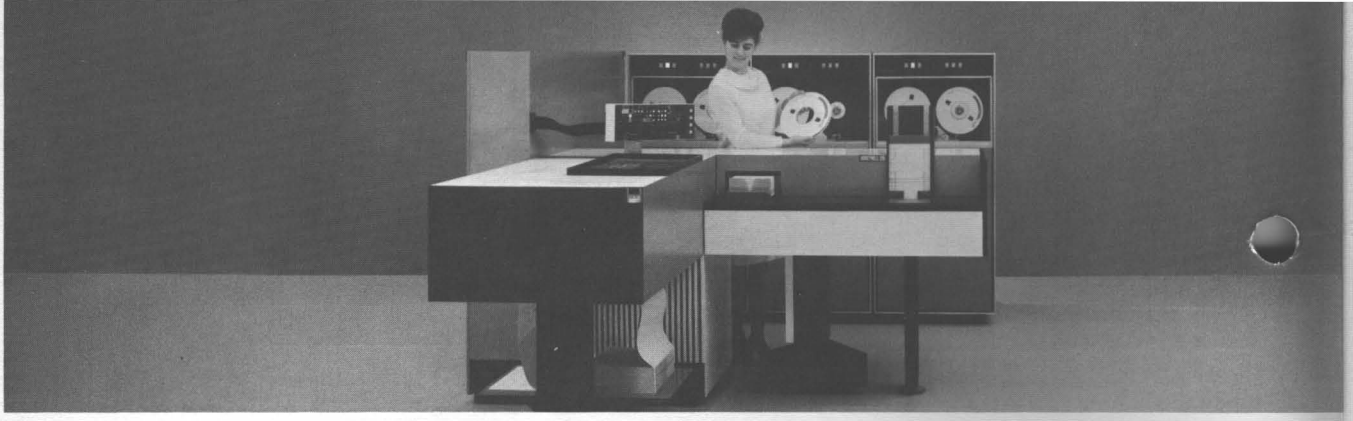
HONEYWELL

SUMMARY DESCRIPTION

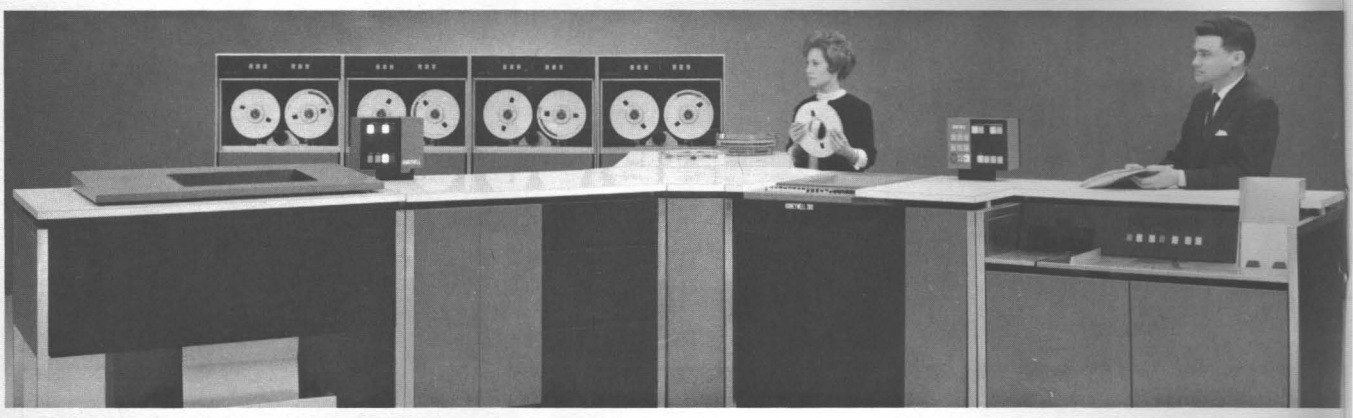
SERIES 200

NEW DIMENSIONS OF PROVEN COMPUTER PERFORMANCE WITH EXCEPTIONAL ABILITY TO MATCH THE EXACT DIMENSIONS OF YOUR BUSINESS

120



200



1200

2200

4200

SERIES 200

SUMMARY DESCRIPTION

Honeywell

ELECTRONIC DATA PROCESSING

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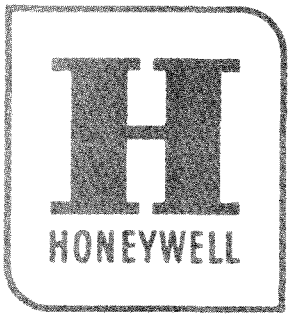

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FOREWORD

This summary description of the Series 200 is intended for those having a general familiarity with data processing. Machine characteristics and programming aids are described in terms which should aid comparisons between the Series 200 systems and competitive equipment. The equipment characteristics reported herein remain subject to minor revision in order that design improvements may be incorporated.

1 Introduction

A computer, like any other tool used by man to tackle a task or problem, is limited in the extent to which it can be applied efficiently. A lightweight truck will probably break down if loaded considerably beyond its design limit. Likewise, a steam shovel is not the economic solution to digging postholes. A modular tool, however, can be applied to a wider range of jobs more efficiently. If the tool has several dimensions, each of which can in turn be modularized, the facility with which it can be tailored to handle specific jobs is enhanced even further.

This is how Honeywell has tackled the problem of matching computers to specific data processing requirements. By breaking computer capability into basic dimensions and providing a range of capability in each dimension, Honeywell is uniquely able to match a computer to a given job. Also, the computer can be expanded or modified very easily to match changes in system requirements. This approach to computer system design is the basis of Series 200.

Series 200 represents an "off the shelf" processing capability consisting of processing, input/output, and software modules that can be brought together in virtually any combination to form systems accurately tailored to solve any business or business-related data processing problem economically. Series 200 includes five compatible processors which display outstanding cost/performance characteristics and offer the user great flexibility in his choice of speed, simultaneity, and memory capacity. A broad array of input/output devices, offered in several performance levels, provide many input/output media alternatives. Software systems are tailored to match the modularity of hardware. Briefly, Series 200 features are:

PROCESSING DIMENSION

- Memory speeds ranging from 3 microseconds to 188 nanoseconds per character
- Memory capacities ranging from 2,048 to 524,288 characters, in modular increments
- Up to 30 index registers; flexible nanosecond control memory
- A universal set of powerful instructions affording program compatibility between processors
- Advanced programming and memory addressing methods, plus editing, and multiply/divide operations
- Powerful floating-point capability

INPUT/OUTPUT DIMENSION

- Up to 64 peripheral control units connected to a processor; each accommodates one or several peripheral devices and is equipped with an automatic program interrupt facility
- A wide variety of peripheral equipment available in a range of performance capabilities, including communication devices, card equipment, magnetic tape and paper tape units, mass storage units, high-speed printers, MICR equipment and memory-to-memory adapter units
- Broad-scale real-time capability that includes an efficient interrupt facility, single- and multi-channel communication controls (the latter accepting data from up to 63 lines simultaneously), multilevel code handling, and a wide range of remote terminal facilities

SOFTWARE/CONVERSION DIMENSION

- Easy-to-use, compatible programming languages; powerful assembly and compiler systems
- Wide array of generalized data manipulation programs: sorts, I/O packages, report generators, and others
- Instruction and data compatibility with 1401, 1410, 1440, 1460, and 7010 systems
- Liberator software for fast and easy program conversion

Clearly, Series 200 meets the needs of business data processing today — and tomorrow as well.

2 Processors

In keeping with design objectives, Series 200 processors constitute the central elements of a modular processing capability. The design of this new processor series is based on, but also fulfills and complements, the Honeywell 200. The result is a line of five powerful but economical models which are fully compatible and easy to use: 120, 200, 1200, 2200, and 4200.

THROUGHPUT – KEYNOTE OF SERIES 200 PROCESSORS

Series 200 processors are designed primarily for business applications and for jobs involving combined business, data communications, and scientific processing. In most data processing, the governing performance dimension is throughput—the quantity of data taken in, processed, and transferred to output media as computed results. High throughput requires not only an ability to transfer a large quantity of data into and out of a processor, it also requires the capacity to process these data internally. This includes the performance of all required computations and manipulations, while at the same time servicing demands from input/output devices quickly enough so that these devices can operate at their rated speeds. Therefore, the internal speeds of the processor must be high enough to allow the required combination of computing and input/output servicing. Clearly, then, high-throughput processors must possess a good *balance* of internal speed and potential input/output demand. As the following discussion will demonstrate, Series 200 processors incorporate an optimally balanced mixture of computing power and peripheral simultaneity at all levels of over-all throughput capability.

Computing Power

The ability of a processor to perform purely internal processing, involving only such operations as arithmetic, logical functions, data transfers, and editing, is largely a function of: (1) the amount of memory available for storing programs, as well as control and working data; (2) control and main memory speeds, which govern the time required to obtain and move instructions and data within the processor; (3) the selection of instructions in the processor's repertoire and the efficiency of the logic by which instructions are implemented; and (4) the memory addressing scheme used. Series 200 processors provide computing power to meet the needs of any business jobs or applications involving business, scientific, and communications processing.

MEMORIES – SPEED AND CAPACITY: High internal speeds are assured by main memory cycle times ranging from 3 microseconds to 188 nanoseconds per 6-bit character and control memory cycle time of 500 nanoseconds. For example, consider the following statistics, which are based on typical situations:[1]

Operation	Execution Time, Microseconds Model 120	Model 1200	Model 4200
Decimal Add	105	33	7.5
Compare	90	25.5	6
Branch on Character Equal	66	15	3
Move Characters to Word Mark	87	24	6
Floating Multiply		165	20.2

[1] Two-character addresses are used to refer to five-character operand fields. Instruction access times are included in the times shown. The times for floating multiply refer to operations using a 36-bit mantissa and a 12-bit exponent.

PROCESSOR MODEL	MEMORY CYCLE TIME	MEMORY CAPACITIES AVAILABLE (thousands of characters)																								
		2	4	8	12	16	20	24	28	32	40	49	57	65	81	98	114	131	163	196	229	262	327	393	458	524
120	3 microseconds/char.	✓	✓	✓	✓	✓	✓	✓	✓	✓																
200	2 microseconds/char.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓												
1200	1.5 microseconds/char.			✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓								
2200	1 microseconds/char.					✓				✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓				
4200	188 nanoseconds/char.									✓				✓		✓		✓		✓	✓	✓	✓	✓	✓	✓

The speeds of Series 200 memories are complemented by the wide range of storage capacities available at each speed level. Memory size in the 120 processor ranges from 2,048 to 32,768 six-bit characters. At the other end of the scale, model 4200 processors are available with 32,768- to 524,288-character memories. The modularity of Honeywell systems is exemplified by the relatively small increments in which main memory can be expanded, even at high capacity levels. Main memories in models 2200 and 4200 can be equipped with a "storage protect" capability which shields the contents of one or more designated memory areas against accidental alteration by unrelated programs. High-speed control memories of 16 to 32 control registers are used in all processors except the 120.

