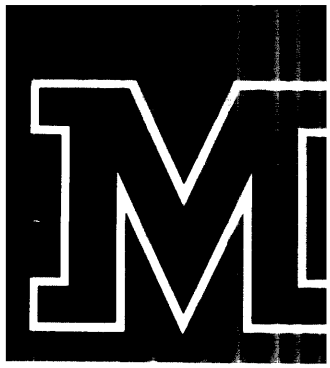
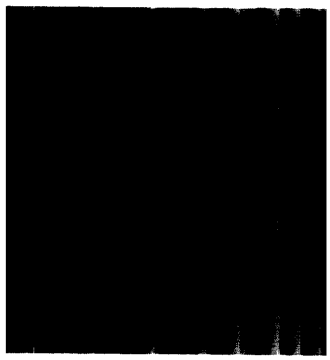
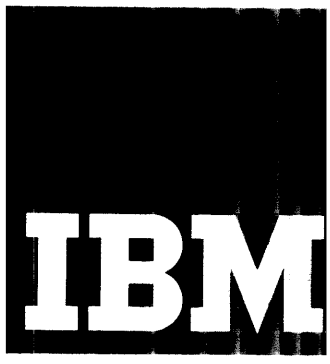






Reference Manual

IBM 1410 Data Processing System

IBM 1301 Disk Storage

IBM

Reference Manual

IBM 1410 Data Processing System

IBM 1301 Disk Storage

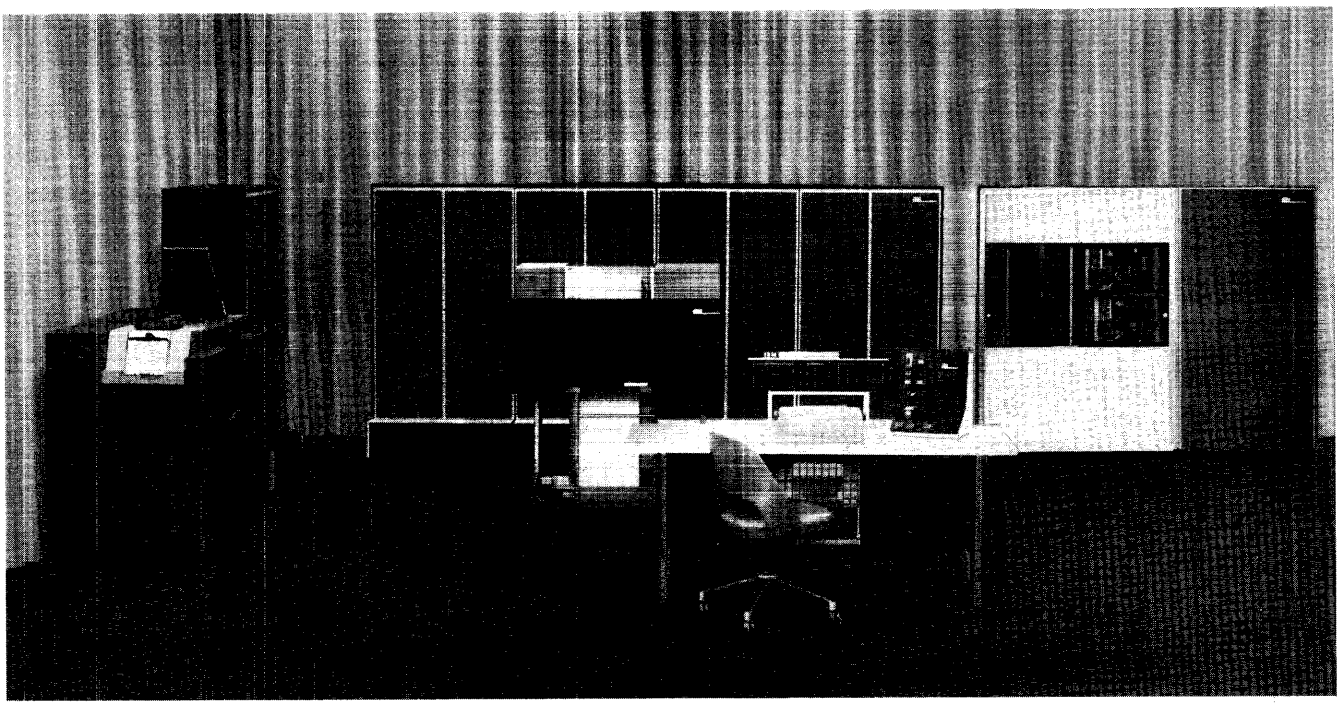
Preface

This manual is a comprehensive presentation of the characteristics, functions, and features of the IBM 1301 Disk Storage and the IBM 7631 File Control as used with the IBM 1410 Data Processing System. The manual can be used for individual study, as an instruction aid, and as a reference guide. Use of this manual assumes a basic knowledge of the IBM 1410 Data Processing System.

This manual obsoletes *General Information Manual,* IBM *1410 Data Processing System – 1301 Disk Storage,* Form D24-1442-1, and *Technical Newsletter,* IBM *1410 Data Processing System – 1301 Disk Storage,* Form N22-0010.

Address comments concerning this manual to:
IBM Corporation
Customer Manuals, Dept. 298
P. O. Box 390
Poughkeepsie, N. Y.

Contents



IBM 1410 Data Processing System

The IBM 1301 Disk Storage (Figure 1) and its associated IBM 7631 File Control provides the IBM 1410 Data Processing System with the advantages and facility of large capacity random access storage. These facilities, combined with the advanced operational characteristics of the 1301-7631, provide a versatile in-line data processing system.

Significant advantages are:

1. Lower cost per character of storage.
2. Entire program libraries contained in readily accessible form.
3. Access to any program or active file in 50-180 milliseconds.
4. Table storage in random addressing schemes.
5. Simplification of program scheduling.
6. Ability to dump and recover files into or from core storage rapidly.
7. Customer control of addressing schemes and record length format.
8. Improved checking techniques – more reliable data recording.

The 1301 Disk Storage is available in two models:

Model 1 – single module, providing capacity for as many as 28,000,000 characters.

Model 2 – two modules, providing capacity for as many as 56,000,000 characters.

As many as five disk storage units (10 modules) can be attached to the 1410 system through one 7631 File Control.

