160-MEGABYTE MOVING HEAD DISK DRIVE

GENERAL DESCRIPTION

3B20D MODEL 2 PROCESSOR

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1. GENERAL

1.01 This section provides a brief physical and functional description of the 160-megabyte moving head disk drives used by the 3B20D Model 2 processor. The 3B20D Model 2 processor will be referred to as 3B20D2 in this document.

1.02 Whenever this section is reissued, the reason(s) for reissue will be listed in this paragraph.

PURPOSE

1.03 The moving head disk drives are high-speed, random access memory devices that are used for mass data storage in a 3B20D2.

CONFIGURATION

1.04 The disk drives are connected to the 3B20D2 via a disk file controller, duplex dual serial bus selector, and a dual serial channel. The disk file controller can communicate with as many as eight drives; but due to cable limitations, only six disk drives may be used.

1.05 The KS-22693, L1, 160-megabyte disk drive may be used with the 3B20D2.

2. PHYSICAL DESCRIPTION

2.01 The disk drives are located in the mini-module disk frame (J1C149A-1). Additionally, the 1200VA inverters, J1C149AB-1, are located in the mini-module disk frame. The mini-module disk frame is a single-bay frame that is 7 feet high and 3 feet 3 inches wide (Fig. 1).

2.02 The disk drives are installed in enclosures that are acoustically insulated to reduce noise levels near the unit and to provide electromagnetic compatibility shielding. These enclosures measure 19 inches wide by 30.1 inches deep by 10.2 inches high. The complete disk drive unit weighs approximately 125 pounds.

2.03 Figure 2 shows the operator/status control panel while Table A lists the controls together with their functions.

2.04 The KS-22693, L1, disk drive has a 160-megabyte storage capacity. The disk drive controls and accesses a 14-inch, 4-platter rigid disk. The uppermost and lowermost data recording surfaces are not used for information storage. Of the remaining six data recording surfaces, one is provided for servo track information and five are for data storage (Fig. 3). The servo surface is accessed by a single data recording head, but each of the other five data recording surfaces is accessed by two movable data recording heads.

2.05 Data is recorded on the data surfaces in tracks. There are 680 tracks per inch. Each recording surface contains 823 tracks per data surface.

2.06 The five major assemblies that make up a disk drive are the mini-module assembly, the frame assembly, the logic chassis, the power supply, and the front panel. See Fig. 4.

A. Mini-Module Assembly

2.07 The mini-module assembly (Fig. 5) is an enclosed, sealed module that contains the spindle, 4-platter rigid disk, heads, and actuator. The mini-module assembly is nonremovable (except by field service personnel). The read/write cards are an integral part of the module but are not enclosed. The cards plug into the front of the module to allow access for maintenance.

2.08 The 4-platter rigid disk is center-mounted on the spindle, which rotates the disk. Rotation of the spindle also acts as a fan to circulate air within the sealed module.

2.09 The heads read from or write on the data recording surfaces depending on the mode selected. The heads rest on the data surfaces (outer area of the disk platter) when the disk drive is not in use.

2.10 The actuator holds the heads and moves them over the rotating disk. The actuator is moved by a magnetic field-controlled voice coil, which moves the heads over the data recording surfaces. The actuator holds both the movable heads and the servo head.

B. Frame Assembly

2.11 The frame assembly houses the components and forms the mounting base for the disk drive. The logic chassis, power supply, and drive motor are considered part of the frame assembly.

2.12 The plug-in logic cards are mounted and interconnected on the logic chassis. The chassis is hinge-mounted and folds up into the vertical position to allow access to other components for maintenance. In the normal position, the chassis is horizonal and locks in that position with a fastener. The back panel provides space for ten plug-in cards and allows access to various points for maintenance. The back panel also receives the dc power for distribution throughout the logic. The signal cables and terminators plug into the input-output cards at the top of the logic chassis. All other signals and interconnections are wire wrapped or plugged into the back panel.

2.13 The disk drive has a self-contained power supply that receives its input from the site main power source. The power supply provides all the voltages necessary for disk drive operation.

2.14 The drive motor provides rotational motion that turns the spindle and disk. A drive belt connected between the pulley on the motor and the spindle pulley transfers the motion from the motor to the spindle.

C. Front Panel

2.15 The front panel houses the three cooling fans and primary air filter for the disk drive. The front panel also has an operator/status control panel. The operator/status control panel contains one indicator and one switch/indicator, which allow the operator to control and monitor the basic operation of the disk drive. See Fig. 2 and Table A.

2.16 The three cooling fans and primary air filter aid in cooling the logic chassis, drive motor, and power supply.

2.17 The disk drive is mounted in an enclosure that provides noise attenuation, electromagnetic compatibility shielding, directed airflow for thermal performance, and individual protection. Operating controls and indicators are mounted on the front panel of the enclosure and are readily accessible to the user.

3. FUNCTIONAL DESCRIPTION

3.01 The disk drive positions the read/write heads over a selected cylinder and then reads or writes data on a selected track. Driving the head in or out to the desired cylinder is termed a "seek."

3.02 Data is stored on the disk in a modified frequency modulation format. The nominal recording frequency is 9.67 MHz; therefore, at a normal disk speed of 3600 rpm, a data cell period is 103.3 nanoseconds. There are 20,160 bytes per track. The disk is capable of being subdivided into sectors. Switches are provided to select 32 sectors per track. Figure 6 shows the different types of switches. Switches 0, 1, 5, 7, and 8 set in the closed or ON position represent 32 sectors per track.

3.03 Disk drives interface with the disk file controller by means of a control cable and a read/write cable (Fig. 7). The control cable connects to all disk drives in a daisy-chain manner, while individual read/write cables connect the disk file controller to each drive. Refer to Fig. 8.

3.04 The control cable carries 30 control and address signals to and from the disk drive. Table B lists these signals. The last disk drive in a string must have a terminator installed on the "control cable out" connector in place of a continuing control cable. The read/write cable contains seven signals, which are listed in Table C.

3.05 The disk drive can identify itself by the four preset select switches on a card in the logic chassis. The select switches can be set to uniquely identify up to 16 disk drives.

3.06 Signals between the disk drives and the disk file controller are carried over twisted pair leads driven by differential line drivers. Figure 9 is a simplified diagram of the connections between control and data drivers and receivers.

3.07 The disk drives are addressed by unit select bits 0 through 3 in the control cable. A match between the address in bits 0 through 3 and the select switch setting causes a drive to be selected. The unit select tag signal then enables the line receivers in the selected drive.

