

CONTROL DATA® 6638
Disk File System

808 Disk File
Hydraulic Cabinet Assembly
6639 Disk File Controller

DESCRIPTION
OPERATION
PROGRAMMING

PRELIMINARY EDITION

Information presented in this edition is preliminary and subject to change. Any corrections necessitated by design changes and/or product improvement will be handled by standard manual revision procedures. Errors and suggestions should be communicated to Development Division, Technical Publications Department.



Preliminary Edition
REFERENCE MANUAL

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PART 1
DESCRIPTION

INTRODUCTION

The CONTROL DATA * 6638 Disk File System is a medium -access time, nonvolatile data storage device. A basic system consists of one 6639 Disk File Controller and one 808 Disk File System. An expanded system consists of two 6639 Disk File Controllers and 808 Disk File System. A disk file system consists of one 808 Disk File (referred to as "disk file") and one hydraulic cabinet assembly. A basic system maintains operations with up to two Data Channels, one at a time; and an expanded system maintains operations with up to four Data Channels, two at a time.

This manual provides specifications, programming information, and operation instructions for the controller. It also provides general information for the disk file. Refer to Table 1-1 for system specifications. This manual is intended for use by operators and programmers who are familiar with 6000 Series computer equipment.

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIPS

Two types of systems are available for interconnecting the Data Channels, controller, and disk file. These are a basic system and an expanded system. The basic system (refer to Figure 1-1) consists of one controller physically attached between the two Data Channels and one disk file. This allows the 10 Peripheral Processors in one or more 6000 Series computers to access the two Data Channels and the one disk file. The Data Channels may simultaneously sample the conditions in the disk file through the controller, but they can operate the controller and disk file on a time-shared basis only. The disk file is divided into two sections, unit 0 and unit 1, which are mechanically and electrically independent of each other. A Data Channel can communicate simultaneously with their selected disk file units. For example, if Data

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TABLE 1-1. DISK FILE SYSTEM SPECIFICATIONS

PHYSICAL DATA						
	<u>HEIGHT</u>	<u>DIMENSIONS WIDTH</u>	<u>DEPTH</u>	<u>WEIGHT</u>	<u>FLOOR LOADING</u>	<u>PAD LOADING</u>
Controller	56-7/8 in. (1.45 m)	42 in. (1.07 m)	20-1/2 in. (0.52 m)	658 lb (299 Kg)		
Disk File System						
Disk File	77 in. (1.96 m)	108 in. (2.75 m)	38 in. (0.97 m)	4000 lb (1815 Kg)	137 lb/ft ² (667 Kg/m ²)	51 lb/in. ² (3.58 Kg/cm ²)
Hydraulic Cabinet Assembly	60 in. (1.52 m)	29-1/2 in. (0.75 m)	39 in. (0.99 m)	1000 lb (454 Kg)	12 lb/ft ² (58.5 Kg/m ²)	13 lb/in. ² (0.91 Kg/cm ²)
ELECTRICAL REQUIREMENTS (APPROXIMATE)						
Controller	208 volts, 3 phase, 400 cycles, 2.3 amperes 120 volts, single phase, 60 cycles, 2.8 amperes					
Disk File System						
Disk File	120/208 volts, 3 phase, 60 cycles, 6 kilowatts					
Hydraulic Cabinet Assembly	120/208 volts, 3 phase, 60 cycles, 7 kilowatts					
ENVIRONMENTAL REQUIREMENTS						
	<u>TEMPERATURE</u>			<u>RELATIVE HUMIDITY</u>		
Operating	60°F (15.56°C) to 78°F (25.56°C) maximum gradient of 20°F (6.67°C) per hour			25% to 75% (provided there is no condensation)		
Storage and Shipping	-20°F (-28.89°C) to 125°F (51.67°C) maximum gradient of 50°F (10.0°C) per hour			5% to 95% (provided there is no condensation)		
Heat Dissipation						
Controller	4100 BTU/hr (1032 Kg-cal/hr)					
Disk File	20,500 BTU/hr (5016 Kg-cal/hr)					
Hydraulic Cabinet Assembly	Requires water, 70°F (21.11°C) at 4 gallons/minute (15.1 liters/minute)					

Channel A is operating with unit 0, Data Channel B must wait until Data Channel A relinquishes operations with unit 0 before it can resume operations with unit 0 or 1.

