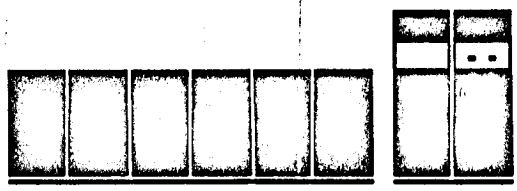
GENERAL ELECTRIC
COMPUTERS

Saltzer

# Disc Storage Subsystem



DSU270

GENERAL ELECTRIC

CPB-1419

| GENERAL ELECTRIC<br>INFORMATION SYSTEMS DIVISION<br>COMPUTER EQUIPMENT DEPARTMENT | PERIPHERAL EQUIPMENT<br>TECHNICAL INFORMATION BULLETIN | DATE<br>Sept. 1968 |
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| | | NO.<br>600-224 |
| SUBJECT Revs. to following areas: Dimensions, Data Stor., Resetting Status, Priority Status, Data Transf. & Operating. | | REF.<br>CPB-1419 |

Replace the following pages with new revised sheets for the DSC270 Disc Unit Subsystem reference manual, CPB1419:

1. Page 4: Correction in cable length. Page 3 - No Change.

2. Page 9: Corrected typographic error: (50 tracks/zone). Page 10, NC.

3. Page 14: Correction to Paragraph 2 under Resetting Status. Pg.13,NC.

4. Page 16: Corrections under Priority of Status. Check Alert paragraph and last consecutive Sector paragraph. Pg. 15, NC.

5. Page 19: Additions to Write and Verify Update paragraph, and addition to Read Update paragraph. Pg. 20, NC.

6. Page 21: Addition to Operating Instructions, Control/Indicator. Pg. 22, NC.

This Technical Information Bulletin is the first TIB to be issued which applies to this manual.

It is suggested that this cover sheet be placed in the front of the manual to serve as a quick check that the changes made by this TIB have been incorporated into the manual.

CPB-1419

# Disc Storage Subsystem

## REFERENCE MANUAL

DSU270

May 1968

INFORMATION SYSTEMS

GENERAL ELECTRIC

# Contents

# Illustrations

# 1. General Description

The General Electric DSU270 Fixed Head Disc Storage Subsystem provides computer users with large capacity, direct access storage of information. This subsystem greatly extends the usefulness of the General Electric processing systems by providing rapid, random access retrieval of stored data.

The capability for rapid information retrieval is a key element in General Electric's Integrated Data Store system. The subsystem serves as an extension of the processing system's core storage. The IDS system replaces the individual files of conventional business information systems with a single, consolidated, interrelated file. This file is organized to take advantage of the random access capabilities of the subsystem.

The data communications equipment available with General Electric Information Processing Systems enables inquiries from remote locations to be made of records stored in the subsystem. Current answers can be supplied automatically within seconds.

The minimum DSU270 subsystem consists of a DSC270 controller, a DFE270 file electronics unit, and a DSU270 disc storage unit. This minimum subsystem provides a total storage capacity of 15.36 million six-bit characters. A maximum subsystem consists of a controller, four file electronics units, and twenty storage units. The maximum subsystem provides a total storage of 307.2 million six-bit characters.

The controller is packaged as a freestanding unit and communicates directly with a high-speed channel in the processing system. The file electronics unit contains the power supply, air supply, and device-oriented electronics for a maximum of five storage units. The electronics unit and its associated storage units, packaged in separate cabinets, are connected at the time of installation.

Checking capability is built into the subsystem to ensure highly accurate data transfers and trouble-free operation. The subsystem automatically transmits status information reflecting its general state and allows the processing system to monitor operations and initiate operator messages and corrective routines.

The subsystem hardware provides a means for users to shorten the average latency time by choosing a particular sequence of operations. (See page 12.)

Switches are provided which will prevent writing on individual discs or on all discs attached to a file electronics unit. These switches do not affect read operations.

## ADDITIONAL DATA CHANNEL OPTION (ADC270)

The user may add an additional data channel, providing a dual-channel controller. When the additional channel is installed, the channels have the capability of simultaneous instruction communication and data transfers, with the restriction that simultaneous data transfers cannot occur within the same file electronics unit.

## SUBSYSTEM CONFIGURATIONS

Figures 1 and 2 illustrate the minimum and maximum configurations possible.

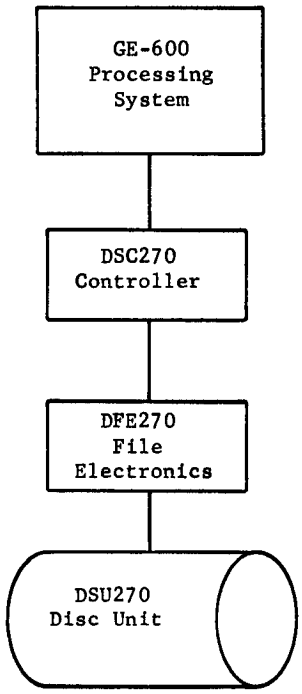
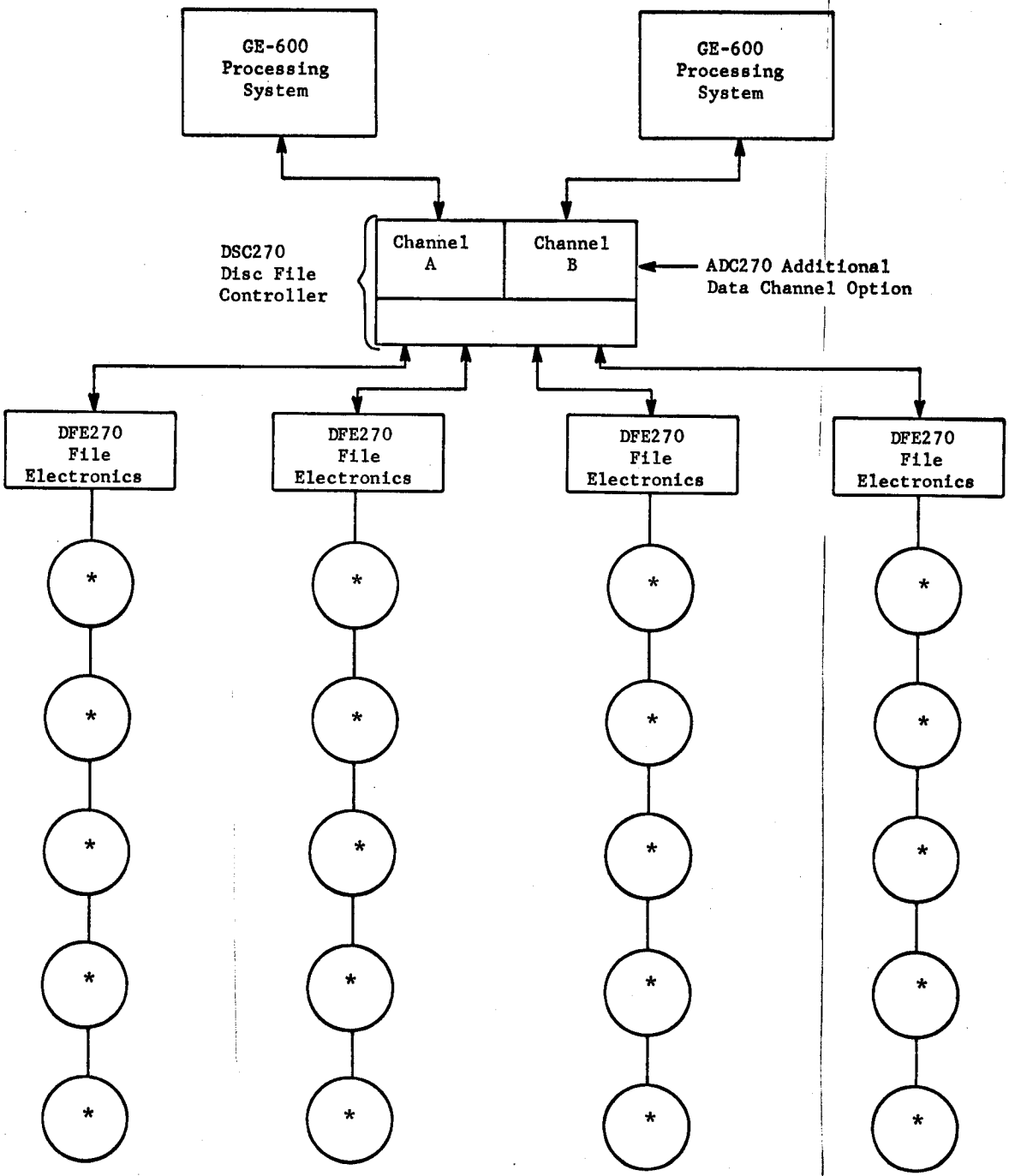



