PRODUCT SPECIFICATION

MSD MERCURY SERIES 8300

8-INCH WINCHESTER

SMD DISK DRIVES

MEMORY SYSTEMS DIVISION
Ann Arbor, Michigan

northern telecom

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	APPROVAL	DATE
GENERAL MANAGER		30 JUL 86
ENGINEERING		10/3/86
OPERATIONS		10-3-86
MARKETING		

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1.0 SCOPE

This document describes the operational specifications and interfacing requirements for the MSD Mercury 8300 Series high performance, 8-inch Winchester Disk Drive with modified 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

The Mercury 8300 will comply with the following regulatory requirements:

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. TUV/VDE

   1) DIN IEC 380/VDE 0806/8.81

2.3 TECHNICAL REFERENCES

a. M8504031 Mercury 8300 Series Product Description

b. M8510071 Mercury 8300 Series Maintenance Manual

c. M8502051 Mercury 8300 Series Installation Guide

3.0 GENERAL DESCRIPTION

3.1 EQUIPMENT DEFINITION

The Mercury Disk Drive 8300 Series is a family of high-capacity, high-performance, high-reliability Winchester 8-inch disk drives featuring the ANSI-standard SMD interface modified to allow a 1.895 MB/Sec transfer rate. 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:

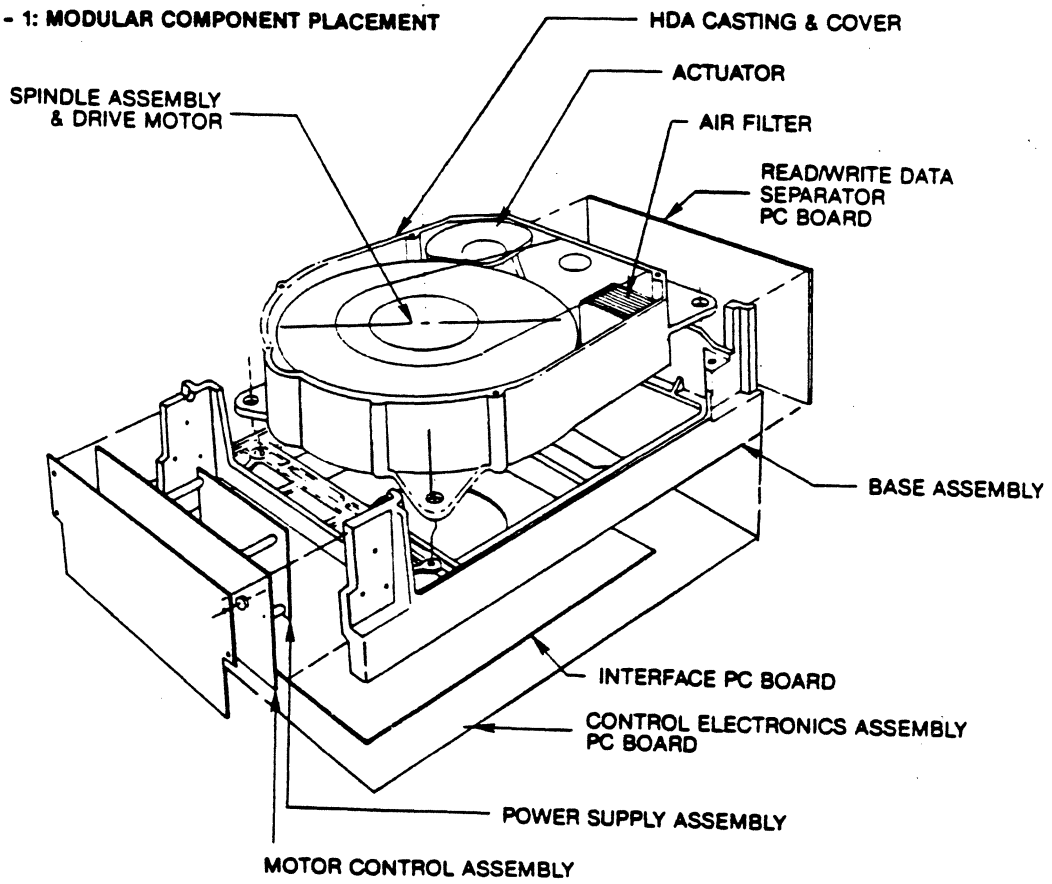
1) HDA casting and cover;
2) air filters;
3) spindle assembly with up to seven 200mm diameter disks;
4) direct drive dc brushless spindle motor with microprocessor speed control, spindle brake assembly and cooling fan; and
5) rotary torque motor actuator with 3370-type flexures, thin-film heads, read/write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

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, 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



3.2 MODELS

The SMD Mercury 8300 Series disk is available in three models and various sector sizes (sectors per track).

3.2.1 Capacity (MB = Megabytes)

Unformatted Capacity	Model No.
378 MB	8310
394 MB	8308
592 MB	8312

3.2.2 Sector Size (Sectors per track)
The Mercury drive is available in four standard sector size variations. Other sector sizes can be provided as needed.

	DATA SECTOR SIZES			
	256	512	512	1024
Sectors Per Track	98	50	56	28
Total Unformatted (bytes)	350	686	612	1225
Customer-Unformatted (bytes)	315	651	577	1190
Customer Formatted (bytes)	256	512	512	1024
Overhead Available (bytes)	59	139	65	166

3.2.3 Model Numbers
The SMD Mercury 8300 Series model numbers are as follows:

	256 Byte Sector Size	512 Byte Sector Size	1024 Byte Sector Size
378 MB	8310-98	8310-50 or 8310-56	8310-28
394 MB	8308-98	8308-50 or 8308-56	8308-28
563 MB	8312-98	8312-50 or 8312-56	8312-28

3.2.4 Drive Type
Drive Type is a three digit number assigned to each Model to differentiate head switch conventions and also major enhancements.
The two major types are:

01X: Standard Headswitch*
06X: Fast Headswitch*

where X (currently "1") denotes enhancement level
* See Section 5.1.2 for details.

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.) The Switchable variables are listed below. 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 M8502051 Mercury 8300 Series Installation Guide for more detailed switch setting procedures. Some of these functions are also available via the External Control Interface (see 8.4).

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 14 bytes before the start of the customer sector (the customer sector excludes the 30 bytes of embedded servo data which is inaccessible to the customer). Under this switch setting, write enable must be delayed 14 bytes from the leading edge of sector or a minimum 25 byte PLO must be written.

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)

Note: Switch 7 and 8 (SMD, IC55, 7-8) are not used.

3.3.4 96/48/24 Sector Option (CEA, S2, Single)
This single slide switch allows a 256 byte sectored drive to be configured to have 96 sectors, a 512 byte sectored drive to have 48 sectors, and a 1024 byte sectored drive to have 24 sectors instead of the normal 98, 50 and 28 sectors (respectively). Sector pulse is inhibited for the remaining sectors when the 96/48/24 option is selected thereby creating a timing gap from the last sector pulse to the index sector. (i.e. sector pulses are not evenly spaced around a track.)

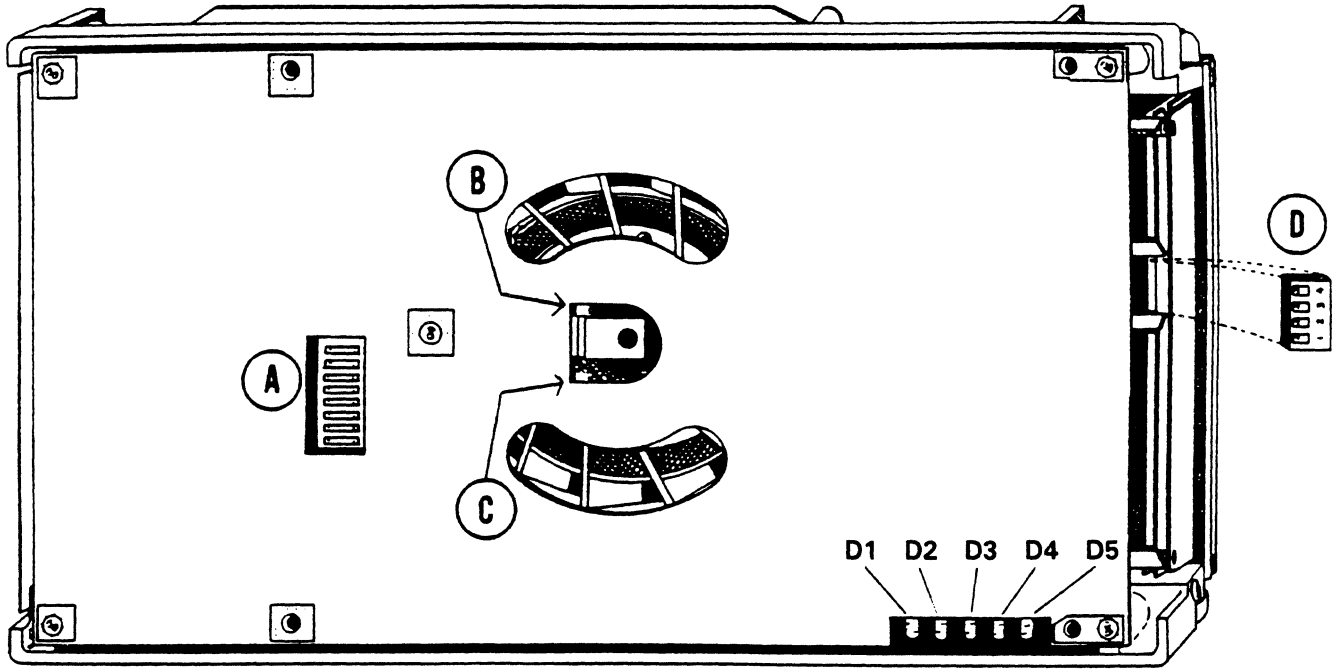
3.3.5 Sector Pulse Inhibit (CEA, S1, Single)
This switch allows a choice between enabling or disabling a SECTOR signal simultaneous with the INDEX signal.

3.3.6 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 which requires the host to activate "pick" before power-up can occur. Pick must remain active during drive operation.

3.3.7 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.

3.3.8 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.).

3.3.9 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.



B

SWITCH S2, CEA BOARD

A

OFF ON

1 2 3 4 5 6 7 8

SECTOR SIZE
S2
24/48/96
28/50/98

C

NO YES
SECTOR PULSE DURING
INDEX SECTOR
S1

SWITCH S1, CEA BOARD

D

OFF NO

1 2 3 4

SWITCH BLOCK S1, SMD INTERFACE BOARD

FIGURE 3.2
Mercury Disk Drive User Variable
Switch Locations

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.

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 8973)
Option 8973 provides an SMD Terminator and a set of four evaluation feet.

3.4.7 Cables

Description	Part No.	
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 drive to tolerate up to 30G of shock while in non-operating mode.

3.4.9 Shockmount Extender (Option 8961)
Option No. 8961 increases the drive width measured at the shockmount from 8.338" to 8.55" (See Figure 7.2).

