AT&T 3B20D Model 3 Computer 340-Megabyte Disk Drive General Description

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1. Overview

1.01 This practice provides a physical and functional description of the KS-22875, L10, 340-megabyte disk drives used by the AT&T 3B20D computer.

1.02 This practice is reissued to update disk file controller (DFC) configuration information, to update the storage capacity description of the 340 megabyte disk drive, and to add Section 6, Acronyms.

1.03 This practice contains no admonishments.

1.04 AT&T welcomes your comments on this practice. Your comments will aid us in improving the quality and usefulness of AT&T documentation. Please use the Feedback Form provided at the back of this practice.

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1.07 Technical assistance for the 3B20D Model 3 computer can be obtained by calling the Regional Technical Assistance Center at **1-800- 225-RTAC**. This telephone number is staffed 24 hours per day. During regular business hours, your call will be answered in your region. During evening and early morning hours, your call will be answered at Rolling Meadows, Illinois.

Purpose

1.08 The 340-megabyte fixed storage drives (FSDs) are high speed, random access memory devices that are used for mass data storage in the computer.

Configuration

1.09 The 340-megabyte disk drives are connected to the computer via a storage module drive (SMD)-type DFC. The DFC can communicate with as many as eight disk drives.

2. Physical Description

2.01 The 340-megabyte FSDs are located in the disk frame (J1C186A-1). Also, power supplies (KS-22997, L2) and power switches (ED-4C481) are located in the disk frame. The single-bay disk frame measures 6 feet 4 inches high by 2 feet 2 inches wide by 2 feet 6 inches deep (Figure 1). These dimensions include wheels supporting the frame for movability and a front door for protection.

2.02 The FSDs are installed in enclosures that are acoustically insulated to reduce noise level near the unit and to provide electromagnetic compatibility shielding. These enclosures measure 8.5 inches wide by 10 inches high by 25 inches deep. The disk drive unit weights approximately 70 pounds (Figure 2).

2.03 The operator control panel is located at the front of the disk drive unit. This panel measures 8.5 inches wide by 10.2 inches high by 1.2 inches deep (Figure 2).

2.04 The remote power supply unit is located beside the disk drive unit. This unit measures 2.5 inches wide by 10 inches high by 22 inches deep and weights approximately 12 pounds.

2.05 Figure 2 shows the disk drive unit along with the power supply and the operator control panel. Table A lists the controls of the operator panel along with their functions.