Figure 1. Minimum Subsystem Configuration




*DSU270 Storage Unit

Figure 2. Maximum Subsystem Configuration

## INSTALLATION REQUIREMENTS

Figure 3 lists the dimensions of the subsystem modules.

| | Controller | File Electronics | Storage Unit |
|---|---|---|---|
| Height | 66 inches | 53 inches | 53 inches |
| Length | 44 inches | 23 inches | 23 inches |
| Depth | 27.5 inches | 45 inches | 45 inches |
| Weight | 1200 pounds | 450 pounds | 575 pounds |

Figure 3. Subsystem Dimensions

Clearance of four feet in front and on the left (file electronics) end, and one and one-half feet in the rear of the DFE and DSU units is required for operation and maintenance. The controller requires three feet in the front and in the rear. The maximum cable length to the controller is 150 feet.

Operating environmental requirements are as follows:

| | |
|---|---|
| Temperature | 65 to 80 degrees Fahrenheit |
| Relative Humidity | 40 to 60 percent |

Power requirements are listed below:

208 or 230 VAC from 3 phases and neutral

63 amperes maximum current for a File Electronic Unit with five storage units

# 2. Functional Capabilities

## CONTROLLER

The controller contains the electronics linking the processing system and subsystem. It receives and interprets instructions from the processing system and transmits them to the file electronics, transmits data to and from the processing system, and monitors the operating state of the subsystem. See Figure 4.

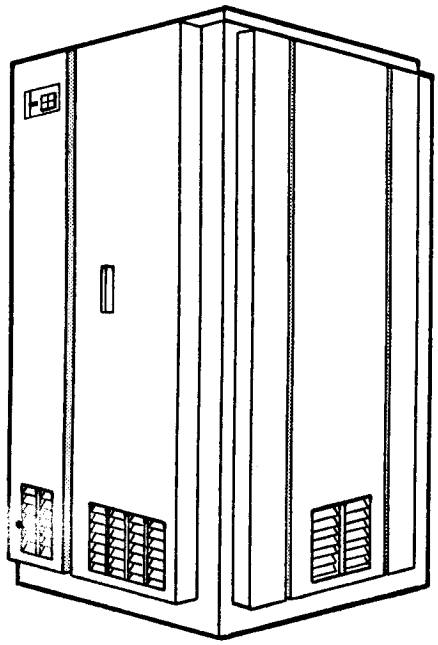


Figure 4. DSC270 Controller

## FILE ELECTRONICS UNIT

The file electronics unit contains the power supply, air supply, and logic necessary for communication and control between the controller and the storage unit(s). At the user's site, the electronics unit is attached to from one to five storage units. See Figure 5.

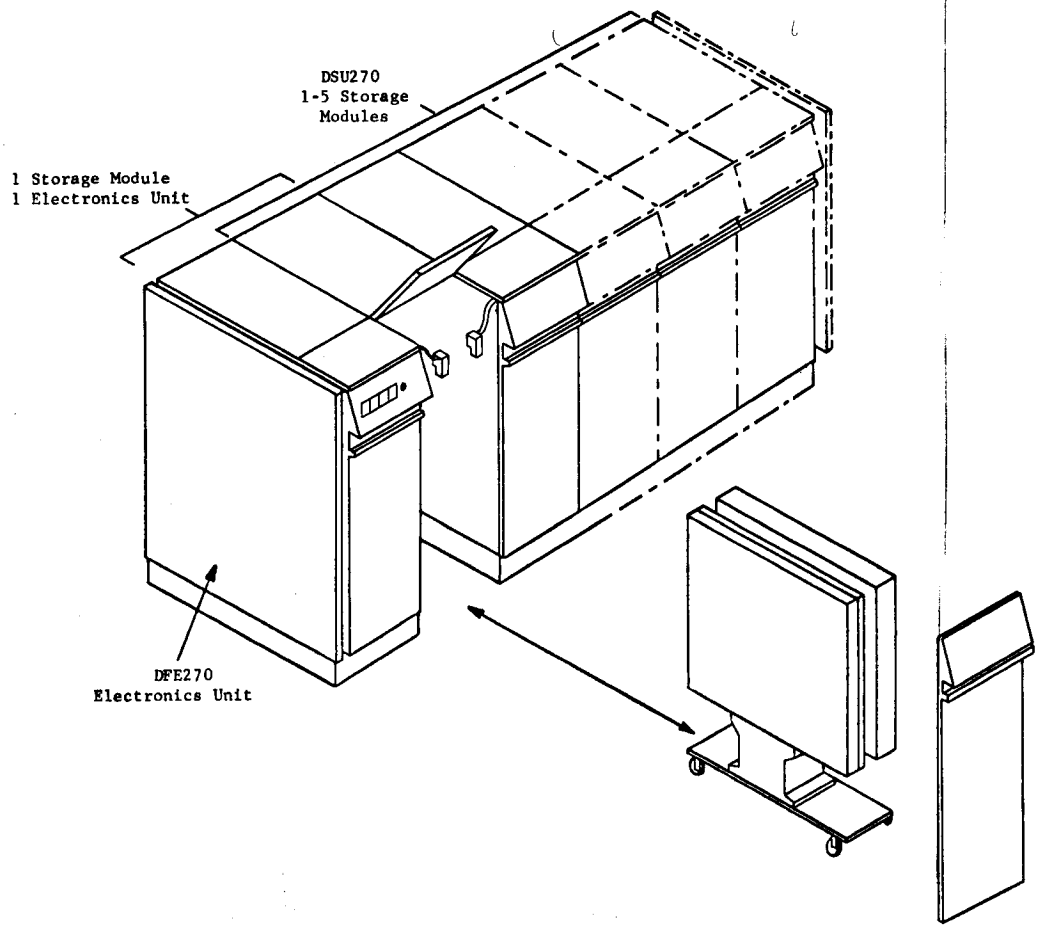



Figure 5. Electronics and Storage Units

## DISC STORAGE UNIT

Each storage unit contains four 26.5-inch diameter discs, the read/write assemblies, and the disc drive motor. The unit is physically separated into two chambers mounted on opposite sides of a pedestal, the whole assembly in turn mounted on a base provided with casters. See Figure 6.

There is timing synchronization within a storage unit from disc to disc, but not across storage unit boundaries.