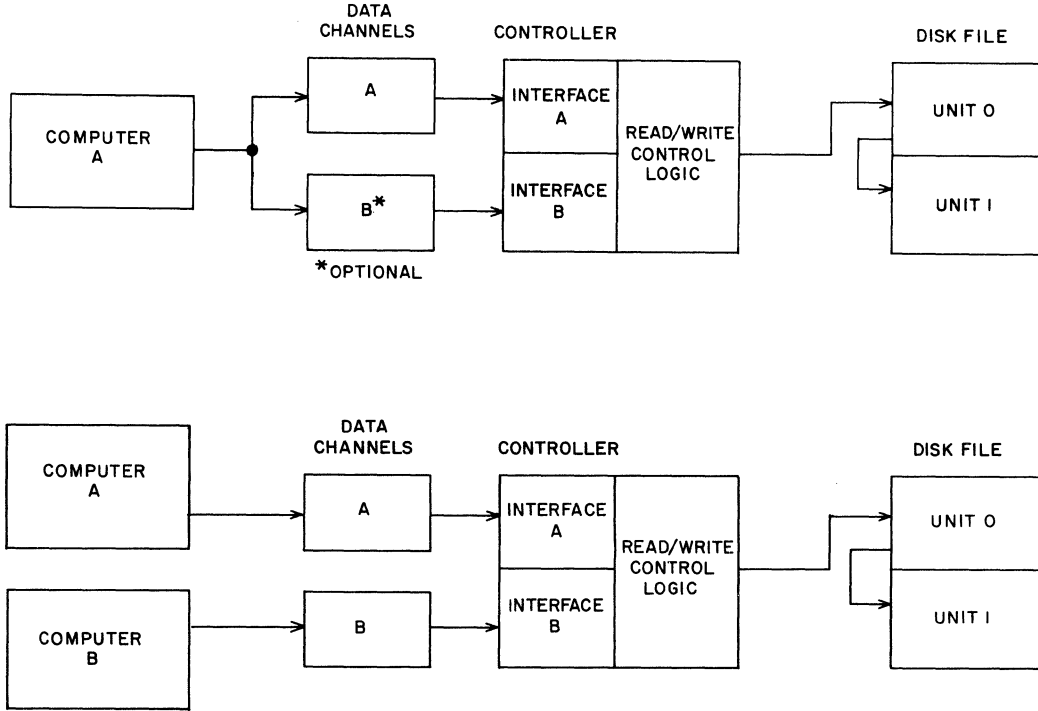
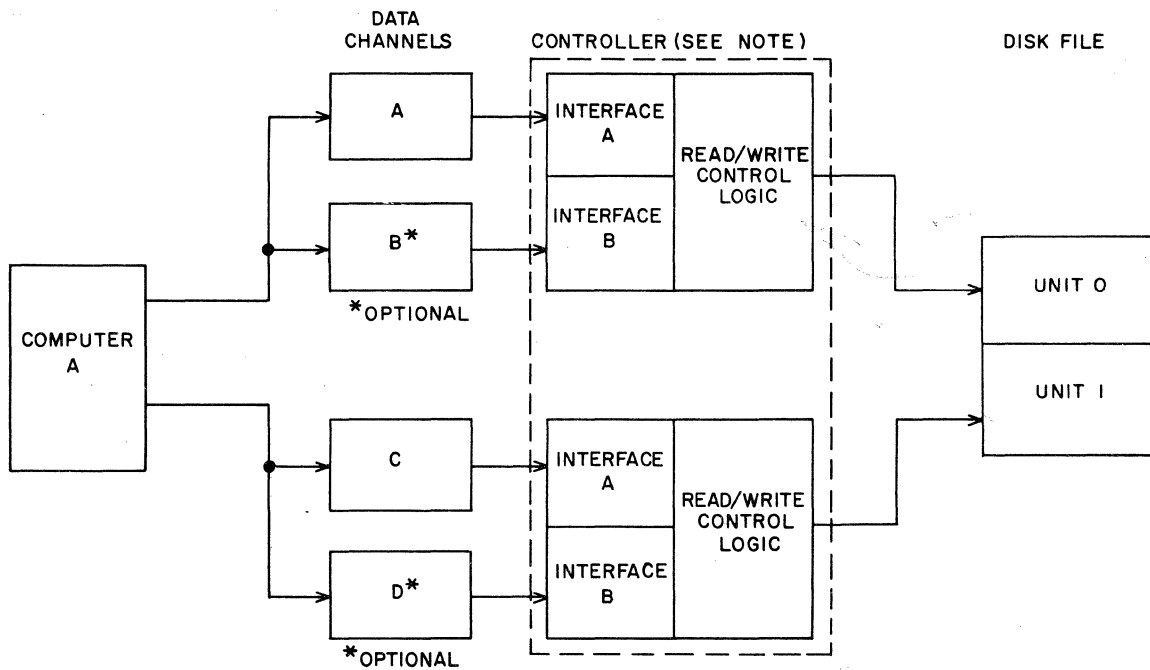


Figure 1-1. Basic System Configurations

The expanded system (refer to Figure 1-2) consists of two controllers* physically attached between four Data Channels and one disk file. Since a disk file contains two units, each connected to a controller and each capable of independent operation, it allows one or more 6000 Series computers, each controlling up to 10 Peripheral Processors, to perform simultaneous operations on both disk file units.

* The second controller is a standard option. Each of the controllers is slightly modified to permit the expanded mode of operation.



NOTE: BASIC CONTROLLER WITH STANDARD OPTION

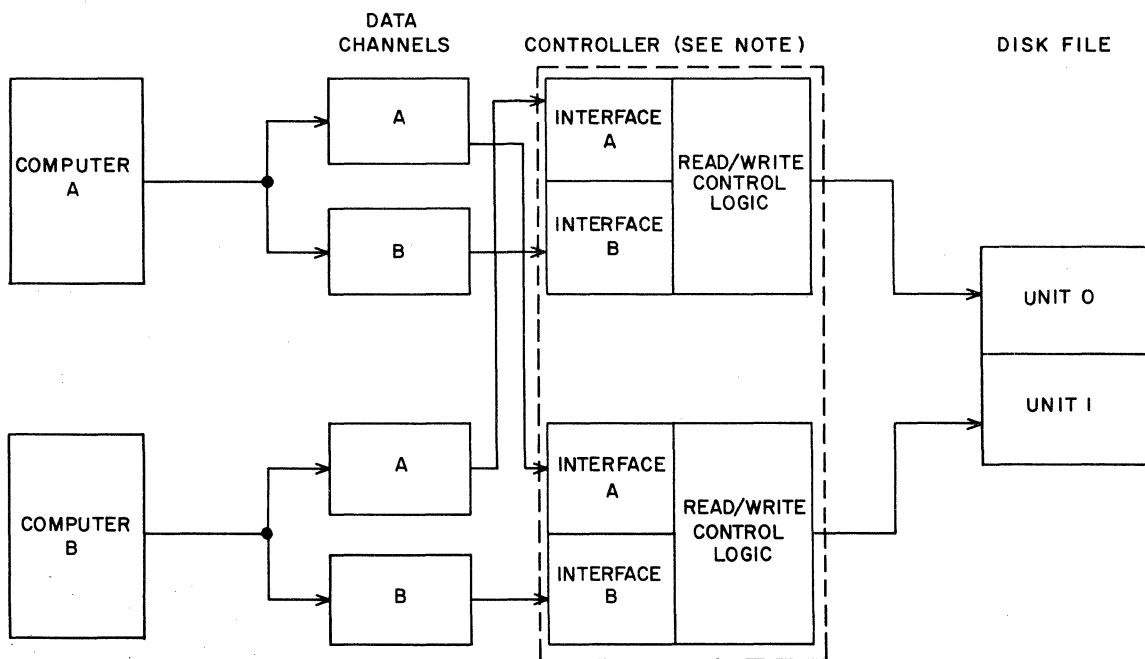


Figure 1-2. Expanded System Configurations

CONTROLLER CHARACTERISTICS

The controller operates as an interface between the computer and the disk file. It buffers data in a 12-bit, parallel format between the computer and disk file via the Data Channel. The controller translates function codes sent by the computer program to control operations in the disk file. These codes condition the controller to connect between the proper Data Channels and disk file and to check the status of conditions within the disk file. They determine from which area in the selected disk file unit the data is to be transferred. Finally, they select the operations that control the transfer of data. The controller provides timing and comparison circuits, registers, and the necessary logic to control and sequence the data handling operations.