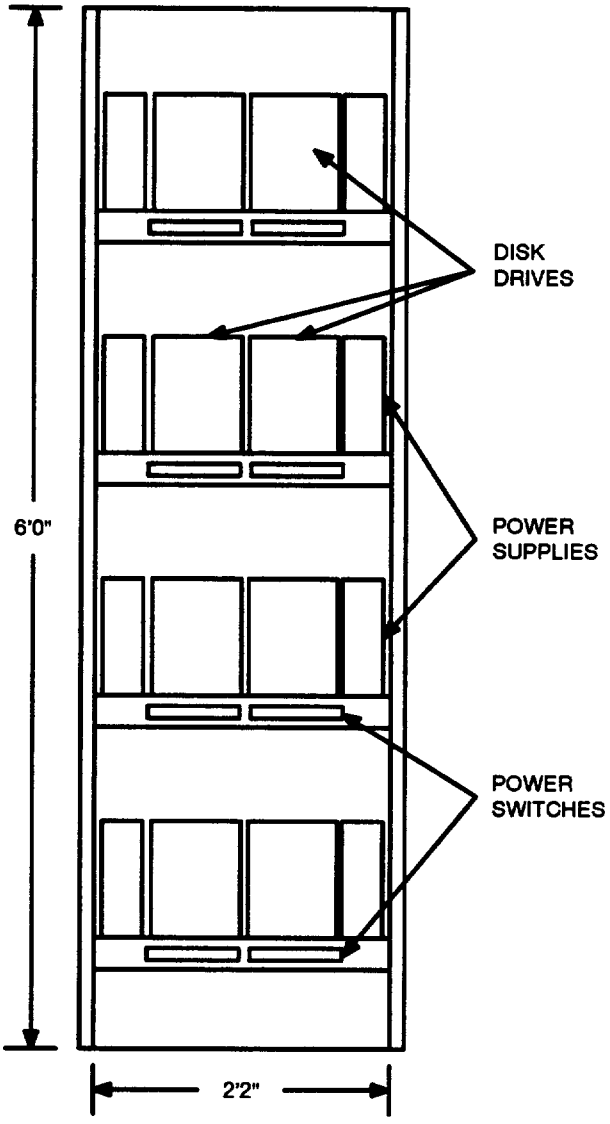

Figure 1. Disk Drive Frame

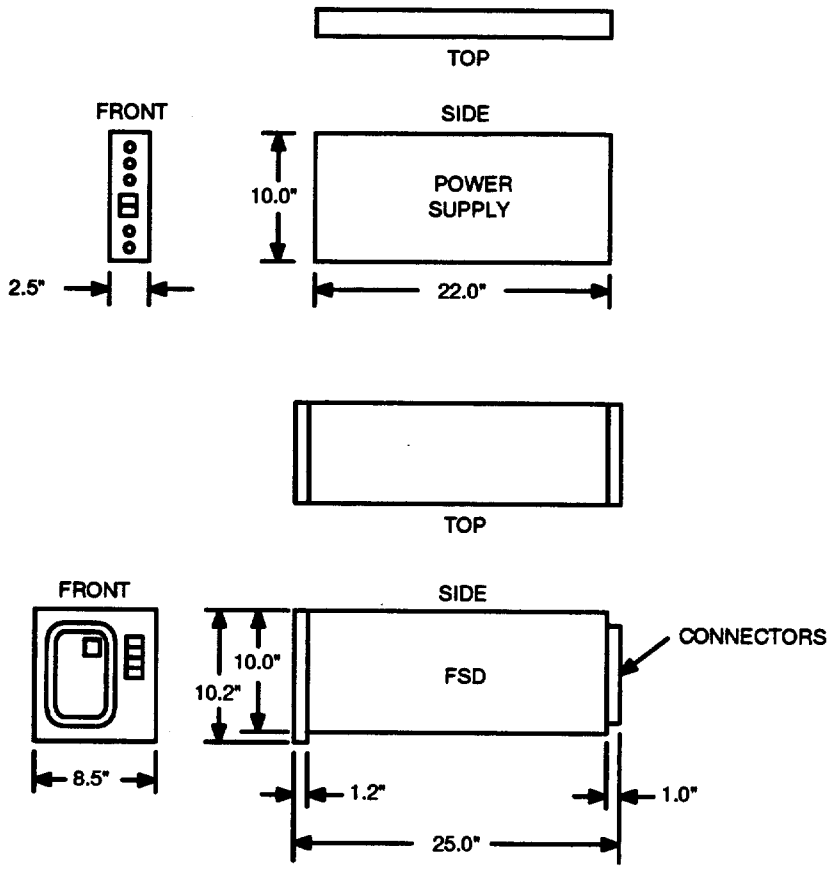

Figure 2. FSD With Remote Power Supply

Table A. Operator Panel Controls and Functions

Control / Indicator	Function
LOGIC PLUG (Removable)	The logic plug activates switches that establish the logical address of the drive. A set of logic plugs, numbered 0 through 3 are included with each unit. Logic plugs, numbered 4 through 7, are available as accessories.
START/STOP	The **START** switch has alternate action, in for start and out for stop. Pressing the **START** switch to the start position activates the power up sequence. The ready indicator, located in the **START** switch, flashes until the disks are up to speed, the heads are loaded, and there are no fault conditions. The Ready indicator is lit continuously when power up is completed. Pressing the **START** switch to release it from the start position causes the ready indicator to flash until disk rotation has stopped.
FAULT/CLEAR	The **FAULT** indicator is inside the Fault Clear Switch, and it lights if a fault exists within the drive. The switch clears the Fault condition if that Fault is no longer present.
WRITE PROTECT	The operation of the **WRITE PROTECT** switch or the control board **WPROT** jumper places the drive in the write protected mode (preventing write operations) and lights the **WRITE PROTECT** indicator.

2.06 The KS-22875, L10, FSD has an unformatted storage capacity of 340 megabytes. After formatting, the disk drive provides approximately 227 megabytes of storage capacity. The disk drive controls and accesses a 9-inch, 7-platter rigid disk. Of the 14 surfaces comprising the 7-platter disk, 1 surface contains servo track information and 12 surfaces contain data storage (Figure 3). The servo surface is a prerecorded read only surface dedicated to head positioning and timing. The surface directly adjacent to the servo surface is not used. The servo surface is accessed by one data recording head, whereas each data storage surface is accessed by two movable data recording heads.

2.07 Data is recorded on the data surfaces in tracks. The data capacity is based on the number of 8-bit bytes that are recorded on a track. There are 20,160 bytes per track. Each read/write head for a particular disk surface may be positioned to any one of 711 positions, starting from the outer edge and moving toward the center. Each position is called a cylinder.

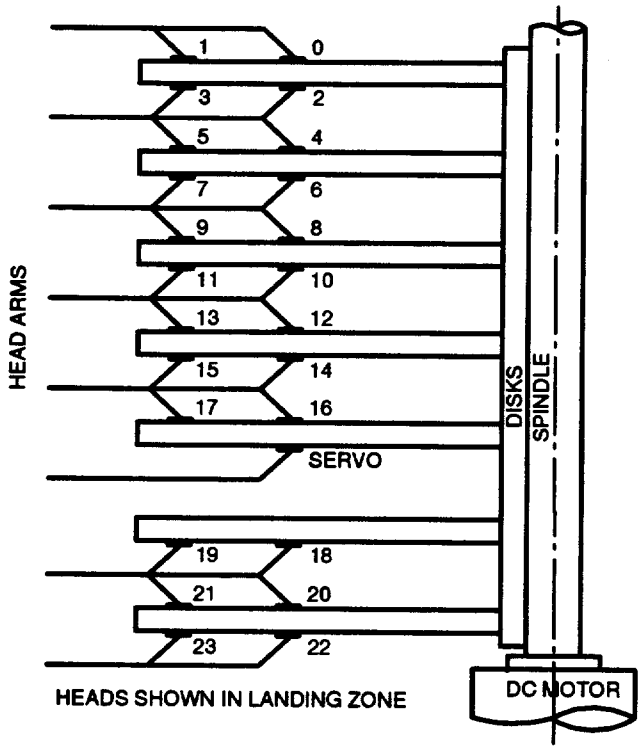

Figure 3. FSD-340 Head Disk Scheme

Disk Drive Configuration

2.08 The three major assemblies that make up an FSD are the module assembly, frame assembly, and the front panel. Figure 4 shows these assemblies.