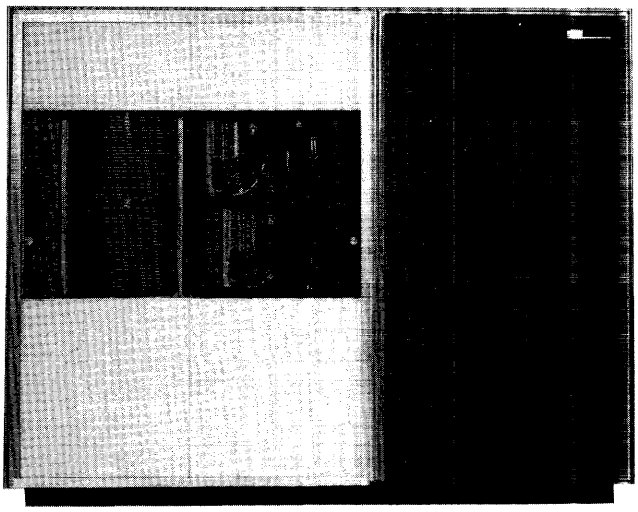


Figure 1. IBM 1301 Disk Storage

The 7631 File Control is available in two models for use with the 1410 system:

Model 1 – for exclusive use with the 1410 system.

Model 3 – for shared use with any IBM 7000 series system and a 1410 system.

The 7631 File Control also provides cylinder mode operation (optional feature) on all models. This feature allows the reading or writing of as many as 112,000 characters in one operation.

The magnetic disk in the 1301 is a thin metal disk coated on both sides with a magnetic recording material. Data are recorded as magnetized spots located in concentric tracks on each face of the disk (Figure 2). There are 250 tracks for the storage of data on each disk face.

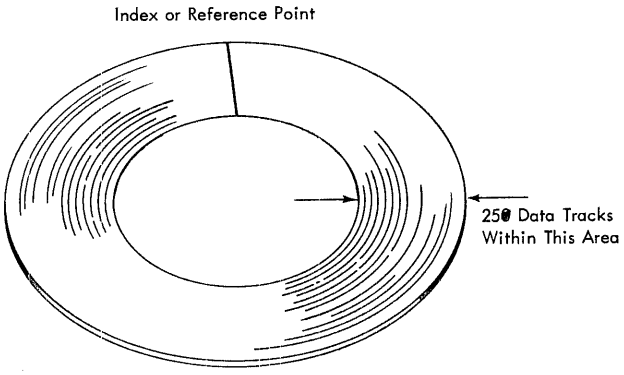


Figure 2. Magnetically Coated Disk

Twenty-five disks are mounted on a vertical shaft. The shaft revolves spinning the disks at approximately 1,790 revolutions per minute. The tracks are accessible for reading or writing by positioning read-write heads between the spinning disks (Figure 3). The stack of 25 magnetic disks, with its associated access mechanism, makes up a disk storage module. Of these 25 disks, the upper 20 disks (40 surfaces) are used to store data. The remaining 5 disks (10 surfaces) are used for machine controlling purposes and as alternate surfaces (Figure 4). The use and function of these surfaces will be discussed later.

Disk Cylinder

In each module of disk storage corresponding disk tracks of each disk surface are physically located one above the other. For example, the outermost tracks on each disk surface are located one above the other, forming a cylinder of 40 data tracks (Figure 5).

The data tracks of the cylinders are numbered sequentially from bottom to top and from the outermost cylinder to the innermost cylinder. On this basis, tracks are numbered from 0000 to 9999. The data tracks are numbered sequentially beginning at the lowest data track of the outermost cylinder as track number 0000 and continuing up through the cylinder to track 0039. Numbering continues with the lowest data track of the adjacent inner cylinder as track number

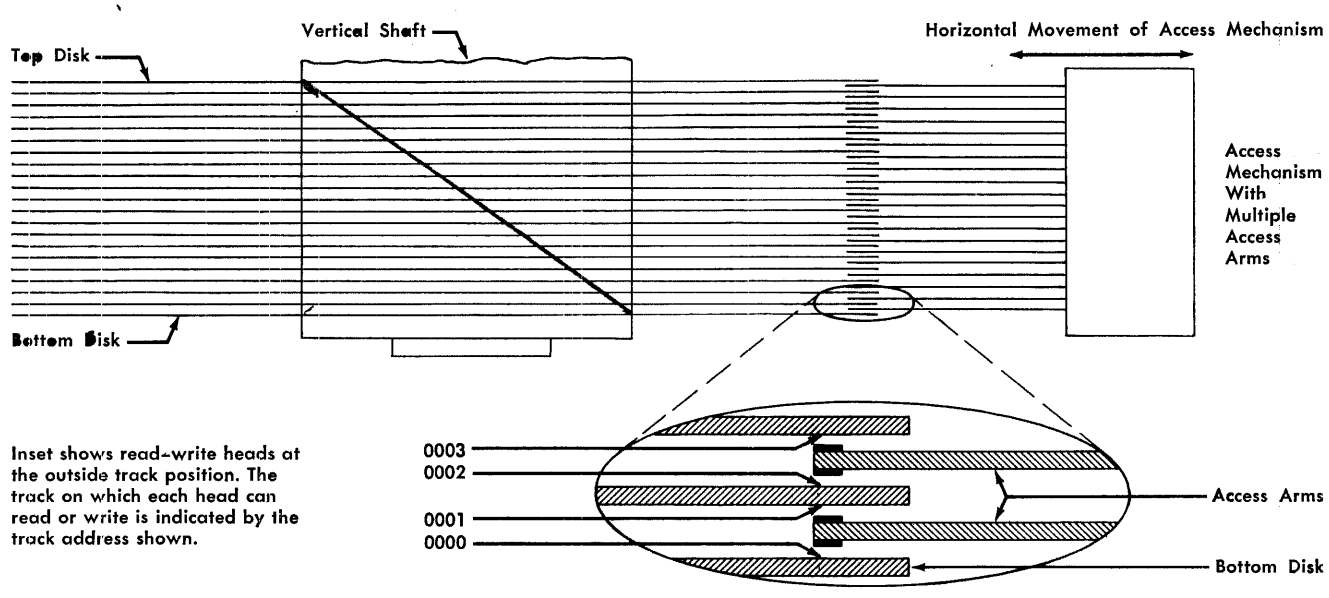


Figure 3. Module and Access Mechanism

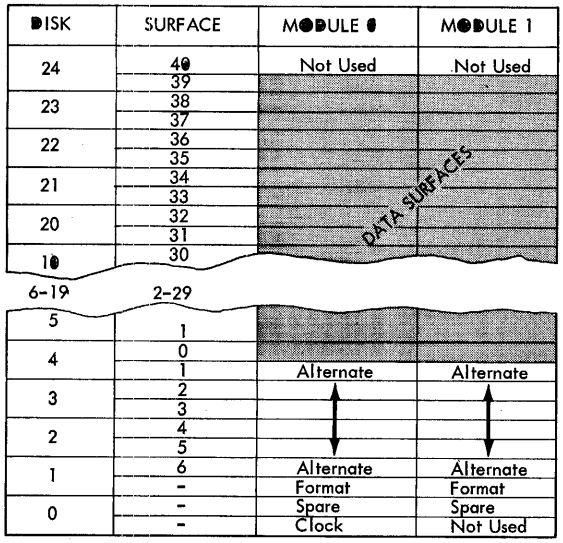


Figure 4. Disk Surface Orientation

0040 and numbering up the cylinder to track number 0079. Continuing through each of the cylinders in a like manner, the last track number, 9999, is the top track of the innermost cylinder.