Information is stored in main memory locations either in pure binary form, as 6-bit alphanumeric characters, or as signed decimal quantities. Any number of consecutive locations can be grouped to form fields; groups of consecutive fields can be delineated as items. Such groupings are defined by programmed or operator's setting of punctuation bits associated with each memory location. (Fields and items are defined, respectively, by word marks and item marks.) Punctuation bits can also be set to form a record, which is defined as any unit of information that is to be transferred between main memory and a peripheral device as the result of a single peripheral data transfer instruction.

With one exception, there are no reserved input/output areas in main memory. The model 120 processor uses a fixed area for print line images, but in all other cases the programmer has complete freedom in specifying the locations and sizes of such areas to meet the needs of any program. This allows both a high degree of programming flexibility and economical usage of memory.

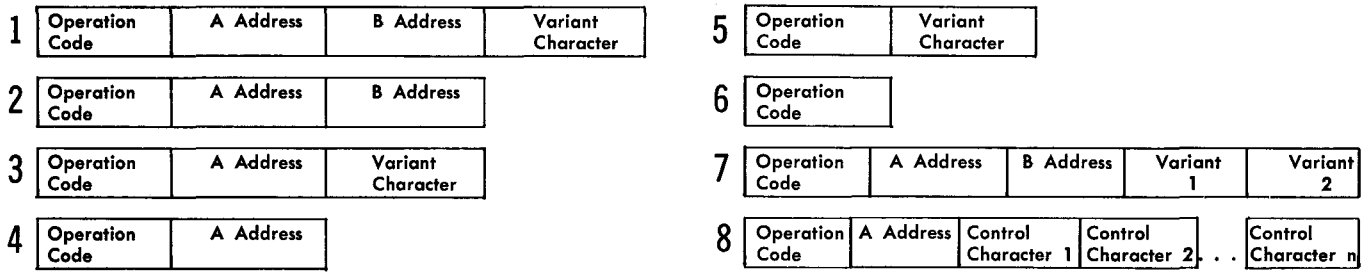
A parity bit in each character position is used to maintain the accuracy of all data. Parity checking, performed automatically, is a method of checking a character each time it is moved in memory to insure that it retains its original meaning.

INSTRUCTIONS: Series 200 processors have available a repertoire of instructions which, with tremendous flexibility and power derived from the use of variant characters, can handle all arithmetic, logical, control, editing, and input/output functions necessary for business data processing. Also included in all processors are instructions for dealing with peripheral and communication interrupts and for manipulating data in codes of up to 12 levels. Hardware multiply and divide operations are standard in all processors except the 120. Models 1200 and 2200 can be equipped with a floating-point arithmetic facility for use in scientific applications; floating-point operations are standard on the 4200.

Instructions are variable in length. The basic instruction format consists of an operation code which specifies the type of operation to be performed, two operand fields which specify the binary addresses of fields to be used in the operation, and a variant character. The variants can be used to expand the meaning of the operation code or to specify literally a piece of data to be used in the operation. However, there are many times when not all of these instruction elements are needed, in which case they may be omitted to minimize both the amount of memory storage required and the time necessary to retrieve and execute an instruction. Peripheral control and input/output instructions have a slightly different basic format than

Series 200 Instruction Repertoire

The table below refers to Series 200 instruction formats, which are:



Name of Operation	Format(s)
Fixed-Point Arithmetic	
*Decimal Add	
*Decimal Subtract	2,4,6
Decimal Multiply	
Decimal Divide	
*Binary Add	
*Binary Subtract	2,4,6
Zero and Add	2,4,6
Zero and Subtract	
Scientific Processing Instructions	
Floating Add	
Floating Subtract	
Floating Multiply	4
Floating Divide	
Decimal-to-Binary Convert	
Binary-to-Decimal Convert	
Logical Functions	
*Extract	2,4,6
*Half Add	
*Compare	2,4,6
*Compare Numeric	
*Substitute	1,4,6
Branch if Character Equal	
Branch on Bit Equal	1,4,6
Branch on Character Condition	
*Branch on Condition Test	3
*Unconditional Branch	4
Branch on Index Register	
Editing	
Move Characters and Edit	2

Name of Operation	Format(s)
General Control Functions	
*Set Word Mark	2,4,6
*Set Item Mark	
*Clear Word Mark	
*Clear Item Mark	
*Halt	2,4,6
*No Operation	6
Load Memory Protect Indicator	4
Store Memory Protect Indicator	
Change Sequencing Mode	1,2,4,6
Change Addressing Mode	6
Data Move Instructions	
*Move Characters to Word Mark	2,4,6
*Load Characters to A-Field Word Mark	
*Move and Translate	7
Extended Move	1
Modify Index Register	4
*Store Control Register	3
Load Control Register	
Interrupt Processing Instructions	
Store Indicators	6
Restore Indicators	
Store Interrupt Source	
Resume Normal Mode	2
Input/Output	
*Peripheral Data Transfer	8
*Peripheral Control and Branch	

* Standard instructions in all processors.

the one described above. The various Series 200 instruction formats are illustrated in the accompanying table.

ADDRESSING: All Series 200 main memory locations are directly addressable. Three additional features facilitate advanced programming and addressing of large memories – indexed and indirect addresssing and variable-length address interpretation.

Six main memory index registers are provided as part of main memories having 32,768 or fewer storage locations; larger memories are equipped with 30 index registers. These registers provide an automatic means for address modification without altering the instruction in which the address is modified. Indirect addressing enables the user to reference stored information via one or more intermediary addresses. Variable-length address interpretation refers to the ability of Series 200 processors to operate in three different address interpretation modes, allowing the programmer to code instructions using either two-character, three-character, or four-character addresses. This facility provides the flexibility necessary to allow the direct addressing of large memories, while at the same time saving processing time and memory space when working in localized areas of memory.

Simultaneity

The speed of internal processing is one of the most important standards in evaluating the total throughput of a system; peripheral simultaneity is the other. Series 200 processors possess several features which enable them to provide powerful but easy-to-use simultaneity: program-assignable read/write channels, multiple input/output trunks, and an interrupt processing facility.

READ/WRITE CHANNELS AND INPUT/OUTPUT TRUNKS: The use of program-assignable read/write channels enables Series 200 processors to compute while concurrently servicing from 2 (Model 120) up to 16 (Model 4200) input/output operations. In addition, Series 200 processors provide facilities for interfacing with a large number of peripheral controls, ranging from a possible 8, in the case of the 120, up to 64 in the 4200. The high internal speeds of these processors insure that even when the high degree of possible simultaneity is fully exploited, the increased demands on the processor to service peripheral devices will still be satisfied. Perhaps even more significant than the effect is the cause: this capacity is built into every Series 200 processor. It does not depend upon complex software or expanded system configurations.

The basic 120 processor is equipped with integrated controls for a 450-line-per-minute printer, a 400-card-per-minute card reader, and a punch which processes cards at rates from 100 to 400 per minute. The card devices can be separate or combined as a reader-punch. Also available is an integrated control for four non-simultaneous magnetic tape units (read/write speed of 24 inches per second). Connections of all other peripheral controls to Series 200 processors is made via input/output trunks. The number of such trunks available in a processor ranges from 4 in the 120 to 64 in the 4200. A control unit which handles both reading and writing (e.g., a magnetic tape control) connects to a pair of trunks. The number of peripheral controls possible in a system depends only on the number of input/output trunks available.

SERIES 200 PROCESSORS
INPUT/OUTPUT CHARACTERISTICS

PROCESSOR MODEL	NUMBER OF I/O TRUNKS	NUMBER OF I/O OPERATIONS SIMULTANEOUS WITH COMPUTING	
		Standard	Maximum
120	4 peripheral controls in processor; also available are up to 4 I/O trunks.	Printing and one tape or card operation.	Printing and two others.
200	8 - 16	3	4
1200	16	4	4
2200	16-32	4	8
4200	32-64	8	16

Data are transferred between main memory and a trunk (and thus a peripheral device) via a read/write channel assigned by the instruction which initiates the transfer. A read/write channel is a data path across an interface between main memory and a peripheral device. Whenever an input/output operation is to be performed, a program-assigned read/write channel completes the path between the required peripheral device and the main memory.

The degree of peripheral simultaneity achievable by any Series 200 processor depends upon the number of read/write channels with which it is equipped. Standard equipment of the model 120 processor includes a write channel, which is permanently assigned

to the 450 LPM printer, and a floating, bi-directional channel which can be assigned to other devices, allowing simultaneous computing, printing, and any card or tape operation. Model 120 processors can also be equipped with up to four input/output trunks and a read/write channel which enables the simultaneous performance of computing, and up to three input/output operations when a device connected to one of the added trunks is being operated. Sixteen read/write channels are available in the 4200, allowing a like number of input and output operations, in any combination, to go on at the same time as internal processing. In order to appreciate the full power of the read/write channel concept, consider the following statistics: In one minute, a Series 200 system equipped with a model 200 processor having four read/write channels can:

read 800 cards;

punch 10 columns of data into 400 cards;

print 1300 lines of 120 characters each;

read or write 4360 tape records of 500 characters;

(or perform any combination of four I/O operations) and in the same minute, execute 1.25 million instructions.

INTERRUPT PROCESSING FACILITY: The Series 200 automatic program interrupt facility provides simple but efficient supervision of processing involving combinations of input/output operations and computing. This facility allows automatic branching as necessary between a main program and servicing routines for all input/output devices. It obviates the need for programmed tests to detect the completion of input/output operations. The automatic hardware interrupt has important applications in the field of data communications and other real time areas, but it is equally applicable to the supervision of operations as universal as reading and punching cards and paper tape, as well as reading and writing magnetic tape.

The Series 200 interrupt processing facility consists of a hardware program interrupt, which signals a particular condition in an input/output control unit, and a set of instructions used in processing interrupts. A program interrupt occurs whenever a peripheral device has completed an input/output operation. For example, an interrupt occurs at the end of data transfer in a tape read or write operation. Likewise, the receipt of a character from a remote station by a communications control unit is signalled by a program interrupt. Interrupts from particular peripheral controls can be inhibited by a program as necessary.

A program interrupt is accompanied by: (1) automatic storage of main program indicator values, control register contents, and an indication of interrupt source; and (2) automatic branching to a routine whose address was previously loaded by program into a special control memory register. This routine can then proceed to determine the number and source of existing interrupts and to process the corresponding input/output demands according to whatever priority was specified by the programmer. The interrupt instruction subset is particularly helpful in this regard. After all demands have been processed, only a single instruction is necessary to resume the main program at its point of interruption and to restore all main program indicators and control registers to their previous values.

Conversion Compatibility

Series 200 processors are designed according to the Liberator concept, which allows the users of various competitive systems to take advantage of the superior performance of Honeywell systems without incurring the prohibitive costs of reprogramming. For example, the instruction repertoire of Series 200 processors is similar enough to those of several other processing systems, viz., the IBM 1400 series, to allow automated, one-time translation of programs written for these competitive systems to a form suitable for execution on higher-performance Series 200 systems.

