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IBM 1301, Models 1 and 2, Disk Storage and IBM 1302, Models 1 and 2, Disk Storage with IBM 1410 and 7010 Data Processing Systems

This manual provides information about IBM Disk Storage – the IBM 1301, Models 1 and 2, and the IBM 1302, Models 1 and 2 – as used with the IBM 1410 and 7010 Data Processing Systems. Use of this manual assumes a basic knowledge of the 1410 and 7010 Systems.

This manual, Form A22-6788, obsoletes Form A22-6670-2, *IBM 1301 Disk Storage with IBM 1410 and 7010 Systems*, and all earlier editions.

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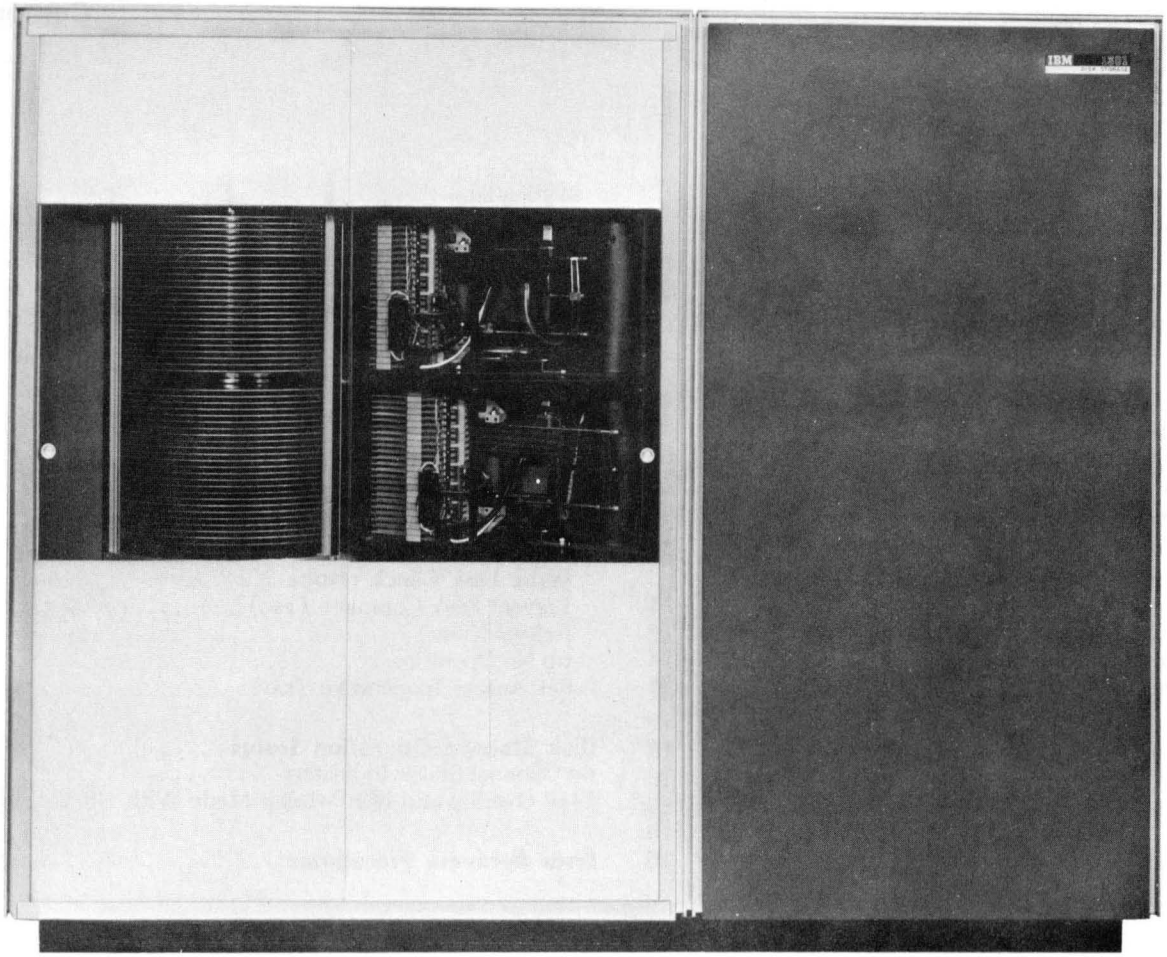


IBM 1301 Disk Storage

IBM 1301 and 1302 Disk Storage, Models 1 and 2, in IBM 1410 and 7010 Systems

Advanced principles of disk storage are made available for use with IBM 1410 and 7010 Data Processing Systems by the IBM 1301, Models 1 and 2, and the IBM 1302, Models 1 and 2, Disk Storage units. These units are similar in appearance and differ primarily in data capacity and data transmission rate. The following table shows some comparisons of each disk storage unit as used in the 1410 and 7010 systems.

	1301-1	1301-2	1301-1	1301-2
Number of Disk Modules per Unit	1	2	1	2
Number of Cylinders per Unit	250	500	500	1,000
Number of Addressable Data Tracks per Unit	10,000	20,000	20,000	40,000
Number of Access Mechanisms per Module	1	1	2	2
Data Track Record Capacity				
6-bit mode (move)	2,800	2,800	5,850	5,850
8-bit mode (load)	2,165	2,165	4,533	4,533
Data Capacity per Unit				
6-bit characters (move)	28,000,000	56,000,000	117,000,000	234,000,000
8-bit characters (load)	21,650,000	43,300,000	90,660,000	181,320,000
Maximum Characters per Cylinder				
6-bit characters (move)	112,000	112,000	234,000	234,000
8-bit characters (load)	86,600	86,600	181,320	181,320
Character Transfer Rate (per Second)				
6-bit characters (move)	90,100	90,100	184,000	184,000
8-bit characters (load)	70,100	70,100	143,000	143,000
Access Mechanism Motion Times (Milliseconds)	50/120/180	50/120/180	50/120/180	50/120/180
Average Rotational Delay (Milliseconds)	17	17	17	17
Scan Time per Cylinder (Seconds)	1.33	1.33	1.33	1.33

Applications of Disk Storage

Disk storage provides IBM 1410 and 7010 Data Processing Systems with the unique ability to either sequentially or randomly record and retrieve externally stored data. It permits the immediate access to specific areas of information without the need to sequentially examine all data recorded in the same file. The fast speed of access to data storage locations provided by random access data processing enables the user to maintain up-to-the-minute files and to make frequent direct reference to and retrieval of the stored data, regardless of the time of record insertion or the physical location of the disk-stored data.

The extensive data storage capacity, swift access to recorded data, high data transmission rates to and from the computer, and broad flexibility of file maintenance and organization provided by disk storage devices introduce new and advanced data processing methods and foster simplification of procedures.

For example, used in conjunction with a magnetic tape system, random access storage can:

Reduce the Number of Tape Reels and Setup Time in a given processing operation.

Provide On-line Storage Facilities for both programs and data, reducing the numbers of runs and setups required.

Facilitate Data Sequencing Requirements because larger tape files can be loaded into disk storage and referred to randomly; this results in substantial reductions in the need for extensive tape sorting runs.

Disk storage expands a system's "working storage" capability, capacity, and accessibility. Each disk cylinder can be used as the operating substitute of a reel of tape. With as many as 500 cylinders available per module, enormous data file availability and capacity are provided, along with swift data access times, and without any tape reel mounting, rewinding, backspacing, or sequential searching activities.

High data capacity, swift access, flexibility of data organization, and processing modes available with disk storage are provided by the design of the IBM 1301 and 1302 Disk Storage. The recording medium of disk storage consists of thin, magnetically coated metal disks. Data and control information are recorded as magnetized spots on concentric tracks on the surfaces of the disks (Figure 1). Each data recording surface of the 1301, Models 1 and 2, contains 250 data tracks; each surface of the 1302, Models 1 and 2, contains 500 data tracks.

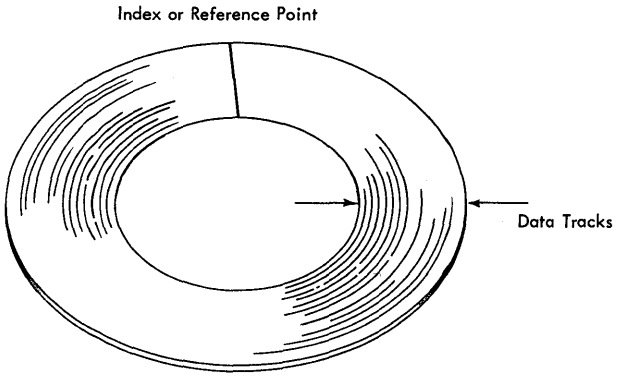


Figure 1. Magnetically Coated Disk

In the 1301 and 1302, the magnetic disks are mounted on a vertical shaft. The shaft rotates, spinning the disks at about 1,790 revolutions per minute. An access mechanism positions read-write heads (Figure 2) close to the spinning disks to make the tracks accessible for reading or writing. The 1301-1 and 1301-2 use one access mechanism; the 1302-1 and 1302-2 use two access mechanisms.

A stack of 25 magnetic disks (50 disk surfaces) with the associated access mechanism(s) make up a disk storage module. The 1301-1 and the 1302-1 are single module units; the 1301-2 and the 1302-2 are double module units.

Of the 25 disks in a stack, 20 disks (40 disk surfaces) are used to store data. The remaining five disks (ten surfaces) are used for machine control and as alternate surfaces as follows: six surfaces are used as alternate surfaces, one surface is used to provide format tracks, two surfaces (the top disk surface and the bottom disk surface) are not used for data processing operations. One surface opposite the format surface is a spare surface and is not addressable.

