AT&T 3B20D Model 1 Computer
300-Megabyte Disk Drive
General Description

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1. Overview

1.01 This practice provides a brief physical and functional description of the 300-Mbyte disk drives used by the 3B20D Model 1 computer.

1.02 This practice is being reissued to include information about the Small Computer System Interface (SCSI) and the effects it has on the 3B20D Model 1 computer. Since this is a general revision, revision arrows used to denote significant changes have been omitted. The Equipment Test lists are not affected.

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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1.06 This practice is issued by:

  Document Development Organization
  Network Systems
  2400 Reynolda Road
  Winston-Salem, NC 27106-4696

Purpose

1.07 The 300-Mbyte disk drives are used as a memory "swap" device in a 3B20D computer.

Configuration

1.08 The 300-Mbyte disk drives are connected to the 3B20D computer via a storage module drive disk file controller (SMD-DFC). The SMD-DFC can communicate with as many as eight disk drives.

1.09 The 300-Mbyte disk drives used by the 3B20D computer are supplied by two different vendors. Manufacturing availability is being discontinued. These disk drives are tabulated as follows:

Vendor	Equipment No.	Capacity
Control Data	KS-22072, L1	300 Megabytes
Century Data Systems	KS-22072, L2	300 Megabytes

2. Physical Description

2.01 The disk drives are located in the disk drive frames (J1C131A-1). Additionally, the disk file inverter [(DFC), ED4C172-30] and the power control unit [(PCU), J1C131AA-1] are located in the disk drive frame. The disk drive frame is a single 2-foot by 2-inch frame.

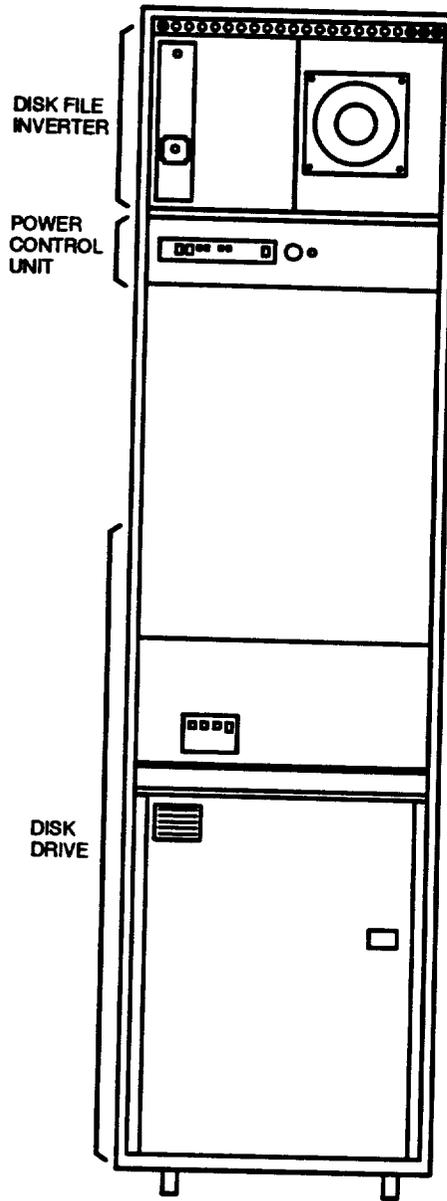**2.02** Figure 1 illustrates the J1C131A-1 disk drive frame.

DISK FILE
INVERTER

POWER
CONTROL
UNIT

DISK
DRIVE

Figure 1. Moving Head Disk Drive Frame

2.03 The disk drives are installed in *quiet enclosures* which are acoustically insulated to reduce noise levels near the unit. These enclosures measure no more than 23 inches wide by 36.5 inches deep by 40.25 inches high. The complete disk drive units weigh approximately 500 pounds.

2.04 The *quiet enclosure* is constructed of tubular steel with removable top, front, and side panels. Each panel contains layers of sound-deadening foam-type materials that are flame-retardant and that provide sound isolation to noises generated within the disk drives. Operating controls and indicators are mounted on the enclosure front panel and are readily accessible to the user. The hinged top cover protects the internal drive assemblies and prevents dust and other contaminants from entering the drive.

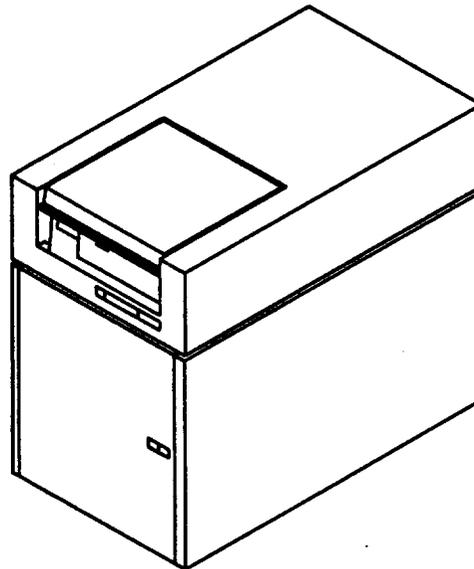**2.05** Figure 2 illustrates the KS-22072, L1 disk drive.

