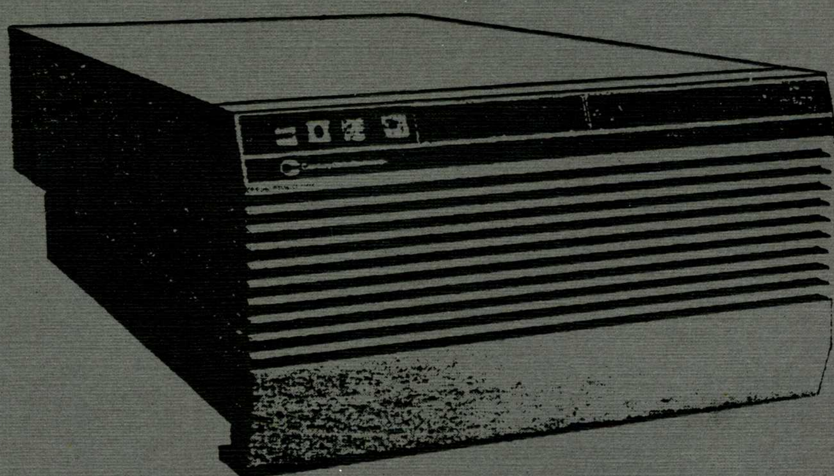
AMS 200/300 PRODUCT DESCRIPTION MANUAL



Century Data Systems
A Xerox Company

Part Number 76251-902

AMS 200/300 PRODUCT DESCRIPTION MANUAL

February 1986

NOTICE: Information given in this document was correct at the time of publication. We reserve the right to update it and to make changes in our products without notice, written or otherwise, to prospective users.

RECORD of REVISIONS	
REVISION	**NOTES**
0	ORIGINAL ISSUE—February 1985
-1	Add AMS 300 Disk Drive Specifications—April 1985
-2	Minor Changes—February 1986

CD020-017 (8/81)

WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the technical manuals, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

This product met the FCC Class A requirements when tested using shielded cables, for both the Radial and Bus cables, which were grounded at the point of entry into the disk drive and also at the system/controller end of both cables.

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SECTION 1
INTRODUCTION

1.0 SCOPE

This manual contains the information necessary to attach the Advanced Marksman Series (AMS) 200/300 Disk Drive directly to a Digital Equipment Corporation (DEC) MASSBUS and provides the technical specifications for reference in OEM contracts. The AMS 200/300 Disk Drive is manufactured by Century Data Systems, (CDS) a Xerox Company located in Anaheim, California.

1.1 GENERAL DESCRIPTION

The AMS 200/300 Disk Drive (Figure 1-1) is a high performance modular disk storage unit designed to attach directly to a Digital Equipment Corporation (DEC) MASSUBS. The AMS 200 Disk Drive can store 174.4 megabytes and the AMS 300 can store 256.2 megabytes of 16-bit formatted data and replaces a single port DEC RP06 or RM05 Disk Drive. The AMS disk drive used with the host computer RH MASSBUS disk interface is hardware and software compatible with the PDP11/XX minicomputer and the VAX family of superminicomputers.

Note

Refer to Section 2, Table 2-1 for the AMS 200/300 Disk Drive and the DEC RP06 and RM05 Disk Drive specifications.

The AMS disk drive can be configured as a conventional disk or with the DYNAMIC DATA RELOCATION™ feature that can be selected at any time. When the disk drive is in the DYNAMIC DATA RELOCATION mode, it identifies and moves the most actively accessed data to other locations so as to reduce the access time while continuing to respond to host computer requests. After moving this data, the disk drive copies high use data from the magnetic media into its semiconductor memory to further improve access performance. Two techniques are retained in the semiconductor memory. One is known as "Caching". Second, sequential file access requests are identified and anticipatory data retrievals are made from the magnetic media to the semiconductor memory. This technique is known as "Look-Ahead". By using these capabilities and properly configuring the AMS disk drive into the host computer system, substantial improvements in both disk and computer system performance can be achieved during periods when the system is being heavily utilized.

The AMS disk drive consists of a sealed disk module, drive motor, four printed circuit boards containing the drive and MASSBUS interface electronics, and power supplies. The disk module is hermetically sealed and uses an absolute breather filter for pressure balancing.

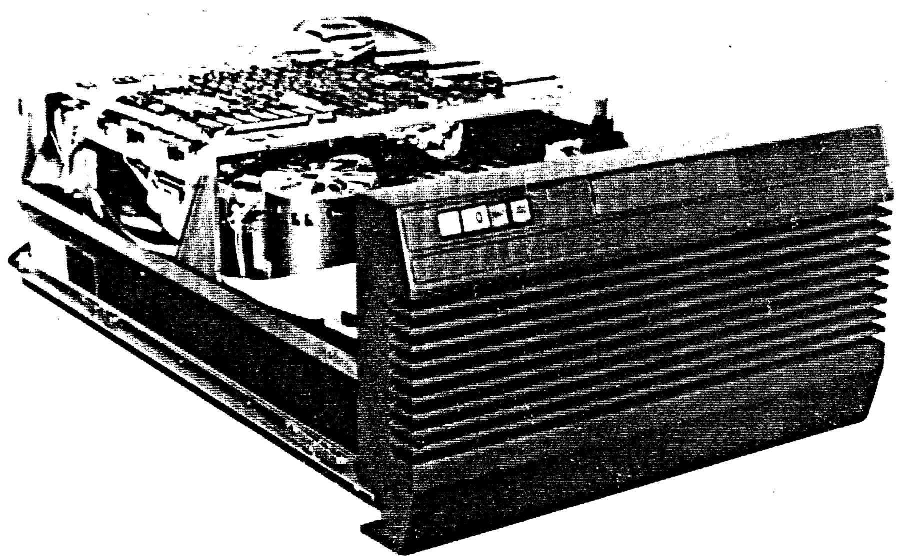


Figure 1-1. AMS 200/300 Disk Drive

The sealed disk module contains the storage media on a spindle, read-write and servo recording heads on a voice coil actuator, and an absolute filter for cleaning the internally circulated air. Seek, read and write operations in the disk drive are carried out under instructions from the built-in MASSBUS Interface. Communications with the host computer are implemented via the standard MASSBUS protocol allowing compatibility with existing DEC software, and PDP-11/XX and VAX computers that support the MASSBUS. Execution of disk instructions is performed by microprocessor controlled electronics contained on easily accessible logic cards.

The microprocessor executes instructions in a high level language under the supervision of a multi-tasking operating system. This resident software implements all of the performance and compatibility features of the AMS disk drive as well as providing data error detection and correction, transparent handling of media flaws on the disk, and front panel selection of optimization and self-test. The AMS disk drive does not require any special power failure or recovery precautions because the data and their physical locations are always stored on the magnetic media of the disk itself. After power failure, all data is recovered by the disk drive during its normal power-up and self test sequence.

The closed loop air system, the design of the electronics package, and the servo track positioning mechanism allow the installation of the AMS disk drive in normal office environments.

During operation the read/write heads of the AMS disk drive fly above the recording surface, thereby eliminating wear of both heads and media surface. Data integrity is superior to that found in past large disk systems because the WINCHESTER style read/write heads fly much closer to the media surface. The AMS disk drive contains an electronic carriage lock that automatically locks the head carriage when power is removed.

The AMS disk drive was designed for reliability and does not require any scheduled preventive maintenance.

1.1.1 Features

- Interfaces to VAX-11/785, VAX-11/780, VAX-11/750 and PDP-11/XX computers.
- Connects to DEC computers through the DEC MASSBUS Adapter. No additional computer input/output slot is required to attach the drive to the computer system.
- Capacity and format is same as RP06/RM05.
- Utilizes standard DEC operating system and diagnostic software.
- Power loss data protection.
- Integrated modular assembly. The AMS disk drive is installed and serviced as a single unit, rather than as a separate controller and drive. No expensive integration process is required during installation.
- Dynamic Data Relocation. Heavily used data are transparently repositioned on the disk to minimize the average seek time. Poor performance from "arm contention" is minimized, and the average seek time is improved up to 10 times over that of conventional disks.
- High speed data caching. The most commonly used data is retained in high speed semiconductor memory for up to 4 times throughout enhancement.
- Read look-ahead buffering. Reduces data access time on sequential disk reads by up to 85 percent.
- Automatic bad block handling. A replacement block on the same cylinder is automatically referenced when a bad block is encountered. No re-seeking to a look-up table is required. The AMS disk drive appears as a "perfect" disk to the host operating system. No bad block files need be constructed by the site manager.
- WINCHESTER technology heads and media provide state-of-the-art performance.
- High speed start/stop head landing zones and a spindle motor brake maximize head and media life.
- VFO data separator, standard
- Disks, heads, linear motor assembly and air filtering systems are all a part of a sealed assembly not requiring field maintenance.
- No regularly scheduled preventive maintenance required.
- Self-tests on power-up and initialization. Turning on the AMS disk drive automatically initiates a procedure that tests for proper functioning.
- Front panel activity lights. Enables fast error diagnosis and correction.

1.1.2 Mounting Configurations

1.1.2.1 Mounting attitudes for the AMS Disk Drive

Horizontal .... spindle pulley down

1.1.2.2 Enclosure

The enclosure, for use with the AMS disk drive can be configured in any one of the following:

- Desk top enclosure
- Rack mounted (fixed)
- Slide mounted
- Four high cabinet mounting

The enclosure provides mounting for the sealed mechanical assembly, drive control boards, enhancement board and power supply. The AC distribution for the power supply is located on the back panel of the enclosure and an Operator Control Panel is located on the front. The enclosure also provides all necessary cooling required by the drive.

1.1.2.3 Rack Mount Slides

The AMS disk drive enclosure can be ordered with a set of slides that mount between the enclosure and a standard RETMA rack and provides forward travel of the drive to extend clear of the rack for ease of maintenance and installation. The enclosure fits in a standard 19 inch by 30 inch rack.

1.2 MAINTENANCE PHILOSOPHY

The AMS disk drive is designed to provide the user troublefree operation with no scheduled preventive maintenance.

Century Data Systems maintenance philosophy establishes levels of maintenance and provides the disk drive user with all the information necessary to use and maintain his equipment.

1.2.1 Maintenance Support Documentation

Documentation used to support Century Data Systems (CDS) maintenance philosophy includes Manuals, Notices, and Bulletins. Those available for the AMS disk drive are as follows:

a. Installation Manual (P/N 76251-20X) is shipped with each drive sold by CDS. This manual contains the information necessary to unpack, inspect, install and test the disk drive. It also includes information on all switch settings, interface cabling and power requirements.

b. Technical Manual (P/N 76236-10X) contains information on shipping, installation and operation as well as theory, maintenance procedures and illustrations.

c. Maintenance Diagrams (P/N 76236-70X) contains the engineering drawings and schematics necessary to maintain the disk drive.

d. Field Parts Catalog (P/N 76236-50X) contains an illustrated parts breakdown of assemblies and subassemblies used in the disk drive.

e. Model T2003 Exerciser Technical Manual (P/N 76271-10X) contains the installation and operating procedures to use the CDS T2003 exerciser to test the AMS disk drive and other CDS disk drives.

f. Model T2005 Maintenance Test Controller (MTC) Installation and Operation Manual (P/N 76223-20X) contains the installation and operating procedures to use the CDS T2005 MTC to test the AMS disk drive and other CDS disk drives.

g. Field Support Documentation Manual contains tables showing spare assembly revision levels, recommended spare parts list, recommended general tools list and special tools list. This manual is sent to all AMS disk drive user's, each time the manual is up-dated.

h. Field Change Notices (FCN) are sent to all AMS disk drive users. The FCN describes one of two types of drive changes:
   Category 1—Changes are supplied to the customer at no charge. This type of change will normally be generated to guarantee a unit operating per a previously released specififcation or to correct an unsafe condition.
   Category 2—Changes are supplied at a minimal charge to the customer. This type of change will normally be generated to enhance equipment performance, improve reliability, or to solve a problem that is peculiar to the operation of a single customer. In this case the customer has the option to purchase or not to purchase the field change.

i. Technical Bulletins are sent to all AMS disk drive users. Bulletins contain information that is vital to equipment performance and maintenance, such as:

(1) Temporary solution to a problem presently being researched by CDS Engineering.

(2) Adjustment procedure for an assembly prior to the release of the Maintenance Technical Manual.

(3) Change to the part number of an assembly.

(4) Maintenance aids to troubleshooting.

AMS disk drive purchasers will automatically be included on the Maintenance Document mailing list for 12 months from the time of last purchase. Subscription service is available from the Product Support Department of Century Data Systems after the 12 month period expires.