The Data Channel issues a function signal and function word to the controller. The function signal causes the controller to sample the word and to define it as a function code. When the controller accepts a function word, it returns an Inactive signal to the Data Channel. The five function codes used in the system are normally issued in the following sequence: 1) Connect and Status, 2) Position Select, 3) Head Group Select, and 4) Read or 5) Write. If the function code is a Read, the Active signal (sent after the Read was replied to) signals the controller to start sending data. The controller then sends a data word together with a Full signal. When the Data Channel accepts the word, it sends an Empty signal, causing the controller to send the next word. The operations continue in this manner until the end of the read buffer. If the function code is a Write, the Active signal (sent after the Write) signals the controller that the Data Channel is ready to start sending data. The Data Channel sends a data word together with a Full signal. The controller accepts the word and returns an Empty signal, causing the Data Channel to send the next data word. The operation continues in this manner until the end of the write buffer.

The Data Channels connect to the controller on a first-come, first-served basis. The controller contains two interfaces, A and B, to accommodate the two Data Channels. If one Data Channel is connected, the other Data Channel cannot complete a connect. If both Data Channels attempt to connect to the controller at the same time, the channel wired to interface A is allowed to connect. The connected Data Channel retains its connect for 100 microseconds after an Inactive signal has been sent by the Data Channel. After the completion of a Read, Write, or Status operation, the Data Channel must issue a new function code within 100 microseconds to retain the connect. If a new function

code is not received within the 100-microsecond time period, the controller disconnects from the Data Channel and reverts to completing a connect on a first-come, first-served basis. A Position Select or Head Group Select function, however, reserves the connect indefinitely because the computer does not send an Inactive signal at the end of these operations.

When the controller receives a Position Select function, it causes the disk file positioner to seek a new position. When the positioner reaches a null, the disk file sends an On Point signal to the controller. The controller verifies the position address by comparing it with a Position code which has been prerecorded in serial form on one of the disk surfaces. One surface holds 32 position codes for one 18-disk group. If the Position code recorded on the track is equal to the position address specified by the function word, the read/write heads are correctly positioned. This, together with On Point and File Ready signals, causes the controller to become Ready. A Ready condition must be present before a Read or Write operation can take place. If a Not Ready comes up during a Read or Write operation, the controller returns an Inactive signal to the Data Channel. A Status, Position Select, or Head Group Select function can be performed when the controller is Not Ready.

DISK FILE CHARACTERISTICS

The disk file provides recording surfaces for mass data storage. Each disk file contains 72 disks divided into two units (designated unit 0 and unit 1) containing 36 disks each. Each 36-disk unit is divided into two 18-disk groups. The four 18-disk groups are mounted on two shafts so that an 18-disk group from each unit is mounted on the same shaft. Two 18-disk groups mounted on one shaft are a "stack". The disk file consists of stacks 0 and 1 (refer to Figure 1-3). Each shaft turns independently so that separate reference and timing signals are provided for each half (stack) of a disk file unit. The disks, together with the hydraulic positioner assemblies, the disk file logic, and the power supplies are contained in the 808 Disk File. The hydraulic cabinet assembly contains the hydraulic system, the air compressor, and the associated hardware.

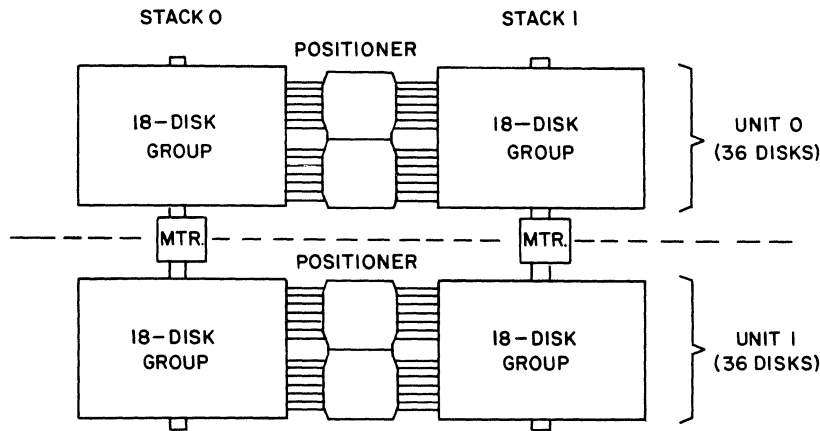


Figure 1-3. 808 Disk File Disk Groupings

Surfaces

Each of the two 18-disk groups within a disk file unit is divided into two nine-disk groups. Each disk file unit, therefore, contains four nine-disk groups. Each nine-disk group contains 18 disk surfaces of which 16 are used for data storage. The remaining two surfaces in each group are either used for data synchronization or are not used. An entire disk file contains 144 disk surfaces (eight nine-disk groups times 18 disk surfaces) consisting of 128 data storage surfaces (eight nine-disk groups times 16 data storage surfaces). The remaining 16 surfaces (eight nine-disk groups times two nondata surfaces) consist of 10 surfaces that are not used and six surfaces that are used to time Data Transfer operations. Four of the six surfaces are used for position verification. The remaining two surfaces contain write clock and sector marks for the two stacks.

Accessing

Each data storage surface is accessed by six read/write heads, of which three are selected at any one time. Since one head group contains 12 read/write heads, it accesses a total of 6 tracks on two disk surfaces at any one time. Since two head groups are used, this provides the capability of transferring 12 bits (1 byte) simultaneously to and from

the disk file. Thirty-two head groups are used to access one disk file unit. These 32 head groups are mounted on a movable assembly (positioner). For the entire disk file, two positioners are used containing a total of 64 head groups. There are 768 read/write heads (12 read/write heads times 64 heads) in the entire disk file. In addition, there are two fixed heads accessing the two disk surfaces which contain write clock and sector marks (refer to Figure 1-4).