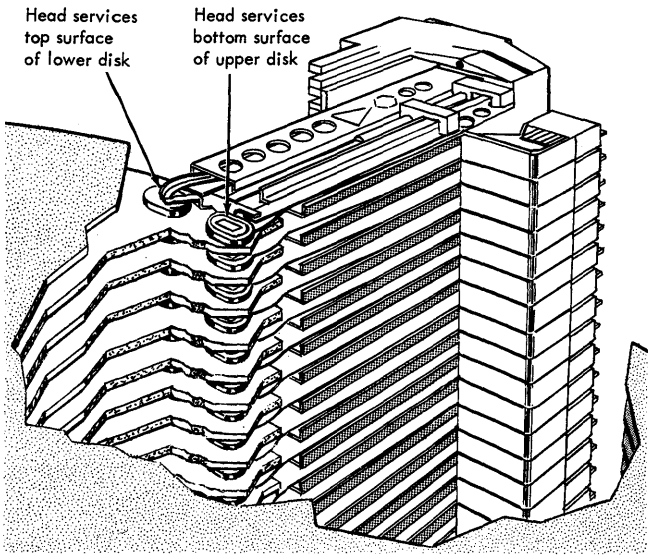


Figure 2. Head Arrangement

The six alternate surfaces are provided so that each data bit can be stored in a magnetically perfect medium. If a disk defect is encountered, the entire track in which the defect occurs is disabled and an alternate surface is specified. This alternate surface is given the address of the disabled track.

The format disk surface and its usage in providing flexibility of record length and format are discussed later.

Access Mechanisms

Information is written on or read from the disk surfaces by magnetic read-write heads mounted on a comb-like access mechanism. The access mechanism has 40 data read-write heads, one format head, and from two to six alternate surface heads. One additional head is used for maintenance purposes.

The access mechanism is hydraulically driven to simultaneously move all heads horizontally to any area of the 250 data cylinders of the access group. After the horizontal movement is completed to the correct track location, one of the data head elements, which consists of both read and write heads, is electronically selected to perform the reading or writing operation on a particular track in the cylinder. The read-write head associated with the format track is moved laterally in unison with the data read-write heads.

Disk Cylinders

In each module of disk storage, corresponding disk tracks of each surface are physically located one above the other. These tracks form a cylinder of 40 data tracks, thus permitting 40 tracks of information to be immediately available. With this vertical alignment of tracks, the mechanical accessing of data by the access mechanism is eliminated, with only electronic switching from one read-write head to another being required. The use of cylinders of data in 1301, Models 1 and 2, and 1302, Models 1 and 2, operations differs from previous types of disk operations as shown in Figure 3.

Data Track, Cylinder, and Access Numbering

The data tracks of the cylinders are numbered sequentially from bottom to top and from the outermost cylinder to the innermost cylinder of each access group.

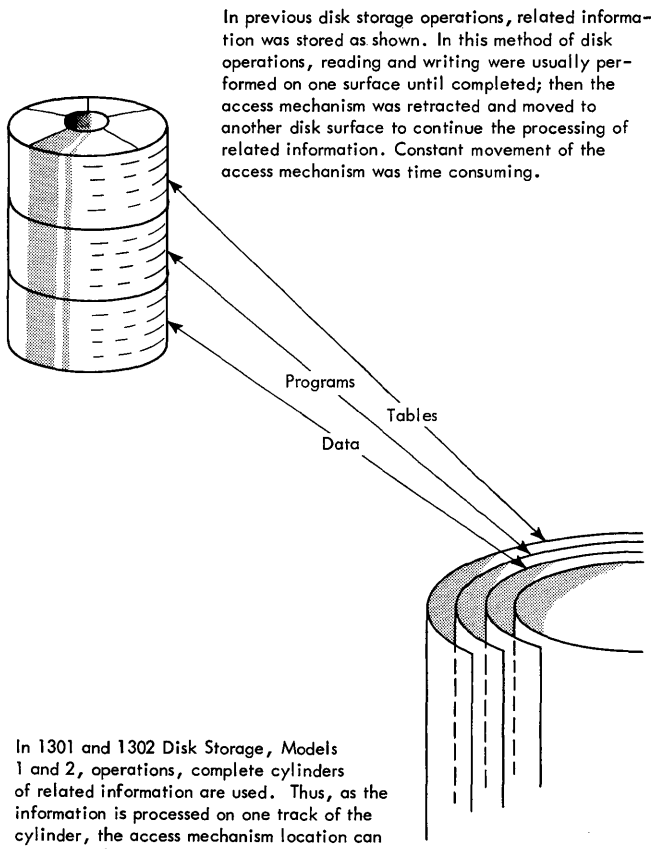


Figure 3. Disk Storage Cylinder Operation

For example, the 1301-1 and 1301-2 Disk Storage, with 250 cylinders in a single access group, contain track numbers 0000 to 9999. The data tracks are numbered sequentially, beginning at the outermost cylinder of the lowest data disk surface (track number 0000) and continuing up through this outermost cylinder to track 0039. Numbering continues with the lowest data track of the adjacent inner cylinder as track number 0040 and numbering up the cylinder to track number 0079. Continuing through each of the cylinders of the single access group in like manner, the last track number, 9999, is the top track of the innermost cylinder.

In the 1302, which contains two access groups of 250 cylinders per group, the same track and cylinder numbering system is used. The second access group of tracks and cylinders is also numbered from 0000 to 9999. By the combination of access mechanism number and track number, each of the thousands of tracks on a module can be individually addressed.

The single access mechanism on the 1301-1 and 1301-2 is always addressed as Access 0. The two access mechanisms of the 1302-1 and 1302-2 are addressed as Access 0 for the outer 250 cylinders and Access 1 for the inner 250 cylinders

The two access mechanisms on the 1302 operate independently and may be in motion simultaneously. Each mechanism is restricted to motion within its own zone of operation; accordingly, one access mechanism cannot read a track written by the other access mechanism.

The cylinder arrangement of tracks permits the optional feature *cylinder mode of operation* to read or write a cylinder (or part of a cylinder) of tracks with a single control instruction, further reducing processing time beyond the reduction in time due to the elimination of *access motion* time.

Module Numbering

Five 1301-1302 units (Models 1 or 2) may be attached to a 1410 or 7010 Data Processing System. If all five were Model 2 units, consisting of two modules each, ten modules would be available. The module number for each disk storage unit is determined by the fixed assignment of cable connectors between the IBM 7631 File Control unit and the attached disk storage unit.

7631 Cable Connector	Disk Module
First	0 and 1
Second	2 and 3
Third	4 and 5
Fourth	6 and 7
Fifth	8 and 9

The lower module of a disk storage unit is always the even numbered module; the upper module is always the odd numbered module.

Data Track Addressing

To address one data track of the maximum possible total of 200,000 (five 1302 Model 2's) it is necessary to specify the following:

Module	0-9	
Access	0-1	
Track Number	0000-9999	(Internal circuitry will select the specific read-write head involved.)

Data Access Times

IBM 1301, Models 1 and 2, and 1302, Models 1 and 2, Disk Storage are designed with three interrelated modes of data access. Two of these modes are mechanical in operation, requiring time for performance. The third is electronic and is generally considered as nonexistent in time performance requirements (zero time).

Figure 4 shows a simplified, single-module disk storage with one comb-like access mechanism. Access to one specific track on a given recording surface is accomplished by the lateral movement of the whole access mechanism from a current track location. The time required for this movement is called access motion time (T_A in Figure 4) and is related to the lateral distance the arm moves. Figure 5 shows the time requirements for access motion time for the IBM 1301, Models 1 and 2, Disk Storage, and Figure 6 shows the access motion time for IBM 1302, Models 1 and 2, Disk Storage.

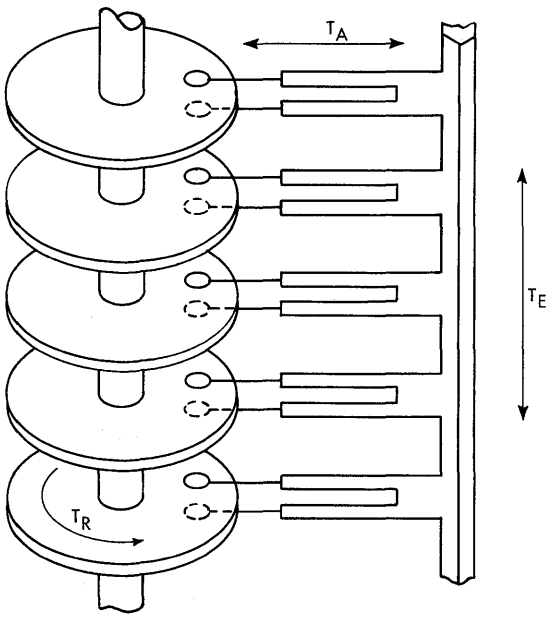


Figure 4. Disk Access Time Requirements

In addition to access motion time, an additional timing factor known as rotational delay time (T_R in Figure 4) is encountered. Rotational delay time is the time required for the disk to position the desired record at the selected read-write head. Maximum rotational delay time is 34 milliseconds; average rotational delay time is 17 milliseconds.

The selection of the proper read-write head is performed simultaneously with access motion time. The read-write head selection time (T_E in Figure 4) consists solely of electronic switching and is negligible.

Total data access time includes the summation of access motion time and rotational delay time. Average rotational delay time (17 milliseconds) is generally used in this calculation.