4.0 STANDARD FEATURES

* Capacity of 378 to 592 megabytes (unformatted)
* Average positioning time as low as 20 milliseconds for the 8310, 21 milliseconds for the 8312.
* SMD compatible interface with 1.895 MB/sec transfer rate
* 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
* Thin-film heads
* 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

5.0 OPERATIONAL CHARACTERISTICS

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

TABLE 5-1: OPERATIONAL CHARACTERISTICS

		8310	8308	8312
Raw Capacity (unformatted)[1]				
Per Drive	(MB)	378.6	394.8	592.2
Per Surface	(MB)	37.8	49.3	49.3
Per Track	(Bytes)	34,300	34,300	34,300

Unformatted User Capacity:	Per Drive	Per Surface	Per Track	Per Sector
8310-98	340.8	34.0	30,870	315
-56	356.7	35.6	32,312	577
-50	359.3	35.9	32,550	651
-28	367.8	36.7	33,320	1190
8308-98	355.3	44.4	30,870	315
-56	371.9	46.4	32,312	577
-50	374.7	46.8	32,550	651
-28	383.5	47.9	33,320	1190
8312-98	533.0	44.4	30,870	315
-56	557.9	46.4	32,312	577
-50	562.0	46.8	32,550	651
-28	575.3	47.9	33,320	1190

Formatted User Capacity:	Per Drive	Per Surface	Per Track	Per Sector
8310-98	276.9	27.6	25,088	256
-56	316.5	31.6	28,672	512
-50	282.6	28.2	25,600	512
-28	316.5	31.6	28,672	1024
8308-98	288.8	36.1	25,088	256
-56	330.0	41.2	28,672	512
-50	294.7	36.8	25,600	512
-28	330.0	41.2	28,672	1024
8312-98	433.2	36.1	25,088	256
-56	495.1	41.2	28,672	512
-50	442.0	36.8	25,600	512
-28	495.1	41.2	28,672	1024

Note 1: includes 35 bytes of servo information per sector

TABLE 5-1 (Cont'd)

	8310	8308	8312
Positioning Time[2]			
Average (ms)	20/20/22.5	20/20/22.5	21/21/23.5
Track-to-Track (ms)	5/6/7	5/6/7	5/6/7
Maximum (ms)	35/35/40	35/35/40	35/38/42
Average Latency Time (ms)	9.05	9.05	9.05
Transfer Rate	1.895	1.895	1.895
Rotational Speed	3313.5	3313.5	3313.5
Recording Density	16,200 bpi	16,200 bpi	16,200 bpi
Encoding Method	RLL 2, 7	RLL 2, 7	RLL 2, 7
Track Density	1069 tpi	1236 tpi	1236 tpi
Cylinders	1104	1439	1439
Start Time	<12 sec	<12 sec	<14 sec
Stop Time	<10 sec	<10 sec	<12 sec
Data Heads	10	8	12
Disks	6	5	7

Note 2: All positioning times include settling time and assume nominal power over full environmental range.

Note 3: Data heads also act as servo heads for precise track positioning.

5.1 PERFORMANCE SPECIFICATIONS

5.1.1 Positioning Times

Positioning time is the time from receipt of seek command by the Mercury Disk Drive until On Cylinder is asserted.

The maximum positioning times shown in Table 5-1 are defined as the time to move the head from track zero to last track.

The track to track positioning time is no greater than 5 ms for a 256 byte sector, 6 ms for a 512 byte sector, and 7 ms for a 1024 byte sector. This is the time to move between any pair of adjacent tracks.

The average positioning times shown in Table 5-1 are 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 positioning 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 knowledge of its position on a surface, the maximum time to execute a RTZ is 1.5 seconds.

5.1.2 Headswitch

Headswitch is the process of changing from one read/write head to another either while seeking or while remaining on the same cylinder. The Mercury drive protects the user from writing until the head is determined to be precisely over the correct track which is determined by reading the positioning information contained within the embedded servo header on the new track. The Mercury drive disables writing during the time period by driving the On Cylinder signal false.

Two "Types" of drives are available:
Standard Headswitch or Type 01X (X=0-9)
and Fast Headswitch or Type 06X (X=0-9).

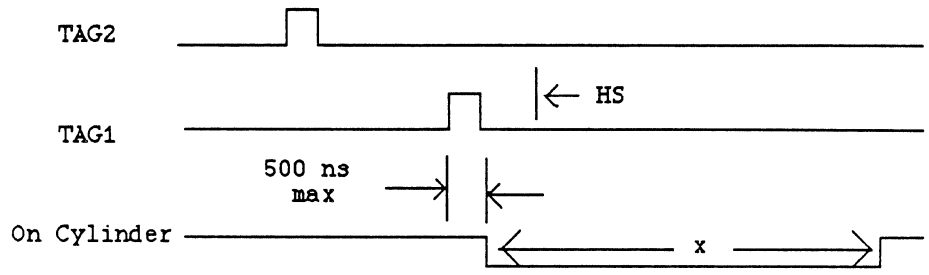
Fast Headswitch differs from Standard Headswitch in that the time On Cylinder is kept false is shorter, thus resulting in shorter headswitch time periods.

The Headswitch Convention selected by the user via a switch on our drive (see 3.3.8) determines whether the headswitch can occur with only a TAG2 (head no.) from the controller or whether a TAG1 (cylinder no.) is also required. If this switch is "on" (TAG2/TAG1 mode), the controller must send a TAG1 command to commence a headswitch.

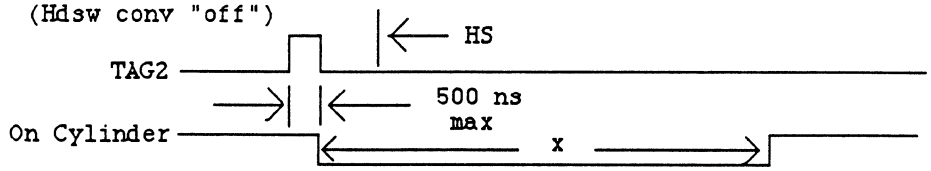
See Figure 5-1 and 5-2 for timing measurements for a headswitch. Note that in the event of an unusual disturbance (shock, etc.) which would affect the head position during a headswitch or seek, the Mercury drive protects the user by keeping on-cylinder "false" until it is safe to write.

I. Remaining on Same Cylinder

A. TAG2/TAG1 Mode
(Hdsw conv "on" -- See 3.3.8)



B. TAG2
(Hdsw conv "off")

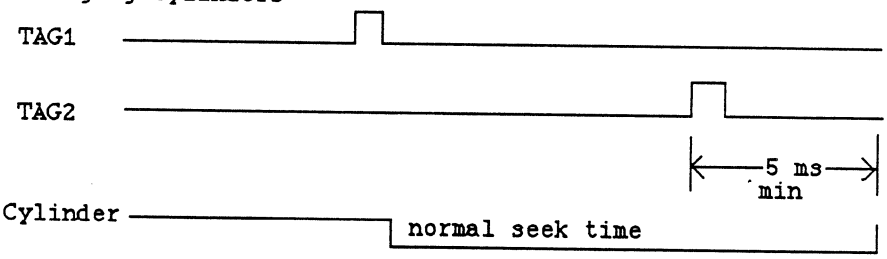


HS = time when headswitch physically occurs

x = 5 sectors

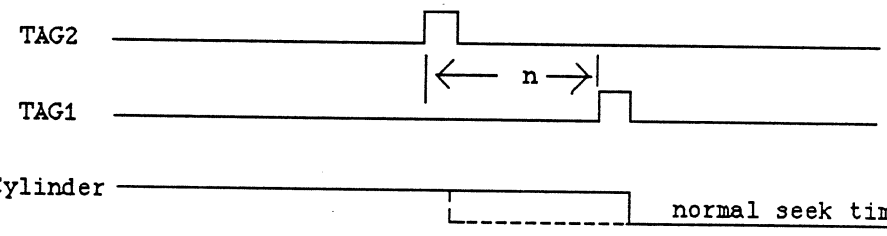
II. While Changing Cylinders

A. TAG1



As long as TAG2 command issued a minimum of 5 ms before on-cylinder returns "True", the headswitch will occur within the normal seek time.

B. TAG2

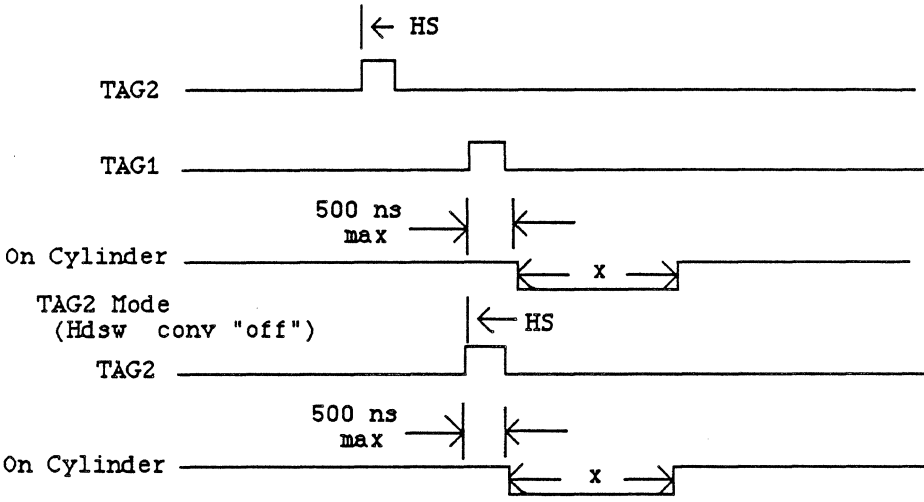


If TAG2 signal is sent before a TAG1 in TAG2 mode, the on-cylinder "false" time is increased by time "n". In TAG2/TAG1 mode, on-cylinder does not go "false" until a TAG1 is received.

FIGURE 5-1: STANDARD HEADSWITCH (TYPE 01X)

I. Remaining on Same Cylinder

A. TAG2/TAG1 mode
(Hdsw conv "on" -- See 3.3.8)



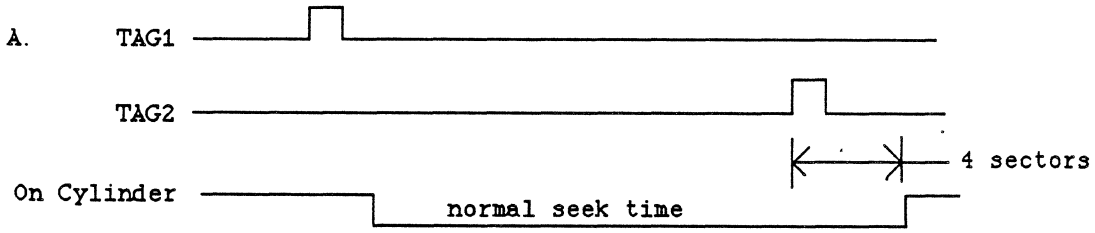
B. TAG2 Mode
(Hdsw conv "off")

HS = time when headswitch physically occurs

x = 2 sectors (adj surface switch)
4 sectors (nonadj surface switch)

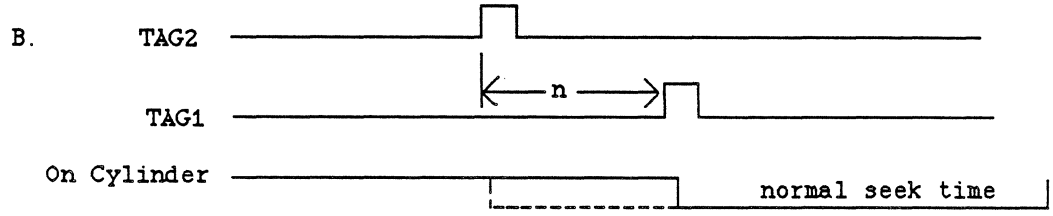
II. While Changing Cylinders

A.



Note: As long as TAG2 command issued a minimum of 4 sectors before on-cylinder returns "True", the headswitch will occur within the normal seek time.

B.



Note: If a TAG2 signal sent before TAG1 in TAG2 drive mode, the on-cylinder "False" time is increased by time "n". In TAG2/TAG1 drive mode, on-cylinder does not go false until a TAG1 is received.

