Century Data Systems
A Xerox Company

Hunter

Performance Specification

76270-901

HUNTER
Performance Specification
MAY 1979

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A Xerox Company

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SECTION 1
INTRODUCTION

1.1 PURPOSE

This manual contains the information necessary to interface a HUNTER disk drive to a controller and ultimately to a computer system. Sections 4 through 6 describes Trident interface HUNTERS. SMD interface HUNTERS are described in Sections 7 through 10. All other sections refer to all members of the HUNTER family unless otherwise noted.

1.2 RELATED DOCUMENTS

Companion Century Data Systems documents include:

- HUNTER Technical Manual, P/N 76270-100
- HUNTER Field Parts Catalog, P/N 76270-500
- T2003 Exerciser Technical Manual

1.3 GENERAL DESCRIPTION

The HUNTER family of disk drives is a series of low cost, high density, modular cartridge disk drives uniquely suited to the OEM's requirements. Using 3330 technology, they provide 32, 67, and 100 megabytes of storage in a 10½" high rack-mounted device. Access time is 6 ms track-to-track and 55 ms full stroke, with a data transfer rate of 1209 Kbytes per second.

HUNTER contains many features which allow the systems designer to incorporate it into his system with a minimum of effort. Among these are self-contained data separator, microprocessor control logic, extensive diagnostic information variable record length capability. HUNTER offers you a third generation replacement for conventional cartridge disk drives.

1.4 FEATURES

DIAGNOSTIC AIDS including detailed error reporting.

FRONT PANEL DISPLAY indicates operator or program errors as well as drive malfunctions thus minimizing service calls.

MAINTENANCE CYLINDERS provide scratch area for maintenance.

ALIGNMENT CYLINDERS provide for replacement and realignment of heads in the field.

VFO DATA SEPARATOR standard.

SECTOR COUNTER AND TARGET REGISTER are integral to drive.

DATA TRANSFER RATE IMPROVEMENT of up to 4:1 over conventional 5440/2315 type drives.

25% IMPROVEMENT in data access time over conventional 5440/2315 type drives.

ENCLOSED CONTAMINATION CONTROL SYSTEM provides superior operation in non-computer room environments.

HEAD OFFSET AND VARIABLE DATA STROBING maximize data integrity.

DUAL ACCESS capability provided for shared data base or redundant systems.

SECTION 2
SPECIFICATIONS

2.1 OPERATIONAL SPECIFICATIONS

2.1.1 Operational specifications for HUNTER Disk Drives are listed in Table 2-1 below.

Table 2-1. Disk Drive Specifications (Nominal)

	H-32	H-64	H-96
Capacity			
Fixed	16.79 MB	50.37 MB	83.96 MB
Removable	16.79 MB	16.79 MB	16.79 MB
Bytes per track	20160	20160	20160
Tracks per cylinder	2	4	6
Bytes per cylinder	40320	80640	120960
Number of cylinders	833	833	833
Single track positioning time	6 ms	6 ms	6 ms
Average positioning time	30 ms	30 ms	30 ms
Maximum positioning time	55 ms	55 ms	55 ms
Rotational speed	3600 RPM	3600 RPM	3600 RPM
Average latency time	8.3 ms	8.3 ms	8.3 ms
Recording density	6060 BPI	6060 BPI	6060 BPI
Track density	384 TPI	384 TPI	384 TPI
I/O Transfer rate	1209 KByte/sec	1209 KByte/sec	1209 KByte/sec
I/O Signal levels	DTL-TTL compatible		
Recording code	MFM-modified frequency modulation		
Interface code (data)	NRZ-none return to zero		
Positioning method	Linear motor track-following servo		
Start time	40 sec. (nominal)		
Stop time	30 sec. (nominal)		

2.2 RELIABILITY

2.2.1 MTBF — Mean Time Between Failures

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

Following an initial period of 200 operating hours, HUNTER drives have been designed to exceed an MTBF of 4000 hours, provided the proper preventive maintenance procedures are followed. To establish a meaningful MTBF, operating hours must be greater than 6000 hours and shall include all sites where the drives are used.

2.2.2 MTTR — Mean Time to Repair

MTTR is defined as the time for an adequately trained and competent serviceman to diagnose and correct a malfunction. HUNTER disk drives are designed so that the MTTR is less than 1.0 man hours.

2.2.3 Preventive Maintenance Time

Routine scheduled preventive maintenance does not exceed one man hour per 18 months based on procedures recommended by Century Data Systems and performed by suitably trained and competent maintenance personnel.

2.2.4 Service Life

Service Life is defined as the amount of time a product may be economically maintained in the field without a factory overhaul. Since the design of the HUNTER allows for the field replacement of all major sub-assemblies, a factory overhaul is not required. Therefore, Service Life is not significant in calculating the costs of owning and operating HUNTER drives.

Key factors affecting the life of HUNTER are based on the application and environment. However, in all cases, strict observance of the prescribed preventive maintenance procedures insures maximum service life and performance.

2.2.5 Cost of Ownership

Based on reliability data, an analysis of a HUNTER in an office environment operation 60 Hr/week with 500 seeks/minute indicated the following: In the first 10 years of operation there is less than a 25% likelihood that any major mechanical sub-assembly will require replacement. These replacements would all be accomplished at the operating site by trained service technicians.

2.2.6 Power Loss

Accidential loss of AC power does not result in any component failure. The drive will retract the heads from the disk pact to ensure that the recording surfaces are not damaged in the event of AC power loss.

2.3 DATA INTEGRITY

Errors attributed to operator mishandling of the disk cartridge or errors in the machine which may be detected and flagged during initialization of the pack are not included in determining error rates.

2.3.1 Recoverable Read Error Rate

A recoverable error is one which may be corrected by no more than 3 attempts to read the record at zero offset and nominal strobe, and 2 attempts to read at each offset position with early, nominal and late strobes (19 reads, see Figure 5-8, Error Recovery). Any combination of Seek-Write, Seek-Read, Seek-Restore is allowed without limitation of combination or duty cycle. Data patterns and track position do not affect Data Error Rate performance. The Recoverable Read Error Rate for HUNTER is less than one error in 10^{10} bits.

2.3.2 Non-Recoverable Read Error Rate

A non-recoverable error is one which remains after the 19 attempts (described above) to read the record in which the error is located. The Non-Recoverable Data Error Rate for HUNTER is less than one error in 10^{13} bits.

2.3.3 Positioning Errors

The Positioning Error Rate is less than one error in 10^{6} Seek executions.

2.4 MEDIA

Only media from an approved Century Data Systems vendor may be used to determine reliability and integrity statistics. A list of approved vendors may be obtained from any Century Data Systems office.

SECTION 3
FORMAT REQUIREMENTS

3.1 GENERAL

To ensure interchangeability between like disk drives and guarantee proper operation over the entire temperature range, any disk drive must have a preamble and postamble associated with each record (See Figure 3-1). These overhead fields provide compensation for mechanical tolerance, amplifier switching times, VFO capture time and allow for synchronization patterns. The size of each of these fields is dependent upon the tolerances, the bit packing density, and the rotational speed of the drive.

HUNTER offers the user a choice of formatting schemes. Either electronic sectoring or address mark sectoring may be used for fixed length records. Address mark sectoring must be used for variable length records.

The format requirements outlined in this document are based on a maximum controller "turn-around" delay time of 300 ns and drive-to-controller, one way cable delay of 20 ns minimum to 200 ns maximum.

3.2 ELECTRONIC SECTORING

Electronic sectoring derives the sector and index pulses from the dibits recorded on the servo track. The index pulse occurs once per revolution and is available on the INDEX line in the bussed cable. The number of sector pulses is variable from 1 to 256. They are available on the SECTOR line in the bussed cable.

On Trident interface HUNTERS, there is an ungated composite sector index pulse (COMPSECIDX) which may be used for Rotational Positioning Sensing if needed.

Figure 3-1 illustrates the component parts of this format and Table 3-1 defines the minimum size of each area.

3.2.1 Format A

Format A is the typical format used in most sector pulse oriented applications. The sector ID field remains unchanged and is not rewritten when the data field is updated.

L_{OH} 50 bytes for Format A. L_{ID} is a system design parameter. It typically contains the cylinder, track and sector address, flags and check character. L_D is also a system parameter and contains both the data field and check character field. Once L_{ID} and L_D are decided upon, they are added to the appropriate L_{OH} to determine the total byte count of each sector. This number is then strapped into the sector jumper plugs as outlined in the HUNTER Technical Manual P/N 76270-100.

Table 3-1. Format A and B Electronic Sectoring

Field	Contents	Length (Bytes)
Preamble	Zero's	16
VFO	Zero's	11
Sync	One's	1*
ID	User defined	Optional
Splice	—	1
VFO Relock	Zero's	11
Data & Check	User defined	Optional
PAD	One's or Zero's	1
Postamble 1	Zero's	8
L_{OH} = Overhead per sector — Format A:		50
L_{OH} = Overhead per sector — Format B:		37
*Length optional, 1 bit min.		

3.2.2. Format B

Some system applications call for the rewriting of the Sector ID every time the data field is updated. If this is the case, the ID field can be considered as part of the data field and the VFO relock and second Sync field may be eliminated.

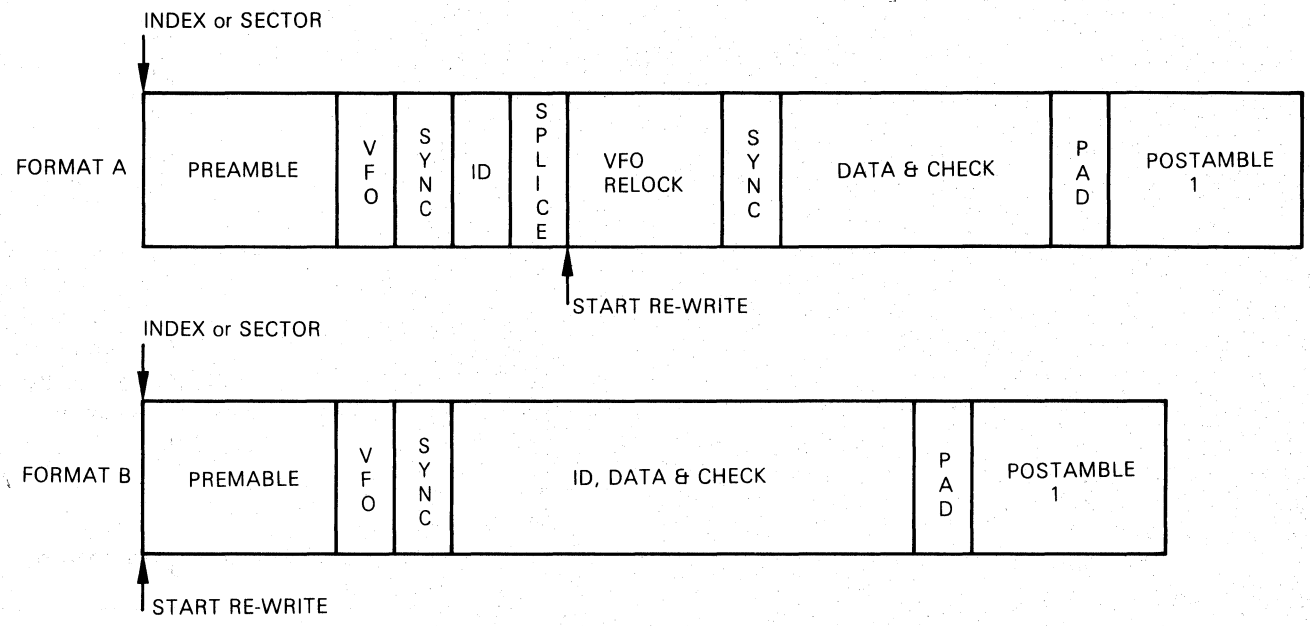


Figure 3-1. Electronic Sectoring Formats A and B

The formula for the maximum number of sectors per track for a given sector size is as follows:

$$n_{Max} = \frac{\text{Track Length}}{L_{OH} + L_{ID} + L_D}$$

n_{Max} = maximum number of sectors

Track Length = 20160

L_{OH} = length of overhead field

L_{ID} = length of sector ID

L_D = length of sector data field

3.3 ADDRESS MARK SECTORING

Address Mark Sectoring derives its reference from special patterns recorded on the data track. Since the tolerances between the servo head and the data heads are eliminated, the overhead is reduced and the net system capacity increases.

HUNTER contains the necessary logic to generate and detect address marks. An I/O command generates the address marks. Another I/O command causes the drive to search to address marks. When one is detected, the Address Mark Detected signal is generated.

Although the sector pulses from the servo surfaces are not used, it is often desirable to use the index mark to gain initial orientation. The index pulse is also a convenient means of denoting the end of a track in a multitrack read or write operation and can initiate the head advance signal in Trident interface HUNTERS to continue the operation.

Address Mark sectoring for sequential read/write operations is illustrated in Figure 3-2 and defined in Table 3-2.

3.3.1 Format C

This format is the most common one used in address mark oriented applications. The sector ID field remains unchanged and is not rewritten when the data field is updated. Adjacent sectors can be processed consecutively.

3.3.2 Format D

If the application calls for rewriting the sector ID field every time the data field is updated, the ID field can be considered as part of the data field and the VFO and first SYNC field may be eliminated. Adjacent sectors can be processed consecutively.

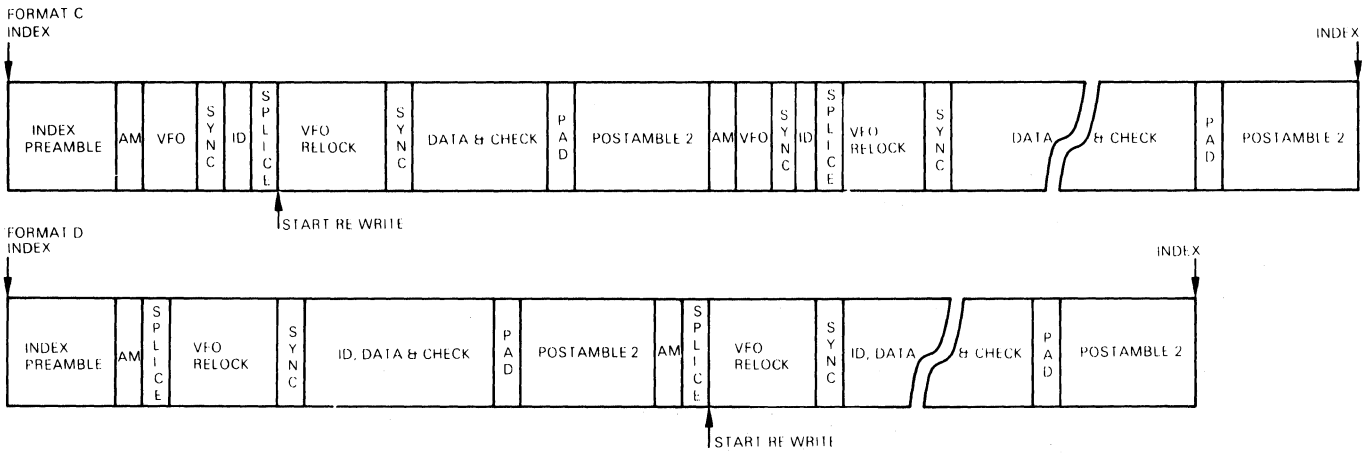


Figure 3-2. Address Mark Formats Sequential Records

Table 3-2. Address Mark Format C and D Sectoring

Field	Contents	Hunter Length (Bytes)
Index Preamble	Zero's	16
AM	Erasure	3
VFO	Zero's	11
Sync	One's	1*
ID	User defined	Optional
SPLICE	—	1
VFO Relock	Zero's	11
Data & Check	User defined	Optional
ID, Data & Check	User defined	Optional
PAD	One's or Zero's	1
Postamble 2	Zero's	15
L_{OH} = Overhead per Sector — Format C:		44
L_{OH} = Overhead per Sector — Format D:		32
Track Overhead for Formats C & D:		16
*Length Optional, 1 bit min.		

3.3.3 Format E

If the system design is such that adjacent records are never processed consecutively, further economy can be achieved. Address Mark formats designed for interlaced records are illustrated in Figure 3-3 and defined in Table 3-3.

Format E is designed for Address Mark applications without the requirement of processing consecutive sectors.

3.3.4 Format F

If the ID field needs to be updated every time the data field is rewritten, further economy can be achieved by considering the ID field as part of the data field. The VFO and first Sync field may be eliminated.

3.4 TRACK ID FIELD

Certain Address Mark applications call for a Track Header with a Track ID field at the beginning of each track. The use of such a track header is optional and the details are illustrated in Figure 3-4 and defined in Table 3-4.