Figure 2. KS-22072, L1 Moving Head Disk Drive

2.06   Figure 3 illustrates the KS-22072, L2 disk drive.
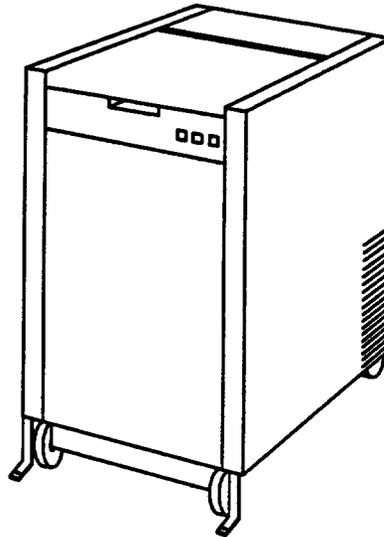

Figure 3. KS-22072, L2 Moving Head Disk Drive

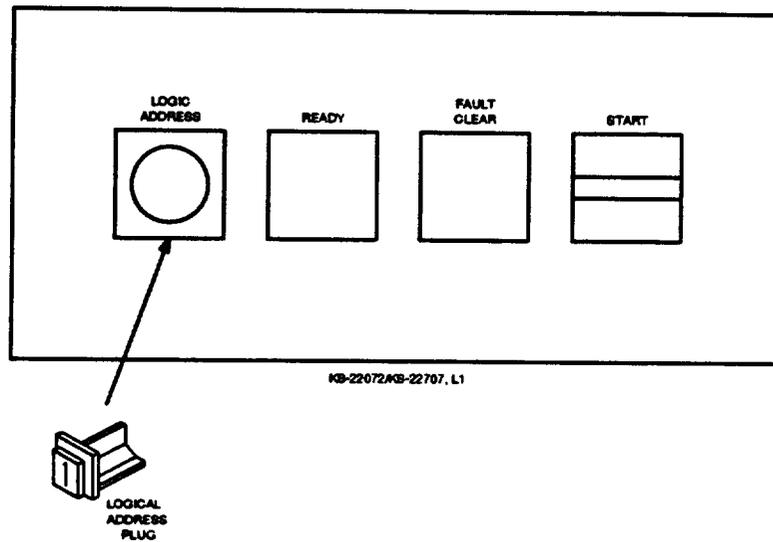**2.07**   Figure 4 illustrates the L1 operator control panels.

Figure 4. KS-22072, L1 Operator Control Panels

2.06 Table A lists the L1 operator controls with their functions.

Table A. KS-22072, L1 Operator Control Panel Functions

Control/Indicator	Function
READY Indicator	Lights when unit is: • Up to speed • Heads are positioned • No-fault condition exists Signifies unit ready for DFC read/write.
Logic Address SloT	The logical address plug is placed in this slot. It determines logical address of the disk drive. The disk address can be set to any number from 0 through 15 by installing the proper plug. If no plug is inserted, the address is 15. Each plug is labeled by the manufacturer with the plug address. **Note:** This plug is the ONLY way the disk file control can identify a disk drive.
START Switch/Indicator	Pressing button when drive is in power-off condition (disk pack not spinning) lights indicator and starts power-on sequence, provided the following conditions are met: • Disk pack is installed. • Pack access cover is closed. • All power supply circuit breakers are on. Pressing the indicator when drive is in power-on condition extinguishes indicator and starts power-off sequence.
FAULT Switch/Indicator	Lights if a fault condition exists within the drive. Providing reason for the fault is no longer present, the indicator is extinguished by any of the following: • Pressing FAULT switch on panel • Fault-Clear signal from controller • Maintenance Fault-Clear switch on fault pack (in disk drive unit)

2.09   The KS-22072, L1 and L2 disk drives have storage capacities of 300 megabytes
(unformatted). After formatting, a disk drive provides approximately 253 million
bytes of storage capacity. The disk packs used in the drives consist of 12 recording
disks. The top and bottom disks are used for protection only. The remaining 10 disks
provide 19 data surfaces and one prerecorded servo surface. See Figure 5 for an
illustration of the disk pack.

2.10   Data is recorded on the disks in tracks, each of which is defined by its distance
from the center of the disk. There are 384 tracks per inch (nominal spacing of
0.0026 inches); and 815 tracks per surface are used. The 19 corresponding tracks on
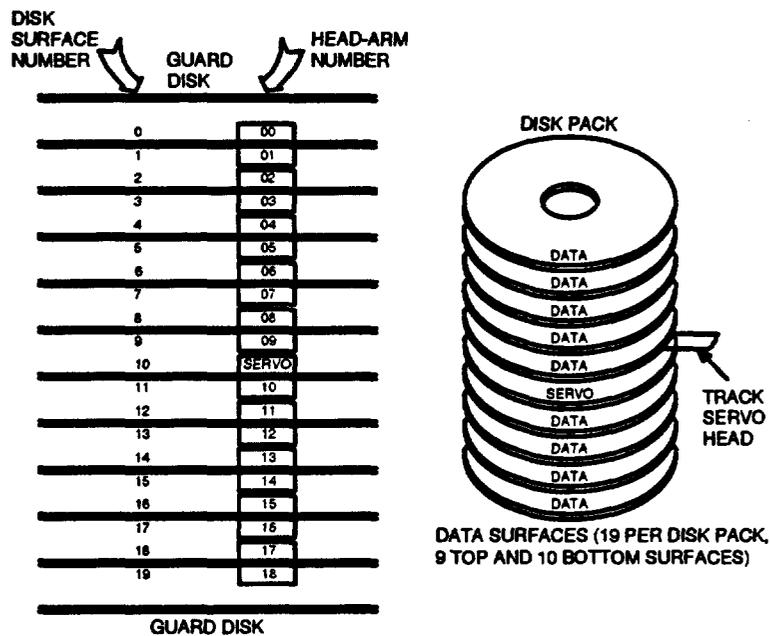the 19 recording surfaces constitute a cylinder.

