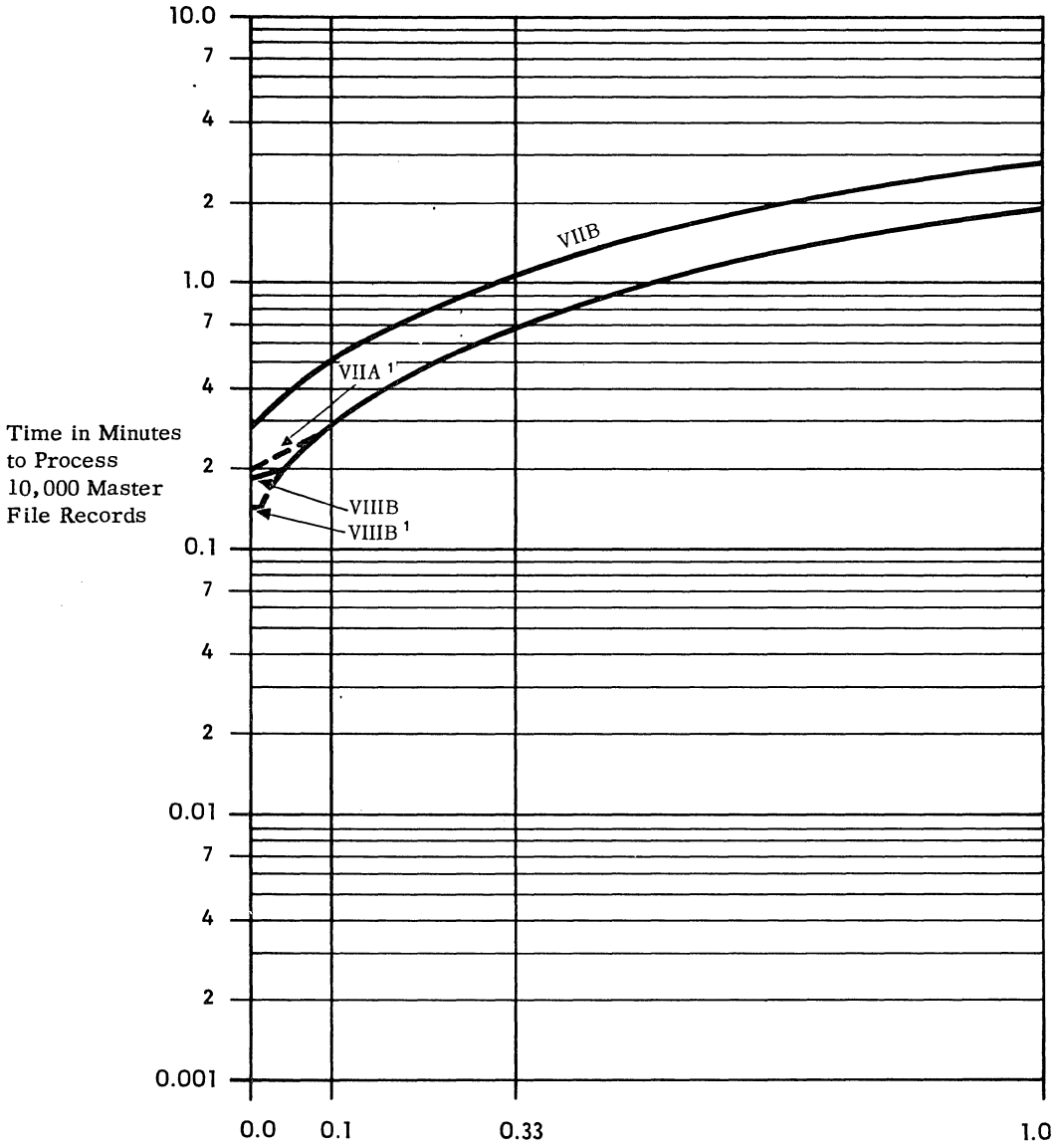
.12 Standard File Problem B

.121 Record sizes
Master file: . . . . . 54 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.122 Computation: . . . . . standard.
.123 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.12.
.124 Graph: . . . . . see graph below.



Broken lines indicates blocked detail and report files.

