

PRODUCT SPECIFICATION

**MSD MERCURY SERIES 8200X
8-INCH WINCHESTER
SMD DISK DRIVES**

MEMORY SYSTEMS DIVISION
Ann Arbor, Michigan

**MSD MERCURY SERIES 8200X
8-INCH WINCHESTER
SMD DISK DRIVES**

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1.0 SCOPE

This document describes the operational specifications and interfacing requirements for the MSD Mercury 8200 Series high performance, 8-inch Winchester Disk Drive with SMD interface. Within this document the Mercury Disk Drive will often be referred to simply as the drive.

2.0 APPLICABLE DOCUMENTS

2.1 PATENTS

The Mercury Disk Drive servo is covered by U.S. patent number 4,414,589 issued November 8, 1983.

"Embedded Servo Track Following System and Method for Writing Servo Tracks"

2.2 INDUSTRY STANDARDS

a. Underwriters Laboratories (UL)

- 1) UL Standard For Safety 478, Electronic Data Processing Units and Systems.

b. Canadian Standards Association (CSA)

- 1) CSA Standard 22.2 No. 154, Data Processing Equipment.

c. American National Standards Institute (ANSI)

- 1) ANSI Standard X3.91M-1982 Storage Module Interfaces.

d. FCC

- 1) FCC Rules Part 15 Subpart J, RF Emissions from Computing Devices.

e. VDE/TUV

- 1) DIN IEC 380/VDE 0806/8.81

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2.3 TECHNICAL REFERENCES

- a. M8306031 Mercury 8200X Series Product Description
- b. M8307071 Mercury 8200X Series Service Manual
- c. M8311051 Mercury 8200X Series Installation Guide

3.0 GENERAL DESCRIPTION

3.1 EQUIPMENT DEFINITION

The Mercury Disk Drive series is a family of high-capacity, high-performance, high-reliability Winchester 8-inch disk drives featuring the ANSI-standard flat cable SMD interface. These drives contain non-removable disks and Winchester type heads in a sealed module called a Head Disk Assembly (HDA). A rotary actuator, using a high performance closed loop servo, performs head positioning.

Embedded servo technology eliminates the need for a dedicated servo surface and provides position control signals. Embedded servo information is factory written between sectors and the servo circuits use this information to position the head subassembly.

The basic components of a Mercury Disk Drive are the HDA and base assembly. The HDA consists of the following:

- 1) HDA casting and cover;
- 2) air filters;
- 3) spindle assembly with up to seven 200mm diameter disks;
- 4) direct drive dc brushless spindle motor with microprocessor speed control, spindle brake assembly and cooling fan; and
- 5) rotary torque motor actuator with 3370-type flexures, mini-composite heads, read/write preamp IC's, velocity transducer and automatic positioner lock.

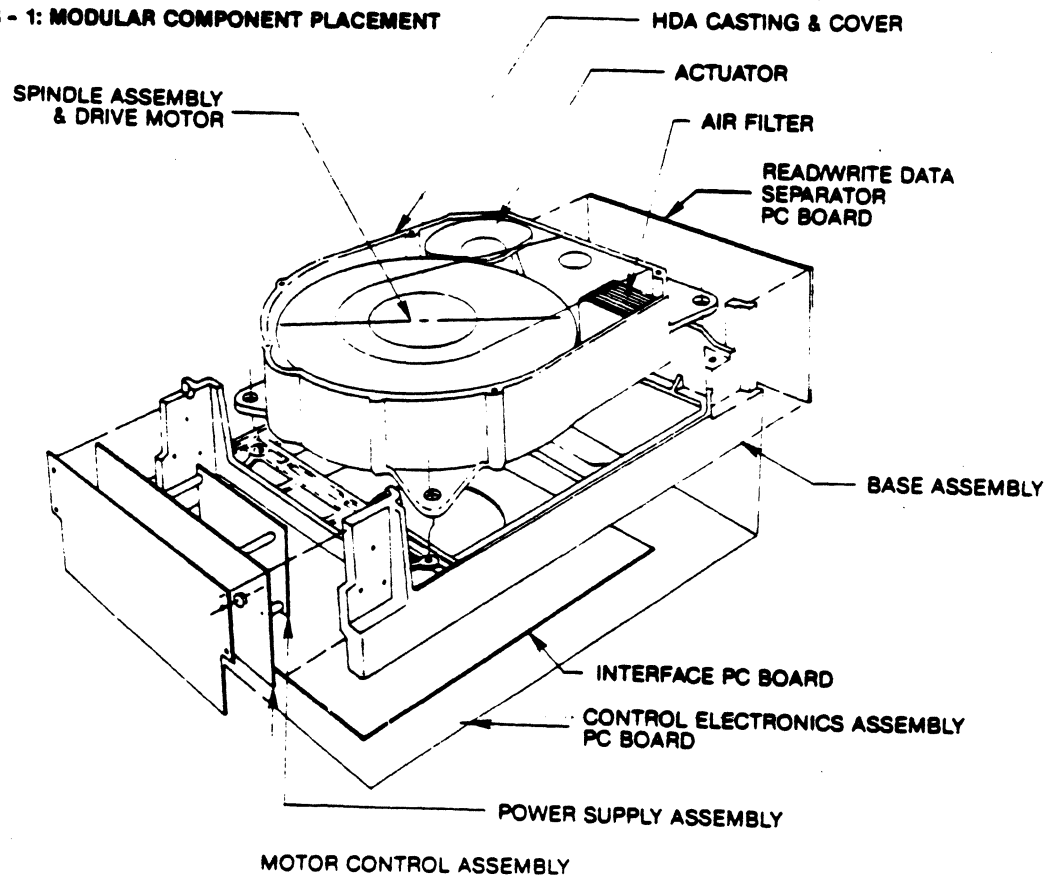
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The base assembly consists of the following:

- 1) base casting;
- 2) Control Electronics Assembly (CEA) PC board;
- 3) read/write-data separator PC board;
- 4) SMD interface PC board;
- 5) motor control/power supply PC board assembly;
and
- 6) internal and external shock mounts.

Several features to enhance system integrity are included. They are phased-locked data separation, NRZ to MFM data conversion, fixed sectoring, self-diagnostics, embedded servo control, double shock mounts, spindle brake, dedicated head landing zone, automatic positioner lock, power monitor that retracts heads to the landing zone upon power loss or RPM variation, and daisy-chain interface capability.

FIGURE 3 - 1: MODULAR COMPONENT PLACEMENT



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3.2 MODELS

The SMD Mercury 8200X Series disk is available in eight different models comprising four capacity options and various sector sizes (sectors per track).

3.2.1 Capacity (MB = Megabytes)

<u>Unformatted Capacity</u>	<u>Model No.</u>
93 MB	8204X
187 MB	8208X
234 MB	8210X
350 MB	8212X

3.2.2 Sector Size (Sectors per track)

The Mercury drive is available in two standard sector size variations. Other sector sizes can be supplied as needed.

	SECTOR SIZES	
	<u>512</u>	<u>256</u>
Sectors Per Track	33	66
Total Unformatted (bytes)	664	332
Customer-Unformatted (bytes)	630	298
Customer Formatted (bytes)	512	256
Overhead Available (bytes)	118	42

3.2.3 Model Numbers

The SMD Mercury 8200 Series order numbers are as follows:

	<u>512 Byte Sector Size</u>	<u>256 Byte Sector Size</u>
93 MB	8204X-33	8204X-66
187 MB	8208X-33	8208X-66
234 MB	8210X-33	8210X-66
350 MB	8212X-33	8212X-66

3.2.4 Drive Type

Drive "Type" indicates a major enhancement to a particular drive model. The drive type is indicated to the right of the model number on the serial number tag.

3.3 SWITCHABLE VARIABLES

The basic Mercury disk drive has several internal variables which are selected via switches located on the CEA Board and the SMD Interface Board. (See figure 3-2) The information in parentheses describes the board upon which the switch block is located, the switch block designation, and the switch number within the switch block. (Example: (SMD, S1, 2)) See M8311051 Mercury 8200X Series Installation Guide for more detailed switch setting procedures.

3.3.1 Write Protection (SMD, IC55, 1)

This switch allows write protection to be enabled (switch "on") or disabled (switch "off"), which inhibits all write operations.

3.3.2 Sector Pulse Location (SMD, IC55, 2)

This switch allows a choice in the location of the sector pulse which is normally used as a reference for writing and reading data. When the switch is "off", the sector pulse occurs 16 bytes before the start of the customer sector (the customer sector excludes the 34 bytes of embedded servo data which is inaccessible to the customer). Under this switch setting, 16 bytes after sector pulse is required in addition to the 11 bytes of PLO sync data.

When the switch is "on", the sector pulse occurs at the start of the customer sector, thus requiring only 11 bytes of PLO sync data after the sector pulse.

3.3.3 Disk Address (SMD, IC55, 3-6)

Disk address 0 through 15 (decimal) can be configured by four switches 3-6. (Switch 3 is least significant bit)

3.3.4 Reserved (SMD, IC55, 7-8)

Switch 7 and 8 are reserved for future use. Some drives do not have a switch 7 and 8, as they employ a 6 switch switchblock.

3.3.5 32 vs 33, 64 vs 66 Sectors (CEA, S1, Single)

This single slide switch allows a 256 byte sectored drive to be configured to have either 64 or 66 sectors, and allows a 512 byte sectored drive to be configured to have either 32 or 33 sectors. Sector pulse is inhibited for the remaining sectors when 32 or 64 sector operation is selected.

3.3.6 Sector Pulse Inhibit (CEA, S2, Single)

This switch allows a choice between enabling or disabling a SECTOR signal simultaneous with the INDEX signal.

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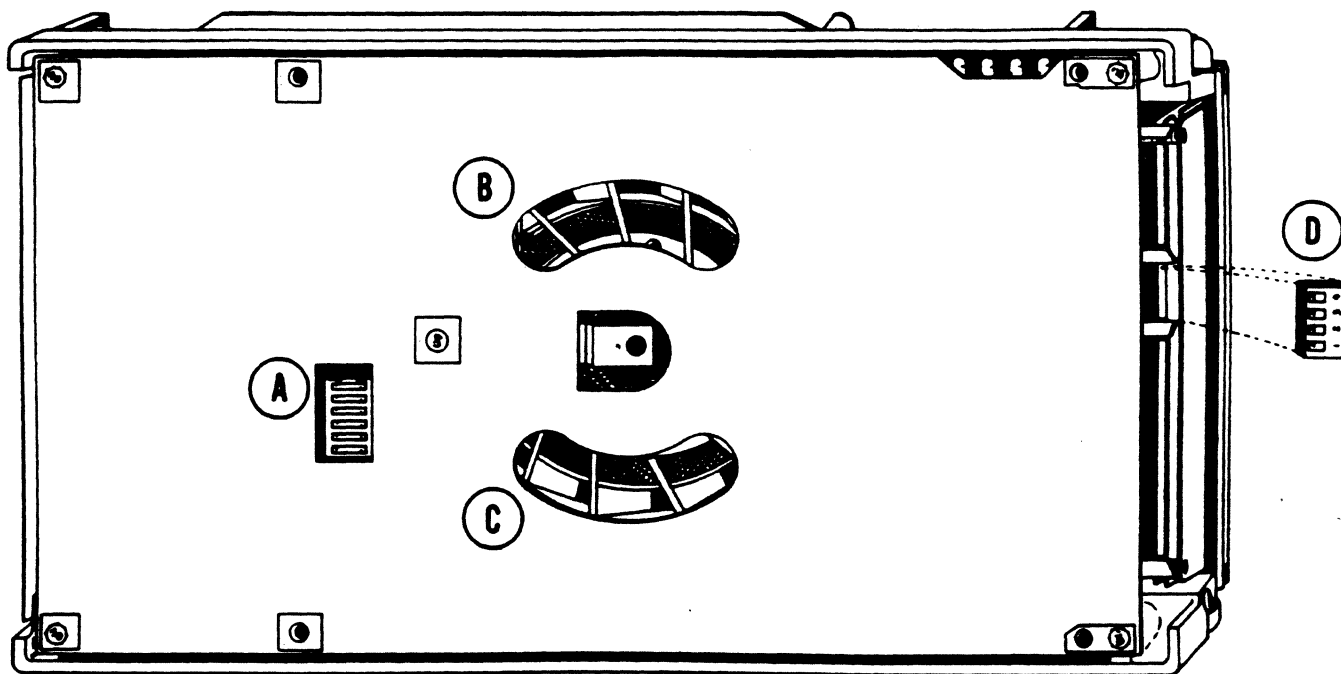
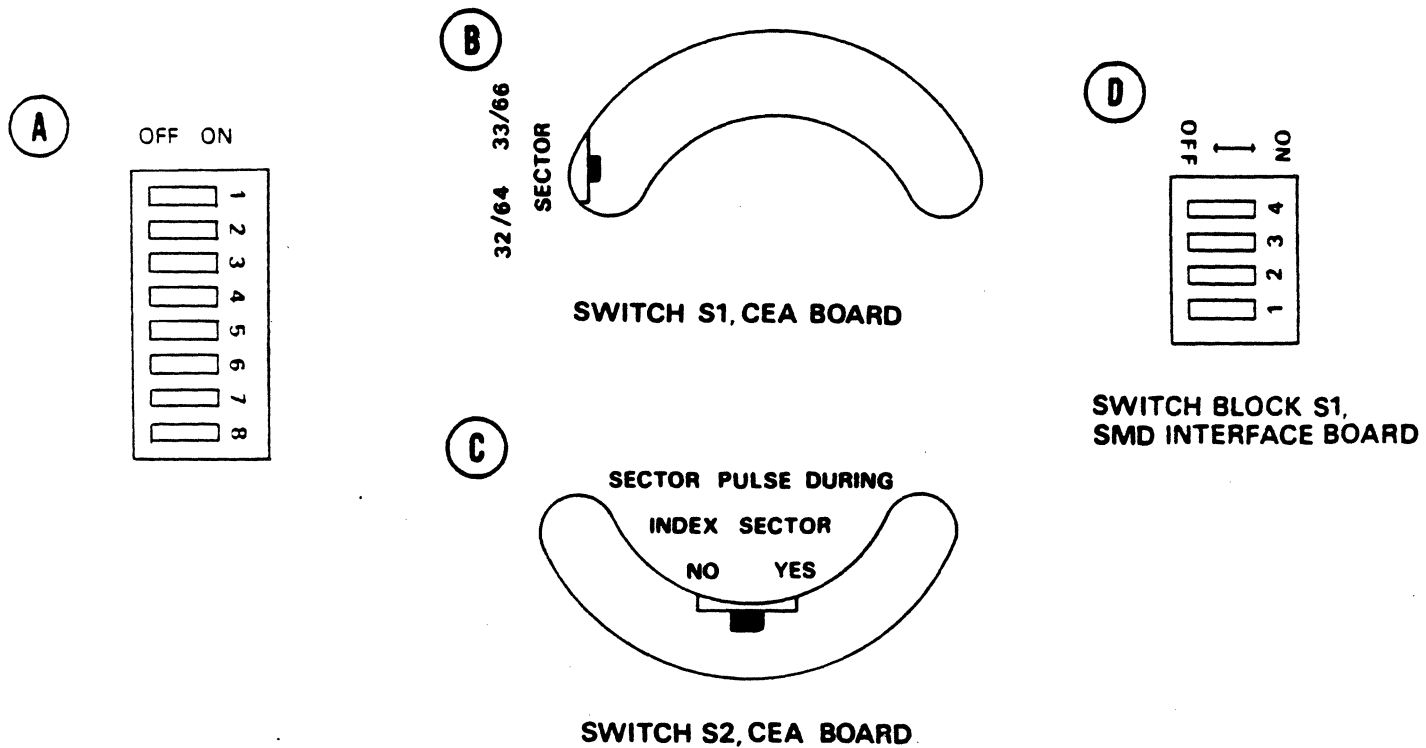