Figure 5. Disk Pack Layout

2.11   The disk drives consist of several major assemblies, some of which are described
as follows:

- Pack On Switch: An interlock that prevents the drive motor from starting when the
pack is not installed.

- Blower Assembly: This assembly contains a blower motor that circulates cooling
air for the drive.

- Pack Access Cover Solenoid: A device that prevents the pack access cover from
being opened if the pack is spinning.

- Parking Brake: A device that holds the spindle while the disk pack is being installed and removed.

- Operator Control Panel Cover: This cover contains switches that allow the operator to control and monitor the basic operation of the drive.

- Shroud and Shroud Cover: These provide protection and ventilation for the disk pack. The shroud area is protected by a shroud door which must be opened whenever the pack is loaded or unloaded. An interlock switch senses the cover being opened and prevents the disk drive from starting or causes the disk drive to perform a power-down sequence, if it is running.

- Spindle and Lockshaft: These provide a mounting surface for the disk pack. The lockshaft secures the disk pack to the spindle. The drive motor transmits rotational motion to the spindle via a drive belt causing the disk pack to rotate. The spindle rotates when a pack is installed, the pack cover is closed, no unsafe condition exists, and the START switch is on.

- Heads: The heads detect data transitions that are on the pack if the drive is reading. Also, the heads write data transitions on the disk pack if the drive is writing.

- Actuator: This assembly positions the heads over the disk pack. The actuator assembly consists of a linear DC motor, carriageway, carriage, and a tachometer to provide velocity feedback. The servo head moves with the positioner and returns a position feedback signal to the servo to maintain position control.

- Magnet: This is used in conjunction with the actuator to move the carriage and heads.

- Read/Write Chassis: The apparatus housing which contains the cards that are essential to the drive operation.

- Pack Access Cover Switch: An interlock that de-energizes the drive motor if the pack access cover is opened while the pack is spinning. It also prevents the motor from starting unless the cover is closed.

- Drive Motor: The motor which provides rotational motion that turns the spindle and disk pack.

- Power Supply: The source of all necessary voltages for the drive operations. The DC power fuse/rectifier printed circuit board contains a temperature sensor which activates the high temperature fault signal which is sent to the controller.

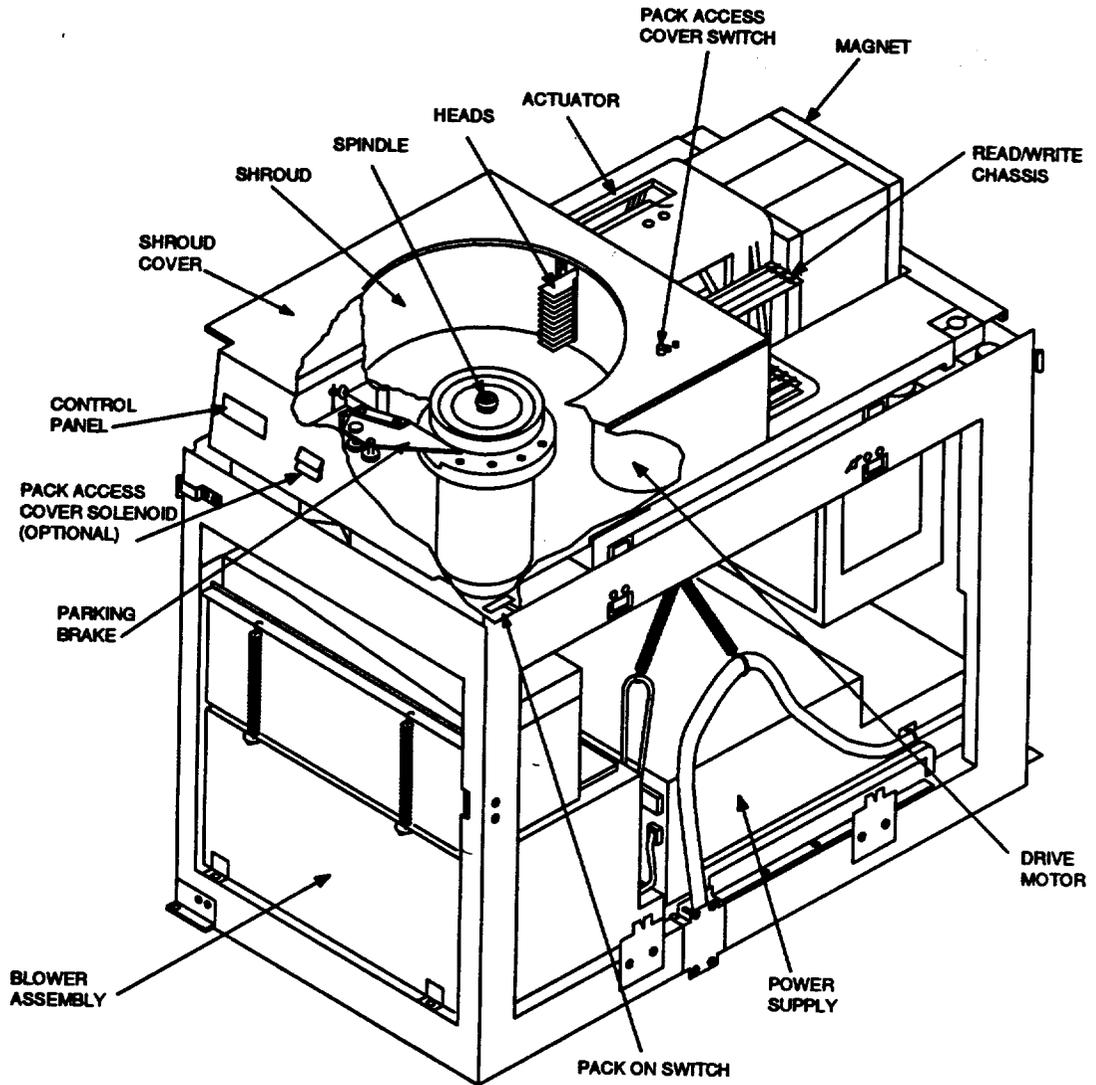Figure 6 illustrates an exploded view of the disk drive without panel covers.