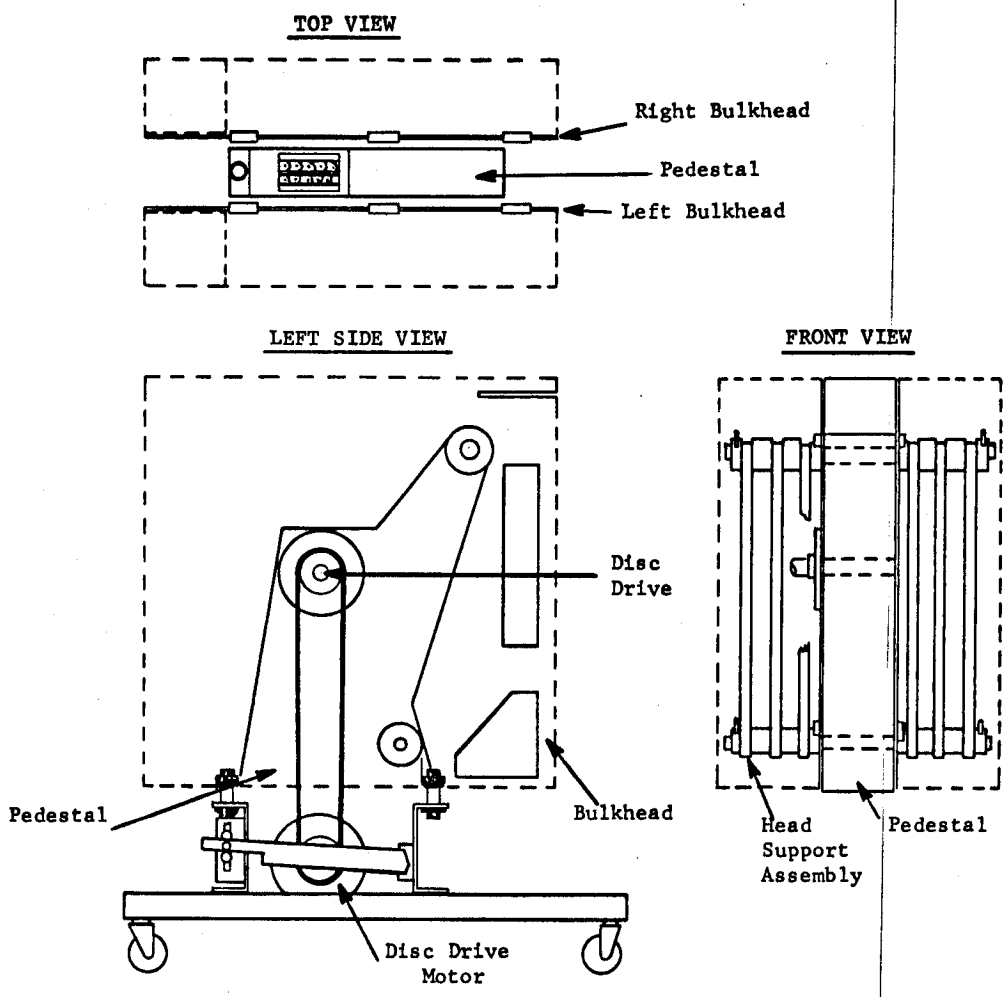



Figure 6. Disc Storage Unit

## DATA STORAGE

### Disc Format

Each disc surface is formatted as shown in Figure 7. Data is recorded in three separate zones of 50 tracks each. Clock and address tracks are associated with each zone.

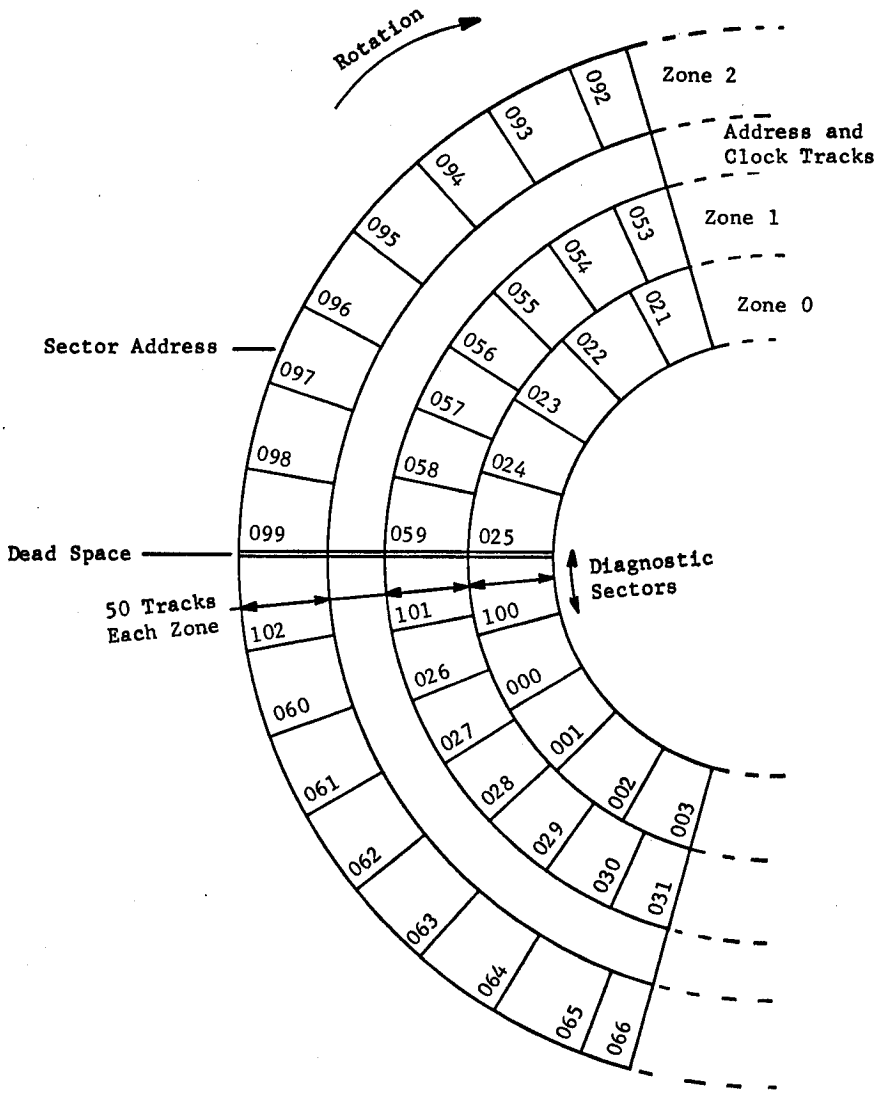



Figure 7. Disc Layout

DATA TRACKS. Each of the 50 data tracks within a zone contains a diagnostic sector and 26 to 40 data sectors.

| Zone | Number of Sectors |
|---|---|
| 0 | 26 |
| 1 | 34 |
| 2 | 40 |

A data sector consists of 2304 serial data bits (384 6-bit data characters) plus 30 bits associated with the check code and 6 spacer bits.

The diagnostic sector is the first sector in each track following a dead space of approximately 20 microseconds. This sector is reserved for use by the service engineer.

DATA STORAGE SUMMARY. A summary of the data storage available in the DSU270 subsystem is presented in Figure 8.

| | Number of Characters | Number of Sectors | Number of 600-Line Words |
|---|---|---|---|
| Sector | 384 | 1 | 64 |
| Track Zone 0 (50 tracks/zone) | 9,984 | 26 | 1,664 |
| Track Zone 1 (50 tracks/zone) | 13,056 | 34 | 2,176 |
| Track Zone 2 (50 tracks/zone) | 15,360 | 40 | 2,560 |
| Disc Surface | 1,920,000 | 5,000 | 320,000 |
| Storage Unit | 15,360,000 | 40,000 | 2,560,000 |
| Electronics Unit | 76,800,000 | 200,000 | 12,800,000 |
| Maximum Subsystem | 307,200,000 | 800,000 | 51,200,000 |

Figure 8. Data Storage Summary

## Data Protection

LOCKOUT SWITCHES. There are 20 lockout switches, one for each disc in up to five units. and one master lockout switch for each electronics unit. These switches are located at the top of the electronics unit. See Figure 12.

If the file electronics master lockout switch is on, no discs connected to that electronics unit may accept a write instruction. If the master switch on the electronics unit is off, only those discs with their individual lockout switches on will be prevented from writing.