FIGURE 3.2
Mercury Disk Drive User Variable
Switch Locations



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- 3.3.7 Remote vs Local (SMD, S1,1)
When "on" this switch activates the local mode allowing disk power-up without host intervention. When "off" the drive is in remote mode requiring the host to activate "pick" before power-up can occur. Pick must remain active during operation.
- 3.3.8 11th Address Bit Inhibit (SMD, S1,2)
This switch when "on" inhibits the 11th (B10) address bit which prohibits addressing cylinders beyond the 1024th cylinder (cylinder address 1023). IMPORTANT!!!...If the B10 address is not driven, the switch must be "on" for proper drive operation. Having this switch "off" allows addressing beyond the 1024th cylinder.
- 3.3.9 Head Switch Convention (SMD, S1,3)
This switch allows a choice in the commands required for a head switch. With switch "on", a head switch requires a TAG1 (cylinder address) along with a TAG2 (head no.). With switch "off", a head switch requires only a TAG2 (head no.).
- 3.3.10 Servo Clock Option (SMD, S1, 4)
This option is for those controllers which require the multiplexing of servo clock and read clock on the read clock line. This switch when "on", routes servo clock through the read clock line when not reading. When reading, read clock is routed through the read clock line. When "off", read clock is always through the read clock line. Note: if this switch is labeled "N/A" on the rear bulkhead plate, it is non-functional.
- 3.4 ACCESSORIES
- Additional accessories available with the Mercury disk drive include:
- 3.4.1 SMD Terminator (Option No. 8950)
One terminator is required for each drive in a radial configuration. Only the last drive in a "daisy-chained" configuration requires a terminator.
- 3.4.2 Daisychain Backplate (Option No. 8951)
A Daisychain Backplate allows a convenient cable attachment for daisy-chained configuration.

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- 3.4.3 SMD Evaluation Kit Without Power Supply (Option No. 8970)
The evaluation kit contains a standard ten foot cable set (SMD A cable, SMD B cable, power cable and ground cable).
- 3.4.4 SMD Evaluation Kit With Power Supply (Option No. 8971)
Option No. 8971 contains a standard ten foot cable set (SMD A cable, SMD B cable and ground cable) along with a NT/MSD approved external +5V/+24V power supply and cable.
- 3.4.5 Power Supply (Option No. 8972)
Option No. 8972 is a NT/MSD-approved external +5V/+24V power supply and cable.
- 3.4.6 SMD Evaluation Kit (Option No. 8973)
Option No. 8973 provides an SMD Terminator and a set of four evaluation feet.
- 3.4.7 Cables

<u>Description</u>	<u>Part No.</u>	
SMD A (Control) Cable	8980-XX	XX = 10,20,30,
SMD B (Read/Write) Cable	8981-XX	40 or 50 ft
Ground Cable	8982-XX	

See Figure 8-1 for cable configurations and maximum cable lengths.

- 3.4.8 30G Shockmount Snubber Kit (Option No. 8960)
Option No. 8960 allows a disk to tolerate up to 30G of shock while in non-operating mode.

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4.0 STANDARD FEATURES

- * Capacities from 93 to 350 megabytes (unformatted)
- * Average positioning time as low as 19.5 milliseconds.
- * SMD compatible interface
- * Self-diagnostics and on-drive status indicators
- * Only +24 VDC and +5 VDC standard voltage required
- * 8-inch floppy disk sized package
- * Embedded servo control
- * Mini-composite heads
- * Lubricated oxide media
- * Microprocessor controlled
- * Extensive automatic pre-write checks enhance data integrity
- * Head is automatically positioned to the landing zone and locked when low voltage or speed reduction is sensed.
- * Double shock mounts, spindle brake, hollow airflow spindle
- * 3370-type head flexures, dedicated head landing zone, automatic positioner lock
- * No routine maintenance or field adjustments
- * Can be mounted in any plane
- * Direct drive DC brushless spindle motor

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5.0 OPERATIONAL CHARACTERISTICS

The operational characteristics of the SMD Disk Drive are shown in Table 5-1.

TABLE 5-1: OPERATIONAL CHARACTERISTICS

	8204X	8208X	8210X	8212X
Raw Capacity¹ (unformatted)				
Per Drive (MB)	93.6	187.3	234.2	350.2
Per Surface (MB)	23.4	23.4	23.4	29.2
Per Track (Bytes)	21,912	21,912	21,912	21,912
Per Sector (Bytes)				
256 data byte sector	332	332	332	332
512 data byte sector	664	664	664	664
User Capacity - 256 byte data sectors (unformatted)				
Per Drive (MB)	84.1	168.2	210.2	314.3
Per Surface (MB)	21.0	21.0	21.0	26.2
Per Track (Bytes)	19,668	19,668	19,668	19,668
Per Sector (Bytes)	298	298	298	298
User Capacity - 512 byte data sector (unformatted)				
Per Drive (MB)	88.8	177.7	222.2	332.3
Per Surface (MB)	22.2	22.2	22.2	27.7
Per Track (Bytes)	20,790	20,790	20,790	20,790
Per Sector (Bytes)	630	630	630	630
User Capacity - 256 or 512 byte data sectors (formatted)				
Per Drive (MB)	72.2	144.4	180.6	270.0
Per Surface (MB)	18.0	18.0	18.0	22.0
Per Cylinder (Bytes)	67,584	135,168	168,960	202,752
Per Track (Bytes)	16,896	16,896	16,896	16,896
Data Heads ²	4	8	10	12
Disks	3	5	6	7

Note 1: Includes 34 bytes of servo information per sector.

Note 2: Data heads also serve as servo heads for precise head/ track alignment.

TABLE 5-1 (Cont'd)

Sector Size:	8204X-8210X		8204X-8210X		8212X	
	Type 030	Type 030	Type 040	Type 040	256	512
	<u>256</u>	<u>512</u>	<u>256</u>	<u>512</u>	<u>256</u>	<u>512</u>
Sectors per Track	66	33	66	33	66	33
Positioning Time ³						
Average	23	27	19.5	22.5	21	23.0
Track-to-Track	6	8	5.3	5.5	5.5	5.7
Maximum	40	45	32	38	33	39
Average Latency Time	9.05		9.05		9.05	
Track Density (tpi)	1039		1039		1203	
Cylinders	1069		1069		1332	
Start Time (sec)	<12		<12		<14	
Stop Time (sec)	<10		<10		<12	
Transfer Rate (MB/sec)	1.209		1.209		1.209	
Rotational Speed (rpm)	3313.5		3313.5		3313.5	
Recording Density (bpi)	10,238		10,238		10,238	
Encoding Method	MFM		MFM		MFM	

Note 3: All positioning times include settling time and are averaged measurements assuming nominal power and environmental.

5.1 PERFORMANCE SPECIFICATIONS

5.1.1 Positioning Times

Positioning time is the time from receipt of seek and/or head change command by the Mercury Disk Drive until On Cylinder is asserted. Positioning Times are shown in Table 5-1 above.

The maximum positioning time is defined as the time to move the head from track zero to the last track.

The track to track positioning time is the time to move between any pair of adjacent tracks.

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Average positioning time is determined by dividing the sum of the time for all possible movements by the total number of movements.

Embedded Servo data is utilized when switching cylinders and/or heads to maintain precise track following. For seek operations, head switch occurs in parallel and is not incremental to seek time when the new head is selected at least 5 milliseconds prior to the seek completion.

Return to Zero (typical) is 50ms. This is defined as the time required to move the heads to track zero after a RTZ command. In the unlikely event that the drive loses its knowledge of its position on a surface, the maximum time to execute an RTZ is 1.5 seconds.

5.1.2 Data Transfer Rate

The nominal serial data transfer rate is 9.68 megabits per second (1.21 megabytes per second). The range of transfer rate variations on a byte-per second basis for read/write operations is + 1% of nominal. This range includes the effects of all factors including spindle speed variations and dynamic jitter on a byte-to-byte basis. Data on the interface is NRZ while the drive internally converts this information to MFM code for reading and writing.

5.1.3 Data Capacity

The total unformatted data capacity of the model 8212X Mercury Disk Drive is 350.2 Megabytes. The total formatted data capacity is 270.0 Megabytes. This capacity does not include allowances for defective or spare sectors. The total formatted capacity, using the recommended allocation of one spare sector per track, is 265.9 Megabytes per spindle (66 sector) or 261.8 Megabyts per spindle (33 sector).

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5.1.4 Start/Stop Time

The disk start time is less than 12 seconds; the stop time is less than 10 seconds. The 8212X is less than 14 seconds start; less than 12 seconds stop. Start time is the time required to reach 90% of full speed. Stop time is from "shutoff" until spindle stop.

5.1.5 Read Initialization Time

Read Initialization time is defined as the time required to switch from one head to another, stabilize the read circuitry, and establish phase lock loop synchronization subsequent to reading data.

5.1.6 Write-to-Read Recovery Time

Assuming head selection is stabilized, the time lapse before Read Gate can be enabled after switching the Write Gate off is 1.2 microseconds, minimum.

5.1.7 Read-to-Write Recovery Time

Assuming head selection is stabilized, the time lapse from dropping Read Gate to enabling Write Gate is 300ns, minimum.

5.2 FUNCTIONAL SPECIFICATIONS

5.2.1 Spindle Speed and Latency

The spindle speed is 3313.5 +/- 0.2% revolutions per minute (rpm). The average latency time is 9.05 milliseconds.

5.2.2 Recording Density

Data is recorded on the Mercury Disk Drive at 10,238 bpi nominal on the inner track.

5.2.3 Encoding Method

The Mercury Disk Drive uses MFM (modified frequency modulation) encoding method for data recording.

5.2.4 Track Density

The Mercury Disk Drive has 1069 data tracks per surface recorded at 1039 tracks per inch nominal (8204X, 8208X, 8210X). The 8212X has 1332 data tracks per surface recorded at 1203 tracks per inch nominal.

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6.0 RELIABILITY SPECIFICATIONS

The following reliability specifications assume correct host/drive operational interface has been implemented, including all interface timings, power supply voltages, environmental conditions, and appropriate data-handling circuits in the host system.

Error rates

Soft Read Errors (Recoverable within 16 retries)	No more than 1 in 10^{10} bits read
Hard Read Errors (Unrecoverable after 16 retries)	No more than 1 in 10^{13} bits read
Seek Errors	No more than 1 in 10^7 seeks

MTBF Drive Assembly

30,000 Power-On Hours

MTTR

30 minutes

Preventative Maintenance

None required

Service Life

Greater than 5 years

Start/Stop Life

Greater than 10,000

Start/Stops

6.1 ERROR RATES

The error rates stated in paragraph 6.0 assumes the following:

1. That the Mercury Disk Drive is operated per specification.
2. That errors caused by media defects or host system failures are excluded from error rate computations.
3. The drive is operated at nominal voltage settings and ambient temperatures and the system grounding requirements indicated in the installation instructions are met.

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6.1.1 Read Errors

Prior to the determination of measurement of read error rates:

1. The data which is to be used for measurement of read error rates must be verified as being written correctly on the media.
2. All media defect-induced errors must be excluded from error rate calculations.

A Recoverable Read Error is one that can be re-read correctly in 16 or fewer retries.

The recoverable read error rate for any read operation shall be no more than one error in 10^{10} bits read.

An unrecoverable read error is one which cannot be read correctly after 16 retries to read the record.

The unrecoverable read error rate shall be no more than one bit in 10^{13} bits read.

6.1.2 Write Errors

Write errors can occur as a result of the following: write data not being presented correctly, media defects, environmental interference, or equipment malfunction. As such, write errors are not predictable as a function of the number of bits passed.

If an unrecoverable write occurs because of a Mercury Disk Drive equipment malfunction, the error is classified as a failure affecting MTBF. Unrecoverable write errors are those which cannot be corrected within three attempts at writing the sector with a write verify after each attempt.

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6.1.3 Media Defects

A media defect is a physical characteristic of the media which results in a repetitive read error that occurs on a properly adjusted drive within specified operating conditions.

Valid data must not be written over known uncorrectable media defects. Therefore, sector/track relocation techniques must be utilized.

6.1.3.1 Allowable Media Defects

Media defects are characterized as being either correctable or uncorrectable as a function of the type and magnitude of the media flaw. An error burst of 11 bits or less is a correctable error. An uncorrectable error is one greater than 11 bits in length. A sector is defective if it contains a media defect. In the Mercury Disk Drive, media certification is performed using the following standards:

- 1) Only one defective sector per track may occur for 33 sector drives. Only two defective sectors per track may occur for 66 sector drives. Otherwise the track is classified as defective. No track shall have more than three defective sectors.
- 2) No surface shall have more than 2 defective tracks.
- 3) The maximum number of defective sectors per drive are:

<u>Model</u>	<u>Maximum Uncorrectable</u>	<u>Maximum Total (Corr. & Uncorr.)</u>
8204X (93MB):	50	100
8208X (187MB):	100	200
8210X (234MB):	125	250
8212X (350MB):	140	280

- 4) Media defect-free areas are defined as cylinder 0, head 0 through head 2.

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Various error correction codes may be implemented to correct errors in the data read from the disk. However, the code chosen should be consistent with Memory Systems Division's certification methods.

6.1.4 Media Defect Logging Information

All drives will have a Media Defect printout attached to each drive which will list the following information.

- 1) Cylinder Address
- 2) Head Address
- 3) Sector Address
- 4) Length (bits \pm 1 bit)
- 5) Error Type (correctable/uncorrectable)

6.1.5 Media Defect Format

The Mercury 8200 Series Disk Drive will be formatted at the factory with the Media Defect Map written in the data fields of all sectors of cylinder 0, 822, and 1068 (1331 for 8212X), heads 0 and 1. These tracks are formatted with the standard format (described in Figure 8.12). This identifies defective sectors for use as part of a system initialization and/or track or sector reallocation routine without recertification. **IMPORTANT!...** If the user wishes to use this information, it is imperative not to write on this area of the disk until such time that that it can be recovered. The map can handle up to 320 defects.