Data Track Organization

The basic recording area of the disk storage unit is the data track; however, the entire recording area of a track cannot be used exclusively for data storage. Other information must be recorded on the track before the track is used as a record storage area. On subsequent read or write operations, this information is used to identify the track and each of the record areas used for the storage of data on that track.

A data track and the data to be written or read from a track are identified by a home address 1 (HA1), a home address 2 (HA2), and as many record addresses (RA) as there are record areas to be established on the data track (Figure 7).

HOME ADDRESS 1 (TRACK NUMBER)

Home address 1 (HA1) is the first information on each data track and follows the index point for that track. It is a four-digit number and is the actual physical address (0000-9999) of a track within one access arm area of a module. The track number is prerecorded (eight-bit unpacked format) in each data track and cannot be written by the user.

HOME ADDRESS 2 (HOME ADDRESS IDENTIFIER)

Home address 2 (HA2), which follows HA1 in each data track, is the home address indentifier. It consists of two or more characters, written by the user, which may be numeric, alphabetic, or special characters, in either six-bit or eight-bit unpacked mode. Although the home address identifier can be greater than two characters long, only the first two characters are verified in machine operations.

Use of more than two HA2 characters is primarily related to shared disk operations involving IBM 7070, 7074, 7040, 7044, 7090, 7094 and 7094 II systems. Sub-

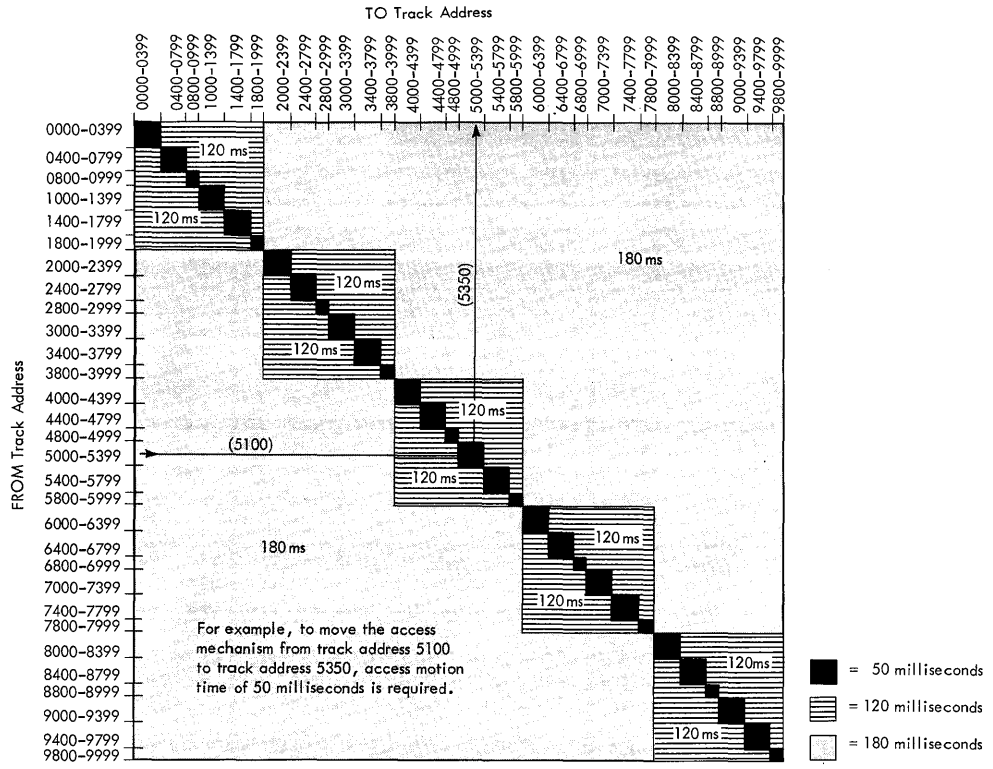


Figure 5. 1301 Disk Storage Access Time

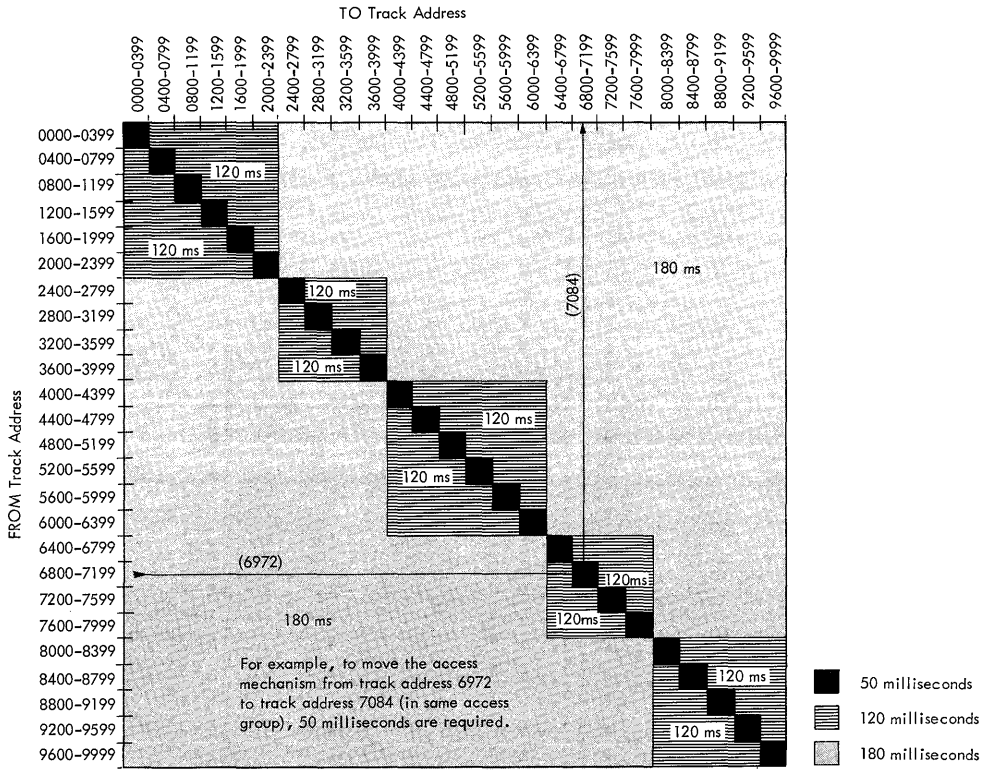


Figure 6. 1302 Disk Storage Access Time

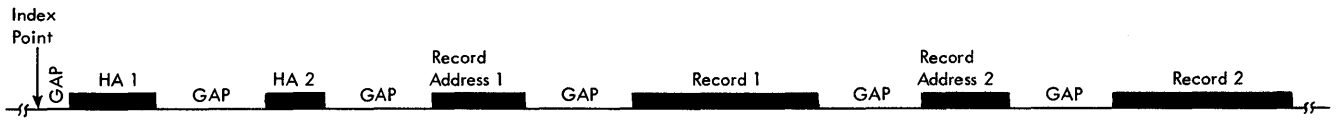


Figure 7. Disk Track Address and Data Arrangement

sequent references to HA2 will consider, in general, only the first two characters. HA2 must be written on the data track by the user before actual writing or reading operations for that track. From an addressing or reference viewpoint, the combined HA1 and HA2 become the actual address of a data track in a module; HA2 simply provides a method by which the user is able to further define the address of each data track. Identification of a track in subsequent reading or writing operations must indicate both the prerecorded HA1 address and the HA2 address established by the user.

In addition to its use as the home address identifier, the HA2 address can serve many useful purposes. For example, HA2, incorporated as part of the track address, can be used as a coded file protection device. That is, in using this file protection scheme, a HA1 address without a proper HA2 address will not allow a data track to be referenced.

RECORD ADDRESS

The data track storage area following the HA1 and HA2 addresses is one long continuous area for the storage of data. The organization of this space, the number of records to be stored, the number of characters in each record, and the identification of each record area are determined by the user. The operations necessary to accomplish layout (format) of data must be performed before the data track can be used for reading or writing. See "Format Track."

Each record area established for a data track is preceded by a record address (RA) (Figure 7). The record address consists of six or more characters, which may be numeric, alphabetic, or special characters. They are assigned and written by the user to fit any convenient addressing scheme. A record address need not have any relationship to the home address of the track where it is written. When the record address (six characters) is verified, only the numeric portion (four low-order bits) of the first four characters is verified. The low-order six bits of the last two characters are verified. (In load mode, the WM bit is not verified.) Only six record address characters are verified. Because of the ability of the 1301, Models 1 and 2, and 1302, Models 1 and 2, to store different length records, highly efficient use of disk storage and flexibility of data organization are provided.

DATA RECORDS

Records on a data track can be of any length from a minimum of two characters for the 1301, Models 1 and 2, and nine for the 1302, Models 1 and 2, to the full length of the data track, less necessary character spaces for a home address, record address, and required gaps.

DATA TRACK GAPS

The gaps following information areas on the data track are required for machine control and code checking purposes. As each information area of the disk is being written (HA1, HA2, record addresses, and records), machine check information is automatically generated and placed in the gap following the area being written. As each of these information areas is read in subsequent operations, new check characters are automatically generated and compared bit for bit with the check characters previously placed in the gap when the information area was written. If they do not compare, an error is indicated.

Note: The index point (Figure 7) is used as a machine reference point on the track; that is, it indicates both the beginning and the end of the track. The index is used by the 7631 in file-control/disk-storage synchronizing functions. The index is not normally used in programming operations.