The formula for the maximum number of sectors per track for a given record size using Address Marks is:

$$n_{max} = \frac{\text{Track Length} - (\text{Track Overhead} + \text{Track Header})}{L_{OH} + L_{ID} + L_{D}}$$

n_{Max} = Maximum number of sectors

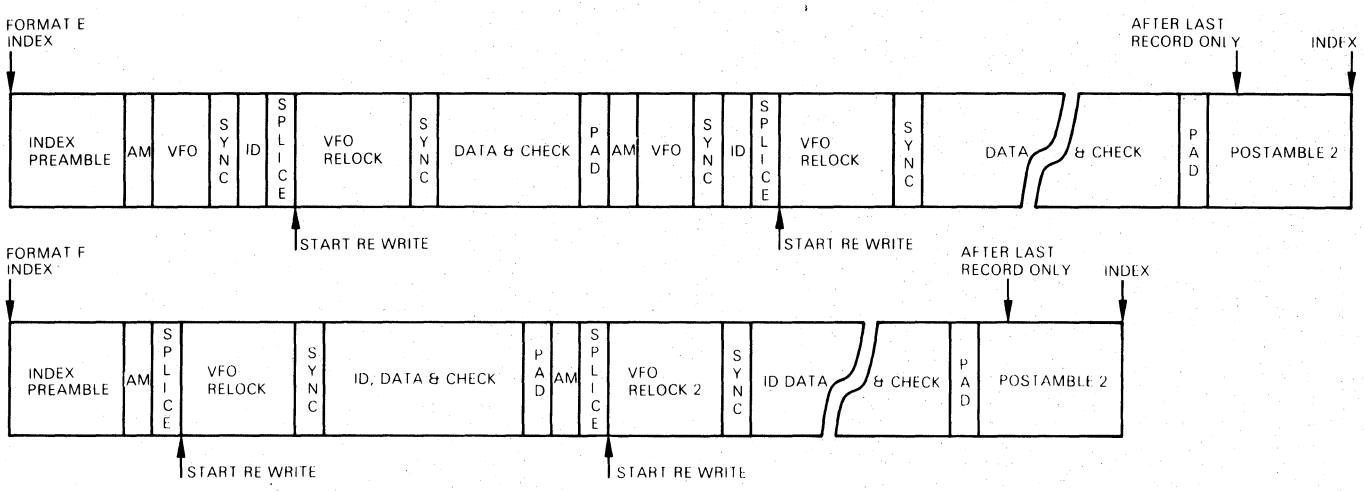


Figure 3-3. Address Mark Formats Interlaced Records

Table 3-3. Address Mark Formats E and F Sectoring

Field	Contents	HUNTER Length (Bytes)
Index Preamble	Zero's	16
AM	Erasure	3
SPLICE	—	1
VFO	Zero's	11
Sync	One's	1*
ID	User defined	Optional
VFO Relock	Zero's	11
Data & Check	User Defined	Optional
ID, Data & Check	User Defined	Optional
PAD	Zero's	2
Postamble 2	Zero's	14
L_{OH} = Overhead per Sector — Format E:		30
L_{OH} = Overhead per Sector — Format F:		18
Track Overhead for Formats E & F:		30
*Length optimal, 1 bit min.		

Track Length = 20160 Bytes

Track Overhead = Format Dependent

Track Header = Optional

L_{OH} = length of overhead field

L_{ID} = length of sector ID

L_D = length of sector data field

Table 3-4. Track Header Format

Field	Contents	HUNTER Length (Bytes)
Index Preamble	Zero's	16
AM	Erasure	3
VFO	Zero's	11
Sync	One's	1*
Track ID	User Defined	Optional
PAD	Zero's	1
*Length optional, 1 bit min.		

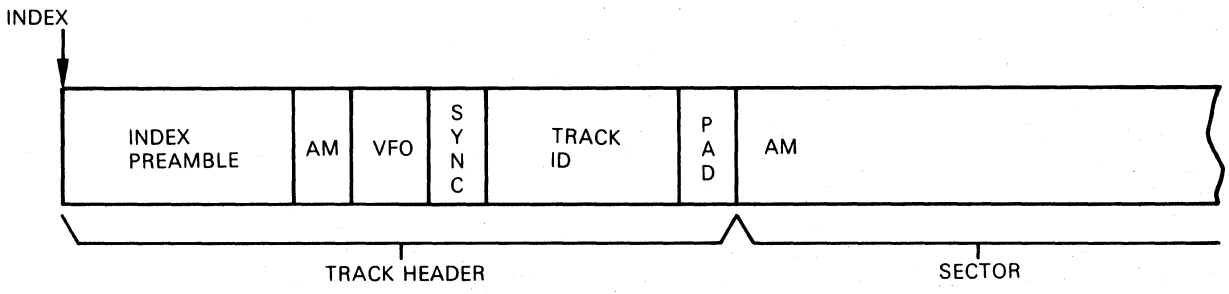


Figure 3-4. Address Mark/Track Header with Track ID Field

SECTION 4
TRIDENT INTERFACE SIGNALS

4.1 DISK DRIVE INTERFACE SIGNALS

Signals appearing at the HUNTER Disk Drive interface and their use are shown in Tables 4-1 and 4-2.

Table 4-1. Radial Cable Signals

Signal Name	Mnemonic	Input/ Output	Description
Select	ISELECT/	I	A low level on this line selects this drive when the terminator is present and the drive is not degated. The drive must be selected at least 200 ns before any bus lines are active.
Selected	ISELECTED/	O	When low, this signal indicates the drive is selected. It goes low within 100 ns of SELECT.
Sequence	ISEQUENCE/	I	A low level on this signal indicates the sequence cycle. If the START switch is on, this signal will control the spindle motor. It should be removed at least one second before controller DC is removed. When the dual access feature is installed, "Sequence" from either control unit will initiate a power up sequence. The drive will not sequence down until both sequencing signals are removed.
Attention	IATTN/	O	When low, the drive has an interrupt active. It will become active at the completion of a "First Seek", "Rezero", "Seek", "Offset Motion", "No Motion Seek", "Seek Incomplete", or when an emergency retract occurs. When the dual access feature is installed, attention will be sent to the access which is connected to the disk drive. Attention is reset by a read command. In addition, a seek command or a rezero will reset attention in the HUNTER.
DC Ground	None	—	This wire is the DC Ground Reference for the drive (Number 8 GA wire should be used).
Composite Sector/Index	ICOMPSECIDX/	O	This line transmits negative going pulses at both sector and index times. The sector pulses are 1.24 ± .24 μs wide and the index pulses are 4 ± 1 μs wide. This signal is not gated with select. It is intended to be used as an input for rotational position sensing circuits (See Figure 4-1).
Termination Power	ICNTLRP5	I	This line supplies +5 VDC from the control unit and is used to terminate "SELECTED", "ATTENTION" and "COMPOSITE SECTOR/INDEX" in each drive. It is also used to terminate the bussed interface in the last unit. The current required is 150 ma per drive plus 1.25A for the bussed interface, worst case.

Table 4-1. Radial Cable Signals (continued)

Signal Name	Mnemonic	Input/ Output	Description
Data	R/W DATA(P) R/W DATA(M)	I/O	When writing, the NRZ write data is transmitted on this line. When reading, the NRZ read data is carried on this line. (See Figure 4-2.)
Clock	R/W/ CLOCK(P) R/W CLOCK(M)	0	When writing, the signal is derived from the servo track on the disk pack. As "Write Clock" it is used to strobe data from the controller. The data shall change only at the rising edge of the square wave (measured at the controller). When "Read Gate" is active, the clock source is switched and synchronized to the data being read from the disk pack. "Read Clock" is also a square wave signal. Data will change within 10 ns of the falling edge of the clock (measured at the drive). See Figure 4-2.
Request (Dual Access Only)	A REQUEST/ B REQUEST/	I	The request line is activated by the control unit whenever access to the disk drive is desired and remains active as long as continued use of the drive is required. Clearing request allows use of the drive by the other control unit. Note: Low level active.
Request From Other C.U. (Dual Access Only)	A REQ FM B/ B REQ FM A/	0	A signal over this line indicates the other control unit is requesting access to the drive. This signal may be used when both control units are dynamically sharing a drive under automatic control. Note: Low level active.

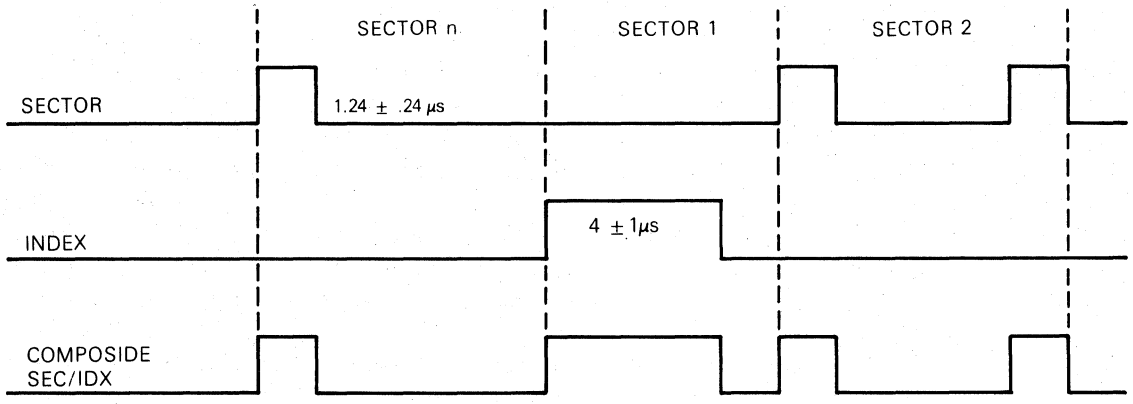


Figure 4-1. Composite Sector/Index Signal

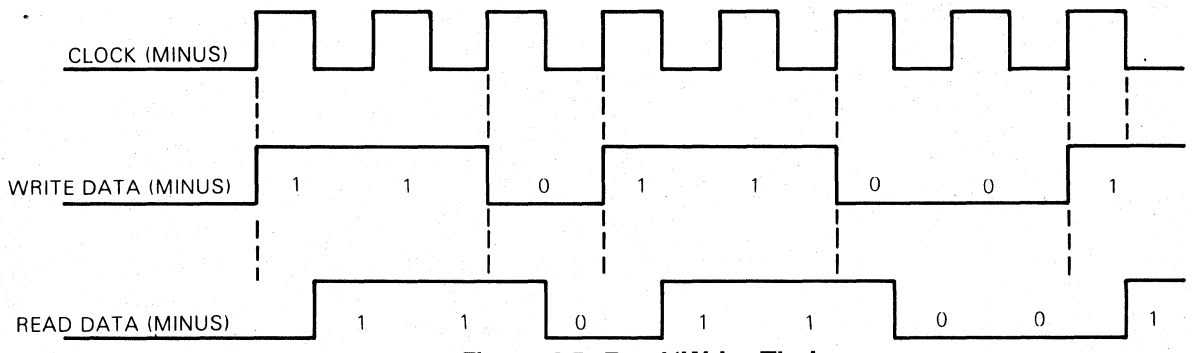


Figure 4-2. Read/Write Timing

Table 4-2. Bussed Cable Signals

Signal Name	Mnemonic	Input/ Output	Description
Bus O → Bus 9	IBUS O/ → IBUS9/	I	The 10 bus lines are interpreted according to the current active tag. The drive must be selected at least 200 ns before any bus lines are active. The bus lines must be active at least 200 ns before the tag line and 200 ns after the tag line. All tag lines must be active at least 800 ns.
End of Cylinder	IEOC/	0	This line when low indicates the contents of the head address register are greater than the number of heads in the drive. This line is active for the following conditions: • Any head greater than 0 is selected when the cartridge is selected. • Any head greater than 0 is selected when the drive is H-32. • Any head greater than 2 is selected with the drive is H-64. • Any head greater than 4 is selected with the drive is H-96.
Offset	IOFFSET/	0	This line when low indicates that the heads are offset. A write operation during offset mode will result in a device check.
Ready	IRDY/	0	This line is low when the heads are loaded and a seek command or offset command are not in progress.
Online	IONLINE/	0	This line is low when the heads are loaded.
Index	IIDX/	0	This line indicates the beginning of a track. It is a 4 $\pm$1 μs low going pulse.
Read Only	IRDONLY/	0	This line when low indicates the read only switch on the selected media is in the read only position. No write command will be executed. It changes state only when the drive is not selected, or a rezero command is issued. The sense may change when switching between fixed and removable media.
Seek Incomplete	ISKINC/	0	This line goes low if the last motion command (seek, rezero, first seek) is not completed within 1.5 sec. This line may be reset by a REZERO command or device check reset if the SKINC occurs after the first seek is completed.
Set Cylinder Tag	ISETCYLTAG/	I	When this line is low, the bus lines are decoded as the next cylinder address. The trailing edge of ISETCYLTAG is the command to move the heads to the new address. ISETCYLTAG must not be issued if the drive is not ready or offset is active.

Table 4-2. Bussed Cable Signals (continued)

Signal Name	Mnemonic	Input/ Output	Description
Set Head Tag	ISETHDTAG/	I	When this alone is low, the data bus is interpreted as Head Address Cartridge Select, and/or Offset Command. It must not be issued if the drive is not ready. If an Offset Command is issued, the drive will not be ready for 2.4 ms from the trailing edge of ISETHDTAG. To reset the selected offset mode, set head tag must be reissued with bus 2 inactive or by the issuance of the REZERO command.
Control Tag	ICONTROLTAG/	I	When this line alone is low, control information is on the Bus. (See Table 4-3.) **NOTE** *The tag lines must be active for at least 800 ns. 1 µs must separate tag signals.*
Sector	ISECTOR/	0	This line represents 1.24 ± µs low going sector pulses generated with respect to index. The number of sector pulses activated per revolution depend upon programmable jumpers located on the MPU board inside the drive. Sector pulses will not be issued until a valid index is detected when switching between media.
Device Check	IDEVCK/	0	When low, this line indicates that at least one of the error conditions in the drive is active. All error conditions in the drive are latched for fault isolation. The error conditions are as follows: • Head unsafe • Write current unsafe or no write transitions • Cylinder Tag when not ready • Read or write and not ready • Offset while attempting to write • Read and write gates on simultaneously • Write gate on when read only set • Illegal cylinder requested • Outer guardband detected during track follow • Emergency retract • Seek incomplete This line is reset by the Device Check Reset command except for an emergency retract condition.

Table 4.2 Bussed Cable Signals (continued)

Signal Name	Mnemonic	Input/ Output	Description
Terminator In	ITERIN/	I	This line is low when all the cables between this drive and the terminator are present and the terminator is present. (Not gated with select.)
Address Mark Detected	IADDMKDET/	0	When an address mark is detected, a low going pulse appears on this line. This signal is only presented, if the address mark signal is activated prior to the address mark on the disk. **NOTE** *The preceding 10 output signals are gated with select and will be active within 200 ns of the leading edge of select, if the signals are active.*

4.2 BUS INTERPRETATION

The bus lines are interpreted according to Table 4-3.

Table 4-3. Bus Definitions

	SETCYLTAG	SETHEADTAG	CONTROLTAG
Bus 0	CAR512		Strobe late
Bus 1	CAR256		Strobe early
Bus 2	CAR128	OFFSET	Write
Bus 3	CAR064	OSFWD	Read
Bus 4	CAR032		ADDMK
Bus 5	CAR016		HST*R
Bus 6	CAR008	CAR SELECT	DEVCKRST
Bus 7	CAR004	HAR 4	HDSEL
Bus 8	CAR002	HAR 2	REZERO
Bus 9	CAR001	HAR 1	HDADV

4.2.1 Set Cylinder Tag

Bus lines 0-9 are defined as cylinder address. Bus 9 is the LSB.

4.2.2 Set Head Tag

Bus lines 5-9 are defined as head address. Bus 9 is the LSB. Bus 2 is the offset command. It may be issued during a Read operation to recover marginal data. If Bus 3 is also active when Offset is commanded, Offset will be in the forward direction (toward the spindle). If Bus 3 is not active Offset will be in the reverse direction. Offset is reset by issuing this command with Bus 2 inactive or by a Rezero command. Bus line 6 is the cartridge select command. Bus lines 5 through 9 should be inactive when Bus line 4 is active.

4.2.3 Control Tag

- Bus 9 Head Advance — This bit will advance the head address by one.
- Bus 8 Rezero — This bit will reposition the heads to cylinder zero if the heads are loaded on the disk. Rezero will reset the head address register to "ZERO" and reset an offset condition, and clear all device checks except emergency retract.
- Bus 7 Head Select — This bit turns on the head selection circuits. This bit must be on at least 10 μs before Read or 5 μs before Write is active.
- Bus 6 Device Check Reset — This bit will reset all error conditions in the drive which do not have active inputs with the exception of an emergency retract condition. An emergency retract condition is removed by cycling the START/STOP front panel switch.
- Bus 5 Reset Head Register — This bit will reset the head address register to zero.

- Bus 4 Address Mark — This bit tells the drive, when reading, to enable the address mark detector or, when writing, to write an address mark. During a read operation this bit must be reset within 1 byte of the leading edge of the "Address Mark Detected" status signal presented to the control unit.

- Bus 3 Read — This bit enables the read circuits and reset the attention line.

- Bus 2 Write — This bit enables the Write circuits.

- Bus 1 Strobe Early — This bit will shift the data strobe early with respect to its nominal position in the data window.

- Bus 0 Strobe Late — This bit will shift the data strobe late with respect to its nominal position in the data window.

SECTION 5
TRIDENT INTERFACE DESCRIPTION

5.1 GENERAL

The controller interface functions may be divided into five areas:

- Power Sequencing
- Positioning
- Data Handling
- Error Correction
- Diagnostic Aids

5.2 POWER SEQUENCING

The Power On and Power Off sequences are illustrated in Figure 5-1. The SEQUENCE signal affords the controller the opportunity to control the sequencing of each drive in a multiple drive system. If the controller does not use this signal, the spindle should be controlled by the START/STOP switch on the front panel rather than the system power switch. When the Power On sequence is complete, the heads are positioned at cylinder zero and any command may be given once the drive is ready. Power should not be removed until one second after the Sequence signal is removed or the front panel switch is placed in the STOP position. In the event of a power failure, writing is inhibited and the heads are retracted to prevent media damage.

5.3 POSITIONING

The positioning logic moves the heads to the desired cylinder and selects the proper track. The sequence is illustrated in Figure 5-2. During the time that the actuator is moving, the READY signal goes inactive. At the end of a seek, READY becomes active and ATTENTION is then reset by the next READ command, seek start or rezero. If the seek is not finished in 1.5 sec. the SEEK INCOMPLETE is set.