Clock Track

Each data storage surface contains 192 tracks in which data can be recorded. The placement of data on each track is synchronized with pulses that have been permanently recorded on one track (clock track) of a nondata surface. The clock track contains 43,000 Write Clock pulses and 100 evenly spaced Sector Mark pulses. Each sector thus contains 430 Clock pulses (refer to Figure 1-5). In addition, there are 24 extra pulses which provide for closure and index mark jitter. One clock track is provided for each of the two stacks. Each clock track is accessed by a fixed head. Since the permanently recorded pulses on the clock track determine data placement, each track on a data surface is divided into 100 sectors and holds a maximum of 43,000 data bits minus preamble and postamble bits.

Records

A record refers to a quantity of data which is written continuously over one or more sectors. Writing starts at a selected sector mark and stops at the end of the buffer. Since the capacity of each Peripheral Processor memory is approximately 4000 words (4096 words minus the computer program), the practical record size is restricted to a maximum of 10 sectors. Each record written on a track contains a preamble of 80 bits and a postamble of at least 28 bits. Preamble and postamble bits are provided as gaps between records (refer to Figure 1-5). A record always begins with a selected sector mark as a reference point. The preamble contains alternating "0" and "1" bits. Two "1" bits in succession signify the beginning of data. Since each record requires at least 108 preamble and postamble bits, the transfer of larger records allows the utilization of more track surface for the recording of data (greater track efficiency). Refer to Table 1-2 for information on record sizes and their relationship to track and sector efficiency.

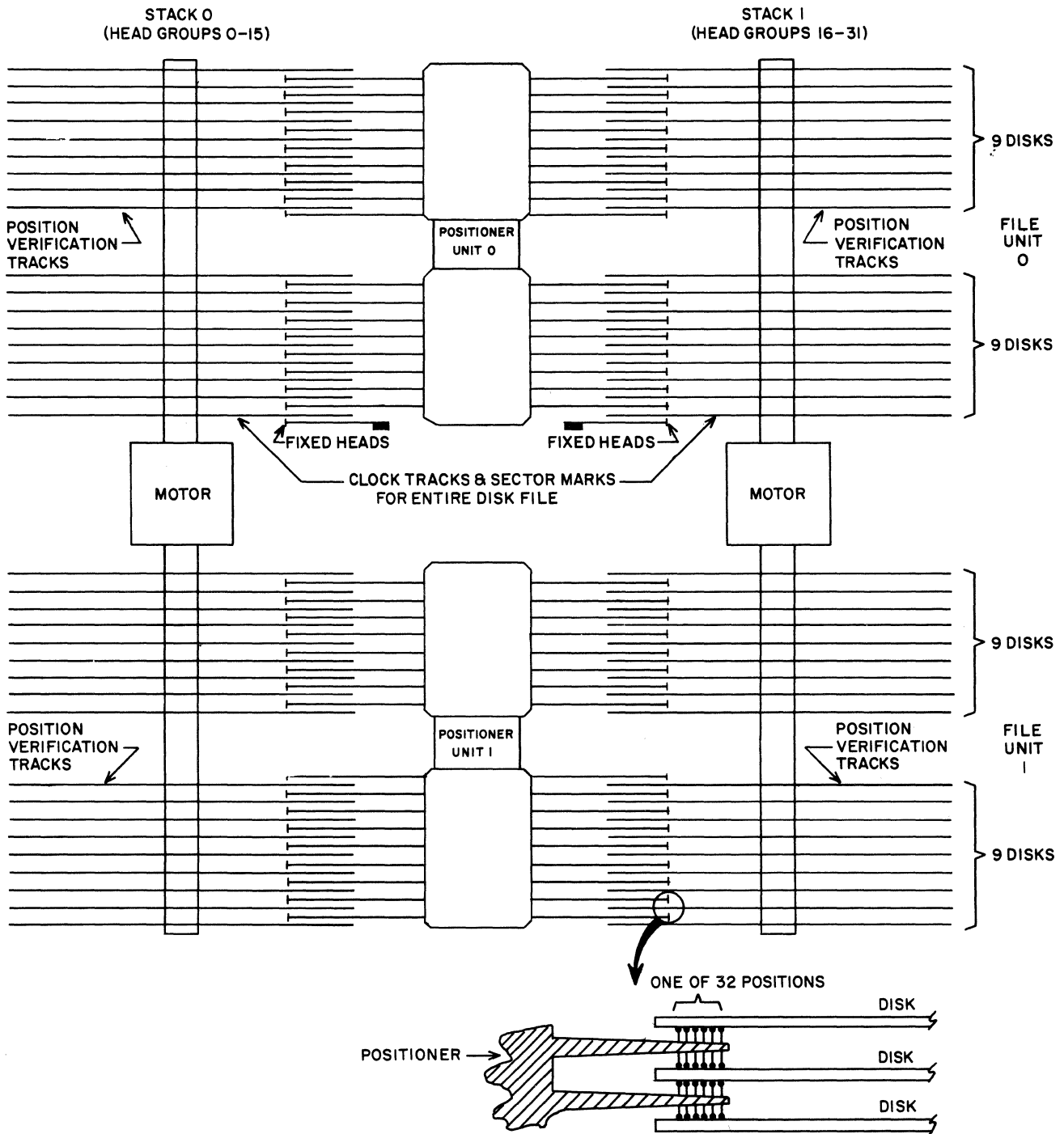
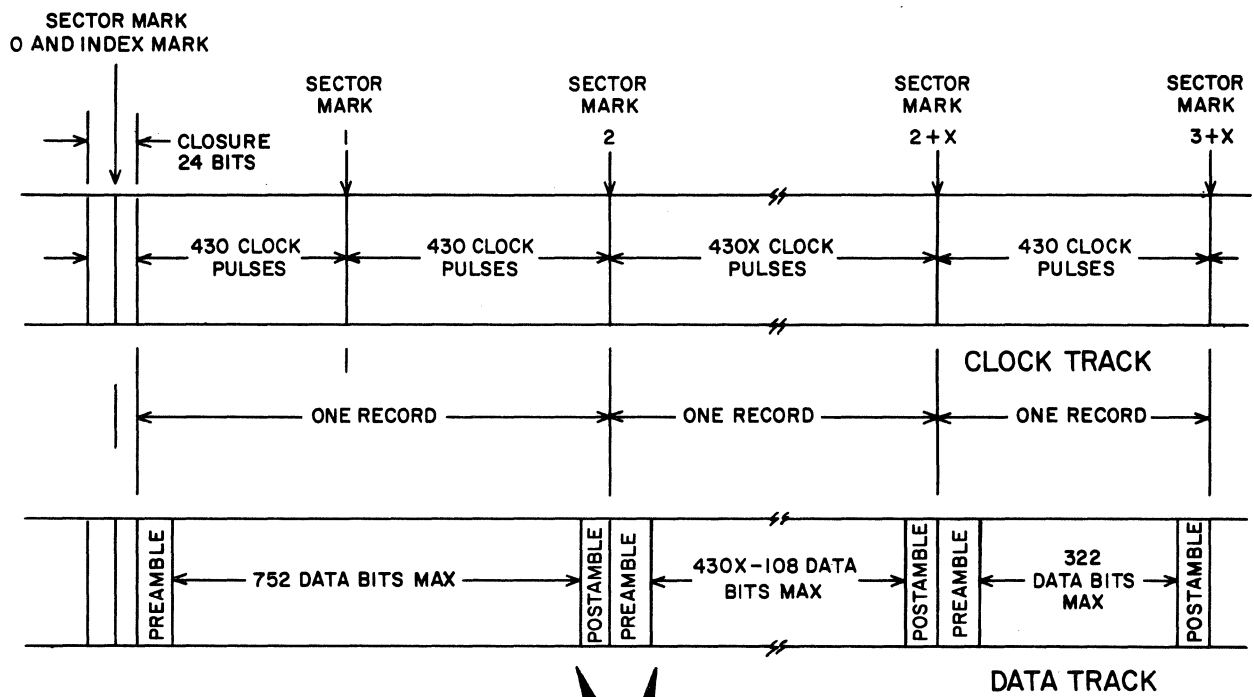