FIGURE 5-2: FAST HEADSWITCH (TYPE 06X)

5.1.3 Data Transfer Rate
The nominal serial data transfer rate is 15.16 megabits per second (1.895 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 RLL (run-length limited) 2, 7 code for reading and writing.

5.1.4 Data Capacity
The data capacity for the various models is outlined in Table 5-1.

5.1.5 Start/Stop Time
The disk start time is less than 12 seconds (8308/8310) or 14 seconds (8312); the stop time is less than 10 seconds (8308/8310) or 12 seconds (8312). Start time is the time time required to reach 90% of full speed. Stop time is from "shutoff" until spindle stop.

5.1.6 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. See 5.1.1 (head switch timing).

5.1.7 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 2.0 microseconds, minimum.

5.1.8 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, based on a nominal disk speed of 3313.5 rpm. The maximum latency time is 18.11 milliseconds.

Latency time is defined as the time required to reach a particular sector after positioning is complete.

5.2.2 Recording Density

Data is recorded on the Mercury Disk Drive at 10,800 fci/ 16,200 bpi nominal on the inner track.

5.2.3 Encoding Method

The Mercury Disk Drive uses RLL 2, 7 (run-length limited) encoding method for data recording.

5.2.4 Track Density

The Mercury Disk Drive has 1104 data tracks per surface recorded at 1069 tracks per inch nominal for the 8310, 1368 data tracks per surface recorded at 1236 tracks per inch nominal for the 8308 and 8312.

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	50,000 Power-On Hours, typical usage
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.

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.

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 two defective sectors per track may occur. Otherwise the track is classified as defective. No track shall have more than three defective sectors.

2) No surface shall have more than 5 defective tracks.

3) The maximum number of defective sectors per drive are:

Per Drive	Maximum Uncorrectable Defective Sectors	Maximum Defective Sectors
8308	180	360
8310	180	360
8312	256	512

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

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 of defect (bits $\pm$ 1 bit)

5) Error Type (correctable/uncorrectable)

6) Position of error from the trailing edge of embedded-servo in bytes ($\pm$ 1 byte). Zero indicates undefined position in sector.

6.1.5 Media Defect Format
The Mercury 8300 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 1103 (8310) or 1367 (8312), heads 0 and 1. These tracks are formatted with the factory 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 it can be recovered. The map can handle up to 600 defects.

The map is divided into twenty 256 byte segments, each of which contains up to 30 defect addresses. The twenty segments are written in the data fields of sectors 0 through 19 of the track and are repeated in sectors 20 through 39, 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.

TABLE 6-1: MEDIA DEFECT MAP FORMAT

Bytes	Value	Comment
0-6	ASCII (MFD8310)*	The model number in ASCII
7-8	1104 or 1438*	Number of cylinders
9	8, 10 or 12*	Number of heads
10	28, 50, 56 or 98	Sectors per track
11-12	256, 512 or 1024*	Bytes per standard sector
13	0-15	Segment Number
14	0-30	Count of defects in this segment of the map
15-254	ccccchhssllttpppp	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 pppp = position of defect (hex)
255	xx	Check sum

* = The data shown above for bytes 0-12 is necessary only once, so it is required only in the first of the sixteen 256 byte segments.

Note: Bytes 256-511 are zero for 512 byte standard sector.
Bytes 256-1023 are zero for 1024 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 10^7 physical seek operations. Unrecoverable seek errors are classified as failures for MTBF calculations.

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.

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 50,000 power on hours (design value) for the Mercury Disk Drive. The MTBF is defined as:

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

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.

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 8300 Installation Guide before installing any equipment.

6.2.6 Service Tools
No special tools are required for installation 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 five 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:

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 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 the drive.

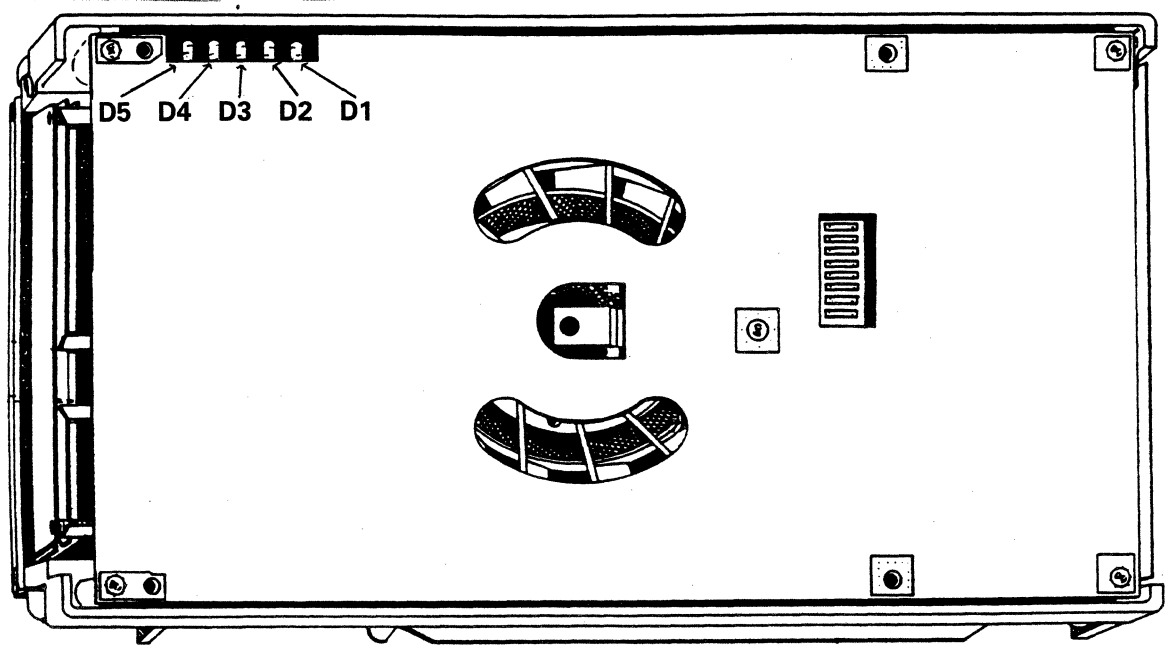
6.2.8.2.2 Drive Motor Control Background Check
The correct speed for the drive motor is continuously monitored. If the speed should fall out of tolerance the heads will be automatically homed, the SMD processor is re-initialized, error status is displayed on the LED's, and drive fault is set.

TABLE 6-2: STATUS LED DISPLAY

STATUS LED					HEX CODE	STATUS CONDITIONS	
GRN D5	RED D4	RED D3	RED D2	RED D1		STATUS	STATUS DESCRIPTION
O	O	O	O	O	00	Initializing	Initialization not yet complete
O	O	O	O	L	01	* ROM Error	Check sum error
O	O	O	L	O	02	* RAM Error	Ram data error
O	O	O	L	L	03	* Power Error	Power monitor fault
O	O	L	O	O	04	Read Channel Error	Unable to read data from disk
O	O	L	O	L	05	* M/C — CEA Cable Error	Tach pluses not occurring
O	O	L	L	O	06	* Motor — M/C Error	Cannot control spindle speed
O	O	L	L	L	07	Clock Gener. Error	Servo headers not occurring
O	L	O	O	O	08	Head Surface Error	Bad head or disk surface
O	L	O	O	L	09	Track Index Error	Cannot find or hold INDEX on track
O	L	O	L	O	0A	* Surface Index Error	Cannot find INDEX on an entire surface during initialization
O	L	O	L	L	0B	* Command Port Error	Unable to clear RTZ and seek commands from host
O	L	L	O	O	0C	Head Stall	Unable to move heads while performing a seek
O	L	L	O	L	0D	Position Servo Error	Head drift off at least one track
O	L	L	L	O	0E	Write Unsafe Error	Head open or shorted, no data transition
O	L	L	L	L	0F	Pick Not Asserted	Pick signal not asserted
L	O	O	O	O	10	Drive Ready with Unit Select	Drive ready and selected at least once
L	O	O	O	L	11	Drive Ready w/o Unit Select	Drive ready, awaiting initial selection
L	O	O	L	O	12	Write Inhibit	Unable to read enough servo headers in one rev.
L	O	O	L	L	13	Write Protect Fault	Attempted to write to write-protected disk
L	O	L	O	O	14	Interface Fault	I/F fault set, not attributed to drive

STATUS LED					HEX CODE	STATUS CONDITIONS	
GRN D5	RED D4	RED D3	RED D2	RED D1		STATUS	STATUS DESCRIPTION
L	O	L	O	L	15	Seek Timeout	Unable to complete seek within allotted time
L	O	L	L	O	16	Servo Header Error	Servo header out of position
L	O	L	L	L	17	* Processor Bus Failure	Unexpected processor restart instruction
L	L	O	O	O	18	Off-track Error	Head off centerline
L	L	O	O	L	19	Open Interface Cable	"A" Cable not properly connected
L	L	O	L	O	1A	Indeterminate Sector Size	Unable to determine Sector Size
L	L	O	L	L	1B		
L	L	L	O	O	1C		
L	L	L	O	L	1D		
L	L	L	L	O	1E		
L	L	L	L	L	1F	* Processor Error	Processor unable to execute instructions

L — Light On
O — Light Off
* — Requires host reset to clear

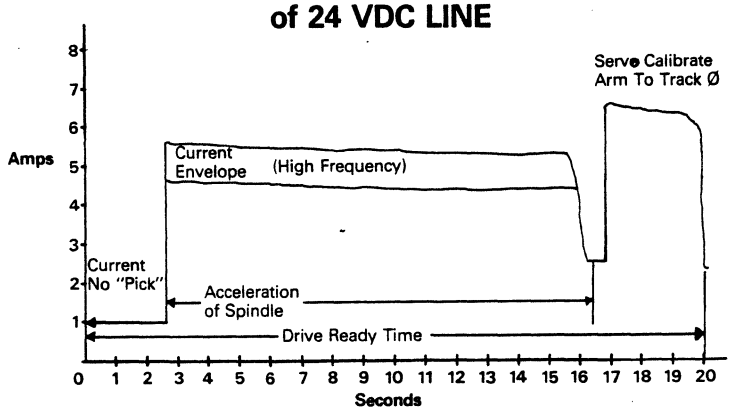


7.0 PHYSICAL/ELECTRICAL SPECIFICATIONS

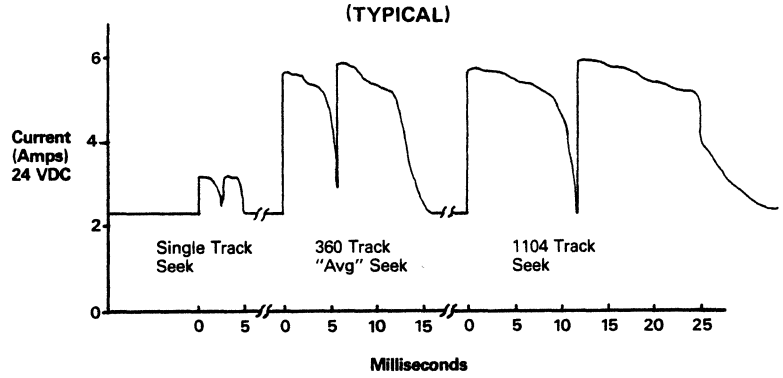
7.1 POWER REQUIREMENTS

a. Current	Maximum Requirements
+24VDC	2.3 A (average idle) 5.5 A (typical while seeking) 6.8 A (peak)
+5VDC	3.5 A (peak)