5.4 DATA HANDLING

Before writing on a new pack, the pack must be formatted. A format from Section 3 must be selected and the sector size decided upon. Figures 5-3, 8-4, and 8-5 illustrate this procedure. Figures 5-4 to 5-7 illustrate reading and writing using both electronic and address mark sectoring. (Refer to Section 8 for associated timing diagrams.)

5.5 ERROR CORRECTION

Two methods for recovering temporary errors are provided. The heads may be positioned slightly off-track in either direction and the data may be strobed early or late. Once an error is detected, two additional attempts should be made to read the record at zero offset and nominal strobe. The strobe should then be varied at zero offset and at each offset position. Figure 5-8 illustrates this sequence and the number of repetitions at each point. If the error cannot be corrected by this procedure, it is considered a permanent error.

5.6 DIAGNOSTIC AIDS

5.6.1 Device Check

The following conditions are illegal and will set the device check flag:

- Head unsafe
- Write current unsafe or no write transitions
- Cylinder Tag when not ready
- Read or write and not ready
- Offset while attempting to write
- Read and write gates on simultaneously
- Write gate on when read only set
- Illegal cylinder requested
- Outer guardband detected during track follow
- Emergency retract
- Seek incomplete

5.6.2 Recover Times

Drive must be ready and selected with any of the following conditions:

- Head select must be active at least 10 μs before the read and 5 μs before the write gate signals.
- When switching between heads or switching from write to read, good data will be present at the interface within 10 μs.
- Switching from not reading to reading, good data will be at the interface within 5 microseconds.
- Switching from not writing or reading to writing, good data will be written within 300 nanoseconds.
- "Head Select" bit must be active 10 μs before the "Address Mark" bit.