3.08 Bus bits 0 through 9 combine with cylinder select tag, head select tag, and control select tag signals to provide commands and status signals to the disk drive.

3.09 The read/write heads are moved to a cylinder position specified by the cylinder address in bus bits 0 through 9 when the cylinder select tag is active. This movement is done by a linear dc motor under control of the signals read from the servo surface of the disk. Figure 10 is a block diagram of the servo system.

3.10 The disk rotates at a nominal 3600 rpm. The read/write heads fly on a cushion of air close to the disk surface. Because of the extremely small distance, the air surrounding the disk must be highly filtered to remove all dust and smoke particles which otherwise would cause damage to the heads and disk. As an example of the cleanliness required, the residue from a fingerprint is twice as thick as the normal distance between the heads and disks.

3.11 Data is written into each track on a disk when the proper write conditions are established. In addition, each track is divided into a number of sectors so that the location of a particular data item is defined by the track address and the sector number.

3.12 Each full turn of the disk is detected when an index mark recorded on the servo surface passes underneath the servo head. In addition, bytes are counted; and each time a sector quantity of bytes is counted, a sector mark is generated. Therefore, a particular area on a disk may be identified by its cylinder number, head number (these two items define a track), and sector number.

3.13 The read/write head assembly consists of five read/write arms plus other mechanisms to guide and support the heads. Radial positioning of the heads is done by a linear dc motor that moves the head assembly in or out to the track. Upon start-up, the heads lift off the disk surface when the disk speed is up to 1000 rpm. After a brief delay to allow the heads to fly and stabilize on the air cushion, they are positioned to the addressed track by the linear motor.

4. MAINTENANCE

4.01 Manual and routine maintenance and trouble clearing will be performed using Task Oriented Practices. In those cases where these procedures are inconclusive or ineffective, the operator will be directed to higher level maintenance centers and documentation.

5. POWER

5.01 The disk drive requires 120-volt 60-Hz single-phase power, which is supplied by a 1200VA inverter. The inverter receives −48 volt dc power from a dedicated 50-ampere fuse in the power distribution frame.

5.02 The inverter contains two circuit breakers and seven circuit packs. The circuit packs are one TN2 circuit pack, five 495H-1 circuit packs, and one 394A synthesizer. The TN2 circuit pack contains the power-cycling switch and alarm circuitry. The 495H-1 circuit packs are dc-to-dc converters (−48 volts to ±175 volts). The 394A synthesizer converts the ±175 volts direct current to 120 volts alternating current.

6. REFERENCES

6.01 The following manufacturer publication provides operation and maintenance instructions for the KS-22693, L1, moving head disk drives:

- Control Data Corporation Installation, Operation, and Maintenance Manual, KS-22693, L1, Disk Drive.