CURRENT PROFILE of 24 VDC LINE



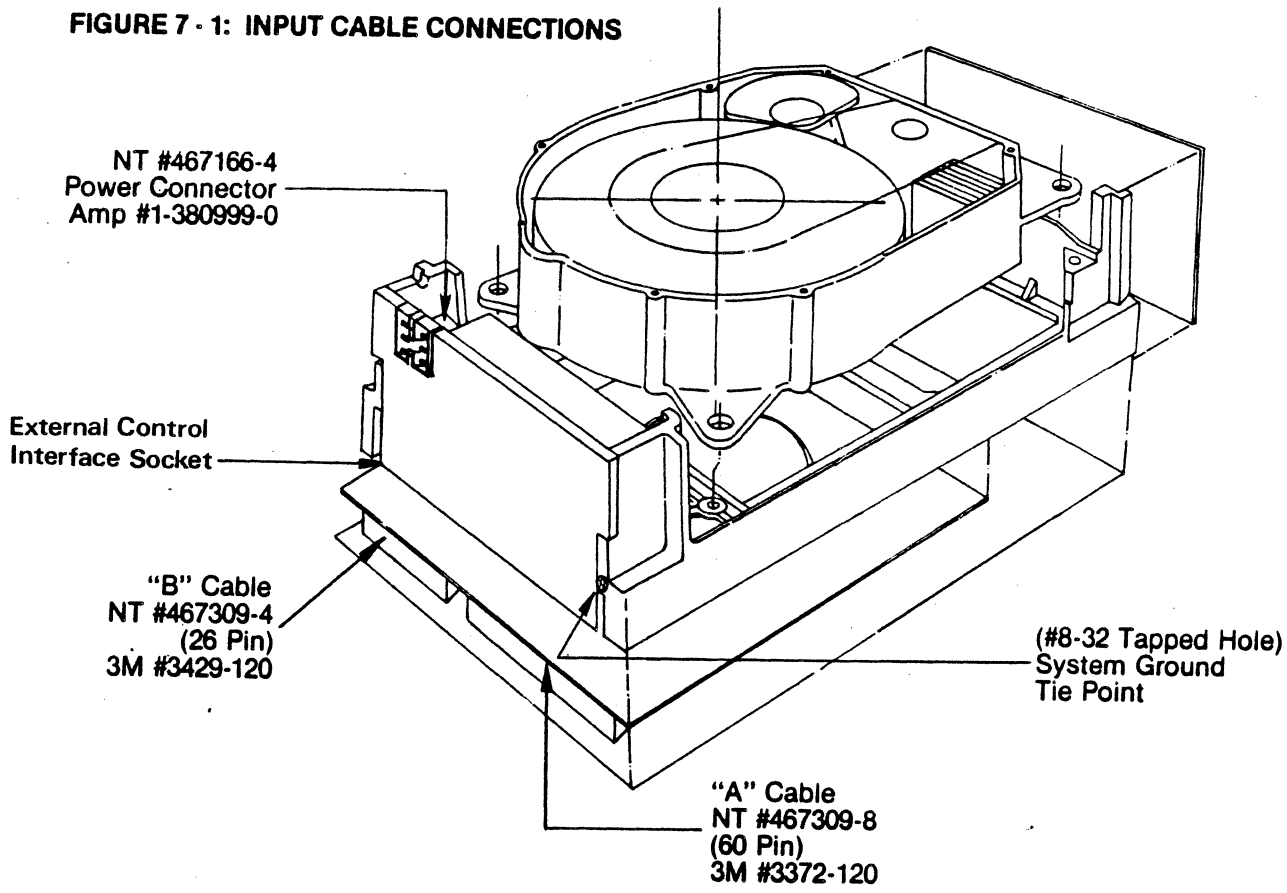
24 VOLT SEEK CURRENT WAVEFORMS
(TYPICAL)



7.1.1 DC Power Connector

INPUT CABLE CONNECTIONS

FIGURE 7 - 1: INPUT CABLE CONNECTIONS



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	± 5%	50 mV	3.5 A (peak)
+24	± 10%	240 mV	7.0 A (peak)

DC Pin Assignments

Pin	Signal
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.

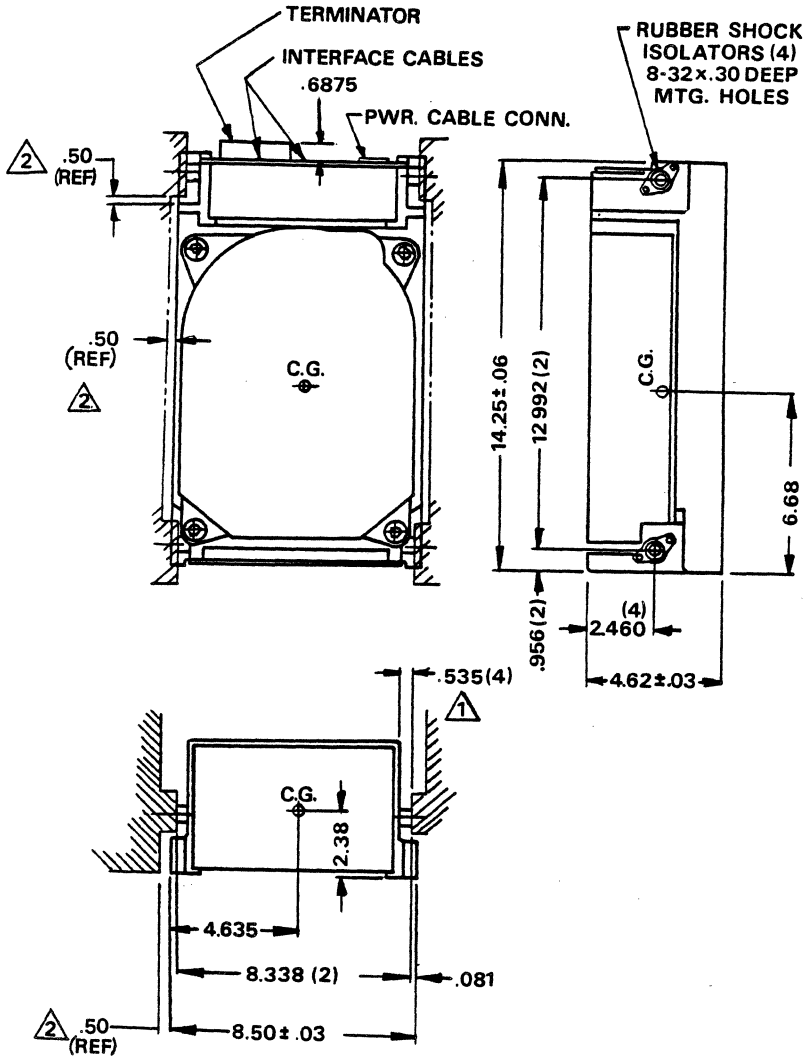
2. Suggestions:
   a. Use independent ground returns and independent feeds.
   b. Use 14 gauge stranded wire, maximum 6 foot length.
   c. Adjust power supply for nominal voltage at the input connector while drive is running.

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 22.5 pounds max.

FIGURE 7-2: MOUNTING DIMENSIONS



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 45 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^{o}C.

7.3.3 Relative Humidity (non-condensing)

1. Operating

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

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:

	Shock	Vibration
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)

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.

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.

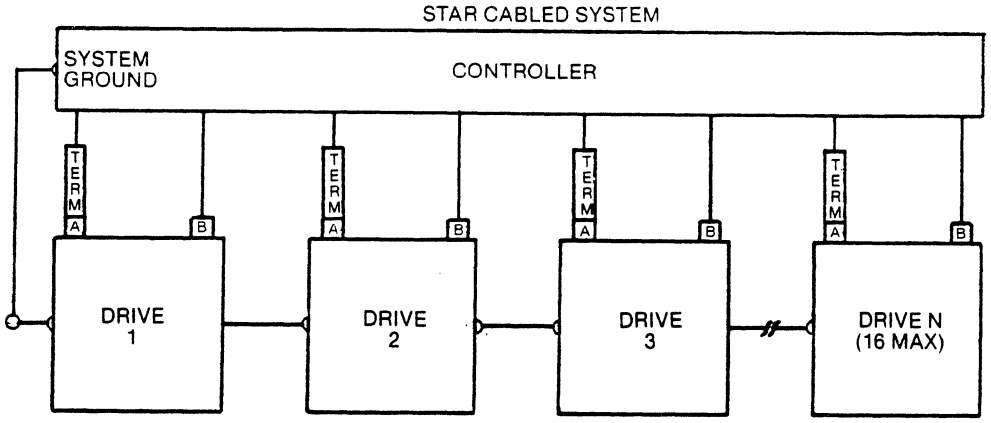
The disk drives are connected to a control unit by means of a Control cable ("A" cable), Read/Write cable ("B" cable), and dc ground cable. The "B" cable connects each drive directly, radial configuration, to the control unit. Fifteen meters is the maximum length of any "B" cable. The "A" cable can connect 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. 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.

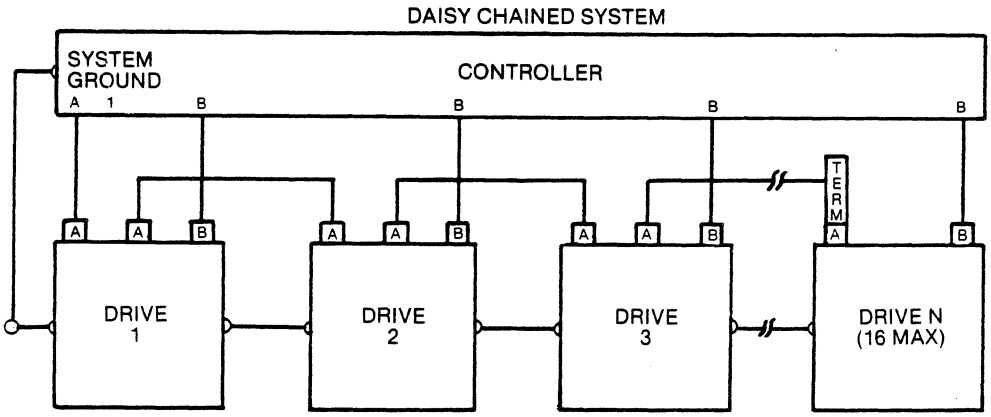
See Section 8.5 for more detail on interface termination.

8-1: CONNECTION TO THE CONTROL UNIT



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.

8.2 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.