Access Mechanism

Read-write heads are mounted on the 24 arms of the access mechanism that moves the arms horizontally between the disks (Figure 3). No vertical motion is involved. Two read-write heads are mounted on each arm. One of the heads services the bottom face of the disk above the arm and the other head services the upper face of the disk below the arm.

The read-write heads on the 24 access arms are aligned one above the other and are mechanically moved in parallel to one of the 250 cylinder positions of the module. When the access mechanism is positioned at a specific cylinder, 40 data tracks of information are available without any further motion of the access mechanism. Only electronic head switching is necessary to select a particular track in the cylinder. With the cylinder mode optional feature, it is possible to read or write a cylinder or part of a cylinder of tracks in one operation.

Access Motion Time

The access mechanism requires time to move from one cylinder to another. The time required is related to how far the arm moves, within certain machine defined limits. To calculate how much time will be required, consider the 250 cylinders of a module organized into five areas of 50 cylinders per area (Figure 6). Also consider each area of cylinders further divided into six sections. Access motion time for any one access is as follows:

1. To move the access arm within a section of any one area requires 50 milliseconds.
2. To move the access arm from one section to another section of an area requires 120 milliseconds.
3. To move the access arm from one area to another area (crossing an area boundary) requires 180 milliseconds.

For example, to move the access arm from track 0000 to 1960 requires 120 milliseconds of access motion time. To move the access arm from track 1960 to 2000 requires 180 milliseconds of time.

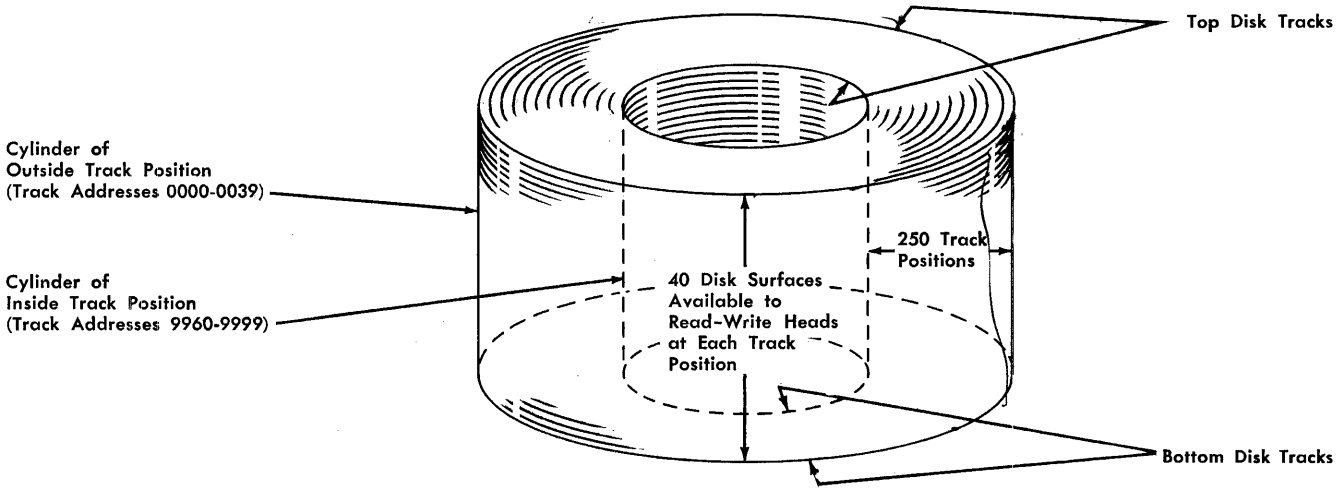


Figure 5. Track Cylinders

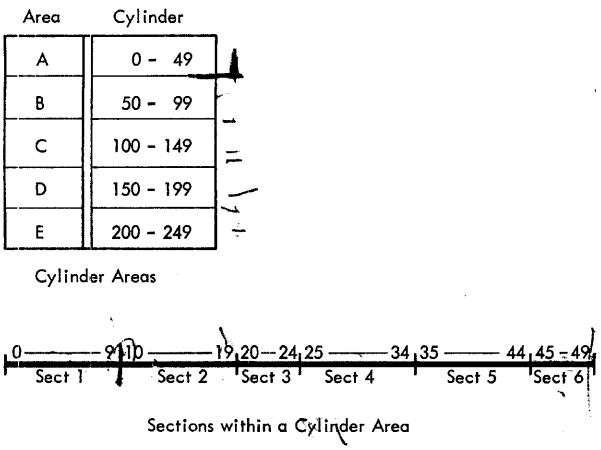


Figure 6. Access Motion Areas and Sections

Rotational Delay Time

A disk storage read or write operation includes a timing factor called "rotational delay time." An index point for each circular disk track denotes the beginning and end of a track (Figure 2). After a cylinder of tracks has been accessed and the proper read-write head for a specific track of the cylinder is selected, actual reading or writing must wait until the specific addressed data or data area of the track is located. Rotational delay time is the time required for the disk to position the desired record at the selected read-write head after an instruction has been initiated. Maximum rotational delay time is 34 milliseconds; average rotational delay time is 17 milliseconds. Data access time includes the summation of access motion time and rotational delay time. Figure 25 is a complete chart of access motion time.

The basic fixed recording area of the 1301 is the data track. The entire recording area of a data track cannot be used exclusively for the storage of data. Certain information must be recorded in the track prior to its use as a storage area. On subsequent read or write operations, this information is used by the machine to identify the track and each of the record areas reserved for the storage of data on that track.

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

Home Address 1

Home address one (HA1) is the first information in 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 in a module. The track number is prerecorded in each data track and cannot be written by the user.

Home Address 2

Home address two (HA2) which follows HA1 in each data track, is called the home address identifier. It consists of two or more characters which may be numeric, alphabetic, or special characters. Although the home address identifier can be greater than two characters in length, only the first two characters are machine verified and therefore effective in machine operations. Use of more than two HA2 characters is primarily related to shared disk operations involving a 7000 Series computer. Subsequent references to HA2, in general, will consider only the first two characters. HA2 must be written on the data track by the user prior to performing actual writing or reading operations for that track. From an addressing or reference viewpoint, HA1 and HA2 together 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 effective 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.

The HA2 address can be used to serve many useful purposes. For example, HA2 as part of the track address can be used as a coded file protection device. That is, a HA1 address without a proper HA2 address part will not allow a data track to be referenced. Also, HA2 in conjunction with HA1 can be used such that the number formed by both addresses corresponds to a part number, policy number, or an account number of data to be placed on the data track. Such a scheme permits a method of classifying and properly storing random groups of data in disk storage.