DATA RECORDING

Information is recorded on a disk track serially by character and serially by bit. A space bit(s) separates characters within a record. Data are recorded in one of two modes, move (M) or load (L) mode. The move mode requires seven bit positions to record a character (s, B, A, 8, 4, 2, 1). Because only six bits are active in the make-up of the character, the move mode is commonly referred to as the six-bit mode.

The load mode requires nine bit positions to record a character (s, WM, b, B, A, 8, 4, 2, 1). In this mode, an additional blank bit (b) and word-mark bit are used. Although only seven bits are active parts of the character, the load mode is referred to as the eight-bit mode.

Information to be written on disk is transferred, character by character, from core storage to the 7631. An odd-bit parity check is performed on each character. A space bit is inserted, and the character is written on the disk. During disk reading, information is read

from disk, character by character. The space bit is removed, an odd parity is generated, and the character is sent to core storage.

DATA TRACK CAPACITY

Each data track on the 1301 Models 1 and 2, has a capacity of 2,840 six-bit or 2,205 eight-bit character positions for recording information. On the 1302, Models 1 and 2, the total track capacities are 5,902 six-bit and 4,585 eight-bit character positions. These figures have been adjusted to compensate for the character positions used in the prerecorded home address 1 (HA1) and the accompanying gaps for the home address. To determine the number of character positions available for storing records, the character positions required for HA2, record addresses, and additional required machine gaps must be considered.

The maximum number of data characters that can be recorded on a data track can be calculated:

1301 Models 1 and 2

Six-bit mode: 2,840 − HA2* − n (RA** + 32) = 2,800 maximum

Eight-bit mode: 2,205 − HA2* − n (RA** + 32) = 2,165 maximum

1302 Models 1 and 2

Six-bit mode: 5,902 − HA2* − n (RA** + 44) = 5,850 maximum

Eight-bit mode: 4,585 − HA2* − n (RA** + 44) = 4,533 maximum

where: n = number of records per track
*HA2 is minimum of two characters
**RA is minimum of six characters.

Note: Records must be at least two characters long for 1301, Models 1 and 2, and nine characters long for 1302, Models 1 and 2.

Table 1 shows the number of records per track for different record lengths and the number of character positions that can be used, as desired, by the program. To calculate what size record can be placed in the remainder of a track, assuming that the same record address is to be used, subtract 32 for 1301, Models 1 and 2, or 44 for 1302, Models 1 and 2, from the remainder.

Format Track

The advanced characteristics of the 1301, Models 1 and 2, and 1302, Models 1 and 2, permit the user considerable flexibility in establishing how the disk storage space is to be allocated, organized, and addressed.

This flexibility of disk storage use makes possible a wide variety of storage formats to meet the needs of many different applications; it also requires that the user organize the disk storage in some particular format before its use as a data storage device. These activities can be likened to the wiring of a control panel for unit record machines, to the housekeeping preparations for a program, or to masking a storage area for future use. For clarity of understanding disk storage, it is important that the operations required for establishing the format track of disk storage should not be confused with the operations related to the use of disk storage.

	Six-Bit Mode				Eight-Bit Mode			
	1301 − 1, -2		1302 − 1, -2		1301 − 1, -2		1302 − 1, -2	
Number of Records/ Track	Record Size (In Characters)	Remainder	Record Size (In Characters)	Remainder	Record Size (In Characters)	Remainder	Record Size (In Characters)	Remainder
1	2,800	0	5,850	0	2,165	0	4,533	0
2	1,381	0	2,900	0	1,063	1	2,241	1
3	908	0	1,916	2	963	1	1,477	2
4	671	2	1,425	0	512	3	1,095	3
5	529	3	1,130	0	402	3	866	3
6	435	0	933	2	329	1	713	5
7	367	3	792	6	276	5	604	5
8	316	6	685	0	249	7	522	7
9	277	3	605	5	205	7	459	2
10	245	8	540	0	182	3	408	3
11	220	0	486	4	162	3	366	7
12	198	6	441	8	145	7	331	11
13	180	4	403	11	131	6	302	7
14	164	10	371	6	119	5	277	5
15	151	3	343	5	108	13	255	8
16	139	6	318	12	99	11	236	7
17	128	16	297	1	91	10	219	10
18	119	12	277	14	84	7	204	11
19	111	7	260	10	77	18	191	4
20	103	18	245	0	72	3	179	3

Table 1. Records per Track

Before any data can be written on or read from a data track within a cylinder, a format track for that cylinder must be written. The format tracks, one for each cylinder, are located on one of the additional disk surfaces not used for data.

FUNCTION OF THE FORMAT TRACK

The function of the format track is to control the use of the data tracks of a cylinder. Once a format track has been written, it establishes the location, character size, and mode of reading or writing that can take place in the home address area, the record address areas, the record areas, and certain gap areas. Data to be written on or read from each data track of a cylinder must conform to the format established by the format track for that cylinder.

The layout and writing of the format track is under the complete control of the user. Once written, however, the format for the cylinder of tracks remains fixed until the format track is rewritten.

To prevent unintentional changes to the information recorded on the format tracks, each disk module is provided with a two-position key lock switch. A format track can only be written upon when the switch is in a WRITE position. The switch is normally placed in a READ position.

FORMAT TRACK CONTROL CHARACTERS

The control characters used to write a format track must first be organized in core storage as a record (format control record). The write format track instruction transfers the core storage format control record to the 7631 File Control. It is converted to a special bit configuration, for machine control purposes, and is written on the addressed format track. Since the format track defines, in machine form, the control action previously defined in the core storage format control record, explanation of how the data tracks of a cylinder are defined will be made in terms of the core storage format control record.

Four different characters, BCD 1, 2, 3, and 4 are used to compose a format control record in core storage. The BCD characters 1 and 2 define data track areas that will be handling data in a six-bit mode. The BCD characters 3 and 4 define data track areas that will be handling data in an eight-bit mode.

Certain format track areas are for machine control and data checking purposes. These areas must be provided unconditionally in the core storage format control record.

Figure 8 shows a typical core storage layout of a format control record in both the six-bit and eight-bit mode.

FORMAT TRACK ARRANGEMENT

The core storage format control record is transmitted to the specified format track by appropriate programming. One format track is required for each cylinder of 40 data tracks. Figure 9 shows format track arrangement and field number information.

1301 Models 1 and 2, Format Track Core Storage Layout

	Gap	HA1	Gap 2	HA2	X Gap	RA1	Y Gap	Record 1	X Gap	RA n	Y Gap	Record N	Gap 3
6-Bit	444	333333333	433333333334	111111	222222222222	1111111111	2111111111112	111----111	222222222222	1111111111	2111111111112	111----111	2
8-Bit	444	333333333	433333333334	333333	444444444444	3333333333	433333333334	333----333	444444444444	3333333333	433333333334	333----333	4
Number of BCD Characters (1,2,3, or 4)	3	9	12	6 Min	12	10 Min	12	6 Min	12	10 Min	12	6 Min	1

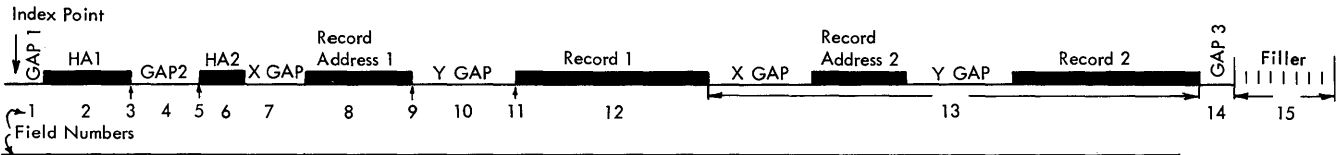
Min = Minimum

1302 Models 1 and 2, Format Track Core Storage Layout

	Gap 1	HA1	Gap 2	HA2	X Gap	RA1	Y Gap	Record 1	X Gap	RA n	Y Gap	Record N	Gap 3
6-Bit	444444	333333333333	433333333333334	11111111	222222222222222	1111111111111	21111111111112	11111111	222222222222222	1111111111111	21111111111112	11111111	2
8-Bit	444444	333333333333	433333333333334	33333333	444444444444444	3333333333333	433333333333334	33333333	444444444444444	3333333333333	433333333333334	33333333	4
Number of BCD Characters (1,2,3, or 4)	6	12	15	9 Min	15	13 Min	15	9 Min	15	13 Min	15	9 Min	1

Min = Minimum

Figure 8. Core Storage Format Control Record — n Records



Field Number	Number of Characters	Digit Used	Comments
1	6	4	Pre-HA1 timing gap.
2	12 (Track Identification Area, Always Written in 8-Bit Mode)	3	This field defines the 4-character physical home address (HA1). Seven characters are for machine requirements. One character is for customer engineering use.
3	1 (Track Identification Area, Always Written in 8-Bit Mode)	4	Pre-HA2 timing gap.
4	13 (Track Identification Area, Always Written in 8-Bit Mode)	3	Pre-HA2 timing gap.
5	1 (Track Identification Area, Always Written in 8-Bit Mode)	4	Pre-HA2 timing gap.
6	7 + HA2	1 or 3*	This field defines the home address identifier (HA2). Seven characters are for machine requirements.
7	15	2 or 4*	Pre-RA timing gap. X gap.
8	7 + RA	1 or 3*	This field defines the record address (RA). Seven characters are for machine requirements.
9	1 (Y Gap)	2 or 4*	Pre-record timing gap.
10	13 (Y Gap)	1 or 3*	Pre-record timing gap.
11	1 (Y Gap)	2 or 4*	Pre-record timing gap.
12	7 + L	1 or 3*	This field defines the record area. Seven characters are for machine requirements.
13	Fields 7 through 12 are repeated for each additional record area required.		
14	1	2 or 4*	This timing gap follows only the last record area on a track (Gap 3)
15	As needed	1 or 3*	This field is used when necessary with fixed word length computers to fill out the last format word in core storage. (7090-7094-7094 II-7040-7044-7074)
15**	Minimum of 11	-	This field is automatically generated by 7631 for machine requirements.