When an addressed disc is write inhibited, the write instructions will not be executed but will be terminated with the Attention, Disc Write Inhibited status.

When a write operation starts on a disc that is not write inhibited, the write operation will continue until completed or until a locked out disc is encountered.

UPDATE PROTECTION. In order to prevent intermixing of Select and data transfer instructions on a dual channel subsystem, the following method is used:

When a Select instruction has been accepted, the addressed file electronics unit is reserved for the channel from which the Select was issued. New instructions from the same channel will be accepted, but all instructions from the other channel will receive a Device Busy status return.

The file electronics unit is released only when one of the following data transfer instructions is properly executed or the Release Instruction is used:

Read

Write

Write and Verify

Compare and Verify

If it is desired to keep the device reserved after the successful completion of a data transfer instruction, the following set of instruction must be used:

Read Update

Write Update

Write and Verify Update

Compare and Verify Update

The Update instructions are to be used when both processor channels have access to the same data base and both processors can update the data. When the updating is completed, the device can be released by execution of a Release instruction or by error-free execution of one of the non-update data transfer instructions.

## ADDRESSING

After accepting a Select instruction, the controller requests six control characters from the processing system. These characters are formatted as shown in Figure 9.

| CHARACTER | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| BITS | 5 4 3 2 1 0 | 5 4 3 2 1 0 | 5 4 3 2 1 0 | 5 4 3 2 1 0 | 5 4 3 2 1 0 | 5 4 3 2 1 0 |
| MEANING | SECTOR COUNT LIMIT | | NONE | SECTOR | | |
| POSSIBLE VALUES | 1-4096 | | MUST BE ZEROS | 0-199999 | | |

Figure 9. Select Address Format

The sector count specifies the maximum number of sectors to be operated on by a subsequent instruction. A sector count of all zeros is defined as 4096 sectors.

The tables in Appendix A relate the storage units, discs, and surfaces to the continuous binary address contained in control characters 3, 4, and 5. Sector addresses greater than 199,999 are illegal.

## SPEEDS AND TIMING

### Data Transfer Rate

The data transfer rates for the DSU270 subsystem are summarized below.

Zone 0
219,000 characters per second, maximum
211,000 characters per second, nominal
200,000 characters per second, effective

Zone 1
284,000 characters per second, maximum
273,000 characters per second, nominal
261,000 characters per second, effective

Zone 2
333,000 characters per second, maximum
320,000 characters per second, nominal
307,000 characters per second, effective

NOTE: Maximum - maximum instantaneous, including 4 percent motor speed variation.

Nominal - nominal instantaneous.

Effective - nominal rate including gaps.

Disc Rotation Speed - 1200, $\pm$48 rpm

Maximum Access Time - 50.3 ms

Average Access Time - 26 ms

### Latency Reduction

Each electronics unit can be synchronized with only one storage unit at a time. The addressed electronics unit presents the angular position of the storage unit it is synchronized with to the controller as a substatus of Channel Ready. The angular position is formatted as:

$2^5$ $2^0$
YXXXXX

Y is 0 (zero) when the addressed device is currently synchronized with the controller. In this case the remaining substatus bits contain the angular position of the addressed electronics unit.

Y is 1 (one) when the addressed device is not currently synchronized with the controller. In this case, the remaining substatus bits have no meaning.

XXXXX can have values from 0 to 26, corresponding to the sector in Zone 0 presently under the read/write heads. (Note: A value of 26 corresponds to the diagnostic sector.)

Knowing the angular position of one storage unit for the file electronics unit that received the last Select instruction and having a queue of addresses to be accessed on that storage unit, the latency time can be reduced by going through the queue and choosing an address that will require the least amount of latency delay before coming under the applicable read/write heads.

Figure 15 in Appendix A relates the sector addresses in Zones 1 and 2 to the sector addresses in Zone 0. The address of the sector in Zone 0 that is presently under the read/write heads is the angular position code transmitted to the processing system by the controller unit.

## INPUT/OUTPUT SIGNALS

Instructions and data transmitted to the disc storage subsystem and data received from the subsystem are accompanied by certain signals that time operations, trigger operations, and identify information. Some signals function automatically, while others can be accessed or caused by programmers or operators. Those signals of direct concern to users are:

End Data Transfer

Terminate

Special Interrupt

### End Data Transfer Signal

When all characters for the instruction currently being executed have been transferred to or from the subsystem, the processing system sends an End Data Transfer signal to tell the subsystem that no more data will be transmitted or accepted for that instruction.

### Terminate Signal

The subsystem sends a Terminate signal to the processing system to indicate completion of an on-line operation that required the subsystem to go into the busy state to complete the operation (read, write, etc.).

### Special Interrupt Signal

The Special Interrupt signal is used as an aid in communication between two processing systems and the subsystem. The signal is generated when an Interrupt Channel instruction has been accepted by the subsystem.

## STATUS

The subsystem transmits to the processing system certain information concerning the operating condition of the subsystem. This information is called the "status" of the subsystem. The status tells the processing system whether the subsystem is ready to accept an instruction or is busy, whether an instruction was successfully executed, when error conditions have occurred, etc.

Status information can be placed in core store and interrogated by the program. When used in this way by the program or operating system, the status permits detecting and attempting to recover from certain error conditions under program control. For conditions that require operator intervention, status enables the program or operating system to give specific instructions to the operator for correcting inoperable conditions.

There are two types of status information -- major status and substatus. Major status indicates the general category of the condition. For some of the major statuses, there are several substatuses that indicate more specific reasons for the existence of the major status.

The major status requires a 4-bit configuration; substatus requires a 6-bit configuration.

Major status information always exists on certain electrical lines in the subsystem and can change only on initiation or termination of an instruction, but substatus information exists in the subsystem only during initiation and after termination of an instruction. All existing substatuses for a major status are sent at the same time as the major status. Each substatus is represented by a particular bit within the configuration.

### Priority of Status

If two major status conditions occur at the same time, a priority system determines which one is reflected first. The status with the highest priority is reflected first. When that condition is corrected, the status next highest in priority is reflected, if that condition still exists. Conditions rank as follows:

At initiation:

Instruction Rejected
Device Busy

Attention
Channel Busy
Channel Ready

At termination:

Data Alert
End of File
Attention
Channel Ready

## Resetting Status

The various status indications of the subsystem can be reset by one of the following:

1. A reset status instruction resets the following major statuses:

   Data Alert
   End of File

2. When an Attention, Device Inoperable condition is corrected in the device area, the status is then reset by the reception of a Select instruction. An Attention, Disc Write Inhibited condition is reset by a subsequent Select instruction.

3. Data alert and end of file are reset by any instruction except Request Status or Channel Interrupt.

4. Channel busy is reset by the terminate signal at the end of the operation.

5. Channel ready is reset when the subsystem becomes busy, on receipt of the next instruction.

6. Instruction rejected is unconditionally reset at the beginning of the next instruction sequence initiation.

## Major Status and Substatus Information

The major status and substatus conditions are described below in detail. The binary configuration for each condition is also shown. An x appearing in the substatus configuration indicates that the particular bit may be either a 0 or a 1. Whenever there is a major status condition that has no substatus, the substatus information transmitted is 000000.

CHANNEL READY (0000). A Channel Ready response to an instruction has one of the following meanings:

1. To an Interrupt Channel or Release instruction at initiation -- the instruction has been accepted.

2. To Select, read, write, and compare instructions at termination -- the preceding operation was error-free, and the subsystem is ready to accept another instruction.

3. To request status -- the previous instruction was executed without error.

4. To reset status -- no inoperable conditions exist.

The substatus possible with channel ready is:

Angular Position (Yxxxxx) -- Where xxxxx is the sector address of the sector in Zone 0 presently under the read/write heads of the selected device.