1.2.2 Related Documents

Companion documents for the AMS 200/300 Disk Drive include:

AMS 200/300 Installation Manual	76251-20X
AMS Disk Drive Technical Manual	76236-10X
AMS Maintenance Diagrams	76236-70X
AMS Parts Catalog	76236-50X
Model T2003 Exerciser Technical Manual	76271-10X
Model T2005 Maintenance Test Controller Installation and Operation Manual	76223-20X

1.2.3 Maintenance Levels

The Century Data Systems maintenance philosophy divides maintenance into three distinct levels, based on the tools and trained personnel available to perform the tasks.

a. Level One Maintenance—The level one functions are those that can be performed without the use of special tools or training. This level of maintenance is called "Operator Maintenance" and includes the following functions:

(1) External enclosure cleaning.

(2) Pre-filter cleaning.

The procedures for performing all Operator Maintenance functions are listed in the AMS Disk Drive Technical Manual P/N 76236-1XX).

b. Level Two Maintenance—The level two functions are those requiring personnel trained in the troubleshooting and maintenance of disk drives. The use of standard and special tools is required. These functions include:

(1) Printed Wire Board (PWB) replacement.

(2) Drive motor or brake replacement.

(3) Servo velocity adjustment.

The procedures for performing all level two maintenance functions are listed in the AMS Disk Drive Technical Manual (P/N 76236-10X).

c. Level Three Maintenance—The level three functions are those requiring the disk drive be returned to the CDS factory for repair and includes the following functions:

(1) Replacement of any subassembly in the sealed assembly.

(2) Replacement of the linear motor.

Procedures for packing and shipping drives or subassemblies back to CDS for repair are listed in the AMS 200/300 Disk Drive Installation Manual (P/N 76251-20X) and AMS Disk Drive Technical Manual Disk Drive (P/N 76236-10X).

1.2.4 Training

Century Data Systems provides training classes for all CDS manufactured disk drives. To receive a Training Brochure and class schedule contact Century Data Systems Product Support Department or any CDS Sales Office.

1.2.5 Unit Differences

Century Data Systems (CDS) assigns an eight digit part number to all parts, subassemblies, assemblies and products used or built by the company. Each part number is divided into a five digit basic number followed by a three digit dash number. The dash number is used to define any differences in the basic part.

The part number for the AMS 200 Disk Drive is 60033-XXX. The -201 is AMS 200 and the -301 is an AMS 300 Disk Drive.

Each unit carries an identification (ID) tag showing the part number with the appropriate dash number as well as the unit's serial number. There are two ID tags for each unit. One is located on the right side of the sealed disk compartment and the second one is located on the back of the disk drive enclosure above the AC input assembly.

SECTION 2
TECHNICAL CHARACTERISTICS

2.1 OPERATIONAL CHARACTERISTICS

Operational characteristics for the AMS 200/300 Disk Drives and the DEC RP06/RM05 Disk Drives are listed in Table 2-1.

TABLE 2-1. DISK DRIVE CHARACTERISTICS

Physical/Electrical Characteristics	**AMS 200/300**	**RP06**	**RM05**
Disk diameter	14 inches	14 inches	14 inches
Number of disks	5	10	10
Number of data surfaces	9.5	19	19
Number of data heads per surface	2	1	1
Number of data heads per cylinder	19	19	19
Number of data cylinders	315 (AMS 200) 823 (AMS 300)	815	815
Number of CE cylinders	12 (AMS 200) 4 (AMS 300)	—	—
Number of tracks per cylinder	19	19	19
Number of 16 bit words per sector	256	256	256
Number of 8 bit bytes per sector	512	512	512
Number of sectors per track	34	22	32
Number of sectors per cylinder	418 data and 228 spare (AMS 200) 608 data and 38 spare (AMS 300)	418 data	608 data
Removable media	No, Winchester fixed	Yes, RP06 Pack	Yes, RM05 Pack
Total capacity (megabytes) 16-bit data words	174.4 (AMS 200) 256.2 (AMS 300)	174.4	256
Performance Characteristics			
Access time to cache and read look-ahead buffers	0.25 milliseconds (ms)	NA	NA
Typical one cylinder seek time	4.5 ms	NA	NA
Maximum one cylinder seek time	5 ms	6 ms	6 ms
Average random seek time	25 ms	28.5 ms	30 ms
Maximum seek time	50 ms	53 ms	53 ms
Average rotational latency	8.33 ms	8.33 ms	8.33 ms
Average random access time	33.3 ms	37.3 ms	38.3 ms
Data transfer rate	1.21 megabytes per second	1.20 megabytes per second	
Data Bit Cell Time	103.3 nanoseconds	155.1 ns	104.1 ns

TABLE 2-1. DISK DRIVE CHARACTERISTICS (Continued)

Bit Interfacing Characteristics	AMS 200/300	RP06/RM05
Computer Interfaces	MASSBUS, single port	MASSBUS, single or optional dual port
Cabling	Forty conductor flat ribbon cables (same as cabinet mounted DEC MASSBUS tape drives)	112 conductor round cable
Maximum drive supported on the MASSBUS	8	8
Mechanical Characteristics		
Weight	138 lbs (63 kg)	600 lbs (273 kg)/746 lbs (338.4 kg)
Mounting	Computer cabinet, 10.5 inches of vertical panel space in a standard 19 inch wide RETMA cabinet	Separate cabinet requiring 6.2/7.3 sq. ft (0.58 sq. mtr./0.68) of floor space
Mounting Dimensions	19 inches (48.3 cm) wide (front panel), 10.5 inches (26.7 cm) height (front panel), 30 inches (76.2) deep as measured from behind front panel into the cabinet. Main chassis width (behind the front panel) 17.8 inches (45.2 cm)	Height 43 inches (109 cm) Width 32 inches (81.3 cm) Depth 28 inches (71.1 cm)
Optional Characteristics		
Start-up Time (Head Load and first seek after AC power applied to spindle motor)	25 seconds	15 seconds
Time for self-test and initial ization completion (Start light on)	55 seconds	15 seconds (no self-test on power-up)
Disk rotational speed	3600 rpm +2/−6%	3600 rpm ±2.5%
Stop Time (Retract heads and stop disk rotation)	30 seconds	15 seconds
Electrical Requirements		
Direct current power	none	none
Alternating current (AC) Power		
Phase	single	three/single
Voltage	100, 115, 200, 220, 240 (±10%) (selected by setting internal power supply jumpers)	208, 240 (±10%) 380, 408
Frequency	50 or 60 Hz ±1 Hz (The frequency selection must be specified in the drive configuration)	50 or 60 Hz ±1 Hz (The frequency selection must be specified in the drive configuration)
Power sequencing	Timed, operator switch selectable time interval from front panel	Daisy chain cable from first drive
Surge (starting) current	23 amps @ 60 Hz, 115 VAC for 15 seconds; 12 amps @ 50 Hz, 220 VAC for 15 seconds	30/39 amps per phase @ 208 VAC Maximum phase current imbalance 70%
Operating (running) current	4.5 amps @ 115 VAC 60 Hz 3.4 amps @ 220 VAC 50 Hz	12/10.1 amps per phase @ 208 VAC
Power consumption	620 Watts @ 115 VAC 60 Hz	2100 Watts/1712 Watts

TABLE 2-1. DISK DRIVE CHARACTERISTICS (Continued)

Environmental Specifications	AMS 200/300	RP06/RM05
Operating temperature	50°F-104°F (10°C-40°C)	59°F-90°F (15°C-32°C)
Storage temperature	−40°F to +140°F −40°C to +60°C	−40°F to +110°F −40°C to +43°C
Temperature gradient		
Operating	18°F (10°C) per hour	12°F (6.7°C)/hr max
Storage	36°F (20°C) per hour	36°F (20°C)/hr max
Drive cooling (internal)	Forced air (fans) 150 CFM (4.5 m^3/min)	Forced air (fans)
Relative humidity		
Operating	10% min, 90% max RH with a wet bulb temperature limit of 80°F (27°C—no condensation)	20% min, 80% max (no condensation)
Storage	5% min, 95% max (no condensation)	(no condensation)
Heat dissipation	2085 BTU/hr @ 115 VAC 60 Hz 2540 BTU/hr @ 230 VAC 50 Hz	7000/5843 BTU/hr max
Barometric pressure		
Operating	−1,000 to 10,000 feet −304 to 3,045 meters (32 to 23 inches HG, 81 to 59 cm HG)	maximum 6,500 feet (2,000 meters) above sea level
Storage	−1,000 to 40,000 feet −304 to 12,190 meters	—
Vibration		
Operating	0.012 inches (0.030 cm) displacement from 20 Hz to 40 Hz sinusoidal motion	1.3g from 2 to 5 Hz
Storage	+1.5g maximum 5 Hz to 500 Hz for one hour along each of the mutually perpendicular axes, with a 20 minute sweep time	1.3g from 2 to 5 Hz
Shock		
Operating	The equipment in nonoperational status shall not suffer damage or fail to operate according to specifications, when subjected to 18 impact shocks of 5g (+10%) consisting of 3 shocks along each direction of three mutually perpendicular axes. Each shock impulse shall be a half sine wave with a time duration of 11 ±1 millisecond	3g for 10 milliseconds, 3 pulses in vertical direction only
Storage or Shipping	—	6g for 30 milliseconds, 3 pulses in vertical direction only
Cleanliness	Normal office environment. Provision must be allowed for not directly exposed to outside weather nor exposed to unusual chemical or atmospheric gas conditions. The air should have less than five million particles (0.5 micron or larger in diameter) per cubic foot of air. Under these	Not specified

TABLE 2-1. DISK DRIVE CHARACTERISTICS (Continued)

Environmental Specifications (Continued)		
	conditions, the air filtering system of the drive can maintain the particle count within acceptable limits.	
Air Flow	150 CPM (4.5 m^3/min). Provision must be allowed for unrestricted air flow entering from the front of the drive and exhausting from the rear.	Not specified
Hardware Compatibility		
Data Format	16-bit words	16- or 18-bit words (18-bit words used on the DEC system 10 and 20 computers)
Computer Compatibility	PDP-11 series; VAX-11/750, VAX-11/780, VAX-11/782, VAX-11/785; DEC-10, DEC-20	PDP-11 series; VAX-11/750, VAX-11/780, VAX-11/782, VAX-11/785; DEC-10, DEC-20
Controller Compatibility	RH10, RH11, RH20, RH70, RH750, RH780	RH10, RH11, RH20, RH70, RH750, RH780

SECTION 3
DISK AND SYSTEM CONFIGURATION

3.1 Data Relocation

The AMS disk drive has a unique feature not found on any disk, controller or computer system—the ability to rapidly and continuously rearrange the data stored on the surface of the disk in order to minimize the expected average seek time. This capability is called DYNAMIC DATA RELOCATION™ (patent pending). The AMS disk drive accomplishes this movement while continuing to respond to host computer requests in a manner such that the data is addressed as though it had not been moved. No changes in the operating system software of the host computer are required. Furthermore, a loss of power will not cause the location of the data to be lost.

3.2 Caching and Read Look-Ahead

In addition to DYNAMIC DATA RELOCATION™, the AMS disk drive can put commonly used, high activity data into its fast, internal semiconductor memory. This capability is known as "caching". The disk drive can also detect sequential file accesses and make anticipatory transfers of data from the disk into its semiconductor memory. This second capability is called "read look-ahead". Subsequent read requests in both circumstances are accomplished very rapidly because both the rotational latency and the seek time of the magnetic disk media are avoided.

3.3 System Performance

Substantial performance improvements in both disk and system performance can be realized by properly utilizing these AMS disk drive capabilities in your computer system. The level of performance improvement depends upon the proper configuration of the hardware and software associated with your disk subsystem, the absence of other system performance bottlenecks, and the level of utilization of your system and the disk drive. For example, in a lightly used computer system, disk performance is *not* a key factor in system performance, and the disk drive behaves much like a conventional disk with the extra speed of caching and read look-ahead. However, in a heavily used system with many jobs and terminal sessions actively using the disk subsystem, disk performance can be crucial to adequate system performance.

3.4 Disk Performance

Disk performance is defined by its two components—the access and transfer times. The access time is the period between the time the computer requests a piece of information on the disk, and the time the first bit of requested information is transferred to the computer. There are two predominant parts to the access time. First, the seek time is the time it takes to move the mechanically actuated read/write heads to the correct location. Second, the rotational latency time is the time it takes for the first bit of information to rotate under the correctly positioned head. The transfer time is the period between the time the first bit of information is transferred, and the time the last bit of information is transferred. The transfer time is dependent on the density of the disk information storage, the rotational speed of the disk and the number of data sectors to be transferred.

3.4.1 Arm Contention

In most PDP-11/XX and VAX minicomputers, the transfer time for disks attached to the MASSBUS is not as great a source of performance problems as it is for disks attached to the UNIBUS. Unlike the UNIBUS, the MASSBUS is designed so that high speed transfers will not be interrupted by requests from low speed devices. The AMS disk drive attaches to the high speed MASSBUS so that the transfer time is less of a performance factor than the access time.