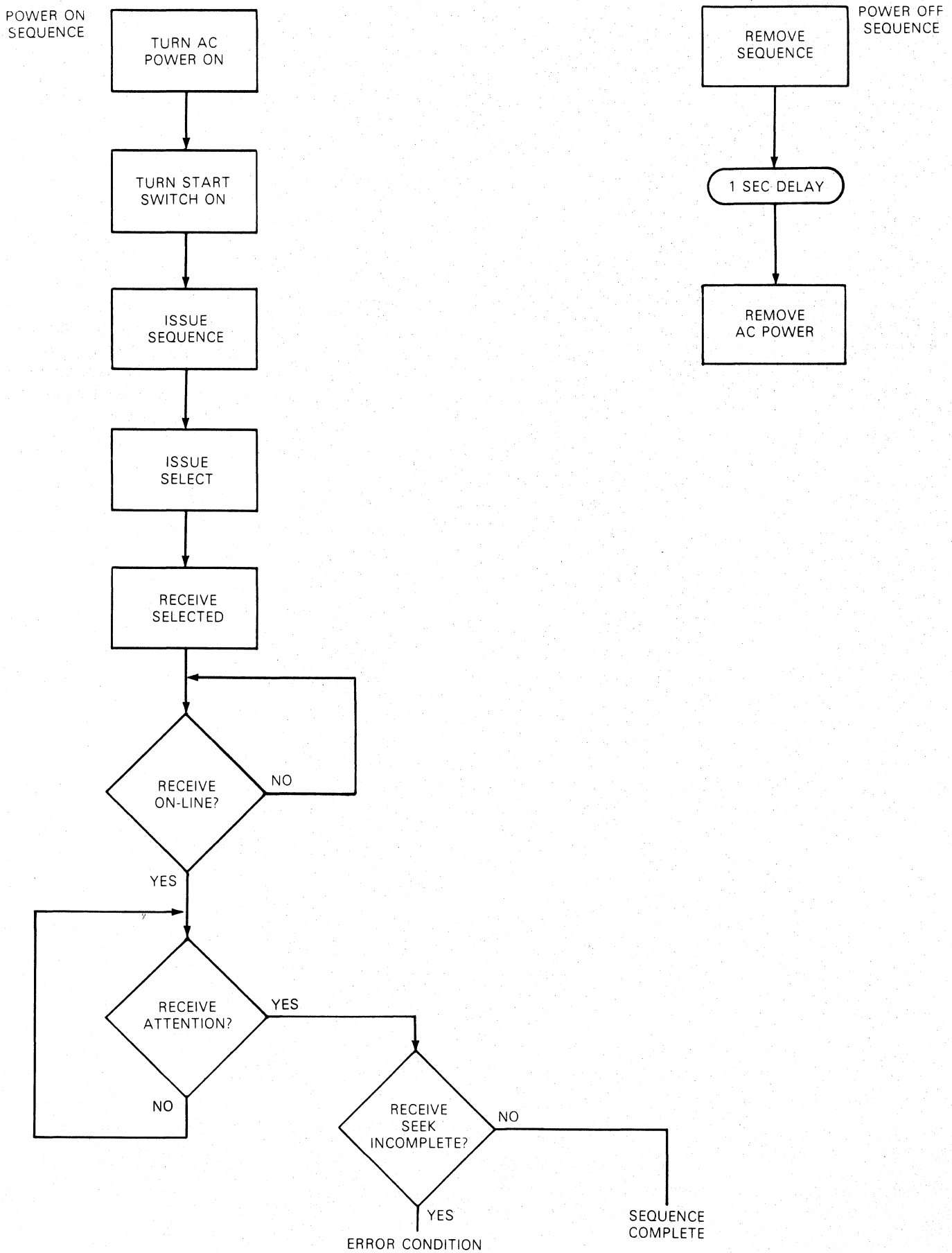


Figure 5-1. Power Sequence

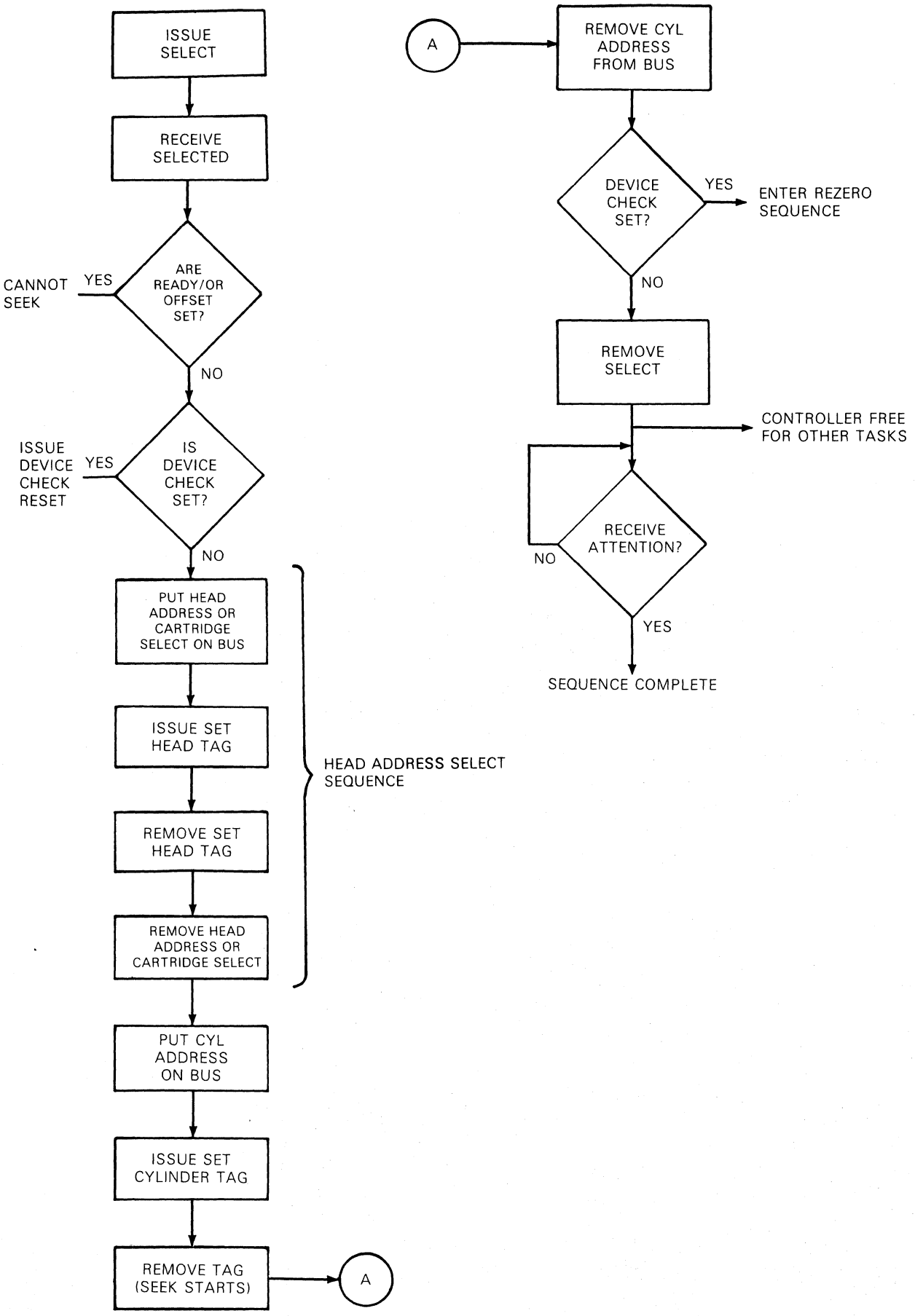


Figure 5-2. Seek Sequence

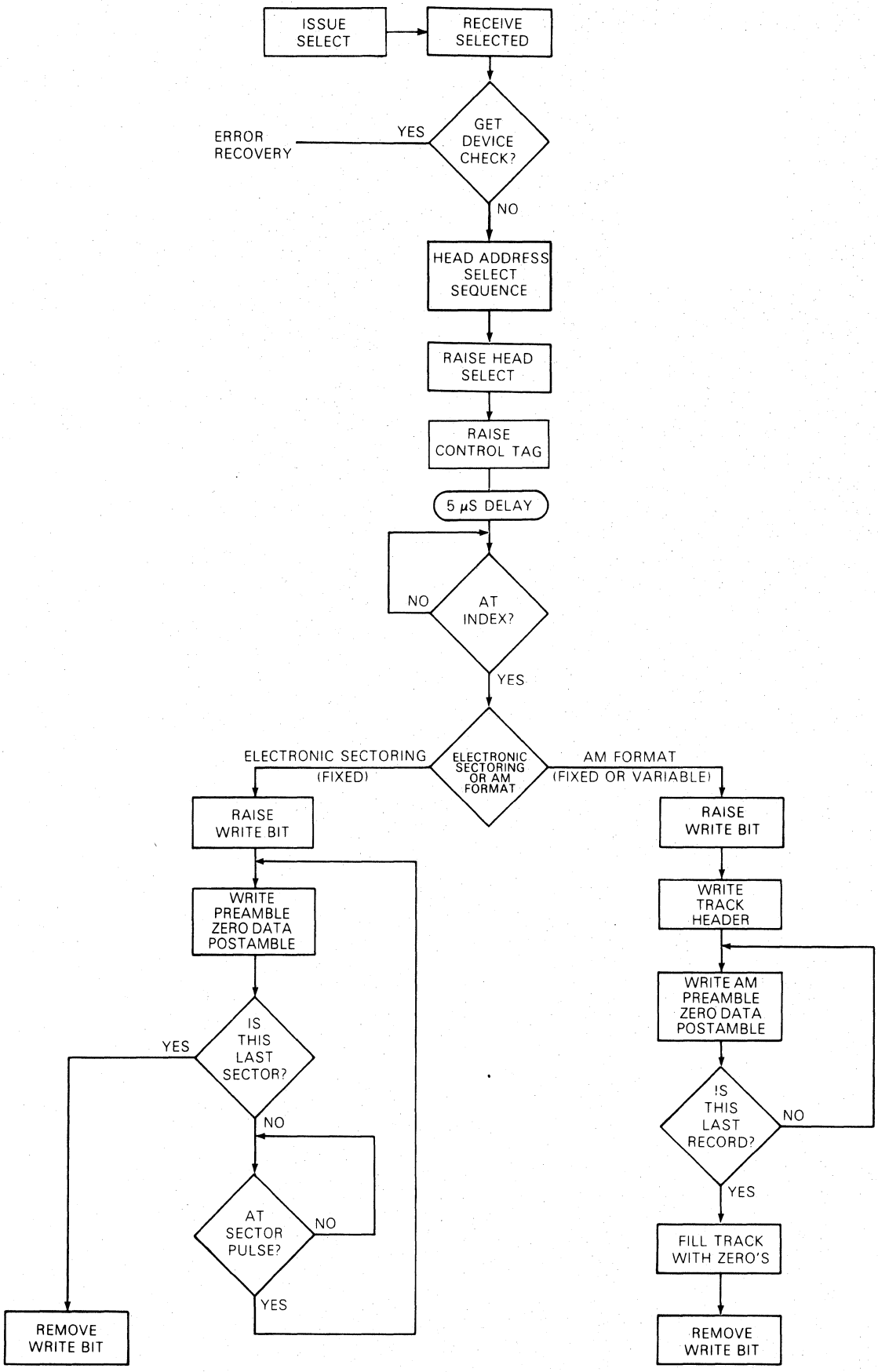


Figure 5-3. Track Initialization

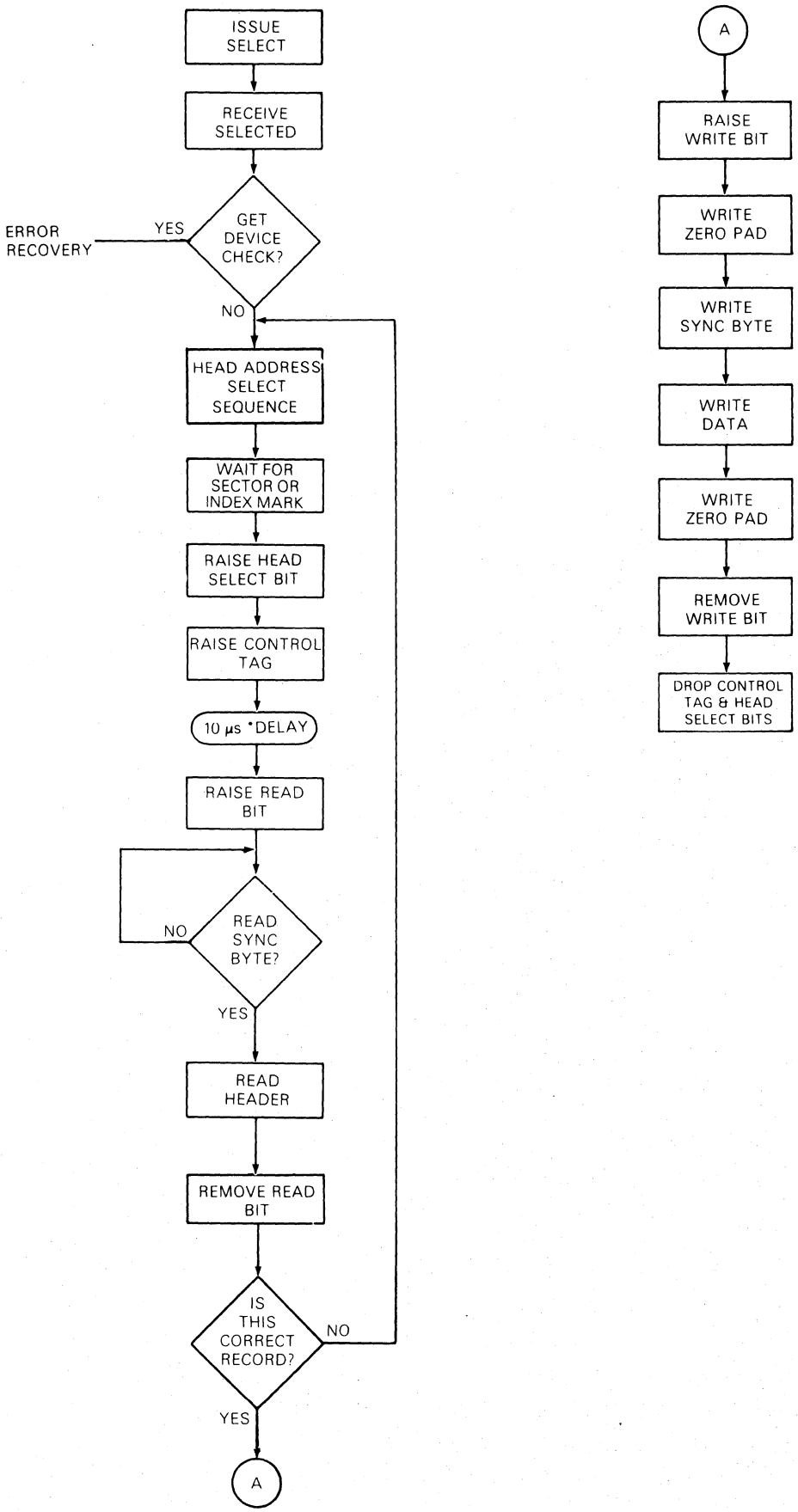


Figure 5-4. Write Using Electronic Sectoring

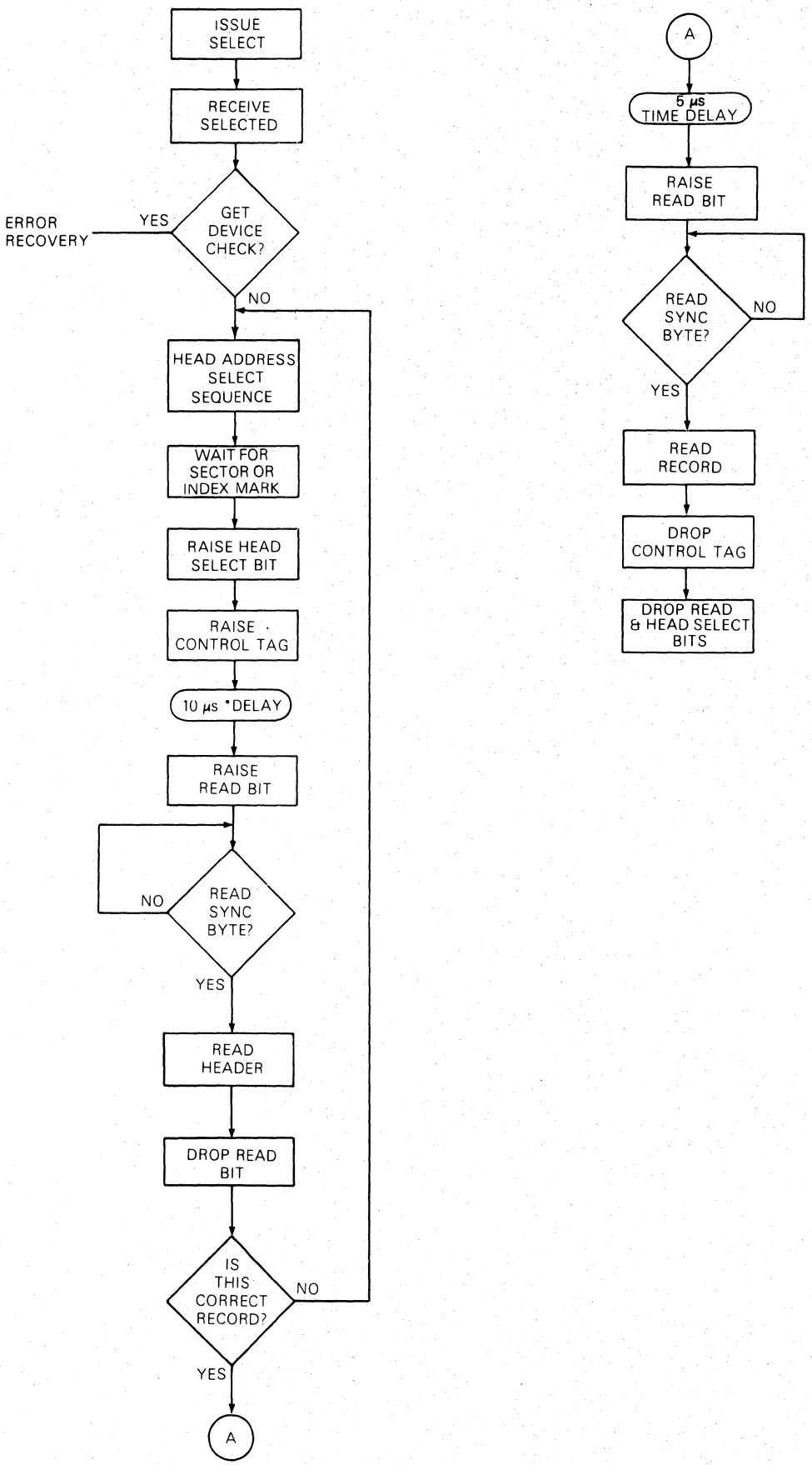


Figure 5-5. Read Electronic Sectoring

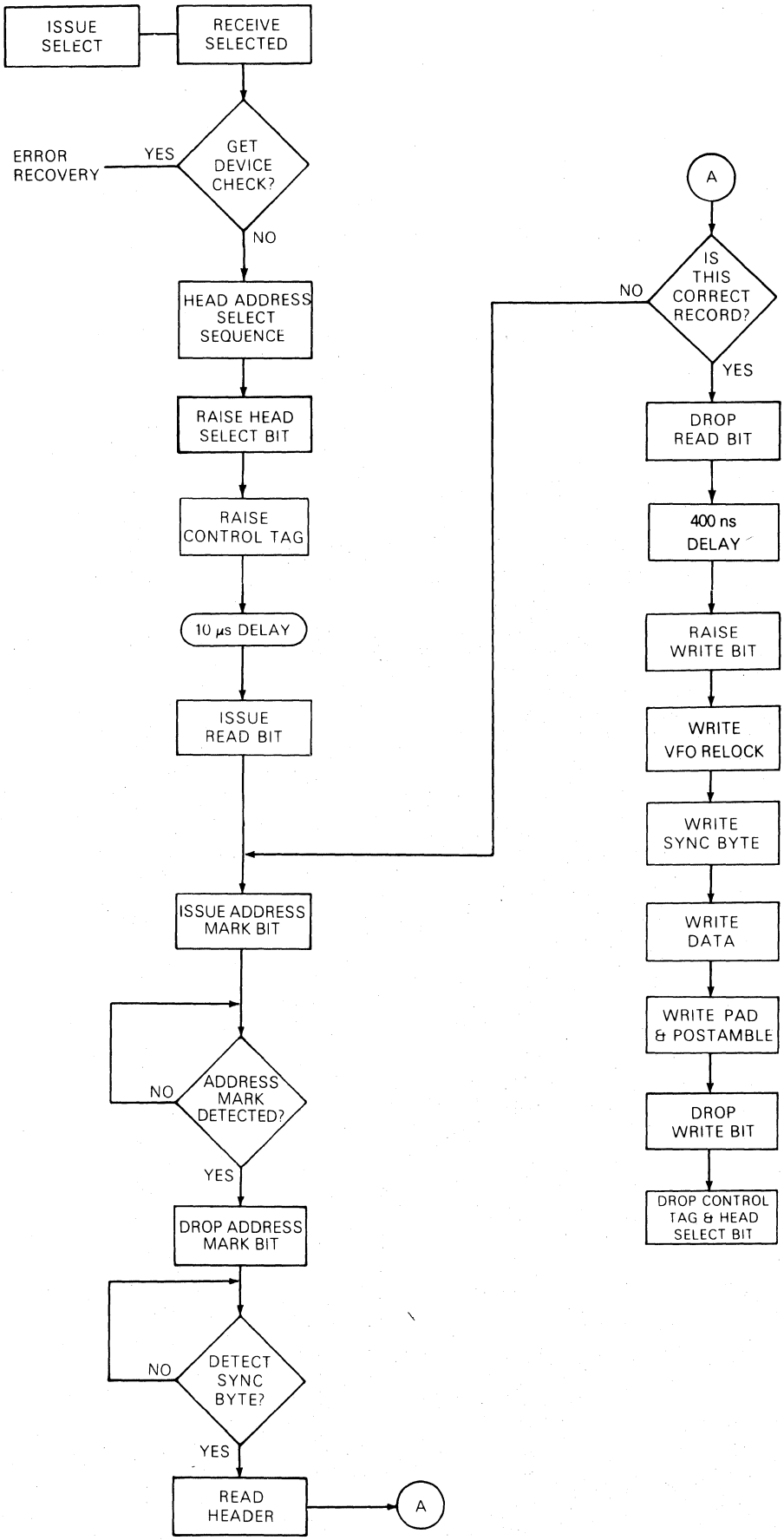


Figure 5-6. Write Using Address Marks

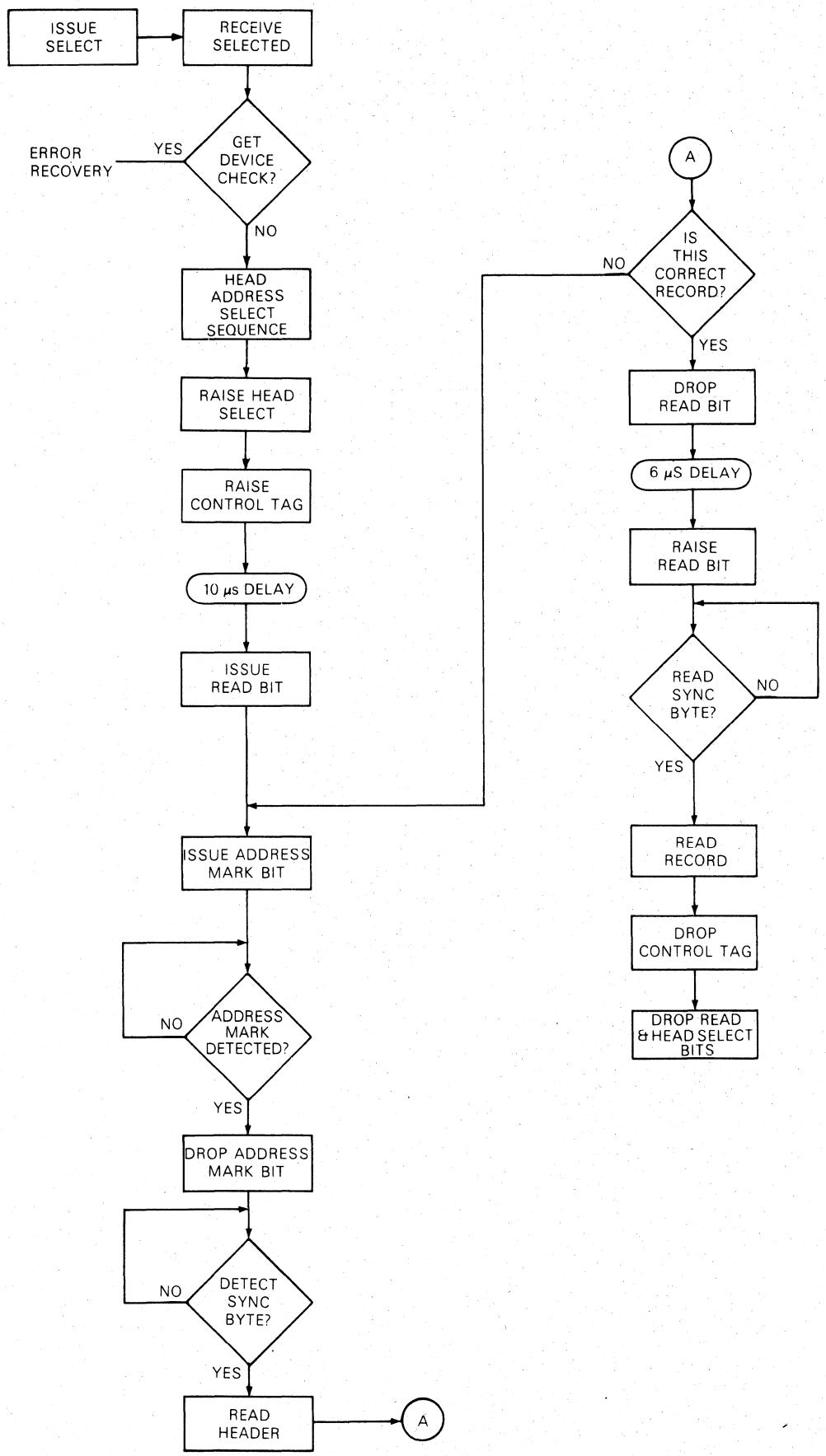


Figure 5-7. Read Using Address Marks

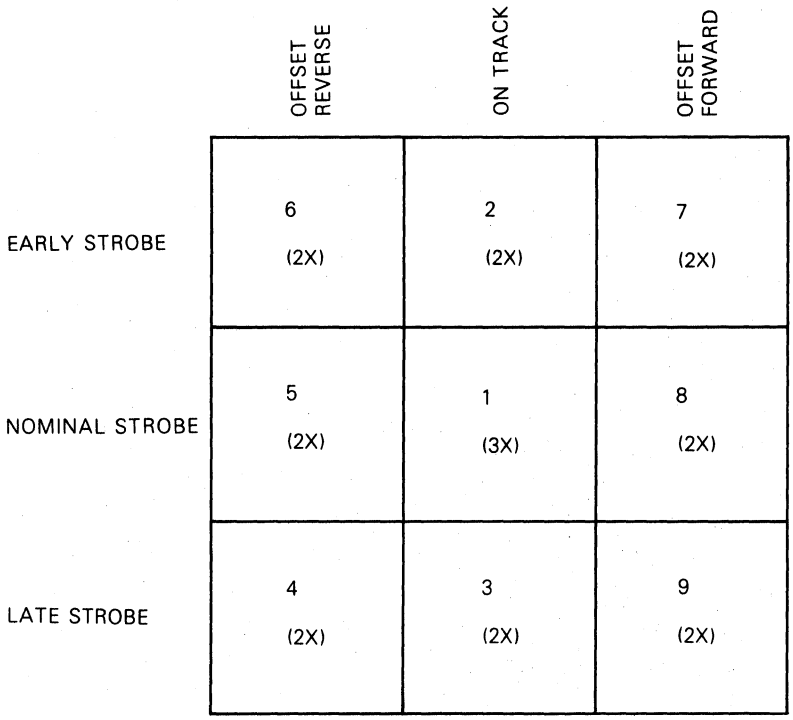


Figure 5-8. Error Recovery

SECTION 6
TRIDENT INTERFACE SIGNALS

6.1 ALL SIGNALS EXCEPT DATA AND CLOCK

Signal type Single ended
High level 5 ±0.5V

Low level 0.2 ±0.2V

Rise and fall times 0 – 50 nS (10% – 90% points)
Termination 100 ohms to + 5V at both ends

6.2 READ/WRITE DATA AND CLOCK

Signal type Differential
Signals levels
Output (as received at the users 100 ohm termination)
High + 1.5V < V_{OH} < + 2.0V

Low OV < V_{OL} < + 0.2V

Input (as received from 75110 line driver)
High OV < V_{IH} < + 0.2V

Low – 0.8V < V_{IL} < – 1.8V

Logical states	logical 0	logical 1	
R/W Clock or Data	high	low	(P line)
R/W Clock or Data	low	high	(M line)

Termination See Figure 6-4.

Recommended Line Receivers
527
75 S 244
74LS04
74LS14

Recommended Line Drivers
75110
74S140
75477
26LS31

6.3 INTERFACE CABLES AND CONNECTORS

The HUNTER interface allows the use of different types of interconnecting cables. This section outlines the various possibilities and their respective requirements.

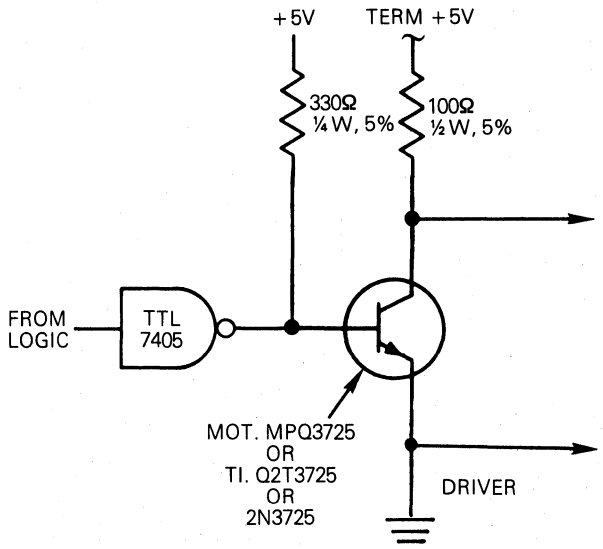


Figure 6-1. Recommended Signal Line Driver

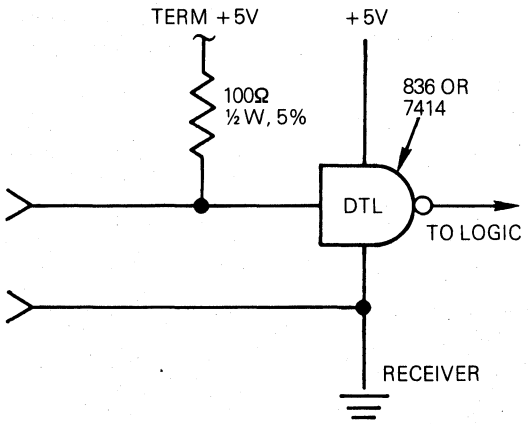


Figure 6-2. Recommended Signal Line Receiver

6.4 INTERFACE CABLE ASSEMBLIES AVAILABLE FROM CENTURY DATA SYSTEMS (CDS)

P.N 19840-XXX, Radial Cable Assy. (15 ft. standard)

26 pin controller
mating connector: 3M 3429-2002
ITT UND4B026D3D
CDS 19535-001
P/N 19839-XXX, Bussed (Signal) Cable Assy., controller to first drive (15 ft. standard)