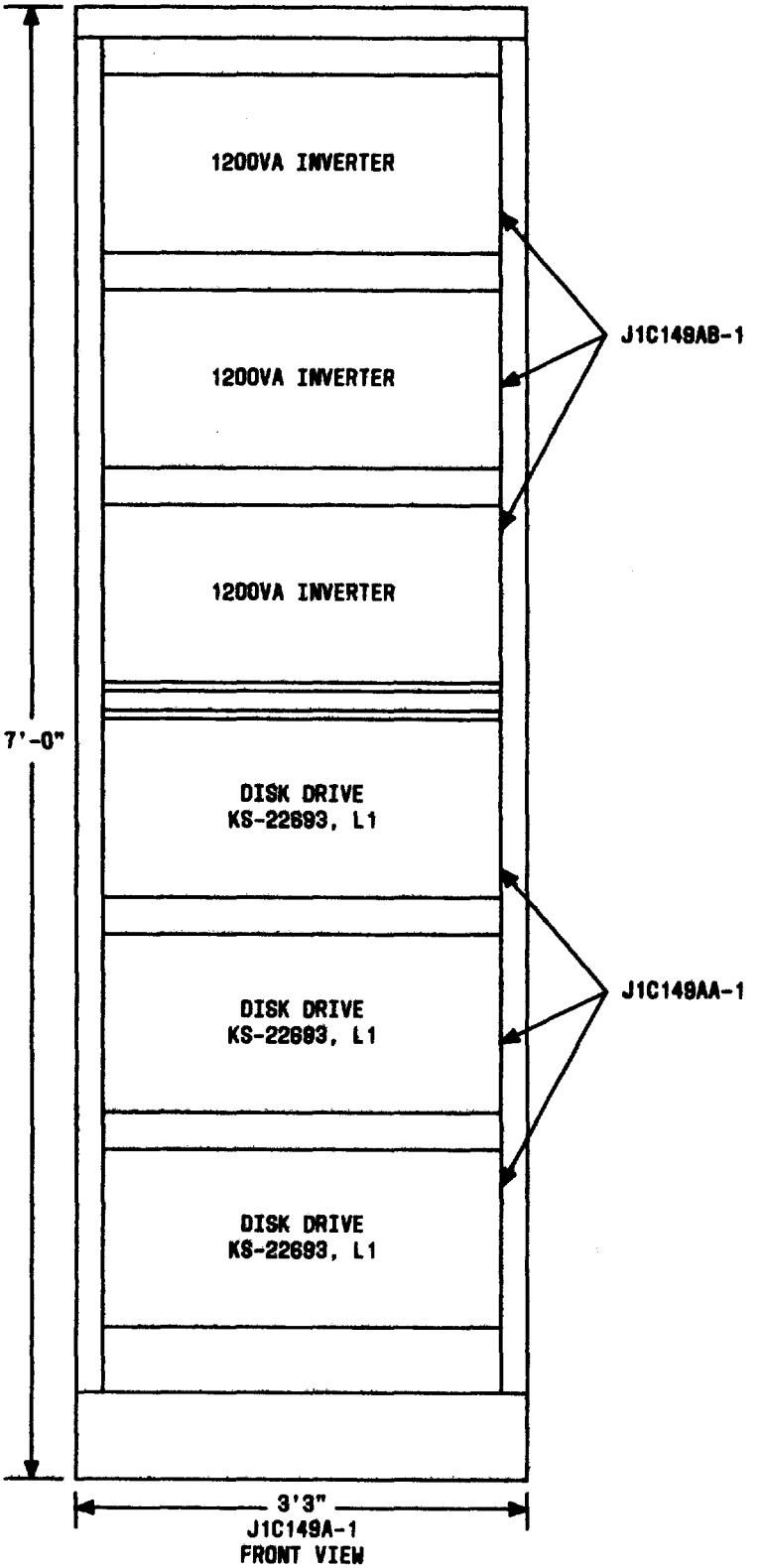


Fig. 1—Mini-Module Disk Frame

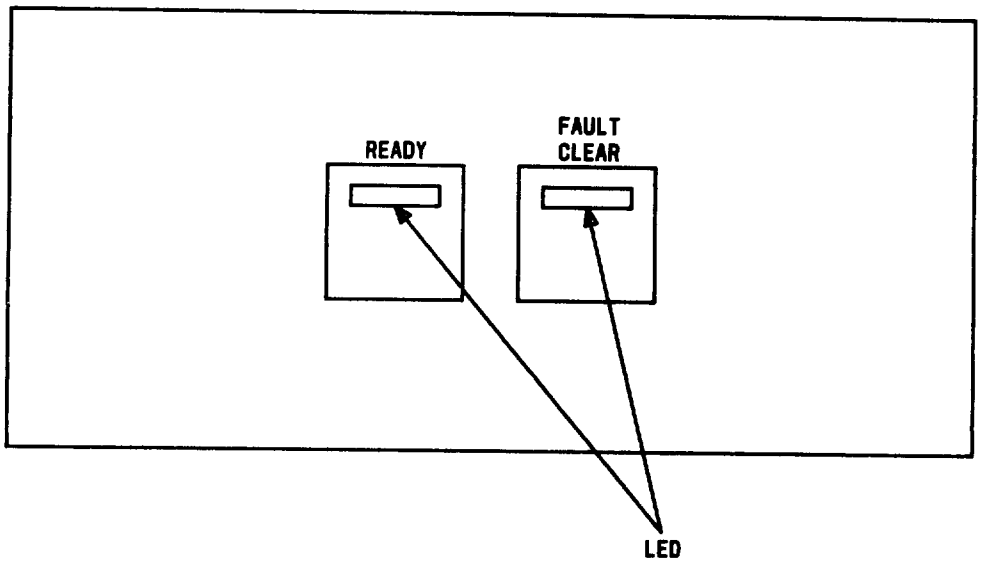


Fig. 2—KS-22693, L1, Operator/Status Control Panel

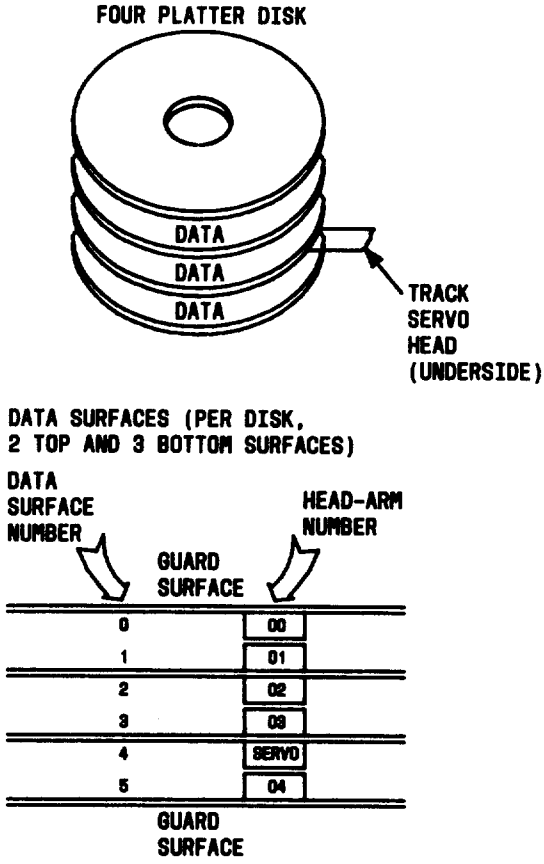