Structural Modularity — Reliability

A major feature of the structural design of Series 200 processors is the use of integrated system modules. Each module contains all the circuitry required for a particular system function; for example, one module contains all the printer control circuitry, another contains the components of the arithmetic unit, etc.

This modularity greatly simplifies expansion of a system; in most cases, expansion involves little more than plugging in additional modules. The reliability of components within each module has been maximized through the use of silicon semiconductors. In addition, Series 200 takes advantage of the latest advances in the application of monolithic integrated circuits.

Summary

Series 200 processors possess optimum combinations of high memory speeds, modular memory capacities, powerful instructions, efficient addressing methods, and flexible input/output traffic facilities which afford the computing power and simultaneity necessary for high throughput rates. The productivity of these processors is enhanced by their programming and operating simplicity. Basic hardware compatibility enables users of competitive systems to convert easily to take advantage of superior Series 200 performance.

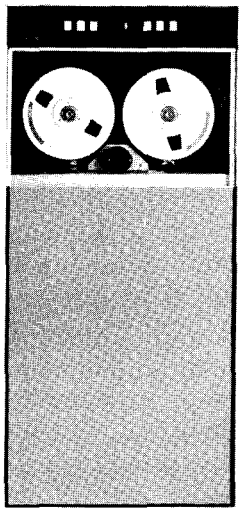
Sound hardware design, always a Honeywell plus, provides modularity and assures reliability. All processors are equipped with:

- Direct, indexed, and indirect addressing
- 2- to 4-character address interpretation
- Program-assignable read/write channels
- Automatic program interrupt
- Multi-level code handling facility

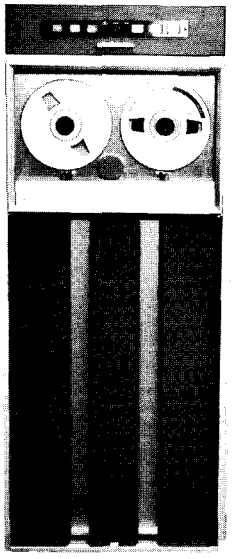
Other processor facilities are tabulated below:

Processor Model	Main Memory Speed (cycle time)	Memory Capacity (thousands of characters)	Number of Input/ Output Trunks	Number of I/O Operations Simultaneous with Computing	Advanced Programming Instructions	Financial Edit Instruction	Multiply and Divide Instructions	Scientific Processing Instructions	Memory Protect Facility
120	3 microseconds per character	2 - 32	4 controls in processor; 4 I/O trunks available.	2 - 3	✓	✓	*	*	*
200	2 microseconds per character	4 - 65	8 - 16	3 - 4	✓	✓	Standard	*	*
1200	1.5 microseconds per character	8 - 131	16	4	Standard	Standard	Standard	✓	*
2200	1 microsecond per character	16 - 262	16-32	4 - 8	Standard	Standard	Standard	✓	✓
4200	188 nanoseconds per character	32-524	32-64	8-16	Standard	Standard	Standard	Standard	✓

✓Feature available.
* Feature not available on this model.



204
B-1, B-2, B-3, B-4, B-7, B-11, B-12



204
B-5, B-6, B-8

3 File Storage Units

Equipment used in computer systems to store program and data files should have the following characteristics: large storage capacity, efficient packing of data on the storage medium, access time and data transfer rate commensurate with the application(s) being performed, and adequate data protection facilities. For those applications requiring high reliability, large storage capacity, and economical use of storage medium, and using serial file access techniques, Honeywell offers its line of industry-acclaimed, vacuum-operated magnetic tape drives. Random access drum units are provided for use in situations, such as may occur in data communications and other real time applications, where file references must be made quickly on a random basis.

PERIPHERAL CONTROLS

Peripheral controls are used to regulate the transfer of data between a processor and file storage units. A significant feature is the fact that these controls operate independently of the central processor and require memory access only when information transfers are performed. In particular, all data validity checks, such as parity checks in magnetic tape transfers, are performed by the controls and do not involve the central processor in any way.

Controls for 24-inch-per-second magnetic tape units accommodate up to four drives. One such control can be included in the Model 120 processor. Otherwise, control units for ½-inch magnetic tape units and random access drums are each connected to a processor by means of two input/output trunks and can accommodate up to eight devices; up to four ¾-inch tape drives can be connected to a control. The number of tape unit and drum controls in a system is limited only by the number of input/output trunks available.

Switching units (Model 205) are available to allow alternate connection of one or more tape units to different control units. Also, both tape and random access drum controls can be switched between Series 200 processors by use of Model 216 peripheral control switching units.

Magnetic Tape Units

Two complete families of magnetic tape units are provided for use in Series 200 systems:

- Units which process ½-inch tape provide: (1) The standard means for storing 6-bit data; and (2) IBM compatibility, including end-of-file mark recognition and the ability to translate between card images in IBM even-parity tape code and Series 200 processor code.
- Units which process ¾-inch tape provide data compatibility with Honeywell 400/1400/800/1800 systems and, in addition, feature Honeywell's industry-acclaimed Orthotronic control technique for data checking and regeneration.

Programmed tape operations include the following:

- ½-inch tape units – read forward, write forward, backspace one record, space forward one record, rewind, rewind and release, and erase; also available is read backward.
- ¾-inch tape units – read forward, write forward, backspace one record, rewind and release, and regenerate tape channel.

As indicated in the accompanying table, data transfer speeds range from 7,200 to 83,300 characters per second for units processing ½-inch tape, and from 32,000 to 88,000 characters per second for ¾-inch units. Also included in the table are "cross-gap" times, the presence of which points to a distinct advantage of Honeywell tape units. When a tape read or write operation is completed, the tape unit begins a deceleration interval which is coincident with the creation of part of the inter-record gap on tape. However, it is not necessary for the unit to stop before beginning to execute a new read or write operation. If such an

MAGNETIC TAPE UNIT SPECIFICATIONS

	Half-Inch Tape Units, Read/Write Speed									¾-Inch Tape Units, Read/Write Speed		
	24 in./sec.	36 in./sec.			80 in./sec.			120 in./sec.	150 in./sec.	60 in./sec.	120 in./sec.	
RECORDING DENSITY char./in.	556	200 556	200 or 800	556 800	200 556	200 or 800	556 800	200 556	200 556	533	533	740
TRANSFER RATE thousand char./sec.	13.3	7.2 20.0	7.2 or 28.8	20.0 28.8	16.0 44.4	16.0 or 64.0	44.5 64.0	24.0 66.7	30.0 83.3	32.0	64.0	88.0
REWIND SPEED inches/sec.	72	108			240			360	360	180	360	360
INTER-RECORD GAP	.45" .75"	.45" .75"			.60" .75"			.70" .75"	.75" .75"	.67"	.67"	.67"
CROSS-GAP TIME	18.7 ms 31.2 ms	12.5 ms 20.8 ms			7.5 ms 9.4 ms			5.8 ms 6.3 ms	5.0 ms	11.0 ms	11.0 ms	5.5 ms
MODEL NUMBER	204B-11, 12	204B-1, 2		204B-7	204B-3, 4		204B-8	204B-5	204B-6	204A-1	204A-2	204A-3

operation is begun at any time during the deceleration interval, the unit merely accelerates, completes the inter-record gap, and begins the next operation.

The power of Series 200 peripheral simultaneity is evidenced by tape processing statistics: The proportion of available central processor time during a data transfer interval shared with a tape read or write operation ranges from 75% to more than 99%, depending upon the data transfer rate of the tape unit and the speed of the processor being used. Simultaneity is further increased in the case of ½-inch tape units: Reading and writing can proceed simultaneously under the direction of a single tape control unit at the same time that computing is in progress (24-inch-per-second drives do not have this facility).

The design of all Honeywell tape units incorporates the vacuum techniques which have earned an outstanding reputation for error-free operation. Vacuum control is used to mount, drive, and stop the tape so as to avoid any danger of damage; the reading surface of the tape has physical contact with the read/write head only. A write-enable ring and a manual tape unit switch guard information on tape from accidental destruction by an unintentional write operation.

All information written on ½-inch tape is immediately read and checked. During a write operation, a parity bit is generated for each frame and another is generated for each data channel. The parity bits accompany the data on tape. Frame and channel parity are checked while reading. Failure of any of these checks automatically causes an indicator to be set which can be tested by a programmed instruction. The ¾-inch tape equipment has the further ability to regenerate any tape channel on the basis of the parity established by the other channels and the frame parity bits.

Random Access Drum File and Control

The Honeywell random access drum file and control provides a highly efficient, random access data storage medium for Honeywell computers. The drum subsystem achieves an optimum combination of high-speed access to voluminous quantities of store data and low storage cost per unit of information.

One to eight drum files can be connected to a control unit to operate on-line in a Series 200 system. The storage capacity of each drum is 20,480 records of 128 six-bit characters each, or 2,621,440 characters. Thus, a single control/drum subsystem can have a total capacity of over 20 million characters.

Program control of drum operations is maintained by use of two instructions: search-and-write and search-and-read. Both instructions can handle variable as well as fixed-length records.

A drum rotation speed of 1200 rpm, coupled with the use of 512 read/write heads, provides access to a specified drum record in an average of only 27.5 milliseconds. Data transfer to and from the drum takes place at an average rate of 102,000 characters per second.

Only one memory cycle of central processor time is required for data transfer between the drum control and main memory. Therefore, the proportion of a data transfer interval available for other central processor operations varies from 69.6% for a Model 120 processor to 92.4% for a Model 4200.

The drum control automatically generates a parity bit for each character to be written. The parity bits accompany the record onto the drum. An automatic character parity check is performed while reading; any discrepancy results in the setting of a program-accessible indicator.

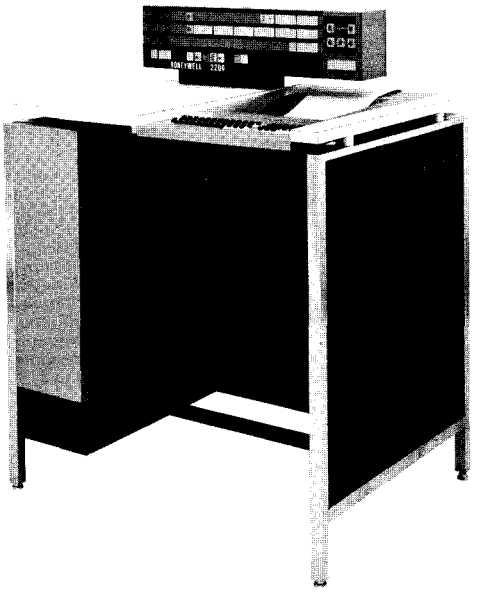
4 Input/Output Devices

Series 200 includes a wide variety of input/output devices so as to enable the use of numerous input/output media. The following devices are offered: card readers, a card punch, a card reader/punch, printers, a paper tape reader, a paper tape punch, communications control units (discussed in a succeeding section), and an operator's console. Most input/output devices are offered in several performance levels, allowing the user to choose a desired input/output medium at an economical processing level. Particularly significant is the fact that any of the devices described here can be connected to any Series 200 processor, contingent only upon the availability of the requisite input/output trunk(s). Thus, a great deal of flexibility is provided to allow accurate tailoring of system capabilities to satisfy user requirements.