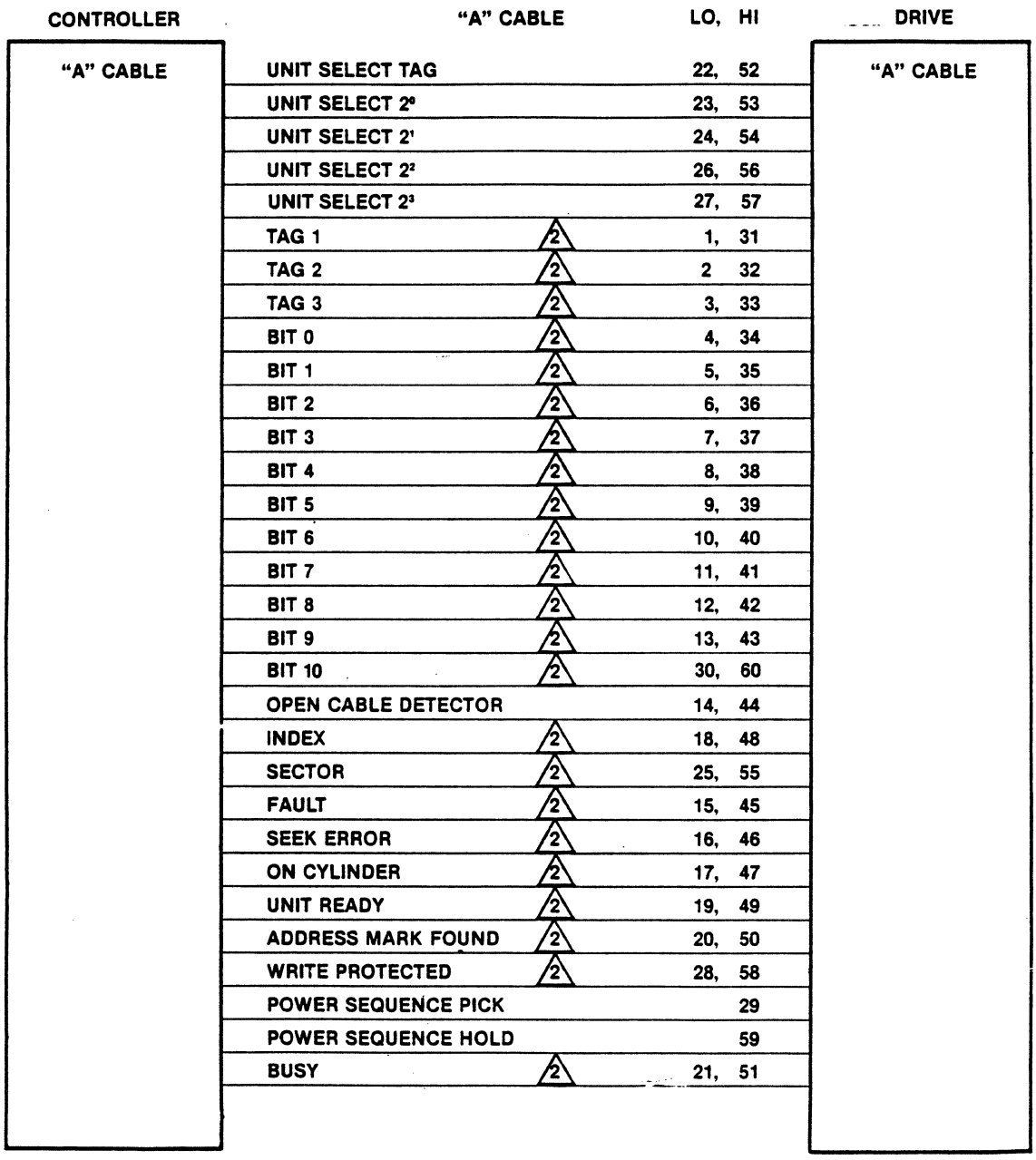
8.2.1.3 Cylinder Address (Tag 1)
The Mercury Disk Drive is a direct addressing device. The controller need only to place the new address on the bus lines and strobe the lines with Tag 1.

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.)

FIGURE 8-2: "A" CABLE INTERFACE



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

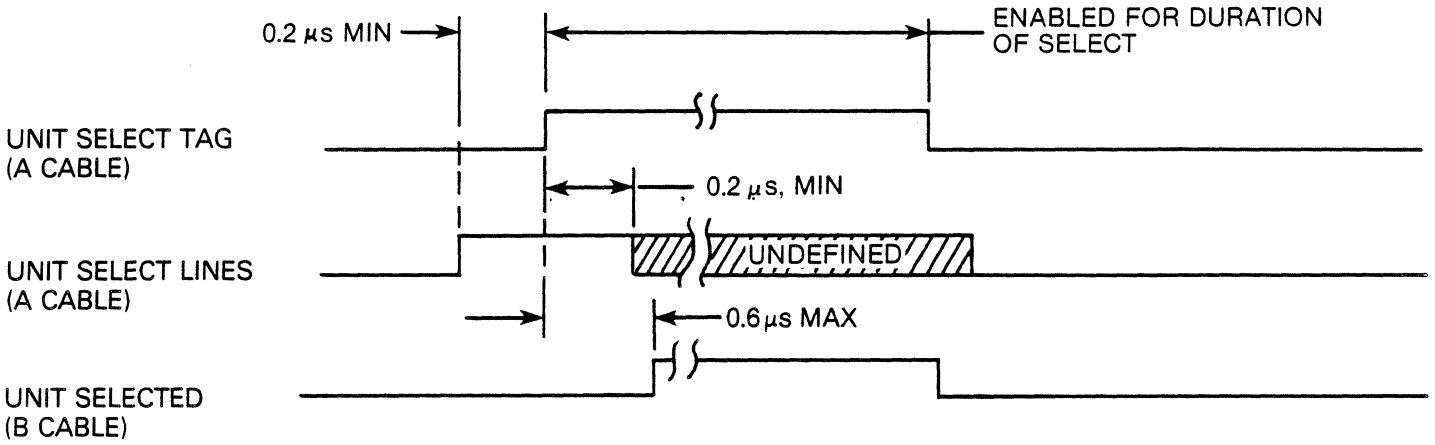


FIGURE 8-4: TAG BUS DECODE

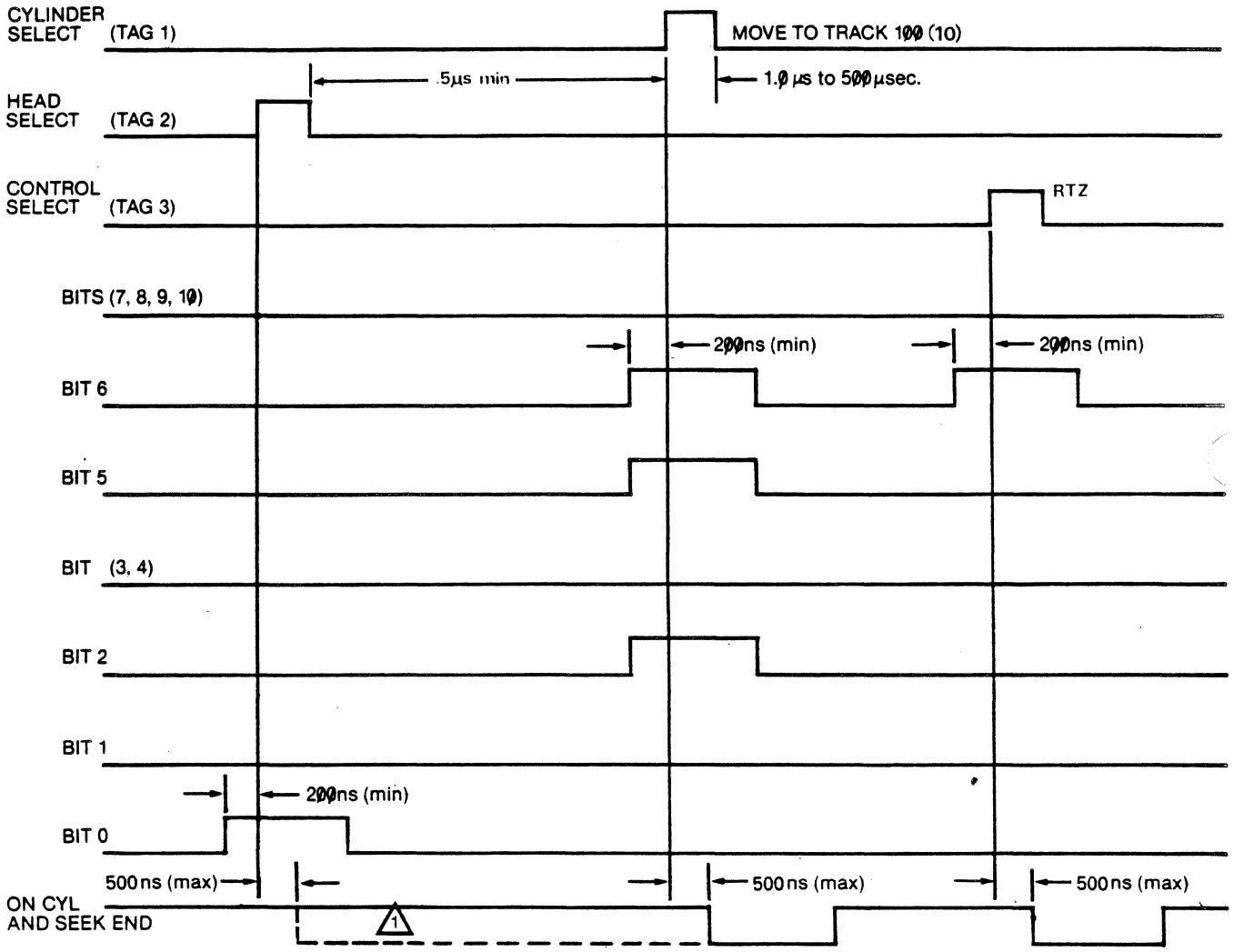
	TAG 1 IN	TAG 2 IN	TAG 3 IN	
BUS	CYLINDER ADDRESS	HEAD SELECT	CONTROL SELECT	UNIT SELECT
Bit 0	2^0	2^0	Write Gate	
1	2^1	2^1	Read Gate	
2	2^2	2^2	Servo Offset Plus	
3	2^3	2^3	Servo Offset Minus	
4	2^4		Fault Clear	
5	2^5		AM Enable*	
6	2^6		RTZ	
7	2^7		Data Strobe Early	
8	2^8		Data Strobe Late	
9	2^9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

*NOT USED ON MERCURY DRIVE

FIGURE 8 - 4: TAG BUS DECODE

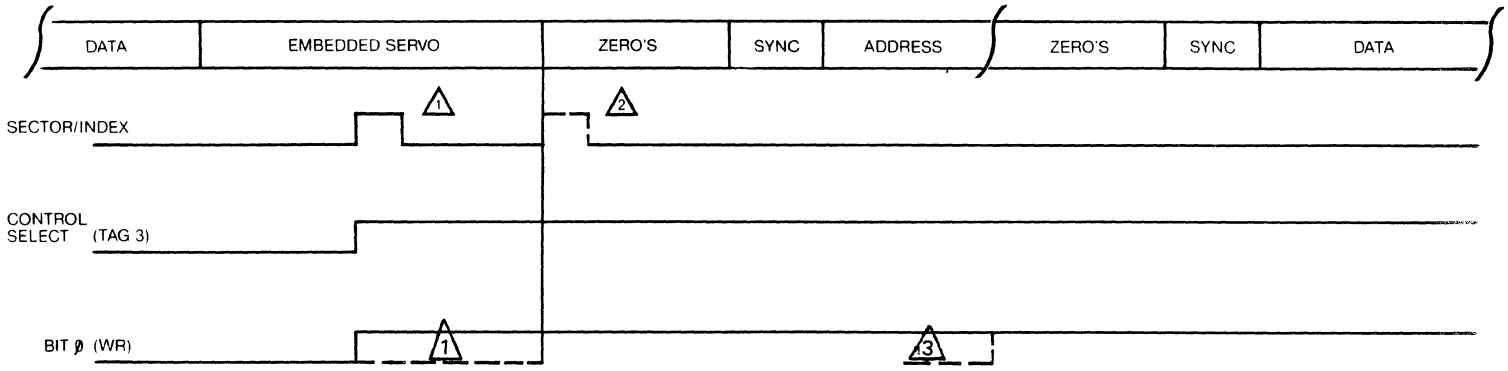
FIGURE 8-5: TAG AND BUS TIMING

TYPICAL SEQUENCE



1 Head switch convention shown; Tag 2 causes "ON CYL" false. Optional convention; Tag 2 followed by Tag 1 required for head switch to occur. Drive does not require "ON CYL" true before accepting a Tag 1 or Tag 2 command.

FIGURE 8-6: TYPICAL WRITE TIMING



1. With sector pulse in this position (see Options), Write must either be delayed 14 bytes (approx. 8 μs) from the leading edge of the sector or a minimum 25 byte zero preamble (PLO) must be written. (The first 14 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.