Fig. 3—Four-Platter Disk Layout

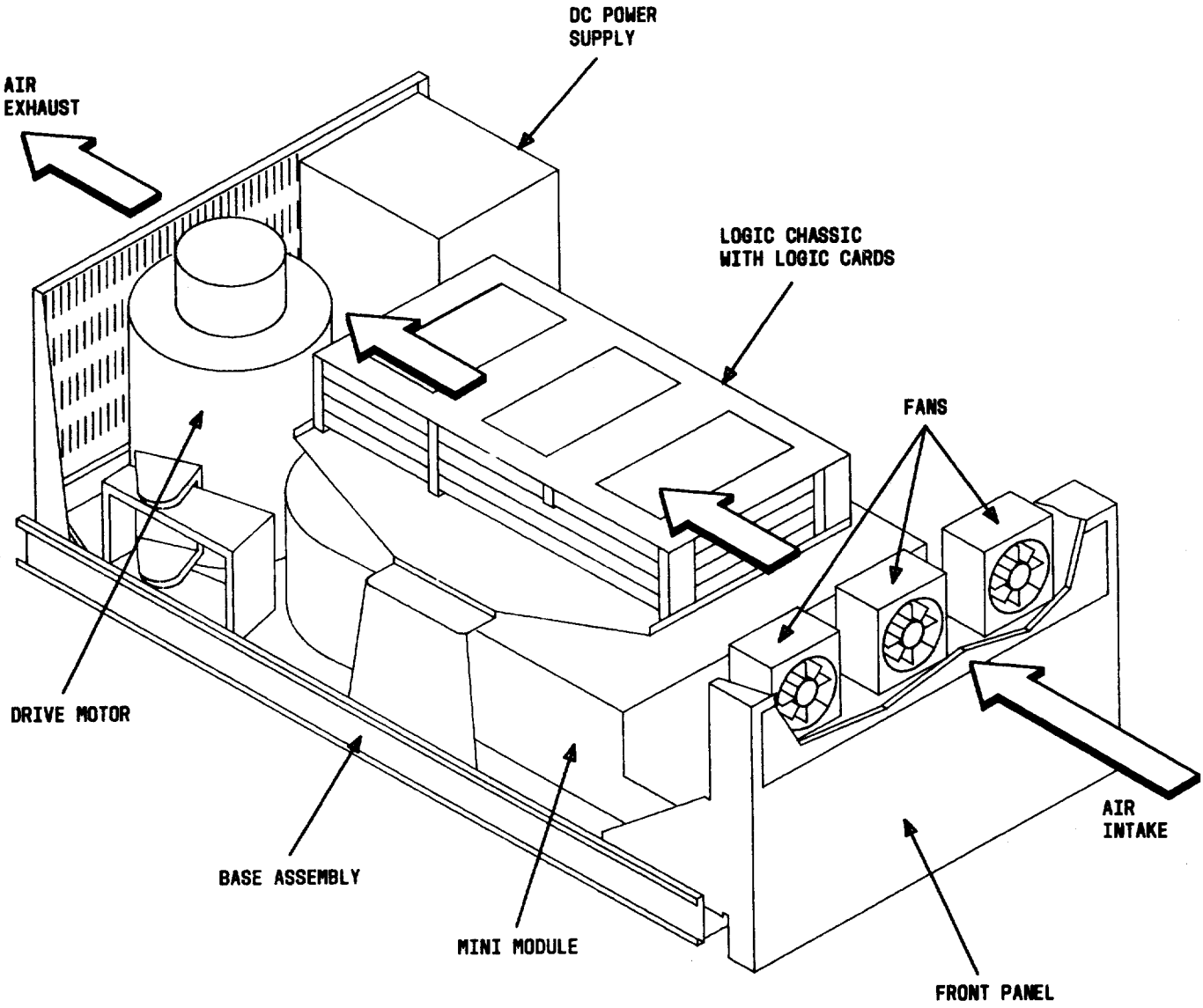


Fig. 4—Disk Drive Major Assemblies

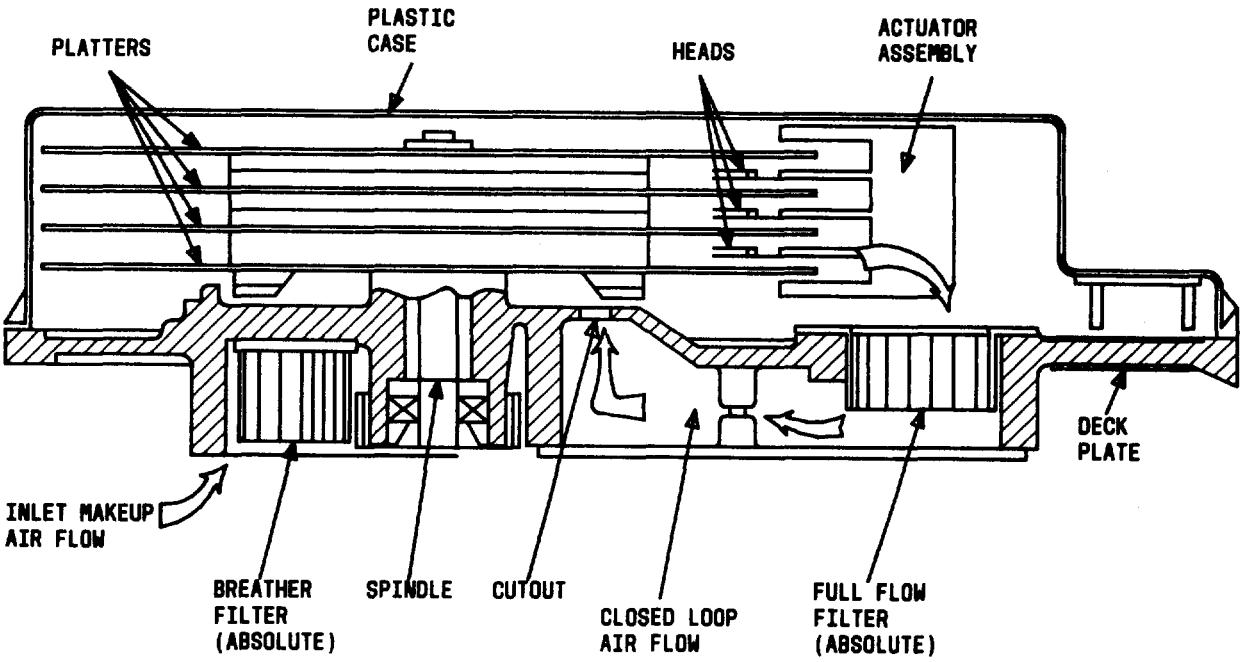
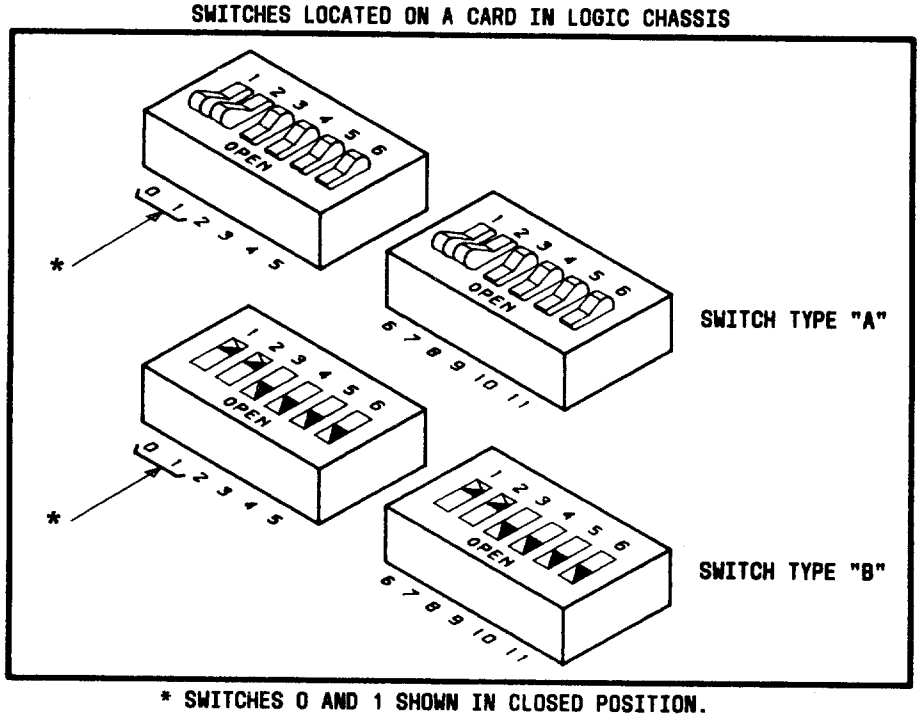