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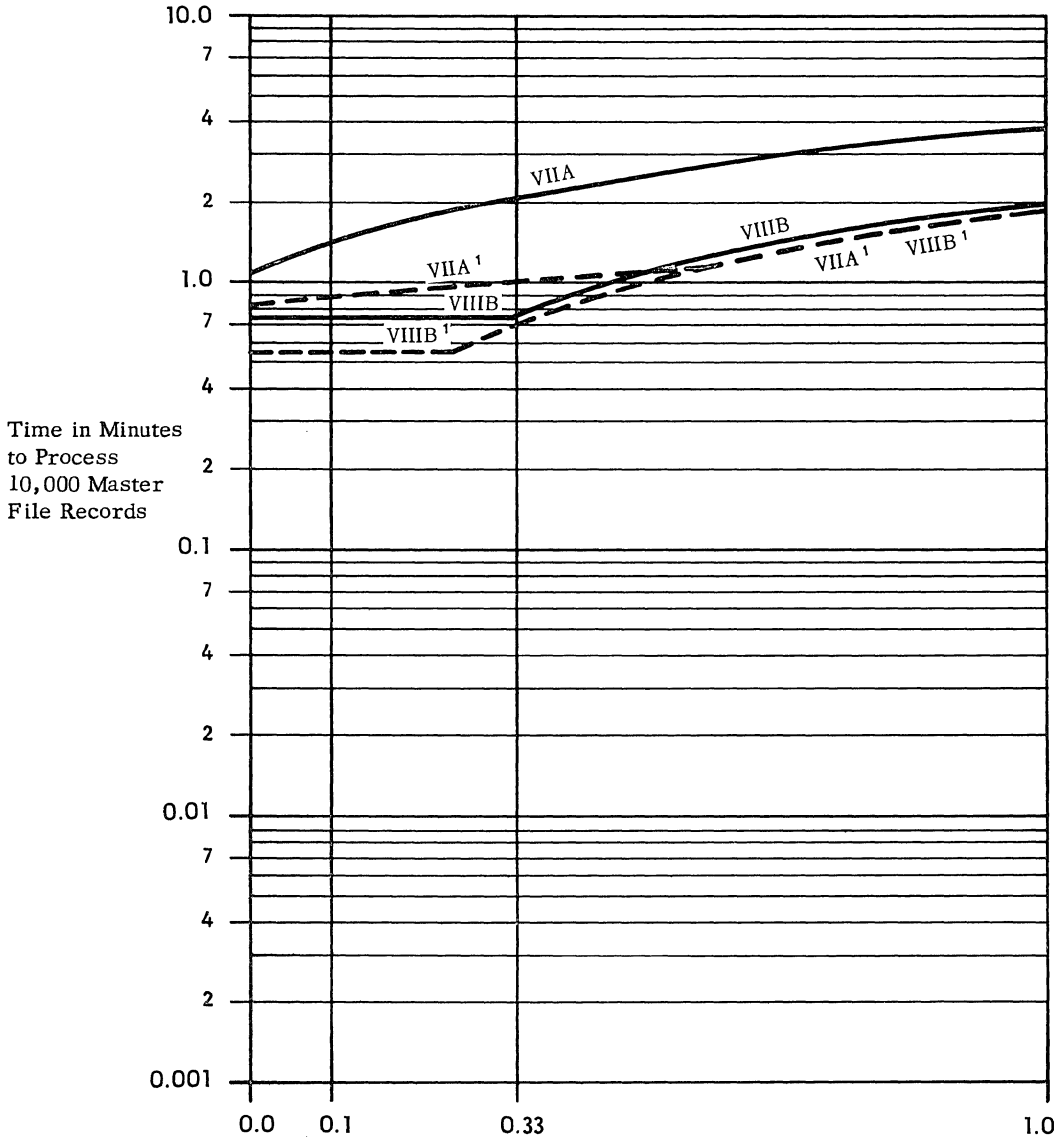
.13 Standard File Problem C

.131 Record sizes
Master file: . . . . . 216 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.132 Computation: . . . . . standard.
.133 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.134 Graph: . . . . . see graph below.



Activity Factor
Average Number of Detail Records Per Master Record

Broken lines indicates blocked detail and report files.