PERIPHERAL CONTROLS

As in the case of file storage units, transfer of data to and from the central processor is regulated by independent peripheral controls which require memory access only briefly when information is actually being transferred; each device described here requires its own individual control (*i.e.*, multiple devices cannot be connected to a control). All data-protection measures, such as validity and echo checks, are performed by the controls and do not involve the central processor.

Model 120 processors include controls for: (1) either a card reader/punch or, separately, a 400 CPM card reader and a card punch; and (2) a 450-line-per-minute printer. Otherwise, control units for input/output devices are each connected to processors by means of one or more input/output trunks. With two exceptions, each of the devices described here requires only one trunk; consoles and the reader/punch each require two. Input/output devices can be switched between Series 200 processors by use of Model 216 peripheral control switching units.



Control Panel and Consoles

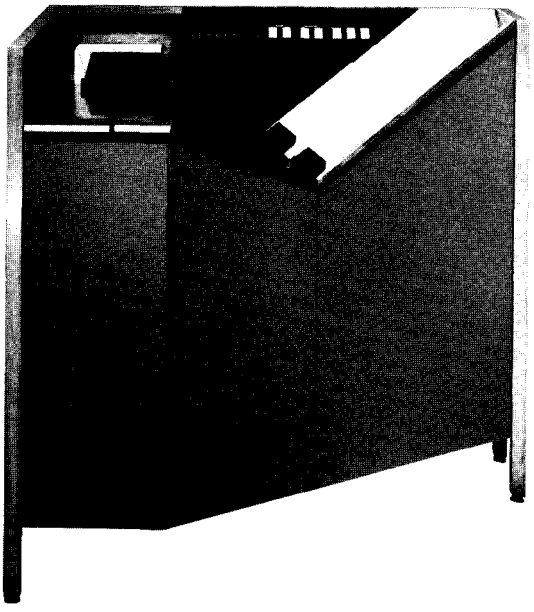
A prospective Honeywell customer can choose one of three devices for over-all control of a Series 200 system: a control panel or one of two operator's console models. All devices provide a visual indication of system status and permit manual intervention into system operation.

The control panel, which is actually an integral part of the central processor, contains various control switches by which the operator can start and stop the machine and can load and interrogate both main and control memory locations. Sense switches may be used in conjunction with programmed instructions to stop processing or to select predetermined program

paths, thereby increasing the flexibility of a program.

The Model 220-1 console includes a control panel, mounted on the console cabinet, and a console typewriter. The typewriter may be used as a peripheral device, operating under program control, or as a logging typewriter. The control panel is used for direct access to memory in this model.

In the Model 220-2 console, most of the control panel functions, including direct access to the central processor, are performed by means of the console typewriter. In addition, the typewriter can perform the peripheral and logging operations described above. The standard control panel is replaced in the Model 220-2 with a smaller version containing only the main power switches, sense switches, and certain check condition indicators.



Card Equipment

In keeping with the concept of modular processing capability, Honeywell offers a flexible array of punched card equipment. The units described are recent Honeywell developments and include such advanced card-handling techniques as column-by-column (end-feed) processing. End-feed card processing provides four important advantages: (1) It simplifies the reading and punching of cards containing non-standard numbers of columns; (2) It enables accelerated feeding over columns not being punched; (3) It frees the central processor for other operations during a very high proportion of card equipment cycle time; and (4) It enables the complete elimination of card cycle clutch points. In card devices employing clutch points, a card input/output instruction can only be acted upon at certain points in the cycle, a situation which limits the device's throughput. The use of end feeding in all Series 200 card equipment enabled Honeywell engineers to incorporate demand feeding, *i.e.*, the execution of card input/output instructions *immediately* upon their receipt by the pertinent control unit. Demand feeding, in combination with the ability to accelerate over unused card fields, provides maximum rates for continuous card reading and punching.

Automatic translation between standard 12-bit Hollerith card code and Honeywell central processor code is a standard facility on all Series 200 card devices. Transcription mode reading and punching are also available on all devices, except when connected to the integrated controls of Model 120 processors.

CARD READERS – 400 AND 800 CPM

Two high-performance devices are offered for use in Series 200 systems to optically read 80- or 51-column punched cards: a 400-card-per-minute reader, Model 214-3; and Model 223, an 800-card-per-minute reader. Processed cards are sent to an output stacker, and those which fail data-protection checks can be offset-stacked under program control. End feeding substantially reduces the time normally required by edge-feed (row-by-row) readers for data transfer to and from main memory; therefore, other peripheral data transfers and computing can be performed during more than 99.9% of a card read cycle. Solid-state electronic components are incorporated in both card reader models to ensure optimum reliability. The speed, simplicity, and reliability of these devices combine to give them the best cost/performance ratios in the industry.

400 CPM CARD PUNCH

The Model 214-1 card punch operates at speeds of up to 400 cards per minute, depending upon which column is punched last. This device also incorporates another new feature, dual-character punching, which employs a dual-die mechanism to punch two characters (columns) simultaneously, and adds significantly to the high speeds and reliability of the unit. The Model 214-1 punch was designed for maximum reliability with minimum periodic maintenance. There are no cams, gears, or sliding parts in the feed mech-

SUMMARY OF CARD EQUIPMENT SPECIFICATIONS

	READERS		PUNCH	READER/PUNCH
SPEED cards/min	400 CPM	800 CPM	100-400 CPM	100-400 CPM
SIMULTANEITY	The central processor, regardless of model, is free to perform other data transfers or computing during at least 99.9% of a card device's transfer interval.			
PROGRAMMED OPERATIONS	Read data and transfer to specified memory area.	1. Read data and transfer to specified memory area. 2. On error card, offset-stack cards or go busy.	Punch data from specified area of memory.	1. Punch data from specified area of memory. 2. Read data and transfer to specified memory area. 3. Read and punch same card.
DATA TRANSFER [1] MODE	Automatic translation between Hollerith card code and 6-bit central processor code is standard. Additional transcription mode reading and punching capability also available.			
DATA PROTECTION	Illegal punch check	Validity and cycle checks	Punch check	Illegal punch check on reading; punch check on punching
INPUT HOPPER/OUTPUT STACKER CAPACITY	1200/1300	3000/2500	1200/1300	1200/1300
MODEL	214-3	223	214-1	214-2

[1] Transcription mode reading and punching not available in Model 120 processor's integrated card equipment controls.

anisms, making lubricating points completely unnecessary. The 214-1 enjoys the same simultaneity advantages afforded other Honeywell end-feed card devices: Other processor and peripheral activities can occur during 99.9% of a card punch cycle. Punching errors are detected by a punch check; recognition of an error causes a program-accessible indicator to be set.

400 CPM CARD READER/PUNCH

This dual-purpose device actually has three operational modes; it reads, or punches, or reads a card and punches additional information into the card on the same pass. Punching speed ranges up to 400 cards per minute, depending upon which column is punched last. Operating speed is 400 cards per minute when reading only; if reading and punching during the same pass, the unit operates at its punching speed. This device combines all of the advanced features of the punch and readers described above. That is, the punch station employs dual-character punching, as well as high reliability due to the absence of wear-producing cams, gears, and sliding parts. The reading station features optical techniques. Other peripheral data transfers and internal computation can be performed by the central processor during 99.9% of a card processing cycle. The reading and punching stations detect errors by means of illegal punch checks and punch checks, respectively. When a discrepancy is sensed, a program-accessible indicator is set, and the card can be offset-stacked.

Paper Tape Equipment

The Honeywell paper tape reader (Model 209) processes 5- through 8-level tape at the rate of 600 frames per second; the punch (Model 210) operates at 120 frames per second. Reading and punching, as well as tape rewind and runout on the reader, are under program control. Tape stops within the length

of a frame at the end of a reading or punching operation, thus ensuring reliable reading of the first and last frames in a record.

Paper tape control units can be conditioned by programmed instruction to process either codes of 5 and 6 levels or codes of 7 and 8 levels. This facility minimizes the amount of central processor time required for data transfer when processing 5- and 6-level tape.

Data transfer between the central processor and either the reader or the punch involves the central processor for only one memory cycle per 5- or 6-level frame and two memory-cycles per 7- or 8-level frame. Thus, the central processor is free during more than 99.9% of a paper tape read or punch interval to perform computations and other input/output data transfers.

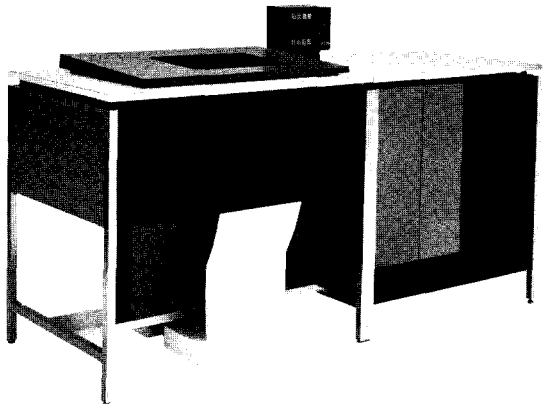
Frame parity can be generated by programmed instruction in preparation for punching. Likewise, frame parity can be checked by the program when reading tape. The reader can also be equipped to check each frame for odd or even parity and to set a program-accessible indicator if this check fails.

Printers

Honeywell offers printers to meet a wide variety of requirements. As indicated in the accompanying table, printing speeds offered range from 450 to 950 single-spaced lines per minute for alphabetics and up to 1300 for lines containing a special numeric character set; 96 to 132 print positions per line are available. Up to eight carbon copies can be provided.

Printing is performed in response to peripheral data transfer instructions issued to the printer control from the central processor. The peripheral control and branch instruction is used to handle such functions as line and form spacing. An edit instruction allows the programmer to arrange output data into any desired format.

During printing, an operator-changeable type roll on which characters are embossed moves past print hammers at each print position. Actuated as the proper character moves by, these hammers print the characters specified in the print instruction. A cycle check technique insures the accuracy of printed information. Standard drums for Honeywell printers have 63 characters available at each print position – 26 alphabetic, 10 numeric, a blank symbol, and a number of special characters (*e.g.*, credit symbol, asterisk, dollar sign, etc.). Each print position of the drum used for high-speed numeric printing has available a special 49-character set which is the same as the standard set except that there are fewer special characters in the smaller set.



MICR Equipment Controls

The availability of controls for magnetic ink character recognition (MICR) equipment ideally equips Honeywell systems to handle banking applications such as check handling, sorting, etc. These controls allow Honeywell systems to accept input from MICR reader/sorters operating at speeds of 1,560 and 1,600 documents per minute.