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 Forward (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 Reverse (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.

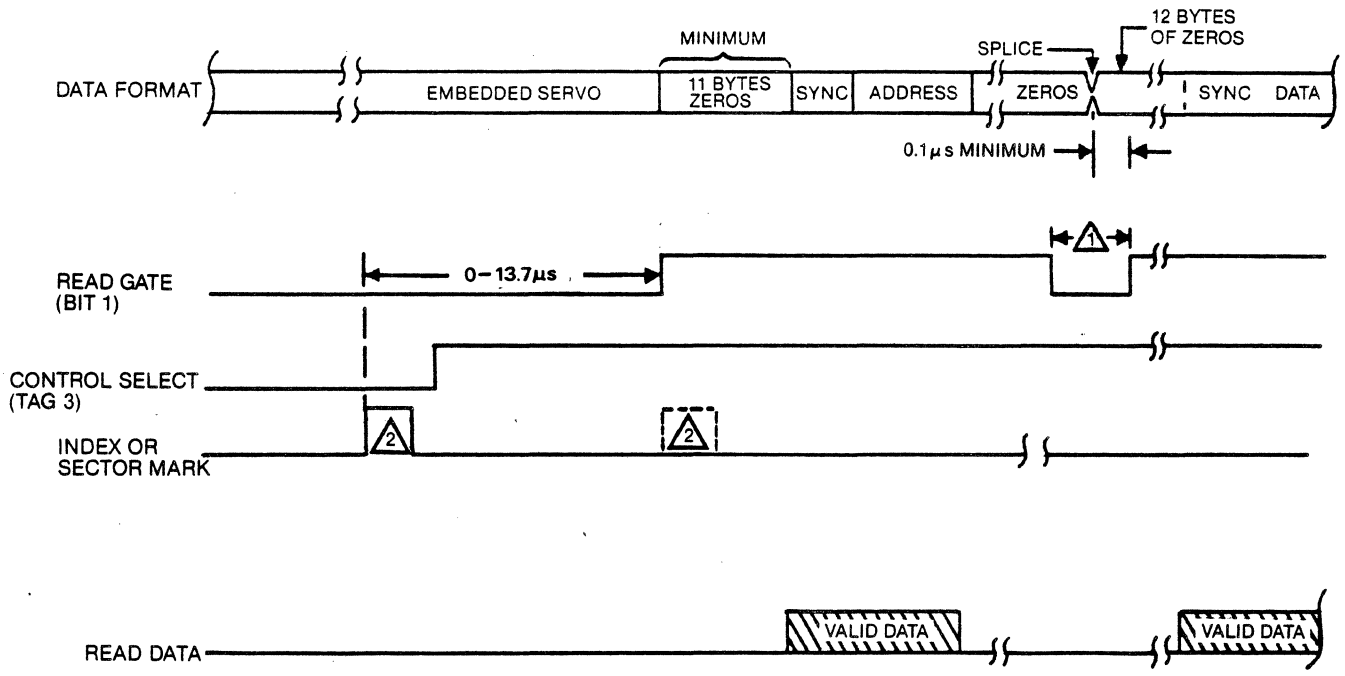
8.2.1.5.6 AM Enable (Bit 5)
Because of embedded servo, variable length sectors are not provided by the Mercury Disk Drive, and thus Address Marks are not used.

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 0. In the unlikely event that the drive loses its knowledge of its heads position on a surface, this command could take 1.5 sec. max.

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.

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.

FIGURE 8-7: READ GATE TYPICAL TIMING



NOTES: 1 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.

2 Sector pulse position is a variable and can be selected to be 14 bytes before customer sector or at customer sector.

FIGURE 8 - 7 : READ GATE TYPICAL TIMING

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 2.0 microseconds (see Figure 8-8). Timing integrity is retained throughout seek operations.

8.2.1.8 Sector Mark
The Sector Mark (typically 2.0 microseconds) 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 sections 3.2.2 and 3.2.3.

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. (Min. Delay between commands is 2 USEC).
3) Write and read asserted simultaneously
4) Cylinder or head command when unit ready is false.

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, error indicators are provided on the CEA PC board. See Table 6-2.

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.
2. Head select address received from the host controller exceeds head address range.
3. Cylinder or head cannot be selected within 500 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 and/or head change command is issued by the host controller and is asserted by the drive after successfully executing the 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.

8.2.1.13 Address Mark Found

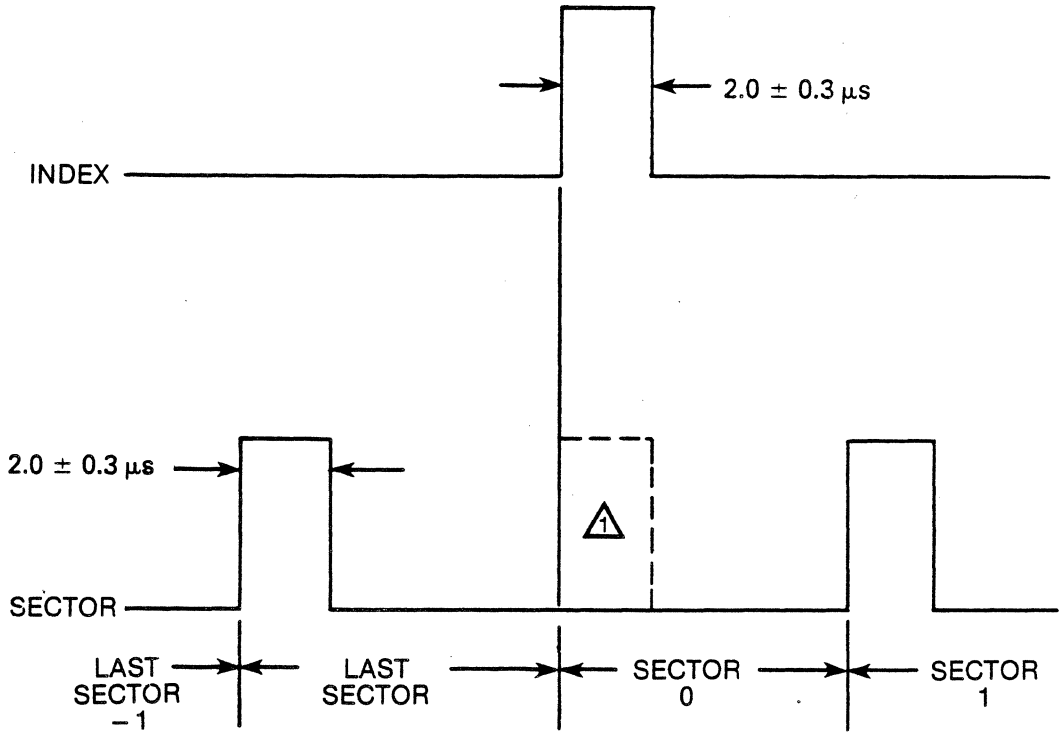
Because of embedded servo requirements, variable length sectors are not provided by the Mercury Disk Drive, and thus Address Marks are not used.

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.



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

FIGURE 8 - 8: INDEX AND SECTOR TIMING

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.

8.2.2.3 Servo Clock
The Servo Clock is a phased-locked 15.16 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).

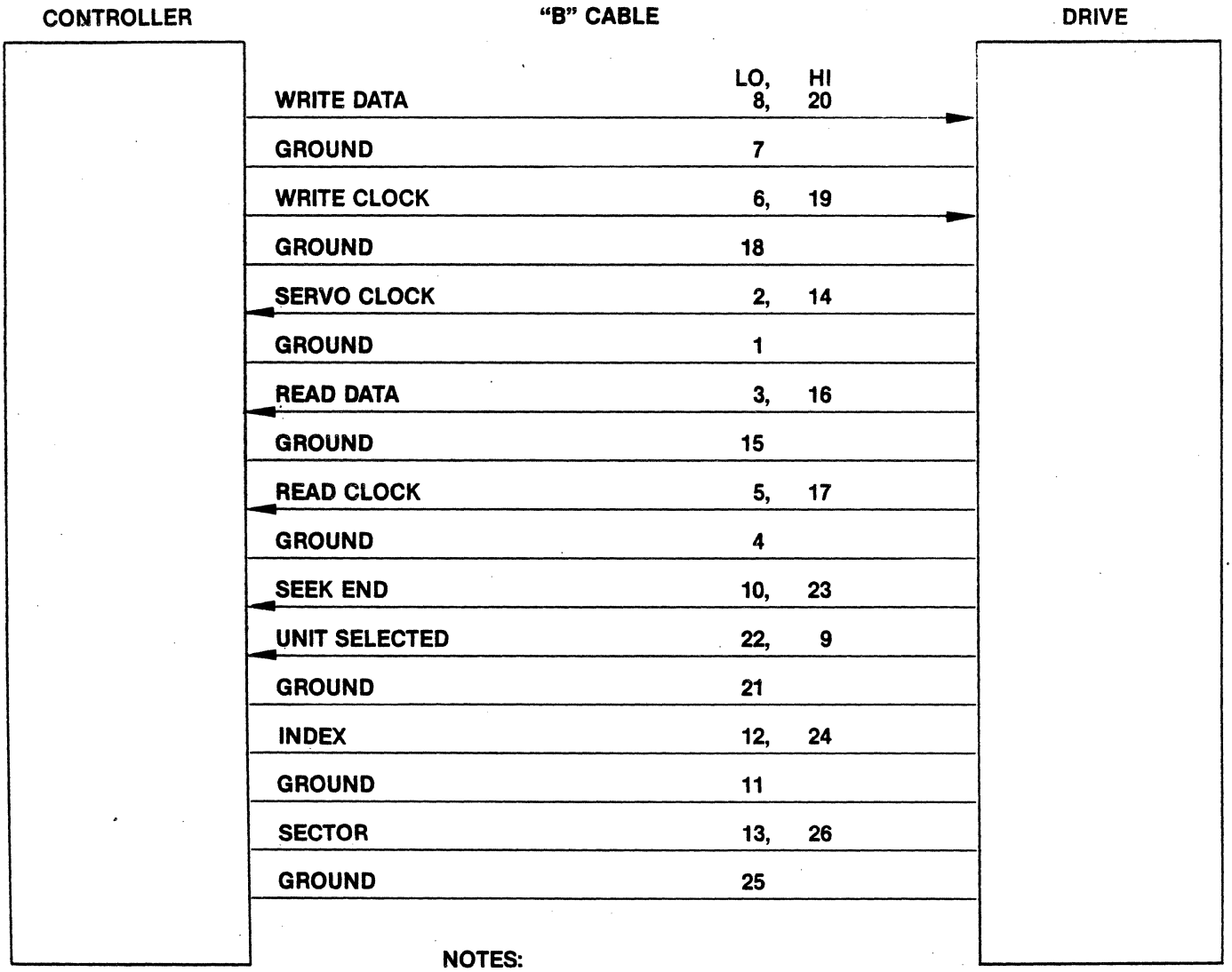
8.2.2.4 Read Data
This line transmits the recovered data in the form of NRZ data (see Figure 8-10(B)).

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). (See 3.3.11 Servo Clock Option)

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
This signal is transmitted by the drive to indicate a successful selection. A delay of a maximum of 600 ns can occur from the assertion of Unit Select Tag (Paragraph 8.2.1.1) to this signal becoming active.