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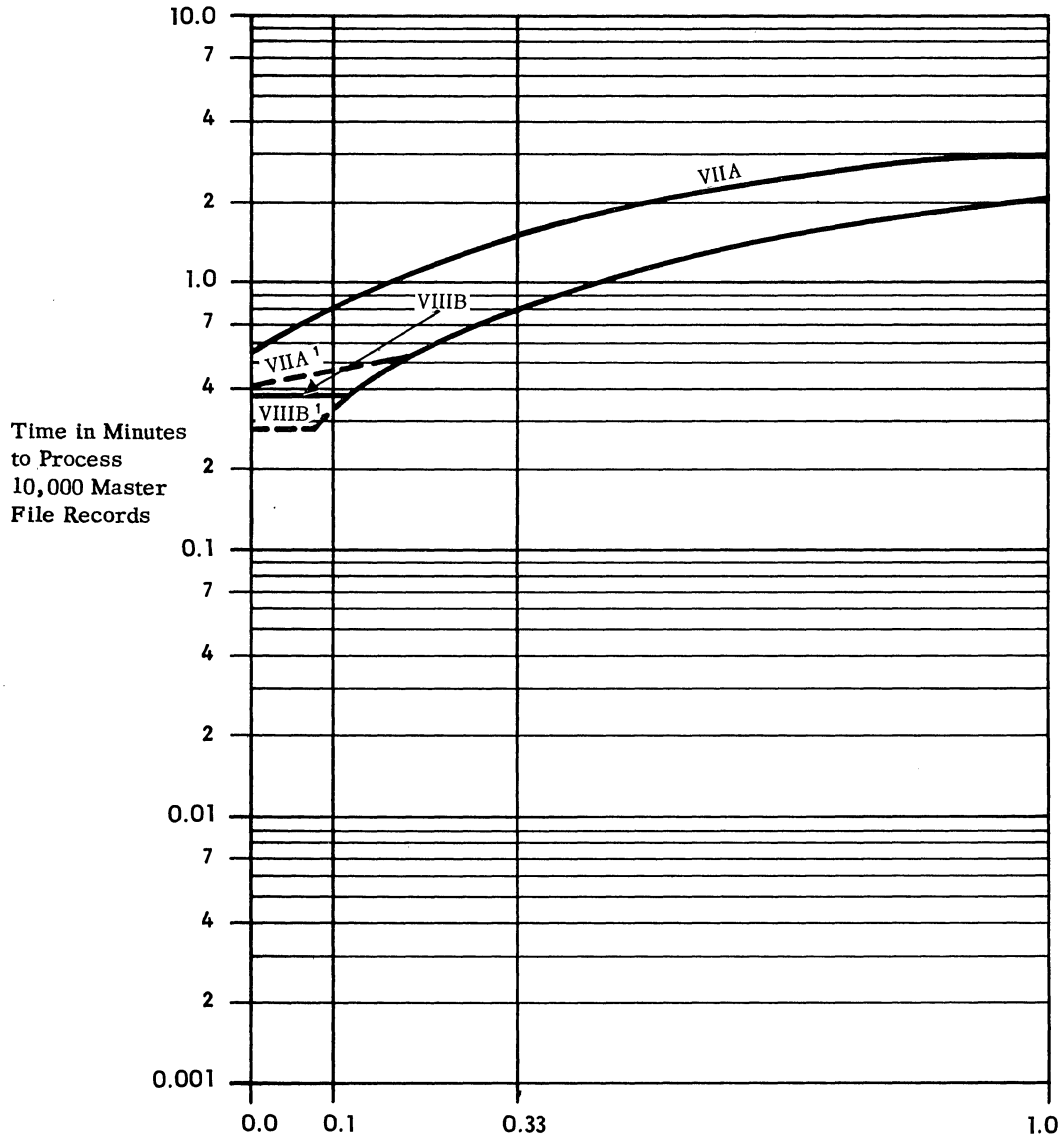
.14 Standard File Problem D

.141 Record sizes
Master file: . . . . . 108 characters.
Detail file: . . . . . 1 card.
Report file: . . . . . 1 line.

.142 Computation: . . . . . trebled.
.143 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.13.
.144 Graph: . . . . . see graph below.



Broken lines indicates blocked detail and report files.

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§ 201.