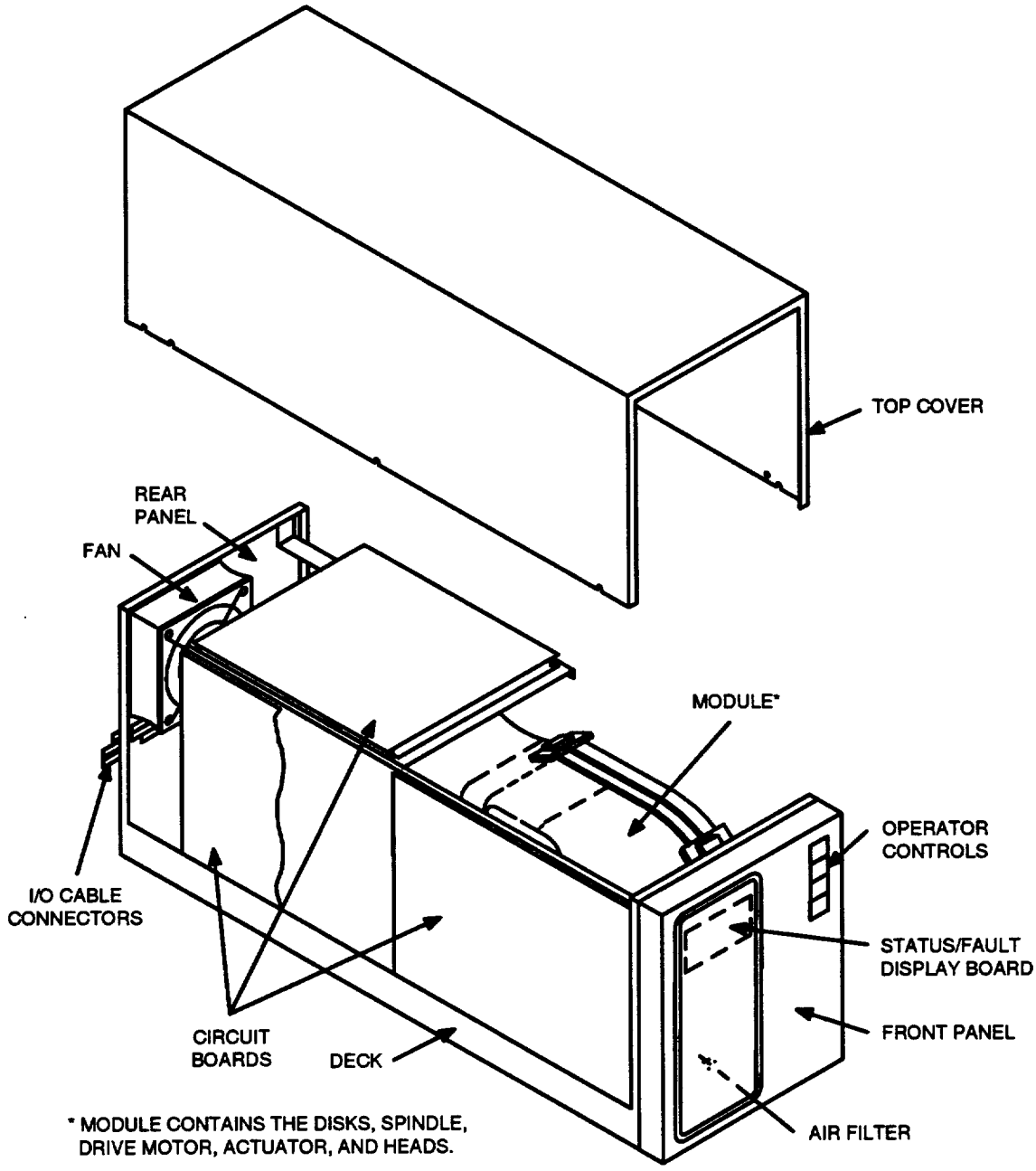

Figure 4. FSD Assemblies

A. Module Assembly

2.09 The module assembly or head disk assembly (HDA) contains the spindle, disks, heads, linear actuator, and the dc drive motor, all of which are sealed to minimize the effects of environmental contamination. The HDA can not be repaired in the field but can be replaced entirely by a field service representative. The defective assembly must be returned to the manufacturer.

2.10 The seven disks provide the recording medium for the drive. These disks are center-mounted on a spindle, and the spindle is coupled directly to the drive motor. When activated, the drive motor rotates the disks at 3600 rpm.

2.11 The actuator is the assembly that holds the heads and moves the heads over the rotating disks. There are 25 heads; a servo head to control actuator positioning, and 24 data heads for data transfers to and from the disks. The actuator has a voice coil which moves in and out of a permanent magnetic field in response to signals from the servo positioning circuitry. The voice coil forces the actuator carriage to roll on parallel rails to move the heads accurately across the disk surfaces. When the drive is not in use, the heads rest on the disk surface in the preassigned landing zone (beyond the data zone in the outer area of the disk surface). The actuator is automatically latched in this position, at shutdown, for moving or shipping protection. 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.

B. Frame Assembly

2.12 The frame assembly houses the HDA and forms the mounting base for the circuit boards, exhaust fan, and control plate. The input/output (I/O) control cables are connected to the control plate located at the rear of the frame assembly.

2.13 There are five circuit boards that screw onto the side, top, or back of the disk drive unit. The I/O, microprocessor control, and mother boards mount on the side of the unit. The read/write data board mounts on the top of the unit and the power supply board mounts on the rear of the disk drive, parallel to the control plate. The circuit boards are interconnected through the mother board, and they contain the electronics required for drive operation. The frame assembly has slide mounts in which the unit can be rolled forward in its rack mount. The circuit packs can then be accessed by removing the top cover. This is done by loosening six nonremovable screws and lifting the cover off.

2.14 At the rear of the disk drive unit, the I/O cable connectors, power module interface connector, and the power module and disk drive ground strap connectors are mounted onto the control plate. Each I/O port contains two control cable connectors and one data cable connector. The power module interface connector connects the cable interfacing the power module to the disk drive unit. Also, the control plate provides the power module and the disk drive with ground connections.

2.15 Air flow is provided by a fan, mounted on the rear panel, to circulate cooling air around the electronic assemblies. This air enters a port in the front panel, passes through an air filter, and exhausts through the rear panel opening.

C. Front Panel

2.16 The front panel contains the switches and indicators which allows an operator to control and monitor the basic operations of the disk drive. The panel contains a slot for a logic (ID) plug, a START/STOP switch/indicator, a FAULT/CLEAR switch/indicator, a WRITE PROTECT switch/indicator, and a STATUS/FAULT DISPLAY board (located behind the front panel insert and filter). See Figure 5 and Table A. The front panel insert also provides an open inlet for air flow to circulate across the electronical components. The opening is protected with an air filter for trapping dust particles traveling through the frame assembly.

2.17 A complete set of removable ID plugs are included with each disk drive. An ID plug is inserted into the front panel to establish a logical address in the control cable.