Figure 6. KS-22072, L1 Disk Drive, Exploded View

3. Functional Description

3.01   Both versions of the disk drives function in essentially the same manner: by positioning the read/write heads over a selected cylinder, then reading or writing data on a selected track. Driving the head in or out to the desired cylinder is termed a "seek." Although the KS-22072, L1 disk drive is specifically mentioned in this document, the KS-22072, L2 disk drive is essentially identical.

3.02   Data is stored on the disk in a modified frequency modulation (MFM) format. The nominal recording frequency is 9.67 MHz; therefore, at a normal disk speed of 3600 rpm, this results in a data cell period of 103.3 nanoseconds. There are 20,160 bytes per track; these can be further subdivided into sectors. Switches are provided to select from 4 to 128 sectors per track.

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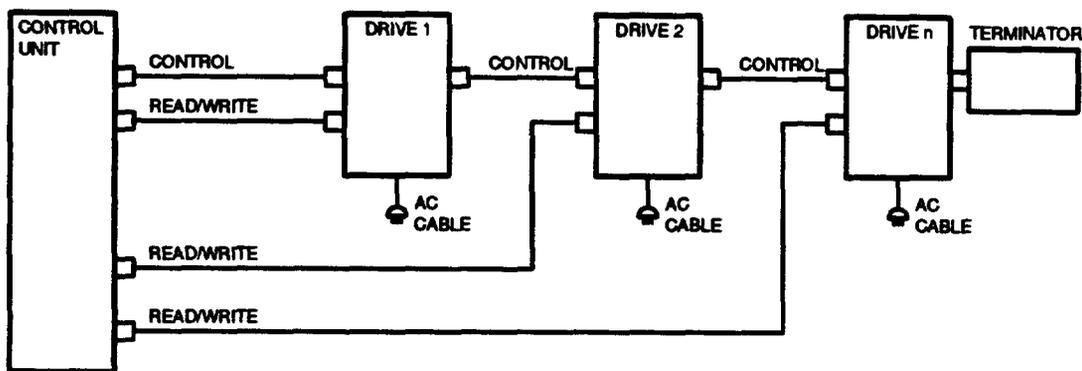
Figure 7. System Daisy-Chain Configuration