.2 SORTING

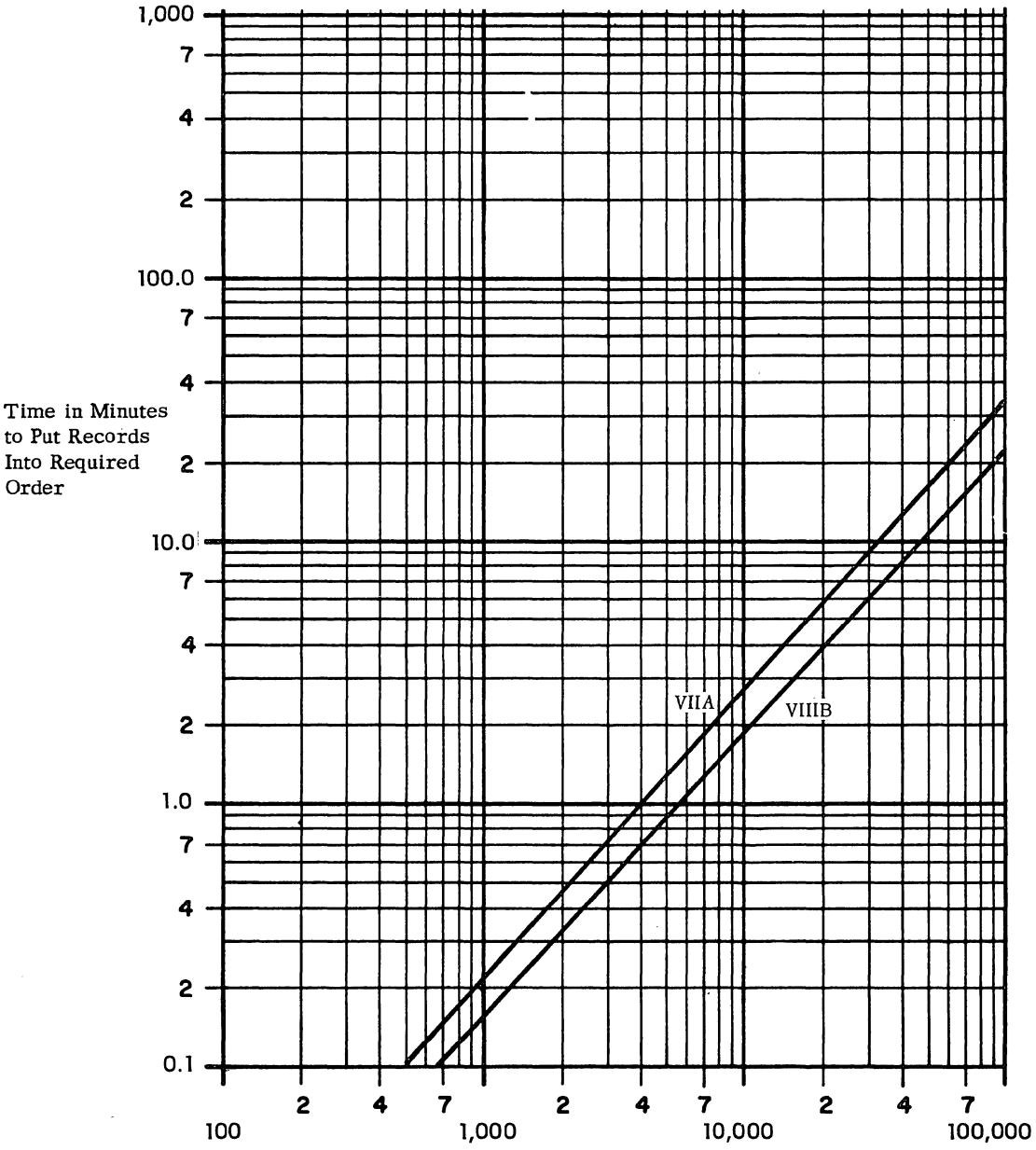
.21 Standard Problem Estimates

.211 Record size: . . . . . 80 characters.

.212 Key size: . . . . . 8 characters.

.213 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.213.

.214 Graph: . . . . . see graph below.



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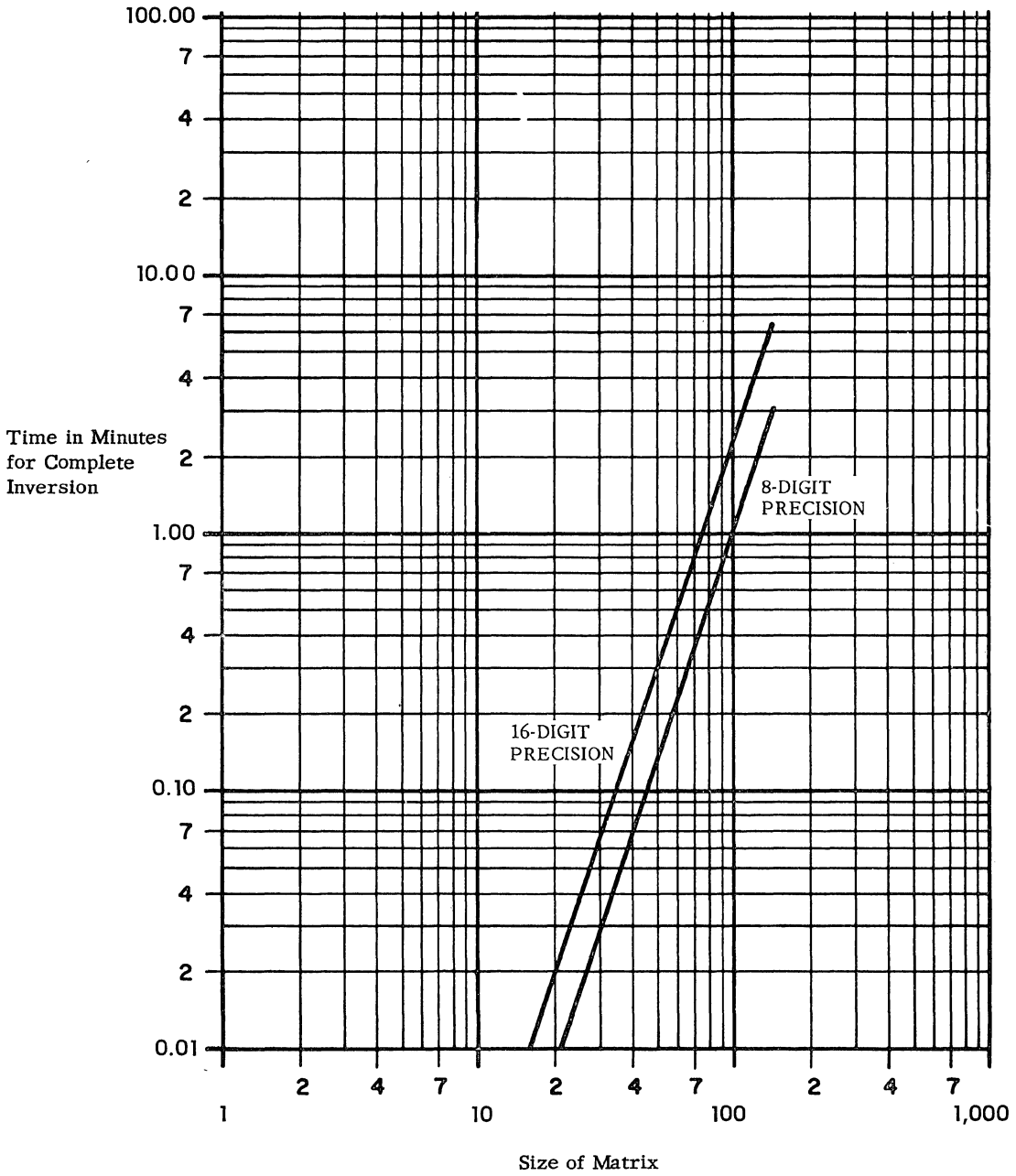
.3 MATRIX INVERSION

.31 Standard Problem Estimates

.311 Basic parameters: . . . general, non-symmetric matrices, using floating point to at least 8 and 16 decimal digits using the optional single and double-precision floating point instructions.