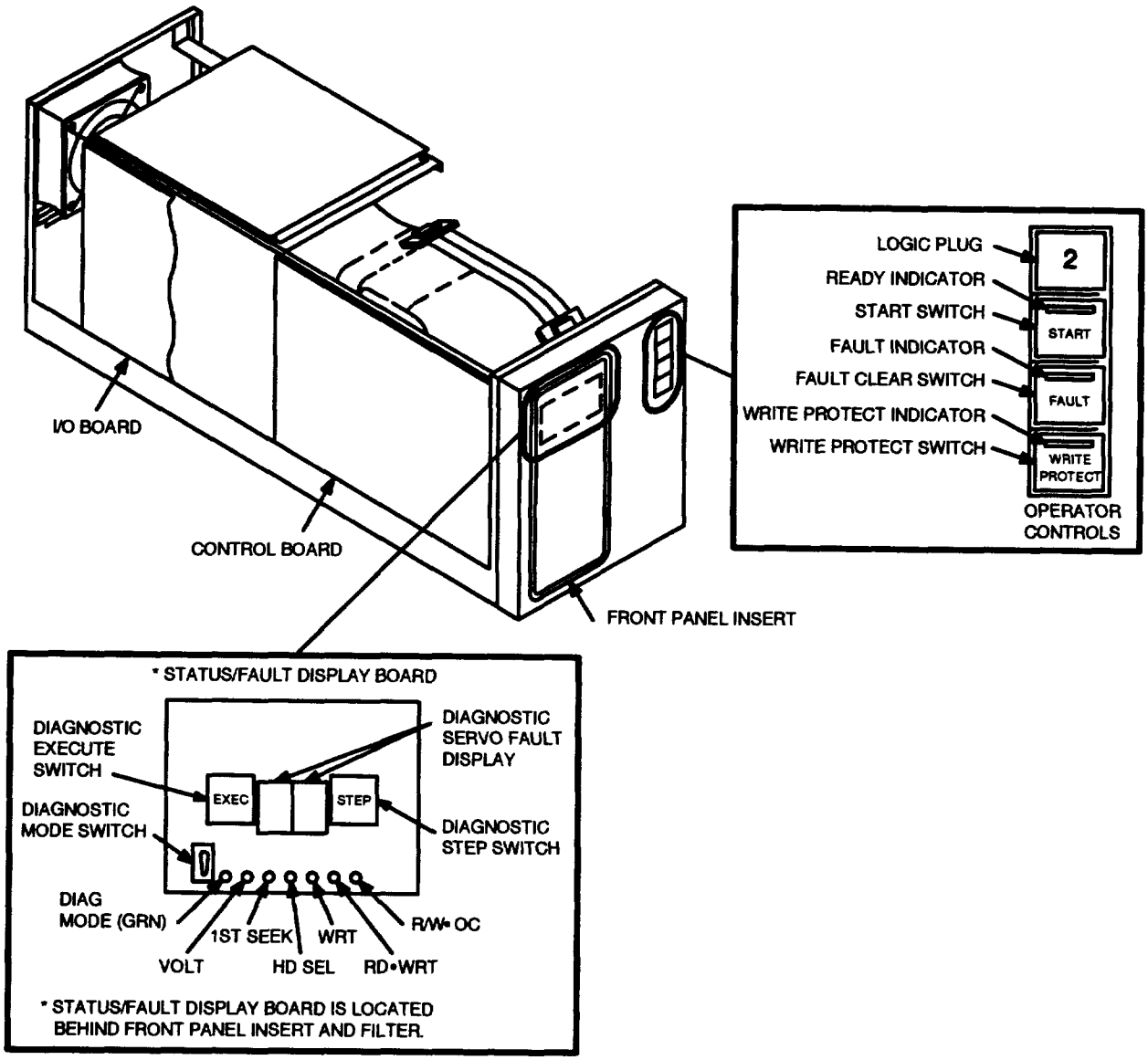

Figure 5. FSD Switches and Indicators

Cable Configuration

2.18 All signals between the control unit and the disk drives are sent over interface lines provided by two separate I/O cables. These lines are contained in either the "A" (address/control) cable or the "B" (read/write) cable. The "A" and "B" cables are commonly referred to as the control and data cables, respectfully. The "A" cable connects to all disk drives in a daisy-chain manner, while individual "B" cables connect the DFC file controller to each drive (Figure 6). Signals between the disk drives and the DFC are carried over twisted pair leads driven by differential line drivers.

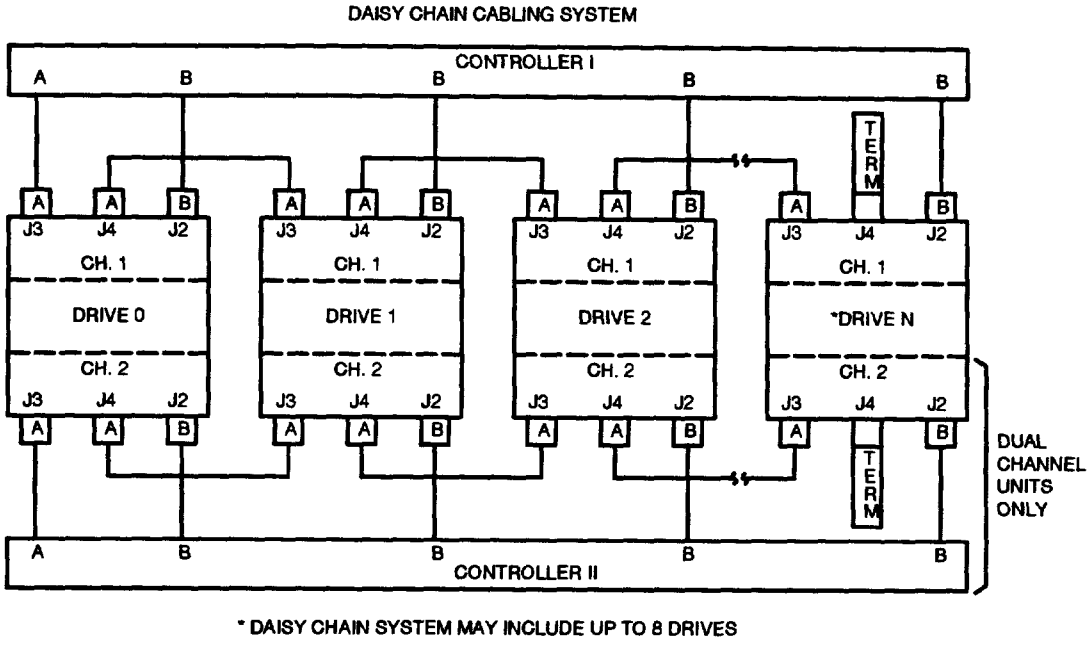

Figure 6. Daisy Chain Cabling System

2.19 All I/O signals are digital, utilizing industry standard transmitters and receivers. Signals to the disk drive enter via line receivers, where they are translated from a differential signal to a transistor-transistor-logic (TTL) compatible logic level for use in the drive. Signals from the disk drive exit via line transmitter, which translate the drive logic to differential signals.

2.20 Each transmission line within the "A" cable, except for the Open Cable Detect line, is terminated with 56-ohm resistors from each side of the balanced differential line to ground at both the transmitting and receiving ends. The Open Cable Detect line will be terminated only at the disk drive end. No termination resistance is used on the power sequence lines in the "A" cable. The "A" cable termination resistors are located in a terminator block attached to the "A" cable output connector of the last drive in the string.