DEVICE BUSY (0001). The Device Busy status is transmitted to the processing system in response to all instructions from one processor channel when the addressed device is reserved to the other processor channel. The instructions will not be executed. (This status occurs in dual-channel subsystems only.)

ATTENTION (0010). The attention status return indicates the presence of a condition which may require manual intervention. The status is reset upon receipt of a subsequent Select instruction.

The substatuses which can occur with the attention status are:

Device Inoperable (000000) -- One of the following conditions exists in the addressed device:

Power Failure

Lack of Air Flow

Heads Not Flying (Low air pressure)

Device Off-Line

Discs Not Up to Speed.

Device Write Inhibited (000001) -- A write instruction has been attempted on a storage unit on which the Write Inhibit switch is in the inhibit position. Read or verify type instructions may be executed on write-inhibited discs.

DATA ALERT (0011). The data alert status is sent to the processing system, along with a terminate interrupt or in response to a request status instruction. This status indicates that an error was detected during execution of the last data transfer instruction. Any new instruction except request status will reset the data alert condition.

The substatuses listed below indicate the specific nature of the data alert.

Transfer Timing Alert (000001) -- Indicates the processing system did not accept or furnish data characters at a rate compatible with the required controller data transfer rate.

Transmission Parity Alert (xxxx10) -- Indicates the controller unit detected a parity error on a data character received from the processing system.

Invalid Select Data (001x0) -- Indicates that, during execution of a Select instruction, the number of characters received by the subsystem did not equal six, or the starting address received by the subsystem specified a non-existent address (a decimal value larger than 199999).

Internal Alert (xx10x0) -- Indicates that the data integrity check failed during a data transfer operation. When this condition occurs during a read operation, the data transfer is continued until the check characters for the sector being read are checked. (Correct parity is assigned to the character in error before transmission to the processing system).

When this condition occurs during a write operation, the data transfer from the processing systems is stopped and the remainder of the sector including the check characters is written with zeros. The character in error will be the last character written.

Check Alert (x1x0x0) -- Indicates that the check code verification failed. The check code verification fails when, during the reading of data from the selected storage unit, it is found that the longitudinal parity check (on all data and check characters for the sector) is not correct.

Compare Alert (1xx0x0) -- Indicates that, during the execution of a Compare and Verify or a Compare and Verify Update instruction, it is found that a data bit from a sector does not compare with the corresponding data bit from the processing system. The controller unit inhibits further data transfer, and at the end of the current sector checks the check characters and terminates the instruction.

END OF FILE (0100). The end of file status indicates that the file limit has been reached; this limit may be physical or program-imposed. Any new instruction, except request status, causes the status to be reset.

The substatuses which can occur with end of file are:

Last Consecutive Sector (0000x1) -- Indicates that the last consecutive sector has been read or written and that the processing system has transmitted (or accepted) an extra data character. (Last consecutive sector = last sector available on an electronics unit, or last sector on a storage unit when the next sequential storage unit is missing.)

Sector Count Limit (00001x) -- Indicates the number of sectors specified in the sector count limit has been transferred and the processing system has not sent an End Data Transfer signal.

INSTRUCTION REJECTED (0101). The instruction rejected status indicates that the subsystem is rejecting the current instruction, but this does not further affect subsystem status in any way. The status is reflected only in response to the instruction being rejected; it is not stored and is cleared by the next instruction.

The following substatus conditions indicate the specific reason for the rejection of the instruction:

Invalid Operation Code (00xxx1) -- Indicates that the subsystem does not recognize the operation code received.

Invalid Device Code (00xx1x) -- Indicates that the subsystem does not recognize the device code received.

Parity Alert on Device/Operation Code (00x1xx) -- Indicates that either the operation or device code of an instruction contained incorrect parity.

Invalid Instruction Sequence (001xxx) -- Indicates that a data transfer instruction was received without a prior Select having been issued.

CHANNEL BUSY (1000). The channel busy status indicates that the subsystem has accepted an instruction and is transferring data. No other instruction will be accepted while the subsystem is in the busy state.

## INSTRUCTIONS

The control electronics of the subsystem recognizes and accepts the following instructions:

| | Octal Code |
|---|---|
| Select | 34 |
| Read | 25 |
| Read Update | 21 |
| Write | 31 |
| Write Update | 35 |
| Write and Verify | 33 |
| Write and Verify Update | 37 |
| Compare and Verify | 11 |
| Compare and Verify Update | 15 |
| Interrupt Channel | 60 |
| Release | 75 |
| Request Status | 00 |
| Reset Status | 40 |

The acceptable device codes are:

| | Octal Code |
|---|---|
| Controller | 00 |
| Electronics Unit 1 | 01 |
| Electronics Unit 2 | 02 |
| Electronics Unit 3 | 03 |
| Electronics Unit 4 | 04 |

An instruction is initiated by receipt of the device and operation codes from the processing system. The major status reflected to the processing system in response to a data transfer instruction initiation will be one of the following:

Attention

Instruction Rejected

Channel Busy

If the instruction is accepted, the subsystem reverts to the Channel Busy status. Upon completion of the instruction initiation, the subsystem requests data or control characters from the processing system; however, data transfer will not start until the address selected by a prior Select instruction comes under the appropriate read/write head.

Execution of an instruction continues until one of the following occurs:

1. An End Data Transfer signal is received from the processing system.
2. An Alert condition is detected.
3. An End of File condition is detected.
4. An Attention condition results.

Upon termination of the data transfer instruction, the subsystem sends a Terminate signal to the processing system. Following the transmission of the Terminate signal, the major status reflected to the processing system will be one of the following:

Channel Ready

Attention

Data Alert

End of File

The instructions which follow are grouped according to function and detailed descriptions are given.

## Select Instruction

The Select instruction transmits a sector count and a starting address to the subsystem (See "Addressing," page 10.) This instruction must precede all data transfer instructions.

When the selected device is not reserved, the acceptance and successful execution of a Select reserves the selected device for the channel that issued the Select instruction. When the selected device is reserved for the channel over which a new Select comes, the device stays reserved, regardless of what happens to the new Select.

When the Select instruction is accepted and successfully executed, the Channel Ready status with the Angular Position substatus is transmitted to the processing system, along with the Terminate signal.

## Data Transfer Instructions

Data transfer instructions either transmit data from the processing system to the subsystem or from the subsystem to the processing system. Up to 4096 sectors of data can be transferred with each instruction.

Successful execution of a non-Update data transfer instruction releases the device from the reserved state. Use of the Update data transfer instructions keeps the device reserved to the channel which issued the previous Select.

WRITE/WRITE UPDATE. These instructions write data from the processing system to the data sectors, beginning at the previously selected sector address. The Write and Write Update instructions are terminated when the write process is concluded.

WRITE AND VERIFY/WRITE AND VERIFY UPDATE. These instructions write data from the processing system to the sectors, starting at the previously selected address. After writing, the sectors are read and the check characters verified. No data is sent to the processing system during the verify portion of this instruction. If an alert condition is detected during the write portion of the command, the operation is terminated at the end of that sector and the verify portion is not attempted.

The Write and Verify and the Write and Verify Update instructions are not terminated until the write process is completed and all sectors written by the instruction are read and their check characters are verified, or until a check error is detected.

If an End Data Transfer signal is received or an alert condition is detected before an entire sector is written, the controller fills the rest of the sector with zero characters, following which the check characters are written. In the case of an alert condition, the check characters are also written as zero characters.

READ/READ UPDATE. These instructions read blocks of data, beginning at the previously selected sector address. When a Read or Read Update instruction is being executed, the read process begins reading data from sequential sectors.

An alert condition or an End Data Transfer signal from the processing system stops the transfer of data. The read operation continues until the check character, of the sector being read, is read and verified. The read instruction is then terminated.