However, the access time is frequently a source of system performance problems for both MASSBUS and UNIBUS disks. In particular, one component of access time, the seek time, can consume 50 to 80 percent of the time spent waiting for the data during periods of high computer and disk subsystem usage. This condition is generally known as "arm contention" because different users are contending for the use of the mechanical arm or actuator which controls the position of the read/write heads.

Figure 3-1 contains a histogram of accesses within a short time period for a lightly used computer system

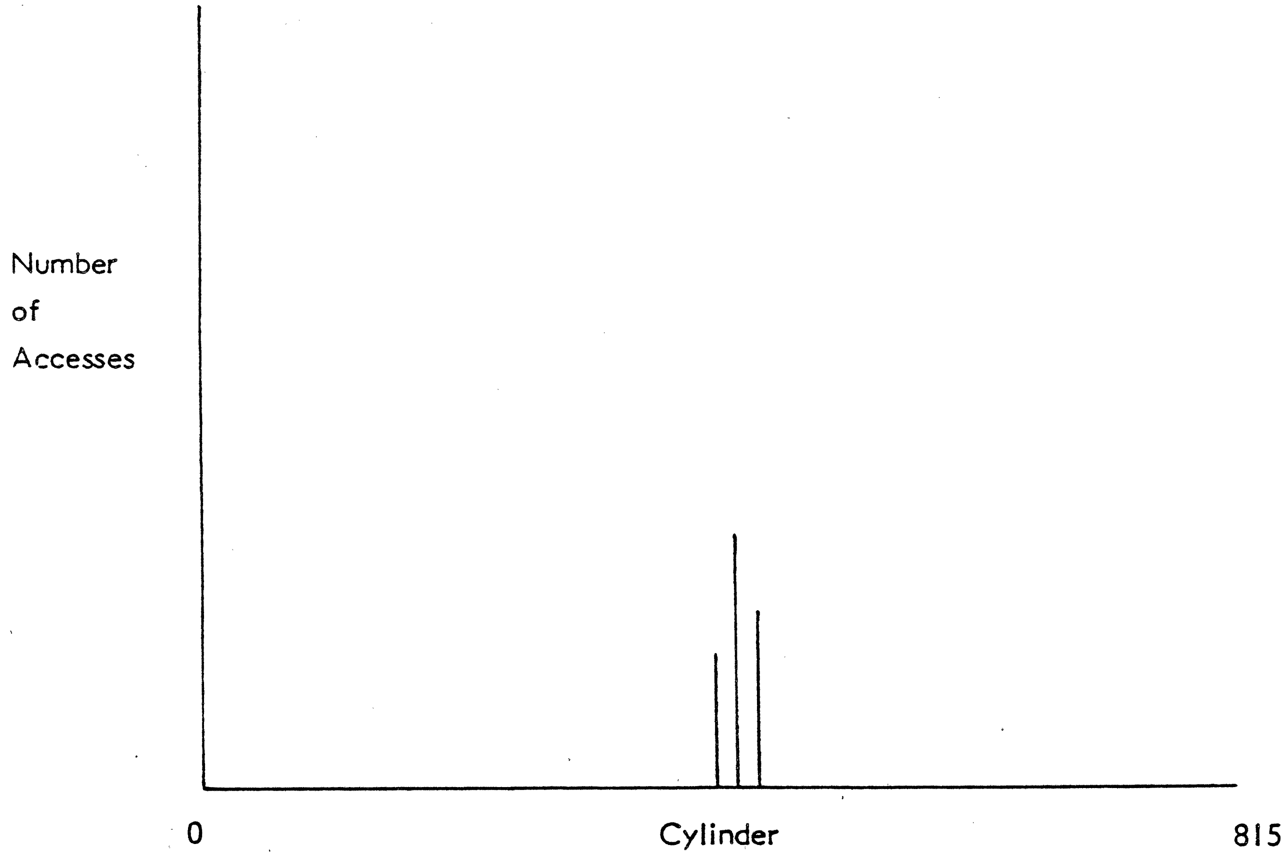


Figure 3-1. Typical Good Performance

with a single active file contained entirely on nearby disk cylinders. This pattern is typical of systems where the system and disk response time is short. In this case, there is not more than one actively used file for each disk in the system. Furthermore, the active file on each disk is not fragmented but is stored in one contiguous area. Disk and system performance is good because subsequent disk accesses do not require long mechanical seeks. Most systems are in this state except during peak usage periods. Under these circumstances, the speed of the seeks is not important since the read/write heads hardly move except during a transition from one file active job to another. Disk performance, in this case, is dominated by the rotational latency time. With the AMS disk drive this time is further reduced by caching and read lookahead.

Figure 3-2 illustrates a poor performance situation. In this case, the system workload has increased or become unbalanced by over-utilization of one disk. Two files have become active on the same disk. This situation also arises when a single file is located on two different areas of the disk (e.g. a file with subsequent extents). As a result, disk accesses require frequent and long seeks, and users perceive rapidly deteriorating system throughput and response time.

In general, if the number of active jobs or tasks resident in the computer's main memory including operating system tasks, equals or exceeds the number of moving head disks, poor performance due to arm contention will be a common occurrence. The number of active jobs may be more than the number of active terminal sessions, because a single monitor or program may handle more than one terminal.

The best means for determining the number of file active jobs at any given time is to use a system performance monitor during periods of peak demand for computer resources. Care must be taken in evaluating the results, however, because some performance monitors do not show the number of tasks that are deactivated by the system due to lack of resources, such as ability to access the disk drive.

Figure 3-3 shows another type of poor performance situation. The files on the disk have become very fragmented over time and are no longer contiguous. Little can be done to improve the performance of such a disk until the data is saved on another disk or tape and then restored to the first disk in a contiguous manner.

Figure 3-2. Poor Performance—Arm Contention

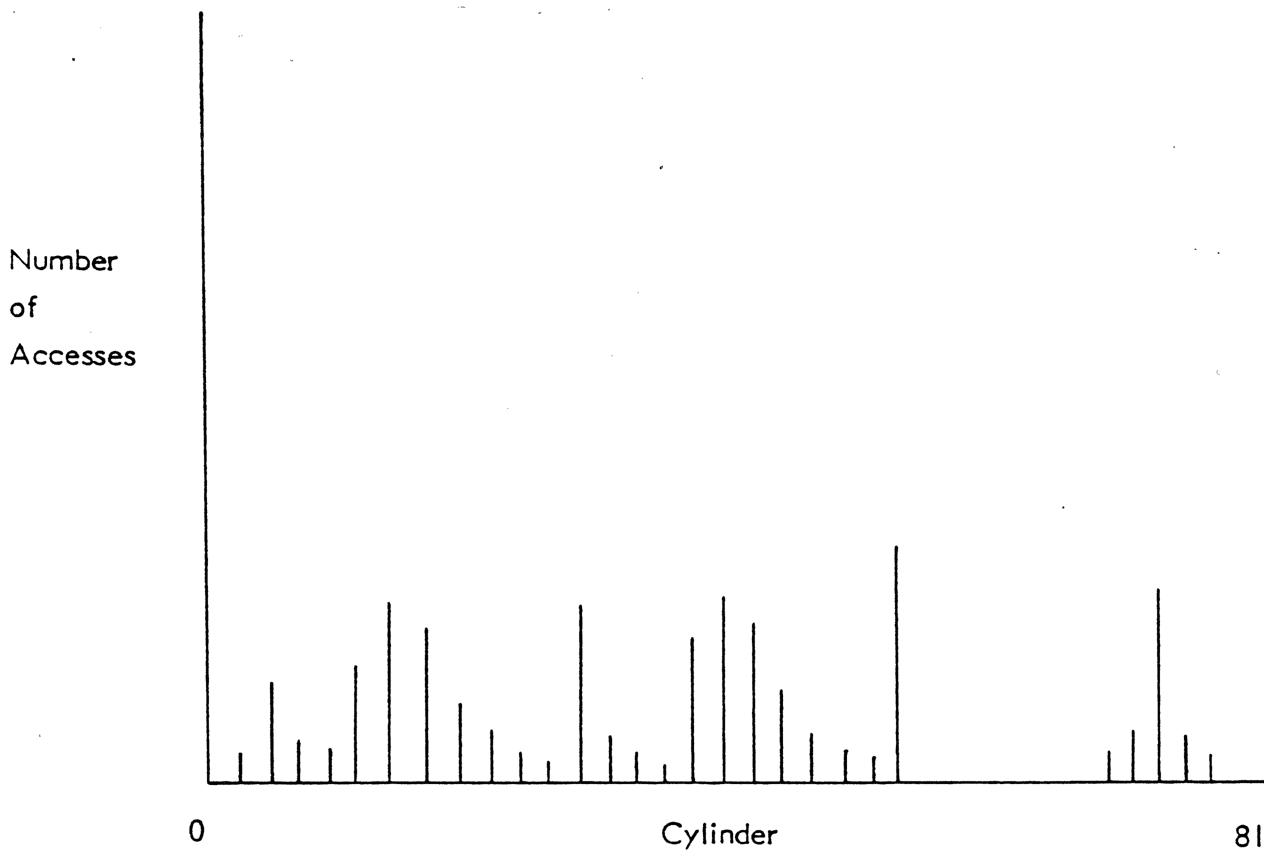


Figure 3-3. Poor Access Performance—File Fragmentation

After the files have been restored contiguously, there are several ways to solve performance problems that are due to arm contention. The most common method is to reduce the number of active jobs allowed at any one time. For example, under VAX/VMS the number of working sets (active jobs in main memory) allowed in the balance set can be reduced by changing a parameter during system generation. Reducing the number of allowable active jobs has two unfortunate consequences. First, the computing and main memory resources of the system are under utilized. Second, users are effectively denied real time access to the computer resources.

The next method for solving arm contention problems is to add large amounts of higher speed semiconductor memory either as main memory (most efficient and cost effective) or as an attachment to the disk subsystem (least efficient and most costly). If the relevant data is contained in this higher speed memory, then long disk seeks can be avoided. The major disadvantage of using large amounts of higher speed memory is the very high cost of its capacity relative to that of disks. Also, this "caching" of data may not relieve arm contention problems because the concentration of accesses in a computer is high, relative to the storage capacity of the disk, but low, relative to the capacity of the high speed memory.

If a file contains an index frequently used as a reference to other files, then caching improves the access speed whether or not arm contention is a problem. The commonly used index items will tend to remain in the fast access cache of the AMS disk drive for use by many users.

Read look-ahead is a form of anticipatory caching which is particularly useful when a file is read sequentially through its physically contiguous sectors. During read look-ahead, the AMS disk drive reads more data than requested when it accesses the magnetic media. Only the data required for that particular access is transferred to the computer system. The rest of the data is retained in the high speed cache memory for subsequent access requests.

The third method of solving the arm contention problem is to manually move data files so that simultaneously active ones are located either adjacent to each other on the same disk or on completely different disks. There are four major problems with this method. First, one or more people must monitor and manually move these data sets. Second, this movement of data cannot be accomplished on a real time basis. It is, therefore, not responsive to changes in the operating environment. Third, additional disks may be required to accommodate simultaneously active files. Fourth, this may be nearly impossible to do in many operating system environments. In short, this method is expensive in terms of both people's time and the cost of additional disks.

The AMS disk drive can be used to automatically and continuously relocate active files to solve arm contention problems. By placing two or more files which may become simultaneously active on the disk drive, the files can be made into one single physical data set by co-locating them on adjacent areas of the disk. This DYNAMIC DATA RELOCATION does not affect their logical and addressing definitions. The files are still accessed in the conventional manner by the host operating system and file utilities. Furthermore, this method responds quickly and automatically to changes in the operating system environment and is unaffected by power failures.

3.5 ERROR FREE MEDIA AND ECC CORRECTION

The AMS 200/300 contains perfect media due to its ability to map out media defects using its own onboard flaw mapping program. Continuous perfect media can be maintained by rerunning this program when a new defect is uncovered. The AMS 200/300 Disk Drive also has the capability of doing its own onboard 11 bit ECC correction. This is for systems that do not have the capability of ECC correction in the host computer. (Typically Bell Unix Systems.)

3.6 SYSTEM CAPABILITIES

The rest of this section is devoted to helping the operator use the unique capabilities of the AMS disk drive effectively. This can be accomplished by properly configuring the disk drive into the system and selecting the appropriate files to be stored on it. First, one must recognize that any device, including the AMS disk drive, may be misused or overused and not accomplish its performance function adequately. In the case of the AMS disk drive, this could happen under three types of circumstances. First, the operating system software (e.g., the disk drive or file allocation routine) can be misconfigured to make the caching and read look-ahead capabilities useless. Second, the files can be so badly fragmented that the concentration of accesses is inadequate for DYNAMIC DATA RELOCATION to be effective. Third, too many large and active files may be assigned to the AMS disk drive while other disks are left essentially idle.