The map is divided into eight 256 byte segments, each of which contains up to 40 defect addresses. The eight segments are written in the data fields of sectors 0 through 7 of the track and are repeated in sectors 8 through 15, 16 through 23, and so on through all of the sectors on the track.

The maps are written in the data fields of the sectors in the format shown in Table 6-1. The ACSII characters are upper-case, no parity characters. Two byte quantities are expressed upper byte first. The check sum is two's complement.

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TABLE 6-1: MEDIA DEFECT MAP FORMAT

Bytes	Value	Comment
0-6	ASCII (MFD82nn)*	The model number in ASCII
7-8	1069 or 1332*	Number of cylinders
9	4-12*	Number of heads
10	33 or 66*	Sectors per track
11-12	256 or 512*	Bytes per standard sector
13	00*	Reserved
14	0-40	Count of defects in this segment of the map
15-254	cccchhssl1tt	Defect address cccc = cylinder (hex) hh = head (hex) ss = sector (hex) ll = length of defect in bits (hex) tt = error type 00 = correctable 01 = uncorrectable
255	xx	Check sum

* = The data shown above for bytes 0-13 is necessary only once, so it is required only in the first of the eight 256 byte segments.

Note: Bytes 256-511 are zero for 512 byte standard sector.

6.1.6 Seek Errors

For measuring the seek error rate, a seek error is defined as a condition where the Mercury Disk Drive fails to position the heads correctly and assumes a correct cylinder and head address. There shall be no more than one recoverable seek error in 10⁷ physical seek operations. Unrecoverable seek errors are classified as failures for MTBF calculations.

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6.1.7 Data Security

The Mercury drive routinely performs protection functions in startup and performance mode to ensure data integrity. They include:

Power Monitor

- Low power detection
- Monitors for open/missing cable
- Power failures will initiate powerdown and head/media protective sequencing.

Spindle Motor Control

- Out of speed detection.
- Stall detection
- Monitors for open/missing cables
- excessive duty cycle warning and detection

Speed failures will be reported to the control processor and initiate powerdown and head/media protection sequencing.

SMD-Interface Protection

- monitors for open/missing cables
- write protection switch
- not "on track" disables write
- illegal write command.

Control Processor

- performs ROM, RAM, check
- processor watchdog timer
- verifies proper head and cylinder selection
- monitors clock generator for lock
- controls "write enable"
- detects position error, off track

Position Servo

- monitors missing cable interlock on velocity transducer
- power fault or motor fault will initiate head/media protection sequence.
- Monitors "on-track"

Read/Write Card

- Power monitor okay
- Write enable asserted
- Write data transitions present
- Write unsafe (open head, shorted head, multiple heads selected, or no write current)
- Write current limited to protect heads

Any single failure will disable writing to ensure data protection.

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6.2 RELIABILITY AND SERVICE

The Mercury Disk Drive has been designed and constructed to the highest standards. The drive, however, must depend upon its host equipment to provide adequate power and environment in order to achieve optimum performance and compliance with applicable industry and governmental regulations. Special attention must be given in the areas of safety, power distribution, grounding, shielding, audible noise control, and temperature regulation of the device to ensure specified performance and compliance with all applicable regulations.

When evaluating systems operation under conditions of EMI the performance of the Mercury Disk Drive within the system shall be considered acceptable if the device does not generate an unrecoverable condition. An unrecoverable error, or condition, is defined as one which:

1. Is not detected and corrected by the device itself;
2. Or is not capable of being detected from the error or fault status provided through the host interface.
3. Or is not capable of being recovered by normal device or system recovery procedures without requiring operator intervention.

6.2.1 Mean Time Between Failure

The Mean Time Between Failure (MTBF) shall exceed 30,000 power on hours for the Mercury Disk Drive. The MTBF is defined as:

Operating Hours

$$\text{MTBF} = \frac{\text{Number of Equipment Hours}}{\text{Number of Equipment Failures}}$$

Equipment failures means any stoppage or substandard performance of the equipment because of equipment malfunction, excluding stoppages or substandard performance caused by operator error, cable failure, adverse environment, power failure, or other failure not caused by the equipment.

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- 6.2.2 Mean Time to Repair
The Mean Time to Repair (MTTR) is 30 minutes. MTTR is defined as the time for a properly trained and competent serviceman to diagnose and correct a malfunction.
- 6.2.3 Preventive Maintenance
No scheduled maintenance is required.
- 6.2.4 Service Life
The Mercury Disk Drive shall have a minimum useful life of five years before factory overhaul or replacement is required. Depot repair or replacement of major parts will be permitted during the lifetime of the drive.
- 6.2.5 Installation
Required connections to the Mercury Disk Drive are power, signal cables, and a system ground consistent with normal peripheral equipment grounding practices. The physical requirements are adequate clearance for service, drive movement during shock, and air intake/exhaust. Refer to the 8200X Installation Guide before installing any equipment.
- 6.2.6 Service Tools
No special tools are required for either installation or maintenance of the Mercury Disk Drive.
- 6.2.7 Product Safety
In addition to applicable NTI corporation standards and MSD division standards, the Mercury Disk Drive shall comply with the requirements of UL 478, CSA Standard C22.2 NO. 154-1975, VDE 0806 and FCC rules part 15 subpart J.
- 6.2.8 Automatic Self Test Capability
Two types of self testing are performed: complete testing at power up and background testing. The results of the self test are displayed on four Status LED's mounted on the CEA card (see TABLE 6-2).
- 6.2.8.1 Power-Up Self Test
At power-up the following self tests are performed:

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6.2.8.1.1 ROM Check

A complete ROM check is performed. If the test should fail the error status is displayed on the LED's, drive fault is set, and the drive motor is powered down.

6.2.8.1.2 RAM Check

A complete RAM check is performed. If the test should fail the error status is displayed on the LED's, drive fault is set, and the drive motor is powered down.

6.2.8.1.3 Clock Generator Check

Every surface is checked to insure that clock generator sync can be maintained. If not, the surface is logged as being bad. Drive fault is set if surface zero is logged as being bad, a fault status signal is returned to the host and the drive is powered down. Any other surface logged as bad will return a seek error to the host once the surface is selected (to allow data recovery).

6.2.8.1.4 Drive Motor Control Check

The drive motor is checked for correct speed. If the speed is incorrect, the error status is displayed on the LED's, drive fault is set and the drive motor is powered down.

6.2.8.1.5 Command Port Check

The command ports are checked to make sure that they can be cleared so that no command is hung in the set state. If the ports cannot be cleared, drive fault is set and the processor continuously attempts to clear the ports.

6.2.8.2 Background Self Test

After power-up the following tests are performed:

6.2.8.2.1 ROM Background Check

A ROM check is continuously performed as a background task while monitoring for commands. If the test should fail the error status is displayed on the LED's, drive fault is set, and the drive motor is powered down.

MEMORY SYSTEMS DIVISION

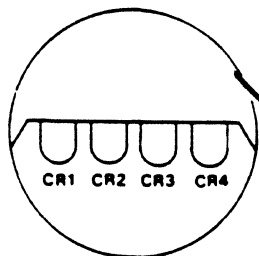
- 6.2.8.2.2 RAM Background Check
A RAM check is continuously performed when servo interrupts are serviced (which occur once per sector). If the test should fail the error status is displayed on the LED's, drive fault is set, and the drive motor is powered down.
- 6.2.8.2.3 Clock Generator Background Check
The clock generator is monitored with every servo interrupt. If the clock generator sync should be lost the processor attempts to re-sync the clock generator. If unable to re-sync, the surface is logged as bad, the error status is displayed on the LED's, and drive fault is set. The drive will attempt to lock to surface zero and if unsuccessful will power down.
- 6.2.8.2.4 Drive Motor Control Background Check
The correct speed for the drive motor is continuously monitored. If the speed should fall out of tolerance the heads will be automatically homed, the SMD processor is re-initialized, error status is displayed on the LED's, drive fault is set, and the drive motor is powered down.

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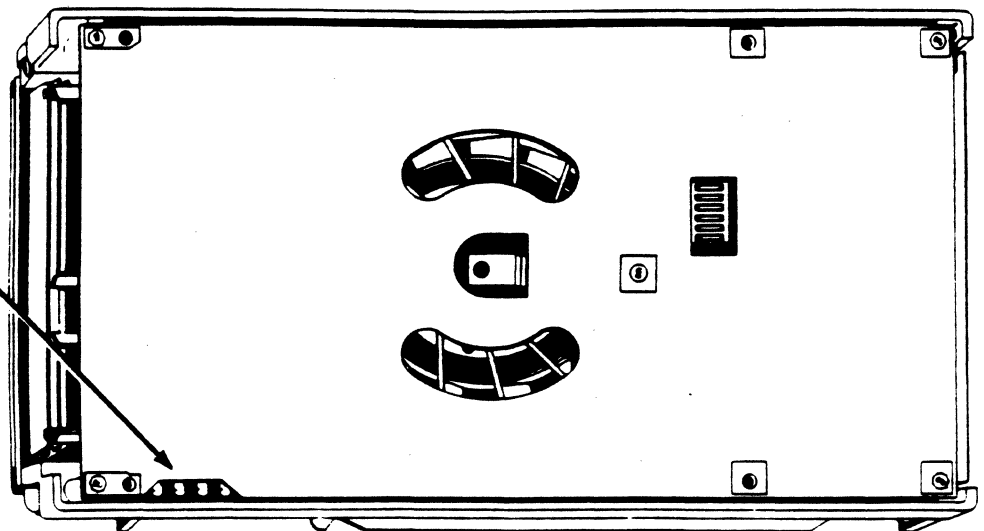
TABLE 6-2: STATUS LED DISPLAY

STATUS LED				HEX CODE	ERROR CONDITIONS	
CR4	CR3	CR2	CR1		STATUS	ERROR DESCRIPTION
0	0	0	0	0	NORMAL OPERATION	NORMAL OPERATION
0	0	0	L	1	ROM ERROR	CHECK SUM ERROR
0	0	L	0	2	RAM ERROR	RAM DATA FAULT
0	0	L	L	3	POWER ERROR	POWER MONITOR FAULT
0	L	0	0	4	READ CHANNEL ERROR	UNABLE TO READ DATA FROM THE DISK
0	L	0	L	5	MOTOR CONTROL/ ERROR CABLE	TACH. PULSES ARE NOT OCCURRING
0	L	L	0	6	MOTOR/MOTOR CONTROL ERROR	CANNOT CONTROL SPINDLE SPEED
0	L	L	L	7	CLOCK GENERATOR ERROR	HEADER INTERRUPTS ARE NOT OCCURRING
L	0	0	0	8	HEAD SURFACE ERROR	BAD HEAD OR DISK SURFACE
L	0	0	L	9	TRACK INDEX ERROR	UNABLE TO FIND INDEX ON A TRACK, OR HOLD INDEX ON A TRACK
L	0	L	0	A	SURFACE INDEX ERROR	UNABLE TO FIND INDEX ON AN ENTIRE SURFACE DURING INITIALIZ.
L	0	L	L	B	COMMAND PORT ERROR	UNABLE TO CLEAR RTZ AND SEEK COMMANDS FROM HOST
L	L	0	0	C	HEAD STALL	UNABLE TO MOVE HEADS WHILE PERFORMING A SEEK
L	L	0	L	D	POSITION SERVO ERROR	HEAD DRIFT OFF CYLINDER
L	L	L	0	E	WRITE UNSAFE ERROR	HEAD OPEN, HEAD SHORTED, NO DATA TRANSITIONS
L	L	L	L	F	PROCESSOR ERROR	PROCESSOR UNABLE TO EXECUTE INSTRUCTIONS

L = LED is lit



DIAGNOSTIC STATUS
LEDs



MEMORY SYSTEMS DIVISION

7.0 PHYSICAL/ELECTRICAL SPECIFICATIONS

7.1 POWER REQUIREMENTS

a. Current

+24VDC

+5VDC

Maximum Requirements

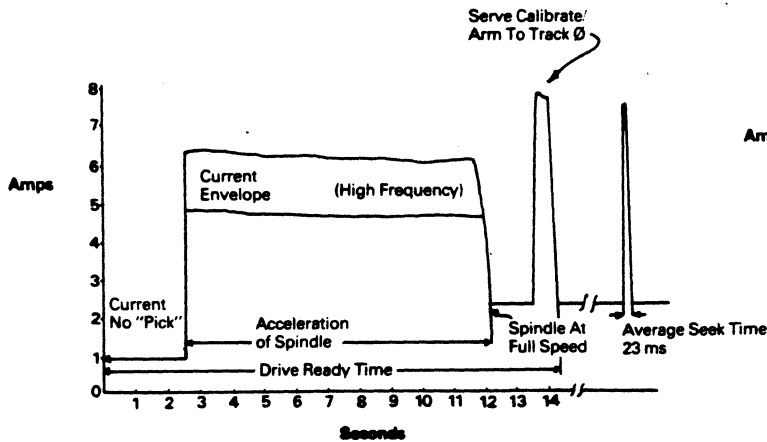
2.3 A (average idle)

6.5 A (typical while seeking)

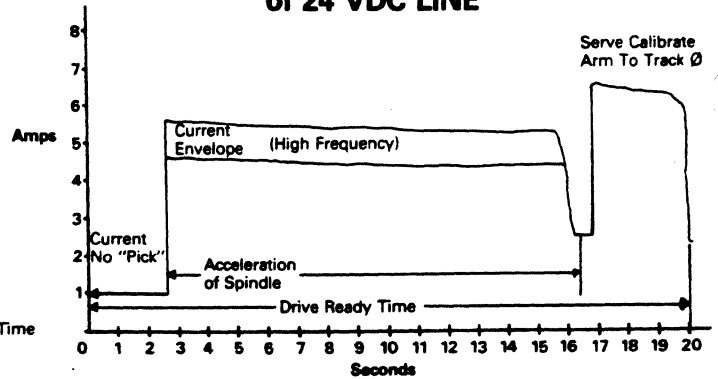
6.8 A (7.8A for 8208X, 8210X
Type 030)