2.21 Each transmission line within the "B" cable is terminated with resistors from each side of the pair to ground only at the receiver end. Receivers located within the disk drive unit have this termination provided within the disk drive unit. The resistors used within the controller have a value of 82 ohms. The resistors used within the disk drive have a value of 82 ohms, preferably. However, the resistors within the disk drive may have a value of 56 ohms provided that the drive meet all performance and timing requirements when 130-ohm, + or – 15-ohm, impedance "B" cable signal lines are used.

2.22 The "A" cable is a 60 pin shielded cable with a line-to-line impedance of 100 ohms. The "B" cable is a 26 pin shielded cable with a line-to-line impedance of 130 ohms. These impedances require that the length of cable "A" does not exceed 100 feet and the length of cable "B" does not exceed 50 feet.

3. Functional Description

3.01 All operations performed by the disk drives are reading and writing. The actual reading and writing is performed by electromagnetic heads that are positioned over the recording surfaces of the rotating disks. There are two heads per disk surface, and the heads are positioned in which data is written in concentric tracks around the disk surfaces (Figure 7).

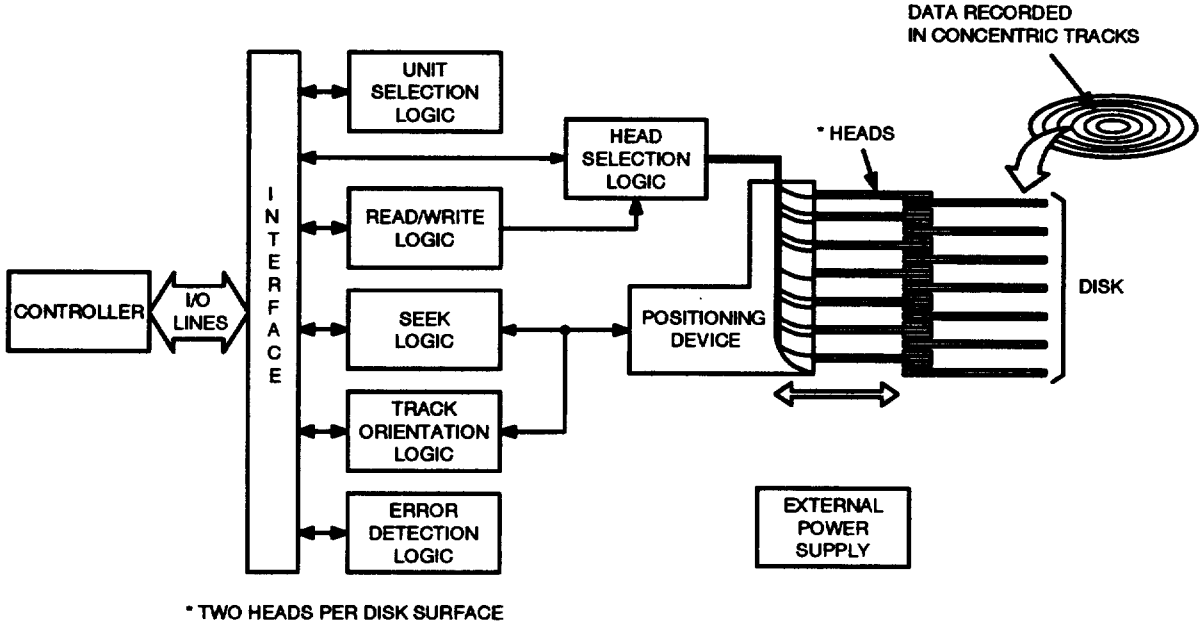

Figure 7. Disk Drive Functional Block Diagram

3.02 Before any read or write operation is performed, the controller instructs the drive to position the heads over the desired track. Driving or positioning the heads in or out to the desired track is termed a "seek". The average seek time is 20 ms. Also, the drive is instructed to use the head located over the surface (head selection) where the operation is to be performed.

3.03 After selecting a head and arriving at the data track, the controller locates the portion of track on which the data is to be written or read. This is called track orientation and is done by using the Index and Sector signals generated by the drive. The Index signal indicates the logical beginning of each track, and the Sector signals are used by the controller to determine the position of the head on the track with respect to index.

3.04 When the desired location is reached, the controller commands the drive to actually read or write the data. During a read operation, the drive recovers data from the disks and transmits it to the controller. During a write operation, the drive receives data from the controller, processes the data, and writes it on the disks.

3.05 Data is transferred from the controller to the disks and from the disks to the controller by signals transmitted over I/O cables. The "A" cable carries 30 control and address signals between the DFC and the disk drive (Figure 8). The drive will not output any signal onto the "A" cable unless the Unit Select line is active. Activation of the Cylinder Select, Head Select, or Control Select tag lines, in conjunction with any bus bit, will not activate any disk drive function unless the Unit Select line is active. Table B lists these signals along with their functions.