L = Number of characters in record area.
* Ones or twos are used for 6-bit mode, threes or fours are used for 8-bit mode.
** This field is never in core storage; it appears only on the format track.

Figure 9. Format Track Arrangement

IBM 7631 File Control

Systems Requirements

Ten disk modules (five disk storage units) may be attached to a computer through one or two properly adapted IBM 7631 File Controls. Existing file controls with a machine serial number of 12,000 or higher may be field-modified to control the IBM 1302, Models 1 and 2, Disk Storage. The 1301, Models 1 and 2, and 1302, Models 1 and 2, may be intermixed.

The IBM 7631 File Control is available in five models:

7631	For Single System Disk Storage Usage	For Shared Disk Storage Usage
Model 1	1410 7010	
Model 2	7070, 7074 7080 7090, 7094, 7094 II 7040, 7044	
Model 3		7070, 7074 7080, 7090, 7094, 7094 II 7040, 7044 with 1410 7010
Model 4		7070, 7074 7080, 7090, 7094, 7094 II 7040, 7044 with 7070, 7074 7080, 7090, 7094, 7094 II 7040, 7044
Model 5		1410 7010 with 1410 7010

File Control Unit Functions

The 7631 File Control performs a variety of functions in a disk storage processing operation; some of these are:

Decode and Execute Control Instructions transmitted from the computer main storage to the disk storage units by way of data channels.

Assemble and Disassemble Characters transmitted between the computer and disk storage.

Perform Data and Program Checking (parity checking, address verification, invalid operation codes, error detection, etc) of information received from, or going to the computer.

Provide Monitoring Services and Allied Programmed Interrogation between disk storage and the attached computer, by the use of communication signals to indicate various disk storage processing conditions. Some of these monitored conditions are: disk storage receipt of a transmitted control instruction, successful or unsuccessful execution of a disk operation, and indication of the status of the several disk modules. See "Disk Storage Operation Status."

Switches and Lights

The control panel on the right front cover of the 7631 is intended primarily for maintenance purposes. In addition to the exposed section, the control panel has a covered section intended for customer engineering use only. On the exposed section there are 122 indicator lights that reflect the status of the data and controls within the 7631. The customer engineering section contains 35 switches for simulation of data and machine control. Operator switches are available in a switch and light assembly above the indicator section of the control panel.

7631 SWITCHES AND LIGHTS

Power-On Switch: This switch sequentially turns on the AC and DC power to the 7631 and attached 1301 and 1302 units. Depression of this switch, with DC power off, will turn on DC power.

Power-On Light: This light turns on when AC power is on in the 7631, 1301 and 1302 units.

DC-On Light: This light turns on when DC power is developed in the 7631.

DC-Off Switch: This switch turns off DC power in the 7631, 1301 and 1302 units.

Power-Off Switch: This switch removes DC and AC power from the 7631 and all connected 1301 and 1302 units.

HAO Switch: This switch must be on to execute the home address operation.

Write Inhibit Switch: This switch, when on, allows the customer engineer to perform a write sequence of operations without the actual writing, thus not disturbing the customer's data.

Write Inhibit Light: This light is on when the write inhibit switch is on.

Test Mode Light: This light indicates that the 7631 and the attached disk storage units are not available for normal customer use.

Thermal Light: This light automatically turns on if the internal machine temperature exceeds 115 degrees Fahrenheit; DC power is automatically turned off. DC power can be restored with the power-on-switch after the machine temperature returns to normal operating limits.

Fuse Light: This light turns on and DC power is removed if any auxiliary AC or DC circuit breakers trip.

1301-1 AND -2 — 1302-1 AND -2 SWITCH

Write Format Track Switch: This key-operated lock switch has a read (RD) and a write (WR) position. To position the switch, a key must be inserted and turned. The switch must be set to the WR position to perform a write format track operation. The position of this switch has no effect on any operation except write format. Each disk module has its individual write format track switch.

Disk Storage Control Instruction Format

This section describes the instruction format of disk storage control instructions for the IBM 1301 and 1302 Disk Storage with the IBM 1410/7010 Data Processing System. Figure 10 shows the format of disk storage instructions.

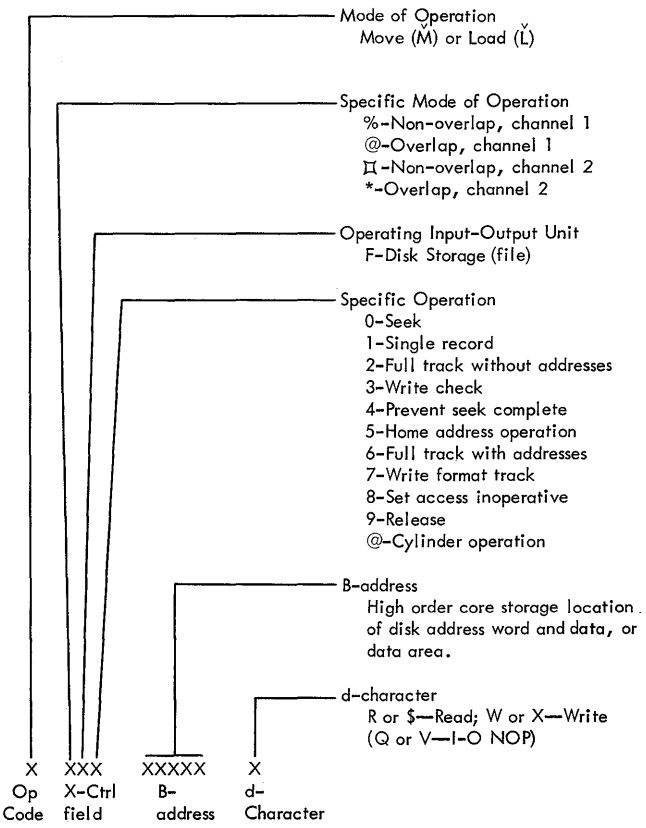


Figure 10. Disk Storage Operation Code Format

Instruction Parts

Operation Code

Disk storage operations are initiated by a move (M) or load (L) instruction. The move instruction specifies that data are to be read or written without word marks (six-bit mode). The load instruction specifies that data are to be read or written with word marks (eight-bit mode).

Note: Data written using a move mode instruction must be read with a move mode instruction. Also, data written using a load mode instruction must be read with a load mode instruction. This insures proper coding relationship between data in core storage and disk storage.

X-Control Field

The high-order character of the x-control field specifies which data transmission channel is to be used and the overlap or non-overlap status of the operation.

The second character (F) specifies the disk storage unit as the active input or output device for this operation.

The low-order position specifies which operation is to be performed:

0 — Seek
1 — Single record
2 — Full track without address
3 — Write check
4 — Prevent seek complete
5 — Home address operation
6 — Full track with address
7 — Write format track
8 — Set access inoperative
9 — Release
@ — Cylinder operation

B-Address

The B-address portion of the instruction addresses a group-mark — word-mark or the high-order position of an eight-character data field in core storage, depending on the operation to be performed. The data field (disk address word) is sent to the 7631 (Figure 11); it specifies an access mechanism, a module number, and a track address in the module except for the single-record operation. The disk address word for the single-record operation will be described with that operation.

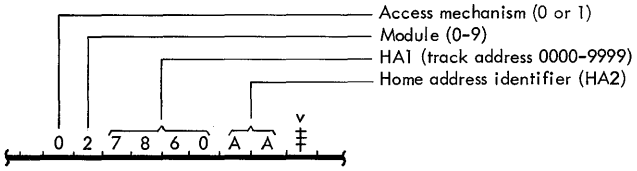


Figure 11. Core Storage Disk Address Word

The high-order position of the disk address word specifies the access mechanism, either access 0 or access 1. Modules are numbered from 0 through 9, depending on a fixed assigned number for each module. The module to be used is indicated in the second position of the disk address word. The next four positions (HA1 part) are used to address a specific track in the module (0000-9999). The last two character positions (HA2 part) are used for the home address identifier characters. A group-mark — word-mark

must appear in the core storage position to the immediate right of the disk address word. The disk address word (Figure 11) addresses access mechanism 0, module 2 and track 7860AA.

Data to be written on disk storage follow the associated disk address word in core storage. Also, data read from disk are placed in core storage following the associated disk address word. A group-mark – word-mark must appear in the core storage position to the immediate right of the last character of the core storage data field to be written or the data area to be used to receive data from disk (Figure 12). The location of a disk address word and its related data field or data area is determined by the user.

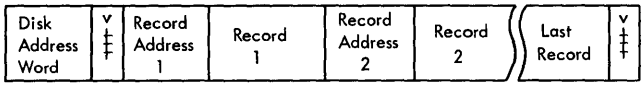


Figure 12. Core Storage Layout – Read or Write Full Track With Addresses

The disk address word must be eight characters in length to establish a valid length for disk address words. In some operations, not all characters of the disk address word are essential to the operation. Portions that are not essential (not verified) may consist of any valid characters; however, characters not verified are parity checked. Figure 13 shows the operations that use a disk address word, the characters that are verified, and the characters that are not verified. Character positions not verified are indicated by the symbol ▨.