Fig. 5—Mini-Module Assembly

ROCKER-TYPE SWITCHES

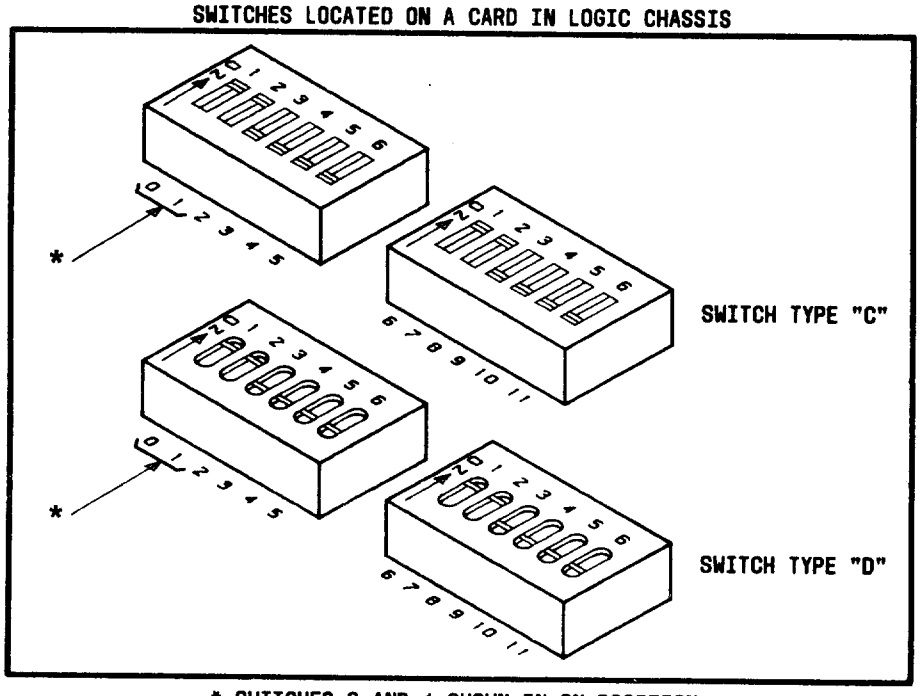
SWITCHES LOCATED ON A CARD IN LOGIC CHASSIS



* SWITCHES 0 AND 1 SHOWN IN CLOSED POSITION.

SLIDE-TYPE SWITCHES

SWITCHES LOCATED ON A CARD IN LOGIC CHASSIS



* SWITCHES 0 AND 1 SHOWN IN ON POSITION.