.312 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.312.

.313 Graph: . . . . . see graph below.



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§ 201.

.4 GENERALIZED MATHEMATICAL PROCESSING

.41 Standard Mathematical Problem A Estimates

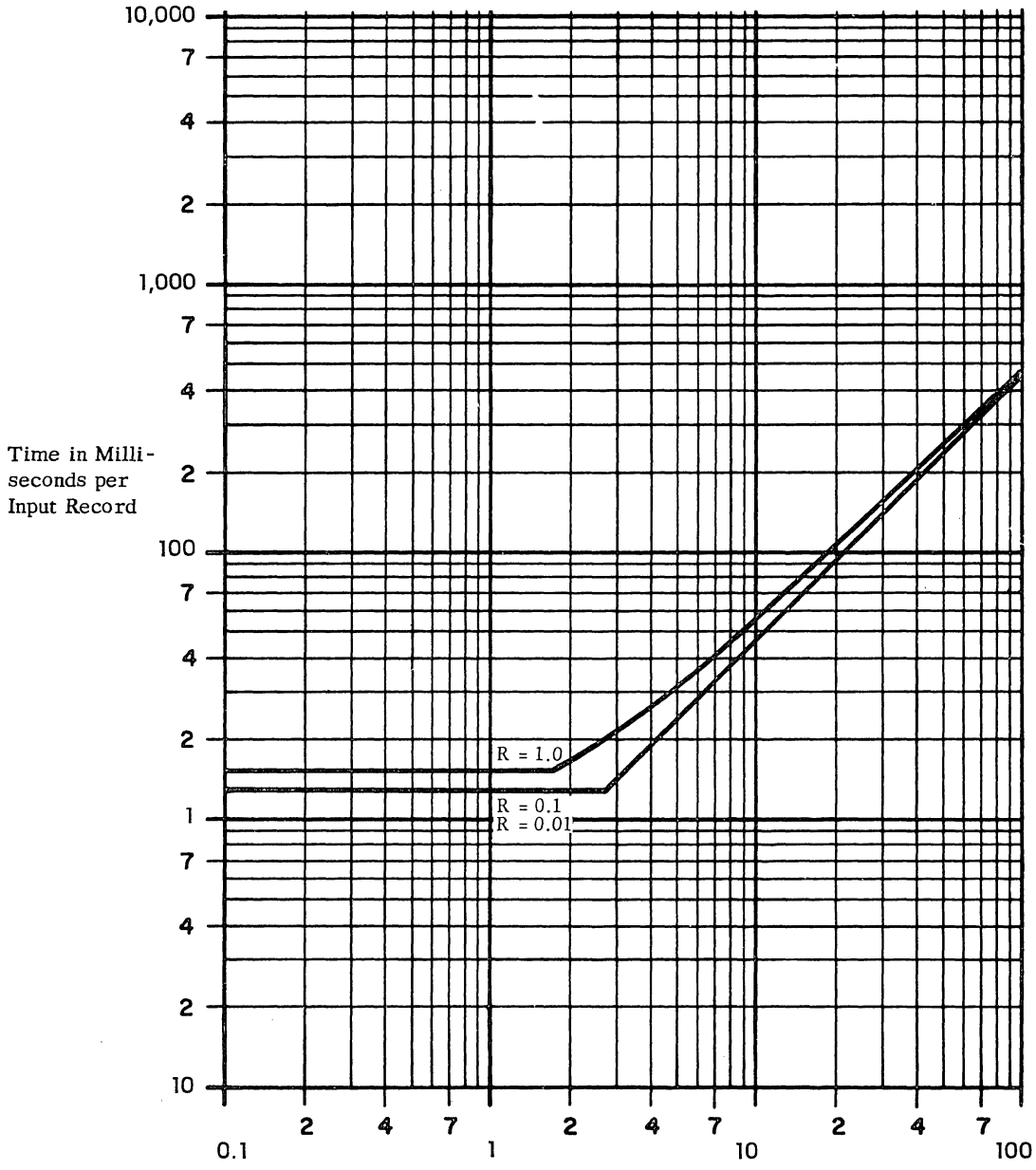
.411 Record sizes: . . . . . 10 signed numbers, avg. size 5 digits, max. size 8 digits.

.412 Computation: . . . . . 5 fifth-order polynomials. 5 divisions. 1 square root.

.413 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.413.