3.04   The control cable carries 31 control and address signals to and from the disk drive (see Figure 8). Table B lists these signals. The last 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.
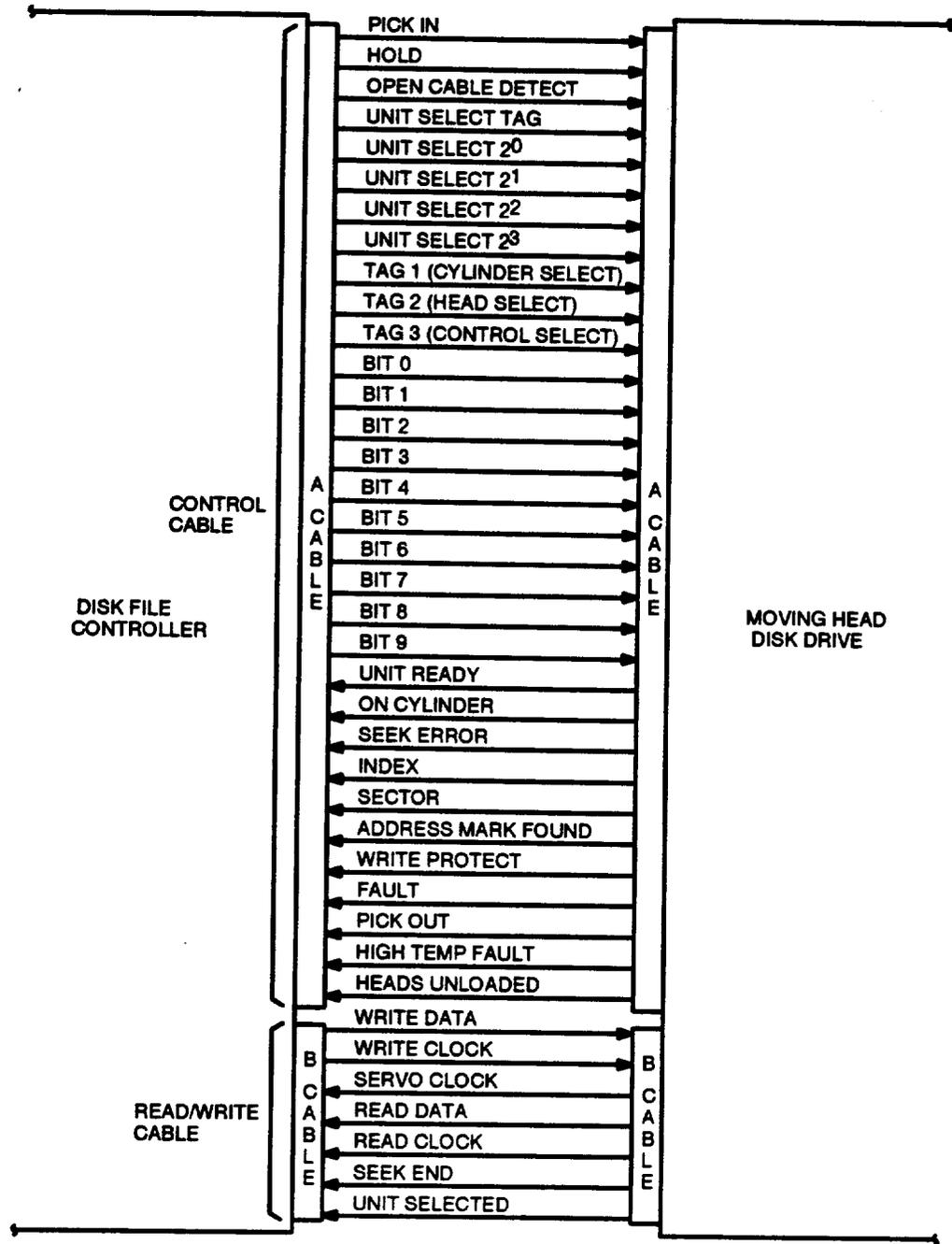
Figure 8. Control and Read/Write Cables

Table B. Control Cable Signals

Signal Line	Function
Lines From Controller To Drive	
Pick In	Used for power sequencing. A ground on this line powers up drive if LOCAL/REMOTE switch is in REMOTE and START switch is on. When drive is up to speed, the ground is passed on to the next drive. If LOCAL/REMOTE switch is in LOCAL, this line is always grounded and therefore Pick Out is always passed to the next drive.
Hold	Used for power sequencing. This line must be grounded at controller for drive to complete and hold remote power-up sequence.
Open Cable Detect	Inhibits unit selection and any unwanted command such as Write Gate when "A" cable is disconnected or controller power is lost.
Unit Select Tag	Starts unit select sequence and is used in conjunction with Unit Select lines $2^0 - 2^3$.
Unit Select lines $2^0 - 2^3$	Used to select the drive. The binary code on these lines must match the code of the drive logical address plug for the drive to be selected. These lines are used in conjunction with the Unit Select Tag.
Tag 1 (Cylinder Select)	Initiates seek functions and used in conjunction with Bus Bit lines. This tag strobes the cylinder address, contained on Bus Bit lines, into drive logic. Drive must be on cylinder before this tag is sent. Bus Bits are interpreted as follows:

Bus Bit	Function	Bus Bit	Function
0	Cyl Adrs 2^0	6	Cyl Adrs 2^6
1	Cyl Adrs 2^1	7	Cyl Adrs 2^7
2	Cyl Adrs 2^2	8	Cyl Adrs 2^8
3	Cyl Adrs 2^3	9	Cyl Adrs 2^9
4	Cyl Adrs 2^4		
5	Cyl Adrs 2^5		

Table B. Control Cable Signals (Contd)

Signal Line	Function	
Tag 2 (Head Select)	Initiates head select functions and used in conjunction with Bus Bit lines. This tag strobes the head address, contained on Bus Bit lines, into drive logic. Bus Bits are interpreted as follows	
	Bus Bit	**Function**
	0	Head Adrs 2^0
	1	Head Adrs 2^1
	2	Head Adrs 2^2
	3	Head Adrs 2^3
	4	Head Adrs 2^4
	5-9	Not Used
Tag 3 (Control Select)	Initiates various operations to be performed by the drive. Used in conjunction with Bus Bit lines and specific operation initiated depends on content of these lines which is defined as follows:	
	Bus Bit	**Function**
	0	Write Select - Enables write drivers.
	1	Read Select - Enables the digital read data lines. With PLO option, leading edge triggers read chain to sync on all-zeroes pattern.
	2	Servo Offset Plus - Offsets the actuator from the nominal or cylinder position toward the spindle.
	3	Servo Offset Minus - Offsets the actuator from the nominal or cylinder position away from the spindle.
	4	Fault Clear - Pulse sent to drive to clear the fault summary flip-flop. This is also used for remote head loading.
	5	Address Mark Enable - When combined with a Write Select, the selected track is erased. When combined with a Read Select, an Address Mark search is initiated.
	6	RTZ - Pulse sent to driver to cause actuator to seek to track zero. Also, when combined with a Read Select, a remote head retract is commanded.
	7	Data Strobe Early - Enables to PLO data separator to strobe the data at a time earlier than optimum.
	8	Data Strobe Late - Enables the PLO data separator to strobe the data at a time later than optimum.
	9	Not used.