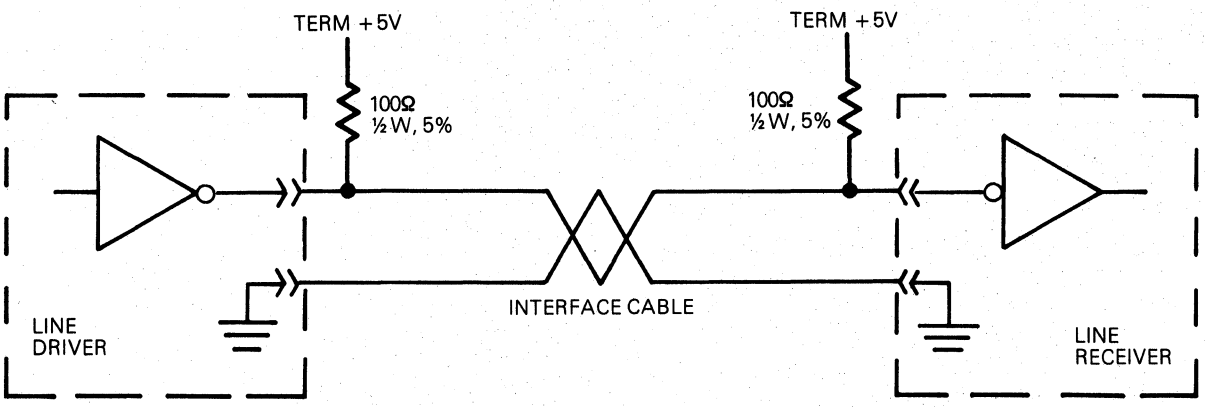


Figure 6-3. Drive-Controller Interface

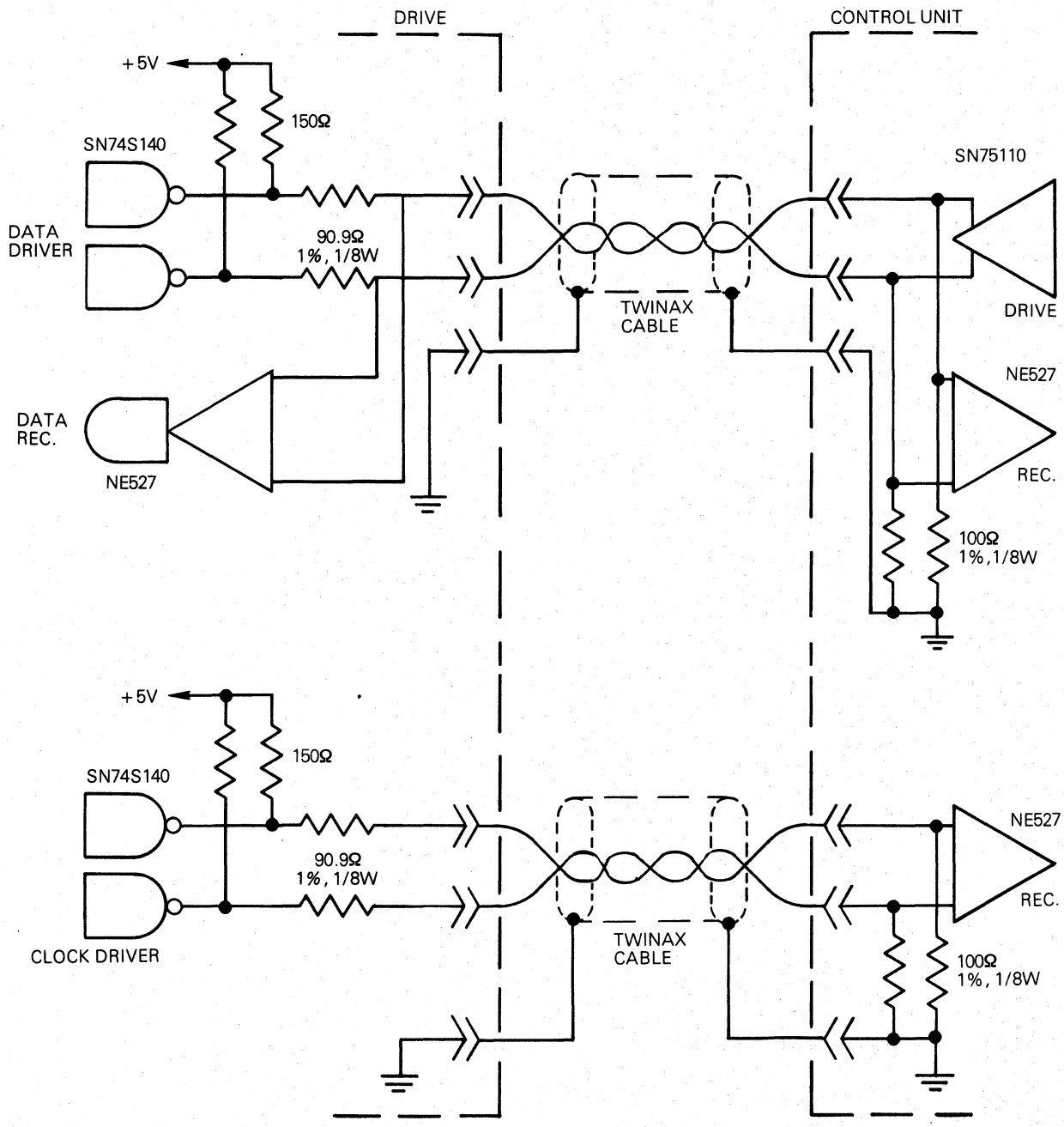


Figure 6-4. Recommended Read/Write Data and Clock Driver/Receiver

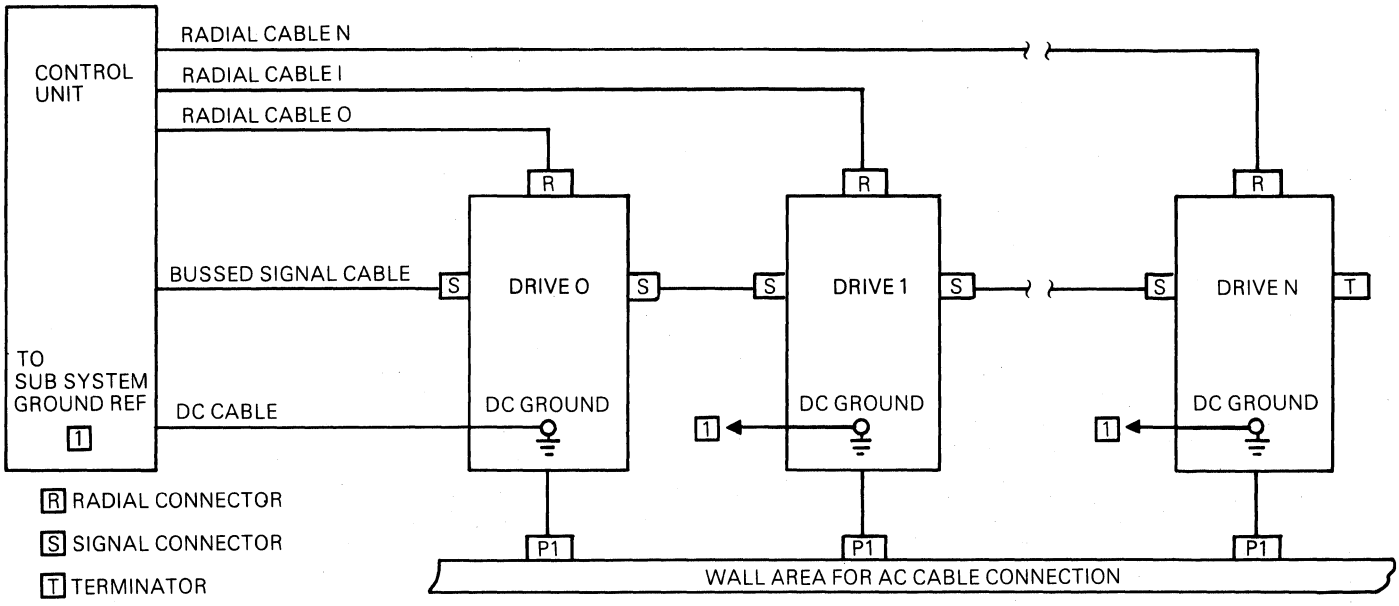


Figure 6-5. Single Access Cabling, Daisy Chain Configuration

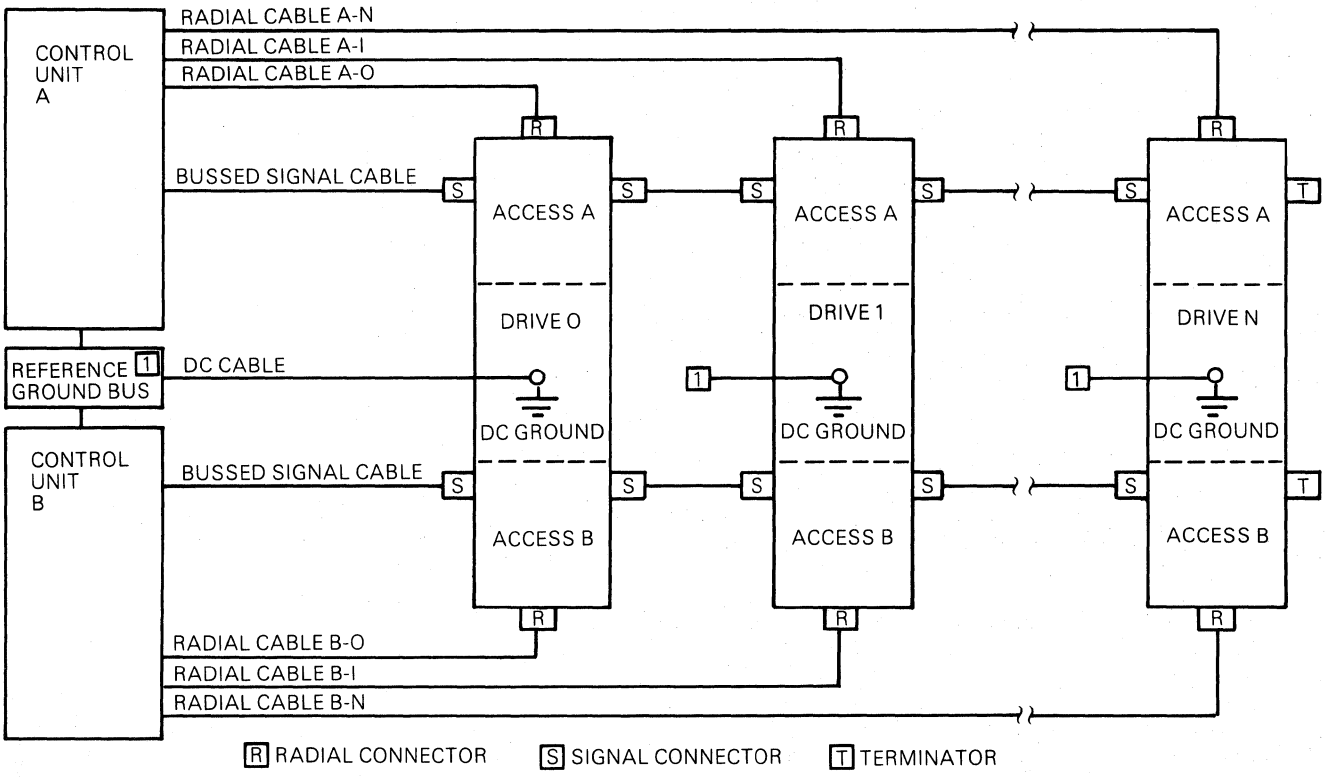


Figure 6-6. Dual Access Cabling, Daisy Chain Configuration

50 pin controller
mating connector: 3M 3433-2002
ITT UND4B050D3D
CDS 16446-001

P/N 19841-XXX, Bussed (Signal) Cable Assy., drive to drive (10 ft. standard)

P/N 19318-001, [T] Terminator

Note: The 3-digit dash number determines the cable length in feet. The maximum individual cable is 50 ft. (15m). The maximum bus cable length (cumulative) is limited to 70 ft. (21m).

The following sections define cable specifications and connector pin assignments for customers who wish to build their own interface cables.

6.4.1 Bussed Cable (Signal Cable)

There are three recommended methods of building the Bussed Cable:

1. Twisted Pair Flat Cable 25 pairs

   Impedance 85Ω ± 10%

Table 6-1. Bussed Cable Pin Numbers (Single Access)

PIN NO.	SIGNAL	PIN NO.	SIGNAL
01	SECTOR	21	GROUND
02	END OF CYLINDER	22	BUS 1
03	ADDMKDET	23	GROUND
04	OFFSET	24	BUS 2
05	TERMINATOR +5V	25	GROUND
06	INDEX	26	BUS 3
07	TERMINATOR +5V	27	GROUND
08	READY	28	BUS 4
09	GROUND	29	GROUND
10	RDONLY	30	BUS 5
11	GROUND	31	GROUND
12	DEVICE CHECK	32	BUS 6
13	GROUND	33	GROUND
14	ONLINE	34	BUS 7
15	GROUND	35	TERMINATOR IN
16	SEEK INCOMPLETE	36	BUS 8
17	GROUND	37	CONTROLTAG
18	SPARE	38	BUS 9
19	GROUND	39	SETCYLTAG
20	BUS 0	40	SETHDTAG

   24 AWG — max. cable length (cumulative) 100 ft. (30m)

   CDS cable P/N 90878-420

   Cable manufacturers — Woven Electronics
   Brand Rex
   Ribbon Cable

   Connectors required —
   [S] CDS P/N 19318-001, Signal Connector

   [T] CDS P/N 19318-001, Terminator

2. Twist 'n' Flat Cable (25 pairs)

   Impedance 105Ω

   28 AWG — max. cable length (cumulative) 70 ft. (21m)

   Cable manufacturer — Spectra Strip,
   P/N 4SS-248-50

3. Flat Ribbon Cable (25 pairs)

   Impedance 105Ω

   28 AWG — max. cable length (cumulative) 70 ft. (21m)

   CDS cable P/N 19153-050

   Cable manufacturers — 3M, P/N 3365/50
   Brand Rex,
   P/N TC1008/50

   Connectors required —

   [S] CDS P/N 19829-001, Ribbon Cable Adapter

   Cable connector, 50 pin, CDS P/N 17265-001 — 3M P/N 34265-0000T

   [T] CDS P/N 19318-001, Terminator

6.4.2 Radial Cable

There are two recommended methods of building the Radial Cable:

1. Twisted Pair Flat Cable plus TWINAX

   Twisted Pair Flat Cable (13 pairs), all signals except Clock and Read/Write Data

Impedance 85Ω ±10%

24 AWG – max. cable length 100 ft. (30m)

CDS cable P/N 90878-414

Cable manufacturers – Woven Electronics
Brand Rex
Ribbon Cable

TWINAX (Clock, Read/Write Data)

Impedance 200Ω ±5% line to line (differential)

100Ω ±10% each line to shield (common mode)

Max. cable length 100 ft. (30m)

CDS cable P/N 11593-001

Cable manufacturer – Brand Rex P/N T5780A

Connectors required –
[R] CDS P/N 16446-001, Radial Cable Connector

2. Flat Ribbon Cable (13 pairs), all signals

Impedance 105Ω

28 AWG – max. cable length 50 ft. (15m)

CDS cable P/N 19706-026

Cable Connector, 26 pin, 3M P/N 3434-000T

Connectors required –

[R] CDS P/N 19687-001, Radial/Flat cable adapter, drive side

Cable connector, 26 pin, 3M P/N 3434-000T

CDS P/N 19685-001, Radial/Flat cable adapter, controller side

Cable connector, 26 pin, 3M P/N 3434-000T

6.4.3 Bus Cable (Dual Access Only)

The recommended cable is a flat ribbon cable (25 pairs)

Impedance 105 Ohms.
28 AWG – max. cable length 100 ft. (30m) (cumulative)
CDS cable P/N 19153-050
Cable manufacturers – 3M, P/N 3365/50
Brand Rex P/N TC1008/50

Table 6-2 Radial Cable Pin Numbers (Single or Dual Access)

SIGNAL PIN	SIGNAL FUNCTION	SIGNAL PIN	SIGNAL FUNCTION
01	GROUND	23	GROUND
02	GROUND	24	COMPOSITE
03	GROUND		SECTOR INDEX
04	REQUEST	25	GROUND
05	GROUND	26	ATTENTION
06	REQUEST	27	GROUND
	(FROM OTHER	28	MODULE
	C.U.)		SELECTED
07	GROUND	29	GROUND
08	NOT USED	30	SEQUENCE
09	GROUND	31	GROUND
10	NOT USED	32	MODULE
			SELECT
11	GROUND	33	GROUND
12	NOT USED	34	READ/WRITE
13	GROUND		DATA (P)
14	NOT USED	35	GROUND
15	GROUND	36	READ/WRITE
16	NOT USED		DATA (M)
17	GROUND	37	GROUND
18	NOT USED	38	READ/WRITE
19	NOT AVAILABLE		CLOCK (P)
20	NOT AVAILABLE	39	GROUND
21	TERMINATOR	40	READ/WRITE
	–5V		CLOCK (M)
22	TERMINATOR		
	–5V		

Table 6-3. Bussed Cable Pin Numbers (Dual Access)

PIN NO.	SIGNAL	PIN NO.	SIGNAL
1	INDEX	2	GROUND
3	READ ONLY	4	GROUND
5	SEEK INCOMPLETE	6	GROUND
7	DEVICE CHECK	8	GROUND
9	ADD MARK DET	10	GROUND
11	READY	12	GROUND
13	END OF CYLINDER	14	GROUND
15	OFFSET	16	GROUND
17	SECTOR	18	GROUND
19	ONLINE	20	GROUND
21	TERMINATOR IN	22	GROUND
23	BUS 2	24	GROUND
25	BUS 3	26	GROUND
27	SET CYLTAG	28	GROUND
29	BUS 1	30	GROUND

Table 6-3. Bussed Cable Pin Numbers (Dual Access) (continued)

PIN NO.	SIGNAL	PIN NO.	SIGNAL
31	CONTROL TAG	32	GROUND
33	BUS 9	34	GROUND
35	SET HDTAG	36	GROUND
37	BUS 4	38	GROUND
39	NOT USED	40	NOT USED
41	BUS 0	42	GROUND
43	BUS 7	44	GROUND
45	BUS 6	46	GROUND
47	BUS 8	48	GROUND
49	BUS 5	50	GROUND

Connector required –

CDS P/N 17266-050
3M P/N 3425-6050

CDS cable terminator P/N 21416-001.