3.5 A (peak)

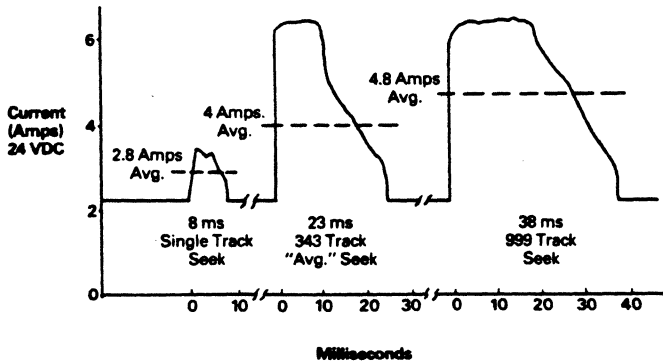
**CURRENT PROFILE
of 24 VDC LINE**



**CURRENT PROFILE
of 24 VDC LINE**

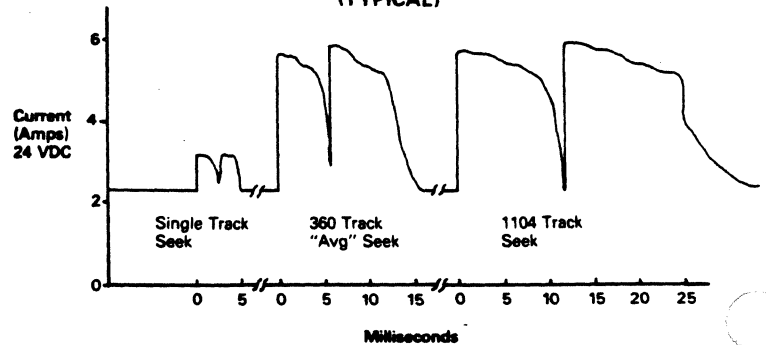


**24 VOLT SEEK CURRENT
WAVEFORMS**



8204X - 8210X (Type 030)

**24 VOLT SEEK CURRENT
WAVEFORMS
(TYPICAL)**



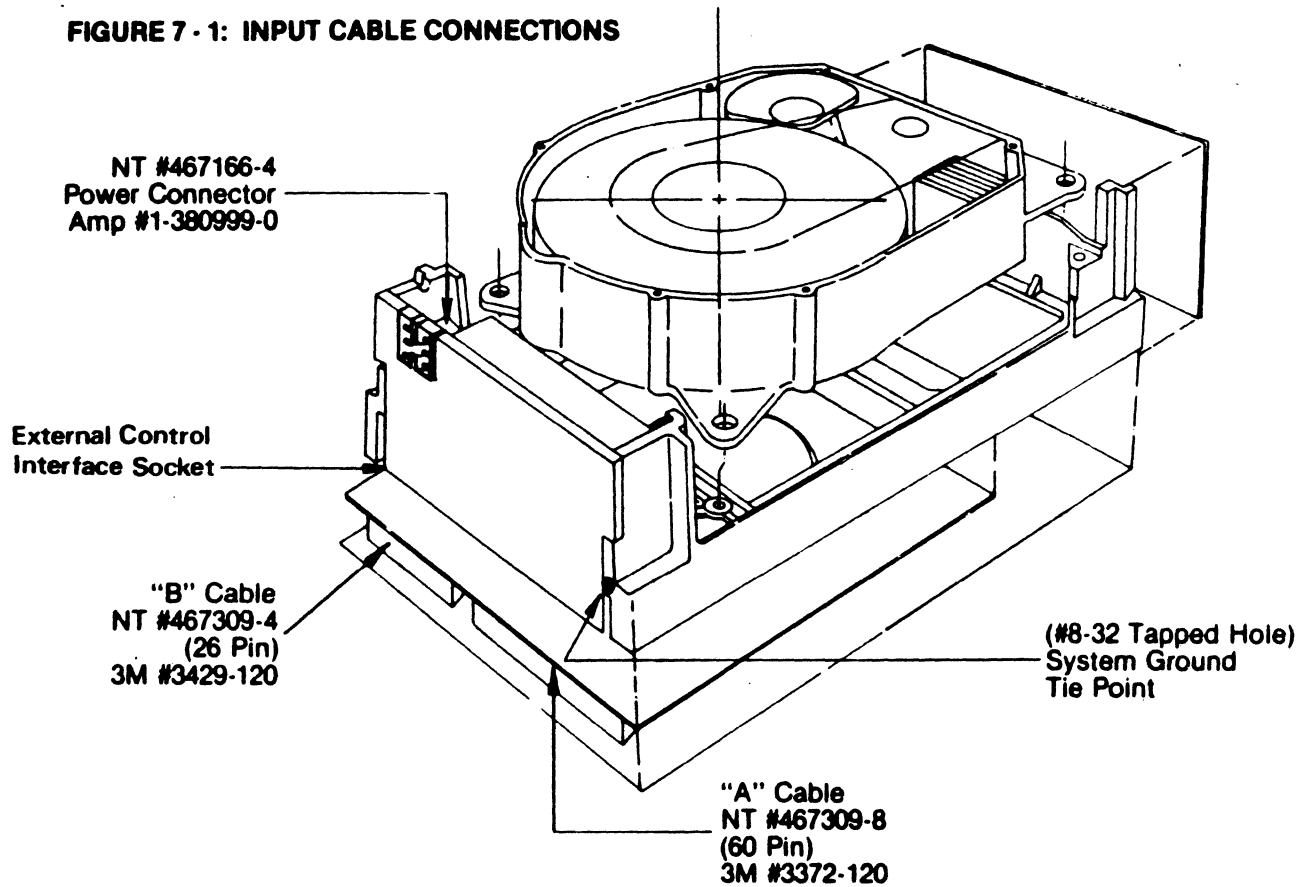
8212X (all)
8204X - 8210X (Type 040)

MEMORY SYSTEMS DIVISION

7.1.1 DC Power Connector

INPUT CABLE CONNECTIONS

FIGURE 7 - 1: INPUT CABLE CONNECTIONS



MEMORY SYSTEMS DIVISION

- 7.1.2 **Recommended Power Supply Capability**
 It is suggested that a user-supplied power source have the characteristics listed in Table 7-2.

TABLE 7.2
Recommended Power Supply Capability

VOLTAGE (V dc)	REGULATION	MAX RIPPLE P/P	MAX Current
+5	$\pm 5\%$	50 mV	3.5 A (peak)
+24	$\pm 10\%$	240 mV	7.0 A* (peak)

DC Pin Assignments

<u>Pin</u>	<u>Signal</u>
1	+24 vdc
3	+24 ground
5	+5 vdc
4	+5 ground
2, 6	Not Used

NOTES:

1. Power supply should have no transients beyond regulation limits for a 3 amp to 8 amp swing at 50% duty cycle, 40 msec repeat rate on the 24 volt line.
2. Suggestions:
 - a. Use independent ground returns and independent feeds.
 - b. Use 14 gauge stranded wire, maximum 6 foot length.
 - c. Adjust power supply for nominal voltage at the input connector while drive is running.

*8.0 A for Type 020/030 8208X, 8210X drives.

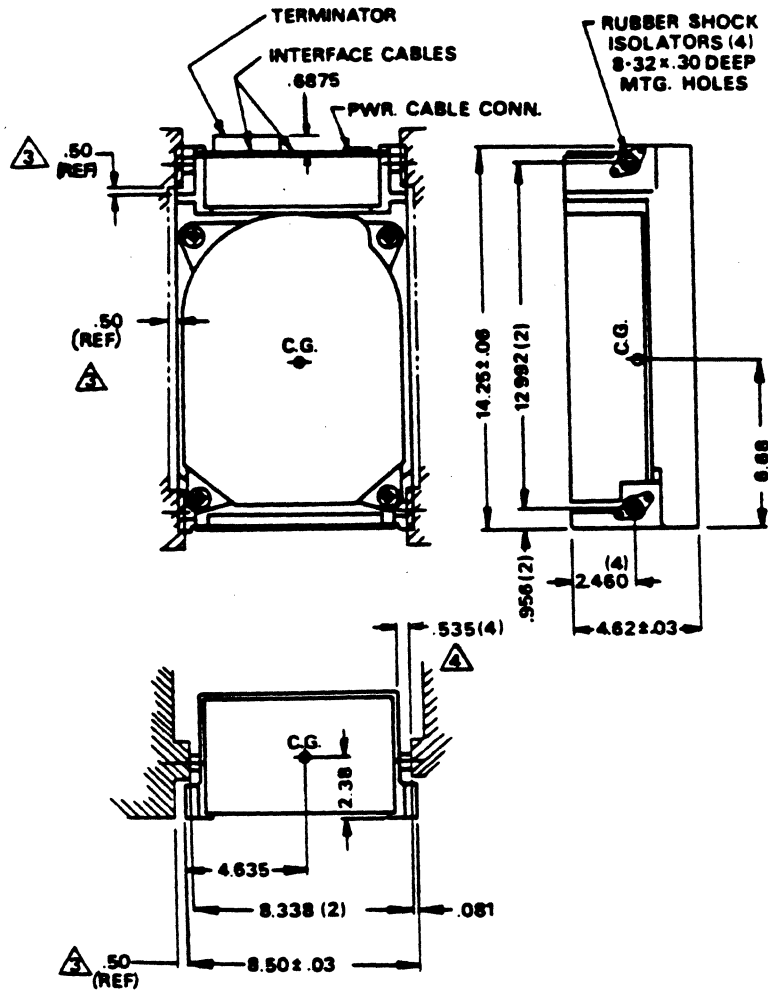
MEMORY SYSTEMS DIVISION

7.2 MECHANICAL SPECIFICATIONS

Refer to Figure 7-2 for overall dimensions of the Mercury Disk Drive and detailed mounting dimensions.

The Mercury Disk Drive weight is 22 pounds max.

FIGURE 7-2: MOUNTING DIMENSIONS



MEMORY SYSTEMS DIVISION

7.3 ENVIRONMENTAL CHARACTERISTICS

The Mercury Disk Drive is designed to operate in an office environment with minimal environmental control. Temperature and humidity specification preclude condensation on any drive parts.

7.3.1 Temperature (ambient air)**1. Operating**

41 to 113 degrees F (5 to 45 degrees C) with a maximum gradient of 18 degrees F (10 degrees C) per hour.

2. Non-Operating

-40 to 140 degrees F (-40 to 60 degrees C) with a maximum gradient of 36 degrees F (20 degrees C) per hour.

3. Packaged (90 days max)

-40 to +140 degrees F (-40 to 60 degrees C) with a maximum gradient of 36 degrees F (20 degrees C) per hour. This specification assumes that the drive is packaged in the shipping container designed for use with the Mercury Disk Drive.

7.3.2 Cooling

The Mercury Disk Drive dissipates 67 watts of power (typical) at idle (running without head movement) with up to an additional 60 watts (typical) dissipated during seeking. The internal cooling fan provides adequate airflow to cool the electronic cards. Sufficient airflow (30 CFM minimum) should be provided to keep the temperature of the HDA (measured at the center point of the HDA cover) at or below 55°C.

7.3.3 Relative Humidity (non-condensing)**1. Operating**

20% to 80% relative humidity with a maximum gradient of 20% per hour.

MEMORY SYSTEMS DIVISION

2. Non-operating

5 to 95% relative humidity.

3. Packaged (packaged in the shipping container designed for use with the Mercury Disk Drive for 90 days maximum.)

5% to 95% relative humidity.

7.3.4 Altitude (Actual or Effective)

1. Operating

-1000 to 10,000 feet, sea level reference.

2. Non-operating

-1000 to 40,000 feet, sea level reference.

The Mercury Disk Drive, in its shipping container, can be shipped via commercial airlines.

7.3.5 Vibration and Shock

The Mercury Disk Drive is designed to withstand the following shock and vibration conditions without damage to its function or physical structure:

	<u>Shock</u>	<u>Vibration</u>
1. Operating (all three axes)	2g (10ms max duration, less than 2 per second)	.2g (5-200Hz) (no more than 3 minutes at any resonant frequency)
2. Non-Operating (all three axes)	5g (30g with Option 8960, Snubber Kit) (10ms max duration, less than 12 per minute)	.5g (5-200Hz) (no more than 3 minutes at any resonant frequency)
3. Packaged for Shipment	36 inch drop (on concrete or equiv, all surfaces, 3 edges, 1 corner)	2g (5-50Hz) (no more than 3 minutes at any resonant frequency)

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- Notes:
- a. Operating and non-operating modes mandate mounting on external shockmounts (provided).
 - b. Shock and vibration measured at external shockmounts for Operating and Non-operating specification; at shipping box for Packaged for Shipment specifications.
 - c. CAUTION: Cabinet-induced resonances can result in greatly magnified forces input to the disk drive. Customer testing should be conducted to minimize this condition.

7.3.6 Acoustic Noise

The Mercury drive will emit no more than 60dBA sound power.

MEMORY SYSTEMS DIVISION

8.0 SMD INTERFACE

8.1 SMD INTERFACE DEFINITION

The Mercury Disk Drive has a Storage Module Device (SMD) interface. This interface conforms to the mechanical, electrical, and functional requirements for the storage module class of interface between disk drives and their respective control units via flatribbon cable as defined in ANSI X3.91M-1982, storage module interfaces.

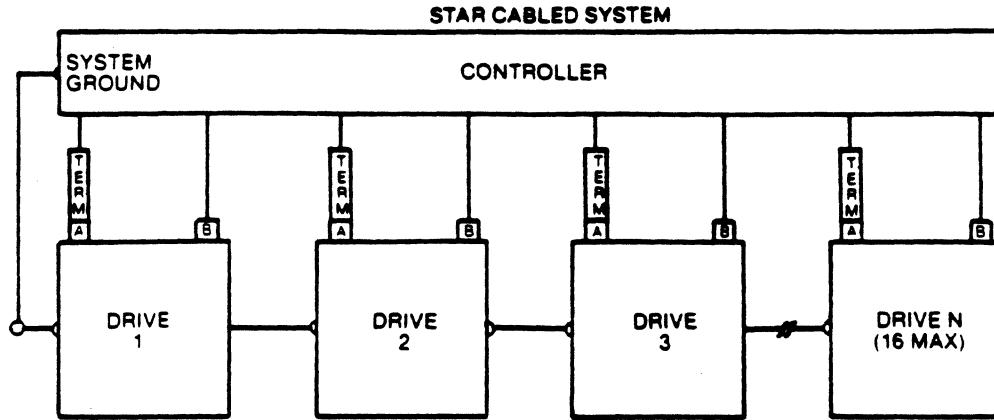
The disk drives are connected to a control unit by means of a Control cable ("A" cable), Read/Write cable ("B" cable), and dc ground cable. The "B" cable connects each drive directly, radial configuration, to the control unit. Fifteen meters is the maximum length of any "B" cable. The "A" cable can connect each drive directly, radial configuration, to the control unit or via other drives in a daisy-chain configuration. The cumulative length of the "A" cables on a given string shall not exceed 30 meters and an "A" cable line terminator must be installed on the last drive of the string. Refer to Figure 8-1. The connector location is shown in Figure 7-1.

All input and output signals are digital, utilizing industry standard transmitters and receivers. (75107 line receivers and 75110 line driver) When used with properly shielded cables, this provides a terminated, balanced transmission system for long distances and/or noisy electrical environments.

The "A" cable is a 60 pin flat cable and the "B" cable is a 26 pin flat shielded cable. Shielding is recommended to minimize cross-talk and reduce inductive coupling due to static discharges, as well as control impedance variations regardless of cable lay.