Figure 1-4. 808 Disk File Disks and Positioners



X = A QUANTITY OF SECTORS,
MAY BE 1 TO 100.

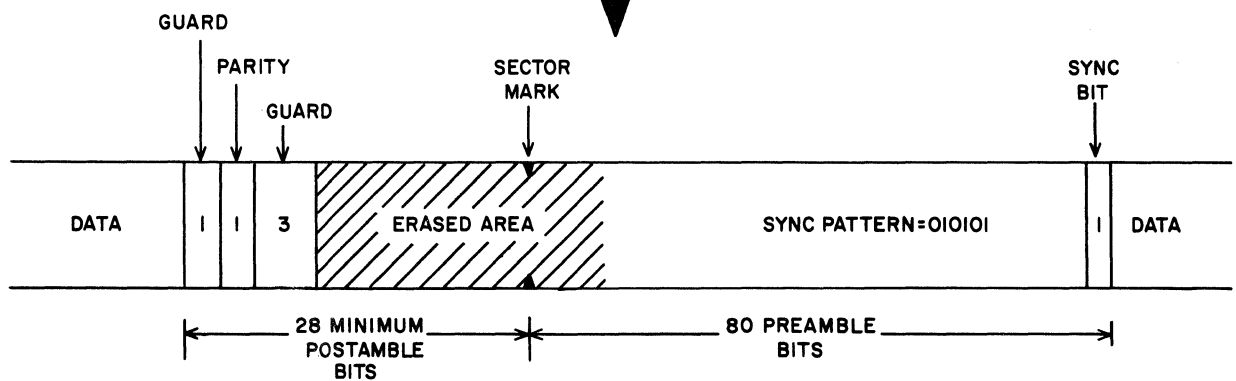


Figure 1-5. Track Formats

TABLE 1-2. TRACK AND SECTOR EFFICIENCY INFORMATION

NUMBER OF RECORDS	NUMBER OF SECTORS IN EACH RECORD	SIZE OF EACH RECORD (BITS OF DATA)	TRACK EFFICIENCY*	SECTOR EFFICIENCY**
100	1	1 to 322	0 to 75	100
50	2	323 to 752	38 to 87	100
33	3	753 to 1182	58 to 91	99
25	4	1183 to 1612	69 to 94	100
20	5	1613 to 2042	75 to 95	100
16	6	2043 to 2472	76 to 92	96
14	7	2473 to 2902	81 to 95	98
12	8	2903 to 3332	81 to 93	96
11	9	3333 to 3762	85 to 96	99
10	10	3763 to 4192	87 to 97	100

*Percentage of track used for recording data

**Percentage of available sectors in a track being utilized

Data Capacity

Each track has a maximum practical capacity of 41,920 data bits (10 records). One disk surface, therefore, can contain a maximum of 8,048,640 data bits (192 tracks times 41,920 data bits). An entire disk file can contain 1,030,225,920 data bits (128 data storage surfaces times 8,048,640 data bits) or 171,704,320 6-bit characters.

Head Groups

Each disk file unit contains 32 head groups selectable by function. Each head group contains 12 read/write heads. Since the 32 head groups are mounted on one positioner, internal electronic switching is provided to allow 384 tracks to be accessed at one position (32 head groups times 12 read/write heads provides for the accessing of 384 tracks). Each stack in the disk file contains 16 head groups. The head groups in stack 0 are designated 0 through 15₁₀, and the head groups in stack 1 are designated 16₁₀ through 31₁₀. The head groups are designated identically in both disk file units.

Positions

The positioner in each disk file unit can move to 32 positions which are selectable by function. The positioner in each disk file unit is capable of accessing 12,288 data tracks (32 positions times 384 data tracks). Also, each positioner can move to a nondata or retract position, selectable by function.