6.5 GROUNDING

AC-chassis ground is electronically isolated from DC-ground within each drive. A DC-ground stud to accept a #8-14, GA wire is provided on the isolated DC-ground for subsystem interconnection. This ground connection with the controller is mandatory for proper operation.

SECION 7
SMD INTERFACE SIGNALS

7.1 DISK DRIVE INTERFACE SIGNALS

Signals appearing at the HUNTER Disk Drive interface and their use are shown in Tables 7-1 through 7-3.

Table 7-1. Radial Cable Signals

Signal Name	Mnemonic	Input/ Output	Description
Unit Selected	IUNITSELECTM IUNITSELECTP/	O	When active this line indicates the drive is selected. This line will be active within 400 nanoseconds of the leading edge of unit select tag when the four unit select bits compare with the address of the drive and the degate switch is in the normal operating position.
Seek End	ISEEKENDM ISEEKENDP/	O	When active this line indicates "on cylinder" or seek error (i.e., seek operation has terminated). If a cylinder address greater than 833 is issued no change will occur in seek end status. HUNTER SEEK END will interrupt for 300 microseconds nominally.
Write Data	IWRITEDATAM IWRITEDATAP/	I	This line carries NRZ write data to be written on the disk pack.
Servo Clock	ISERVCLKP ISERVCLKM/	O	This line transmits a 9.68 MHz ± the percent of speed variation. Clock phase is locked to the servo dibit pattern. Servo Clock is available to the controller at all times (not gated with Select) and is used to form Write Clock.
Read Data	IRDDATAM IRRDDATAP/	O	This line carries NRZ data recovered from the disk.
Read Clock	IRDCLKP IRDCLKM/	O	This line transmits a 9.68 MHz clock that is phase locked to the recovered data it is internally derived and is synchronized with the detected data.
Write Clock	IWRTCLKP IWRTCLKM/	I	This line is retransmitted "SERVO CLOCK"

Table 7-2. Bussed Cable Signals

Signal Name	Mnemonic	Input/ Output	Description
Unit Ready	IUNITREADYP IUNITREADYM/	O	When active this line indicates that the selected drive is up-to speed, heads are loaded on the disk pack, and no fault condition exists.

Table 7-2. Bussed Cable Signals (continued)

Signal Name	Mnemonic	Input/ Output	Description
On Cylinder	IONCYLINDERP IONCYLINDERM/	O	When active this line indicates the R/W heads are positioned on a track. ON CYLINDER goes inactive with any seek command. An offset command causes ON CYLINDER to go inactive for 1.0 ±0.4 milliseconds
Index	IINDEXP IINDEXM/	O	When active indicates the starting point of a data track. INDEX is 2.5 mirocseconds wide. Timing integrity is maintained during seek operations. INDEX is also available on the Radial Cable.
Unit Select Tag	UNITSELO UNITSELO/	O	When active this line gates the 4 unit select lines into the logical address compare circuit.
Unit Select 1, 2, 4 & 8	IUNITSEL 1, 2, 4 or 8 IUNITSEL 1/, 2/, 4/, & 8/	I	These four lines are binary coded to select one of 16 logical units (0-F). The unit number is selected via an address selector plug inserted into the operator control panel. Removal of the plug is decoded as address F. The operator must verify that no duplicate plugs are installed in drive on the same control bus.
BUS O → Bus 9	IBUSO-9 IBUSO/-9/	O	The 10 bus lines are interpreted according to the current tag. The drive must be selected at least 200 nanoseconds before any bus lines are active. The bus lines must be active at least 200 nanoseconds before the tag line and 200 nanoseconds after the tag line. The tag line must be active at least 800 nanoseconds.
Busy (Dual Access Only)	ABUSY ABUSY/ BBUSY BBUSY/	O	This signal indicates to the controller that the drive has been selected by another control unit.

The 10 bus lines are decoded by the three tag lines as defined below:

	Tag 1 (Set Cyl)	Tag 2 (Set Hd)	Tag 3 (Control Select)
BUS BIT	CYLINDER BIT	HEAD ADDRESS BIT	COMMAND BIT
0	1	1	Write Gate
1	2	2	Read Gate
2	4	4	Servo Offset FWD
3	8		Servo Offset REV
4	16	CARSEL*	Fault Clear
5	32		Address MK Enable
6	64		Return to Zero
7	128		Data Strobe Early
8	256		Data Strobe Late
9	512		Priority Select Reserve (DA Only)

Note: There shall only be one tag line active at any given time. There shall be at least a 1.0 microsecond delay after the trailing edge of a tag before the leading edge of another tag. *Low active for cartridge.

Table 7-3. Interface Signals

Signal Name	Mnemonic	Input/ Output	Description
Tag 1 (set Cylinder)	ITAG 1 ITAG 1/	I	When active the bus lines are decoded as the next cylinder address and the trailing edge of Tag 1 is the command to move the heads to the new address. Tag 1 is not to be issued if the drive is busy (not on cylinder).
Tag 2 (SET HEAD)	ITAG 2 ITAG 2/	I	When active, Bus lines 0, 1 and 2 are decoded as the next head address. Bus O is the LSB. The head address register changes on the leading edge of the Set HD Tag when active Bus selects the cartridge.
Tag 3 (Control Tag)	ITAG 3 ITAG 3/	I	When active, bus lines are decoded as commands.
Sector Mark	ISECTORP ISECTORM/	O	When active indicates the start of a sector. The pulse is 1.24 $\pm$.24 microseconds wide with the leading edge occuring at the beginning of a sector.
Seek Error	ISEEKERRORP ISEEKERRORM/	O	When active this line indicates that the unit was unable to complete a servo operation within 1.5 seconds, or that a cylinder address greater than 833 was issued. It is reset by rezero or manual restart.
Fault	IFAULTP IFAULTM	O	When active, this line indicates that at least one of the following error conditions is active in the drive. a. Read or write and not on cylinder b. Write with offset active c. Writing with more than 1 head selected or no transitions detected. d. Write with heads off track e. Write Gate and Read Gate active simultaneously f. DC voltage unsafe
Address Mark Found	IAMDETP IAMDETM/	O	This line will be active for 7 microseconds nominal when an address mark is detected.
Open Cable Dector	ICABLEIN ICABLEIN/	I	When active indicates an open bussed interface cable or loss of controller power. Drive receives and the transmitters are inhibited.
Power Sequence Pick	IPICK/	I	The PICK signal is used to start one drive at a time when several drives are daisy chained together. PICK must be held active low for a minimum of 250 milliseconds after the signal HOLD is asserted if only one drive is under control. If several drives are daisy chained, it is necessary to hold the signal PICK active low until all drives have powered up; this requirement exists because the signal PICK is only passed down the chain after a drive comes up to speed. Hence, PICK must be held active low for 20x (n) seconds when 'n' drives are daisy chained together.

Table 7-3. Interface Signals (continued)

Signal Name	Mnemonic	Input/ Output	Description
Power Sequence Hold	IHOLD/	I	The HOLD signal is used in conjunction with the PICK signal must be held active low for the entire duration of time that a controller expects a drive to remain powered up. The HOLD signal simply loops from one drive to the next when a daisy chain configuration is employed, therefore, if the HOLD signal is taken into an inactive high state by the controller, every drive in the daisy chain is sequenced down. Once a drive is sequenced down it is necessary to issue both the PICK and HOLD signals to cause a drive to sequence up.

7.2 TAG 3 (CONTROL TAG) INTERPRETATIONS

7.2.1 Bus 0 — WRITE GATE

This bit turns on the Write circuits.

7.2.2 Bus 1 — READ GATE

This bit turns on the Read circuits. The leading edge of Read Gate instructs the data separator to synchronize on a previously written all zeros pattern in a gap.

7.2.3 Bus 2 — SERVO OFFSET FORWARD

This bit will position the R/W heads off-track towards the spindle.

7.2.4 Bus 3 — SERVO OFFSET REVERSE

This bit will position the R/W heads off-track away from the spindle.

7.2.5 Bus 4 — FAULT CLEAR

This bit will reset the following FAULT conditions in the drive provided the condition is not currently active. A 100 nanosecond minimum pulse is required.

a. Not ready and read or write.
b. Write and not on cylinder.
c. Offset and write.
d. Write and no DC write current.
e. Write and no write data transitions.
f. Write and read only active.
g. Illegal head address, multiple heads selected or no head selected when drive is ready.

7.2.6 Bus 5 — ADDRESS MARK ENABLE

When reading, this bit tells the data separator to look for an address mark. This bit must go inactive within 1.0 microseconds after the leading edge of "ADDRESS MARK FOUND". When writing, this bit tells the data separator to write an address mark (24 bits of no transitions.)

7.2.7 Bus 6 — RETURN TO ZERO (RTZ)

This bit will reposition the heads to cylinder zero if the heads are loaded on the disk. Rezero will reset: SEEK ERROR. A 100 nanosecond minimum pulse is required.

7.2.8 Bus 7 — DATA STROBE EARLY

This bit will move the Data Strobe earlier than nominal.

7.2.9 Bus 8 — DATA STROBE LATE

This bit will move the Data strobe later than nominal.

7.2.10 Bus 9 — RELEASE (DUAL ACCESS ONLY)

Enabling this line will release the access reserved or priority select the drive. (See Section 10, Dual Access Option, for details.)

SECTION 8
SMD INTERFACE DESCRIPTION

8.1 GENERAL

The SMD interface HUNTER characteristics may be divided into six areas:

- Power Sequencing
- Positioning
- Data Handling
- Data Error Correction
- Fault Indication
- Recovery Times

8.2 POWER SEQUENCING

Figure 8-1 illustrates the power sequence.

To power sequence up a single drive the controller issues two low active signals, PICK and HOLD simultaneously. The PICK signal may be dropped 250 milliseconds after HOLD is asserted. The drive comes up to speed and is on cylinder zero, forty seconds after the PICK and HOLD signals are issued. Once the drive is up to speed it monitors the HOLD signals. If the controller removes the HOLD signal the drive power sequences down and retracts the heads.

8.3 POSITIONING

The positioning logic moves the heads to the desired cylinder and selects the proper track. The sequence is illustrated in Figure 8.2. During the time that the actuator is moving, the ON CYLINDER signal goes inactive. At the end of a seek, ON CYLINDER becomes true and SEEK END is set. SEEK END is then reset by the next seek command.

If the seek is not finished in 1.5 seconds, the SEEK ERROR flag is set. If an illegal cylinder address is given SEEK ERROR status is set. If either of these conditions occur, a REZERO command must be given to clear the fault and reestablish a reference point.

8.4 DATA HANDLING

Before writing on a new pack, the pack must be formatted. A format from Section 3 must be selected and the sector size decided upon. Figures 8-3, 8-4, and 8-5 illustrate this procedure. Figures 8-6 through 8-14 illustrate reading and writing both electronic and address mark sectoring.

8.5 DATA ERROR CORRECTION

Two methods for recovering temporary errors are provided. The heads may be positioned slightly off-track in either direction and the data may be strobed early or late. Once an error is detected, two additional attempts should be made to read the record at zero offset and nominal strobe. The strobe should then be varied at zero offset and at each offset position. If the error cannot be corrected by this procedure, it is considered a permanent error. See Figure 5-8.

8.6 STATUS INDICATION

The following illegal conditions will be displayed on the status indicator:

- Write and read signals active
- Writing while not ready
- Writing with offset active
- Writing and off track for any reason
- Writing and no heads or multiple heads selected
- Writing and no current transitions detected
- Writing and read only active
- Write current and not writing
- DC voltages unsafe

If error condition is no longer present, the fault indicator may be reset by: Fault Reset Switch, Tag 3 and Bus 4 or a Unit Restart.

8.7 RECOVERY TIMES

a) Drive must be ready, and Head Address Register not changed at least 10 microseconds before read and 5 microseconds before write.

b) Switching between heads or switching from write to read, a 10 microsecond delay is required.

c) Switching from not reading to reading, good data will be at the interface within 5 microseconds.

d) Switching from not writing or reading to writing, good data may be written within 1 microsecond.