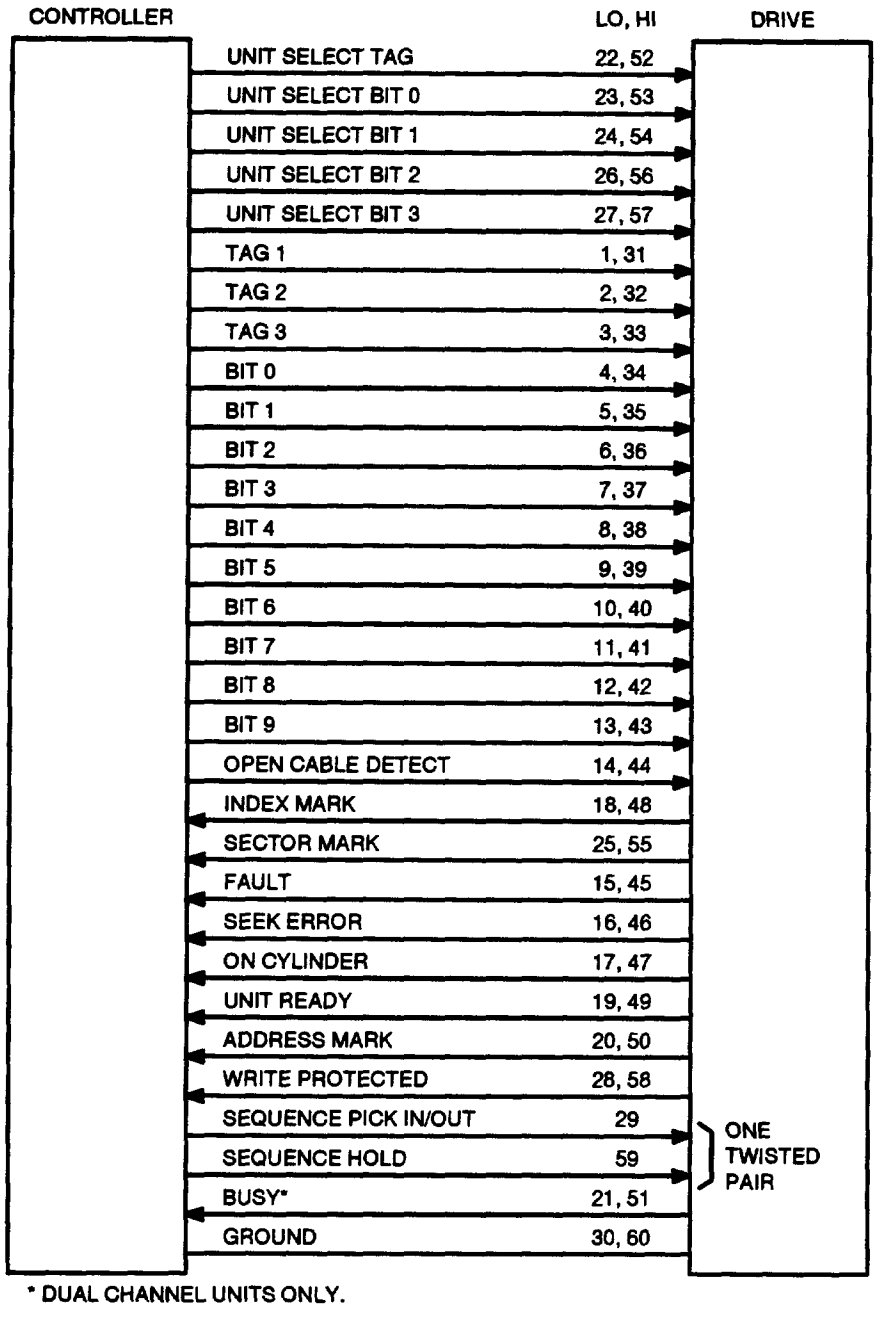

Figure 8. Control Cable Signals

Table B. Control Cable Functions

Signal / Line	Function
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	The four binary coded unit select lines are used to perform drive ID selection. A maximum of 8 drives is permissible per system bus, with unit numbers 0 through 7 being valid. The unit number is selected by inserting an ID plug into the front panel of each individual unit. If the installed ID plug number matches the requested number at the rising edge of the unit select tag, that unit will become selected.
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 711 and greater 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
Tag 2 (head select)	This tag line gates the data on bus bit lines 0 through 4 to the disk drive head address register. If bus bits 5 through 9 should happen to be active in conjunction with tag 2, these bits will be ignored by the drive.

Table B. Control Cable Functions (Contd)

<table>
<tr><th>Signal / Line</th><th colspan="3">Function</th></tr>
<tr><td>Tag 3 (control select)</td><td colspan="3">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:</td></tr>
<tr><td></td><td>Bus Bit</td><td>Name</td><td>Function</td></tr>
<tr><td></td><td>0</td><td>Write gate</td><td>Enables write driver. Not accepted if a seek error or fault status exists.</td></tr>
<tr><td></td><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 a seek error or fault status exists.</td></tr>
<tr><td></td><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></td><td>3</td><td>Servo offset negative</td><td>Not used by all units. Offset 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></td><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></td><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>
<tr><td></td><td>6</td><td>Return to zero</td><td>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.</td></tr>
<tr><td></td><td>7</td><td>Data strobe early</td><td>Enables the phase locked oscillator data separator to strobe the data at a time earlier than nominal.</td></tr>
<tr><td></td><td>8</td><td>Data strobe late</td><td>Enables the phase locked oscillator data separator to strobe the data at a time later than nominal.</td></tr>
<tr><td></td><td>9</td><td>Release</td><td>Used with the dual-channel option only. Clears the channel reserved and channel priority select reserve status.</td></tr>
</table>

Table B. Control Cable Functions (Contd)

Signal / Line	Function
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.
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.
Index mark	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 mark	This signal is derived from the servo tracks. The number of sector signals that occur for each revolution of the disk is switch selectable and is determined by counting sector clocks. The switches are located on the control board in the logic chassis.
Fault	An active line 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. The fault signal indicates that a fault condition exists within the disk drive. The fault immediately disables the write circuitry to prevent data destruction. The fault clear condition is activated by either a controller-initiated reset or by the **FAULT** switch located on the front panel of the drive unit. Fault causes are individually stored on the control board and are displayed via light-emitting diode (LED) indicators, also located on the control board. The **FAULT** switch located on the front panel of the drive clears the stored fault causes provided the fault condition no longer exists.
Seek error	This signal indicates that a seek error has occurred. It indicates that the unit was unable to complete a seek within 350 ms, that an illegal track address was received, or that the head carriage has moved out of the recording area. The seek error can be cleared by a return-to-zero command or by a power-up operation.
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.
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.

Table B. Control Cable Functions (Contd)

Signal / Line	Function
Address mark found	This signal indicates that the selected head is presently over the address mark area of a track.
Write protected	Enabling the write protect function inhibits writing under all conditions and sends a write protected signal to the controller. Attempting to write while protected causes a fault to be issued. Write protection is accomplished by activating a switch on a circuit board in the logic chassis or from a **WRITE PROTECT** switch located on the front panel of the drive.
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.

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

3.06 The "B" cable carries seven data signals between the DFC and the drives (Figure 9). These signals are listed in Table C along with their functions.

3.07 Data is stored on the disks 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. Each track contains twenty 160 8-bit bytes. The disk is capable of being subdivided into sectors, ranging from 4 through 128 sectors. Sector selection is made via 12 independent switches located on the microprocessor control board in the logic chassis. The number of sectors per revolution, generated by the drive logic, is switch selectable and is determined by counting sector clocks. Each sector contains a certain number of clock pulses (received from the servo tracks). The number of clock pulses in each sector is the result of the number of sectors required by the controller. The slide-type switches provide 32 sector selections per track. Figure 10 shows the location of the Sector Select switches.

3.08 The disk drive uses 4 binary coded unit select bit lines (0 through 3) to perform drive ID selection. A maximum of 8 drives are permissible per system bus, with unit numbers 0 through 7 being valid. This number selection is accomplished by inserting an ID plug into the front panel of the drive. The disk drives are then addressed when the Unit Select bit lines match the ID plug inserted into the front panel, and when the leading edge of the Unit Select tag is received. The Unit Select tag then enables the line receivers in the selected drive.