Table B. Control Cable Signals (Contd)

Signal Line	Function
Bus Bits (0 - 9)	Used in conjunction with Tags 1, 2, and 3.
Unit Ready	Indicates that drive is selected, up to speed, heads are loaded and no fault exists.
On Cylinder	Indicates drive has positioned the heads over a track.
Seek Error	Indicates that the unit was unable to complete a seek within 500 ms, or that carriage has moved to a position outside recording field.
Lines From Controller To Drive	
Index	Occurs once per revolution of disk pack and the leading edge is considered leading edge of sector zero.
Sector	Derived from servo surface of disk pack, this signal can occur any number of times per revolution of disk pack. Number of sector pulses occurring depends on setting of switches.
Address Mark	Indicates that an Address Mark has been found. Enabled by a combination of Read Gate and Address Mark Enable.
Fault	Indicates that one or more of these faults exist: DC power fault, head select fault, write fault, write or read while off cylinder, and Write Gate during a Read operation.
Pick Out	Used for power sequencing in star configuration. When drive is up to speed, this line is grounded. This signals the controller to send Pick In to the next drive in the sequence.
High Temperature Fault	Indicates that temperature is excessive in the internal air flow system.
Heads Unloaded	Indicates that the heads are not loaded (in the BJ4A2Y only).

Table C. Read/Write Cable Signals

Signal Line	Function
Servo Clock	9.67 MHz clock signals derived from servo track dibits.
Read Data	Carries NRZ data recovered from disk pack.
Read Clock	Clock signals derived from NRZ Read Data.
Seek End	Seek End is a combination of ON CYL or SEEK ERROR indicating that a seek operation has terminated. If an address greater than 822 cylinders has been selected there will be no change in Seek End status.
Unit Selected	Indicates that the drive is selected. This line must be active before drive will respond to any commands from controller.
Write Data	Carries NRZ data to be recorded on disk pack.
Write Clock	Synchronized to NRZ Write Data, it is a return of the Servo Clock. This signal is transmitted continuously.

3.05 A module select identifier plug must be installed in the front panel of each disk drive in order for the drive to identify itself. There are 16 different identifier plugs available so that up to 16 disk drives may be uniquely identified and addressed.