SUMMARY OF PRINTER SPECIFICATIONS

	450 LPM PRINTER	650 LPM PRINTER	950 LPM PRINTER
SPEED ATTAINABLE WITH NUMERIC PRINT FEATURE	NA	1300 LPM	1266 LPM
% OF DATA TRANSFER INTERVAL AVAILABLE TO CP FOR OTHER OPERATIONS	Model 120: 84% Model 4200: 99%	Model 120: 75% Model 4200: 98%	Model 120: 60% Model 4200: 97%
PRINT POSITIONS PER LINE	120	96, 108, 120, or 132	120 or 132
CHARACTERS PER PRINT POSITION	63	63 standard; 49 with numeric print feature.	
SKIP SPEED inches per second	Minimum of 35; speeds up to 55 in/sec attainable as successive lines are skipped.		
VERTICAL SPACING	6 or 8 lines per inch.		
MODEL	222-5	222-1, -2, -3	222-4

5 Data Communications Facilities

Honeywell provides a broad-scale data communications capability, the highlights of which are:

- Single- and multi-channel control units to handle an exceptionally wide array of communications lines, speeds, and terminal devices.
- Fast-access mass storage devices.
- Powerful processor communications features, including an automatic interrupt system, multi-level code handling capability, an interval timer, and a programmable real time clock.
- An advanced, multi-purpose remote terminal device, the data station.
- A full line of software for interrupt processing and message handling.

Of particular importance is the fact that this entire communications capability is available for use in any Series 200 system, regardless of the processor model chosen by the user.

Processor Communications Features

Several features available in Series 200 processors make them especially well suited to handle communications applications. The simultaneity, automatic hardware interrupt facility, and high internal speeds of these central units provide a very significant capability – *effective processing of communications and conventional jobs at the same time.* Flexibility in application design is provided by the ability to process ASCII as well as other 8-bit codes.

SIMULTANEITY

The use of program-assignable read-write channels in Series 200 processors enables them to direct the data flow to and from several peripheral devices and, concurrently, to perform computing operations. For example, the Model 200 processor can perform up to four input/output operations at the same time that internal processing is going on. Projected to the Model 4200 processor, this facility allows 16 peripheral data transfers to proceed simultaneously with computing. This greater throughput is simultaneity's chief contribution to integrated communications/business data processing systems. While other processors might falter under a multiple load such as this, Honeywell's simultaneity assures high production rates on conventional applications even while handling heavy communication traffic.

INTERNAL SPEED

Concurrent I/O and internal processing must be coupled with internal speeds high enough to allow efficient handling of data received or transmitted to provide an effective computing system. Honeywell memory cycle times ranging from 3 microseconds per character down to only 188 nanoseconds per character provide internal processing speeds which are suitable complements to the aforementioned simultaneity. These speeds enable complete processing of communications data even when transmission is at high-volume rates. For example, the Model 200 processor, which has a 2-microsecond memory cycle, can efficiently handle single-channel applications at rates up to 150,000 characters per second.

AUTOMATIC INTERRUPT FACILITY

Available for use in all Series 200 processors is a completely automatic program interrupt facility. The advantage of this interrupt is that it enables simple but efficient direction of processing involving concurrent real time and business or scientific applications. The interrupt facility allows automatic branching, as necessary, between a main program and real time service routines. In particular, the readiness of a

communications control to receive data for transmission or to relay data coming in from a line can automatically trigger entrance to a stored routine to service the external demand immediately. (Interrupt routines, applicable to most communications environments, are provided by Honeywell as part of the standard software.) Automatic signalling of control status obviates the necessity for programmed tests of these units to detect the arrival of data or the readiness to transmit. The interrupt facility also includes automatic storage of main program indicator values and control register contents, as well as an interrupt source indication.

MULTI-LEVEL CODE-HANDLING FACILITY

All Series 200 processors are equipped with a facility enabling them to bring into memory and manipulate data in many different codes. This feature includes the ability to translate automatically between character codes of up to 12 levels and also to trap special code configurations of up to 12 levels.

TIMING DEVICES

Two types of devices are available for use in Series 200 processors to give programs access to real time information; each requires one input/output trunk. A Model 213-3 interval timer provides automatic program interrupts at program-specified intervals. A Model 213-4 time-of-day clock permits a program to determine the current clock time in hours, minutes, seconds, and tenths of seconds. These devices may be used in such applications as: (1) timing of program runs; (2) logging times of remote inquiries and information input; and (3) starting programs at specified intervals or clock times, as in polling a communications network.

Data Communications Controls

Both single-channel and multi-channel controls are available to enable Series 200 systems to receive and transmit data over toll and leased lines. One of the most outstanding features of these devices is the broad selection of lines, speeds, and terminal devices to which they can be connected — this selection is one of the largest offered by any manufacturer. The compatible services and equipment are indicated in the accompanying table.

APPLICABILITY OF HONEYWELL COMMUNICATIONS EQUIPMENT

Terminal	Service & Line	Data Set	Speed per Line	Single-Channel Control Models	Adapter [1] Unit Models
DATASPEED 2	Voice Lines	202C-D	105 cps	281-1H	285-1H
DATASPEED	Voice Lines	402C	75 cps Para. Send	281-3A	285-3A
DATASPEED	Voice Lines	402D	75 cps Para. Rec.	281-4A	285-4A
DIGITRONICS D505	Voice Lines	202C-D 201A-B	1200/1800 bps 2000/2400 bps	281-2C 281-2E	285-2C 285-2E
GE DATANET 600	Voice Lines	202C-D	50 cps	281-1F	285-1F
Honeywell Computers and Other Manufacturers' Computers	Voice Lines Telpak A	201A-B 301B	2000/2400 bps 5100 cps	281-2B 281-2F	285-2B —
Honeywell Data Station	Voice Lines	202C-D	1200/1800 bps	285-1H	285-1H
IBM 1050	W.U. 180 Baud TWX Prime	Type 70 103A	14.8 cps 15 cps	281-1K 281-1E	285-1K 285-1E
IBM 7701, 1013	Voice Lines	202C-D	1200/1800 bps	281-2A	285-2A
IBM 7702, 1013	Voice Lines	201A-B	2000/2400 bps	281-2D	285-2D
TTY 19, 28	5-Level Telegraph	—	60-100 wpm	281-1C	285-1C
TTY 32	Western Union Telex Dialed Telex	— —	66 wpm 66 wpm	281-1A 281-1G	285-1A 285-1G
TTY 33, 35	TWX Prime [2]	103A	100 wpm	281-1B	285-1B
TTY 35	8-Level Telegraph	103F	100 wpm	281-1D	285-1D
Any Terminal Device	Voice Lines	801A1/801C1	—	—	285-5A[3]
(Service Approval Pending)	AT&T 150 Baud Line	103F	15 cps	281-1J	285-1J

[1] References to Adapter Units imply Model 284 multi-channel controls, since the 285 interfaces each line connected to a multi-channel control.

[2] A Bell Telephone Service.

[3] This is an automatic dialing unit; it complements the adapter unit when requested.

SINGLE-CHANNEL CONTROL

The single-channel control (Model 281) directs the transmission and reception of messages in 5- to 8-level codes at rates of up to 5,100 characters per second. The input/output circuitry can interface with devices transferring up to 150,000 characters per second for short bursts, as such devices become available. This control is a half-duplex device; *i.e.*, messages are both transmitted and received, but not simultaneously. Additional controls can be added to a system in order to provide full-duplex or multiple-channel operation.

MULTI-CHANNEL CONTROL

The multi-channel control can direct the transmission and reception of messages over as many as 63 communication lines. A communications adapter unit is required as an interface between the control and each channel being used. Data can be transferred at rates up to 300 characters per second in a single line. Even when allowance is made for the normal input/output programming accompanying such an operation, the Model 200 processor can maintain a total character rate (all channels) of up to approximately 2400 characters per second. Faster Series 200 processors can of course better this speed.

DATA PROTECTION

The validity of data being communicated is protected by three different means:

- A transmission lapse results in the automatic setting of a program-accessible indicator in the receiving processor.
- Where applicable, the controlling program can initiate an automatic message-receipting system.
- For codes of more than 6 bits, a frame parity check is available. A long-check feature is also available with single- and multi-channel controls connected to 15 or 63 lines.

COMMUNICATIONS SWITCHING UNITS

Communications switching units of the 216 series enable any two Honeywell systems to share a group of communications lines or to switch between different groups of lines. Up to 63 lines may be switched simultaneously.

Fast-Access Storage

A major requirement of many communication applications, such as those involving inquiry and message switching, is fast access to information which has been placed in storage. Of course, core memory provides the fastest access possible. But when dealing with large files, core memory becomes too expensive. To fill this need for economical storage, Honeywell offers the complete line of magnetic tape units and the random access drum described in a preceding section. The drum can access any record at random in an average time of 27.5 milliseconds. Honeywell magnetic tape units provide sufficiently fast access for the majority of applications, and are by far the most economical devices in terms of storage capacity per dollar.

Data Station

The Honeywell data station is a multi-purpose remote terminal device which can be used for a broad range of communications applications, as well as for off-line jobs. This device gives branch offices, warehouses, remote reporting locations throughout a plant, or any other company outposts, the power to prepare source data locally and to communicate directly with a centrally located computer.

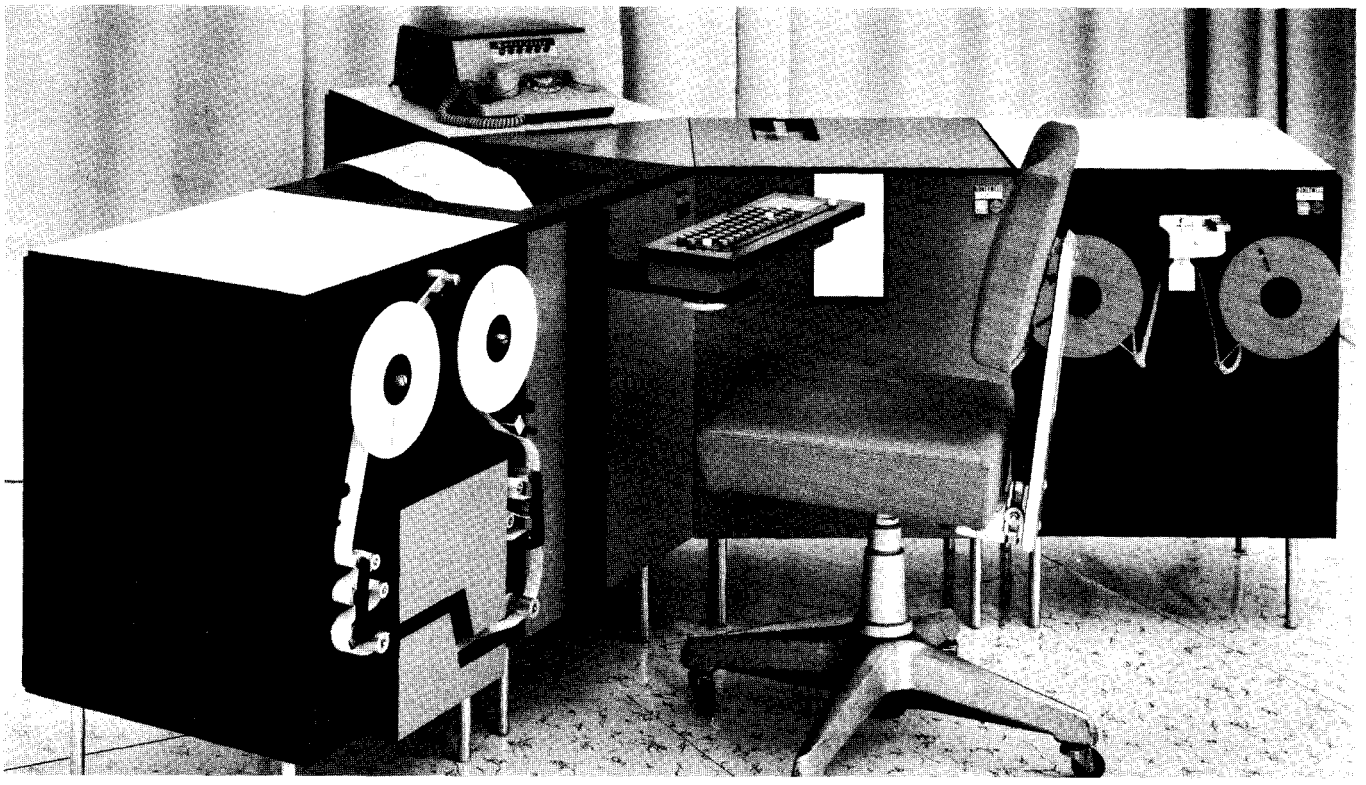
The data station features a very competitive transmission speed of 120 characters per second and a wide choice of input/output devices, including paper tape and punched card equipment, a keyboard, page printers, and an optical bar code reader that introduces new applications possibilities. The basic control unit (288-1) can handle a keyboard plus any combination of four of the peripheral devices included in the accompanying table.