PART 2
OPERATION

To bring the system up from a power-off state, turn on the main 400- and 60-cycle distribution power. The distribution boxes are usually located on a wall adjacent to the disk file and controller. Perform the following procedures:

- 1) Check that circuit breaker CB1 in the controller is turned on.
- 2) Open the end panel on the disk file to expose the maintenance panel. Make sure that all the toggle switches are in the down position (automatic operation) and that all the circuit breakers are turned on.
- 3) Press the START indicator switch on the end panel.
- 4) Open the large panels on the back side of the disk file to expose two maintenance panels. The top maintenance panel is for unit 0 and the bottom panel is for unit 1. Place the MODE switches on both panels in the NORMAL position.
- 5) Allow the disk file to run for 15 to 20 minutes. At the end of this time, check to see that the HYDRAULIC OIL TEMP indicators on the end panel are not lighted. Also, the two READY indicators on the front side of the disk file should be lighted.
- 6) Issue an instruction to select one position (from 0 through 31) from program control to each disk file unit. This moves the disk file positioners off the retract position. The controller and disk file are now ready for program operation.



PART 3
PROGRAMMING
FUNCTION CODES

CONNECT AND STATUS

This code interconnects the Data Channel, controller, and disk file. It also causes the controller to return one of two status words to the Data Channel. The code bit assignment is shown in Figure 3-1.

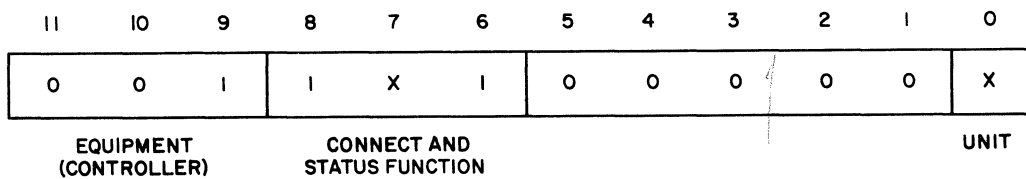


Figure 3-1. Connect and Status Function Word

Bits 9-11

These bits designate the equipment code number (controller) to which two Data Channels are wired. If desired, the equipment code number can be altered by a small wiring change.

Bits 6-8

This bit combination attempts to connect the controller to the Data Channel, and it designates one of two formats of a status word to be returned by the controller. If bit 7 (17XX) is a "1", the controller responds with the first status word. If bit 7 (15XX) is a "0", the controller responds with the second status word. Either bit combination attempts to connect the controller to the Data Channel. Whether or not a connect is made, the controller responds with the status word designated by bit 7. If a connect is not made, any functions other than status hang up the channel.

Bits 1-5

These bits are not used.

Bit 0 (Not applicable if the standard option is used)

This bit designates one of two disk file units to be selected. All further operations are performed on the selected unit.

First Status Word

When bit 7 of the Connect and Status function code is a "1", the controller returns the status word shown in Figure 3-2.

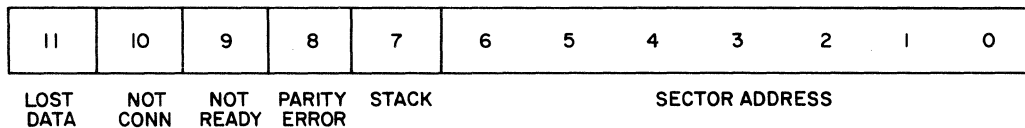


Figure 3-2. First Status Word

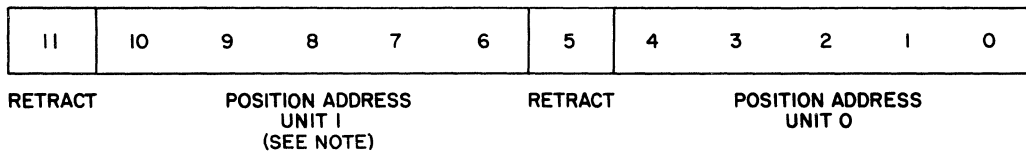
- 1) Bit 11: This bit is a "1" if a Lost Data condition occurs during a Read or Write operation. For example, the input or output buffer must follow a Read or Write function, respectively, within 90 microseconds or data is lost. The lost data bit remains present until a new Read or Write function is issued. If a lost data error occurs, the controller returns an Inactive signal to the Data Channel.
- 2) Bit 10: This bit is a "1" if the Data Channel has failed to connect to the controller because the controller has already been connected by the other Data Channel. No function other than status can be performed until a connect has been made.
- 3) Bit 9: This bit is a "1" when a Disk File Fault condition exists or when the disk file accessing mechanism is not yet verified as being "on track". No functions other than status can be performed when a Disk File Fault condition

exists. All functions except a Read or Write can be performed when not on track. Any Read or Write function that is attempted when the disk file accessing mechanism is not on track is held up until on track is verified.

- 4) Bit 8: This bit is a "1" if a parity error was detected at the end of a Read operation, and it remains present until a new Read or Write function is issued by program control.
- 5) Bit 7: This bit indicates to which stack the sector address (bits 0-6) refers. When this bit is a "0", stack 0 was the last stack used; when the bit is a "1", stack 1 was last used. This bit is always equal to bit 4 of the last Head Group Select function code.
- 6) Bits 0 through 6: These bits indicate the sector count plus one of the sector currently under the read/write heads. These bits are derived from the Sector Mark counters, and they reflect the sector address from the stack designated by bit 7.

Second Status Word

When bit 7 (17XX) of the Connect and Status function code is a "0", the controller returns the status word shown in Figure 3-3. This word indicates the last position addresses issued from the controller to each of the disk file units.



NOTE: If the standard option is used, bits 6 through 11 are zeros.

Figure 3-3. Second Status Word

POSITION SELECT

This code causes the access mechanism to seek one of 32 positions in the disk file (refer to Figure 3-4).