3.06 Signals between the disk drives and the DFC 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.

A. STATUS LINE TRANSMITTER

B. DATA LINE TRANSMITTER

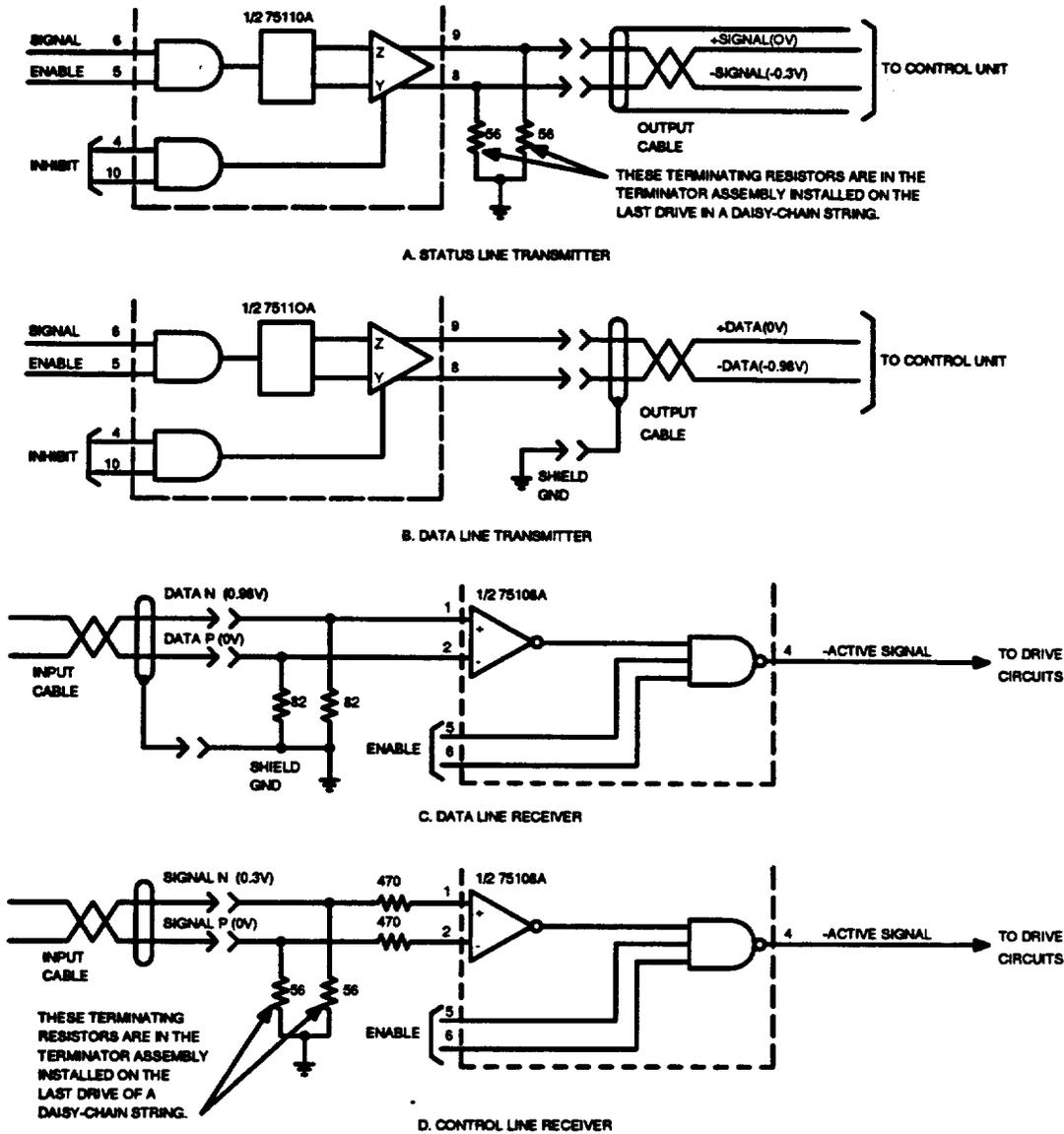C. DATA LINE RECEIVER

D. CONTROL LINE RECEIVER

Figure 9. Line 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 pattern in the identifier plug in a device causes that 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 pack. Figure 10 is a block diagram of the servo system.

3.10 The disk pack rotates at a nominal 3600 rpm. The read/write heads float on a cushion of air between the disk surface and the head. This air cushion supports the heads at approximately 32 microinches (0.000032 inches) from the disk surface. Because of this extremely small distance, the air surrounding the disk pack 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. In order to assure the cleanliness of the air supply, an absolute air filter is provided which removes particles as small as 0.3 microns (0.0000118 inches) in diameter.

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. There can be 20,160 bytes stored on each track. The number of sectors in each track is established by the settings of sector switches (Figure 11). The number of bytes per sector depends on the selected number of sectors per track.

Figure 10. Basic Servo Block Diagram

ROCKER-TYPE SWITCHES

SWITCHES LOCATED ON A CARD IN LOGIC CHASSIS

SWITCH TYPE "A"

SWITCH TYPE "B"

* SWITCHES 0 AND 1 SHOWN IN CLOSED POSITION.

SWITCH TYPE "C"

SWITCH TYPE "D"