In order to properly configure the AMS disk drive and the system software, the following operation should be followed. The system should not use physical interleaving of disk sectors for storing data to allow the read look-ahead capability to operate properly. If the usual number of sectors transferred is greater than 16 (normally the range is 1 to 8), read look-ahead should be disabled on the AMS disk drive on the front panel. Otherwise, the AMS disk drive will waste time uselessly reading ahead. Similarly, SEEK and SEARCH commands should be configured in the operating system software to supply the AMS disk drive with complete and accurate cylinder, track and sector information, and the AMS disk drive should be properly configured to allow for an appropriate number of sectors to be used as an offset for this information. This permits the AMS disk drive to accurately check its cache memory to avoid having to actually perform the SEEK or SEARCH command in cases where the desired information is in the cache memory. If the operating system software does not supply complete information with these commands, then the AMS disk drive should be configured to wait for the actual READ or WRITE command to supply the complete information. Ignoring the SEEK or SEARCH commands usually has little or no effect on typical system performance.

Badly fragmented files can be made contiguous by saving and restoring to and from a separate storage medium on a file name basis. Disk saves done on an image basis will not accomplish the physical consolidation of files. Certain systems such as standard UNIX and the Berkeley versions of UNIX prior to 4.2 are especially prone to rapid file fragmentation. The files in these systems should be made contiguous at least once a week (in most cases) in order to achieve good system peformance. Figure 3-4 is a graphic representation of the effect of file fragmentation on disk throughput performance. If the disk subsystem is the performance bottleneck in the computer system, then file fragmentation can have a disastrous effect on total system performance.

Overloading the AMS disk drive with too many active files can be solved by properly planning and managing the allocation of files among the available disks. The first step is to classify the files into groups which are necessarily co-located on the same disk. Usually one of these groups of files includes the system software and related files. This group of files should be the first candidate for location on the AMS disk drive. An exception would be the system swapping files. The swapping files are used for short term storage of program code normally resident in the computer's main memory. These files are more advantageously stored on a separate disk.

The next files chosen should be any two or more user files which are known to be simultaneously active for extended periods of time (perhaps files active for more than ten minutes). The remaining very active files should be allocated, one each, to the remaining

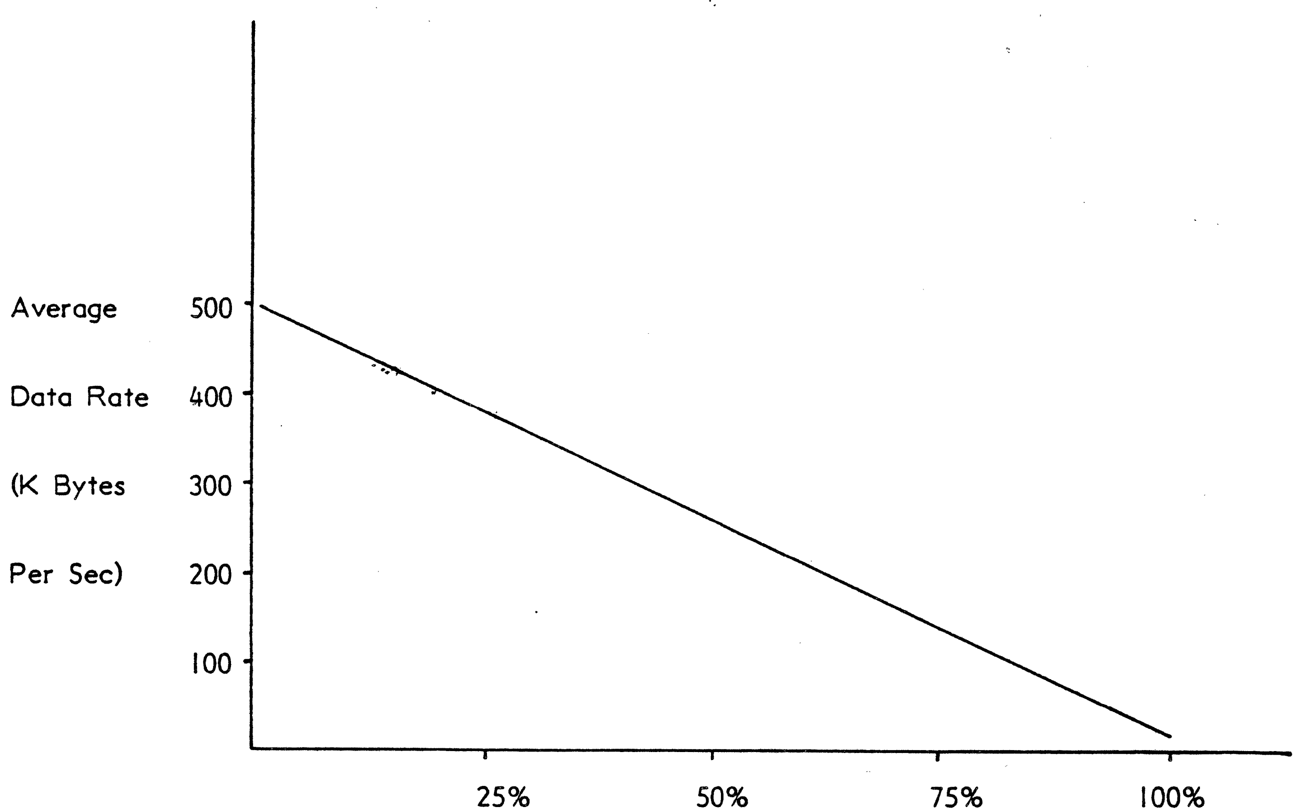


Figure 3-4. Poor Throughput Rate—File Fragmentation

conventional disks. The most active files should be placed on the conventional disks first. The remainder can be put on the AMS disk drive. This configuration strategy should result in the optimum performance for most systems.

In most cases this strategy results in the AMS disk drive being selected as logical device number 0 on a particular MBA Adapter string. No magnetic tape drives should be placed on the same MASSBUS Adapter as the AMS disk drive. Instead, a separate adaptor should be used so that the typically long tape transfers will not interfere with disk performance.

The strategy outlined here may have to be modified in individual circumstances. For example, if a site has a fixed head disk, the system software and swapping files are best placed on it. The operator may also want to experiment with different configurations to suit the individual site requirements.

File fragmentation can significantly reduce Winchester disk throughput in file oriented backup operations. With a disk sector size of 512 bytes and an average access time of 35 milliseconds, the average data-transfer rate slows to only about 20K bytes per second when files are 100 percent fragmented.

SECTION 4
RELIABILITY AND SERVICE LIFE

4.0 RELIABILITY

4.0.1 MTBF—Meantime Between Failures

MTBF is defined by the expression:

$$\text{MTBF} = \frac{\text{Operating Hours}}{\text{No. of Equipment Failures}}$$

MTBF is defined as the expected number of operating hours between equipment failures. Operating hours relate to the total "AC Power On" hours less any maintenance time. Equipment failures are defined as malfunctions requiring repairs, adjustments or replacements on an unscheduled basis, i.e., emergency maintenance required because of hardware failure or substandard performance. Excluded is downtime or substandard performance due to operator error, adverse environment, power failure, controller failure, cable failures or malfunctions not caused by the drive.

The AMS Disk Drives have a designed MTBF of 10,000 hours. The sealed mechanism alone has a designed MTBF of 25,000 plus hours.

4.0.2 MTTR—Mean Time to Repair

MTTR is defined as the time for an adequately trained and competent service man to diagnose and correct a malfunction at the subassembly level. The AMS Disk Drives are designed so that the MTTR is less than one-half manhour. The sealed portion of the drive is not field repairable and must be returned to the factory or factory authorized repair center for repair in a special clean room environment.

4.0.3 Preventive Maintenance Time

No regularly scheduled preventive maintenance is required.

4.1 DATA INTEGRITY (Before Flaw Mapping)

4.1.1 Recoverable Errors

A recoverable error is one which may be corrected by no more than 9 attempts to read the record. Any combination of seek-write or seek-read is allowed without limitation. Data patterns and track positions do not affect data error rate performance. The recoverable read error rate for the AMS Disk Drives is less than ten errors in 10^{11} bits read.

4.1.2 Non-Recoverable Errors

A non-recoverable error is one which remains after 9 attempts to read the record in which an error is located. The non-recoverable error rate for the AMS Disk Drives is less than ten in 10^{14} bits read.

4.1.3 Access Errors

The access error rate is less than ten in 10^7 seek executions.

4.1.4 Media Defect Specifications

The AMS Disk Drives are designed to operate with systems capable of correcting an error burst (usually due to a media defect) of up to 11 bits, providing the rest of the track is error-free.

a. Definitions

   Correctable Error Tracks
   A correctable error track is defined as a track having one error burst which is $\geq$11 bits in length.

   Uncorrectable Error Tracks
   An uncorrectable error track is defined as a track having more than one error burst, or one single error burst $>$11 bits in length.

b. Specification

   The maximum number of correctable error tracks on an AMS Disk Drive is 80.

   The maximum number of uncorrectable error tracks on an AMS Disk Drive is 15.

   The maximum combined number of correctable and uncorrectable error tracks on an AMS Disk Drive will not exceed 80.

c. Error Free Areas

   On the AMS disk drive, there shall be no errors of any type on the two tracks defined by Cylinder 0, Heads 00 and 01.

d. Media Defect Logging Information

Each AMS Disk Drive has a flaw map shipped with it which lists the following information concerning each error burst.

- Head
- Cylinder
- Location (bytes from index) for the first error burst on the track

An asterisk (*) to indicate uncorrectable flaw

This map is unimportant with an AMS 200/300 since it is flaw-free.

SECTION 5
SWITCHES AND INDICATORS

5.1 FRONT PANEL SWITCHES AND INDICATORS

All operator switches and indicators are located on the AMS Disk Drive front panel. Figure 5-1 shows a view of the front panel. The description and function of each switch and indicator follows:

5.1.1 START Indicator/Switch

The START indicator/switch provides the system operator with a method of sequencing the disk drive up or down independent of the system.

If the system operator sets the START switch to the Out position (indicator off), when the disk drive is sequenced up, the drive will sequence down immediately. This means the read/write heads will be moved to the landing zone and then the drive motor is turned off.

Sequencing the disk drive up by setting the START switch to the In position (indicator lighted) depends on the setting of the LOCAL/REMOTE switch located on the I/O and Control PWB.

5.1.2 Ready Indicator/I.D. Plug (White)

This indicator/I.D. plug is used to select an address (0-7) for MASSBUS drives. When the indicator is illuminated, indicates the drive is up to speed and in an operational condition. This light will blink on and off while powering up or down. Note: Only unit numbers 0-7 are allowed for MASSBUS operation.

5.1.3 FAULT Indicator/Reset Button (Red)

This indicator, when illuminated, indicates that "Fault" is active. When depressed, FAULT will reset if none of its set conditions are still active.

5.1.4 WRITE PROTECT Indicator/Switch

This indicator/switch, when not illuminated, indicates all data operations are enabled. Pressing the switch, will light the indicator and indicate write operations are disabled (the drive is write protected).

5.2 REAR PANEL SWITCH

5.2.1 AC Switch

This switch is located on the AC distribution panel at the rear of the disk drive. The switch, when off, removes the AC from the drive.

5.3 INTERNAL SWITCHES

The I/O and Control PWB contains a number of rocker (dip) switches that are preset to match the operating system parameters. Refer to the following steps for switch settings.

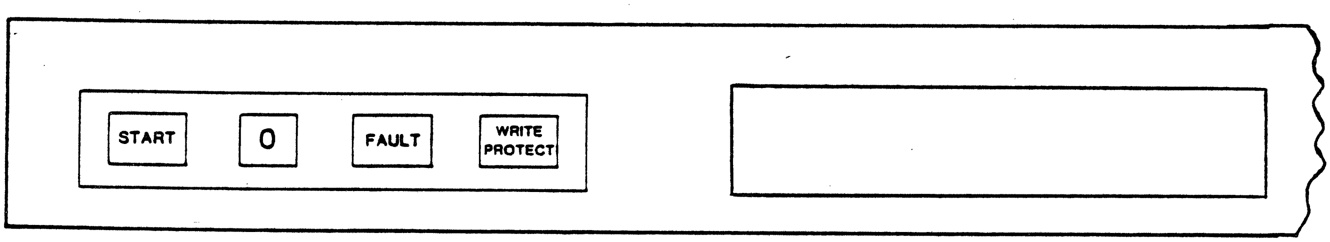


Figure 5-1. Operator Control Panel

5.3.1 Dip Switch Setting for I/O and Control Dual Access PWB P/N 26310-001

Note

The switch setting information given below for switches S1, S2 and S3 is for reference only. Refer to Figure 5-3 for proper setting of these switches when used with the AMS 200/300 Disk Drives.

a. Verify the part number of the SMD Dual Access PWB before starting.