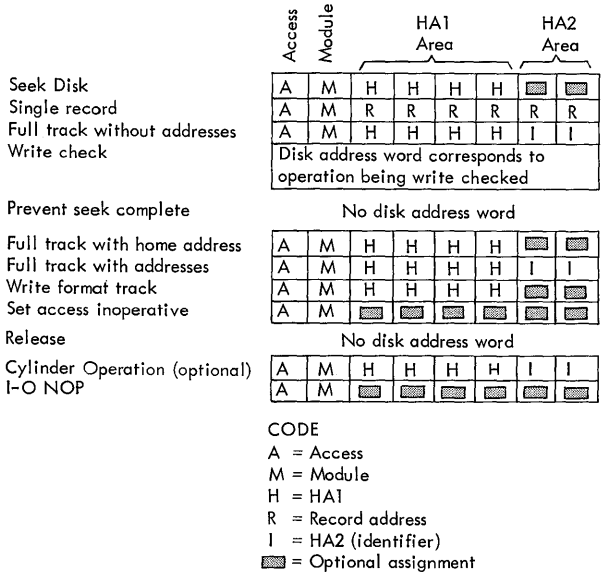


Figure 13. Disk Address Word Format

d-Character

This portion of the instruction specifies whether a read operation (R or $), a write operation (W or X), or an I-O no-op (Q or V) is to take place. Read or write instructions defining the limit of a core storage field or area by a group-mark – word-mark use the R or W d-character, respectively.

Read or write instructions that define the limit of a core storage field or area by the end-of-storage indication use the $ or X d-characters, respectively. Explanation of instructions in this manual assumes the use of only the R or W d-character for reading or writing operations. The Q or V d-characters used with the I-O no-op will be explained in the discussion of this operation.

Note: Instructions using the $ or X d-character cannot be overlapped.

Disk Storage Control Instructions

Seek Disk (SD)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF0	bbbbb	R or W

Function: This instruction is used to position the access mechanism at a particular cylinder of a module. The eight-character disk address word specifies the access mechanism, module, and track in the module (Figure 14).

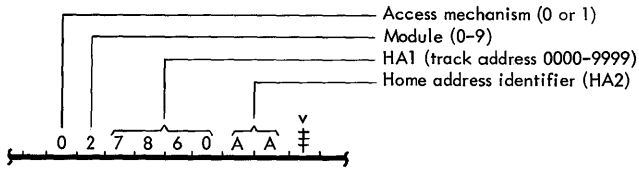


Figure 14. Core Storage Layout – Disk Address Word

The disk address word is transferred to the 7631 File Control, and the selected access mechanism seeks the cylinder specified in the disk address word. In this instruction, either M or L operation codes and any one of four d-characters (R, $, W, or X) may be used; their presence in the instruction is necessary only to establish a valid instruction length. Also, characters in the HA2 portion of the disk address word can be any two characters. Their presence is necessary only to establish a valid disk address word length.

Note: A seek instruction need not be given if the specified access mechanism is already positioned at the cylinder to be used in a subsequent cylinder or full track operation. In single record operations, a seek need not be performed if the track to be used is already indicated by a previous operation.

An interrupt on completion of a seek operation will occur if the 1410 is equipped with the priority feature (optional feature). The priority feature is standard on 7010, therefore, an interrupt on completion of seek will occur in 7010 operation.

Write Format Track (WFO)

Op Code	*X-control field*	*B-address*	*d-character*
M	xF7	bbbbb	W or X

Function: This instruction writes the format for a specified cylinder of tracks. The format control record, to be written on the format track, follows the group-mark – word-mark of the disk address word in core storage (Figure 15). The core storage format control record must be in the format required for the format track of the 1301 or 1302.

Figure 15. Core Storage Layout – Write Format Track

The actual cylinder in which the format track is to be written is determined by a prior seek disk operation. The format track of a cylinder is selected by addressing any of the 40 data tracks of a specific cylinder. For example, the format track address for cylinder 1 can be any address from 0000 to 0039. The HA 2 portion of the disk address word is not machine verified; therefore it can consist of any desired characters.

If disk end-of-format track is sensed before the group-mark – word-mark following the format track record in core storage, a wrong length format error is indicated and the operation stops.

Note: The format switch must be set to FT WRITE for this operation.

Write Full Track With Home Address (WHA)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF5	bbbbb	W or X

Function: A track of data consisting of a home address 2 (HA2), record addresses, and records is written on a data track from core storage. The data to be written follow the group-mark – word-mark character of the disk address word in core storage (Figure 16).

The core storage data are written on the addressed data track corresponding to the format established by the format track. Desired or fictitious records must be supplied for each record area as it exists in core storage so that record addresses will be written in the designated area of the data track as prescribed by the format track. The HA2 portion of the disk address word is not machine-verified; therefore, it can be any desired characters.

If the group-mark – word-mark is sensed before the disk end-of-track, the wrong length record indicator is set on, and blanks are written on the data track until the end-of-track is sensed. If disk end-of-track is sensed before group-mark – word-mark in core storage, data transmission stops, the wrong length record indicator is set on, and the operation stops.

Note: The home address switch on the 7631 must be on to perform this operation.

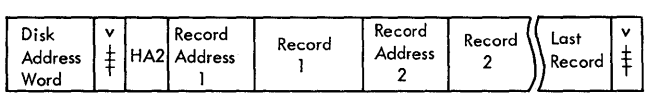


Figure 16. Core Storage Layout – Write/Read Full Track With Home Address

Read Full Track With Home Address (RHA)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF5	bbbbb	R or $

Function: A track of data consisting of a home address 2 (HA2), record addresses, and records is read from the addressed disk track and placed in core storage to the right of the group-mark – word-mark of the disk address word for this instruction (Figure 16). The operation continues until a group-mark – word-mark in core storage or a disk end-of-track is sensed. The HA2 portion of the disk address word is not machine verified; therefore, it can be any desired characters.

If the group-mark – word-mark is sensed before the disk end-of-track, data transfer stops and the wrong length record indicator is set on. Disk reading continues, however, until the first disk end-of-record is sensed. If the disk end-of-track is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Write Full Track With Record Addresses (WFT)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF6	bbbbb	W or X

Function: A track of record addresses and data records is written on a data track from core storage. The data to be written follow the group-mark – word-mark character of the disk address word in core storage (Figure 17).

The record addresses and records are written on the disk in the area following the home address of the addressed data track. Record addresses and record

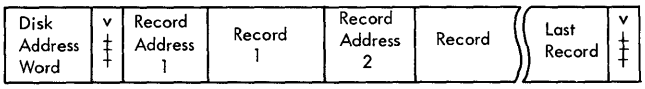


Figure 17. Core Storage Layout – Write/Read Full Track

lengths must correspond to the format established on the format track.

If the group-mark – word-mark is sensed before the end-of-track and not at the end of a disk record address or record, the wrong length record indicator is set on and blanks are written on disk until the first end-of-record address or record is sensed. The operation then terminates.

If the group-mark – word-mark is sensed before end-of-track but at the end of a disk record address or record, the wrong length record indicator is *not* set on and the operation stops.

If the disk end-of-track is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Read Full Track With Record Addresses (RFT)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF6	bbbbb	R or $

Function: A track of record addresses and data records is read from a disk track and placed in core storage to the right of the group-mark – word-mark of the disk address word for this instruction (Figure 17).

If the group-mark – word-mark is sensed before the disk end-of-track, data transfer stops and the wrong length record indicator is set on. The operation continues however until the first disk end-of-record is sensed. If the disk end-of-track is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Note: A partial track can be written with the write full track operation. The read full track operation, however, requires reading of a full track or the wrong length record indicator will be set on.

Write Full Track Without Record Addresses (WDT)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF2	bbbbb	W or X

Function: A track of data records is written on a disk track from core storage. Records to be written follow the group-mark – word-mark of the disk address word (Figure 18). Records from core storage are written on the data track record areas established by the format track. Record address areas of the data track are skipped over in this operation. Core storage record lengths must correspond to the formatted data track record lengths.

If the group-mark – word-mark is sensed before the end-of-track and not at the end of a disk record, the wrong length record indicator is set on and blanks are written on disk till the first end of record is sensed. The operation then terminates.

If the group-mark – word-mark is sensed before end-of-track but at the end of a record, the wrong length record indicator is *not* set on and the operation stops.

If the disk end-of-track is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Read Full Track Without Record Addresses (RDT)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF2	bbbbb	R or $

Function: A data track of records only is read from a disk track and placed in core storage to the right of the group-mark – word-mark following the disk address word for this instruction (Figure 18).

If the group-mark – word-mark is sensed before the disk end-of-track, data transfer stops and the wrong length record indicator is set on. The operation continues, however, until the first disk end-of-record is sensed. If the disk end-of-track is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Note: A partial track can be written with the write full track without record addresses operation. The read full track without record addresses operation requires the reading of a full track or the wrong length record indicator will be set on.

Write Cylinder (WCY) Optional Feature

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF@	bbbbb	W or X

Function: Data records in core storage, following the disk address word for this instruction, are written on disk starting at the addressed track of a cylinder and continuing through successive record locations and tracks of a cylinder (Figure 19). Records written on disk must correspond to the disk record areas as defined by the format track of the cylinder.

If the group-mark – word-mark is sensed before an end-of-cylinder and not at the end of a record in the cylinder, the wrong length record indicator is set on and blanks are written on disk until the first end of record is sensed.