.414 Graph: . . . . . see graph below.

CONFIGURATION VII A LENGTH (8 DIGIT PRECISION); FLOATING POINT
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



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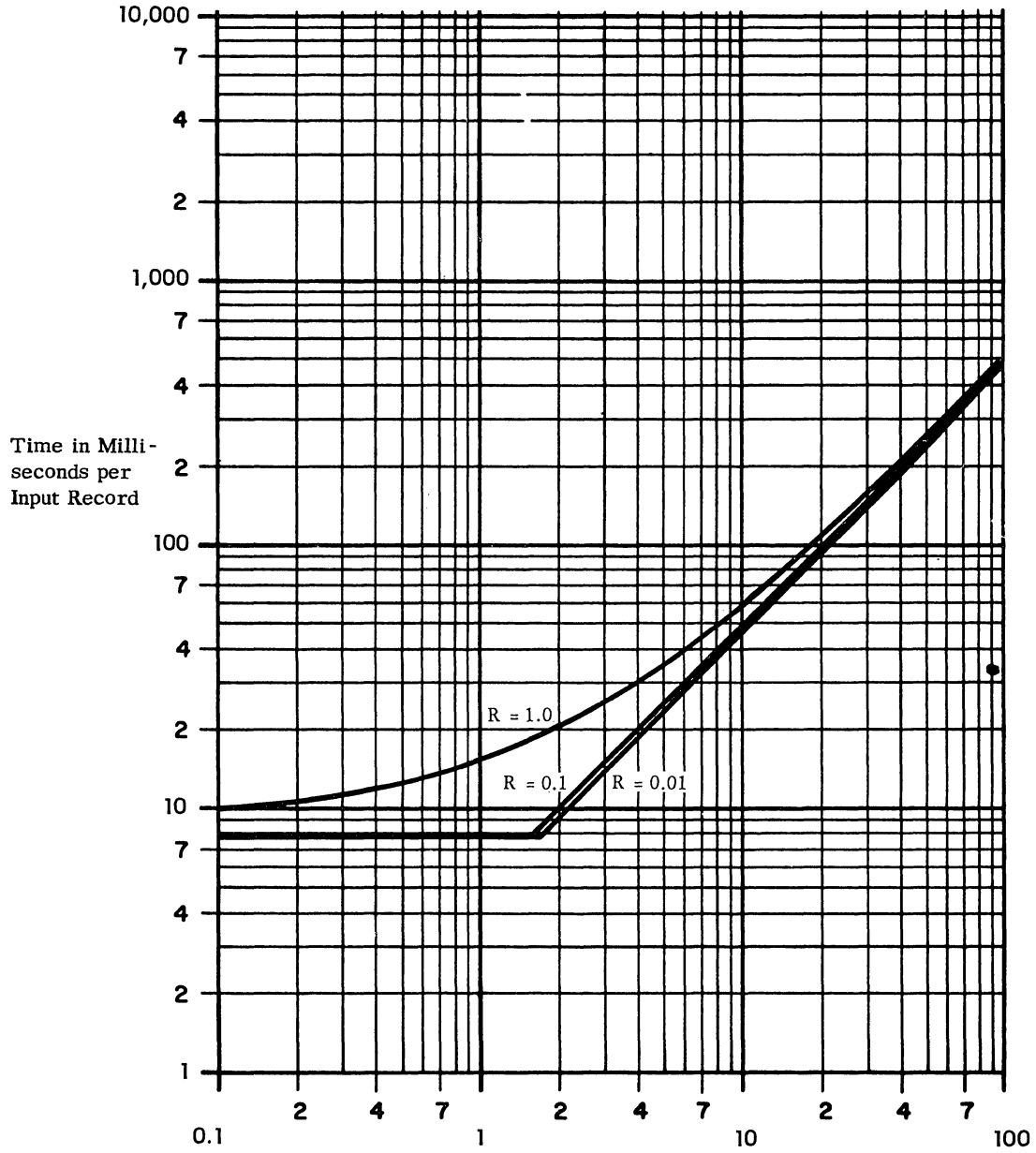
.415 Graph: . . . . . see graph below.

CONFIGURATION VIII B LENGTH (8 DIGIT PRECISION); FLOATING POINT
R = NUMBER OF OUTPUT RECORDS PER INPUT RECORD



§ 201.