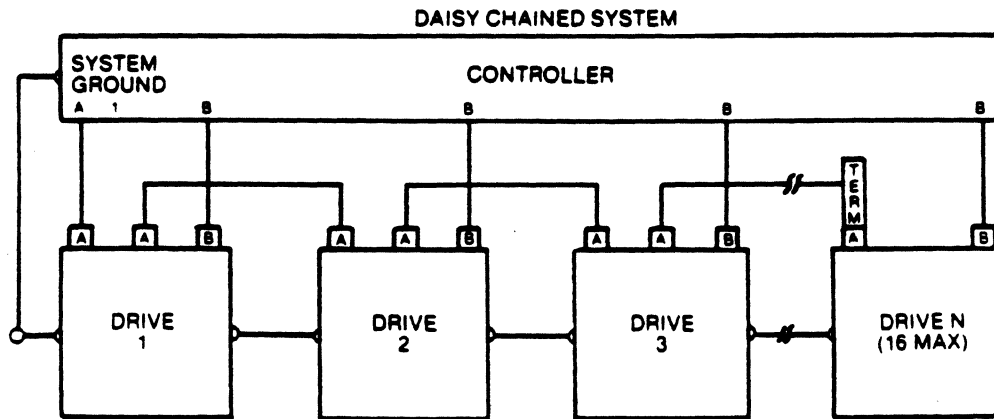
See Section 8.5 for more detail on interface termination.

MEMORY SYSTEMS DIVISION



NOTES:

1. Maximum individual "A" cable lengths = 30 meters.
2. Maximum individual "B" cable lengths = 15 meters.



NOTES:

1. Termination of "A" cable lines are required at controller and the last unit of the daisy chain or each unit in a star.
2. Termination of "B" cable receiver lines are required at the controller and are on the unit's receiver cards.
3. Maximum cumulative "A" cable length per controller = 30 meters.
Maximum individual "B" cable length = 15 meters.

8 - 1: CONNECTION TO THE CONTROL UNIT

MEMORY SYSTEMS DIVISION

8.2 SIGNAL LINES

8.2.1 CONTROL ("A") CABLE LINES (See Figure 8-2)

8.2.1.1 Unit Select Tag (See Figure 8-3)

This signal gates the desired logic number into the Logic Number Compare circuit. The unit will be selected internally 600 ns maximum after leading edge of this signal. This signal must be active for the duration of the select.

8.2.1.2 Unit Select (2^0 , 2^1 , 2^2 and 2^3)

These four lines are binary coded to select the drive unit number. The unit number (0 through 15) is selected by means of a dip switch located on the SMD I/F PC board in each drive.

Address and Control functions are transferred on 11 lines. The significance of the information on these lines is indicated by one of three Tag Lines (see Figure 8-4). See Figure 8-5 for timing.

8.2.1.3 Cylinder Address (Tag 1)

The Mercury Disk Drive is a direct addressing device. The controller need only to place the new address on the bus lines and strobe the lines with Tag 1.

8.2.1.4 Head Select (Tag 2)

This signal is the head address that will be selected by bits 0 through 3.

8.2.1.5 Control Select (Tag 3)

This signal acts as an enable and must be true for the entire operation of the control options as detailed below.

8.2.1.5.1 Write Gate (bit 0)

The Write Gate line enables the write driver.
(See Figure 8-6 for typical write timing.)

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CONTROLLER	"A" CABLE	LO, HI	DRIVE	
"A" CABLE	UNIT SELECT TAG	22, 52	"A" CABLE	
	UNIT SELECT 2'	23, 53		
	UNIT SELECT 2'	24, 54		
	UNIT SELECT 2'	26, 56		
	UNIT SELECT 2'	27, 57		
	TAG 1	2 ▲		1, 31
	TAG 2	2 ▲		2, 32
	TAG 3	2 ▲		3, 33
	BIT 0	2 ▲		4, 34
	BIT 1	2 ▲		5, 35
	BIT 2	2 ▲		6, 36
	BIT 3	2 ▲		7, 37
	BIT 4	2 ▲		8, 38
	BIT 5	2 ▲		9, 39
	BIT 6	2 ▲		10, 40
	BIT 7	2 ▲		11, 41
	BIT 8	2 ▲		12, 42
	BIT 9	2 ▲		13, 43
	BIT 10	2 ▲		30, 60
	OPEN CABLE DETECTOR			14, 44
	INDEX	2 ▲		18, 48
	SECTOR	2 ▲		25, 55
	FAULT	2 ▲		15, 45
	SEEK ERROR	2 ▲		16, 46
	ON CYLINDER	2 ▲		17, 47
	UNIT READY	2 ▲		19, 49
	ADDRESS MARK FOUND	2 ▲		20, 50
	WRITE PROTECTED	2 ▲		28, 58
POWER SEQUENCE PICK		29		
POWER SEQUENCE HOLD		59		
BUSY	2 ▲	21, 51		

NOTE:

60 position
 28 awg, straight flat cable
 Maximum length = 30 meters

2 Gated by unit selected.

FIGURE 8 - 2: "A" CABLE INTERFACE

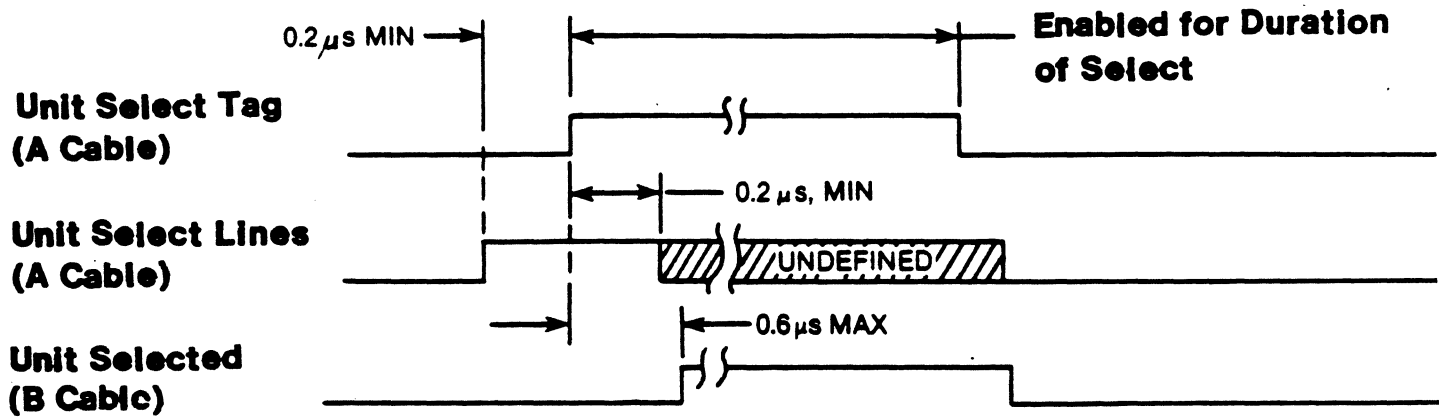


FIGURE 8-3: LOGIC NUMBER SELECT AND TIMING DIAGRAM

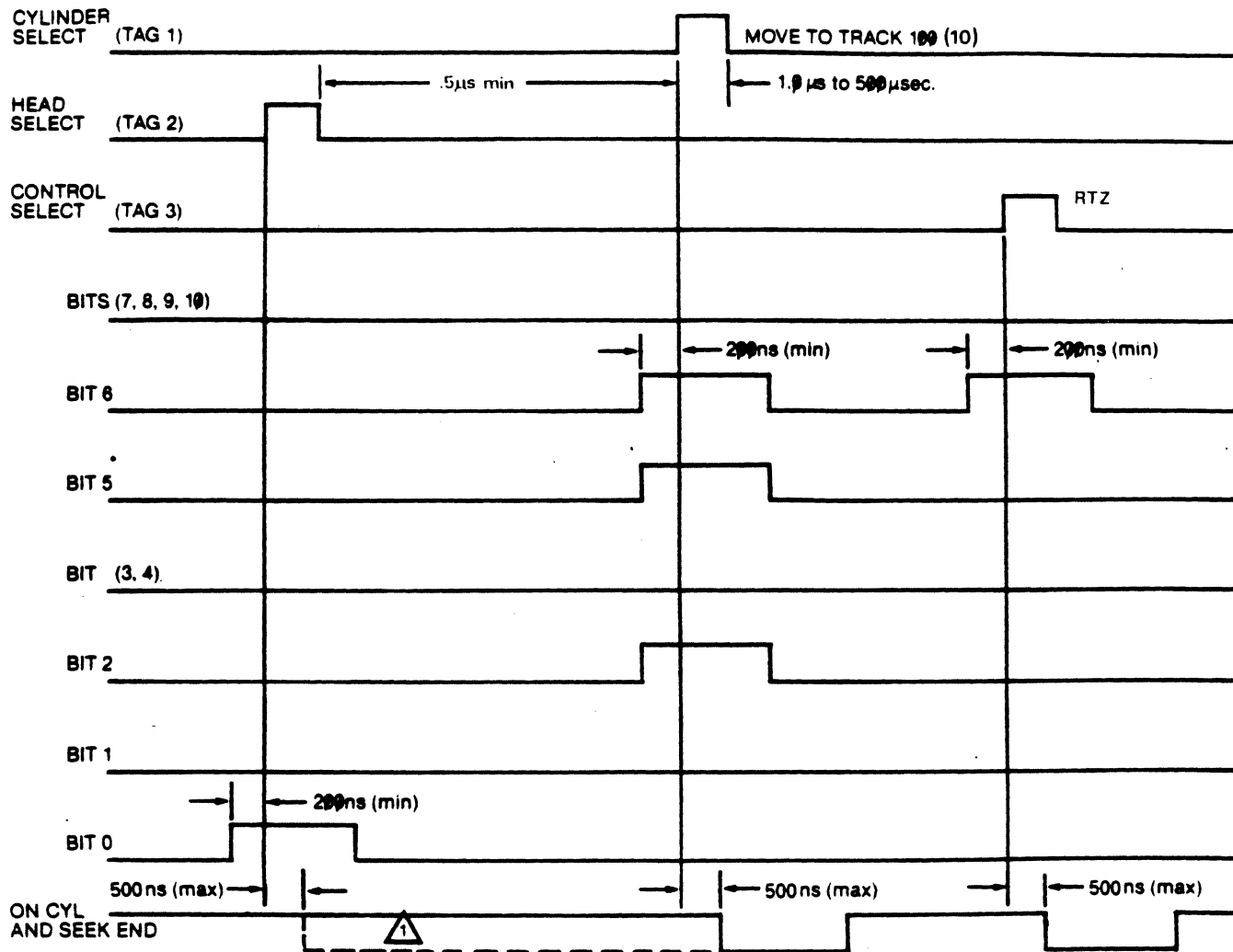
MEMORY SYSTEMS DIVISION

	TAG 1 IN	TAG 2 IN	TAG 3 IN	
BUS	CYLINDER ADDRESS	HEAD SELECT	CONTROL SELECT	UNIT SELECT
Bit 0	2 ⁰	2 ⁰	Write Gate	
1	2 ¹	2 ¹	Read Gate	
2	2 ²	2 ²	Servo Offset Plus*	
3	2 ³	2 ³	Servo Offset Minus*	
4	2 ⁴		Fault Clear	
5	2 ⁵		AM Enable*	
6	2 ⁶		RTZ	
7	2 ⁷		Data Strobe Early*	
8	2 ⁸		Data Strobe Late*	
9	2 ⁹		Release*	Priority Select*
10	2 ¹⁰			

*NOT USED ON MERCURY DRIVE

FIGURE 8 - 4: TAG BUS DECODE

TYPICAL SEQUENCE



1 Head Switch convention:
 TAG 2/TAG 1 = on cyl False at TAG 1
 or TAG 2 = on cyl False at TAG 2 or TAG 1
 see Section 3.3.9

ZERO TRACK SEEK

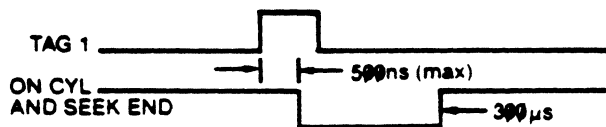
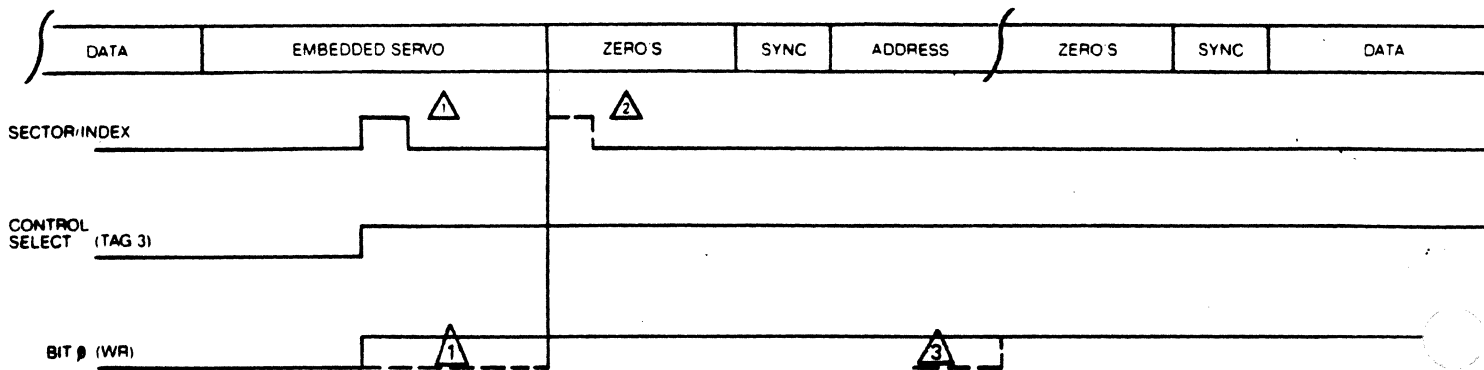