Record Address

The data track storage area following the HA1 and HA2 addresses, is one long continuous storage space. How this space is to be organized, how many records are to be stored, how many characters are in each record, and how each record area is to be identified is determined by the user. The operations necessary to accomplish this must be performed before the data track can be used for reading or writing. How this is actually accomplished is discussed under "Planning the Format Track."

Each record area established for a data track is preceded by a record address (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 are verified. All of the bits of the last two characters are verified. Characters of a record address exceeding six in number are not verified.

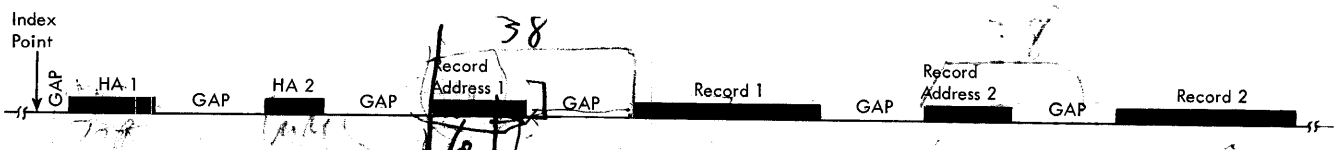


Figure 7. Disk Track Address and Data Arrangement

Records

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

Data Track Gaps

The gaps on the data track following the various information areas are reserved for machine control and code checking information. As each information area of disk, HA1, HA2, record addresses, and records is being written, check information (check characters – 16 bits) is automatically generated and is placed in the gap following the area being written. As each of these information areas is read in subsequent operations, new check information is automatically generated (16 bits) and compared bit for bit (verified) with the check information previously placed in the gap when the information area was written. If they do not compare, an error is indicated.

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 6-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 8-bit mode. Figure 8 shows the recording characteristics of disk storage.

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. Space bits are inserted and the character is written on the disk. Information is read from disk character by character. The space bits are removed, an odd parity check performed, and the character sent to core storage.

Data Track Capacity

Each data track of the module has a capacity of 2,840 six-bit or 2,205 eight-bit character positions for the recording of information. These figures have been adjusted to compensate for the character positions used in the prerecorded home address one and the gaps

Characteristics*	Move Mode (6-Bit)	Load Mode (8-Bit)
Maximum Characters per Track	2,800	2,165
Maximum Characters Available per Access Setting (Cylinder)	112,000	86,600
Maximum Character Capacity Model 2 Disk Storage	56,000,000	43,300,000
Maximum Character Capacity per File Control (5-1301's)	280,000,000	216,500,000
Instantaneous Character Rate (characters/second)	90,100	70,100
Positioning of Access Mechanism	50-180 milliseconds	
Average Rotational Delay	17 milliseconds	

* Figures involving character capacity represent the maximum utilization of space. (Each track is written with a single record.)

Figure 8. Characteristics of Disk Storage

for the home address. To determine the number of character positions that are available for storing records, the character positions required for HA2, the record addresses, and the gaps must be considered. With HA2 representing the number of characters in the home address identifier, N representing the number of records on the track, L representing the number of characters per record, RA representing the number of record address characters (assumed to be the same for each record address), and 32 representing the number of character positions required for record address gaps, track capacity used can be determined by the following formulas:

For the 6-bit mode: HA2+N (L+RA+32) =2,840 or less

For the 8-bit mode: HA2+N (L+RA+32) =2,205 or less.

With HA2 equal to two character positions, RA equal to 6 character positions, and L of constant length, the formulas can be reduced to:

For the 6-bit mode: N = 2838/(L + 38) records per track

For the 8-bit mode: N = 2203/(L + 38) records per track.

For a number of variable length records within the same track, the calculations require the summation of a series of quantities representing the number of records and their length or

$N_1(L_1+38) + N_2(L_2+38) + \ldots\ldots N_n (L_n+38) = 2838$ (6-bit mode)

$N_1(L_1+38) + N_2(L_2+38) + \ldots\ldots N_n (L_n+38) = 2203$ (8-bit mode).

N_1 is the number of records of L_1 length in the track, N_2 is the number of records of L_2 length, etc.

Characters per Record	Six-Bit Mode N (Records)	Six-Bit Mode Remainder	Eight-Bit Mode N (Records)	Eight-Bit Mode Remainder
80	24	6	18	79
100	20	78	15	133
200	11	220	9	61
300	8	134	6	175
400	6	210	5	113
500	5	148	4	51
1000	2	762	2	127
2165	1	635	1	0
2800	1	0	--	--

Figure 9. Records per Track for Various Record Sizes

Figure 9 shows the number of records per track for different record lengths (80 to 2800) and the number of character positions remaining 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 size record address is to be used, subtract 38 from the remainder.

Format Track

The advanced characteristics of the 1301 permit the user considerable flexibility in establishing how the disk storage space is to be allocated, organized, and addressed. This concept of disk storage use makes possible a wide variety of storage formats to meet the needs of many varied applications. The concept also requires that the user organize the disk storage in some particular format prior to 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 of disk storage should not be confused with the operations related to the use of disk storage.

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 250 format tracks, one for each cylinder, are located on one of the additional disk surfaces not used for data.

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 which 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 a cylinder of tracks remains fixed until the format track is rewritten.

Planning the Format Track

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 are used to define areas of the data track which will be handling data in a 6-bit mode. The BCD characters 3 and 4 are used to define areas of the data track which will be handling data in an 8-bit mode. It should be pointed out that certain areas of the format track are used for machine control and data checking purposes. These areas must unconditionally be provided for in the core storage format control record.

A typical core storage layout of a format control record in both the 6-bit and 8-bit mode is shown in Figure 10.

Track Identification Area

The track identification area consists of Gap 1, HA1, and Gap 2. The track identification area is always written to indicate the 8-bit mode and is the same for all format control records. Gap 1 consists of three 4's; HA1 is nine 3's; Gap 2 is a 4 followed by ten 3's and a 4. From this point, the remaining area of the format control record must indicate either a 6-bit or 8-bit mode of operation. It cannot be a combination of the two modes.

Home Address 2 Area

The home address two (HA2) area must be formatted for four more character positions than the number of characters to be used for HA2. For example, if HA2 is to be a two character home address identifier (minimum size), six BCD characters (1 or 3) must be used.

X Gap Area

An X gap area must precede every record address area of the format control record. This gap is indicated by 12 BCD characters (either 2's or 4's depending on the mode of operation).