FIGURE 8-9: CABLE INTERFACE



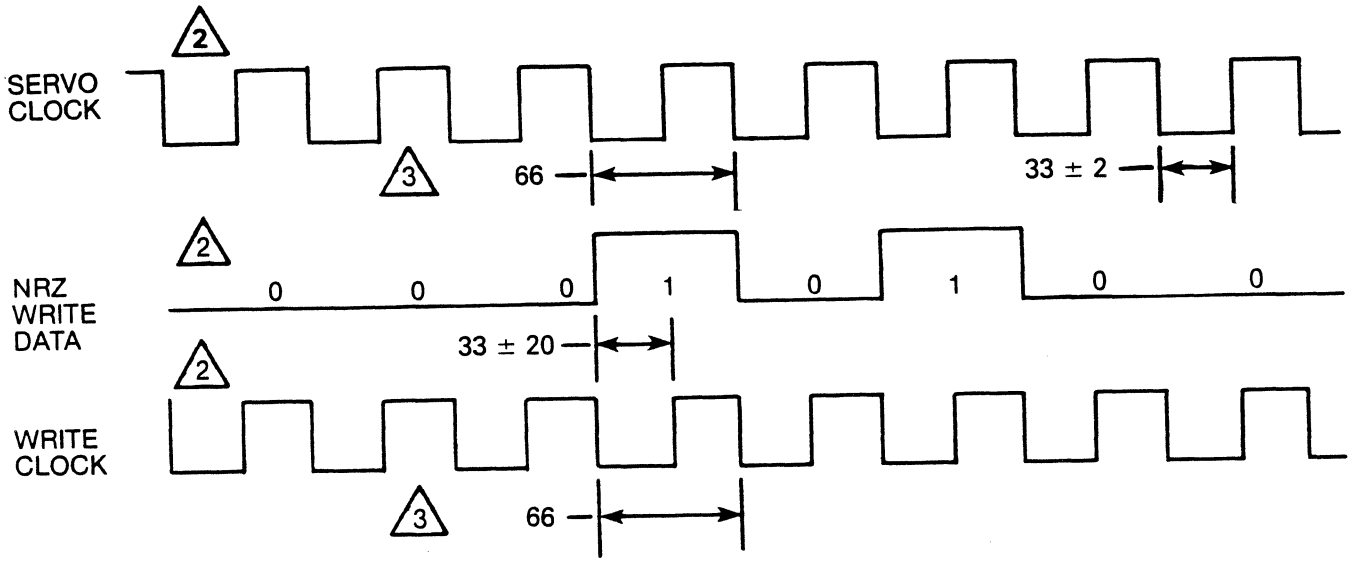
NOTES:

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

FIGURE 8 - 9: CABLE INTERFACE

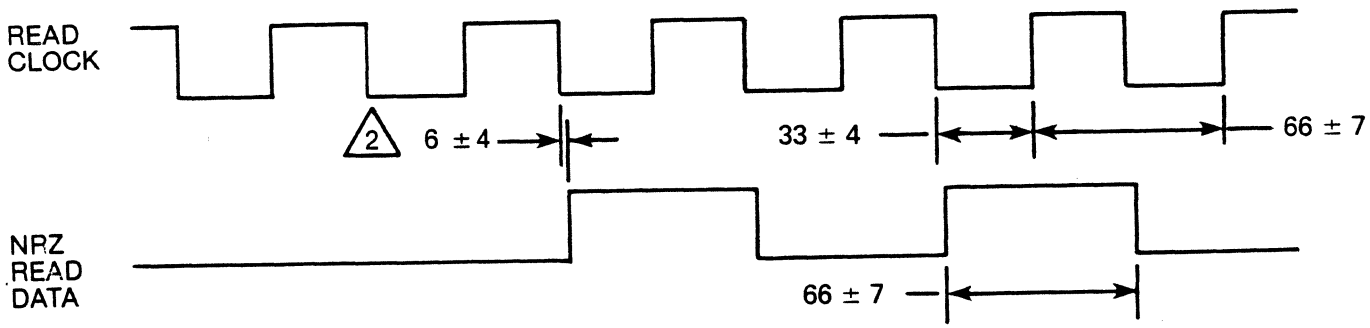
FIGURE 8-10: DATA TIMING

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 caused by:
   - Variations between inner and outer cylinder.
   - Dynamic jitter on bit-to-bit basis. Applies when on cylinder.
   - For ±.2% drive speed variation.

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

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

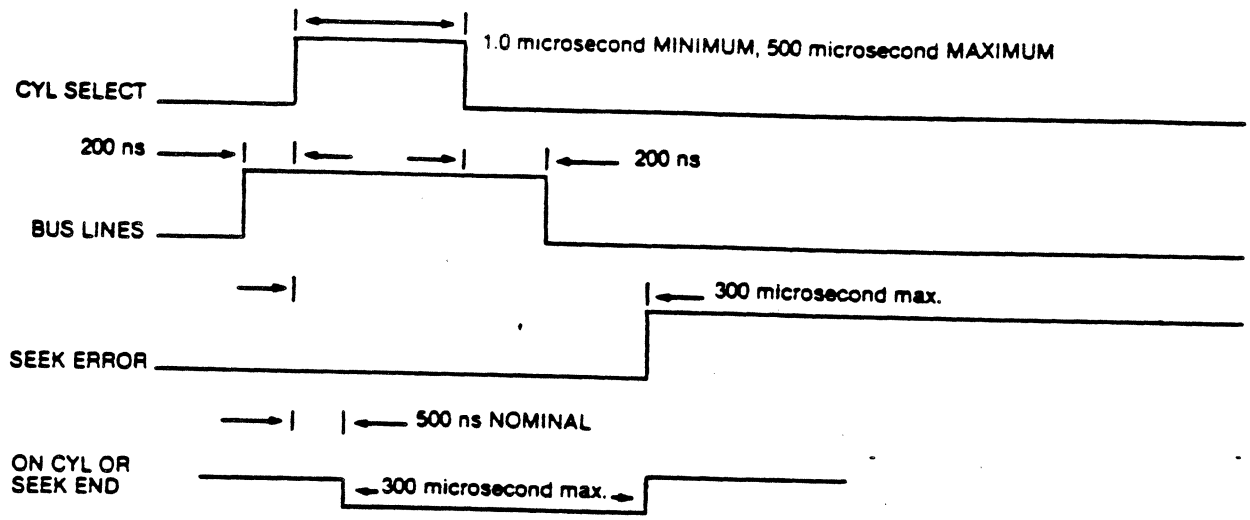


FIGURE 8 - 11: SEEK END TIMING (Invalid Cylinder Address)

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 14 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).

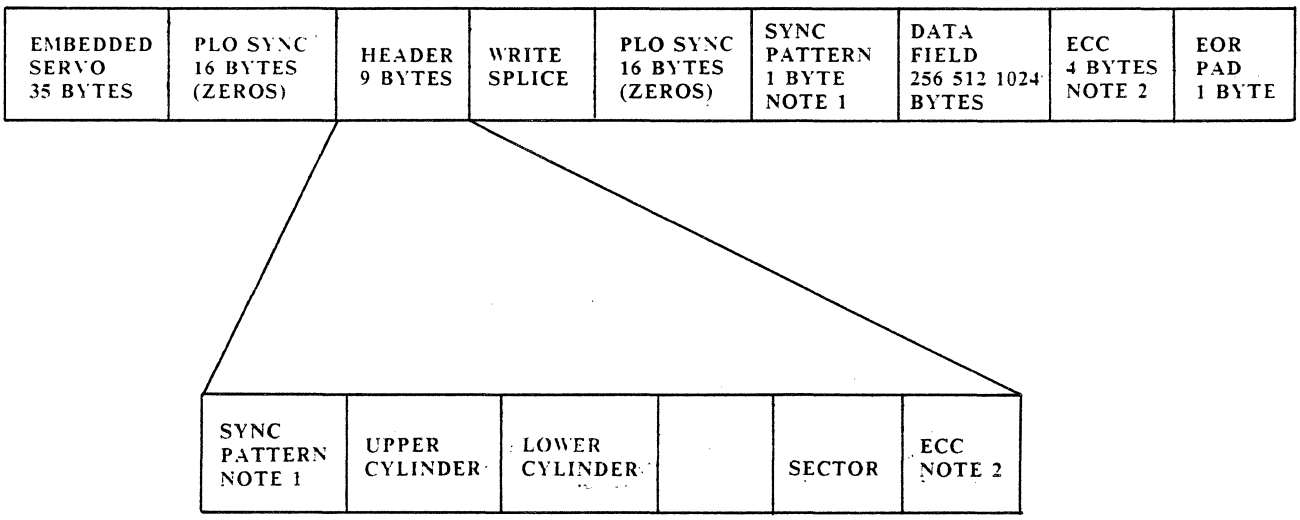
4. Write Driver Turn On

   The write driver turn on time is approximately 800 ns. This time has to be accounted for to accommodate write splices.

5. End-of-Record Tolerance

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

FIGURE 8 - 12A: FACTORY WRITTEN SECTOR FORMAT



NOTE 1: SYNC PATTERN is 19(HEX)
NOTE 2: ECC Generation Polynomial is $X^{32} + X^{23} + X^{21} + X^{11} + X^2 + 1$
ECC does not include sync byte
ECC is reset to zeroes at start of data

8.4 EXTERNAL CONTROL INTERFACE

The external control interface provides external switch inputs for: Unit Select, Write Protect, Remote/Local 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 LEDs is not provided on the connector and must be supplied from the external power supply.

TABLE 8 - 1: EXTERNAL CONTROL INTERFACE

Pin	Signal	Direction
1	GND	---
2	FPSWO*	Input
3	FPSW1*	Input
4	FPSW2*	Input
5	FPSW3*	Input
6	REM/LOC*	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

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 3.3.8), the local mode is activated.

8.4.3 External Control Enable (FPENA*)
Signal FPENA* enables the external unit select switches on the External Control Interfaces when active low and disables the unit select switches 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.

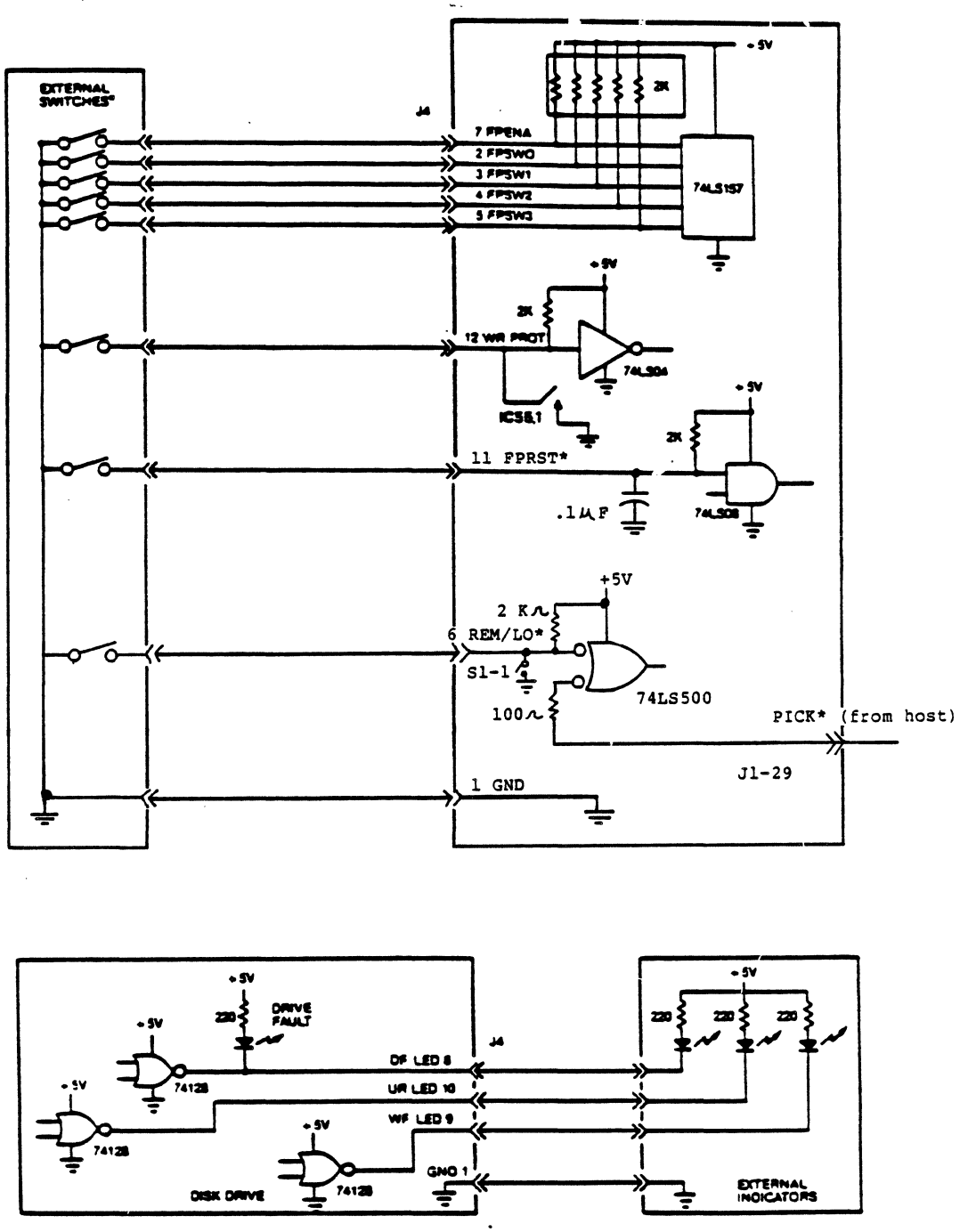
8.4.5 Write Fault External Signal (WFLED*)
The LED drive signal WFLED, indicates a write fault has occurred.