* SWITCHES 0 AND 1 SHOWN IN ON POSITION.
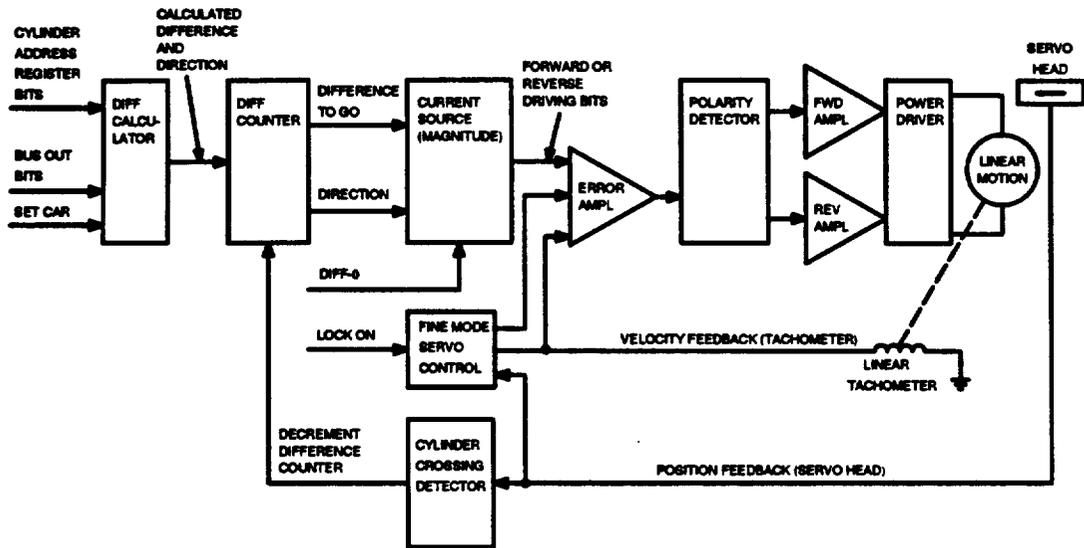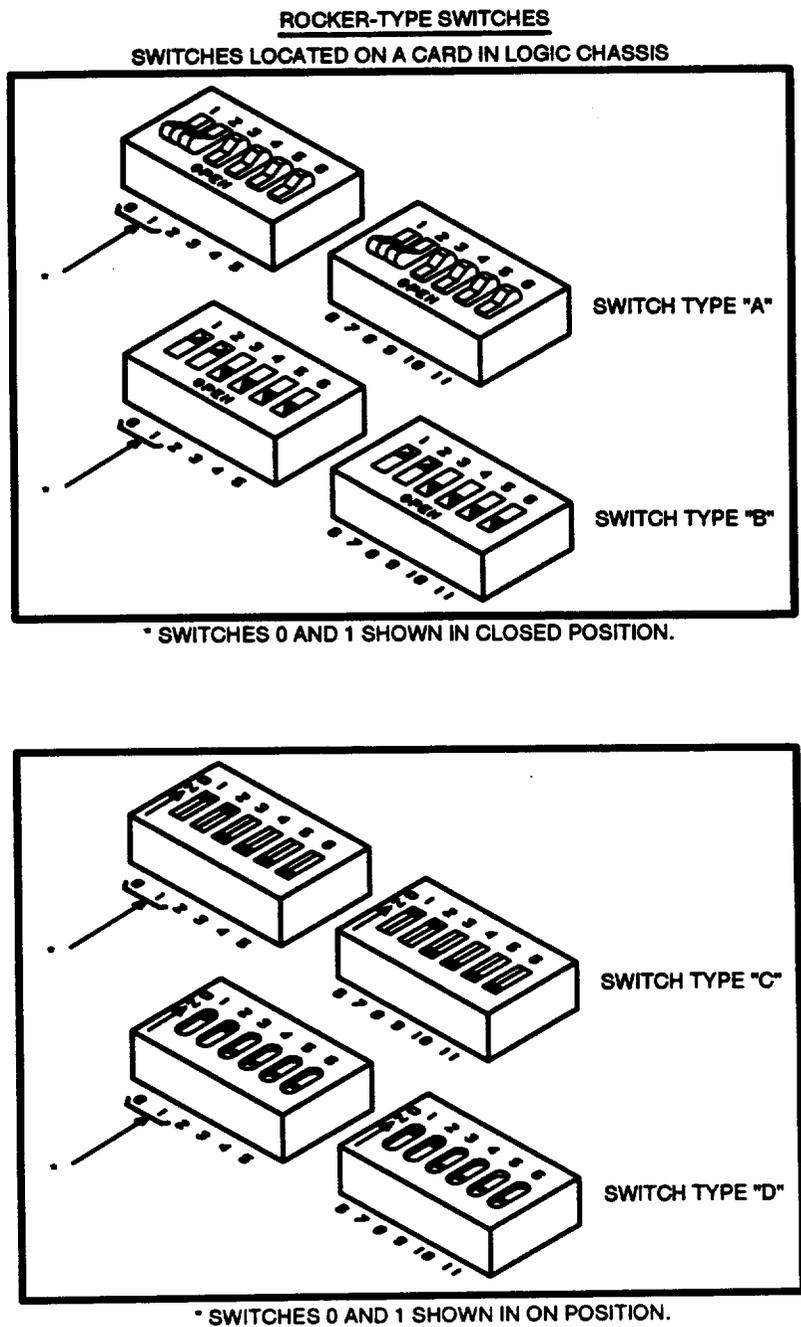
Figure 11. Sector Select Switches

3.12 Each full turn of the disk pack is detected when an index mark recorded on the servo surface passes underneath the read 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 20 read/write arms, plus other mechanisms to guide and support the heads. Radial positioning of the heads is done by a linear dc motor which moves the head assembly in or out to the track. Upon start-up, the heads remain retracted until the disk attains 3000 rpm, at which time the heads are extended into the head loading zone. 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 will be performed using Task Oriented Practices (TOP) to guide and direct step-by-step procedures. 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 drives require an input of 208 volts ac, single-phase, 60 Hz power. This power is normally obtained from the commercial building AC power source. A converter is supplied which provides uninterrupted AC from the office –48 volt battery supply if a failure of commercial power occurs.

6. References

6.01 The following AT&T Practices contain additional information pertaining to the 3B20D computer disk drives:

PRACTICE   TITLE

AT&T 254-301-010   *AT&T 3B20D Model 1 Computer, Description and Theory of Operation*

AT&T 254-301-020   *AT&T 3B20D Model 1 Computer, Power Systems, Description and Theory of Operation*

AT&T 254-301-100   *AT&T 3B20D Model 1 Computer, Input/Output Interfaces, Description and Theory of Operation*

AT&T 254-301-200   *AT&T 3B20D Model 1 Computer, Main Store, Description and Theory of Operation,*

6.02 The following manufacturer publications provide operation and maintenance instructions for the KS-22072, L1 and L2 Disk Drives:

(1) *Control Data Corp. Installation, Operation, and Maintenance Manual KS-22072, L1 Disk Drive*

(2) *Century Data Systems Installation, Operation and Maintenance Manual, Model 833 KS-22072, L2 Disk Drive*

7. Acronyms and Abbreviations

7.01 The following is a list of acronyms and abbreviations used in this practice.

DFC   Disk File Controller

MFM   Modified Frequency Modulation

PCU   Power Control Unit

SCSI   Small Computer System Interface

SMD-DFC   Storage Module Drive Disk File Controller

TOP   Task Oriented Practices

How Are We Doing?

Document Title: 3B20D Model 1 Computer 300-Megabyte Disk Drive General Description

Document No.: AT&T 254-301-210   Issue Number: 3   Publication Date: February 1992

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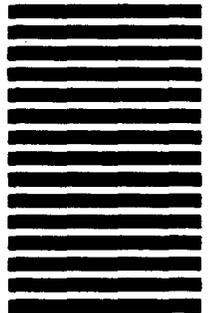Company/Organization: _____ Date: _____

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