Record Address Area

This area must provide for four more character positions than the number of characters to be used for the record address. For example, if a record address is to be six digits in length, then ten BCD 2's and 4's must be used in the format control record to define the record address area. Because a record address can have a

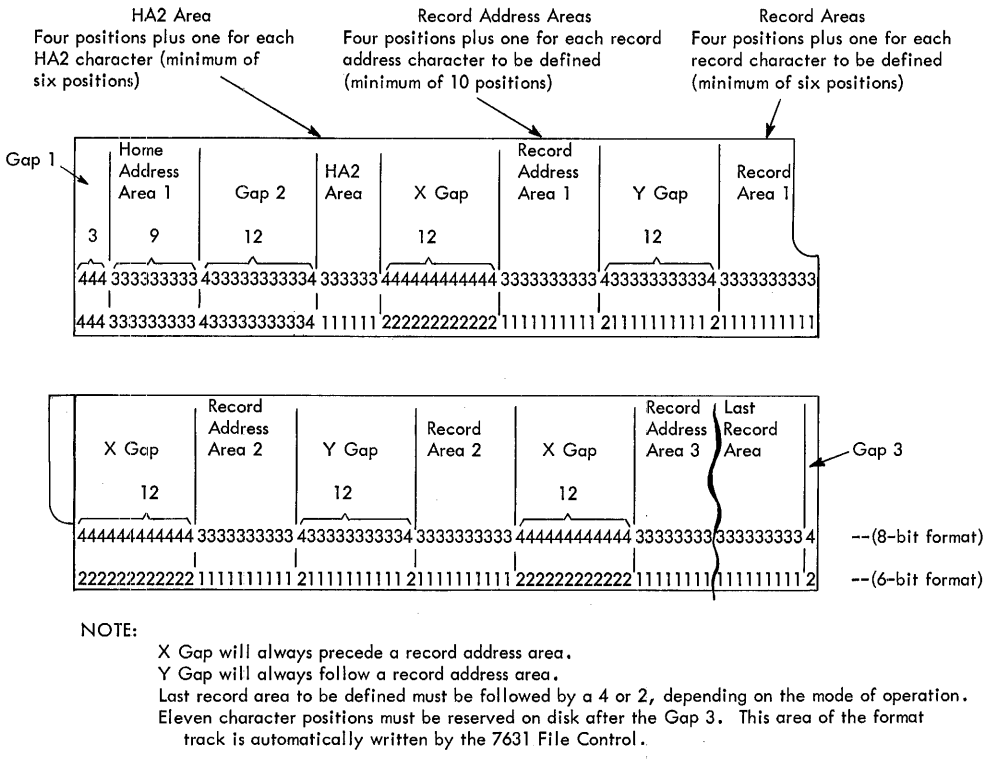


Figure 10. Organization of Core Storage Control Record

minimum of six character positions, the record address area of the format control record must provide for a minimum of 10 character positions.

Y Gap Area

A Y gap area must follow every record address area of the format track record. This gap is made up of one BCD 2 or 4, followed by ten BCD 1's or 3's and a BCD 2 or 4.

Record Area

This area must provide for four more BCD character positions than there are to be characters in the disk record. For example, for an 80-character record, 84 BCD 1's or 3's must be provided in the format control record. Data records can be a minimum of two characters in length, therefore the format control record must contain a minimum of six BCD characters.

From this point the sequence of the areas to be established in the format data record is an X gap, record address area, Y gap, record area, etc., until the last record area.

Gap 3 Area

Gap 3 is a one character gap that follows the last record area of the format track. Gap 3 is indicated in the format control record by a BCD 2 or 4, depending upon the mode of operation to be used.

NOTE: Although the format track does not need to be completely formatted for use, it does require that at least 11 character positions be reserved (not used) following the Gap 3 area of the format track. This area will automatically be written by the 7631.

Disk Storage Control Instruction Format

This section describes the instruction format of disk storage control instructions for use with the IBM 1301 Disk Storage and the IBM 1410 Data Processing System. The format of disk storage instructions is shown in Figure 11.

The various parts of the disk storage instruction and their functions are as follows.

Operation Code

Disk storage operations are initiated by a move (M) or load (L) operation type instruction. The move instruction specifies that data are to be read or written in the 6-bit mode. The load instruction designates 8-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 the proper coding relationship between data in core storage and disk storage.

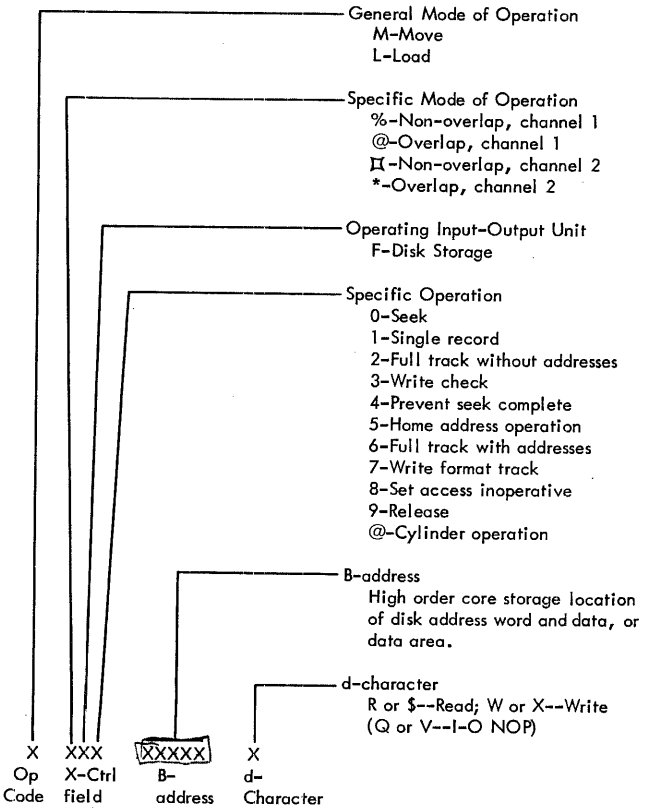


Figure 11. Disk Storage Operation Code Format

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 1301 disk storage 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 addresses
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 with word mark or the high order position of an 8 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 12); it specifies an access mechanism, a module number and a track address in the module except for the single record operation. Description of the disk address word for the single record operation will be made with that operation.

The high order position of the disk address word specifies the access mechanism. Because there is only one access mechanism per module, the access mechanism address is always zero. Modules are numbered from 0 through 9, depending upon 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 with word mark must appear in the core storage position to the immediate right of the disk address word. The disk address word, illustrated in Figure 12, addresses access mechanism 0, module 2 and track 7860AA.

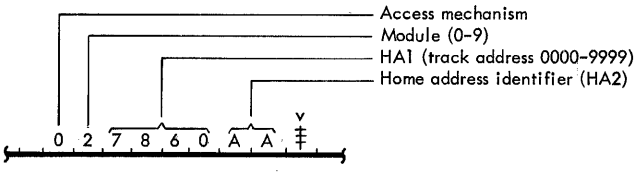


Figure 12. Core Storage Disk Address Word

Data to be written on disk follows the associated disk address word in core storage. Also, data read from disk is placed in core storage following its associated disk address word. A group mark with 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 13). The location of a disk address word and its related data field or data area is determined by the user.