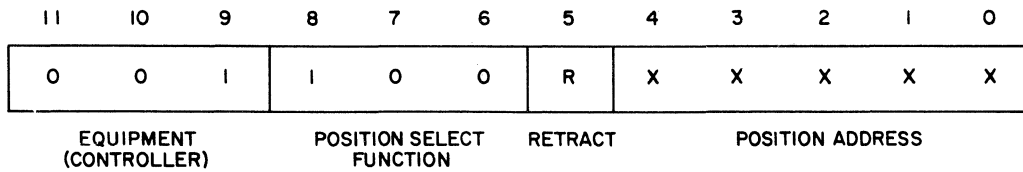


Figure 3-4. Position Select Function Word

Bits 9-11

These bits designate the controller to which the data channels are wired.

Bits 6-8

These bits designate the Position Select function.

Bit 5

When this bit is a "1", it causes the positioner to withdraw the read/write heads from the data zone to a nondata zone. This withdrawn position is provided as a standby location in which the read/write heads may reside with a low risk of data loss in the event of hardware failure.

Bits 0-4

These bits designate one of 32 positions in the disk file which are available to the access mechanism.

HEAD GROUP SELECT

This code causes the selection of one of 32 head groups in the disk file (refer to Figure 3-5).

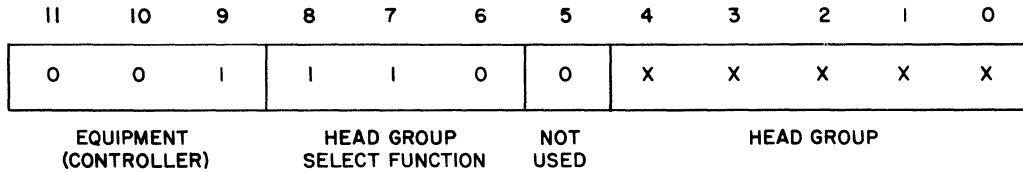


Figure 3-5. Head Group Select Function Word

Bits 9-11

These bits designate the controller to which the data channel is wired.

Bits 6-8

These bits designate the Head Group Select function.

Bit 5

This bit is not used.

Bits 0-4

These bits select one of 32 head groups in the disk file. When bit 4 is a "0", a head group in stack 0 (head groups 0 through 15) is being selected, and when bit 4 is a "1", a head group in stack 1 (head groups 16 through 31) is being selected.

WRITE

This code initiates a variable-length Write operation in the disk file (refer to Figure 3-6). The controller automatically generates and writes a check byte at the end of the write buffer. This byte is checked at the end of each Read operation to verify the accuracy of data transmission. Writing is end-around within a head group.

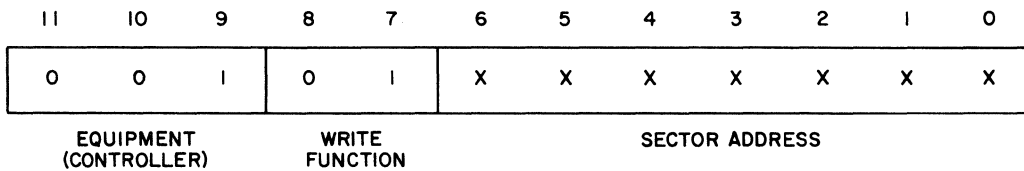


Figure 3-6. Write Function Word

Bits 9-11

These bits designate the controller to which the Data Channel is wired.

Bits 7 and 8

These bits designate the Write function.

Bits 0-6

These bits designate the address of the sector mark at which the Write operation is to begin.

READ

This code initiates a variable-length Read operation in the disk file (refer to Figure 3-7). At the end of the input buffer, the controller checks the next byte read from the disk file

to verify the accuracy of data transmission. This byte was generated and written by the controller during the Write operation. Reading is end-around within a head group.

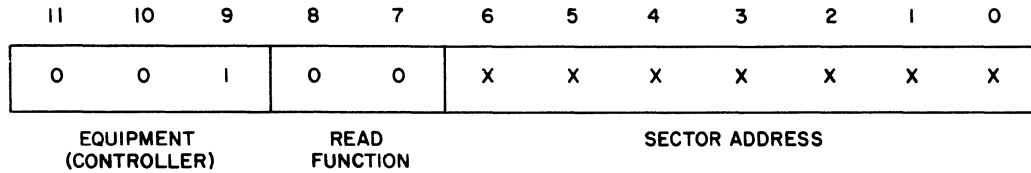


Figure 3-7. Read Function Word

Bits 9-11

These bits designate the controller to which the Data Channel is wired.

Bits 7 and 8

These bits designate the Read function.

Bits 0-6

These bits designate the address of the sector mark at which the Read operation is to begin.

PROGRAMMING CONSIDERATIONS

After a connect has been made, functions can be issued in any order provided that not more than 100 microseconds have elapsed between any deactivate (the Data Channel sends an Inactive signal to the controller to disconnect it) and the next function. Normally, functions are issued in the following sequence: Connect and Status, Position Select, Head Group Select, and Read or Write. Once a position and a head group have been selected, it is not necessary to reselect them for subsequent operations.

For optimum utilization of the disk file system, two processors should be used. However, if one processor is used to perform alternate sector type operations, a Head Group function can be issued at the end of one record to retain the connect and lock out the other channel while internal transfers between the Peripheral and Central Processors are carried out. If it is subsequently determined that the controller can be released, an activate-deactivate can be used. The deactivate causes the controller to disconnect in 100 microseconds. A new connect is then necessary before further operations can take place.

At the end of a Read or Write operation, a status check should be performed to check for abnormal conditions such as Lost Data, Not Connected, Parity Error, or Not Ready. Status checks performed between sectors must be part of a very rapid sequence. If the postamble is of minimum size (28 bits), there will be only about 30 microseconds to perform the following:

- 1) Check the Data Channel to see if it is active or if it was deactivated by the controller.
- 2) Deactivate the Data Channel if at the end of the buffer and the Data Channel is still active.
- 3) Issue connect and status function word.
- 4) Activate the Data Channel.
- 5) Input the status word.
- 6) Check the status word.
- 7) Deactivate the Data Channel.
- 8) Issue a new function word.