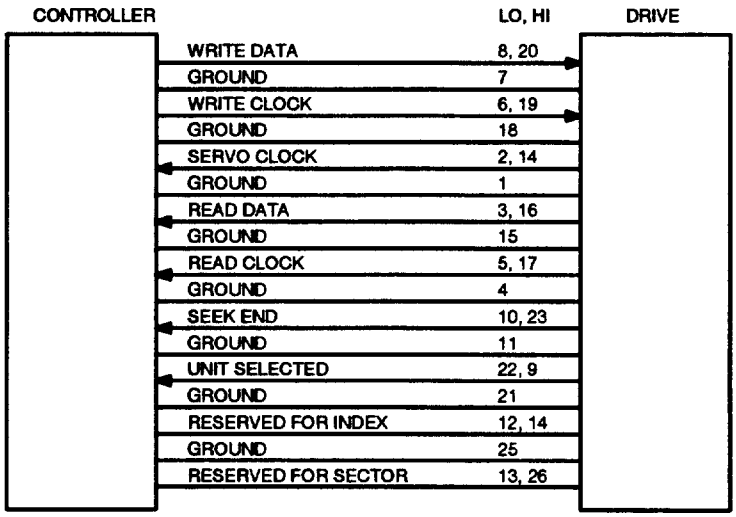

Figure 9. Data Cable Signals

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 tribits. 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.

3.09 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.

3.10 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.

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.

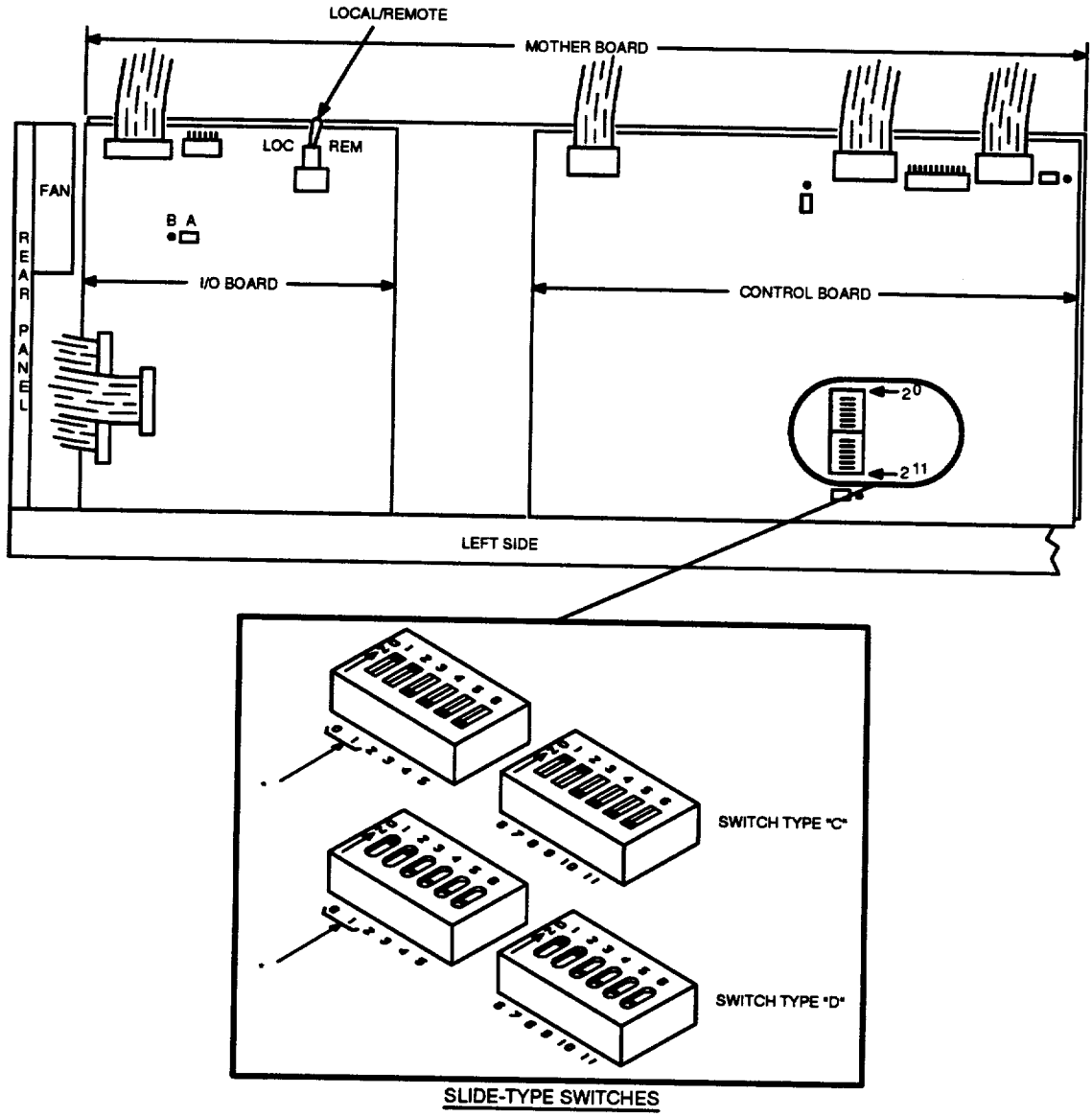

Figure 10. Sector Select Switches

4. Maintenance

4.01 The air filter must be clean to ensure proper air circulation throughout the drive. The filter is located behind the front panel insert (Figure 11). The filter should be inspected by an operator periodically and either replaced or cleaned when dirty. Cleaning the filter is recommended only if replacement filters are not available. The interval for filter maintenance depends on the operating environment. In computer room conditions, a 6-month interval is suggested. In other conditions, the interval should be varied accordingly.

5. Power

5.01 Input power of –48 volts DC is supplied to the entire disk drive frame and then distributed internally through fuses. The KS-22997, L2 power supply provides the power to the disk drives. The remote power supply, a multiple output DC-DC converter, receives –48 volt DC input and provides nominal outputs of +5.1, –5.1, +24, –24, and +40 volts DC.