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 microprocessor to initialize and clears all faults.

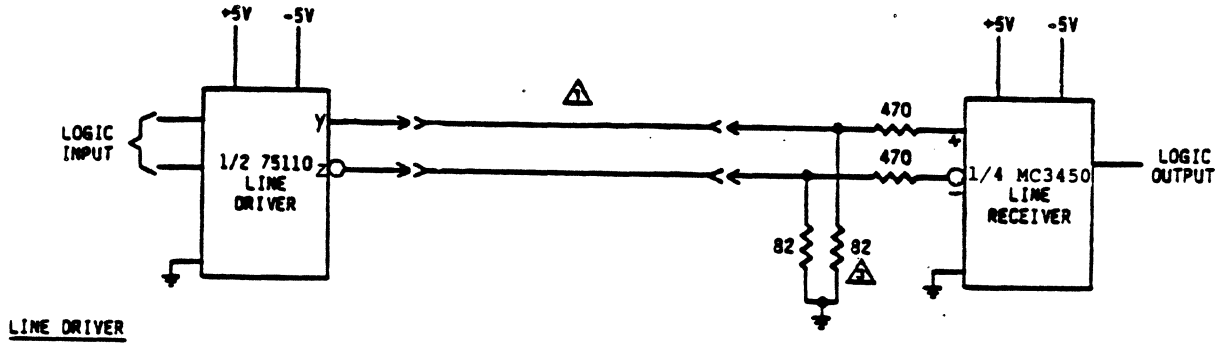
8.4.8 Write Protect External Control (WRPROT*)
Signal WRPROT*, when active low, inhibits all write operations. Activation of WRPROT or the Write Protect on the SMD Interface card will write protect the drive.

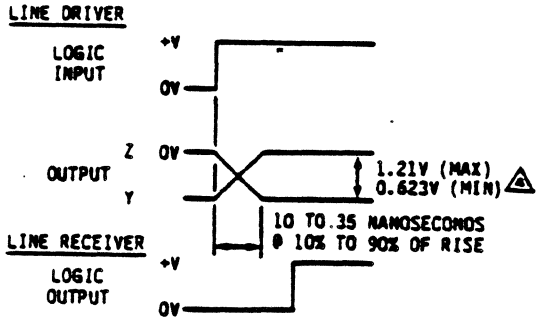
FIGURE 8-13: EXTERNAL CONTROL INTERFACE SIGNAL TERMINATORS



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 internally to the drive as shown in Fig 8-16 and 8-17.





CABLE CHARACTERISTICS

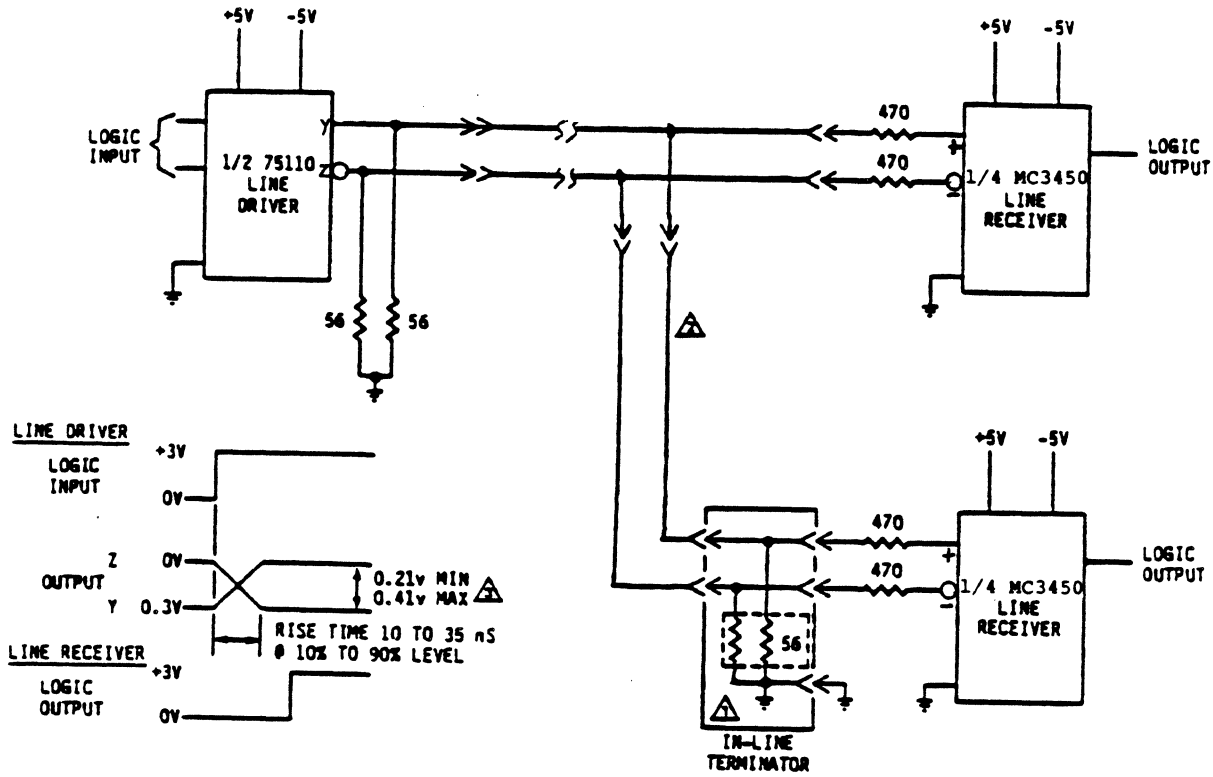
Type: 25 conductor flat ribbon cable
Impedance: 100 ±15 ohms
Wiresize: 28 AWG, 7 strands, each conductor
Propagation Time: 1.4 to 1.6 nS/Ft.
Max Cable Length: 50 ft

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

NOTE

1. All resistor values shown are in ohms.



The 56 ohm ±5% 1/4 watt in-line terminator resistors should only be located near the last line receiver on the SMD Interface Control Cable.

CONTROL CHARACTERISTICS

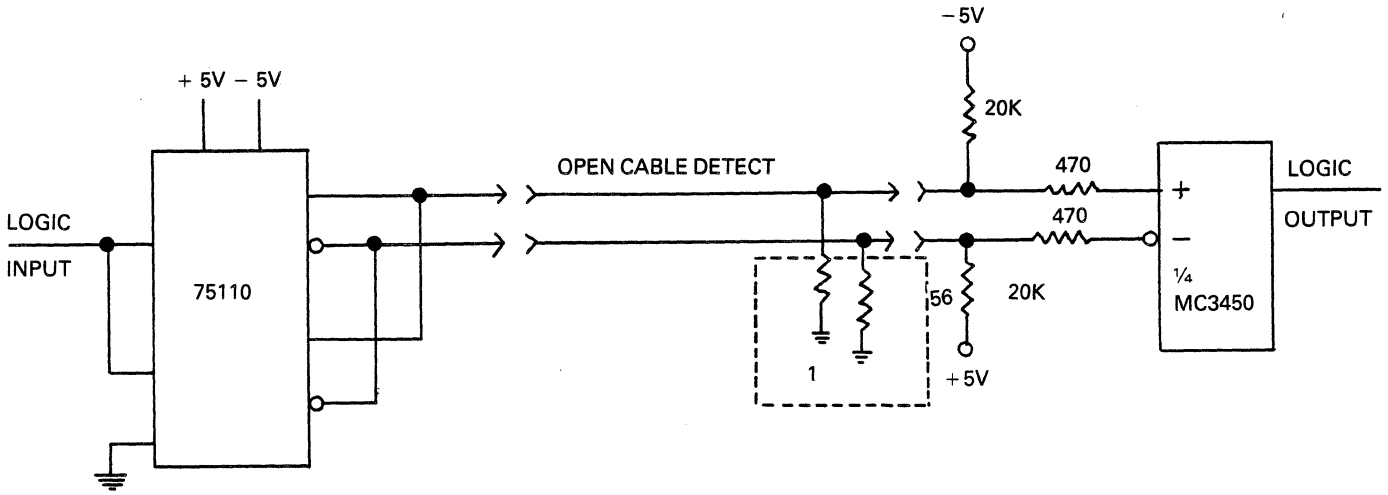
Impedance: 100 ±10 ohms
Wire Size: 28 AWG, 7 strands
Propagation Time: 1.4 to 1.6 nS/Ft.
Type: 60 pin flat ribbon cable
Max. Cable Length: 100 ft, cumulative
Voltage Rating: 150 Vrms

Voltage range includes line driver output swing in low state when I_{out} is 11 ±3ma 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. All resistor values are shown in ohms.

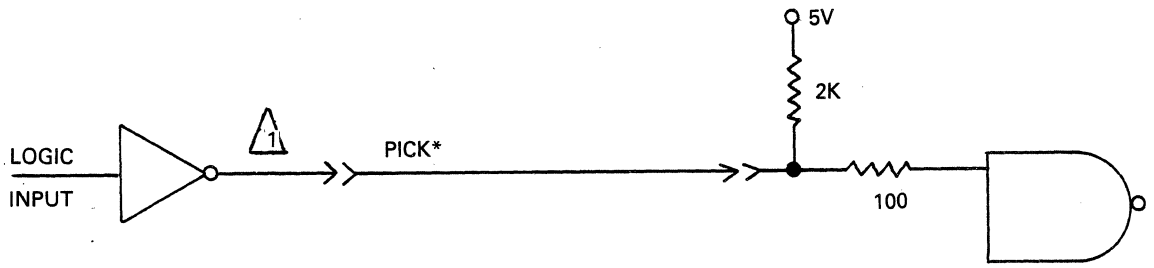
FIGURE 8-15



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

⚠1 Located on terminator assy.

FIGURE 8-16



⚠1 Must be capable of sinking 2.5 mA per drive.

FIGURE 8-17