DATA STATION PERIPHERAL DEVICES

Device	*Speed*	*Model*
Card Reader	120 char/sec	289-7
Paper Tape Reader	50 char/sec	289-6
	120 char/sec	289-4
Paper Tape Punch	50 char/sec	289-6
	120 char/sec	289-5
Optical Bar Code Reader	50 char/sec	289-8
Page Printer and Keyboard	10 char/sec	289-2
	40 char/sec	289-3

ON-LINE OPERATION

The data station transmits over a telephone-grade



DATA STATION

line using a DATA-PHONE 202C or 202D dataset; party line operation is available. It uses the 8-bit ASCII code which includes parity. Communications can be directed locally by the operator or remotely by the central computer. Parity and long checking are used to protect against transmission errors. An automatic facility is available for initiation of automatic retransmission of data containing errors.

OFF-LINE OPERATION

When not being used for on-line operations, the data station can be used for local activities such as data preparation. By way of illustration, possible off-line operations include keyboard to paper tape and card to paper tape with simultaneous printing.

Communications Software

To complement the capability of Series 200 hardware, Honeywell provides a full line of software to aid in implementing a variety of applications ranging from sophisticated message switching to polling systems. Some of the functions performed by this software are:

Interrupt Processing – Determination of which communications line is demanding service and whether the line is incoming or outgoing; recognition of the priority of high-speed lines over low-speed lines in gaining access to processing routines, and optimal distribution of processing time to critical operations and less demanding operations.

Real Time Input Analysis – Conversion of the communication code to that used by the processor; interpretation of message headers if necessary; accumulation of messages in memory; generation of storage assignment requests; checking of message format for validity, generation of output queue requests; and addition of control information to messages.

Output Stacking and Interfacing – Generation of requests to processor for messages; reception of messages from output queues; transmission of messages; maintenance of queuing and line priority information.

Random Access Storage and Retrieval – Allocation of random access storage; reading and writing of records; placing and retrieving of queue entries; and performance of all message-queuing functions.

Line Status Direction – Determination of line availability; over-all control of line utilization.

6 Software

Series 200 hardware reflects the most advanced know-how in the computer industry. To consummate the effectiveness of the system, Honeywell has developed a comprehensive array of programming, conversion, and operating aids (or software) that will ensure each user's realization of the hardware's great potential. All software is supplied in versions tailored to fit equipment configurations comprising many different memory capacities and input/output combinations.

Series 200 software is composed of the following elements:

1. *Program Preparation Aids* which convert programs from easy-to-use source languages to Series 200 machine language.
2. *Conversion Programs* which allow the users of several competitive systems to take advantage of the superior throughput and cost/performance characteristics of Series 200 without paying the prohibitive costs of reprogramming.
3. *Generalized Data Manipulation Programs* which perform data processing chores common to most users, such as sorting, input/output operations, and report generation.
4. *Control Programs* which direct the loading, segmentation, library search, and space and time sharing of memory for a group of programs running both sequentially and concurrently.
5. *Utility Routines* which perform auxiliary operations such as object program maintenance and selection, tape searching, tape file copying, and media conversions.

Honeywell furnishes a complete set of software to monitor data communications activities. The functions provided are described in the preceding section.

PROGRAM COMPATIBILITY

A distinctive feature of Series 200 programming aids is that they and the object programs which they produce are operationally compatible with one another. This property enables the operating system to draw all elements into an integrated whole. Object programs produced by a variety of program preparation aids as well as programs from the software library itself, may all be intermixed on run tapes and processed by the PLUS Operating System.

Complete program compatibility is a built-in feature of Series 200. A single machine language is used with all of the models 120/200/1200/2200/4200, allowing the user to run on the Model 4200 any program written for the smaller machines. Thus, software and software-producd object programs which run on even the smallest possible processor can also run on the larger configurations, and usually with a considerable gain in performance due to the faster cycle times and increased input/output simultaneity.

Program Preparation Aids

Honeywell supplies the Series 200 user with an assembly system (Easycoder) and two compilers, COBOL and FORTRAN.

THE EASYCODER SYSTEM

Versions of Easycoder are provided to meet the needs of all system sizes and compositions. This flexibility includes provisions for all types of peripheral configurations and takes advantage of increased internal and input/output processing facilities where

available. Additional Easycoder functions, included in versions for systems having the requisite equipment, include:

Maintenance of Symbolic Program File – A file of Easycoder source programs is input to each assembly run and is updated as specified by the programmer.
Selective Assembly – Run tapes contain specific programs selected by the programmer from both an input deck of new programs and a tape file of previously processed symbolic programs.

Library Facilities – A basic tape library of general-purpose routines is furnished by Honeywell to perform common jobs; to this the user can add his own often-used programs and routines. Programs in the library can be conveniently assembled into an object program by the use of macro instructions.

EASYCODER PROGRAMMING STATEMENTS

The Easycoder assembly language includes easily remembered operation codes which are abbreviations for the names of programming statements that the Assembly Program can interpret. For example, the mnemonic SI is the operation code for the Set Item Mark statement, which is the direct counterpart of a Series 200 machine instruction. The mnemonic ORG, on the other hand, is the operation code for an Origin statement, which is not assembled but which directs the Assembly Program in allocating memory space to the succeeding statements.

A typical Easycoder statement may consist of a tag, a mnemonic operation code, one or more operand addresses (or literal operands), and one or more variant characters. Addresses may be either absolute decimal numbers or symbolic tags. The normal placement of these elements is shown here.

	LOCATION	OPERATION CODE	OPERANDS
1	COMPAR	BCE	GOTOIF,SAMEAS,23
2			

The BCE (Branch if Character Equal) instruction shown in this example can be referenced elsewhere in the program by the symbolic tag COMPAR. (The location field could be blank or it could contain an absolute address so as to assign a specific location to the machine-language equivalent.) The Assembly Program produces a machine-language instruction which will cause a program branch to location GOTOIF if location SAMEAS contains the octal value 23, as indicated by the variant character.

An Easycoder statement may also specify the value of an operand directly by means of a literal. In this example, the assembled instruction will cause the

	LOCATION	OPERATION CODE	OPERANDS
1		S	+24,ACCUM
2		BA	#2850,BEGIN

decimal literal 24 to be subtracted from the contents of the field tagged ACCUM. A statement may also contain a binary or octal literal.

Symbolic addresses may be expressed relative to a tag defined elsewhere in the program. For example, the following statement is assembled as an instruction

	LOCATION	OPERATION CODE	OPERANDS
1		A	ADDEND,AUG+10
2			

which will add the contents of the field tagged ADDEND to the field 10 locations beyond the location tagged AUG.

Both indexed and indirect addressing may be specified in Easycoder language. For example, assume that the BCE statement above is modified as follows:

	LOCATION	OPERATION CODE	OPERANDS
1	COMPAR	BCE	(GOTOIF),SAMEAS+X1,23
2			

In this case, the variant character is compared to the contents of the location whose address is formed by adding the address of the data tagged SAMEAS to the value stored in index register 1 (X1). If the characters are identical, the program branches, not to location GOTOIF, but to the location whose address is stored at location GOTOIF (indirect addressing).

DATA FORMATTING STATEMENTS

As indicated above, there are two different types of Easycoder programming statements. The statements which do not have machine-language equivalents are data formatting statements and assembly control statements.

Data formatting statements direct the Assembly Program to perform the following operations:

1. Store a specified constant in a field whose location is indicated by an absolute or symbolic address.
2. Store a specified address as a constant in a field whose location is indicated by an absolute or symbolic address.

3. Set aside a specified memory area whose location is indicated by an absolute or symbolic address.
4. Set aside one or more specified memory areas and punctuate them as indicated for fields, items, and records. In addition, indexing of all references to these fields, items, and records can be specified.

Typical Easycoder data formatting statements are shown below. The first statement directs the Assembly Program to store the decimal value +6 as a constant in a location to be addressed by the tag SIX.

	LOCATION	OPERATION CODE	OPERANDS
1	SIX	DCW	+6
2	STORE	RESV	30
3	CODE	DSA	PART
4			

The second statement reserves an area of 30 locations which can be referenced by the tag STORE. The third statement directs the Assembly Program to store the absolute address assigned to the tag PART in a field which can be referenced by the tag CODE.

ASSEMBLY CONTROL STATEMENTS

Easycoder assembly control statements direct the Assembly Program to perform a variety of operations, including the following:

1. Specify the beginning and end of a program.
2. Load a block of coding at a particular address.
3. Provide for a temporary interruption of object program loading in order to execute a block of object program instructions.
4. Assemble addresses in either 2-, 3-, or 4-character form.
5. Equate a tag with either an absolute address or another tag.
6. Equate an octal constant with a tag which represents a variant character.
7. Generate a dump routine to accompany the object program, which will obtain a printed listing of the contents of any portion of main memory.
8. Generate a routine to accompany the object program, which will clear specified portions of memory to zeros before the object program is loaded.

Typical Easycoder assembly control statements appear as follows:

	LOCATION	OPERATION CODE	OPERANDS
1		MORG	64
2		ADMODE	2
3		EX	900
4	OFLOW	CEQU	*1C50
5		BCT	SUB2,OFLOW
6		CLEAR	BSUB,ESUB
7		HSM	ENTER,EXIT+2

The first statement indicates that memory allocation for subsequent statements should begin with the next location whose address is a multiple of 64. The second statement directs the Assembly Program to assemble the address portions of all subsequent statements as two-character addresses. The third statement causes the Assembly Program to provide for a temporary interruption of object program loading and for a transfer of program control to location 900.