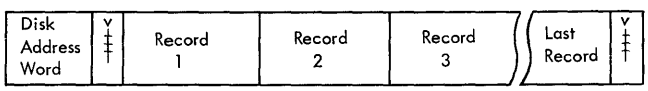


Figure 18. Core Storage Layout – Write/Read Full Track Without Record Addresses

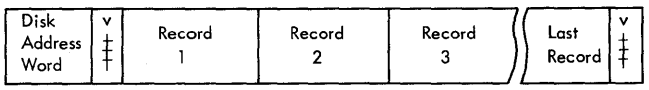


Figure 19. Core Storage Layout – Write/Read Cylinder Operation

If the group-mark – word-mark is sensed before the end-of-cylinder but at the end of a record in the cylinder, the wrong length record indicator is *not* set on the operation stops.

If the end-of-cylinder is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Read Cylinder (RCY) Optional Feature

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF@	bbbbb	R or $

Function: Disk records, beginning at the addressed track of a cylinder of tracks, are read and placed in core storage to the right of the group-mark – word-mark following the disk address word for this instruction (Figure 19). Reading continues, record by record, track by track, through the cylinder.

If the group-mark – word-mark is sensed before the disk end-of-cylinder data transfer stops, the wrong length record indicator is set on but disk reading continues until the first end-of-record is sensed. If disk end-of-cylinder is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Note: A partial cylinder can be written with the write cylinder operation. The read cylinder operation requires that reading proceed from the addressed track to the end of cylinder or the wrong length record indicator will be turned on.

Write Single Record (WD)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF1	bbbbb	W or X

Function: A single record in core storage is written on a disk track next to its associated record address. For this operation the home address part (HA1 and HA2) of the disk address word contains the record address of the record to be written (Figure 20). The track in which the single record is to be written is selected by a previous seek disk operation or any track or single record operation which addressed the desired track.

The single data record to be written immediately follows the disk address word in core storage (Figure 21.) The data record in core storage must correspond to the record area on disk as prescribed by the format track.

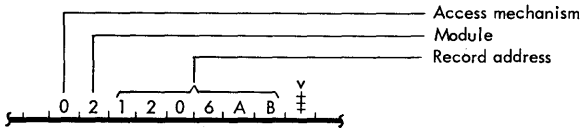


Figure 20. Disk Control Word – Write Single Record

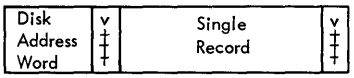


Figure 21. Core Storage Layout – Write/Read Single Record

If the group-mark – word-mark is sensed before the disk end-of-record, the wrong length record indicator is set on and blanks are written until disk end-of-record is sensed. If disk-end-of-record is sensed before the group-mark – word-mark, no further data are transmitted and the wrong length record indicator is set on.

Read Single Record (RD)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF1	bbbbb	R or $

Function: A single data record on a disk track is read and placed in core storage following the group-mark – word-mark of the disk address word for this instruction (Figure 21). Reading from disk starts with the first character of the addressed data record.

If the group-mark – word-mark is sensed before the disk end-of-record, data transfer stops and the wrong length record indicator is set on. The operation continues, however, until the disk end-of-record is sensed. If the disk end-of-record is sensed before the group-mark – word-mark, the wrong length record indicator is set on and the operation stops.

Write Disk Check (WDC)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF3	bbbbb	W or X

Function: The write disk check operation provides a method of checking data previously written on disk. If this operation is used, it must immediately follow the operation which is to be write-checked or it must immediately follow an I-O NOP instruction. A write disk check following an I-O NOP instruction provides a method to write check an operation that occurred at some prior time. See "I-O No Operation" for details.)

Data recorded on disk storage are read and compared bit for bit with the data in core storage previously written on disk. The type of write disk check operation (single record, track, or cylinder) performed depends on the preceding mode of operation; that is, if a single-record operation preceded the write disk check instruction, then the check will be a write disk check single record.

The B-address and d-character for the write disk check instruction should be the same as the B-address and d-character of the write operation being checked.

When write-checking the format track, the address given can be any of the 40 physical track numbers in that cylinder. The preceding file instruction must be a

write format track instruction to have the machine write-check the format track. The format switch can be in either the read or write position.

Prevent Seek Complete (PSC)

Op Code	*X-control field*	*B-address*	*d-character*
M	xF4	bbbbb	R or W

Function: This instruction is effective only on the 7631 Model 3 and 5 (shared system operation). It is used to prevent seek complete interrupts to the 1410 or 7010 system (equipped with the priority function) caused by seek operation of the sharing system.

The instruction turns on a circuit that prevents seek complete signals produced by the sharing system from reaching the 1411 or 7114 and causing an interrupt. The circuit is turned off when the 1410 or 7010 issues a seek instruction.

An L operation code may also be used. The B-address must refer to a core storage location that contains a group-mark – word-mark.

Release (REL)

Op Code	*X-control field*	*B-address*	*d-character*
M	xF9	bbbbb	R or W

Function: This instruction is effective only with the 7631 Model 3 and 5. For shared system operation, control of the 7631 is established as follows. The first system to issue a file instruction or command gains control of the 7631 and effectively "locks out" the sharing system. The system establishing control retains control until it issues a release instruction. Execution of the release instruction or order disconnects the 7631 from the using system and makes it available to either sharing system.

If the 1410 or 7010 attempts to issue a file instruction while the sharing system has control of the 7631, the 1410 or 7010 will receive a busy indication. The B-address of the release instruction must refer to a core storage location that contains a group-mark – word-mark. An L operation code may also be used.

I-O No Operation (N + Any I/O Statement)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xFx	bbbbb	Q or V

Function: This operation is functional only on the 1410 or 7010 systems equipped with the priority processing. The primary function of this instruction is to set the I-O channel status indicators for a given I-O unit so that the status of that unit can be tested by a branch if I-O channel status indicator on instruction – R(I)d or X(I)d. No data transfer occurs with this instruction. (File addresses in file address tests will be transferred.)

Example: Assume that seek instructions have been issued to several access mechanisms on different modules. The first access mechanism to reach its destination will cause an interrupt to the 1410 or 7010 system. Once the program determines that the interrupt was caused by completion of a seek, the particular mechanism which caused the interrupt can be determined by:

1. Using the I-O no operation instruction to set the status indicators for each mechanism to which a seek was issued.
2. Testing the I-O busy indicator for a busy condition by means of the R(I)d instruction. If the access is in motion, a busy condition will result. If the access mechanism is not in motion, a busy condition will not result (seek is complete), and it can be assumed that the access mechanism addressed is the one that caused the interrupt.

If the I-O no operation instruction is being used to set the I-O channel status indicators, the op code may be M or L, the units position of the x-control field can be any valid character, the HA1 and HA2 areas of the disk address word can be any valid characters, and the d-character can be either Q or V.

The I-O no operation instruction can also be used to set the mode of operation (single record, track, or cylinder) for a succeeding write disk check operation. In this case, the units position of the x-control field of the instruction must indicate the type of write check operation to be performed.

Set Access Inoperative (SAI)

Op Code	*X-control field*	*B-address*	*d-character*
M	xF8	bbbbb	R or W

Function: This operation provides a programmed disconnection of a faulty access unit from a system. Reactivation must be accomplished manually by the customer engineer after the fault has been corrected. An L operation code may also be used. The d-character may be R or W. The disk storage address word should indicate access and module. The HA1 and HA2 areas can be any valid characters.

Disk Storage Operation Status

I-O Channel Status Indicators

The I-O channel status indicators that can be set by a disk storage operation are outlined in Figure 22 and described as follows:

NOT READY

This indicator is set on if the 7631 File Control is off-line, if the disk storage unit is not available for use (power off or off-line status), or if the access mechanism cannot be moved or operated electrically. A home address check also turns on this indicator. A home address check results whenever a full track with home address instruction is given and the home address switch (located on the 7631 control panel) is not in the on position.

BUSY

The busy indicator is turned on if an access is addressed while in motion, or if (shared operation) the 7631 Model 3 or 5 is not available because it is being used by the other sharing system.

DATA CHECK

This indicator is turned on as the result of a parity check, a check character code check, a write disk check, a format character check, or an invalid track number check.

Indicator	Cause	d-character in R or X(I)d
Not ready	Access inoperative or 7631 off-line 7631 power off Home address switch check	1
Busy	Addressed access in motion 7631 (Model 3 or 5) busy in shared use	2
Data check	Parity check Check character code check Write disk check Format character check Invalid track number	4
Condition	Wrong length format No record found Write check without mode setting Disk storage circuit check File control circuit check Invalid operation code	8
No transfer	No read or write operation performed (No data or address is transferred)	& (A-bit)
Wrong length	Short or long record	- (B-bit)

Figure 22. I-O Channel Status Indicators Set During IBM 1301 or 1302 Operations

1. A parity check results whenever a data character being transferred between core storage and disk storage fails to pass an odd-bit parity test.

2. A check character code check results when code characters, generated for each disk record and address during the write operation, do not compare bit for bit when read during a read operation.

3. A write disk check error results when the character sent from core storage fails to compare with the character previously written on disk.

4. A format character check results from an illegal code being used to write the format track. (Only BCD 1, 2 or 3 and 4 can be used.)

5. Invalid track number check occurs when the track address cannot be interpreted by the disk storage unit as a legal track address.

Note: To correct the machine after an invalid track number check, seek cylinder 0, and then seek the desired cylinder.

CONDITION

This indicator is turned on as a result of: wrong length format, no record found, write check without mode setting, disk storage circuit check, file control circuit check, and invalid operation code.

1. The wrong length format results when an attempt is made to write a format track for a greater number of characters than the track will hold.