Note

Only one access, the A access, is used for the AMS 200/300 Disk Drive.

b. Figures 5-2 and 5-3 show the switch blocks located on the P/N 26310-001 I/O and Control PWB.

c. Each I/O and Control PWB also contains 14 Fault (Maintenance) and Access indicators (LED's) that are shown in Figures 5-2 and 5-3. Refer to Table 5-1 for fault indicator condition and description.

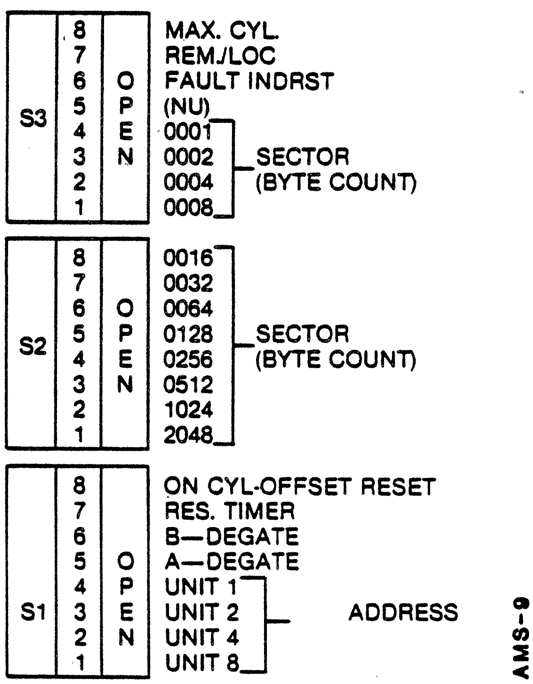


Figure 5-2. Switch Blocks (P/N 26310-001)

5.3.2 Maximum Cylinder Switch (see Figure 5-3)

The setting of this switch (S3-8) is used by the disk drive control firmware to determine the maximum legal cylinder address. When this switch (S3-8) on I/O and Control PWB is closed, the maximum legal cylinder address is address 844. With the switch in the open position, the maximum legal cylinder address is 822. Set the switch to the open position (822) for the AMS 200/300 Disk Drive.

TABLE 5-1. I/O AND CONTROL PWB INDICATORS

LED	Condition/Fault
DS1	Overtemperature (Linear Motor)
DS2	DC Unsafe
DS3	Power Amplifier Unsafe
DS4	Read/Write Fault
DS5	Read Error
DS6	Write Error
DS7	Read Only
DS8	Offset Or Not On Cylinder
DS9	Seek Error
DS10	A Priority
DS11	A Reserved
DS12	B Priority
DS13	B Reserved
DS14	Fault

5.3.3 Local/Remote Switch (See Figure 5-3)

The Local/Remote switch (S3-7) determines whether the disk drive is to be sequenced up and down locally (by the front panel START switch only) or remotely (by the PICK and HOLD signals issued by the system controller). The PICK and HOLD signals are routed from the system controller to each disk drive serially. To initiate a sequence-up function, the PICK and HOLD signals are routed to the first disk drive, starting its sequence-up function. When the first disk drive is up to speed, the signals are routed to the next disk drive and so on down the line until all disk drives are sequenced up.

When the switch (S3-7) is in the LOCAL (closed) position it is not necessary to issue a PICK or HOLD signal and sequencing is done by opening and closing the front panel START switch. When it is in the REMOTE (open) position PICK and HOLD signals must be issued from the system controller (START switch must be closed). For AMS 200/300 Disk Drives this switch must be open.

5.3.4 Fault Indicator Reset Switch (See Figure 5-3)

Nine different fault conditions are indicated by individual LED's located on the I/O & Control PWB. During maintenance (fault finding) the Fault Indicator Reset switch (S3-6) can be used to reset the fault flip-flops (switch closed) which causes the fault LED's to turn off. During normal operations, this switch should be placed in the open position, allowing a fault condition

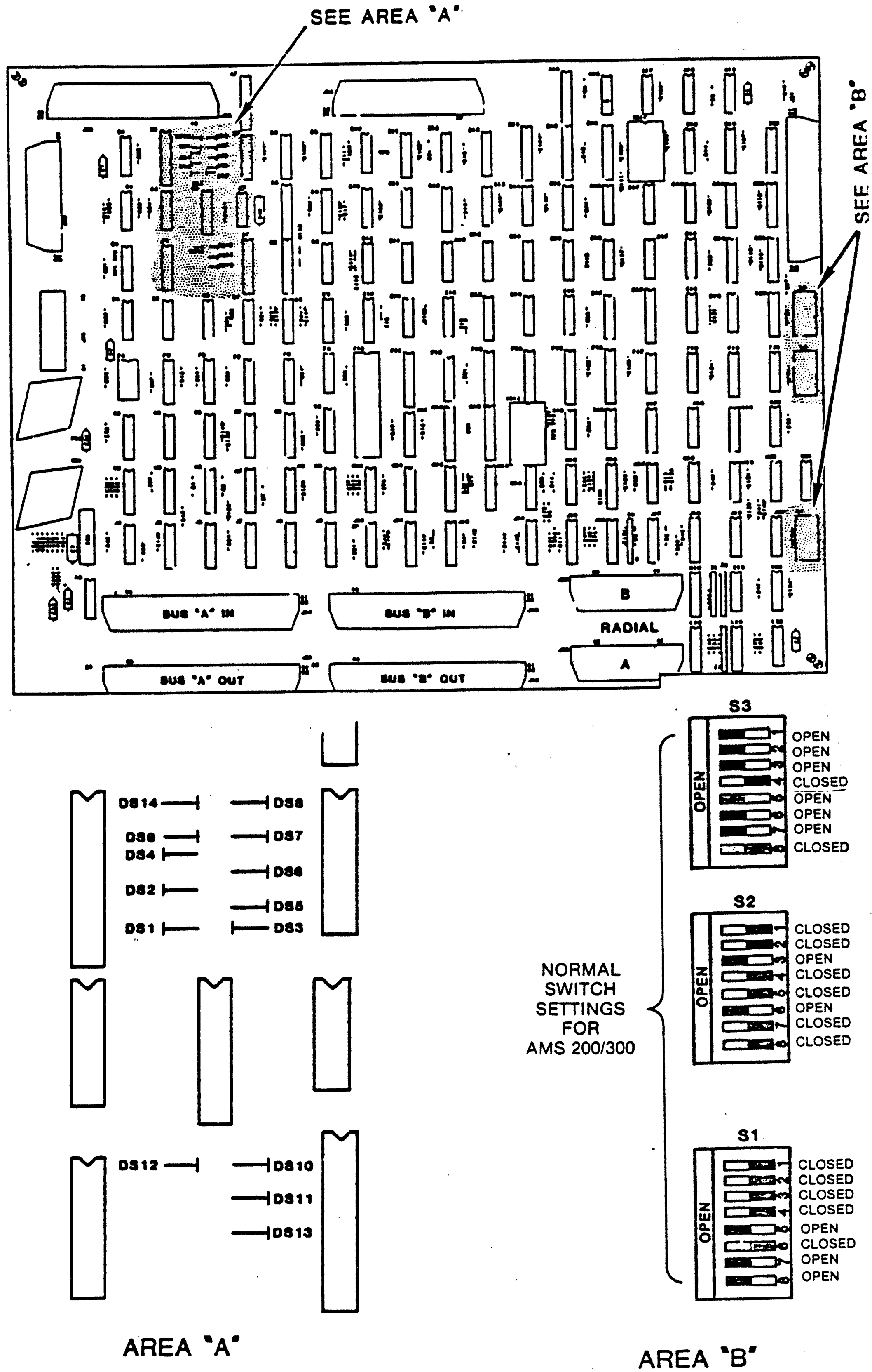


Figure 5-3. I/O and Control PWB Switches and Indicators, PWB P/N 26310-001

to set the appropriate fault flip-flop and turn on the LED. If the switch was kept in the closed position, fault conditions would be reported to the system, but would not be captured in a fault flip-flop. Table 5-1 shows the fault LED's.

5.3.5 Sector Switches (See Figure 5-3)

The sector switches (S2-1 thru -8 and S3-1 thru -4) are used, when the system uses hard sectoring, to set the total byte capacity for each sector on the disks. Refer to Table 5-2 for the sector switches settings table and formula.

The switches should be set using the following formula:

$$\text{Sector Switches} = \frac{\text{Track Byte Capacity (20,260)}}{\text{Number of Sectors}} - 2$$

The following Table 5-2 shows total byte count, switch byte count and switch settings for 22, 32 and 34 sectors. Set the switches for 34 sectors when used with the MASSBUS adapter.

5.3.6 On Cylinder Offset Reset Switch (See Figure 5-3)

The On Cylinder Offset Reset switch (S1-8) allows for SMD or CMD compatibility of the interface signal ON-CYLINDER. With the switch closed, signal ON-CYLINDER drops at the beginning and end of an Offset Operation (CMD). With the switch open, signal ON-CYLINDER drops at the beginning of an Offset Operation only (SMD). Set this switch to the open position for AMS 200/300 Disk Drives.

5.3.7 Reserve Timer Switch (See Figure 5-3)

This switch (S1-7) is the Dual Access Reserve Timer mode switch. When the switch is open, the first access to select the drive, reserves the drive until that access specifically releases the drive by activating Control Tag and Bus Bit 9. When the switch is closed, the reserve status of the drive is automatically released 500 milliseconds after the end of an I/O operation. For AMS 200/300, always place this switch in the open position.

5.3.8 Degate Switches (See Figure 5-3)

Access A Degate switch (S1-5) and Access B Degate switch (S1-6) are used to place the disk drive online or offline to the system cabled to the associated access.

However, the controller (enhancement PWB) is always connected to the A access and the B access is unused. The switch should be set to the closed position for AMS 200/300 Disk Drives.

5.3.9 Unit Address Switches (See Figure 5-3)

In systems with more than one disk drive, each drive will be assigned a different unit address. In systems with only one disk drive the unit address for the drive is usually "zero". The unit address switches (S1-1 thru S1-4) on the I/O and Control PWB are in parallel with the unit address plug on the front panel of the enclosure. If the front panel plug is to be used, the switches must be left in the open position to prevent interaction with the front panel address plug. The unit address is set by these switches for drives without a front panel. Each switch is binary weighted and when

TABLE 5-2. SECTOR SWITCHES SETTINGS

0 = SWITCH CLOSED   1 = SWITCH OPEN

			SECTOR SWITCHES BINARY WEIGHTS											
NUMBER OF SECTOR/TRACK	TOTAL NUMBER OF BYTES/SECTOR	BYTE COUNT SET IN SWITCHES	2048 (S2-1)	1024 (S2-2)	0512 (S2-3)	0256 (S2-4)	0128 (S2-5)	0064 (S2-6)	0032 (S2-7)	0016 (S2-8)	0008 (S3-1)	0004 (S3-2)	0002 (S3-3)	0001 (S3-4)
022	0916	0914	0	0	1	1	1	0	0	1	0	0	1	0
032	0630	0628	0	0	1	0	0	1	1	1	0	1	0	0
034	0592	0590	0	0	1	0	0	1	0	0	1	1	1	0

open equals a binary 'one' in that weighted position. Because the AMS 200/300 has its own controller (enhancement PWB) the address switches must always be zero. Set switches S1-1 thru S1-4 to the closed position.

5.4 OPERATOR CONTROLS AND INDICATORS

Operating controls and status indicators are on the front of the AMS disk drive, beneath a removable front panel cover, and on the power supply chassis at the rear of the unit. Other switches and controls are located within the disk drive. These are not used during normal operation and are accessible only by removing the top cover. They are set at the factory and should only be changed if a malfunction is suspected.

The disk drive AC ON/OFF switch next to the AC power cord controls the application of AC and DC power to the drive and MASSBUS interface.

The front of the AMS disk drive contains two switch and indicator sets. One can be observed and changed with the front panel and cover attached. These indicators are used to indicate status during normal operation. The other set of indicators and switches which are infrequently changed are located behind the front panel cover. (See Figure 5-4.)

5.4.1 START Indicator

The START indicator (5) is turned on when the controller and disk have completed self-test and are ready for operation. This normally hidden indicator is useful only to service personnel.

5.4.2 POWER-UP Control

The dip switches numbered 1, 2, 3 and 4 are read during power-on in order to control the delay before the drive motor is energized. This is useful in larger systems to avoid the higher power surge of having multiple motors starting simultaneously. Each delay increment is used to run the internal self test loop.