The fourth and fifth statements illustrate how a symbolic tag can be used in place of a variant character. The CEQU statement directs the Assembly Program to equate the tag OFLOW to the octal value 50. The fifth line contains a Branch statement which causes the program to branch to the location tagged SUB2 if the condition specified by the variant character tagged OFLOW is present (condition 50 represents arithmetic overflow).

The CLEAR statement on the sixth coding line specifies that the area from location BSUB to location ESUB is to be cleared to zeros before the object program is loaded. The HSM statement directs the Assembly Program to generate a memory dump routine capable of listing the contents of the memory area from location ENTER to location EXIT+2.

EASYCODER ASSEMBLY PROGRAM

The Easycoder Assembly Program translates the symbolic source program (written on the Easycoder coding form and subsequently punched into a source-program card deck or written on magnetic tape) into machine-language entries. Mnemonic operation codes are replaced by their machine equivalents. Absolute addresses are assigned to all symbolic tags which appear in the location field and replace all other references to those tags. All operations indicated by data formatting statements and assembly control statements are performed. In addition to an executable machine-language object program, the Assembly Program also produces a printed listing containing the symbolic source program and the corresponding object-program entries.

SERIES 200 COBOL COMPILER SYSTEM

COBOL consists of a language which is a standardized, business-oriented subset of English and a processing system called a compiler. The programmer describes a solution to a business problem in COBOL language, and then the processing system generates machine-language instructions capable of performing the operations described by the programmer's statements.

COBOL LANGUAGE

The English-language statements of COBOL provide a relatively machine-independent method of expressing a business-oriented problem to a Series 200 computer. Commonly used nouns, verbs, and connectives are used in the procedural portion of a COBOL program to construct easily understood sentences. The excellent documentation provided by COBOL – problem definition as well as method of solution – enables more than one programmer to work on a particular problem with minimal duplication of effort.

COBOL COMPILERS

To complement the modularity of the Series 200 hardware, the various COBOL compilers implement a set of language modules, expanding the features of COBOL as the machine capacity is increased. This design approach allows the COBOL user to enhance the power of the source language and to produce larger object programs as the need arises.

The Series 200 COBOL compilers are syntax-directed; the smallest version can operate in a configuration consisting of four magnetic tape units, a card reader, an on-line printer, and a processor containing a 16,384-character memory. (Most competitive compilers possessing a comparable set of language elements require a memory about three times this size.) Other compilers are available for memory sizes of 32,768 characters and larger. Honeywell COBOL compilers are known for their high performance, and the smallest version of the Series 200 compiler is no exception: Compile times for typical programs run on a Model 200 processor are on the order of one to two minutes.

All Series 200 COBOL compilers are modularly expandable and self-adapting to memories larger than the minimum. They accept batched source programs and will operate in a batch-compile, load-and-go mode.

The Series 200 COBOL compilers possess several significant operating features:

1. Maintenance facilities for source-language files.
2. An object-time, data distribution system plus dynamic and static dumping facilities to expedite program testing.
3. Dynamic reassignment of read/write channels at object time.

COBOL PROGRAMMING FORM

PROGRAMMER _____ FOR _____ PAGE _____ OF _____

PROGRAM _____ DATE _____ IDENT

```
IDENTIFICATION DIVISION.
PROGRAM-ID. UPDATE.
DATE-WRITTEN. FEBRUARY 10, 1965.
DATE-COMPILED. FEBRUARY 11, 1965.
AUTHOR. JOHN PARNELL.
INSTALLATION. JONES DEPARTMENT STORE.
SECURITY. CONFIDENTIAL TO COMPANY.
REMARKS. THIS PROGRAM READS PURCHASE RECORDS FROM A MAGNETIC
    TAPE FILE, UPDATES AND EDITS INFORMATION IN EACH RECORD, AND
    PRODUCES A TOTAL-RECORDS MAGNETIC TAPE FILE; ERROR PRINTOUTS
    ARE PROVIDED WHERE NECESSARY.

ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. MODEL-200
OBJECT-COMPUTER. MODEL-200; MEMORY SIZE 16384 CHARACTERS.
    6, TAPE-UNITS, 1 READER-PUNCH, 1 PRINTER.
SPECIAL-NAMES. CONSOLE-TYPEWRITER IS ERROR-PRINTER .
INPUT-OUTPUT SECTION.
FILE-CONTROL. SELECT PURCHASE-FILE, ASSIGN TO TAPE-UNIT AA, TAPE-UNIT
    AB, SELECT TOTAL-FILE, ASSIGN TO TAPE-UNIT AC, TAPE-UNIT AD.
I-O-CONTROL. APPLY TRAILING-COUNT ON PURCHASE-FILE, TOTAL-
    FILE.

DATA DIVISION.
FILE SECTION.
FD PURCHASE-FILE; BLOCK CONTAINS 50 RECORDS; LABEL RECORDS
    ARE STANDARD; VALUE OF IDENTIFICATION IS "PURCHASE"; DATA
    RECORD IS PURCHASE-RECORD.
01 PURCHASE-RECORD.
    02 LOCATION NUMBER; PICTURE IS 99999.
    02 ORDER NUMBER; PICTURE IS 9999.
    02 STOCK-NUMBER; PICTURE IS 99999V99.
    02 UNITS-ON-HAND; PICTURE IS 999.
    02 UNIT-PRICE; PICTURE IS V99.
    02 UNIT-CODE PICTURE IS XX.
WORKING-STORAGE SECTION.
77 ERROR-INDICATOR-1 PICTURE IS S9, VALUE IS ZERO.
01 LABEL-RECORDS.
    02 DATE, OCCURS 5 TIMES.
    03 MONTH PICTURE IS 99.
    03 YEAR PICTURE IS 99.

PROCEDURE DIVISION.
BEGIN SECTION.
OPEN-FILES. OPEN INPUT PURCHASE-FILE; OUTPUT TOTAL-FILE.
COMPUTING SECTION.
READ-LOOP. READ PURCHASE-FILE; AT END GO TO END-PROCESSING.
    IF STOCK-NUMBER IS NOT NUMERIC GO TO BAD-STOCK-NUMBER.
COMPUTE-TOTAL-PRICE. MULTIPLY UNITS-ON-HAND BY UNIT-PRICE
    GIVING TOTAL-PRICE; ON SIZE ERROR GO TO EXCEEDS-ROUTINE.
    MOVE TOTAL-PRICE TO EDITED-PRICE.
TRANSFER-DATA. MOVE PURCHASE-RECORD TO TOTAL-RECORD.
ERROR-SWITCH. GO TO PRODUCE-OUTPUT.
PRODUCE-OUTPUT. WRITE TOTAL-RECORD. GO TO READ-LOOP.
ERROR-1. SECTION.
BAD-STOCK-NUMBER. ALTER ERROR-SWITCH TO PROCEED TO
    MARK-STOCK-NUMBER. GO TO COMPUTE-TOTAL-PRICE.
```

SERIES 200 FORTRAN COMPILER SYSTEM

The Series 200 Fortran Compiler System consists of two basic elements: a source language (Fortran IV) whose structure closely resembles the language of mathematics, and compilers which translate the statements and formulas written in the source language into Series 200 machine-language programs.

FORTRAN LANGUAGE

Programs are written directly as algebraic expressions and arithmetic statements. Additional statements, such as transfer, decision, indexing, and input/output statements, control the processing of the algebraic expressions and arithmetic statements. The smallest compiler version translates a major portion of Fortran IV, including logical statements and testing, data initialization, labelled COMMON areas, and type statement declarations. Even more sophisticated language elements are accepted by the larger versions.

THE FORTRAN COMPILERS

All Series 200 Fortran compilers are designed for rapid compilation and optimum efficiency of object coding. Translated programs can be combined with other previously compiled and assembled programs and immediately executed to obtain fast results. The smallest version requires as few as 16,384 characters of memory, plus four magnetic tape units, a card reader, card punch, and printer. Larger versions, which exploit the added features and instructions of the scientific hardware option, can process programs utilizing very large core storage capacities, up to 524,000 characters. Special features of the Fortran compilers include object code optimization and a highly sophisticated diagnostic system.

Liberator Conversion Programs

The Liberator concept, an integral design feature of every Series 200 processor, permits users of a number of older systems to enjoy the benefits of these processors without the cost and effort of reprogramming. This concept has many facets, including compatibility of programming languages, data formats, and peripheral input/output devices.

Because Honeywell has realized the compatibility dimension in hardware design, programs written for the IBM 1401, 1410, 1440, 1460, and 7010 systems need only be converted once in order to run on processors 120/200/1200/2200/4200 without the aid of inefficient simulators and usually in a fraction of their original execution time. This conversion can be achieved using any one of a series of available programs in the following major categories:

1. Easytran, which converts programs at the symbolic level, operating either on a Honeywell system or on a 1400-series system.
2. Bridge, which converts programs at the machine level, operating on Honeywell equipment.

EASYTRAN – SYMBOLIC LANGUAGE CONVERSION

Easytran is a conversion program which accepts as input symbolic source programs written in SPS and/or Autocoder language. The source program is completely analyzed and then translated statement by statement. During this process, most symbolic statements are replaced on a one-for-one basis with equivalent Easycoder statements. Those statements which have no direct Easycoder equivalent are replaced either with in-line macrocoding or with calls to Easytran subroutines which perform the desired functions; those whose functions are automatically handled by Series 200 hardware are deleted.

The principal output of Easytran is a symbolic program in the proper form for input to the Easycoder Assembly System. Additional outputs include a parallel listing of the Autocoder and Easycoder symbolic programs, a cross-reference listing of all labels (tags) used in the input program, and an English-language diagnostic listing which points out any areas where programmer hand-tailoring may be required.

BRIDGE – MACHINE LANGUAGE CONVERSION

Translation of 1401-series programs at the machine-code level is performed by the program Bridge, operating on Honeywell equipment. The principal output of Bridge is an operable object program in either single-card or condensed-card load format, or in the form of card images on magnetic tape. Translation also produces a side-by-side listing of the original and the converted programs. Flags in the listing signal any questionable entries the conversion of which should be checked by the user. Those instructions which cannot be converted on a one-for-one basis are replaced by calls to the object time package, a group of subroutines which are entered as required at execution time. The object time package improves the efficiency of the converted program by automatically overlapping input/output operations to take advantage of Honeywell peripheral simultaneity.

The memory mapping of the original program is retained by Bridge. This feature facilitates any machine-language changes that may be required in the converted program and enhances the usefulness of the original program documentation.

Generalized Data Manipulation Programs

In addition to program preparation aids, Honeywell also provides an extensive array of software to relieve the user of the tedious and complex task of programming such common jobs as sorting, input/output operations, and report generation. Many of these generalized programs are offered in two or more versions, each specifically tailored to take fullest advantage of a particular range of equipment configurations.