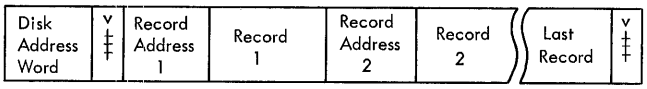


Figure 13. Core Storage Layout – Read or Write Full Track With Addresses

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 with word mark use the R or W d-character, respectively.

Read or write instructions which 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 will assume 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.

The disk address word must be eight characters in length to establish a valid length for disk address words. In some operations not all of the characters of the disk address word are essential to the operation. Portions which are not essential (not verified) may consist of any valid characters; characters not verified are parity checked, however. Figure 14 shows those operations which 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 ▨.

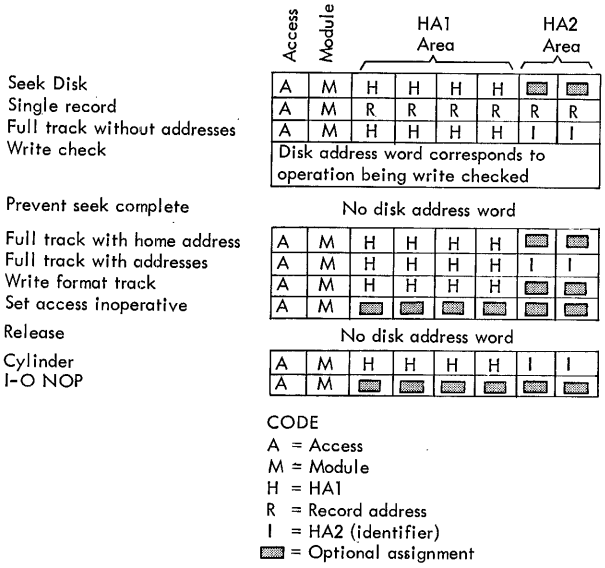


Figure 14. Disk Address Word Format

Disk Storage Control Instructions

Seek Disc (SD)

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

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 15).

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 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

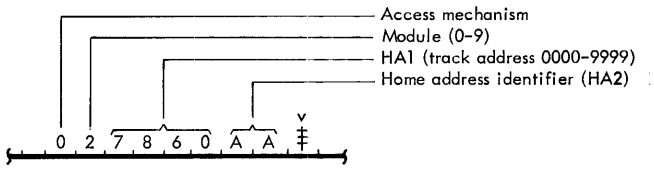


Figure 15. Core Storage Layout – Disk Address Word

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.

Write Format Track (WFO)

Op Code	*X-control field*	*B-address*	*d-character*
M	xF7	xxxxx	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 with word mark of the disk address word in core storage (Figure 16). The core storage format control record must be in the format as described under "Planning the Format Track."

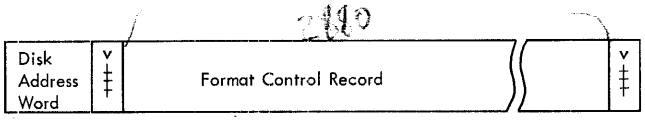


Figure 16. Core Storage Layout — Write Format Track

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 number one can be any address from 0000 to 0049. The HA2 portion of the disk address word is not machine verified, therefore can be any desired characters.

If disk end-of-format track is sensed prior to the group mark with 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 (1301) 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	xxxxx	W or X

Function: A track of data consisting of a home address two (HA2), record addresses and records is written on a data track from core storage. The data to be written follow the group mark with word mark character of the disk address word in core storage (Figure 17).

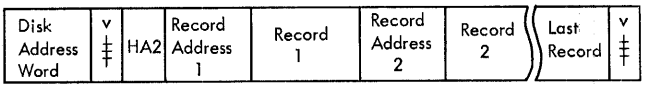


Figure 17. Core Storage Layout — Write/Read Full Track With Home Address

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 areas 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 with word mark is sensed prior to 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 prior to the group mark with 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, located on the 7631, must be on to perform this operation.

Read Full Track With Home Address (RHA)

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

Function: A track of data consisting of a home address two (HA2), record addresses, and records are read from the addressed disk track and placed in core storage to the right of the group mark with word mark of the disk address word for this instruction (Figure 17). The operation continues until a group mark with 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 with 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 prior to the group mark with word mark the wrong length record indicator is set ON and the operation stops.

Write Full Track With Addresses (WFT)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF6	xxxxx	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 follows the group mark with word mark character of the disk address word in core storage (Figure 18).

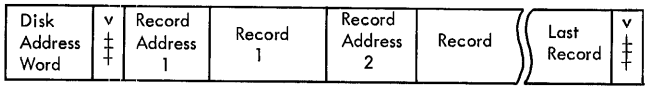


Figure 18. Core Storage Layout – Write/Read Full Track

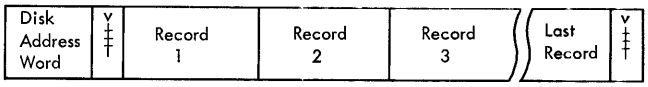


Figure 19. Core Storage Layout – Write/Read Full Track Without Record Addresses

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

If the group mark with word mark is sensed prior to 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 till the first end-of-record address or record is sensed. The operation then terminates.

If the group mark with word mark is sensed prior to 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 prior to the group mark with word mark, the wrong length record indicator is set ON and the operation stops.

Read Full Track With Addresses (RFT)

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

Function: A track of record addresses and data records are read from a disk track and placed in core storage to the right of the group mark with word mark of the disk address word for this instruction (Figure 18).

If the group mark with word mark is sensed prior to 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 prior to the group mark with 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 the 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	xxxxx	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 with word mark of the disk address word (Figure 19). 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 with word mark is sensed prior to 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 with word mark is sensed prior to 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 prior to the group mark with 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	xxxxx	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 with word mark following the disk address word for this instruction (Figure 19).

If the group mark with 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 prior to the group mark with 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@	xxxxx	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 20). Records written on disk must correspond to the disk record areas as defined by the format track of the cylinder.

If the group mark with word mark is sensed prior to an end-of-cylinder and not at the end of a record in the cylinder, the wrong length record indicator is set

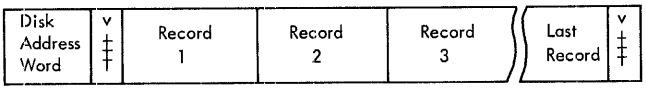


Figure 20. Core Storage Layout – Write/Read Cylinder Operation

ON and blanks are written on disk till the first end of record is sensed.