FIGURE 8 - 5: TAG AND BUS TIMING

MEMORY SYSTEMS DIVISION

FIGURE 8-6: TYPICAL WRITE TIMING

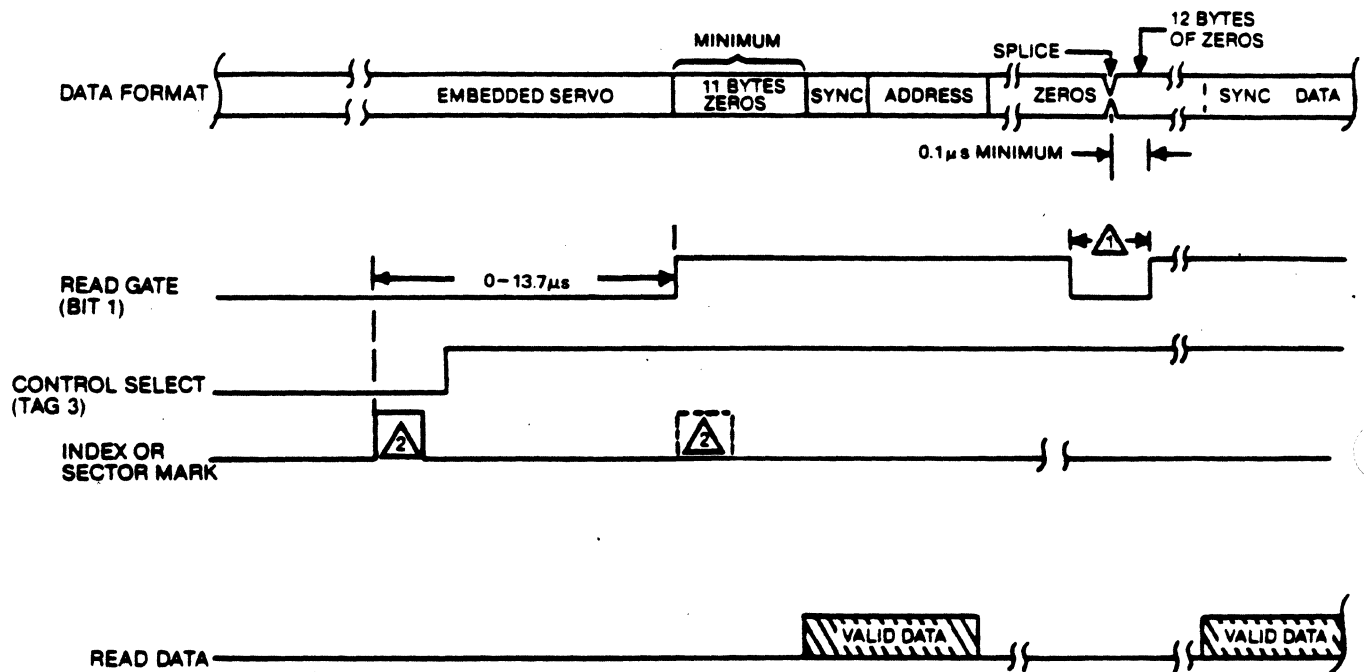


1. With sector pulse in this position (see Options), Write must either be delayed 16 bytes (approx. 8 μ s) from the leading edge of the sector or a minimum 27 byte zero preamble (PLO) must be written. (The first 16 bytes are not written by the drive)
2. In this position, Write may be asserted with the leading edge of sector and commence immediately writing the 11 bytes (min.) of PLO.
3. Write occurs here for writing the data Field only.

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- 8.2.1.5.2 Read Gate (Bit 1)
Enabling of the Read Gate (see Figure 8-9), enables digital read data on the transmission lines. The leading edge of Read Gate triggers the read chain to synchronize on an all zeroes pattern. (See Figure 8-7 for Read Gate and Write Splice relationship).
- 8.2.1.5.3 Servo Offset Plus (Bit 2)
This feature is not required by the Mercury Disk Drive due to its embedded servo track following. The drive treats this signal as a NO-OP and doesn't drop On Cylinder.
- 8.2.1.5.4. Servo Offset Minus (Bit 3)
This feature is not required by the Mercury Disk Drive due to its embedded servo track following. The drive treats this signal as a NO-OP and doesn't drop On Cylinder.
- 8.2.1.5.5 Fault Clear (Bit 4)
A 250 ns minimum pulse sent to the Mercury Disk Drive will clear the Fault flip-flop if the fault condition no longer exists.
- 8.2.1.5.6 AM Enable (Bit 5)
Because of embedded servo, variable length sectors are not provided by the Mercury Disk Drive, and thus Address Marks are not used.
- 8.2.1.5.7 RTZ (Bit 6)
A 250 ns minimum, 1.0 ms maximum pulse, sent to the drive will cause the actuator to seek track 0 and clear the Seek Error fault. This seek requires the same amount of time as a normal seek to track. In the unlikely event that the drive loses knowledge of its head position on a surface, this command could take 1.5 seconds maximum.
- 8.2.1.5.8 Data Strobe Early (Bit 7)
Not required by Mercury Disk Drive. The drive treats this signal as a NO-OP and takes no action.

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- NOTES:**
- ⚠️ Read gate must be dropped prior to the write splice. It must be reinitiated at least one bit after the write splice and with at least 10 bytes of zero bits remaining in the sync field. 12 byte example consists of one byte for write splice and 11 bytes for PLO sync.
 - ⚠️ Sector pulse position is a variable and can be selected to be 16 bytes before customer sector or at customer sector.

FIGURE 8 - 7 : READ GATE TYPICAL TIMING

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8.2.1.5.9 Data Strobe Late (Bit 8)
Not required by Mercury Disk Drive. The drive treats this signal as a NO-OP and takes no action.

8.2.1.5.10 Release (Bit 9)
Dual channel functions not utilized by Mercury Disk Drive. The drive treats this signal as a no-op and takes no action.

8.2.1.6 Open Cable Detect
The Open Cable Detect circuit disables the interface in the event that the "A" interface cable is disconnected or controller power is lost.

8.2.1.7 Index
This signal occurs once per revolution, and its leading edge is considered the leading edge of Sector Zero, typically 2.5 microsecond (see Figure 8-8). Timing integrity is retained throughout seek operations.

8.2.1.8 Sector
The Sector is derived from the embedded servo information. Timing integrity is maintained throughout seek operations (see Figure 8-8). The number of bytes per sector and thus the number of sectors per revolution is set at the factory. See section 3.3.2.

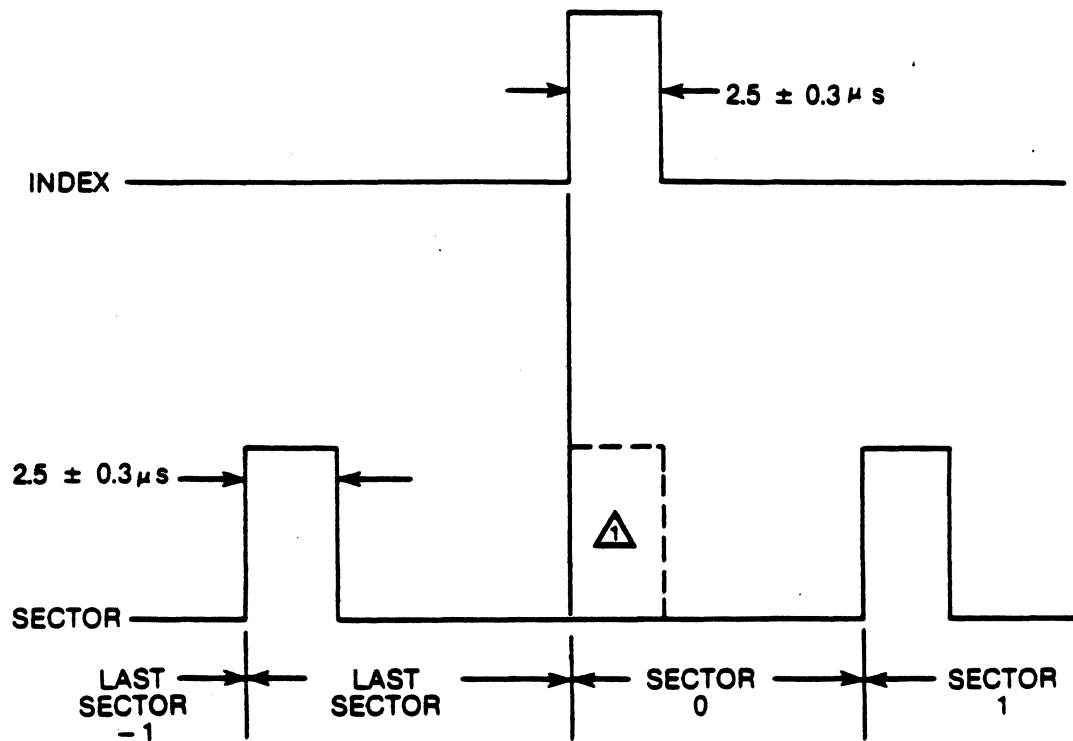
8.2.1.9 Fault
When this line is true, a fault condition in the drive is indicated and write/read operations are disabled. Some examples of fault conditions are:

Drive Fault: see Table 6-2

Interface Faults:

- 1) Write/Read operation while either unit ready or on cylinder is false.
- 2) Simultaneous cylinder/head commands (minimum delay is 2 usec).

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 Sector pulse "present" or "inhibited" during Index pulse is a customer-selectable variable.

FIGURE 8 - 8: INDEX AND SECTOR TIMING

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- 3) Write and read asserted simultaneously.
- 4) Cylinder or head command when unit ready is false.

Write Fault:

- 1) write protect asserted;
- 2) absence of write clock or data;
- 3) attempting to write while off track.

The Fault line may be cleared by a Clear Fault command on the I/O or by depressing Reset on the optional front panel (providing the error condition no longer exists). As a maintenance aid, indicators are provided on the CEA PC board.

8.2.1.10

Seek Error

Seek Error is asserted to indicate that one of the following error conditions exist, and the error condition can only be cleared by successfully executing a RTZ command.

1. Cylinder select address received from the host controller exceeds cylinder address range (0-1068).
2. Head select address received from the host controller exceeds head address range.
3. Cylinder or head cannot be selected within 220 milliseconds.
4. The selected R/W head has moved to a track other than that last specified by the host.

8.2.1.11

On Cylinder

On cylinder is negated when a seek command is issued by the host controller and is asserted by the drive after successfully executing a seek command.

8.2.1.12

Unit Ready

When true this line indicates that the unit is up to speed and no fault condition exists within the drive.

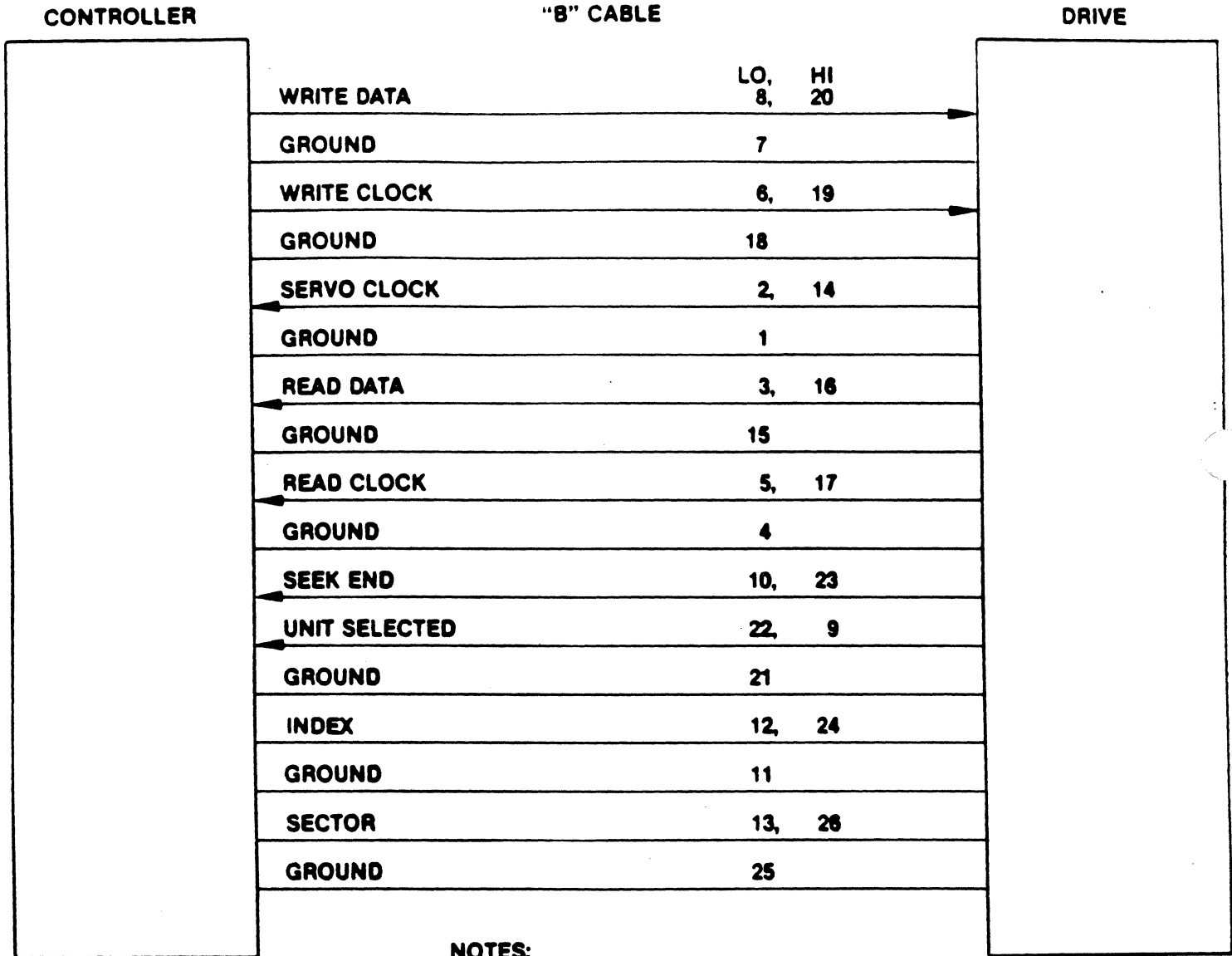
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- 8.2.1.13 Address Mark Found
Because of embedded servo requirements, variable length sectors are not provided by the Mercury Disk Drive, and thus Address Marks are not used.
- 8.2.1.14 Write Protected
Enabling the Write Protect function inhibits the writer under all conditions, illuminates a LED on the optional front panel, and sends a Write Protected signal to controller. Attempting to write while protected will cause a fault to be issued. The write protect function can be enabled by an external front panel switch or by the switch located on the SMD board (see 3.3.1).
- 8.2.1.15 Power Sequence Pick
Power Sequence Pick, when active low, allows drive spin-up. Reference 3.3.6 Remote/Local.
- 8.2.1.16 Busy
In a single channel drive, the input to the driver for this signal is grounded, forcing it to the inactive level. The Mercury drive does not have a dual ported (channel) implementation.
- 8.2.1.17 Power Sequence Hold
Not used.
- 8.2.2 READ/WRITE ("B") CABLE LINES (See Figure 8-9)
- 8.2.2.1 Write Data
This line carries NRZ data which is to be recorded on the disk.
- 8.2.2.2 Write Clock
This line transmits the Write Clock signal which must be synchronized to the NRZ Data as illustrated in Figure 8-11(A). The Write Clock is the Servo Clock retransmitted to the drive by the controller, during a write operation. The Write Clock need not be transmitted continuously, but must be present during data transfer.
- 250 ns prior to Write Enable.