(Open = 1, Closed = 0)

SWITCH NUMBER 4	3	2	1	APPROXIMATE DELAY BEFORE STARTING MOTOR
0	0	0	0	Immediate
0	0	0	1	30 Seconds
0	0	1	0	60 Seconds
0	0	1	1	90 Seconds
0	1	0	0	2 Minutes
0	1	0	1	2 Minutes 30 Seconds
0	1	1	0	3 Minutes
0	1	1	1	3 Minutes 30 Seconds

Note: Switches 5 and 6 must be 0!!

5.4.3 Test ERROR/STEP Code

These red lights display the step number being executed during the power-on self-test. In addition, they display other error codes, conditions or activity. Table 5-3 explains the meaning of the numbers displayed in these lights.

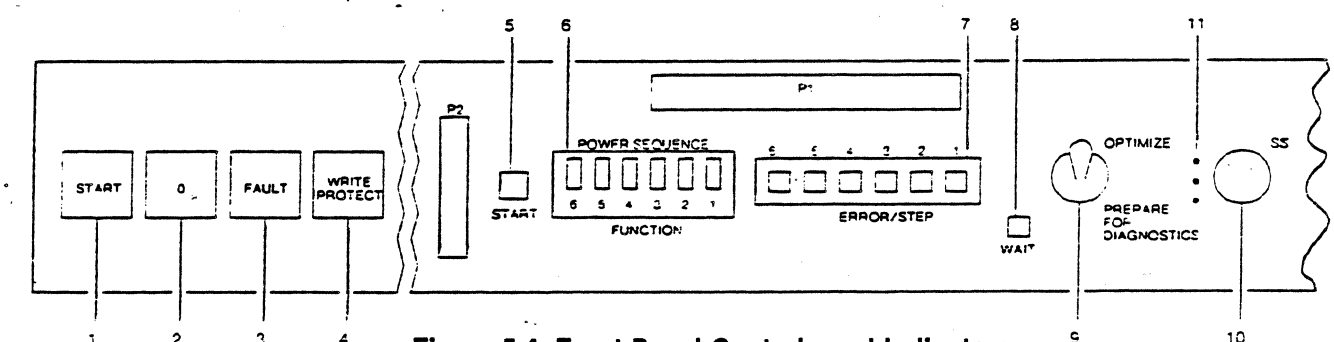


Figure 5-4. Front Panel Controls and Indicators

TABLE 5-3. CONTROLS AND INDICATORS

Control/Indicator	Description/Function
1 START Switch/Indicator	IN position turns on the drive motor and positions the heads over the data tracks. OUT position moves the heads to the landing zone area, turns off the drive motor, and activates the brake to stop the disks. This light will continue flashing after unit is spun down until power is removed. This is due to the MASSBUS controllers continued polling of the MASSUBS.
2 Ready Indicator/ Logical Address Plug (White) (MASSBUS Unit No.)	Indicates that the drive is powered up and the logical address of the drive (SMD only) is stamped on the indicator lens. Flashes during the power up until the drive is ready and during power down until the disks have stopped.

TABLE 5-3. CONTROLS AND INDICATORS (Continued)

Control/Indicator	Description/Function
3 FAULT Pushbutton Switch/Indicator (Red)	Indicates that an unsafe operating condition has been detected and that corrective action is required. Pressing the switch will clear any fault condition that no longer exists.
4 WRITE PROTECT Switch/Indicator	WRITE PROTECT (ON) position disables the write logic for read-only disk protection. OFF position enables all data operations. Note: An electrical interlock prevents switch actuation from disrupting a write operation in progress.
5 START Light	This normally hidden indicator is useful only to service personnel.
6 POWER SEQUENCE/ FUNCTION Switches	The dip switches numbered 1, 2, 3 and 4 are read during power-on in order to control the delay before the drive motor is energized. This is useful in larger systems to avoid the higher power surge of having multiple motors starting simultaneously. Each delay increment is used to run the internal self test loop. Note: Switches 5 and 6 must be set to zero or the test will loop forever. If switches (1-6) = Hex 3E, the self test will loop forever even if the switches are cleared. Power cycling the disk is then required to operate the disk. If switches (1-6) = Hex 3F, the disk will not be connected to the controller. Both 3E and 3F are only useful to service personnel. SWITCH NUMBER (Open = 1, Closed = 0) 4 3 2 1 APPROXIMATE DELAY BEFORE STARTING MOTOR 0 0 0 0 Immediate 0 0 0 1 30 Seconds 0 0 1 0 60 Seconds 0 0 1 1 90 Seconds 0 1 0 0 2 Minutes 0 1 0 1 2 Minutes 30 Seconds 0 1 1 0 3 Minutes 0 1 1 1 3 Minutes 30 Seconds Note: Switches 5 and 6 must be 0!! Note: For the DIP switches, 0 is closed and 1 is open. These switches and switches 5 through 8 are also used to perform certain functions on the MASSBUS adapter, as explained in Table 5-4.
7 ERROR/STEP Indicator	These red lights display the step number being executed during the power-on self-test. In addition, they display other error codes, conditions or activity. Table 5-5 explains the meaning of the numbers displayed in these lights.
8 WAIT Indicator	This red light turns on during power up and whenever the Prepare for Diagnostics is changed, and indicates that the Controller has yet to achieve the indicated state. There may be a long delay after setting the switch to Prepare for Diagnostics before this light goes off. The ERASE RESET function may be used to make the disk instantly ready for diagnostics, if the disk data has already been backed up.
9 OPTIMIZE/ PREPARE FOR DIAGNOSTIC Switch	During normal operation this switch is set to the OPTIMIZE position so that the adapter performs DYNAMIC DATA RELOCATION, caching and read look-ahead. However, to run the host computer-based diagnostics, the switch must be placed in the PREPARE FOR DIAGNOSTICS position, which turns OFF caching and safely relocates stored data to its home position. This relocation may take up to about 17 minutes, during which time the WAIT led will remain lit. The PREPARE FOR DIAGNOSTIC switch can be changed at any time, including during normal on-line system operation. If time is a factor, and if the data is properly backed-up on other media, a destructive ERASE-RESET function (described later) can make the controller ready for diagnostics immediately.
10 PUSHBUTTON S5 Switch	This is used in conjunction with the switches to execute front panel functions on the AMS disk drive, such as off-line formatting.
11 3-PIN HEADER	The bottom two pins are used with a factory adapter to read the ERROR/STEP function on a CRT.

TABLE 5-4. ERROR/STEP INDICATORS

Binary/ Light No. 6 5 4 3 2 1	Hex	Description
		Power On Self-Tests, Error Codes
1 1 1 1 1 1	3F	Power up state (START and WAIT also ON).
0 0 0 0 0 0	0	Start of self-test.
1	1	2910 tests at interrupt level complete.
1 0	2	2910 tests at main level complete.
1 1	3	Check of constants versus EPROM complete.
1 0 1	5	Check of refresh timeout complete.
1 1 0	6	Check of internal and some external registers.
1 1 1	7	Check of 2903 instructions complete.
1 0 0 0	8	Check of parity flip-flop and trivial RAM test complete.
1 0 0 1	9	RAM read/write test #1 complete, first bank.
1 0 1 0	A	RAM read/write test #2 complete, first bank.
1 0 1 1	B	RAM read/write test #3 complete, first bank.
1 1 0 0	C	RAM read/write test #1 complete, second bank.
1 1 0 1	D	RAM read/write test #2 complete, second bank.
1 1 1 0	E	RAM read/write test #3 complete, second bank.
1 1 1 1	F	Microcode self-test complete.
1 0 0 0 0	10	High level language initialized.
1 0 0 1 0	12	External register test #2 complete.
1 0 0 1 1	13	RAM addressing test complete for bank 1.
1 0 1 0 0	14	RAM addressing test complete for bank 2.
1 0 1 0 1	15	Long RAM pattern test complete for bank 1.
1 0 1 1 1	17	Internal SMD port loop back test complete.
1 1 0 1 0	1A	Past self-test, initialization step 1 complelte.
1 1 0 1 1	1B	Past self-test, initialization step 2 complete.
1 1 1 0 0	1C	Past self-test, initialization step 3 complete.
1 1 1 0 1	1D	Disk selected and returned good status.
1 1 1 1 0	1E	Successful initialization of tables from disk complete.
		Other Error Codes
1 1 0 0 0 0	30	27128 EPROM 0-16K located in 6Cl failed checksum.
1 1 0 0 0 1	31	27128 EPROM 16-32K located in 6C2 failed checksum.
1 1 0 1 0 1	35	Illegal front panel function requested by operator.
1 0 1 0 1 0	2A	The AMS failed to write the updated tables to the disk. Check that write lock is OFF and that the disk is ready. The problem must be corrected and the function repeated, since any changes to the tables will be lost when power is cycled.

5.4.4 OPTIMIZE/PREPARE FOR DIAGNOSTIC Switch

During normal operation this switch is set to the OPTIMIZE position so that the adapter performs DYNAMIC DATA RELOCATION, caching and read look-ahead. However, to run the host computer-based diagnostics, the switch must be placed in the PREPARE FOR DIAGNOSTICS position, which turns OFF caching and safely relocates stored data to its home position. This relocation may take up to about 17 minutes, during which time the WAIT led will remain lit.

5.4.5 WAIT Light

This red light turns on during power up and whenever the Prepare for Diagnostics switch is changed, and indicates that the Controller has yet to achieve the indicated state. There may be a long delay after setting the switch to Prepare for Diagnostics before this light goes off.

5.4.6 PUSHBUTTON

This is used in conjunction with the switches to execute front panel functions on the AMS disk drive such as off-line formatting.

TABLE 5-5. SWITCH SELECTIONS

Selections Switches 7654321*	Hex	Function	Requires a Second S5 Press?	Description
0001010	0A	Decrease Look-Ahead	No	Controls the number of sectors that the controller will read past the end of the host request when look-ahead is "triggered". The default is 16 (= HEX 10). When pressed, the new number is displayed on the front panel lights in binary. (The look-ahead count is stored on the disk. See function #C, "Write Tables".)
0001011	0B	Increase Look-Ahead	No	Controls the number of sectors that the controller will read past the end of the host request when look-ahead is "triggered". The default is 16 (= HEX 10). When pressed, the new number is displayed on the front panel lights in binary. (The look-ahead count is stored on the disk. See function #C, "Write Tables".)
0001100	0C	Write Tables	Yes	Save current internal tables on disk as is done constantly during dynamic data relocation. This insures current values of search mode and look-ahead are retained even if power down occurs before another relocation occurs.
0010111	17	Auto-ECC	No	Controls the enabling of automatic ECC correction. Selecting the function acts to toggle the enable. After the function is invoked, a single front panel light indicates ECC enable was off but is now on. No front panel lites on indicate ECC enable was on but is now off.
0011000	18	Decrement Look-Back	No	Used to speed up disk access during interleaved operation. Set to 9 for COSMOS operation. Set to 0 for standard RP06.
0011001	19	Increment Look-Back	No	Used to speed up disk access during interleaved operation. Set to 9 for COSMOS operation. Set to 0 for standard RP06.
1011110	5E	Reset-User Flaws	Yes	Service personnel only!! Format and reset the cylinder tables and the map of the disk flaws found by the find-flaws front panel function (user-flaws). This effectively clears the user flaw information and performs an erase-reset function.
1011111	5F	Reset-All Flaws	Yes	Service personnel only!! Format and reset the cylinder tables, the user flaw map, and the manufacturer's flaw map. This deletes all of the information about disk media flaws which is used to make the disk appear "perfect". This should only be used by service personnel in the very rare event that a malfunction has caused these flaw maps to be destroyed. Find-flaws should be run for at least 24 hours after this operation.
1100001	61	Restart-Board	Yes	Starts execution of self test as if the AMS disk drive was power cycled.
1100010	62	Erase and Reset Tables	Yes	Initialize cylinder mapping tables to a one-to-one organization and resets all selection to default values. This is also a quick way to make the disk ready for diagnostics. The identity of all relocated data is lost, so this should only be done after the disk data is properly backed up elsewhere. Erase reset must be done before

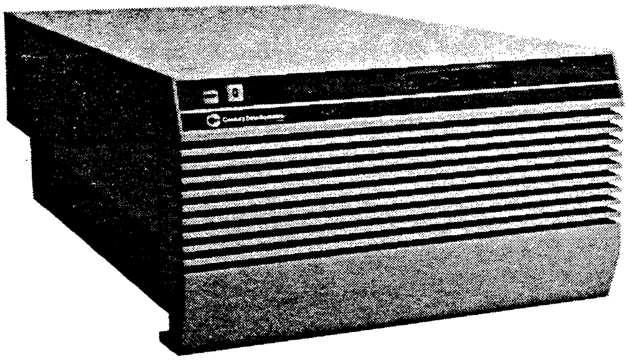
TABLE 5-5. SWITCH SELECTIONS (Continued)

Selections Switches 7654321*	Hex	Function	Requires a Second S5 Press?	Description
				formatting the disk using the host formatting program, so that the normal format organization is obtained. This does not erase the flaw map table generated by the find-flaws function. It also does some table housekeeping. If this function is not done following a find-flaws function, the start light on the operator control panel will continue to flash after the drive comes ready.
1100011	63	Format	Yes	Formats entire disk except for hidden flaw maps. Clears the host bad sector file. This function is not normally used as it does not format with the standard DEC format.
1100100	64	Find-Flaws	Yes	Finds and maps out disk media flaws to create a "perfect" media disk. This adds flaws to the user flaw map. The entire disk, including the cylinder tables, but excluding the two flaw maps, is checked with multiple data patterns until the button is held down with the switches set to zero. Do not terminate this command by removing ac power or by pressing the start switch. The erase and reset tables front panel function should be run after this function. This test should be run for a minimum of 24 hours to a maximum of 48 hours. **NOTE:** When replacing an HDA assembly, the sequence of functions to be done is 5F, 64 (for 24 hours), and 62. The drive is then ready to be formatted and tested with system diagnostics. Set operating parameters and Write Tables before beginning online operation.