5.02 Input power and chassis ground connections are made via six wide male faston connectors, located on the units back panel. Of these six connectors, one lug is for the –48 volt input (N48V), one lug is for the +48 volt return (N48VR), and four lugs are for chassis ground connection. Output voltages are brought out via J1, a 15 pin connector, and J3, a 6 pin connector. Control lines are brought out via J2, a 6 pin connector. Figure 12 shows these connectors at the back of the power supply.

5.03 The units front panel has a 12 ampere main circuit breaker for input power and two 3.0 ampere circuit breakers for +24 volt output protection. The front panel also has a local power switch, a green "power on" indicator, and a red "alarm" indicator (Figure 12).

5.04 The converter is capable of operating over a voltage input range of –41.6 to –60.0 volts DC. The converter powers down when the input voltage drops below approximately –39.0 volts and will restart when the voltage rises above approximately –40.75 volts.

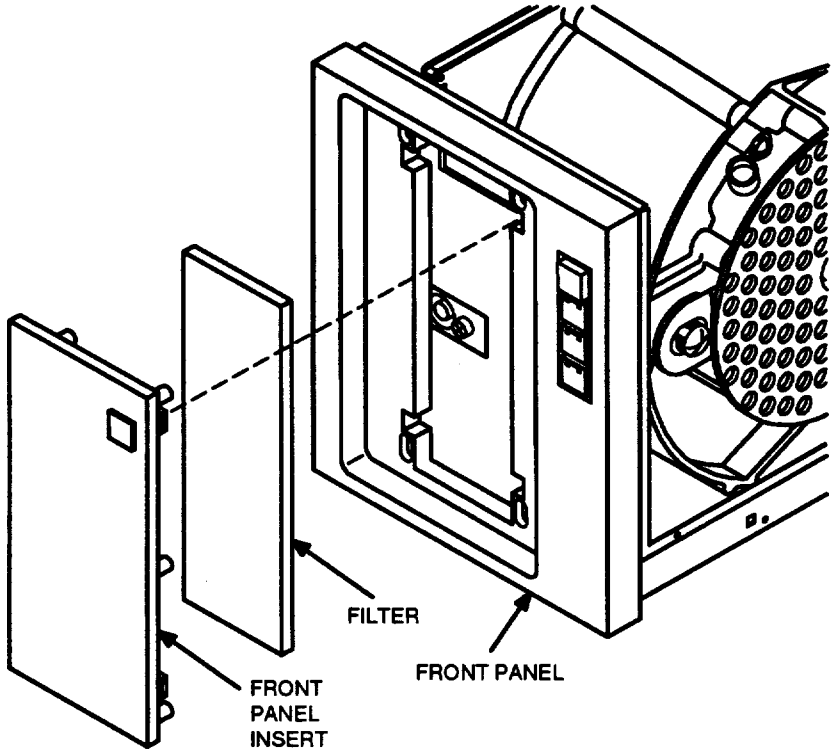

Figure 11. Air Filter Replacement

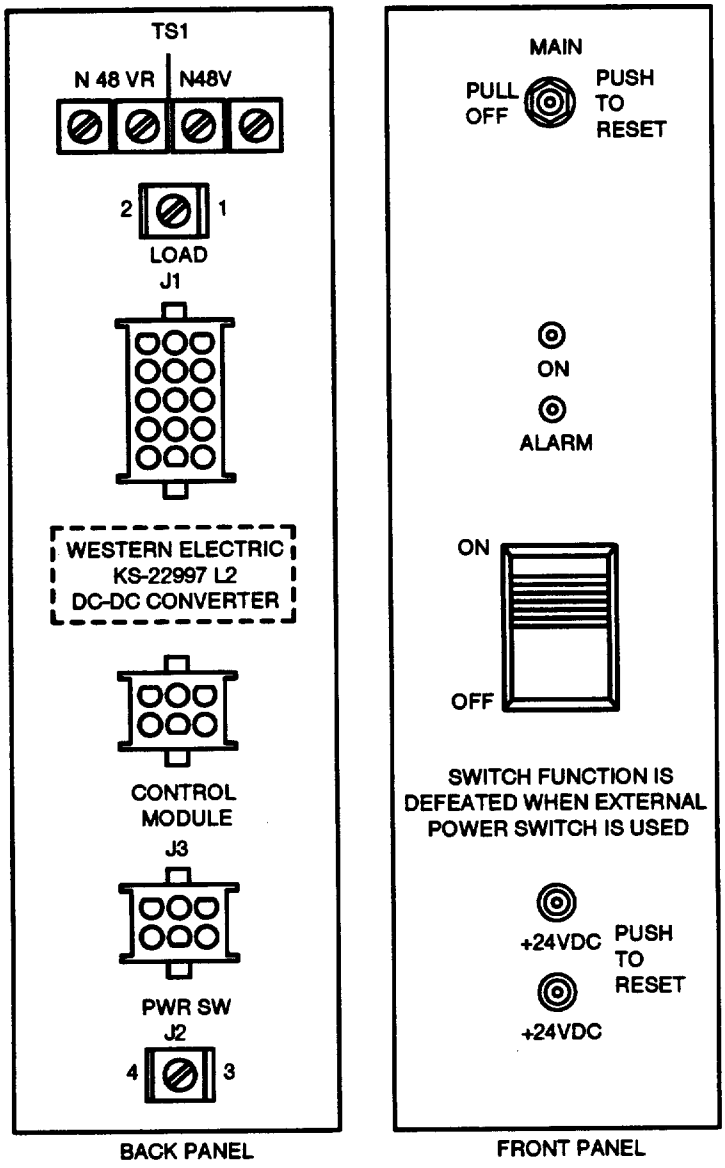

Figure 12. KS-22997, L2 Power Supply

6. Acronyms

6.01 The following acronyms are used in this practice:

DFC	Disk File Controller
FSD	Fixed Storage Drive
HDA	Head Disk Assembly
ID	Identification
I/O	Input/Output
LED	Light-Emitting Diode
SMD	Storage Module Drive
TTL	Transistor-Transistor-Logic

How Are We Doing?

Document Title: AT&T 3B20D Model 3 Computer 340-Megabyte Disk Drive General Description

Document No.: AT&T 254-302-212 Issue No.: 2 Date: February 1992

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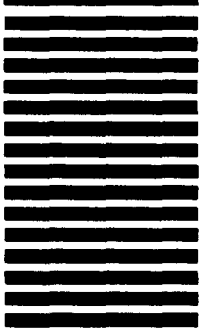

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