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- 8.2.2.3 **Servo Clock**
The Servo Clock is a phased-locked 9.677 MHz clock generated from the embedded servo information (see Figure 8-10(A)). Servo Clock is available at all times (not gated with Unit Select).
- 8.2.2.4 **Read Data**
This line transmits the recovered data in the form of NRZ data (see Figure 8-10(B)).
- 8.2.2.5 **Read Clock**
The Read Clock defines the beginning of a data cell. It is an internally derived clock signal and is synchronous with the detected data as specified in Figure 8-10(B). This signal is in phase sync within 9 microseconds after Read Gate.
- 8.2.2.6 **Seek End**
Seek End is output in concurrence with Seek Error or On Cylinder to indicate termination of a seek operation. Seek End will respond within 300 microseconds when a cylinder or head select command is issued with an address out of range. (See Figure 8-11)
- 8.2.2.7 **Unit Selected**
When the Unit Select bit lines compare with the dip switch setting and when the leading edge of Unit Select tag is received, the Unit Selected line becomes true and is transmitted to the controller on the "B" cable.
- 8.2.2.8 **Index**
This signal occurs once per revolution, and its leading edge is considered the leading edge of Sector Zero, typically 2.5 microsecond (see Figure 8-8). Timing integrity is retained throughout seek operations.
- 8.2.2.9 **Sector**
The Sector is derived from the embedded servo information. Timing integrity is maintained throughout seek operations (see Figure 8-8). The number of bytes per sector and thus the number of sectors per revolution is set at the factory. See section 3.3.2.

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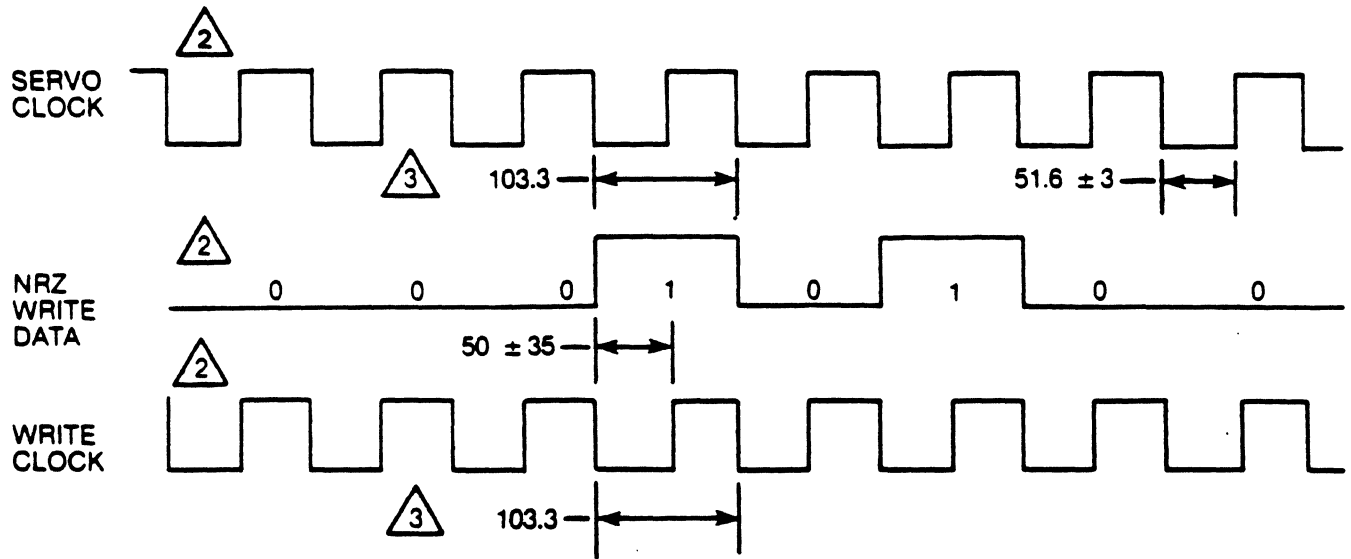
NOTES:

1. 26 conductor, shielded flat cable.
Maximum length: 50 ft.
2. No signals gated by unit selected.

FIGURE 8 - 9: CABLE INTERFACE

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A. WRITE TIMING



Notes:

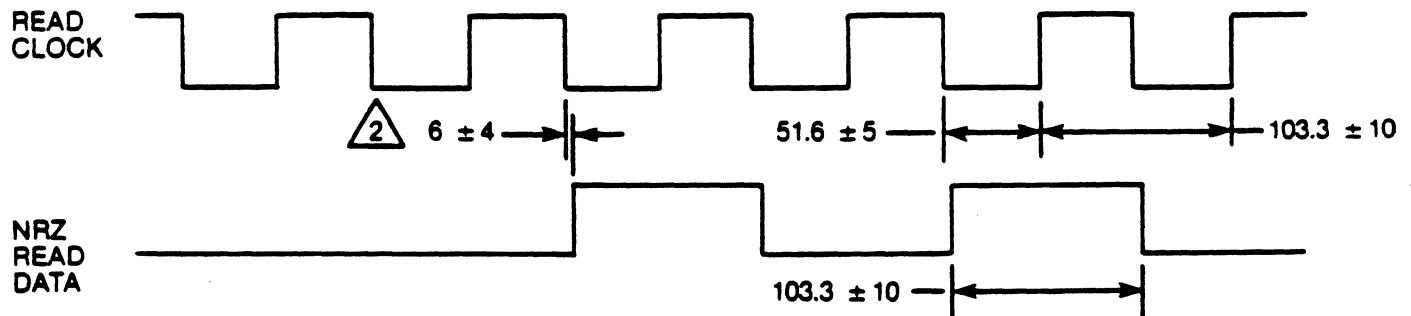
1. All time in ns.

△2 At drive I/O connector.

△3 Similar period symmetry is ± 2 ns. At I/O connector in drive speed variation tolerance is $\pm 1\%$ consisting of:

- Variations between inner and outer cylinder.
- Dynamic jitter on bit-to-bit basis. Applies when on cylinder.

B. READ TIMING



Notes:

1. All time in ns.

△2 Negative edge of clock precedes significant edge of data at I/O connector.

FIGURE 8 - 10: DATA TIMING

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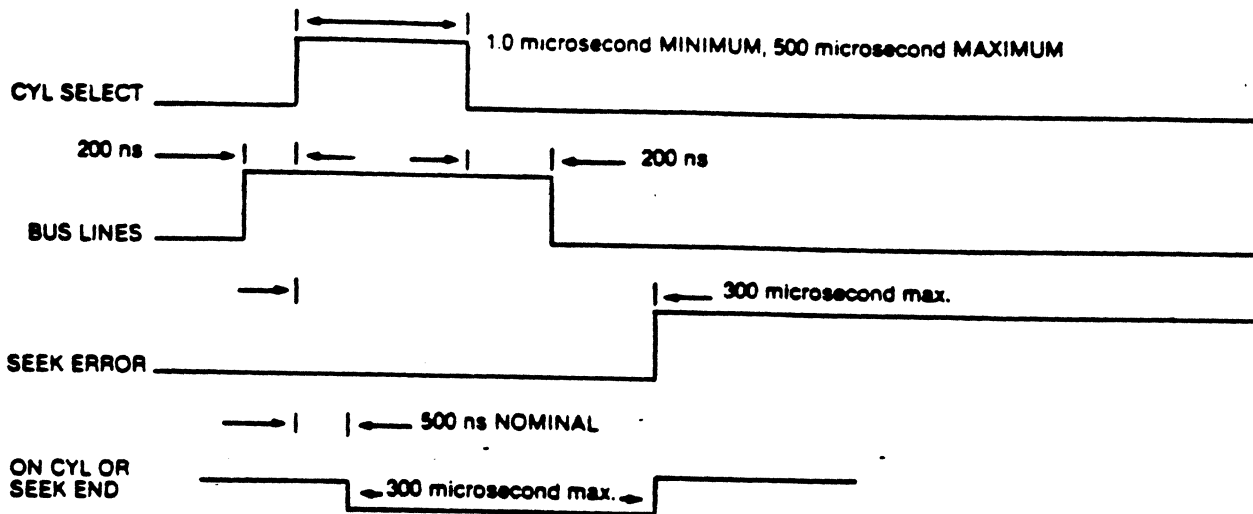


FIGURE 8 - 11: SEEK END TIMING (Invalid Cylinder Address)

8.3 DATA FORMAT AND DATA CONTROL TIMING

The record format on the disk is determined by the controller. The Index and Sector pulses are available for use by the controller to indicate the beginning of a track or sector. Minimum format for fixed sector data records are shown in Figure 8-12.

Some disk drive dependent constraints must be recognized when designing a format. The following is a list of those format procedures.

1. Beginning-of-Record Tolerance

When the Sector Pulse Location Switch (see 3.3.2) is "off", this tolerance is 16 bytes and is required to insure that the writing of data occurs beyond the protected servo area. If the switch is "on", there is no need for any beginning-of-record tolerance.

2. Read PLO Synchronization

The synchronization time needed to allow the Phased-Locked Oscillator to synchronize is 11 bytes of zeroes minimum before the sync pattern of the address field and data field.

3. Sync Pattern

The sync pattern consists of a sequence of bits indicating the desired sync pattern and starting with a "logical one" bit. It indicates the beginning of the address or data fields (one "logical one" is the minimum required).

4. Write Driver Turn On

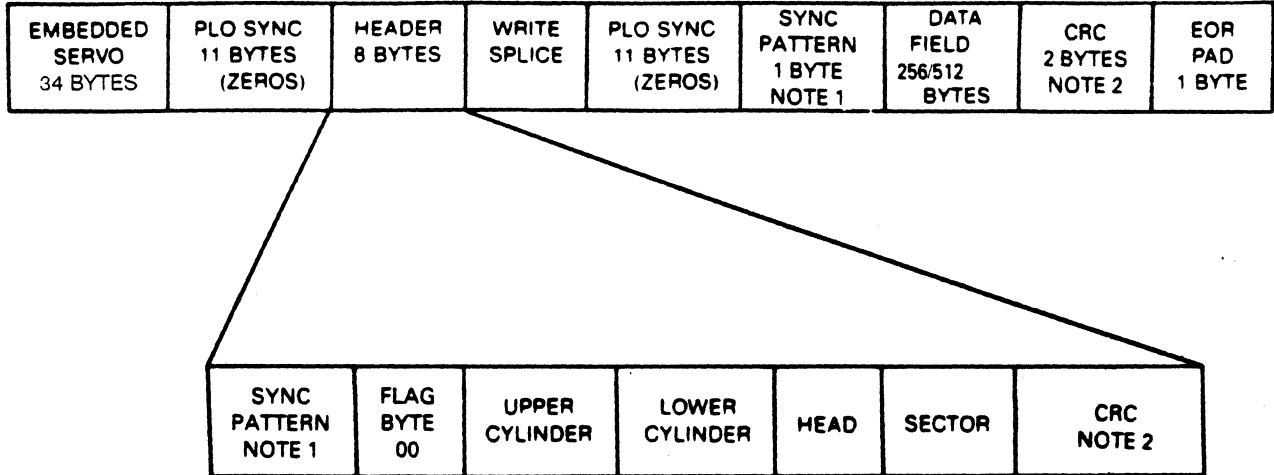
The write driver turn on time is approximately 800 ns (8 bits). This time has to be accounted for to accomodate write splices.

5. End-of-Record Tolerance

This tolerance is one byte of zeroes to allow the internal encoding delay time during write operations.

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FIGURE 8 - 12: FIXED SECTOR FORMAT



NOTE 1: SYNC PATTERN is 80(HEX).
 NOTE 2: CRC Generation Polynomial is $X^{16} + X^{12} + X^5 + 1$
 CRC includes the SYNC Byte.
 CRC is reset to zeroes at start of sync.

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8.4 EXTERNAL CONTROL INTERFACE

The external control interface provides external switch inputs for: Unit Select, Write Protect, Sector Pulse Location and Drive Reset. Additionally, LED drivers are provided for the following signals: Drive Fault, Write Fault and Unit Ready. Connections for the external control signals are provided by a 16 pin DIP socket located near the Read/Write ("B") cable connector of the SMD Interface Board.

Female Socket: NT Part #467226-1
 Male DIP Connector: 3M Part #3416-0000 or equivalent
 (user supplied)

Table 8-1 provides the pin assignments for the external control interface. Figure 8-13 describes the external control interface signal terminations. NOTE: Control panel grounding to the user chassis is necessary to prevent Electro-Static Discharge (ESD) problems. Also note that 5 Volts for the LED's is not provided on the connector and must be supplied from the external power supply.