Fig. 6—Sector Select Switches

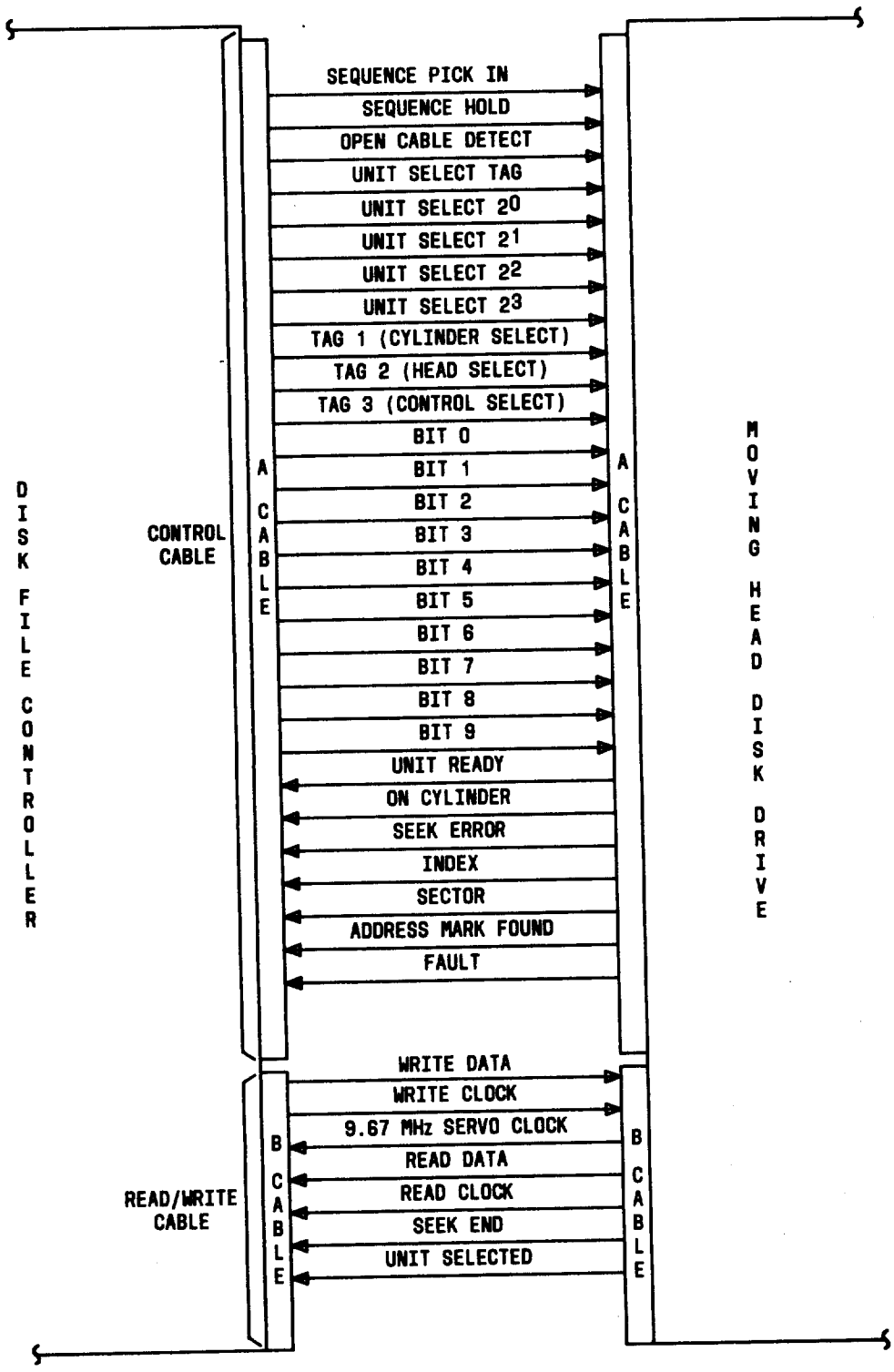


Fig. 7—Control and Read/Write Cables

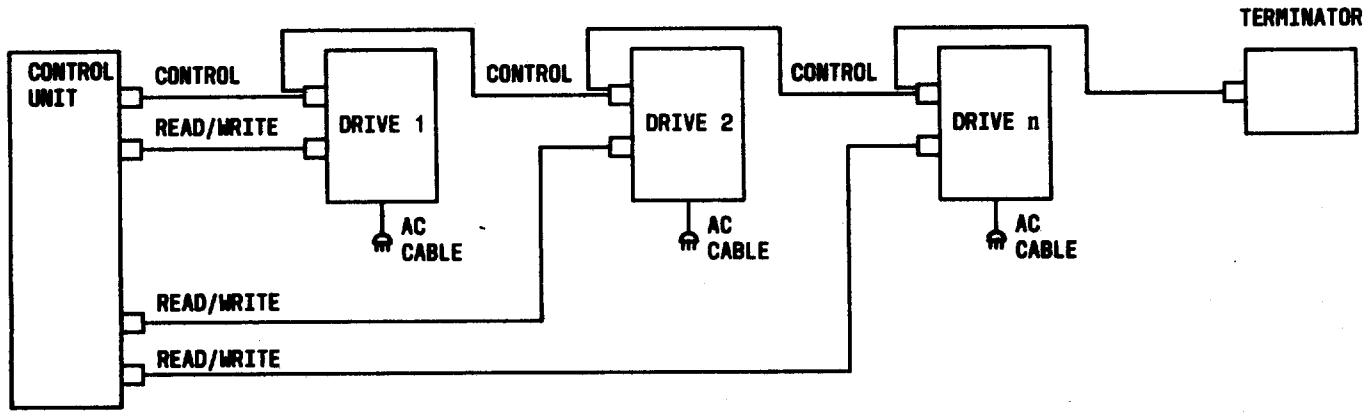
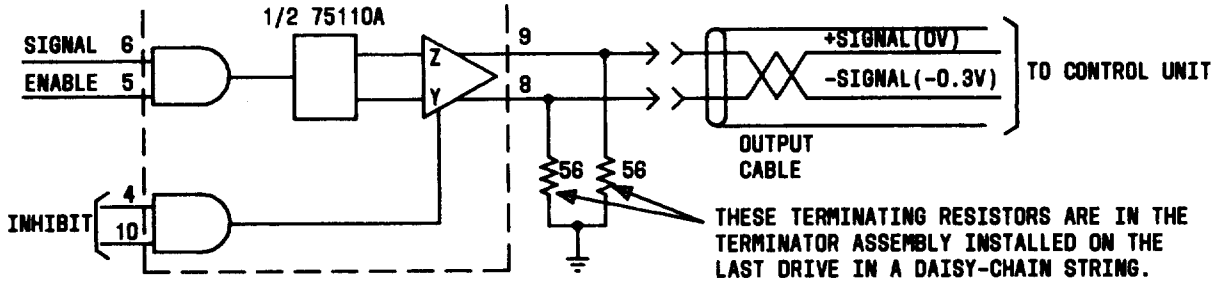
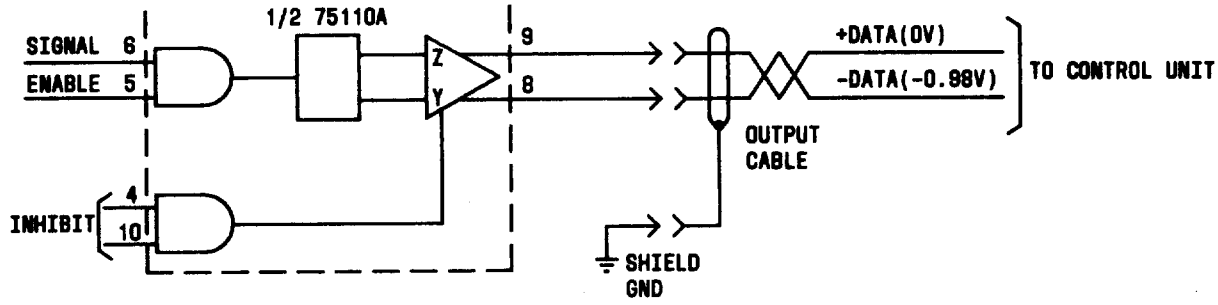