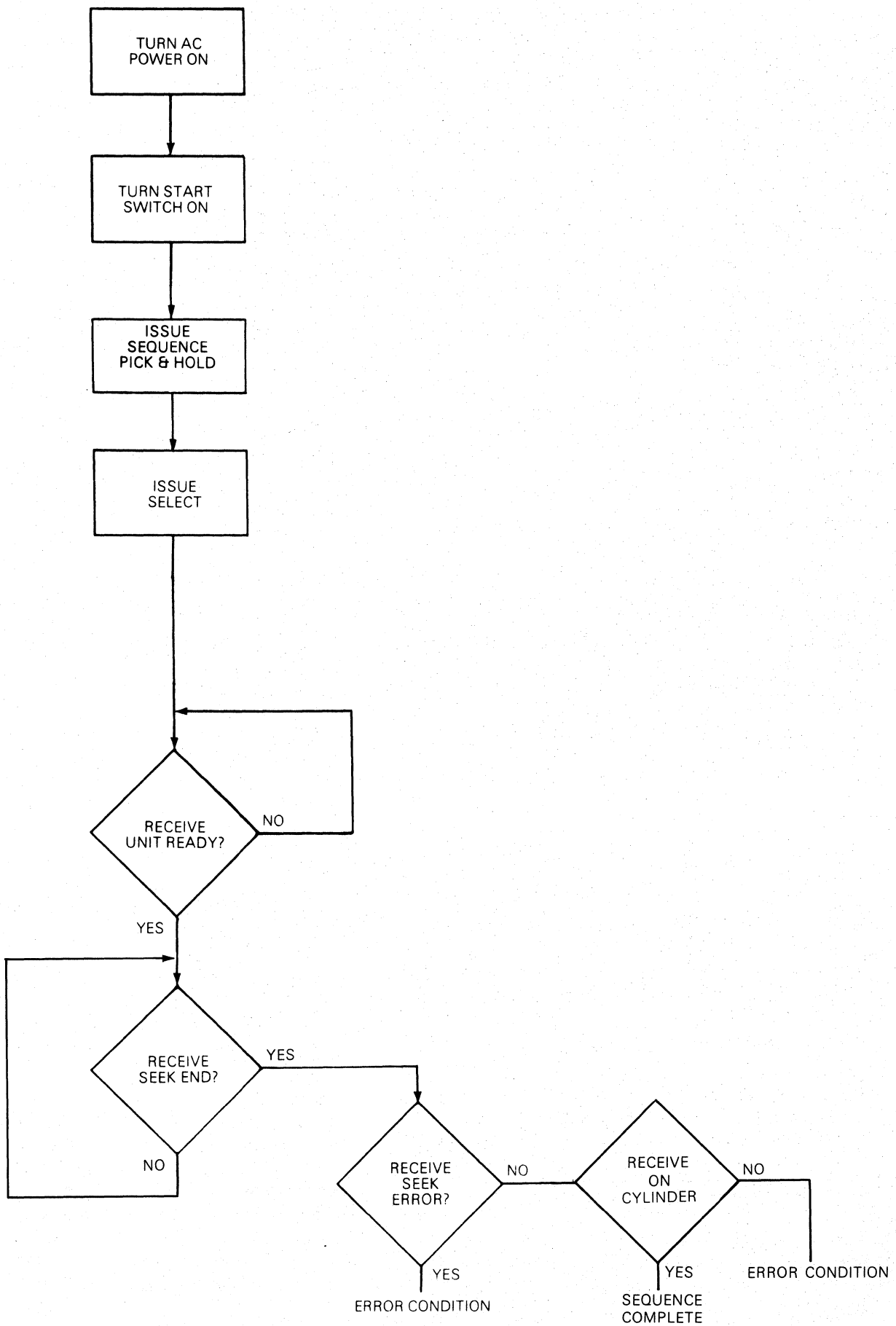


Figure 8-1. Power Sequence

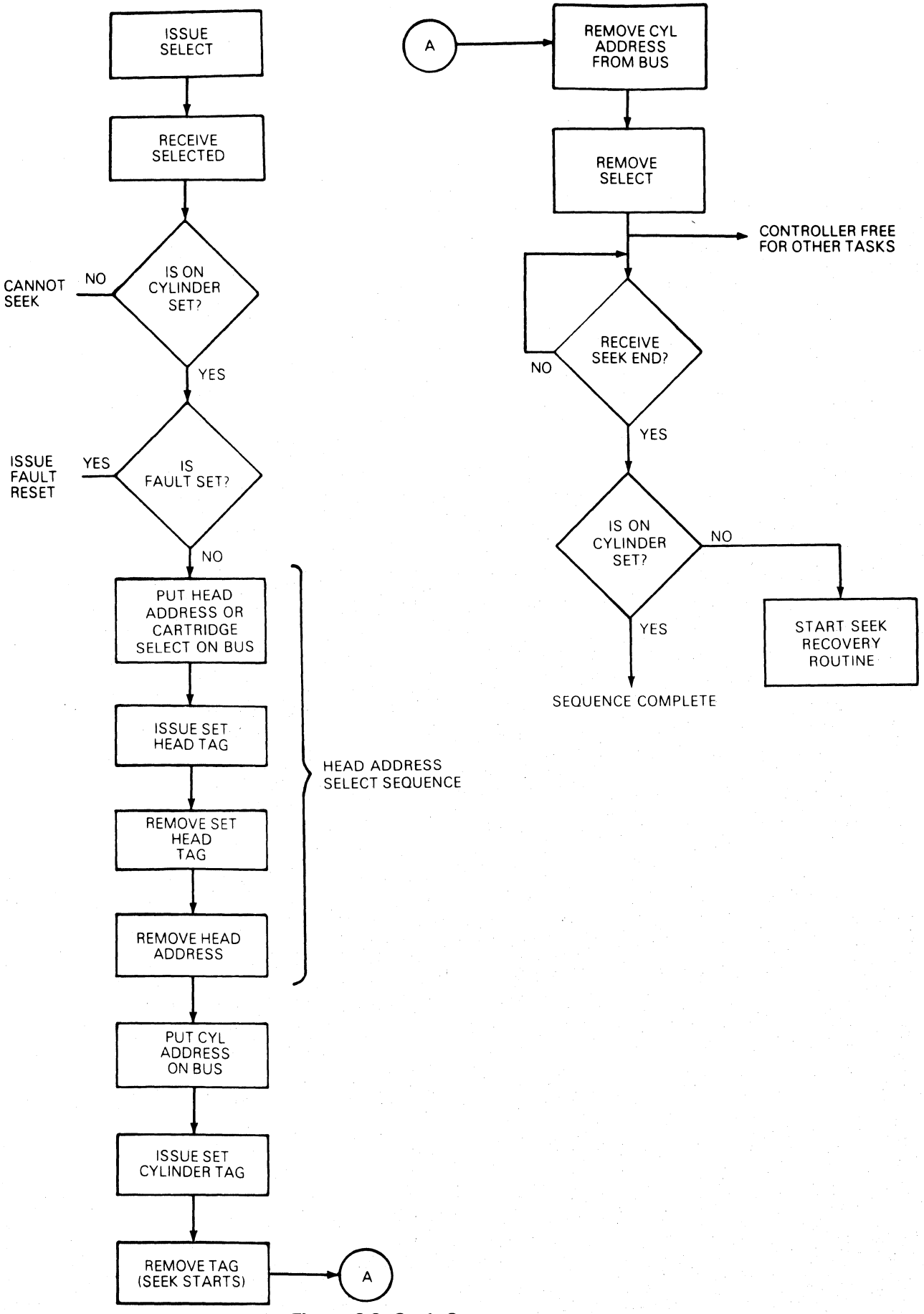


Figure 8-2. Seek Sequence

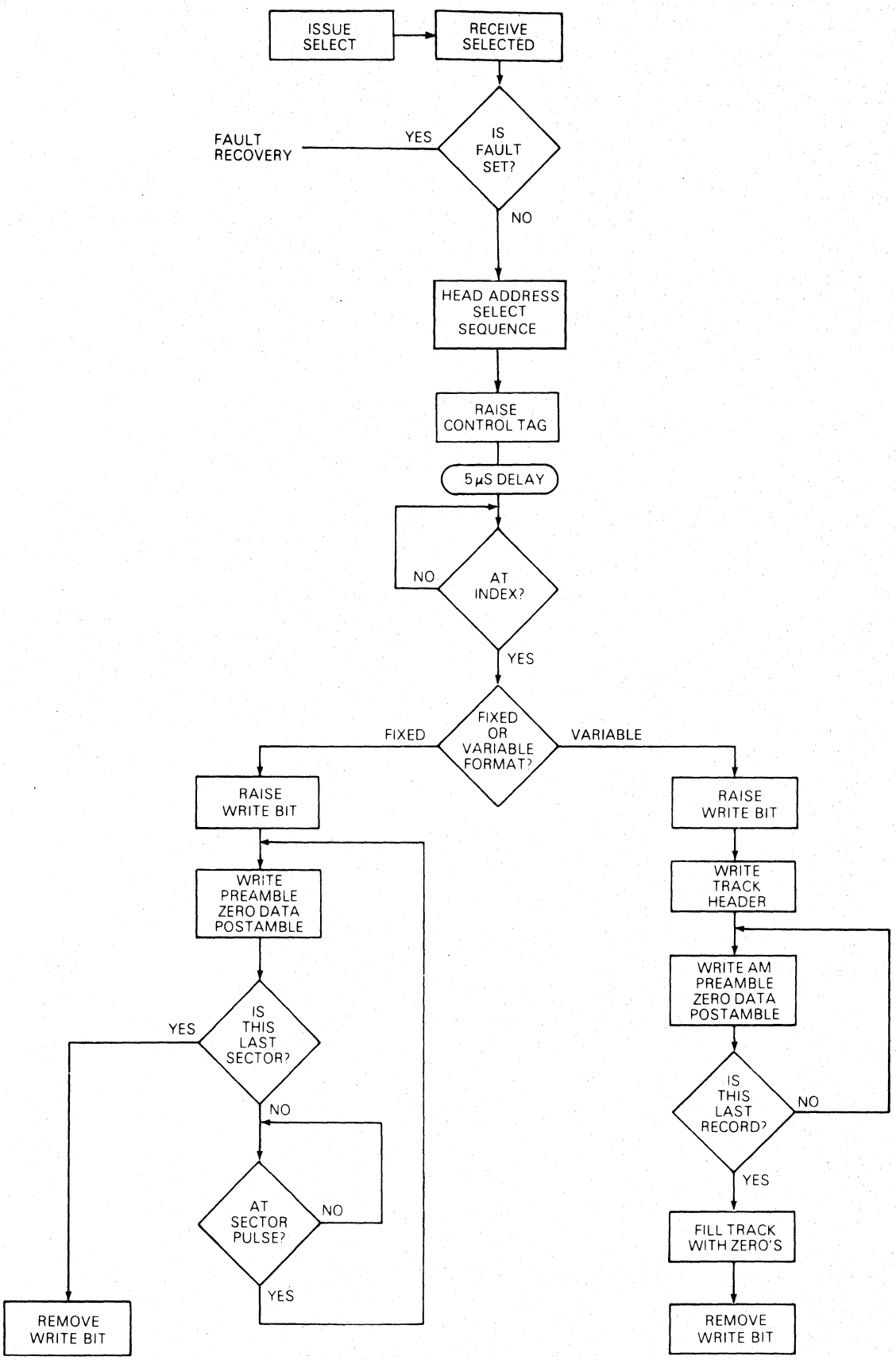


Figure 8-3. Track Initialization

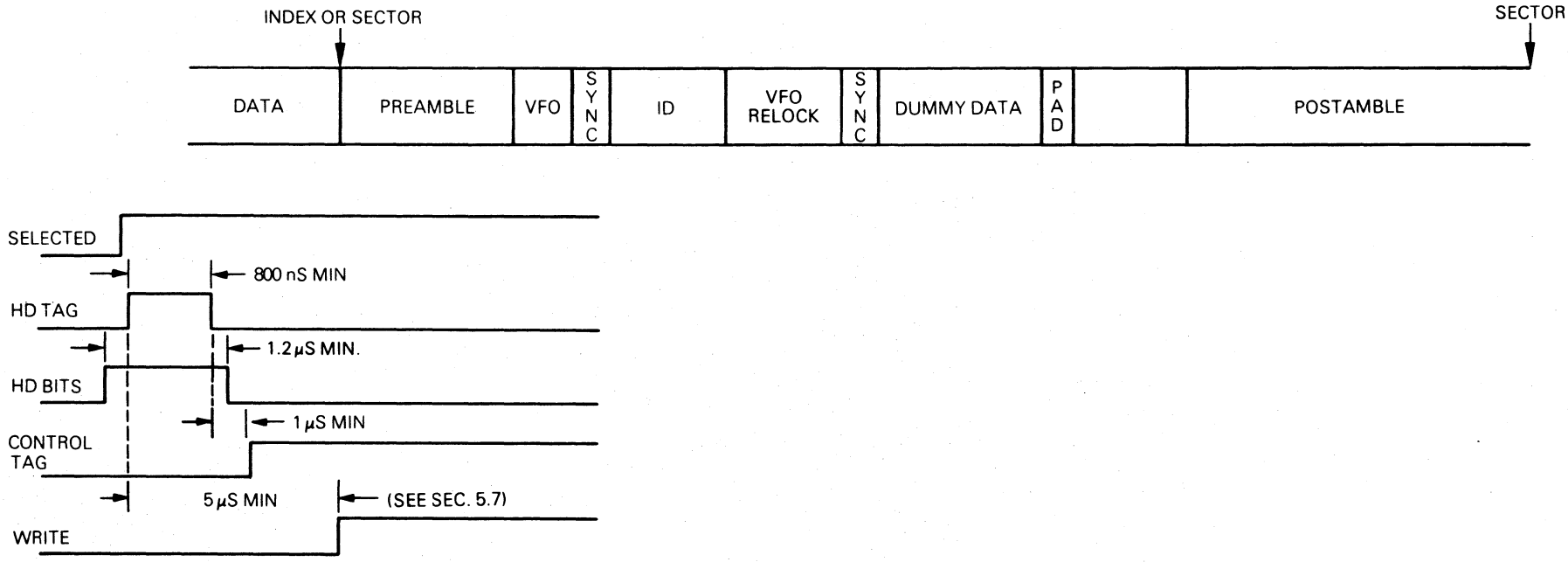


Figure 8-4. Initializing for Electronic Sectoring (Format A)