If the group mark with word mark is sensed prior to the end-of-cylinder but at the end of a record in the cylinder, the wrong length record indicator is *not* set ON and the operation stops.

If the end-of-cylinder is sensed prior to the group mark with 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@	xxxxx	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 with word mark following the disk address word for this instruction (Figure 20). Reading continues, record by record, track by track, through the cylinder.

If a group mark with word mark is sensed prior to 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 prior to the group mark with 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	xxxxx	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 21). 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 22). The data record in core storage must correspond

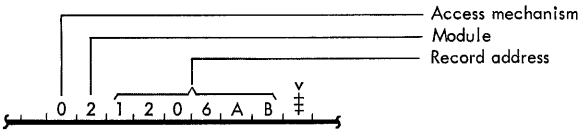


Figure 21. Disk Control Word – Write Single Record

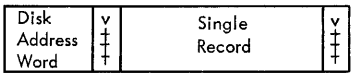


Figure 22. Core Storage Layout – Write/Read Single Record

to the record area on disk as prescribed by the format track.

If the group mark with word mark is sensed prior to 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 prior to the group mark with 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	xxxxx	R or $

Function: A single data record on a disk track is read and placed in core storage following the group mark with word mark of the disk address word for this instruction (Figure 22). Reading from disk starts with the first character of the addressed data record.

If the group mark with 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 prior to the group mark with word mark, the wrong length record indicator is set ON and the operation stops.

Write Disk Check (WDT)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF3	xxxxx	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 which occurred at some prior time. (See I-O NOP 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 upon 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 (1301) can be in either the read or write position.

Prevent Seek Complete (PSC)

Op Code	*X-control field*	*B-address*	*d-character*
M or L	xF4	xxxxx	W

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

The instruction turns on a latch, preventing seek complete signals produced by the sharing system from reaching the 1411 and causing an interrupt. The latch is turned off when the 1410 issues a seek instruction.

Either M or L operation codes may be used. The B-address must refer to a core storage location that contains a group mark with word mark.

Release (REL)

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

Function: This instruction is effective only with the 7631 Model 3. The 7631 Model 3 permits a 1410 Data Processing System and a 7000 Series Data Processing System to share 1301 Disk Storage. 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 attempts to issue a file instruction while the sharing system has control of the 7631, the 1410 will receive a busy indication. The B-address of the release instruction must refer to a core storage location that contains a group mark with word mark. The operation code may be M or L.

I-O No Operation (NOP)

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

Function: This operation is functional only on the 1410 system equipped with the priority processing feature. 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.

Example: Assume that seek instructions have been issued to several 1301 access mechanisms. The first access mechanism to reach its destination will cause an interrupt to the 1410 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 NOP 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 NOP 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 NOP 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 or L	xF8	xxxxx	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. The operation code may be M or L. 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

The input-output channel status indicators that can be set by a disk storage operation are outlined in Figure 23.

Disk Storage I-O Channel Status Indicators

The disk storage control indicators and their associated status conditions are as follows.

Not Ready

This indicator is set on if the 7631 File Control is off-line, if the 1301 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 is not available because it is being used by the other sharing system.

Indicator	Description	d-character Control Bit
Not ready	Access inoperative or 7631 off-line 7631 power off Home address switch check	1
Busy	Access in motion 7631 not available (model 3)	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
Wrong length	Short or long record	B

Figure 23. Disk Storage Input-Output Channel Status Indicators

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.

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 one, two or three and four can be used.)
5. Invalid track number check occurs when any of the four digits of the track number are not between 0 and 9.

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 1301.
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 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.

Timing Considerations

The disk rotation speed of 1790 revolutions per minute, combined with the data recording method, makes possible a maximum character rate of 70,000 or 90,000 characters per second. An entire cylinder (112,000 characters) can be read in approximately 1360 milliseconds. A whole module (28,000,000 characters) can be read in less than seven minutes. These timings include access motion time and rotational delay time, and are significant to timing estimates for such operations as file maintenance, audit trail preparation, and disk scheduling searching, where large volumes of data can be used in the same sequence in which the data are arranged in disk storage.

When reading or writing a series of tracks (cylinder operation), system time of 350 microseconds is provided at the end of the track to permit the verification of the home address (HA) of the next track to be processed. This allotted time permits the verification of the HA immediately following the end of the previously processed track instead of waiting for a disk revolution (33 milliseconds) to reposition the HA for verification.

In establishing job times for programs that make reference to individual records or groups of records in disk storage, the disk storage reference cycle is considered. A disk storage reference cycle includes the time required to complete all the disk storage operations for a particular processing operation. A typical disk storage reference cycle (move mode), assuming a random distribution of records within the disk storage module, is shown in Figure 24.

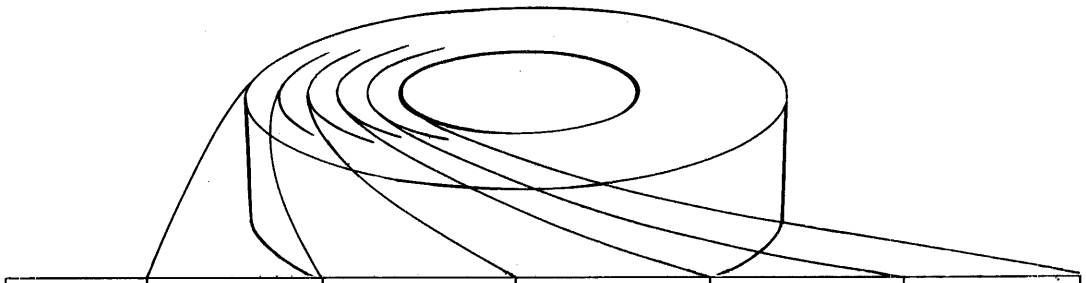
160 ms	Average access motion time	0
17 ms	Average rotational delay time	17
3 ms	Read (using a 270 character record)	3
31 ms	Available processing time before the record can be written back	31
3 ms	Write	3
31 ms	Elapsed rotation time before a WRITE DISK CHECK instruction can be executed	31
3 ms	WRITE DISK CHECK	3
248 ms	Total Disk Storage Reference Cycle Time	88

Figure 24. Disk Storage Reference Cycle

If the records in disk storage are arranged in such a way that no access motion time is required (all records for the job stored in the same cylinder), the total disk storage reference cycle time is reduced to 88 milliseconds (Figure 24). Thus, the distribution of records within disk storage has a great effect on total job time.

Access motion time within specific groups of ten adjacent cylinders is 50 milliseconds. Access motion time within specific groups of 50 adjacent cylinders is 120 milliseconds. To compute average data access time (the time required to seek a particular data record or track in disk storage), add 17 milliseconds average rotational delay time to access motion time.

Figure 25 shows access motion time between cylinders in a disk storage module.