MAGNETIC TAPE INPUT/OUTPUT PACKAGE – TIPTOP

Implemented to handle both Honeywell and competitive data conventions, the tape input/output control package provides object code, as directed by macro instructions, to perform the following functions: reading and writing tape records, blocking and unblocking of items within records, opening and closing files, and detection and automatic correction of errors (see accompanying illustration). Both fixed and variable-length records and handled by TIPTOP.

PAPER TAPE INPUT PACKAGE – TOPPER

The input package for paper tape systems – TOPPER – can handle 5-, 6-, 7-, or 8-level paper tapes. TOPPER performs all input functions stated above for TIPTOP with the added capability for data editing. Exits are also provided to a user-supplied code conversion table.

TAPE SORT AND COLLATE PROGRAMS

These are generalized programs which adapt themselves, as directed by programmer-specified parameters, to operate in a particular hardware configuration and to sort and collate data in a particular format. All of the sort programs take advantage of the industry-acclaimed Polyphase sorting technique developed by Honeywell. Tailored for use in small systems is a sort program which requires only three tape units and receives its specialization parameters by card or paper tape. This program sorts fixed-length records on up to seven keys and provides facilities for own-coding.

More advanced sort programs are furnished for use in larger systems. These programs provide the added advantages of read-backward Polyphase sorting and the ability to handle variable-length records. A sort program can be automatically linked to a series of related operations by coding the preceding program to establish the sort parameter values before it terminates. These programs are also self-adapting to memories larger than the minimum.

For use in conjunction with each of the sort programs, when needed, a collate program is available. The collate program accepts two or more sorted files and combines them to produce a single composite file in proper sequence.

SCIENTIFIC SUBROUTINES

Series 200 users have available to them an extensive library of scientifically oriented subroutines which complement the capabilities of the Fortran compiler. This library includes the usual basic Fortran routines, such as square root, exponential, logarithmic, and trigonometric functions, as well as matrix, statistical, and other more comprehensive routines. All of the subroutines in this library can be used with or without the scientific hardware option.

TABULATING EQUIPMENT SIMULATION – TABSIM

A tabulating equipment simulator, TABSIM prepares printed reports from input consisting of a deck of punched cards (or a tape file of card images). The input deck contains control cards and data on detail cards. In general terms, the output report represents the data on the detail cards, edited and processed arithmetically.

REPORT GENERATION

Honeywell furnishes a program for automatic creation of reports according to user specifications. To use the report generator, the programmer merely prepares a set of parameters defining control fields and report lines. These parameters are used as input to the report generator, which produces a symbolic program. The assembled version of this program accepts raw data from cards or tape, edits it, and generates the desired reports.

SOFTWARE FOR RANDOM ACCESS DEVICES

Honeywell offers a comprehensive array of programming and operating aids for the Series 200 drum user, including a Drum Loader/Monitor, a program for updating program files on a drum, a special drum sort, input/output routines, and utility routines.

RANDOM ACCESS SORT

A separate program is furnished to sort data stored on magnetic drums. This program obtains the item keys of data stored on a drum, sorts the keys, and then stores on the drum a table containing the keys and the addresses of the corresponding file items. Items may be brought in from the drum in the order of the sorted keys by using the Easycoder macro instruction FETCH.

RANDOM ACCESS I/O PACKAGE – DIPDOP

Direct, serial, and random processing of drum files are provided by this control package. Easycoder macro instructions are available to direct the performance of the following drum input/output functions:
Direct-Address Processing – Reading or writing of data from a sector whose address is given.
Serial Processing – Reading or writing of the item following the one currently being processed.
Random Processing – Transfer of an item between core memory and a drum location whose address is determined by mathematical transformation of the item's key.

The drum input/output package processes either fixed or variable-length items and blocks and unblocks items within records. To further assist the user, it also affords facilities for detection and automatic correction of errors.

RANDOM ACCESS FILE UTILITY ROUTINES

Honeywell has designed a "package" or generalized utility routines for use at drum installations. The jobs performed by these routines include the following:

Examining the contents of a drum file.

Transferring a file between a drum and punched cards or magnetic tape (the transfer may be in either direction).

Making corrections to a file stored on a drum.

The separate routines which perform these functions may be assembled with a control routine to form an independent system called DIAL (Drum Interrogation, Alteration, and Loading); or individual routines may be assembled directly into an object program. In particular, Easycoder users may obtain specified DIAL functions by use of macro instructions such as LOCATE, UNLOAD, RESTORE, EDIT, CORRECT, COMPARE, and CLEAR.

Operating System — PLUS

The PLUS Operating System is the central integrating element for all programs running in medium- and large-scale Series 200 installations. It enables object programs generated by the program-preparation aids to be combined with one another, and with Honeywell-supplied routines, to produce run tapes, drum files, ordinary card decks containing all user-required functions. The key to this flexibility is the previously noted compatibility of object programs produced by the Series 200 software.

The PLUS System comprises a series of control and utility routines. These programs and routines can be combined to meet the specific requirements of each user while providing for the systematic exploitation of the equipment capabilities.

CONTROL PROGRAMS

Control programs form the core of the PLUS Operating System. They provide for the automatic processing of sequential programs during checkout or production runs. Under directions from the operator or from a running program, the control programs handle such functions as loading, segmentation control, and library search. In addition, they also control space and time sharing among several jobs running concurrently. They handle all communication between the operator and the running programs and provide for the effective coordination of the system operations from a single location.

JOB-ORIENTED OPERATION

In the loading operation for a medium-scale system, for example, programs may be called singly or by "job." That is, an instruction may be given to execute a program with a given name, or to perform an entire job consisting of several programs. In effect, the specification by the operator of a job to be done makes certain programs on tape (viz., those constituting the specified job) "visible" to the Loader.

UTILITY ROUTINES

Honeywell provides a growing library of utility routines to extend the capabilities of the standard operating aids provided for Series 200 users. Descriptions of some of these routines follow.

THE UPDATE AND SELECT PROGRAM

This program accepts as input a transaction program tape, an old program master file, and a deck of director and correction cards. The transaction and master file tapes can contain machine-language programs produced by the Easycoder Assembly System and the COBOL and FORTRAN compilers, as well as Honeywell software programs. The Update and Select Program can perform the following functions under control of parameters specified on the input director cards:

Program Master File Update — Programs from the old master file are deleted, corrected, or left unchanged, and new programs are added from the transaction tape. Updating can include changing of program job assignments. A new program master file tape is produced.

Program Selection — A run tape which contains selected programs from the new program master file is produced for use in checkout or production operations.

Directory Listing — A directory is printed which includes a separate listing of programs in the new program master file and on the production run tape.

DYNAMIC TAPE AND MEMORY DUMP ROUTINES

These routines, particularly valuable when debugging programs, provide automatic, "on-the-fly" recording of the contents of memory and of magnetic tape files. Calls to these routines may be programmed in advance by use of macro instructions or initiated at object time by the operator.

PATCH ROUTINE

The use of Patch enables octal changes (or corrections) to be made to specified programs at object program execution time. The changes occur in core memory only; they do not affect the object program stored on the run tape.

THOR — TAPE HANDLING OPTION ROUTINE

THOR is a set of general tape-handling and correction routines for use with the Series 200. Under the direction of parameters supplied by the operator from punched cards, paper tape, or the control panel,

THOR can perform nine separate functions. These include:

Compare and Print – A specified number of records from each of two tapes are compared, record for record, with all non-identical records printed in either alphanumeric or octal mode.

Locate – A tape is searched for the first occurrence of specified information.

Correct and Copy – A designated record is copied from one tape to another with specified corrections.

In manipulating magnetic tapes, either a record-counting method or a file identification method may be employed. The file option provides added convenience in that it permits operation over an entire tape or file, rather than over a specified number of records.

SCOPE – SYSTEM FOR COORDINATION OF PERIPHERAL EQUIPMENT

SCOPE consists of a group of independent coroutines which control the automatic transfer of data between pairs of peripheral devices such as magnetic tape, punched card equipment, paper tape equipment, and printers.

A variety of data conversion operations can be performed by SCOPE. The degree of simultaneity achieved in performing combinations of these conversion operations depends upon the Series 200 processor employed.

"Own-coding" routines (prepared in Easycoder assembly language) may be included in a SCOPE deck to perform such functions as editing and unblocking of records. For example, if it is desired to edit records coming from or going to various terminal devices, own-coding can be inserted into each of the terminal device coroutines at specified points.

Series 200 Character Codes

Key Punch	Card Code	Central Processor Code	Octal	High Speed Printer	Key Punch	Card Code	Central Processor Code	Octal	High Speed Printer
0	0	000000	00	0		X, 0 or X[1]	100000	40	—
1	1	000001	01	1	J	X, 1	100001	41	J
2	2	000010	02	2	K	X, 2	100010	42	K
3	3	000011	03	3	L	X, 3	100011	43	L
4	4	000100	04	4	M	X, 4	100100	44	M
5	5	000101	05	5	N	X, 5	100101	45	N
6	6	000110	06	6	O	X, 6	100110	46	O
7	7	000111	07	7	P	X, 7	100111	47	P
8	8	001000	10	8	Q	X, 8	101000	50	Q
9	9	001001	11	9	R	X, 9	101001	51	R
	8, 2	001010	12	'		X, 8, 2	101010	52	#
#	8, 3	001011	13	=	$	X, 8, 3	101011	53	$
@	8, 4	001100	14	:	*	X, 8, 4	101100	54	*
Space	Blank	001101	15	Blank		X, 8, 5	101101	55	"
	8, 6	001110	16	>		X, 8, 6	101110	56	≠[2]
	8, 7	001111	17	&		X or X, 0[1]	101111	57	¦[2]
&	R, 0 or R[1]	010000	20	+		8, 5	110000	60	<[2]
A	R, 1	010001	21	A	/	0, 1	110001	61	/
B	R, 2	010010	22	B	S	0, 2	110010	62	S
C	R, 3	010011	23	C	T	0, 3	110011	63	T
D	R, 4	010100	24	D	U	0, 4	110100	64	U
E	R, 5	010101	25	E	V	0, 5	110101	65	V
F	R, 6	010110	26	F	W	0, 6	110110	66	W
G	R, 7	010111	27	G	X	0, 7	110111	67	X
H	R, 8	011000	30	H	Y	0, 8	111000	70	Y
I	R, 9	011001	31	I	Z	0, 9	111001	71	Z
	R, 8, 2	011010	32	;		0, 8, 2	111010	72	@
•	R, 8, 3	011011	33	.	'	0, 8, 3	111011	73	'
□	R, 8, 4	011100	34	)	%	0, 8, 4	111100	74	(
	R, 8, 5	011101	35	%		0, 8, 5	111101	75	C_R
	R, 8, 6	011110	36	□		0, 8, 6	111110	76	□
	R, or R, 0[1]	011111	37	?		0, 8, 7	111111	77	¢

(1) Special code, designated by a card read or punch PCB instruction, which provides compatibility with Honeywell 400 and 800 systems.

(2) Symbol which will be printed by a printer which has a 63-character drum.

Honeywell

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