*Switch 7 is the unit ID plug where removal indicates a 1 and the plug inserted indicates a 0.

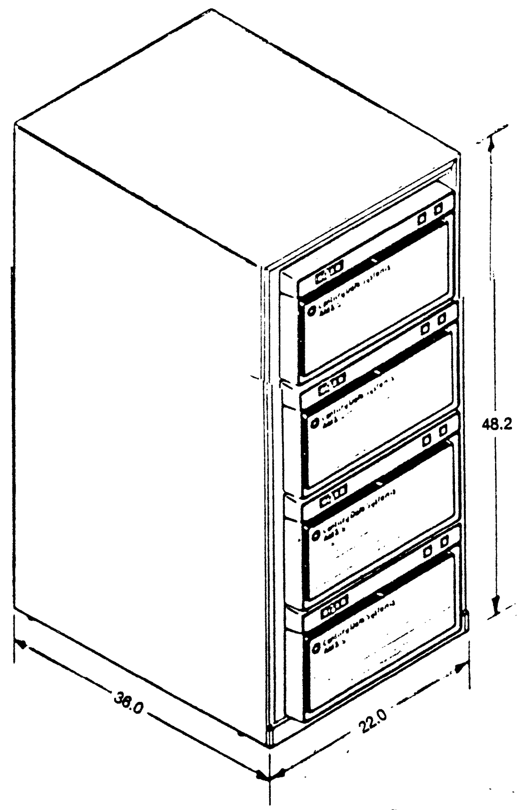
SECTION 6
PHYSICAL CHARACTERISTICS

6.1 PHYSICAL CHARACTERISTICS



Height (with enclosure)	10.5 inches (267mm)
Width	17.8 inches (452mm)
Depth	30.0 inches (762mm)
Weight	138 lbs. (63 kg)
Shipping Weight	158 lbs. (70 kg)

Figure 6-1. AMS Disk Drive with Enclosure Dimensions



4 Units in Cabinet

Height (with enclosure)	48.2 inches (approx.)
Width	22.0 inches (55.9cm)
Depth	36.0 inches (91.4cm)

Figure 6-2. AMS Disk Drives Installed in Four-High Cabinet Dimensions

6.2 ACCESSORIES AND OPTIONS

The AMS Disk Drive includes a basic drive, power supply, desk top enclosure and MASSBUS interface. Accessories and/or options that may be added to this configuration include:

Round or flat connectors, terminators and cables.

Rack and slide mounts.

Four-high cabinets.

Power options of 100V AC, 50/60 Hz; 115V, 50/60 Hz; or 220/240V AC 50 Hz single phase operation.

SECTION 7
POWER REQUIREMENTS

7.1 DRIVE WITH POWER SUPPLY

7.1.1 AC Power

100*/115**V (+10%, −10%), 50/60 Hz (±1.0 Hz)
Running: 4.5 Amps
Starting: 23 Amps

200/220/240*V (+10%, −15%), 50 Hz (+0.5, −1.0 Hz)
Running: 3.4 Amps
Starting: 12 Amps

*Internal jumper must be changed
**115V available only for 60 Hz operation

7.1.2 DC Power

±24V, ±7%
±12V, ±3%
+5V, ±1%

7.2 AC POWER CORD

7.2.1 120V, 15A, 60 Hz

Power cord is 7.5 feet long* and has a NEMA 5-15P plug.

7.2.2 100/220/240V, 50 Hz

Power cord is 7 feet long* and has a NEMA 5-16P plug.

*Units installed in cabinets will contain power cords 15 feet long.

SECTION 8
SYSTEM INTERFACE CABLES

8.1 GENERAL

This section contains the recommended cable requirements for the AMS disk drive to the MASSBUS interface system.

WARNING

This product may not be in compliance with the FCC Class A computing device requirements if operated without the use of properly shielded cables.

8.2 CABLES AND CONNECTORS

The MASSBUS connection to the AMS disk drive can be accomplished using either flat ribbon or round cables. The AMS disk drive should be attached to the MASSBUS so that there is less than 100 feet (30 meters) between it and the MASSBUS controller located within the computer. Allowances should be made for the internal cabling of each drive on the MASSBUS. In the case of the AMS disk drive, this internal length is 2 feet (0.6 meters). If flat ribbon cable is used, be sure that it conforms to the 40 conductor standard with FCC approved shielding and is terminated with H855 type connectors at each end. These cables may be ordered with the disk drive or from other vendors such as Digital Equipment Corporation (part numbers BC06R-06/JX through BC06R-50/JX are different length options of a complete DEC cable). An optional flat-to-round MASSBUS cable transition bracket and round MASSBUS cables may be additionally ordered with the AMS disk drive. These options are useful when the disk drive is mounted within a cabinet that is separated from the computer cabinet. Round MASSBUS cables may also be ordered from Digital Equipment Corporation (BC062 series).

Cables of the required number and lengths to interconnect the disk drive, MASSBUS adapter and controller are frequently fabricated on site to match the physical arrangement of the system. Refer to Table 8-1 for pin number designations.

If the AMS disk drive is not to be mounted within the computer cabinet or one immediately adjacent and attached, then the following applies:

a. The MASSBUS cabling connections (A, B and C flat ribbon cables) may be fabricated to substitute for those shipped with the AMS disk drive. Longer flat ribbon cables may be fabricated with standard connectors. Ensure that the total length of the MASSBUS cables does not exceed 100 feet.

b. If the flat ribbon cables from the AMS disk drive must be laid between separated cabinets, they should be protected from foot traffic and other possible damage. These cables should be run under false floors, or a standard above-floor cable protector should be laid over the flat ribbon cables.

Wherever possible, use round MASSBUS cables between separated cabinets.

8.2.1 Termination

Finally, ensure that the last MASSBUS device in the string is properly terminated. If the last device is a DEC MASSBUS disk, it should have a DEC Terminator Pack Kit (7009938) on the MASSBUS OUT round cable connector. If the last device is a tape drive, it should either have a DEC Terminator Pack Kit (709938) on its MASSBUS OUT round cable connector, or it should have the appropriate terminating resistors on its MASSBUS interface boards. If the AMS disk drive is the last MASSBUS device attached, use the DEC Terminator Pack Kit (7009938) supplied with the original MASSBUS disk subsystem. In all cases, the DEC Terminator Pack Kit (709938) should be installed on the last MASSBUS OUT flat-to-round connector.

Figure 8-1 illustrates the MASSBUS signal line configuration. See Table 8-2 for description of signal lines. Figure 8-4 shows the AMS disk drive internal cabling.

TABLE 8-1. MASSBUS SIGNAL CABLE DESIGNATIONS

Cable	Pin*		Polarity	Designation
MASSBUS Cable A	A	1	−	MASS D00
	B	2	+	
	C	3	+	MASS D01
	D	4	−	
	E	5	−	MASS D02
	F	6	+	
	H	7	+	MASS D03
	J	8	−	
	K	9	−	MASS D04
	L	10	+	
	M	11	+	MASS D05
	N	12	−	
	P	13	−	MASS C00
	R	14	+	
	S	15	+	MASS C01
	T	16	−	
	U	17	−	MASS C02
	V	18	+	
	W	19	+	MASS C03
	X	20	−	
	Y	21	−	MASS C04
	Z	22	+	
	AA	23	+	MASS C05
	BB	24	−	
	CC	25	−	MASS SCLK
	DD	26	+	
	EE	27	+	MASS RS3
	FF	28	−	
	HH	29	+	MASS ATTN
	JJ	30	−	
	KK	31	−	MASS RS4
	LL	32	+	
	MM	33	−	MASS CTOD
	NN	34	+	
	PP	35	+	MASS WCLK
	RR	36	−	
	SS	37	+	MASS RUN
	TT	38	−	
	UU	39		SPARE
	VV	40		BND

*Alternate pin designation schemes

TABLE 8-1. MASSBUS SIGNAL CABLE DESIGNATIONS (Contiued)

Cable	Pin*		Polarity	Designation
MASSBUS Cable B	A	1	−	MASS D06
	B	2	+	
	C	3	+	MASS D07
	D	4	−	
	E	5	−	MASS D08
	F	6	+	
	H	7	+	MASS D09
	J	8	−	
	K	9	−	MASS D10
	L	10	+	
	M	11	+	MASS D11
	N	12	−	
	P	13	−	MASS C06
	R	14	+	
	S	15	+	MASS C07
	T	16	−	
	U	17	−	MASS C08
	V	18	+	
	W	19	+	MASS C09
	X	20	−	
	Y	21	−	MASS C10
	Z	22	+	
	AA	23	+	MASS C11
	BB	24	−	
	CC	25	−	MASS EXC
	DD	26	+	
	EE	27	+	MASS RS0
	FF	28	−	
	HH	29	+	MASS EBL
	JJ	30	−	
	KK	31	−	MASS RS1
	LL	32	+	
	MM	33	−	MASS RS2
	NN	34	+	
	PP	35	+	MASS INIT
	RR	36	−	
	SS	37	+	MASS SPI
	TT	38	−	
	UU	39		SPARE
	VV	40		GND

*Alternate pin designation schemes

TABLE 8-1. MASSBUS SIGNAL CABLE DESIGNATIONS (Continued)

Cable	Pin*		Polarity	Designation
MASSBUS Cable C	A	1	−	MASS D12
	B	2	+	
	C	3	+	MASS D13
	D	4	−	
	E	5	−	MASS D14
	F	6	+	
	H	7	+	MASS D15
	J	8	−	
	K	9	−	MASS D16
	L	10	+	
	M	11	+	MASS D17
	N	12	−	
	P	13	−	MASS DPA
	R	14	+	
	S	15	+	MASS C12
	T	16	−	
	U	17	−	MASS C13
	V	18	+	
	W	19	+	MASS C14
	X	20	−	
	Y	21	−	MASS C15
	Z	22	+	
	AA	23	+	MASS CPA
	BB	24	−	
	CC	25	−	MASS OCC
	DD	26	+	
	EE	27	+	MASS DS0
	FF	28	−	
	HH	29	+	MASS TRA
	JJ	30	−	
	KK	31	−	MASS DS1
	LL	32	+	
	MM	33	−	MASS DS2
	NN	34	+	
	PP	35	+	MASS DEM
	RR	36	−	
	SS	37	+	MASS SP2
	TT	38	−	
	UU	39	H	MASS FAIL
	VV	40		GND