Group 1	0000-0360	2000-2360	4000-4360	6000-6360	8000-8360
Group 2	0400-0760	2400-2760	4400-4760	6400-6760	8400-8760
Group 3	0800-0960	2800-2960	4800-4960	6800-6960	8800-8960
Group 4	1000-1360	3000-3360	5000-5360	7000-7360	9000-9360
Group 5	1400-1760	3400-3760	5400-5760	7400-7760	9400-9760
Group 6	1800-1960	3800-3960	5800-5960	7800-7960	9800-9960
	BLOCK 1	BLOCK 2	BLOCK 3	BLOCK 4	BLOCK 5
	0000-1960	2000-3960	4000-5960	6000-7960	8000-9960

NOTE: Numbers shown in the above chart are track numbers of the lowest numbered track in each cylinder and are the "cylinder addresses."

Examples: Group 1, Block 1 contains 10 cylinders (0000-0360) and 400 tracks (0000-0399);
Group 3, Block 1 contains 5 cylinders (0800-0960) and 200 tracks (0800-0999).

Access Motion Time is calculated as follows:

Movement between cylinders in the same group in a block is 50 milliseconds;

Movement between cylinders not in the same group in a block requires:

120 Milliseconds when within any one of the 5 blocks.

Examples, between cylinders 0000 and 0400; 0000 and 1960;

180 Milliseconds when between any of the 5 blocks.

Examples, between cylinders 1960 and 2000; 0000 and 9960.

To approximate average access motion time for a specific job (assuming a random distribution of records):

1. Determine the numbers of the cylinders to be used.
2. Select a used cylinder in the block that contains the most cylinders used.
3. From that cylinder:
   A. Count the number of cylinders used in the same group and multiply this count by 50 ms,
   B. Count the remaining number of cylinders used in the same block and multiply this count by 120 ms,
   C. Count the remaining number of other cylinders used in the disk storage unit and multiply this count by 180 ms,
   D. Divide the sum of A, B, and C by the total number of cylinders used.

Figure 25. Access Motion Time

1410/7000 Shared 1301 Disk Operation

The 7631 File Control Model 3 permits a 1410 Data Processing System and a 7000 Series Data Processing System to share 1301 Disk Storage. 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 or order. Execution of the release instruction or order disconnects the 7631 from the using system and makes it available to either sharing system.

Recognition of 7631 availability is as follows. Assume that system A has control of the 7631 and system B attempts to issue a disk storage instruction or order.

1. If system B is a 1410, the 1410 will receive a busy indication.
2. If system B is a 7090 or 7094, a channel interrupt will occur and turn on the adapter check indicator.
3. If system B is a 7080 and a transfer ready instruction (TRS 01) is not used before issuing the order, the channel will wait until the 7631 is available.
4. If system B is a 7070 or 7074, the channel will wait until the 7631 is available.

In programming a shared file system, one of the following two basic methods may be used, depending upon the application.

1. System A or B issues one or more seeks and retains control of the 7631 until all seek instructions or orders have been processed.
2. To permit the overlap of seek execution times, both systems issue a series of seek instructions before either system processes the seeks.

If the second method is used, each system must determine which seek complete signals are the result of seeks which it initiated, as opposed to a seek complete signal resulting from a seek issued by the sharing system. Seek complete signals are available to both systems when the 7631 is not under control of either system. When the 7631 is under control of one system, seek complete signals are available only to the controlling system.

Assume that the 7000 Series system will respond first to a seek complete signal. A sense instruction will be issued, thereby gaining control of the 7631. Upon examination of the sense bits, the system will determine if the seek complete signal was caused by a seek that it initiated. If it was, it will service the seek. If it was not, the 7000 Series system will release and allow the 1410 system to respond.

When the 1410 system (with priority processing feature) interrupts due to a seek complete, a series of Y(I)d tests are made to determine the nature of the interrupt. Having found that the interrupt was caused by a seek complete, each access mechanism which is seeking *due to 1410 initiation* must then be tested by issuing an I-O NOP instruction (M/L XFO BBBBB Q) to set the channel status indicators for the access mechanism. This is followed by an R(I)‡ to test for a busy condition.

The 1410 system (with priority processing feature) is provided with an instruction to prevent "unwanted" seek complete signals (interrupts) from reaching the 1410 when sharing a 7631 with a 7000 Series system. The prevent seek complete instruction (M/L XF4 xxxxx w) turns on a latch in the 1411 Processing Unit which blocks seek complete signals from reaching the 1411. This latch will be turned off (allowing seek complete signals) whenever the 1410 system issues a seek instruction.

Because fixed word length machines like the 7070/74 and 7090 must write addresses that are multiples of their word size, careful consideration must be given to address lengths when sharing files. In general, the 1410 system must defer to fixed word machines when sharing a common file area. To illustrate, consider the following example. Two records of 840 characters are to be written (full track with addresses) on the 1301 from 1410 storage. The two record numbers are 123401 and 123402. The home address is 555501. For each of the 1410/7000 combinations, the record in 1410 core storage would be as follows:

SYSTEMS	HA2	RECORD ADDRESS 1	RECORD 1	RECORD ADDRESS 2	RECORD 2
1410/7090	010000	123401	xx . . . xx	123402	xx . . . xx
1410/7080	01	123401	xx . . . xx	123402	xx . . . xx
1410/7070	0100000000	1234010000	xx . . . xx	1234020000	xx . . . xx

Note that in the case of the 1410/7090 the two digit home address identifier (HA2) must be written as six digits to conform to the 7090 word length. In the case of the 7070/74, the HA1 and record addresses must be 10 digits to conform to the 7070/74 word length.

Switches and Lights (7631 and 1301)

The control panel of the 7631, located on the right front cover, is primarily intended for maintenance purposes. In addition to the exposed section, the control panel has a covered section that is 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 engineer section contains thirty-five 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. Depression of this switch sequentially turns on the AC and DC power to the 7631 and attached 1301's. 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 and 1301's.

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

Power-Off Switch. Depression of this switch removes DC and AC power from the 7631 and all connected 1301's.

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

Write Inhibit Switch. This switch, when on, allows the customer engineer or diagnostic programmer 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 1301's are not available for normal customer use.

Thermal Light. This light automatically turns on if the internal machine temperature exceeds 115 degrees Fahrenheit. While the light is on, the power-on switch is not effective. DC power is off until the temperature in the 7631 returns to specified limits.

Fuse Light. This light is turned on and DC power is removed if the AC circuit breaker is tripped.

1301 Switches

Write Format Track Switch. This is a key-operated lock switch with a read (RD) and 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 module of the 1301 has its individual write format track switch.

3/62:10M-VO-32

IBM 1410 — IBM 1301 Printed in U.S.A. A22-6670

IBM®
International Business Machines Corporation
Data Processing Division
112 East Post Road, White Plains, New York