TABLE 8 - 1: EXTERNAL CONTROL INTERFACE

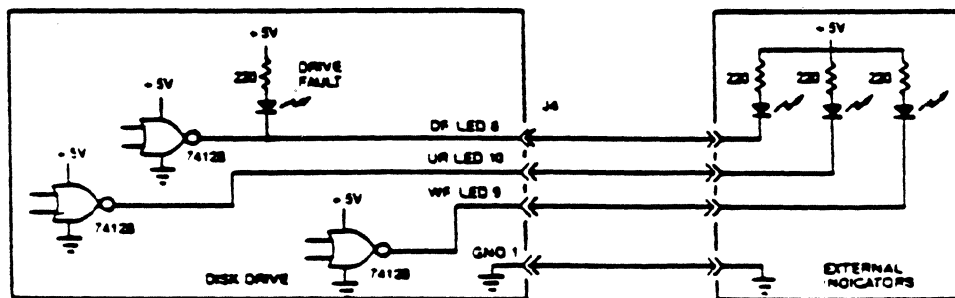
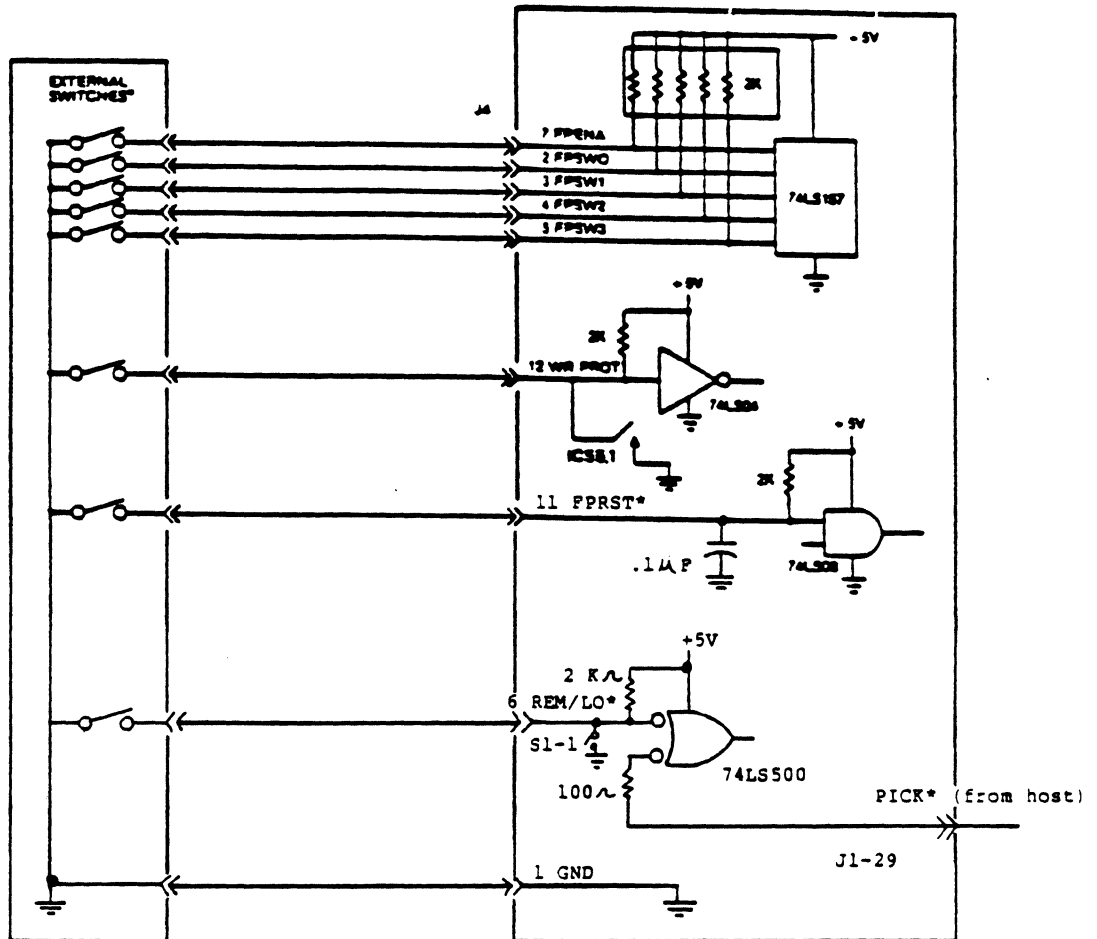
<u>Pin</u>	<u>Signal</u>	<u>Direction</u>
1	GND	---
2	FPSWO*	Input
3	FPSW1*	Input
4	FPSW2*	Input
5	FPSW3*	Input
6	REM/LO*	Input
7	FPENA*	Input
8	DFLED*	Output
9	WFLED*	Output
10	URLED*	Output
11	FPRST*	Input
12	WRPROT*	Input
13	N.C.	---
14	N.C.	---
15	N.C.	---
16	N.C.	---

* = active low signals

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- 8.4.1 Unit Select External Control (FPSW0-FPSW3*)
The unit select external control signals, FPSW0-FPSW3, are binary coded, active low signals which set the unit address of the drive.
- 8.4.2 Remote/Local (REM/LO*)
REM/LO*, when active low, activates the local mode allowing disk power-up without host intervention. Otherwise, the remote mode exists which requires the host to activate "pick" before power-up can occur. If "local" is selected on either signal REM/LO or the Remote/Local switch on the SMD board (see 3.3.7), local mode is activated.
- 8.4.3 External Control Enable (FPENA*)
Signal FPENA* enables the external control interface when active low and disables unit select switch on the SMD I/F card.
- 8.4.4 Drive Fault External Signal (DFLED*)
The LED drive signal DFLED, indicates a drive fault has occurred.
- 8.4.5 Write Fault External Signal (WFLED*)
The LED drive signal WFLED, indicates a write fault has occurred.
- 8.4.6 Unit Ready External Signal (URLED*)
The LED drive signal URLED, indicates the unit is ready.
- 8.4.7 Drive Reset External Control (FPRST*)
Signal FPRST*, when active low, causes the control micro-processor to initialize and clears all faults.
- 8.4.8 Write Protect External Control (WRPROT*)
Signal WRPROT*, when active low, inhibits all write operations. Activation of either WRPROT or the Write Protect on the SMD Interface card will write protect the drive.

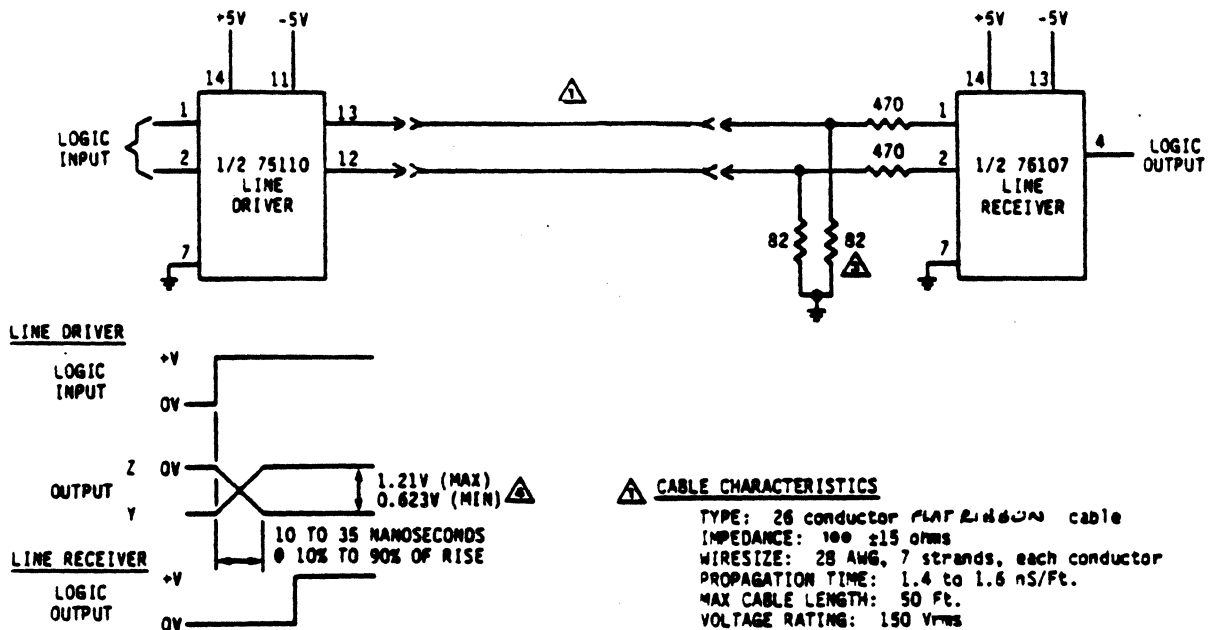
FIGURE8-13: EXTERNAL CONTROL INTERFACE SIGNAL TERMINATORS



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8.5 INTERFACE TERMINATION

The Read/Write ("B") Cable is terminated by an 82 ohm resistor to ground on the receiver end only. See figure 8-14. The Control ("A") Cable is terminated by 56 ohm to ground on both the driver and last receiver in chain. See figure 8-15. The control signals "Open Cable Detect" and "Pick" have bias networks internal to the drive, as shown in Fig. 8-16 and 8-17.



NOTE

1. Refer to Figure 3-8 for SMD Read/Write Interface cable connector pin assignments and active signal polarities.
2. All resistor values shown are in ohms.

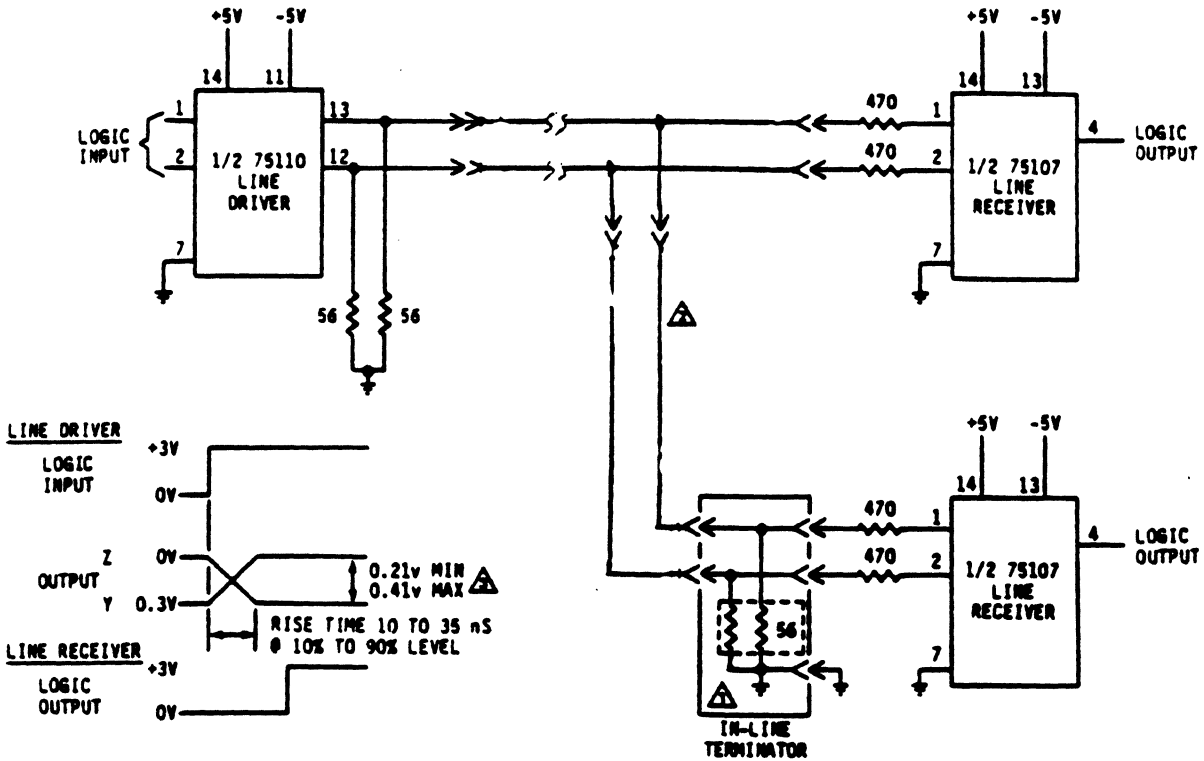
⚠ The 82 ohm ±5%, 1/4 watt terminator resistors should be physically located with each line receiver connected to the cable.

⚠ Voltage range includes line driver output swing in low state when I_{out} is 11 ±3mA and the terminator resistor value is in the range of 56 ±5% ohms.

READ/WRITE CABLE SIGNAL TERMINATIONS

figure 8-14

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⚠ The 56 ohm $\pm 5\%$ 1/4 watt in-line terminator resistors should only be located near the last line receiver on the SMD Interface Control cable.

⚠ **CONTROL CABLE CHARACTERISTICS**

IMPEDANCE: 100 ± 10 ohms
WIRE SIZE: 28 AWG, 7 strands
PROPAGATION TIME: 1.4 to 1.6 nS/Ft
TYPE: 60 pin PLAT ribbon cable
MAX CABLE LENGTH: 100 FT cumulative
VOLTAGE RATING: 150 Vrms

⚠ Voltage range includes line driver output swing in low state when I_{out} is 11 ± 3 mA and terminator resistor is in the range of 56 ± 5 ohms.

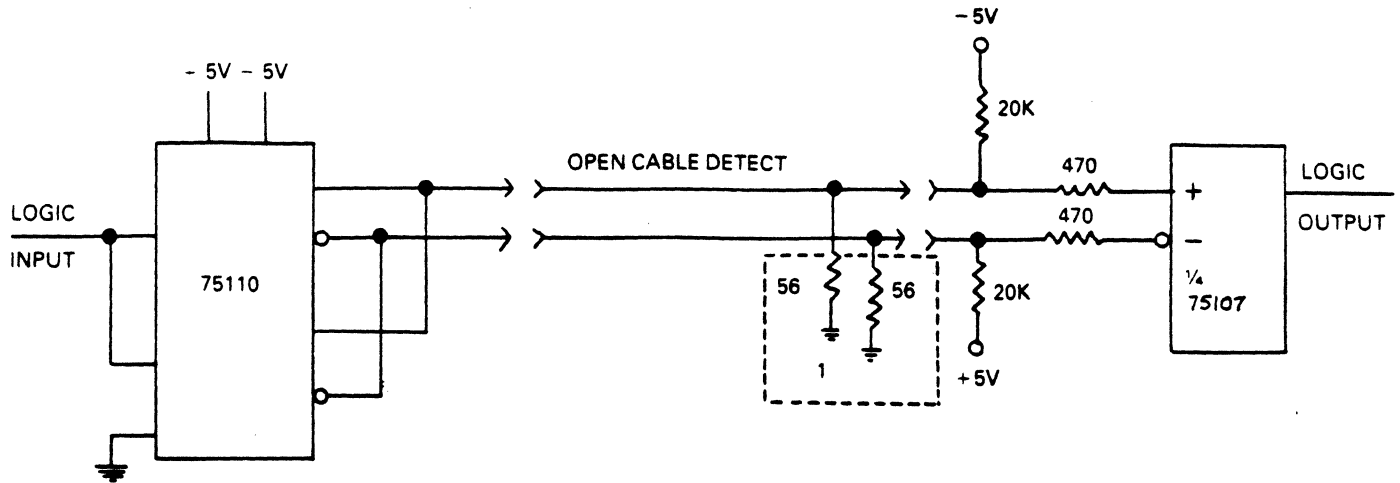
NOTE

1. Interface circuits shown are not applicable to SMD Interface Control cable "OP CABLE" and "PICK" signals.
2. Refer to Figure 3-1 for the SMD Interface Control cable connector pin assignments and active signal states.
3. All resistor values shown are in ohms.

CONTROL CABLE SIGNAL TERMINATIONS

figure 8-15

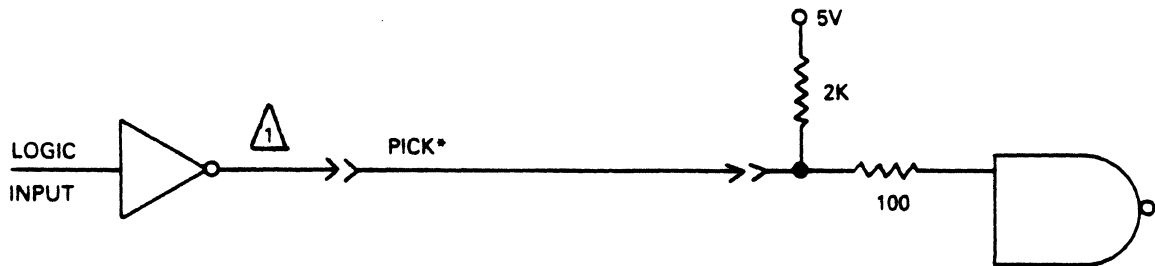
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Use to ensure proper operation of the Open Cable detect circuitry. Two 75110 transmitters should be connected in parallel as shown

Located on terminator assy.

FIGURE 8-16



Must be capable of sinking 2.5 mA per drive.

FIGURE 8-17