POSITIONING TIMES

There are eleven major positions spaced 0.370 inch apart. Each major position includes two minor positions spaced 0.020 inch to the right or left of each major position. This results in 33 possible positions of which 32 (positions 0 through 31) are available as data positions under program control. Refer to Figure 3-8 for position assignments. Position and access time are as follows:

	Milliseconds (maximum)
Adjacent major move	45
Average of several maximum positioning times between extreme major positions	110
Single minor move (0.020 inch)	20
Double minor move (0.040 inch)	25
Verification time	250 (microseconds maximum)
Latency time	52
Average of several worst-case access times (access time includes positioning, verification, and latency times)	162.25

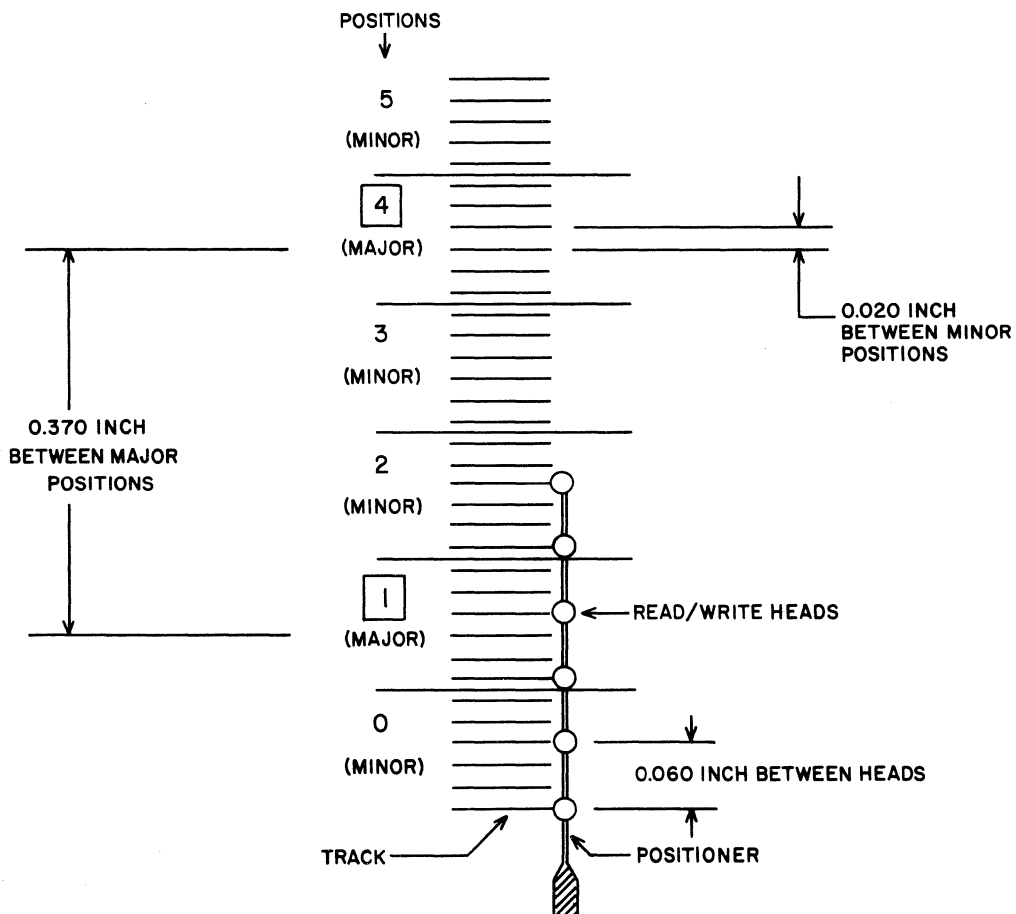


Figure 3-8. Major and Minor Positions

HEAD SWITCHING

Since the preamble and postamble gap between sectors is at least 108 bits (129.6 microseconds) and head switching time is approximately 60 microseconds, the read/write heads can be switched between sectors. If the switching involves a new stack, there is a delay of at least 4 milliseconds before a Ready is present. This time is needed for the disk file positioning mechanism to send an On Point signal to the controller.

SEEK OVERLAP AND POSITION HOLD

Each disk file unit stores the last position and head group address issued to it. Thus, it is possible to have one disk file unit positioning while the other unit is reading, writing, switching heads, or positioning. It is also possible to have both units retain their position so that a larger amount of disk storage surface is available with no positioning delay. To transfer operations from one disk file unit to another, a Connect and Status function must be issued. There are three restrictions to these capabilities:

- 1) A Not Ready is present for at least 4 milliseconds after any Position Select function is issued.
- 2) There may be a delay of up to 250 microseconds to verify the new position when the operation is transferred to another unit.
- 3) If the operation is transferred to a new stack, there will be a delay of at least 4 milliseconds.

DATA TRANSFER RATES

Data transfer takes place at the following rates:

- 1) The parallel 12-bit (byte) transfer rate is a nominal 847 kc.
- 2) The nominal bit-to-bit (or byte-to-byte) transfer rate is 1.18 microseconds.

APPENDIX A

Insertion of the following changes make this manual correct through Product Designation 6638-A02.

On page 1-5, change the fourth sentence of the second paragraph to read:

"Normally, functions are issued in the following sequence: 1) Connect and Status, 2) Position Select, 3) Head Group Select, and 4) Read or 5) Write."

On page 1-5, beginning with the fifth sentence of the last paragraph, delete the remainder of the last paragraph.

On page 1-6, delete the partial paragraph at the top of the page.

On page 1-6, change the last sentence of the second paragraph to read:

"A Status or Head Group Select function can be performed when the controller is Not Ready." Add the following sentence: "A Position Select function will be held up until an On Point signal is received."

On page 3-3, add the following sentence to the remainder of step 3) at the top of the page: "A Position Select function is issued to the disk file only when an On Point signal is present."

On page 3-7, add the following:

0	0	1	1	X	1	1	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

EQUIPMENT FUNCTION
 DISCONNECT

Figure 3-7A. Function Disconnect Word.

"The 1740 function disconnects the Data Channel from the controller approximately 100 microseconds after an instruction is executed. The controller will not respond with a status word after the disconnect function."

On page 3-8, change step 1) of the second paragraph to read:

"Check channel activity to see if the Data Channel was deactivated by the controller."



COMMENT SHEET

CONTROL DATA 6638 DISK FILE SYSTEM

(6639 Disk File Controller)

Reference Manual

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