## Comparison Instructions

COMPARE AND VERIFY/COMPARE AND VERIFY UPDATE. These instructions compare data from the processing system to data beginning at the previously selected sector address. The status at termination differentiates between equal and unequal comparison. Up to 4096 sectors can be compared and verified with each instruction.

Once the addressed sector is found, the controller compares the data characters received from the processing system, bit-by-bit, with the data characters read from the disc. The check characters in all sectors or partial sectors read will be checked and verified.

### No-Op Instructions

Two instructions are used to reflect the status of the subsystem to the processing system.

REQUEST STATUS. This instruction sends the status of the subsystem to the processing system. Any status that exists in the controller from a previous operation will remain unchanged.

RESET STATUS. This instruction resets any existing Data Alert or End of File status in the subsystem and transmits the remaining status of the subsystem to the processing system. See Figures 16 and 17 for the status returns possible with these two instructions.

### Dual Channel Operating Instructions

INTERRUPT CHANNEL. This instruction is used only with a subsystem containing the dual channel option. When issued by the processing system on one channel, it results in a Special Interrupt signal being transmitted to the processing system on the other channel.

At the initiation of the Interrupt Channel instruction, either the Instruction Rejected or Channel Ready status is reflected. Note: The substatus of Invalid Instruction Sequence cannot be transmitted in response to the Interrupt Channel Instruction.

RELEASE. This instruction releases the addressed device from the channel through which the Release is issued. A device code of 00 releases all devices reserved for the issuing channel. Device codes of 01, 02, 03, or 04 release the corresponding electronics units.

Following a Release, a data transfer instruction to the same device will not be executed unless preceded by a Select.

# 3. Operating Instructions

The subsystem is equipped with operator control and indicator panels on the controller and on each electronics unit. Functions of the controls and indicators are discussed in the following paragraphs.

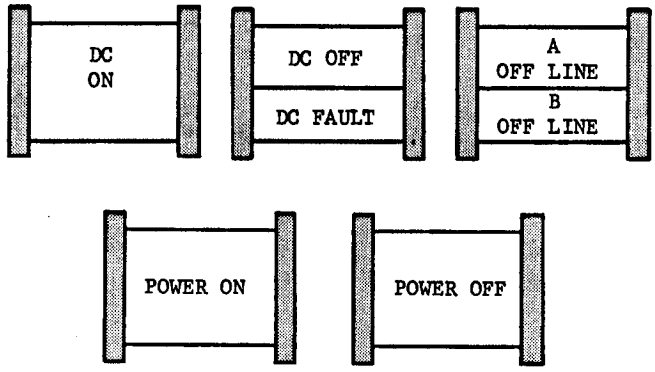



Figure 10. Controller Panel

| Control/Indicator | Function |
|---|---|
| DC ON pushbutton and indicator (yellow) | Pressing this control turns on the d.c. power to the controller. Light comes on when power is fully on. |
| DC OFF/DC FAULT pushbutton and indicator (white/red) | Pressing this control turns d.c. power off in the controller. DC FAULT light comes on only to indicate a malfunction in the power supply. |
| A/B OFF LINE indicator (yellow) | With dual channel option, the portion illuminated indicates which channel is off line. |
| POWER ON and POWER OFF | When illuminated, pushbuttons and indicators show status of A.C. Power. |

## ELECTRONICS UNIT PANEL

The electronics unit control and indicator panel, shown in Figure 11, provides the operator controls for the electronics unit and the attached storage units.

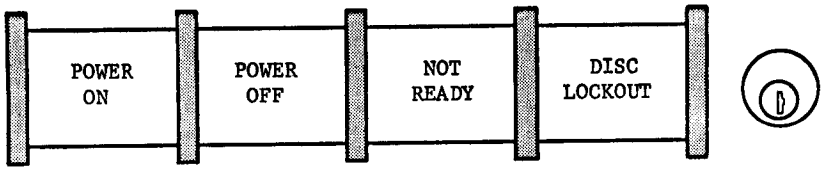



Figure 11. Electronics Unit Panel

| Control/Indicator | Function |
|---|---|
| POWER ON pushbutton and indicator (green) | Depressing this control supplies a. c. and d. c. power to the electronics unit and the storage units. Indicator glows when power is on. |
| POWER OFF pushbutton (black) | Depressing this control turns off a. c. and d. c. power to the electronics unit and storage units. |
| NOT READY indicator (white) | This indicator comes on when power is applied and remains on until the heads are flying and the air pressure is normal. The indicator is also on if the electronics unit has been set to the local mode. |
| DISC LOCKOUT indicator (red) | This indicator glows when any of the individual Lockout switches is on. |

## WRITE PROTECT SWITCHES

The write protect (Lockout) switches are located at the top of the electronics unit. The key lock in the center of the control panel releases the cover over the switches. There are 20 separate Lockout switches for the individual discs and one Master Lockout switch. See Figure 12.

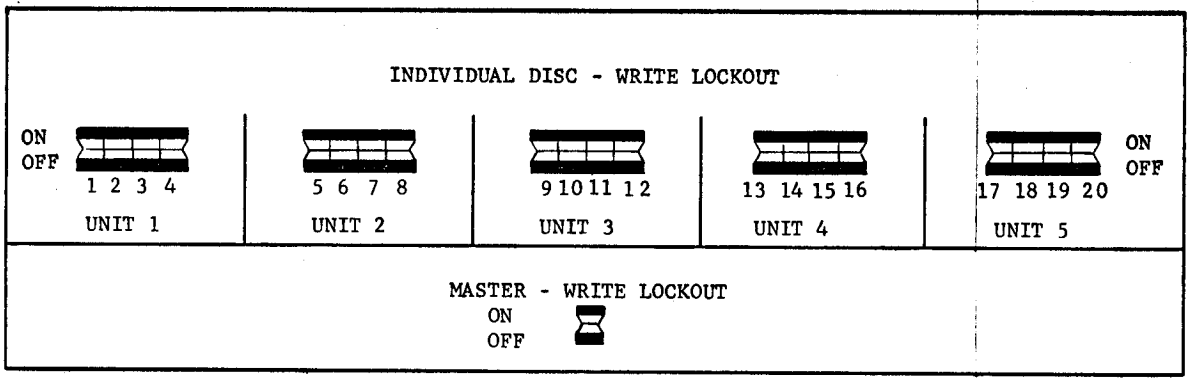



Figure 12. Write Protect Switches

The switches enable the operator to prevent data from being written on one or more of the discs associated with a particular file unit. When in the normal position, these switches have no effect on instruction execution. When a write instruction is addressed to a disc whose corresponding switch is in the Protect position, the instruction is not accepted and Attention status is sent to the processing system.

## OPERATING PROCEDURES

The following steps are to be taken to prepare the subsystem for operations:

1. Press the POWER ON control on the electronics unit operator's panel. When power is fully applied, the light glows green.
2. Press the POWER ON control on the controller operator's panel. When power is fully applied, the light glows yellow.
3. Be sure the discs in the file units are turning.
4. Wait until the NOT READY indicator has gone off.
5. Set the Write Protect switches in accordance with the programmer's instructions.

During operations, the operator monitors the panel on the electronics unit for Attention conditions and corrects conditions that require operator action.

The subsystem is shut down as follows:

1. Press the POWER OFF control on the electronics unit operator's panel.
2. Press the DC OFF control on the controller operator's panel.

## ROUTINE OPERATOR MAINTENANCE

The operator keeps the outsides of the cabinets of the subsystem clean and free of dust.