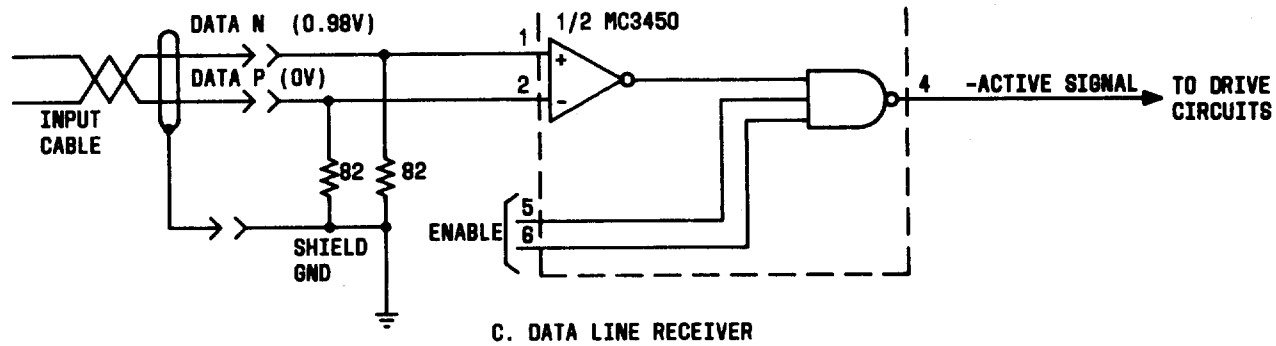
Fig. 8—System Daisy-Chain Configuration



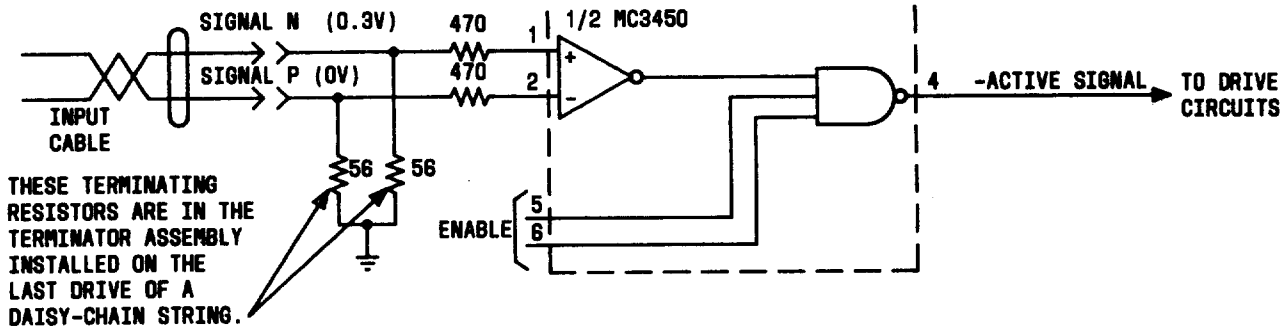
A. STATUS LINE TRANSMITTER



B. DATA LINE TRANSMITTER



C. DATA LINE RECEIVER



D. CONTROL LINE RECEIVER

Fig. 9—Line Drivers and Receivers

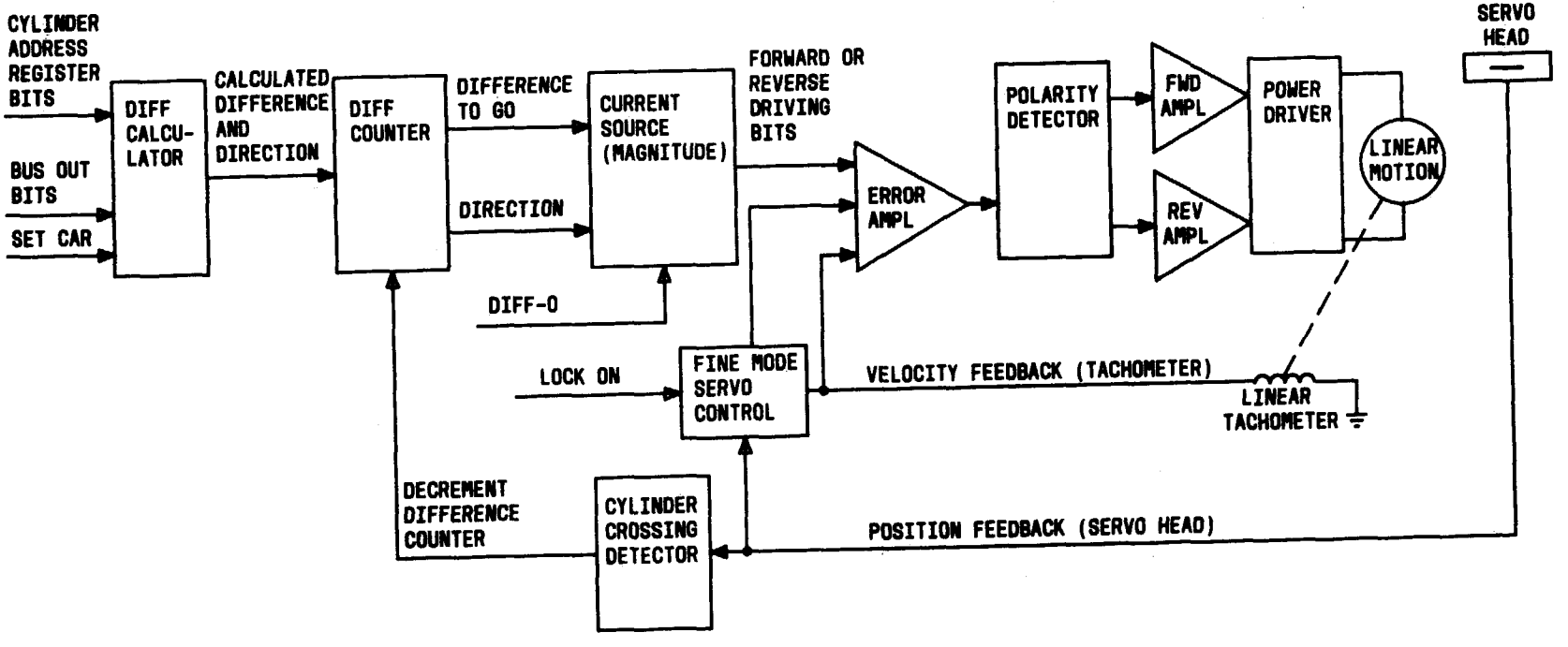


Fig. 10—Basic Servo Block Diagram

TABLE A

KS-22693, L1, OPERATOR/STATUS CONTROL PANEL FUNCTIONS

CONTROL/INDICATOR	FUNCTION
READY indicator	The indicator is lighted when the unit is: • Up to speed • Heads are positioned • No-fault condition exists.
FAULT switch/ indicator	The indicator is lighted if a fault condition exists within the drive. When the fault no longer exists, the indicator is extinguished by any of the following: • Pressing the FAULT switch/indicator on the panel • Fault-clear signal from the controller • A drive power-up operation.

TABLE B

CONTROL CABLE FUNCTIONS

SIGNAL/LINE	FUNCTION
Sequence pick in*	A ground from the controller on this line powers up the disk drive if the LOCAL/ REMOTE switch is in the REMOTE position and the START switch is on. When the disk drive is up to speed, the sequence relay is deenergized and the sequence pick in signal is sent to the next disk drive.
Sequence hold	A ground from the controller on this line holds the disk drive in a power-on condition. Removing the ground from this line powers down all operating disk drives in the system.
Open cable detector	The absence of the open cable detect signal will disable all of the disk drive receivers and transmitters that are connected to the control cable. Thus inhibiting unit selection and/or controller commands.
Unit select tag	This signal gates the desired disk drive unit select lines into the logical number compare circuit. If the desired number matches the number physically assigned to the disk drive, that disk drive is selected. A unit select tag accompanied by an active bus bit 9 indicates a priority select status. The disk drive is unconditionally selected and reserved by the channel issuing this command provided that both channels are enabled and a priority select condition does not exist on the other channel.
Unit select lines 2^0, 2^1, 2^2, and 2^3	A binary code is placed on these four lines to select a disk drive. The binary code must match the logical address of the disk drive determined by the position of four switches on a card in the logic chassis. Disk drives can be numbered 0 through 15.
Tag 1 (cylinder select)	This tag line gates the data on the bus out lines to the disk drive cylinder address register. Bus bits 0 through 9, with the value shown below, encode the cylinder address for the movable head seek operation. Cylinder addresses of 823 through 895 are illegal and will encode a seek error. Bus bits are interpreted as follows: BUS BIT — FUNCTION 0 — Cylinder address value 2^0 1 — Cylinder address value 2^1 2 — Cylinder address value 2^2 3 — Cylinder address value 2^3 4 — Cylinder address value 2^4 5 — Cylinder address value 2^5 6 — Cylinder address value 2^6 7 — Cylinder address value 2^7 8 — Cylinder address value 2^8 9 — Cylinder address value 2^9

* This signal is called sequence pick out when output from the drive but is called sequence pick in when input to the next drive.