.5 GENERALIZED STATISTICAL PROCESSING

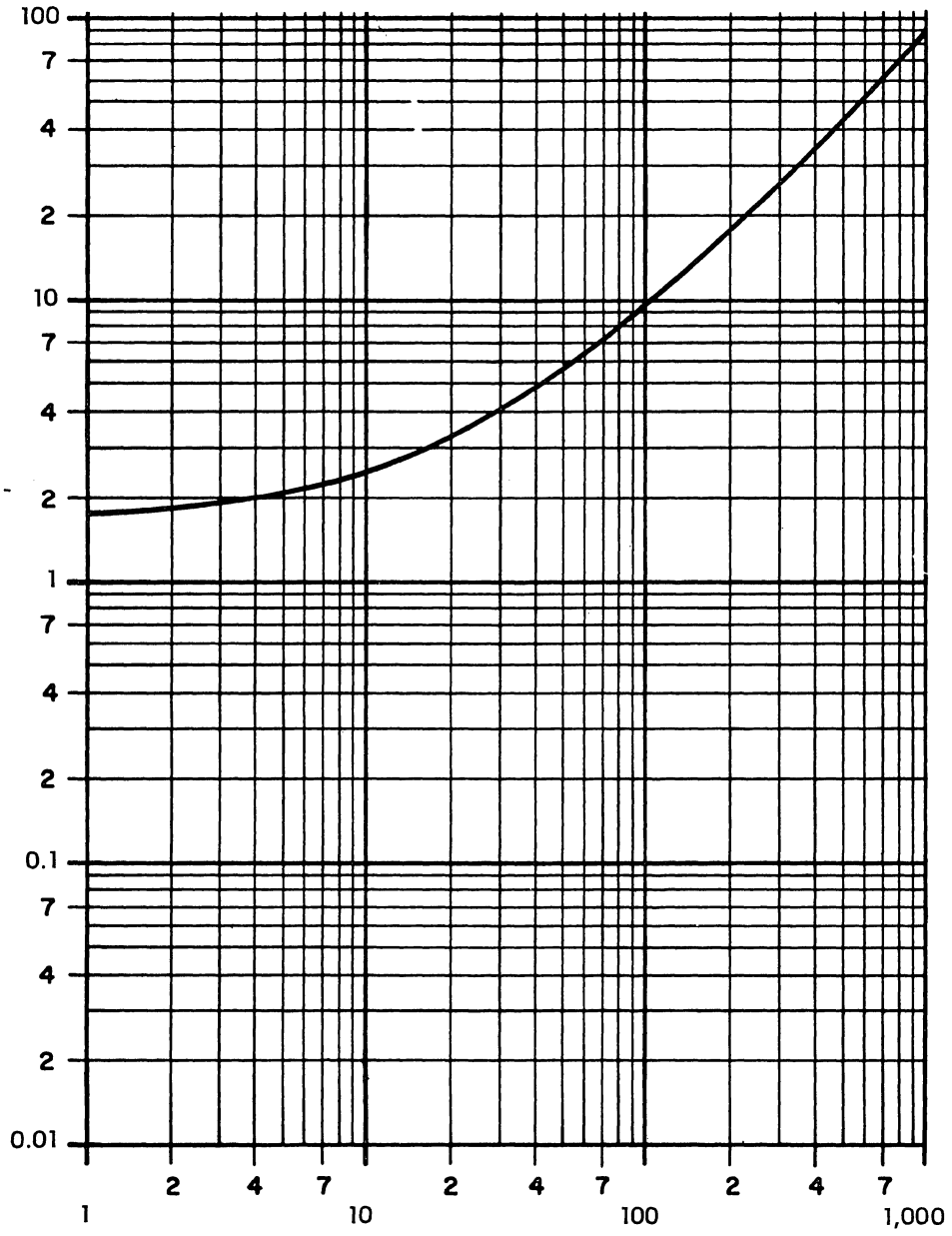
.51 Standard Statistical Problem A Estimates

.511 Record size: . . . . . thirty 2-digit integral numbers.

.512 Computation: . . . . . augment T elements in cross-tabulation tables.

.513 Timing basis: . . . . . using estimating procedure outlined in Users' Guide, 4:200.513.

.514 Graph: . . . . . see graph below.



T, Number of Augmented Elements
Roman numerals denote Standard Configurations

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PRICE DATA

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
CENTRAL PROCESSOR	7106	Central Processor Standard Equipment			
	Model I	8,192 words of storage	17,500	225	1,150,000
	II	16,384 words of storage	18,500	235	1,200,000
	III	32,768 words of core storage 1 Output Typewriter Data Channel A	20,500	255	1,300,000
		Optional Features			
	#3880	Extended Performance	500	11.25	15,000
	#4428	Floating Point Arithmetic Single Precision	350	6.25	10,000
	#4429	Floating Point Arithmetic Double Precision	550	17.25	18,000
	#5080	Memory Protection	75	2.25	3,000
	#7498	Storage Block Internal Time	60	2.25	2,400
STORAGE	1301	Disc Store (5 Max.)			
	Model I	28 million characters	2,100	138.00	115,500
	Model II	56 million characters	3,500	238.00	185,500
		Optional Feature			
	#3213	Cylinder Mode	25	1.00	1,250
		Prerequisite Equipment			
	7631	File Control (2 max.)			
	Model I	Unshared	835	30.00	42,000
	Model II	Shared with 1410 or 7010	1,035	35.00	52,000
	Model III	Shared with 7000 series system	1,035	35.00	52,000
	#1074	Control Adapter	225	3.25	8,000
	7094 I or II	Data Channel (see I/O)			
	#1845 or	Data Channel B Adapter	250	6.75	11,000
	#1846	Adapter for Data Channel C, D, and E (1 each)	50	1.00	1,800
INPUT-OUTPUT DATA CHANNELS	7904 I	Data Channel B or D	1,500	33.50	95,000
	7904 II	Data Channel C or E	2,000	57.00	118,000
		Optional Equipment			
	#1040	Adapter, Tape 1414 (1 max. per channel)	90	2.25	4,200
	#1074	Adapter, Control (1 max. per channel) to attach a 7631, 1414 VI, or 7750.	225	3.25	8,000
	#1080	Adapter, Direct Data or Non-IBM devices (1 max. per channel)	300	4.25	2,000
		Prerequisite Equipment			
	#1845	Data Channel B Adapter	250	6.75	11,000
	#1846	Adapter for Data Channel C and D and E (1 each).	50	1.00	1,800