# Appendix A
# Addressing

| STORAGE UNIT | DISC | SURFACE | BINARY ADDRESS RANGE | | | | | | DECIMAL EQUIVALENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | ADDRESS OF FIRST SECTOR | | | ADDRESS OF LAST SECTOR | | | FIRST | LAST |
| 0 | 0 | 0 | 000000 | 000000 | 000000 | 000001 | 001110 | 000111 | 0 | 4999 |
| | | 1 | 000001 | 001110 | 001000 | 000010 | 011100 | 001111 | 5000 | 9999 |
| | 1 | 0 | 000010 | 011100 | 010000 | 000011 | 101010 | 010111 | 10000 | 14999 |
| | | 1 | 000011 | 101010 | 011000 | 000100 | 111000 | 011111 | 15000 | 19999 |
| | 2 | 0 | 000100 | 111000 | 100000 | 000110 | 000110 | 100111 | 20000 | 24999 |
| | | 1 | 000110 | 000110 | 101000 | 000111 | 010100 | 101111 | 25000 | 29999 |
| | 3 | 0 | 000111 | 010100 | 110000 | 001000 | 100010 | 110111 | 30000 | 34999 |
| | | 1 | 001000 | 100010 | 111000 | 001001 | 110000 | 111111 | 35000 | 39999 |
| 1 | 0 | 0 | 001001 | 110001 | 000000 | 001010 | 111111 | 000111 | 40000 | 44999 |
| | | 1 | 001010 | 111111 | 001000 | 001100 | 001101 | 001111 | 45000 | 49999 |
| | 1 | 0 | 001100 | 001101 | 010000 | 001101 | 011011 | 010111 | 50000 | 54999 |
| | | 1 | 001101 | 011011 | 011000 | 001110 | 101001 | 011111 | 55000 | 59999 |
| | 2 | 0 | 001110 | 101001 | 100000 | 001111 | 110111 | 100111 | 60000 | 64999 |
| | | 1 | 001111 | 110111 | 101000 | 010001 | 000101 | 101111 | 65000 | 69999 |
| | 3 | 0 | 010001 | 000101 | 110000 | 010010 | 010011 | 110111 | 70000 | 74999 |
| | | 1 | 010010 | 010011 | 111000 | 010011 | 100001 | 111111 | 75000 | 79999 |
| 2 | 0 | 0 | 010011 | 100010 | 000000 | 010100 | 110000 | 000111 | 80000 | 84999 |
| | | 1 | 010100 | 110000 | 001000 | 010101 | 111110 | 001111 | 85000 | 89999 |
| | 1 | 0 | 010101 | 111110 | 010000 | 010111 | 001100 | 010111 | 90000 | 94999 |
| | | 1 | 010111 | 001100 | 011000 | 011000 | 011010 | 011111 | 95000 | 99999 |
| | 2 | 0 | 011000 | 011010 | 100000 | 011001 | 101000 | 100111 | 100000 | 104999 |
| | | 1 | 011001 | 101000 | 110000 | 011010 | 110110 | 101111 | 105000 | 109999 |
| | 3 | 0 | 011010 | 110110 | 110000 | 011100 | 000100 | 110111 | 110000 | 114999 |
| | | 1 | 011100 | 000100 | 111000 | 011101 | 010010 | 111111 | 115000 | 119999 |
| 3 | 0 | 0 | 011101 | 010011 | 000000 | 011110 | 100001 | 000111 | 120000 | 124999 |
| | | 1 | 011110 | 100001 | 001000 | 011111 | 101111 | 001111 | 125000 | 129999 |
| | 1 | 0 | 011111 | 101111 | 010000 | 100000 | 111101 | 010111 | 130000 | 134999 |
| | | 1 | 100000 | 111101 | 011000 | 100010 | 001011 | 011111 | 135000 | 139999 |
| | 2 | 0 | 100010 | 001011 | 100000 | 100011 | 011001 | 100111 | 140000 | 144999 |
| | | 1 | 100011 | 011001 | 101000 | 100100 | 100111 | 101111 | 145000 | 149999 |
| | 3 | 0 | 100100 | 100111 | 110000 | 100101 | 110101 | 110111 | 150000 | 154999 |
| | | 1 | 100101 | 110101 | 111000 | 100111 | 000011 | 111111 | 155000 | 159999 |
| 4 | 0 | 0 | 100111 | 000100 | 000000 | 101000 | 010010 | 000111 | 160000 | 164999 |
| | | 1 | 101000 | 010010 | 001000 | 101001 | 100000 | 001111 | 165000 | 169999 |
| | 1 | 0 | 101001 | 100000 | 010000 | 101010 | 101110 | 010111 | 170000 | 174999 |
| | | 1 | 101010 | 101110 | 011000 | 101011 | 111100 | 011111 | 175000 | 179999 |
| | 2 | 0 | 101011 | 111100 | 100000 | 101101 | 001010 | 100111 | 180000 | 184999 |
| | | 1 | 101101 | 001010 | 101000 | 101110 | 011000 | 101111 | 185000 | 189999 |
| | 3 | 0 | 101110 | 011000 | 110000 | 101111 | 100110 | 110111 | 190000 | 194999 |
| | | 1 | 101111 | 100110 | 111000 | 110000 | 110100 | 111111 | 195000 | 199999 |
| | | | 3 | 4 | 5 | 3 | 4 | 5 | | |
| | | | Control Character Number | | | Control Character Number | | | | |

**Figure 13. Storage Unit Address Ranges**

| STORAGE UNIT | DISC | SURFACE | ZONE | TRACK | SECTORS | TOTAL SECTORS |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 Through 25 | 26 |
| 0 | 0 | 0 | 1 | 0 | 26 Through 59 | 60 |
| 0 | 0 | 0 | 2 | 0 | 60 Through 99 | 100 |
| 0 | 0 | 0 | 0 | 1 | 0 Through 25 | 126 |
| 0 | 0 | 0 | 1 | 1 | 26 Through 59 | 160 |
| 0 | 0 | 0 | 2 | 1 | 60 Through 99 | 200 |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| 0 | 0 | 0 | 0 | 49 | 0 Through 25 | 4926 |
| 0 | 0 | 0 | 1 | 49 | 26 Through 59 | 4960 |
| 0 | 0 | 0 | 2 | 49 | 60 Through 99 | 5000 |
| 0 | 0 | 1 | 0 | 0 | 0 Through 25 | 5026 |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| 0 | 0 | 1 | 0 | 49 | 0 Through 25 | 9926 |
| 0 | 0 | 1 | 1 | 49 | 26 Through 59 | 9960 |
| 0 | 0 | 1 | 2 | 49 | 60 Through 99 | 10000 |

**Figure 14. Addressing Sequence**

| STORAGE UNIT | DISC | SURFACE | ZONE | TRACK | SECTORS | TOTAL SECTORS |
|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | 0 | 0 Through 25 | 10026 |
| 0 | 1 | 0 | 1 | 0 | 26 Through 59 | 10060 |
| 0 | 1 | 0 | 2 | 0 | 60 Through 99 | 10100 |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| 0 | 1 | 1 | 0 | 49 | 0 Through 25 | 19926 |
| 0 | 1 | 1 | 1 | 49 | 26 Through 59 | 19960 |
| 0 | 1 | 1 | 2 | 49 | 60 Through 99 | 20000 |
| 0 | 2 | 0 | 0 | 0 | 0 Through 25 | 20026 |
| 0 | 2 | 0 | 1 | 0 | 26 Through 59 | 20060 |
| 0 | 2 | 0 | 2 | 0 | 60 Through 99 | 20100 |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| 0 | 3 | 1 | 0 | 49 | 0 Through 25 | 39926 |
| 0 | 3 | 1 | 1 | 49 | 26 Through 59 | 39960 |
| 0 | 3 | 1 | 2 | 49 | 60 Through 99 | 40000 |