TABLE B (Contd)

CONTROL CABLE SIGNALS

<table>
<tr><th>SIGNAL/LINE</th><th>FUNCTION</th></tr>
<tr><td>Tag 2 (head select)</td><td>This tag line gates the data on bus bit lines 0 through 3 to the disk drive head address register. The bus bits have the significance listed below.
<table>
<tr><th>SELECT BUS BIT</th><th>VALUE</th><th>FUNCTION</th></tr>
<tr><td>0</td><td>2^0</td><td>Head Select</td></tr>
<tr><td>1</td><td>2^1</td><td>Head Select</td></tr>
<tr><td>2</td><td>2^2</td><td>Chip Select</td></tr>
<tr><td>3</td><td>2^3</td><td>Chip Select</td></tr>
<tr><td>4—9</td><td></td><td>Not Used</td></tr>
</table></td></tr>
<tr><td>Tag 3 (control select)</td><td>This tag line gates the data on the bus bit lines to the logic circuits of the disk drive for commanding various operations. The operation performed is dependent upon which of the bus bit lines is active. The significance of the bus bits are as follows:
<table>
<tr><th>BUS BIT</th><th>NAME</th><th>FUNCTION</th></tr>
<tr><td>0</td><td>Write gate</td><td>Enables write driver. Not accepted if there is a seek error or fault status.</td></tr>
<tr><td>1</td><td>Read gate</td><td>Enables read circuitry. Leading edge triggers the read chain circuit to synchronize on an all-zeros pattern. Not accepted if there is a seek error or fault status.</td></tr>
<tr><td>2</td><td>Servo offset positive</td><td>Not used by all units. Offsets the actuator from the on-cylinder position 200 microinches towards the spindle. Disables the on-cylinder signal for 2.75 milliseconds.</td></tr>
<tr><td>3</td><td>Servo offset negative</td><td>Not used by all units. Offsets the actuator from the on-cylinder position 200 microinches away from the spindle. Disables the on-cylinder signal for 2.75 milliseconds.</td></tr>
<tr><td>4</td><td>Fault clear</td><td>A pulse sent to the drive to clear the fault flip-flop. It is cleared if the fault condition no longer exists.</td></tr>
<tr><td>5</td><td>Address mark enable</td><td>When this signal occurs with a write gate, an address mark is written. When this signal occurs with a read signal, an address mark search is initiated.</td></tr>
</table></td></tr>
</table>

TABLE B (Contd)

CONTROL CABLE FUNCTIONS

SIGNAL/LINE	FUNCTION		
Tag 3 (control select) (Contd)	BUS BIT	NAME	FUNCTION
	6	Return to zero	A pulse sent to the disk drive to move the positioner to track 0. It also resets the head address register, difference counter, and seek error flip-flop.
	7	Data strobe early	Enables the phase locked oscillator data separator to strobe the data at a time earlier than nominal.
	8	Data strobe late	Enables the phase locked oscillator data separator to strobe the data at a time later than nominal.
	9	Release	Used with the dual-channel option only. Clears the channel reserved and channel priority select reserve status. (Refer to unit selection discussion.)
Bits 0—9 (bus lines)	These ten lines carry data to the disk drive. The meaning of the data is a function of the active tag line.		
Unit ready	Unit ready indicates that the disk drive is up to speed, that the servo head is positioned on cylinder, and that no fault condition exists.		
On cylinder	This indicates that the servo head is positioned at a track. Any positioner movement, including servo offset, results in a loss of the signal.		
Index	This signal is derived from the servo tracks. It occurs once per revolution of the disk, and its leading edge is the leading edge of sector zero.		
Sector	This signal is derived from the servo tracks. The number of sector signals that occur for each revolution of the disk is switch selectable at a card in the logic chassis.		
Seek error	Seek error indicates either a maximum seek error or a main processing unit seek error. A maximum seek error is caused by an illegal address for a movable head seek. An illegal movable head seek address is one between 823 and 895. A main processing unit seek error is caused by any of the following: • Fault code 12 (end of travel): detection of inner or outer guard band (with on-cylinder sense) at the completion of a seek		

TABLE B (Contd)

CONTROL CABLE FUNCTIONS

SIGNAL/LINE	FUNCTION
Seek error (Contd)	• Fault Code 13 (no lock in 250 milliseconds): on cylinder lost for over 250 milliseconds (except during return to zero) • Fault code 16 (maximum address fault): illegal address detected by discrete circuitry or by main processing unit • Fault code 17 (failure to complete return to zero): failure to either enter guard band within 1024 tracks or failure to lock onto track 0 properly. The seek error can be cleared by a return-to-zero command or by a power-up operation.
Fault	When the line is active, it indicates that one or more of the following faults exist: • DC voltage fault • Head select fault • Write fault • Write or read attempted while off cylinder • Write gate during a read operation.
Address mark found	This signal indicates that the selected head is presently over the address mark area of a track.

TABLE C

READ/WRITE CABLE FUNCTIONS

SIGNAL/LINE	FUNCTION
Read data	This line transmits data recovered from the disk. This data is transmitted in a nonreturn-to-zero form to the controller.
Read clock	This clock is derived from and is synchronous with the detected data. Read clock defines the beginning of a data cell and is transmitted continuously.
Write data	This line transmits nonreturn-to-zero data from the controller to the disk drive for recording on the disk surface in modified frequency modulation form.
Write clock	This clock is the 9.67-MHz clock retransmitted to the disk drive during a write operation. Write clock must be synchronized to the nonreturn-to-zero data and must be transmitted 250 nanoseconds prior to write enable.
Servo clock	Servo clock is a phase-locked 9.677-MHz signal generated from the servo track quadbits. Servo clock is continuously transmitted and is used to generate write data.
Unit selected	This signal indicates that the disk drive has accepted a unit select request. This line must be active before the disk drive will respond to any command from the controller.
Seek end	This signal indicates either an on-cylinder status or seek-error status resulting from a seek operation that has terminated.