2. The no record found results when the address specified by the instruction cannot be located on the specified track.

3. A write check without mode setting results from an illegal write check operation. This occurs when the operation to be write checked has not meaning or application to the write check operation.

4. A disk storage circuit check indicates a circuit failure in the disk storage unit.

5. A file control circuit check indicates a circuit failure in the 7631.

6. An invalid operation code check occurs when invalid operation codes are sent to the 7631 or the code fails to pass an odd-bit parity test.

NO TRANSFER

This indicator is turned on if data or addresses are not transferred between the 1411/7114 and the 7631 when

the operation to be performed requires this transfer. If the write inhibit switch is set on at the 7631 during a write operation, the no transfer indicator is turned on.

WRONG LENGTH RECORD

This indicator is turned on when a long or short record is detected.

1410 Overlap and Non-Overlap Mode with 1302

Any 1410 I-O instruction to the 1302 may be either overlapped or non-overlapped, but read and write instructions require non-overlap mode during data transfer. The *address* portion of the data field (first eight characters) is always transferred in either overlap or non-overlap mode, as designated by the I-O instruction. The 1302, Models 1 and 2, operates at 184,000 cycles, transferring a character every 5.45 microseconds. Because of the 5.45-microsecond transfer rate, the actual data transfer (or checked) portion of a read, write, or write disk check operation is non-overlapped.

When the file control recognizes that a 1302, Model 1 or 2, is selected for a read, write, or write disk check, it signals back to the 1411, alerting the CPU that the data portion of the operation is to be non-overlapped. The 1411 will continue to send the address to the 7631 in overlap mode (if in use) until the end of the current address transfer. When the current address transfer is completed, the 1411 (CPU) will examine the other I-O channel and, if the I-O channel is not in an in-process status, a signal will be sent to the file control to permit the 1302 to search for the address.

While waiting for the 1302 to locate the record, the 1411 CPU may be used to perform all normal functions except move, load, or unit control (M, L, or U) operations. If an M, L, or U operation code is sensed for the other channel, the 1410 system is placed in non-overlap mode. If an M, L or U op code is not detected, overlap mode will continue until the file control signals to the 1411 that the address sent by the 1411 has been located. That signal (address compare true) causes the 1411 to operate in non-overlap mode until the completion of the 1302 operation.

Error Recovery Procedures

The following procedures form the basis of the error recovery routines used in input-output programming for IBM Programming Systems packages. For efficient utilization of data processing systems, these procedures are recommended wherever possible in writing input-output routines.

Figure 23 shows four of the 7631-1301/1302 status conditions sent to the 1411 or 7114 and specifies the minimum action required. The actions referred to in Figure 23 are:

Action 1

1. Repeat the operation.
2. If the error condition persists, print message 1 (see below).

Action 2

1. Repeat the operation as many as four times.
2. If the error condition persists, recalibrate the access mechanism with a seek to the customer engineering track. Use 9@00 to 9@39 for the seek address.
3. Seek to any track address (0000-9999). This moves the access mechanism to cylinder 0.
4. Seek to the desired track.
5. Repeat the operation as many as four times.
6. If the error condition persists, print message 1.

Action 3

1. Repeat the operation as many as four times.
2. If the error condition persists, print message 1.

Status Sent to Processing Unit	7631 Error Condition	When Encountered During a Read Operation	When Encountered During a Write or Write Check	When Encountered During an Address Transfer
Not Ready	7631 Power Off 7631 Off-Line Home Address Switch Check Addressed Access Inoperative	Action 1	Action 1	Action 1
Busy	Mod 3 or 5 7631 Unavailable Addressed Access in Motion	Action 1	Action 1	Action 1 (See Note 1)
Data Check	Parity Check Cyclic Code Check Data Compare Check Format Character Check Invalid Track Number	Action 3 or 4 (See Note 2)	Action 3 or 4 (See Note 2)	Action 1
External Condition	Wrong Length Format No Record Found Invalid Instruction Sequence 7631 Circuit Check Disk Storage Circuit Check Invalid Operation Code	Action 1 or 2 (See Note 3)	Action 1 or 2 (See Note 3)	Action 1

Note 1: 7631 Model 3 or 5 not available - A 1410/7010 attempt to use a dual system 7631 that results in a busy signal before address is transferred is an indication that the 7631 is in use by the other system. In this case, Action 1 is not appropriate.

Addressed Access in Motion - A 1410 without a Priority Processing Feature must continually test this indicator to learn when an access mechanism, previously instructed to seek, has come to rest. In this situation, Action 1 is not appropriate.

Note 2: If during a read, write, or write check, a data check is accompanied by a no transfer indication, Action 4 is appropriate; otherwise, use Action 3.

Note 3: When the external condition is accompanied by a no transfer indication, Action 2 is appropriate; otherwise, use Action 1.

In IBM 1301 IOCS routines, a no record found condition causes an exit to the user. A return to the IOCS routine with the same record address causes execution of a no record found error routine. The user may have an overflow indication that must be interrogated on the track that caused the no record found condition. (See Operator's Guide for 1301 IOCS for 1410, Form C28-0277.)

Figure 23. Error Conditions and Actions Required

Action 4

1. Seek to any track address (0000-9999). This moves the access mechanism from the customer engineering track to cylinder 0.
2. Seek to the desired track and read or write.
3. If the error condition persists, print message 1.

Message 1

Message 1 identifies an uncorrectable error. Further procedure is determined by the application.

MESSAGE 1 FORMAT

Minimum: 1 through 3.
Recommended, if Core Storage Permits: 1 through 4.
Maximum: 1 through 5.

1. XXXX – A message code used when the message is associated with a halt or waiting loop.
2. Type of error—read, write, write check, or control.
3. Unit involved – access number, module number, track number.
4. Previous unit involved – access number, module number, track number; FROM address, the previous address sought on the module in error.
5. Current unit involved – access number, module number, track number; TO address, the address to which the access mechanism was going, or had reached, at error time.

Message 2

STATISTICAL PRINT-OUT

Where feasible, a message 2 should be printed at the end of a program segment or run, or at some convenient time.

MESSAGE 2 FORMAT

1. Access number, module number.
2. Number of entries into error routine.
3. Number of message 1's printed (uncorrectable errors).

Figures 24, 25, 26, and 27 show the significance of combinations of all six 1411 or 7114 status indicators in relationship to the time an error condition is recognized. At the completion of an instruction, the contents of the B-address register for E channel non-overlap operations, or the contents of the E-address register for E channel overlap operations, indicate the time of recognition of the conditions.

The setting of the wrong length record indicator depends on detection of the condition by the 7631 during or after the transfer of the allotted characters.

Status Indicators						7631 Error Condition
Not Ready	Busy	Data Check	Cond	No Trf	Wrong Length Record	
1	0	0	0	0	0	7631 Power off or off line
0	1	0	0	0	0	7631 Mod 3 or 5 unavailable

Note: B-address register or E-address register = B-address in instruction.

Figure 24. Conditions Occurring Before or During Instruction Read-out to CPU

Status Indicators						7631 Error Condition
Not Ready	Busy	Data Check	Cond	No Trf	Wrong Length Record	
1	0	0	0	0	0	Addressed Access Inoperative
1	0	0	0	0	0	Home Addr Sw Chk *
0	1	0	0	0	0	Addressed Access in motion
0	0	1	0	0	0	Parity Chk
0	0	0	1	0	0	1301/1302 Circuit Chk
0	0	0	1	0	0	Invalid Op Code
0	0	0	1	0	0	Write Chk without mode setting*
0	0	0	0	1	0	Release Instruction*
0	0	0	0	1	0	Block Interrupt Instruction*

* These conditions are unique to particular instructions (for example, a home address switch check occurs only during a home address operation).

Note: B-address register or E-address register = B-address in instruction +9.

Figure 25. Conditions Occurring During File Address Transfer

Status Indicators						7631 Error Condition
Ready	Busy	Data Check	Cond	No Trf	Wrong Length Record	
0	0	0	1	1	0	No Record found
0	0	0	1	1	0	Cyclic Code Chk
0	0	1	0	1	0	Invalid Track Number*
0	0	0	1	1	0	7631 Circuit Chk
0	0	0	1	1	0	1301/1302 Circuit Chk

* If an invalid track number is indicated, the programmer will be required to reissue the proper seek instruction twice, unless cylinder zero is required, in which case one seek instruction to zero is sufficient.

Note: For a write operation, the B-address register or the E-address register = B-address in instruction +11. For a read operation, the B-address register or the E-address register = B-address in instruction +9.

Figure 26. Conditions Occurring After File Address Transfer

Status Indicators						7631 Error Condition
Ready	Busy	Data Check	Cond	No Trf	Wrong Length Record	
0	0	1	0	0	1 or 0	Parity Chk
0	0	1	0	0	1 or 0	Cyclic Code Chk
0	0	1	0	0	1 or 0	Write Disk Chk*
0	0	1	0	0	1 or 0	Format Character Chk*
0	0	0	1	0	0	Wrong Length Format*
0	0	0	1	0	1 or 0	7631 Circuit Chk
0	0	0	0	0	1	Incorrect format or data area

* These conditions occur only during specific instructions.

Note: B-address register or E-address register is greater than B-address in instruction +9.

Figure 27. Conditions Occurring During Data Transfer

Where the general wrong length record indication (1 or 0) is shown (Figure 27), either indication may exist.

The setting of the no transfer latch distinguishes either between detection before or after file address transfer, or distinguishes between detection before or after data record transfer of the accompanying status indications.

With respect to shared use of the 7631, if a program does not use disk storage, the block seek complete instruction should be executed to avoid interaction between programs of the sharing systems.

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