*Alternate pin designation schemes

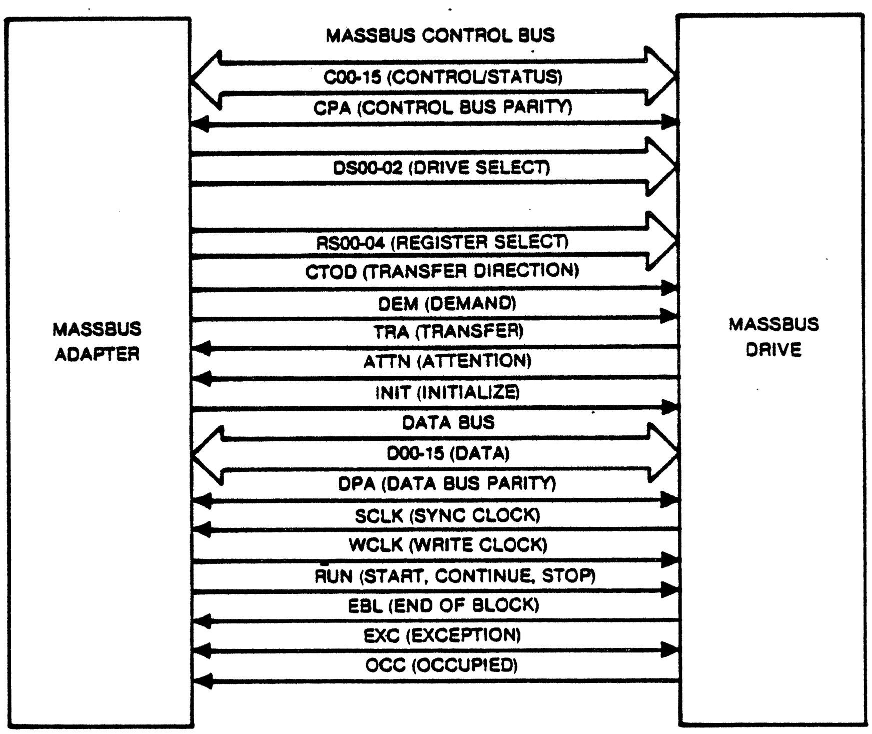


Figure 8-1. MASSBUS Signal Line Configuration

TABLE 8-2. MASSBUS LINE DESCRIPTIONS

SIGNAL LINE	DESCRIPTION
CONTROL BUS	
Control and Status (C00-15)	Transfers 16 parallel control or status bits to or from the drive.
Control Bus Parity (CPA)	Transfers odd control bus parity to or from the drive. Parity is simultaneously transferred with control bus data.
Drive Select (DS0-2)	Transfers a 3-bit binary code from the MBA to select a controller. The drive responds when the (unit) select switch in the controller corresponds to the transmitted binary code.
Register Select (RS0-4)	Transfers a 5-bit binary code from the MBA to select a particular drive register.
Controller to Drive (CTOD)	Indicates in which direction information is to be transferred on the control bus. For a controller-to-drive transfer, the MBA asserts CTOD; for a drive-to-controller transfer, the MBA negates CTOD.
Demand (DEM)	Asserted by the MBA to indicate a transfer is to take place on the control bus. For a controller-to-drive transfer, DEM is asserted by the MBA when data is present. For a drive-to-controller transfer, DEM is asserted by the MBA to request data and is negated when the data has been strobed from the control bus. In both cases, the RS, DS, and CTOD lines are asserted and allowed to settle before assertion of DEM.
Transfer (TRA)	Asserted by the drive in response to DEM. For a controller-to-drive transfer, TRA is asserted when the data is strobed and negated when DEM is removed. For a drive-to-controller transfer, TRA is asserted when the data is asserted on the bus and negated when the negation of DEM is received.
Attention (ATTN)	The drive asserts this line to signal the MBA of any change in drive status or an abnormal condition. ATTN is asserted any time a drive's ATA status bit is set. ATTN is common to all drives and may be asserted by more than one drive at a time.
Initialize (INIT)	Asserted by the MBA to initialize all drives on the bus. This signal is transmitted whenever the MBA receives an initialize command.
Fail (FAIL)	When asserted, this line indicates a power fail condition has occurred in the MBA or the MBA is in maintenance mode.
DATA BUS	
Data (D00-15)	These bidirectional lines transer 16 parallel data bits between the MBA and drives.
Data Bus Parity (DPA)	Transfers an odd parity bit to or from the drive. Parity is simultaneously transferred with bits on the data bus.
Sync Clock (SCLK)	Asserted by the drive during a read operation to indicate when data on the data bus is to be strobed by the MBA. During a write operation SCLK is asserted to the MBA to indicate the rate at which data would be presented by the MBA on the data bus.
Write Clock (WCLK)	Asserted by the MBA to indicate when data written to the drive is to be strobed.
Run (RUN)	Asserted by the MBA to initiate data transfer command execution. During a data transfer, the drive samples RUN at the end of each sector. If RUN is still asserted, the drive continues the transfer into the next sector; if RUN is negated, the drive terminates the transfer.
End-of-Block (EBL)	Asserted by the drive at the end of each sector. For certain error conditions where it is necessary to terminate operations immediately. EBL is asserted prior to the normal time. In this case, the transfer is terminated prior to the end of the sector.
Exception (EXC)	Asserted by the drive or MBA to indicate an error condition during a data transfer command. EXC remains asserted until the trailing edge of the last EBL pulse.
Occupied (OCC)	Indicates acceptance of a valid data transfer command.

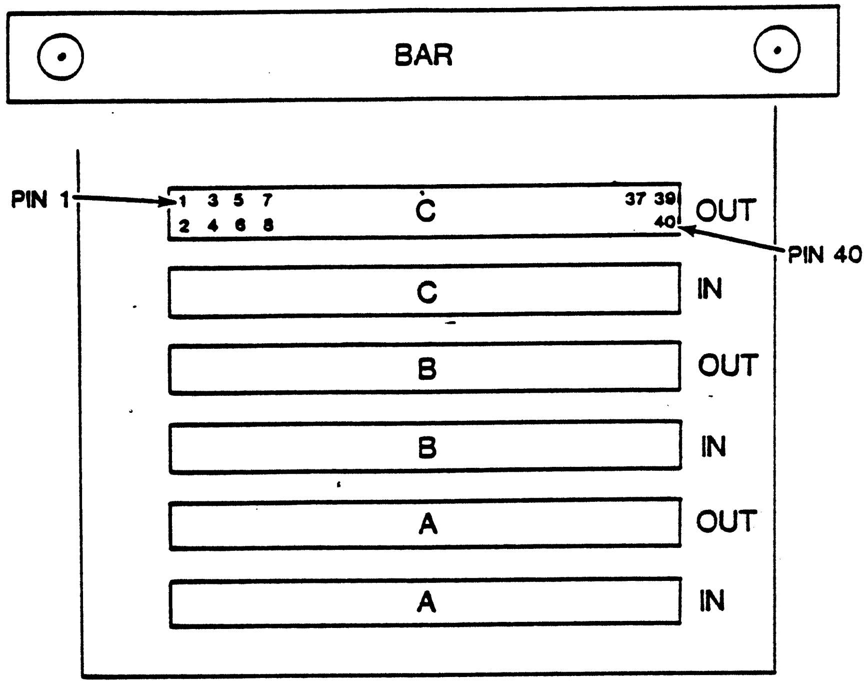
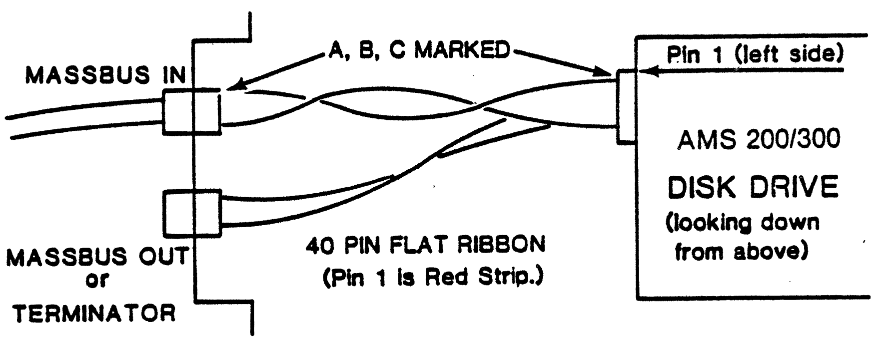


Figure 8-2. AMS Disk Drive MASSBUS Connector (rear of drive)



USING OPTIONAL FLAT RIBBON TERMINATOR

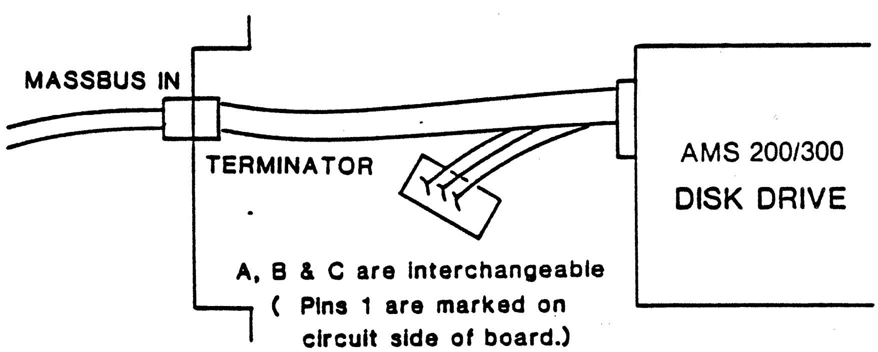
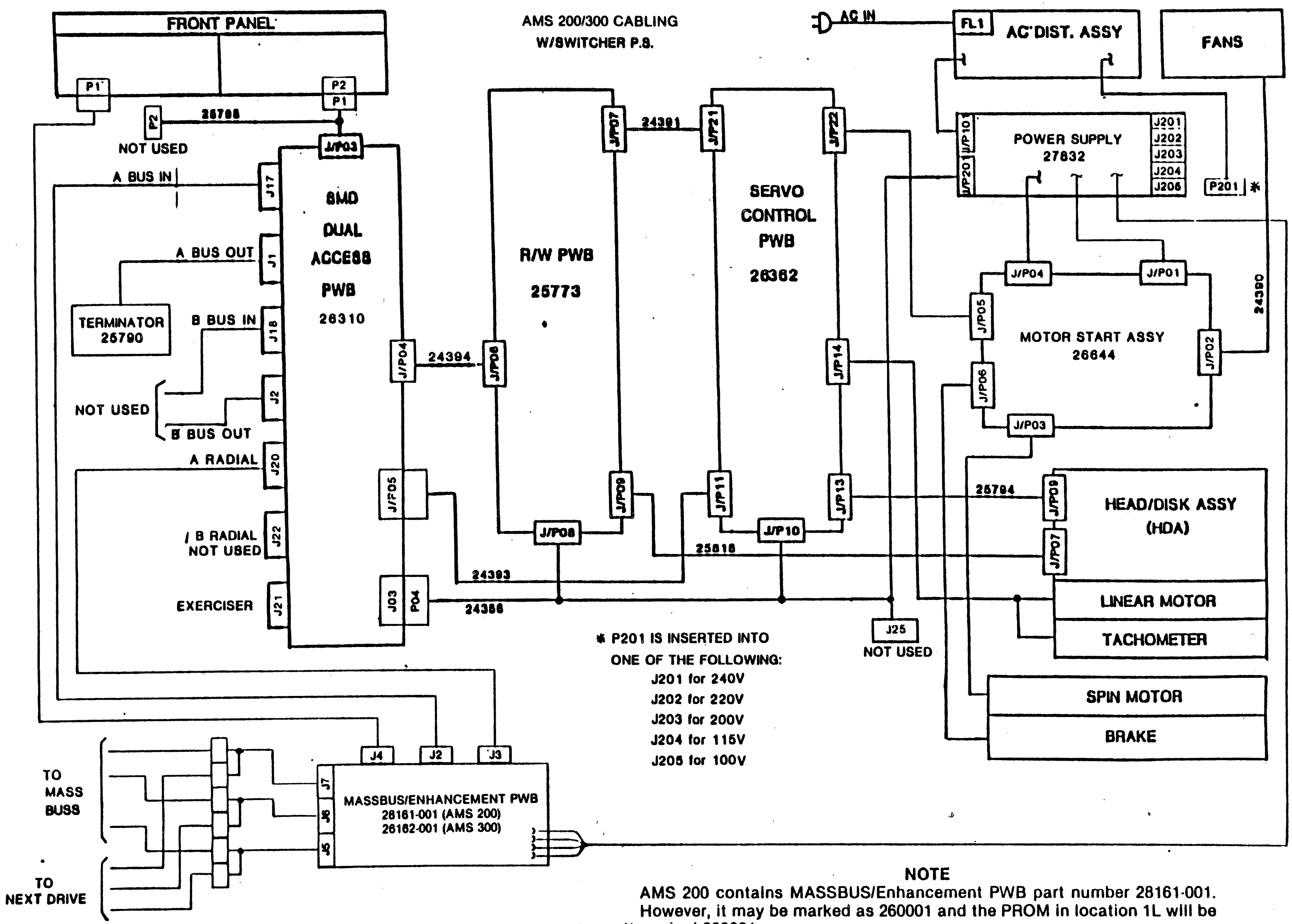


Figure 8-3. MASSBUS to Disk Drive Cabling Diagram



NOTE

AMS 200 contains MASSBUS/Enhancement PWB part number 28161-001. However, it may be marked as 260001 and the PROM in location 1L will be marked 330001.

AMS 300 contains MASSBUS/Enhancement PWB part number 28162-001. However, it may also be marked as 260001 and the PROM in location 1L will be marked 330011.

Figure 8-4. AMS 200/300 Disk Drive Internal Cabling

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