**Figure 14. (Continued)**

| STORAGE UNIT | DISC | SURFACE | ZONE | TRACK | SECTORS | TOTAL SECTORS |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 Through 25 | 40026 |
| 1 | 0 | 0 | 1 | 0 | 26 Through 59 | 40060 |
| 1 | 0 | 0 | 2 | 0 | 60 Through 99 | 40100 |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| 1 | 3 | 1 | 0 | 49 | 0 Through 25 | 79926 |
| 1 | 3 | 1 | 1 | 49 | 26 Through 59 | 79960 |
| 1 | 3 | 1 | 2 | 49 | 60 Through 99 | 80000 |
| 2 | 0 | 0 | 0 | 0 | 0 Through 25 | 80026 |
| 2 | 0 | 0 | 1 | 0 | 26 Through 59 | 80060 |
| 2 | 0 | 0 | 2 | 0 | 60 Through 99 | 80100 |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| 4 | 1 | 1 | 0 | 49 | 0 Through 25 | 199926 |
| 4 | 1 | 1 | 1 | 49 | 26 Through 59 | 199960 |
| 4 | 1 | 1 | 2 | 49 | 60 Through 99 | 200000 |

Figure 14. (Continued)

| ZONE 0 SECTOR ADDRESS | ZONE 1 SECTOR ADDRESS | ZONE 2 SECTOR ADDRESS | ANGULAR POSITION CODE TRANSMITTED |
|---|---|---|---|
| | | | $2^5 2^4 2^3 2^2 2^1 2^0$ |
| 0100 | 0101 | 0102,0060 | * 0 1 1 0 1 0 |
| 0000 | 0026,0027 | 0061 | 0 0 0 0 0 0 |
| 0001 | 0028 | 0062,0063 | 0 0 0 0 0 1 |
| 0002 | 0029 | 0064 | 0 0 0 0 1 0 |
| 0003 | 0030 | 0065,0066 | 0 0 0 0 1 1 |
| 0004 | 0031,0032 | 0067 | 0 0 0 1 0 0 |
| 0005 | 0033 | 0068,0069 | 0 0 0 1 0 1 |
| 0006 | 0034 | 0070 | 0 0 0 1 1 0 |
| 0007 | 0035,0036 | 0071,0072 | 0 0 0 1 1 1 |
| 0008 | 0037 | 0073 | 0 0 1 0 0 0 |
| 0009 | 0038 | 0074,0075 | 0 0 1 0 0 1 |
| 0010 | 0039,0040 | 0076 | 0 0 1 0 1 0 |
| 0011 | 0041 | 0077,0078 | 0 0 1 0 1 1 |
| 0012 | 0042 | 0079 | 0 0 1 1 0 0 |
| 0013 | 0043 | 0080,0081 | 0 0 1 1 0 1 |
| 0014 | 0044,0045 | 0082 | 0 0 1 1 1 0 |
| 0015 | 0046 | 0083,0084 | 0 0 1 1 1 1 |
| 0016 | 0047 | 0085 | 0 1 0 0 0 0 |
| 0017 | 0048,0049 | 0086,0087 | 0 1 0 0 0 1 |
| 0018 | 0050 | 0088 | 0 1 0 0 1 0 |
| 0019 | 0051 | 0089,0090 | 0 1 0 0 1 1 |
| 0020 | 0052 | 0091 | 0 1 0 1 0 0 |
| 0021 | 0053,0054 | 0092,0093 | 0 1 0 1 0 1 |
| 0022 | 0055 | 0094 | 0 1 0 1 1 0 |
| 0023 | 0056 | 0095,0096 | 0 1 0 1 1 1 |
| 0024 | 0057,0058 | 0097,0098 | 0 1 1 0 0 0 |
| 0025 | 0059 | 0099 | 0 1 1 0 0 1 |

* When the $2^5$ bit of the angular position code is 0 (zero), as shown above, the remaining bits contain the angular position of the addressed electronics unit.

When the $2^5$ bit of the angular position code is 1 (one), the remaining bits have no meaning.

Figure 15. Relationship of Sector Addresses

# Appendix B
# Status Returns

| Status | Major Status Code | Sub-Status Code | Select | Write | Write and Verify | Read | Compare and Verify | Interrupt Channel | Release | Write Update | Read Update | Write and Verify Update | Compare and Verify Update | Request Status | Reset Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel Ready | 0000 | | | | | | | X | X | | | | | X | X |
| Angular Position | | YXXXXX | | | | | | | | | | | | X | X |
| Device Busy | 0001 | | X | X | X | X | X | | | X | X | X | X | X | X |
| Attention | 0010 | | X | X | X | X | X | | | X | X | X | X | X | X |
| Device Inoperable | | 000000 | X | X | X | X | X | | | X | X | X | X | X | X |
| Device Write Inhibited | | 000001 | | | | | | | | | | | | X | X |
| Data Alert | 0011 | | | | | | | | | | | | | X | |
| Transfer Timing Alert | | 000001 | | | | | | | | | | | | X | |
| Transmission Parity Alert | | XXXX10 | | | | | | | | | | | | X | |
| Invalid Select Data | | 0X01X0 | | | | | | | | | | | | X | |
| Internal Alert | | XX10X0 | | | | | | | | | | | | X | |
| Check Alert | | X10XX0 | | | | | | | | | | | | X | |
| Compare Alert | | 1XX0X0 | | | | | | | | | | | | X | |
| End of File | 0100 | | | | | | | | | | | | | X | |
| Last Consecutive Sector | | 0000X1 | | | | | | | | | | | | X | |
| Sector Count Limit | | 00001X | | | | | | | | | | | | X | |
| Instruction Rejected | 0101 | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Invalid Operation Code | | 00XXX1 | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Invalid Device Code | | 00XX1X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Parity Alert | | 00X1XX | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Invalid Instruction Sequence | | 001XXX | | X | X | X | X | | | X | X | X | X | | |
| Channel Busy | 1000 | | X | X | X | X | X | | | X | X | X | X | | |

Figure 16. Status Returns to Instruction Initiations

| Status | Major Status Code | Sub-Status Code | Select | Write | Write and Verify | Read | Compare and Verify | Interrupt Channel | Release | Write Update | Read Update | Write and Verify Update | Compare and Verify Update | Request Status | Reset Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Channel Ready** | 0000 | | X | X | X | X | X | | | X | X | X | X | | |
| Angular Position | | YXXXXX | X | X | X | X | X | | | X | X | X | X | | |
| Device Busy | 0001 | | | | | | | | | | | | | | |
| Attention | 0010 | | X | X | X | X | X | | | X | X | X | X | | |
| Device Inoperable | | 000000 | X | X | X | X | X | | | X | X | X | X | | |
| Device Write Inhibited | | 000001 | | X | X | | | | | X | | X | | | |
| Data Alert | 0011 | | X | X | X | X | X | | | X | X | X | X | | |
| Transfer Timing Alert | | 000001 | X | X | X | X | X | | | X | X | X | X | | |
| Transmission Parity Alert | | XXXX10 | X | X | X | | X | | | X | | X | X | | |
| Invalid Select Data | | 0001X0 | X | | | | | | | | | | | | |
| Internal Alert | | XX10X0 | | X | X | X | X | | | X | X | X | X | | |
| Check Alert | | X1X0X0 | | | X | X | X | | | | X | X | X | | |
| Compare Alert | | 1XX0X0 | | | | | X | | | | | | X | | |
| End of File | 0100 | | | X | X | X | X | | | X | X | X | X | | |
| Last Consecutive Sector | | 0000X1 | | X | X | X | X | | | X | X | X | X | | |
| Sector Count Limit | | 00001X | | X | X | X | X | | | X | X | X | X | | |
| Instruction Rejected | 0101 | | | | | | | | | | | | | | |
| Invalid Operation Code | | 00XXX1 | | | | | | | | | | | | | |
| Invalid Device Code | | 00XX1X | | | | | | | | | | | | | |
| Parity Alert | | 00X1XX | | | | | | | | | | | | | |
| Invalid Instruction Sequence | | 001XXX | | | | | | | | | | | | | |
| Channel Busy | 1000 | | | | | | | | | | | | | | |

**Figure 17. Status Returns to Instruction Terminations**

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