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PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
	7106 I II, III, and IV	Data Channel A (processor)	see	central	processor
		Optional Equipment			
		Adapter, Card 1414 (1 max., none with #1046).	80	3.25	3,600
	#1046	Adapter, 1622 (1 max., none with #1038	95	2.25	4,700
	#1040	Adapter, Tape 1414 (1 max.)	120	4.25	5,500
	#1034	Adapter, 1401 (1 max., requires #7080)	100	2.25	3,800
	#7080	Serial Input-Output Adapter	100	1.50	3,750
INPUT-OUTPUT CONTROLLERS	7631 II	File Control for 1301 DSU	835	30.00	42,000
	III	File Control for 1301 DSU	1,035	35.00	52,000
	IV	File Control for 1301 DSU	1,035	35.00	52,000
		Prerequisite Equipment			
		See Storage, 1301			
		Optional Features			
		See Storage, 1301			
	1414 I	I/O Synchronizer Tape, 729 II, IV, V	975		
	1414 II	I/O Synchronizer Tape, 7330	500		
	1414 III	I/O Synchronizer Unit record	675		
	1414 IV	I/O Synchronizer Unit record and communications	775		
	1414 V	I/O Synchronizer Communications	?		
	1414 VI	I/O Synchronizer Communications	850	12.00	43,350
	1414 VII	I/O Synchronizer Tape, 729 II, IV, V, VI	1,125		
		Prerequisite Equipment			
		See Input-Output, Data Channels.			
		Optional Features			
	#3585	Model I 800 CPI for 729 V			
	F92950	Model I Tape, Read Gapless	270		
	W99187	Model III Printer, 1404 with compare	580		
	E10112	Model III & IV Printer, 1404 attachment without compare	90		
	#7680	Model III & IV Printer, 1403 II attachment	550		
	#7681	Model III & IV Printer, 1403 II Additional Synchronizer Storage	60		
	#6024	Model IV Read/Punch, 1402 Read/Punch Column Binary	?		
	M04578	Model IV Trans. Remote to 1001	260		
	882017	Model IV Inquiry Adapter, Indicator	10		
	M00447	Model IV 2nd Buffer 1403 - channel 1	630		
	730631	Model IV Reader 2nd 1011 Paper Tape	45		
	#7184	Model I & VII Tape Intermix for 7330s	45		2,250

PRICE DATA (Contd.)

§ 221.

CLASS	IDENTITY OF UNIT		PRICES		
	No.	Name	Monthly Rental $	Monthly Maintenance $	Purchase $
INPUT-OUTPUT UNITS	729 II	Magnetic Tape Unit	700	116.00	36,000
	729 IV	Magnetic Tape Unit Maximum	900	128.00	41,250
	729 V	Magnetic Tape Unit 10 per	750	122.00	37,200
	729 VI	Magnetic Tape Unit Channel	950	134.00	42,450
	7330	Magnetic Tape Unit	450	52.25	22,000
For prerequisite equipment see appropriate 1414 or Data Channel.		Optional Equipment			
	#7830	Tape Switching Feature for 729 MTUs attached to a 7155	85	6.50	4,400
	EO3378	Required for each 7330 MTU attached to a 7155	125		
	7155	Switch Control Console			
	Model I	2 tapes	35	5.50	1,775
	Model II	4 tapes	55	11.00	2,675
	Model III	6 tapes	80	16.50	3,875
	Model IV	8 tapes	100	22.00	4,775
	1009	Data Transmission Unit (1 max per 1414 IV, V, VI)	500	11.50	26,400
	1011	Punched Tape Reader (1 max per 1414 IV, V, VI)	500	42.50	22,400
	1014	Inquiry Station (20 max per 1414 IV, V, VI)	200	12.50	11,000
	1402 II	Card Read/Punch (requires 1414 III, IV)	615		
	1403 I	Printer (requires #7680)	725	172.00	32,900
	1403 II	Printer (requires #7680 and 7681)	775		
	1404 II	Printer (requires E10112)			
	1622	Card Read/Punch	615		
		Optional Features:			
	M01376	Punch Octal/binary	160		
	M01377	Read Octal/binary	140		
	M99145	Punch 250 cpm	170		
	M03473	Read 800 cpm	75		
	M03747	Read 500 cpm	65		
	M00711	File Feed	35		

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