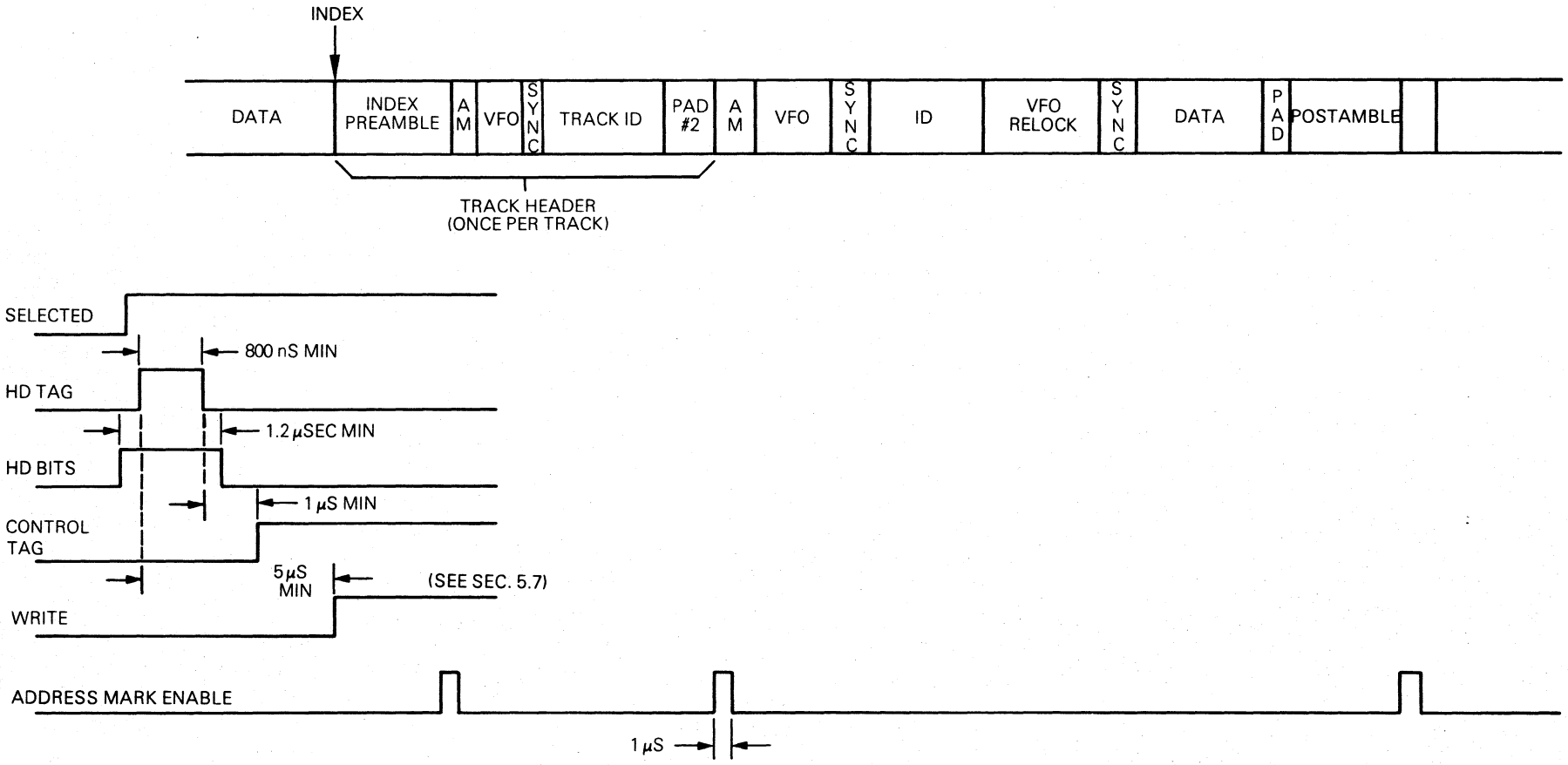


Figure 8-5. Initializing for Address Mark Sectoring

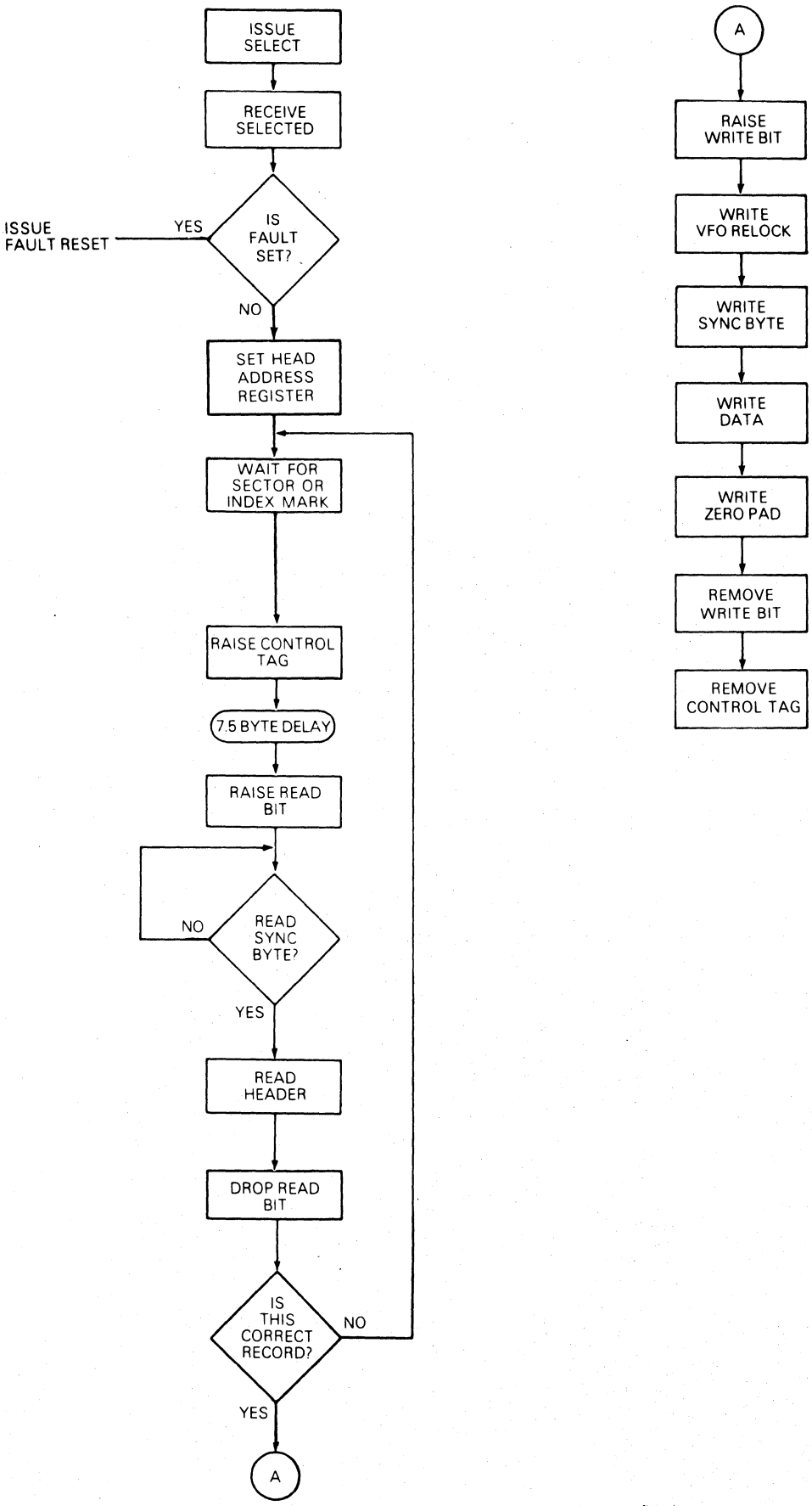


Figure 8-6. Write Using Electronic Sectoring

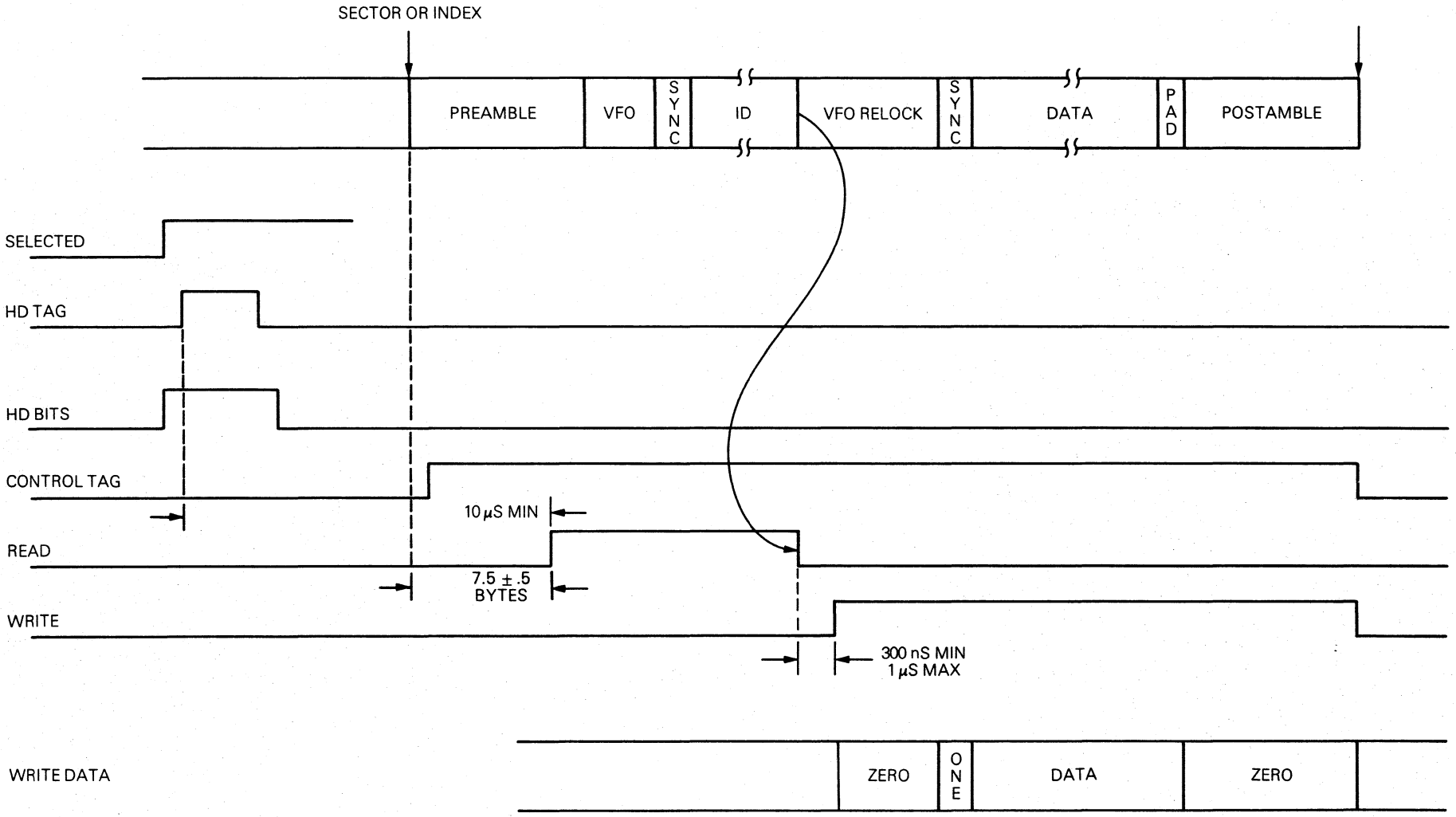


Figure 8-7. Write Using Electronic Sectoring (Format A)

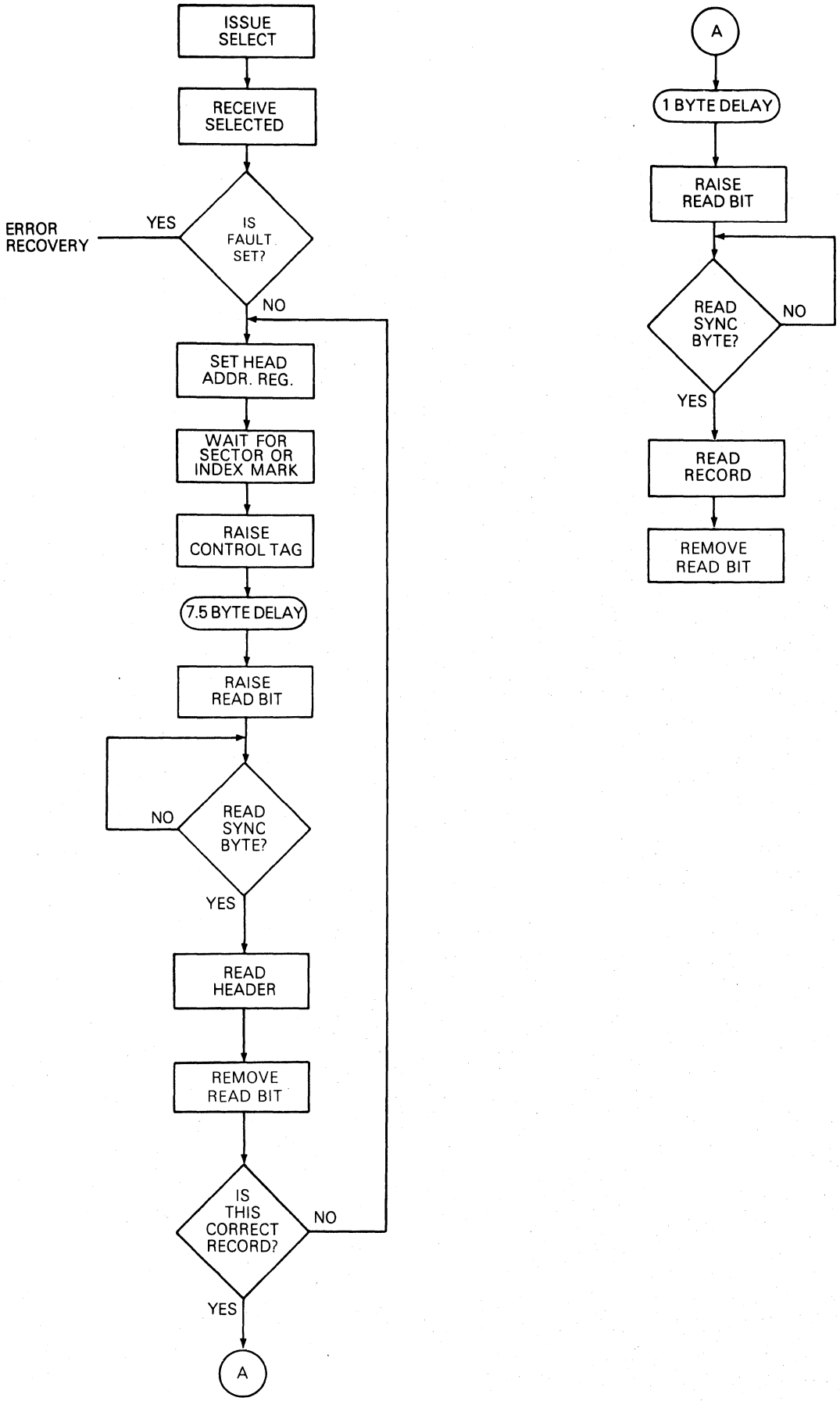


Figure 8-8. Read Using Electronic Sectoring

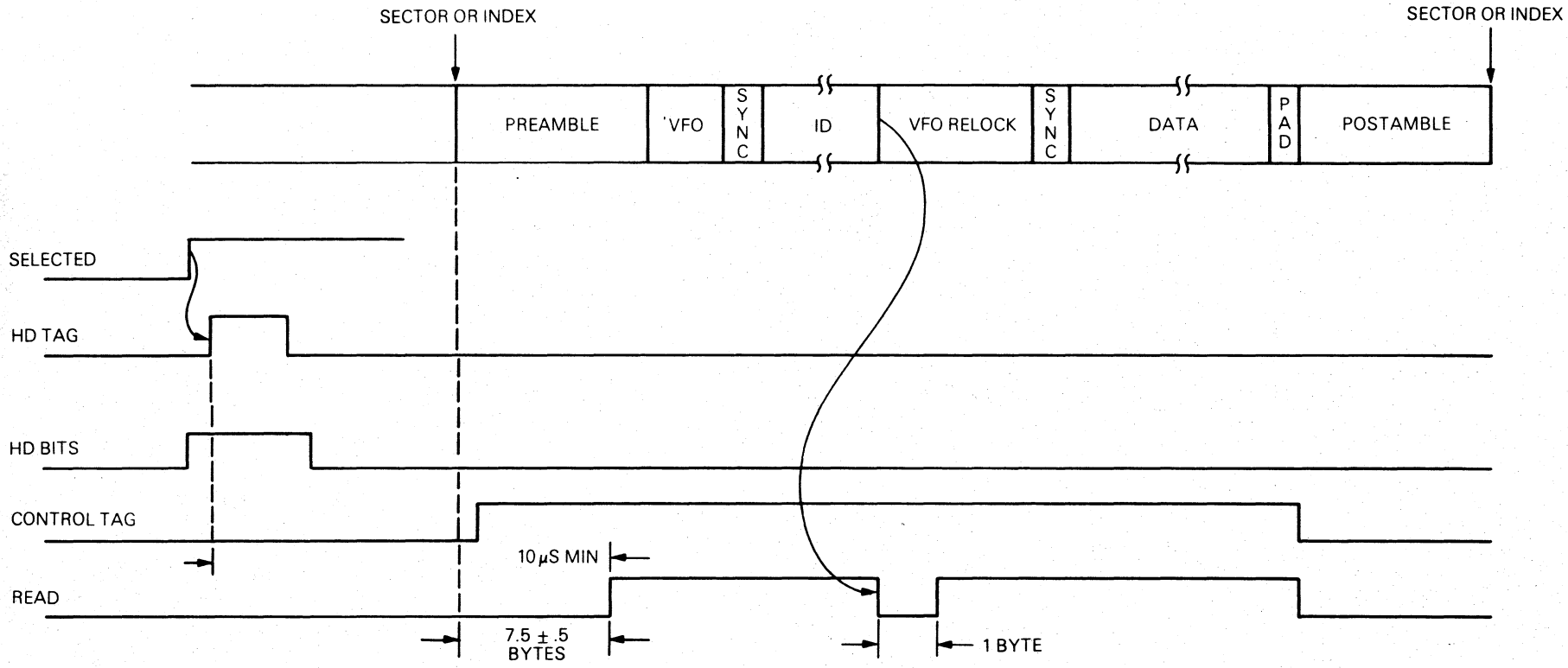


Figure 8-9. Read Using Electronic Sectoring (Format A)

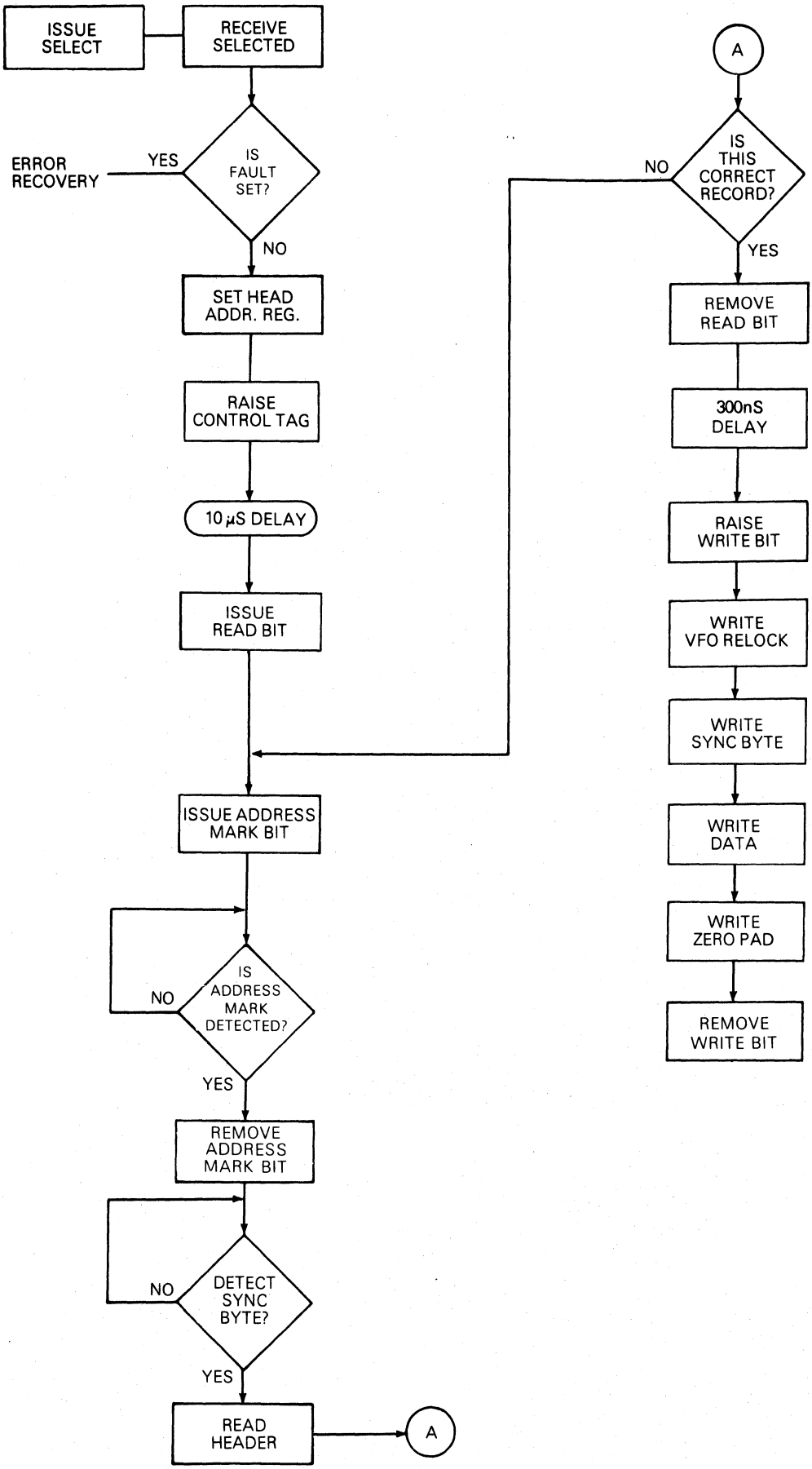


Figure 8-10. Write Using Address Marks

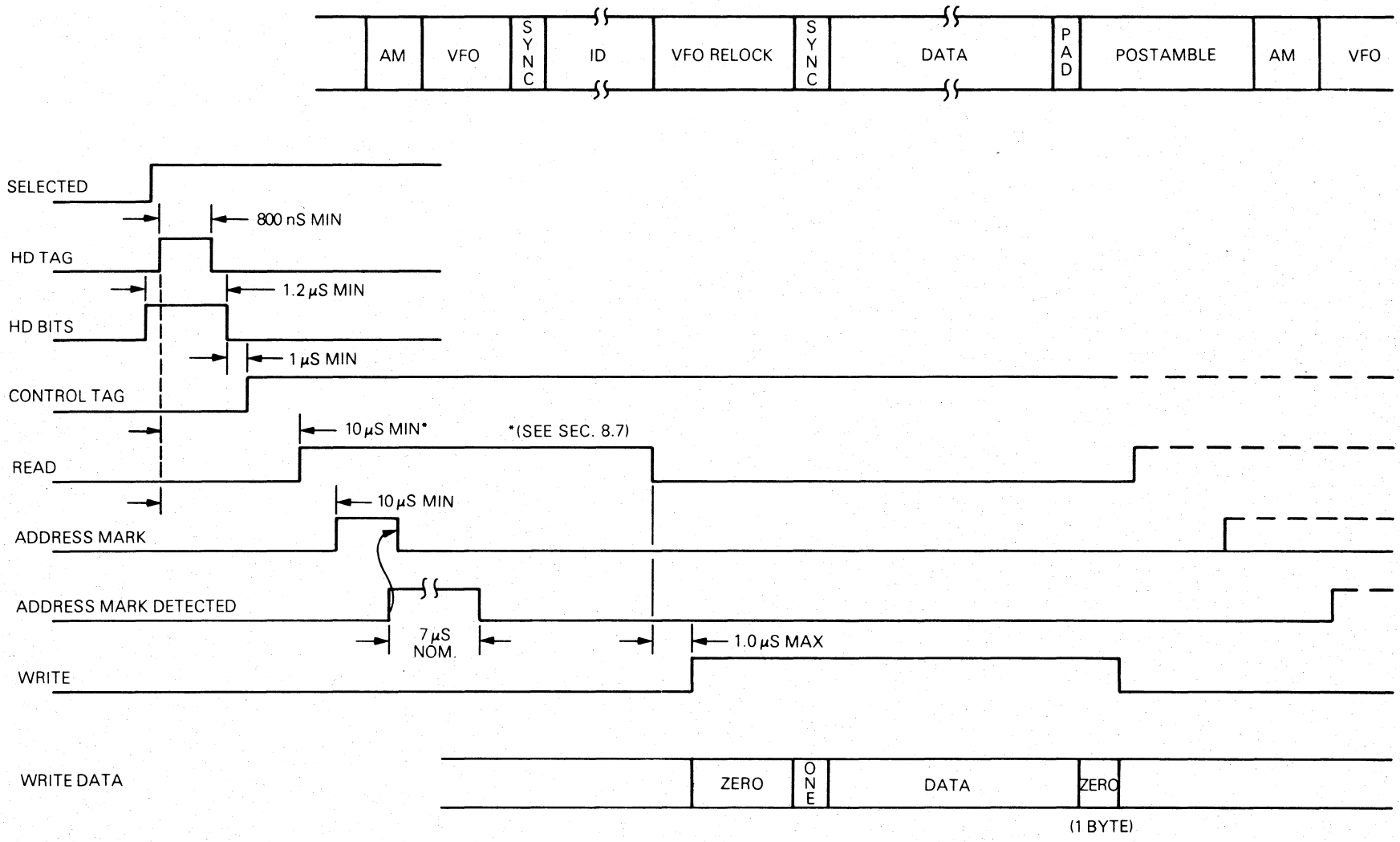


Figure 8-11. Write Using Address Mark Sectoring (Format C)

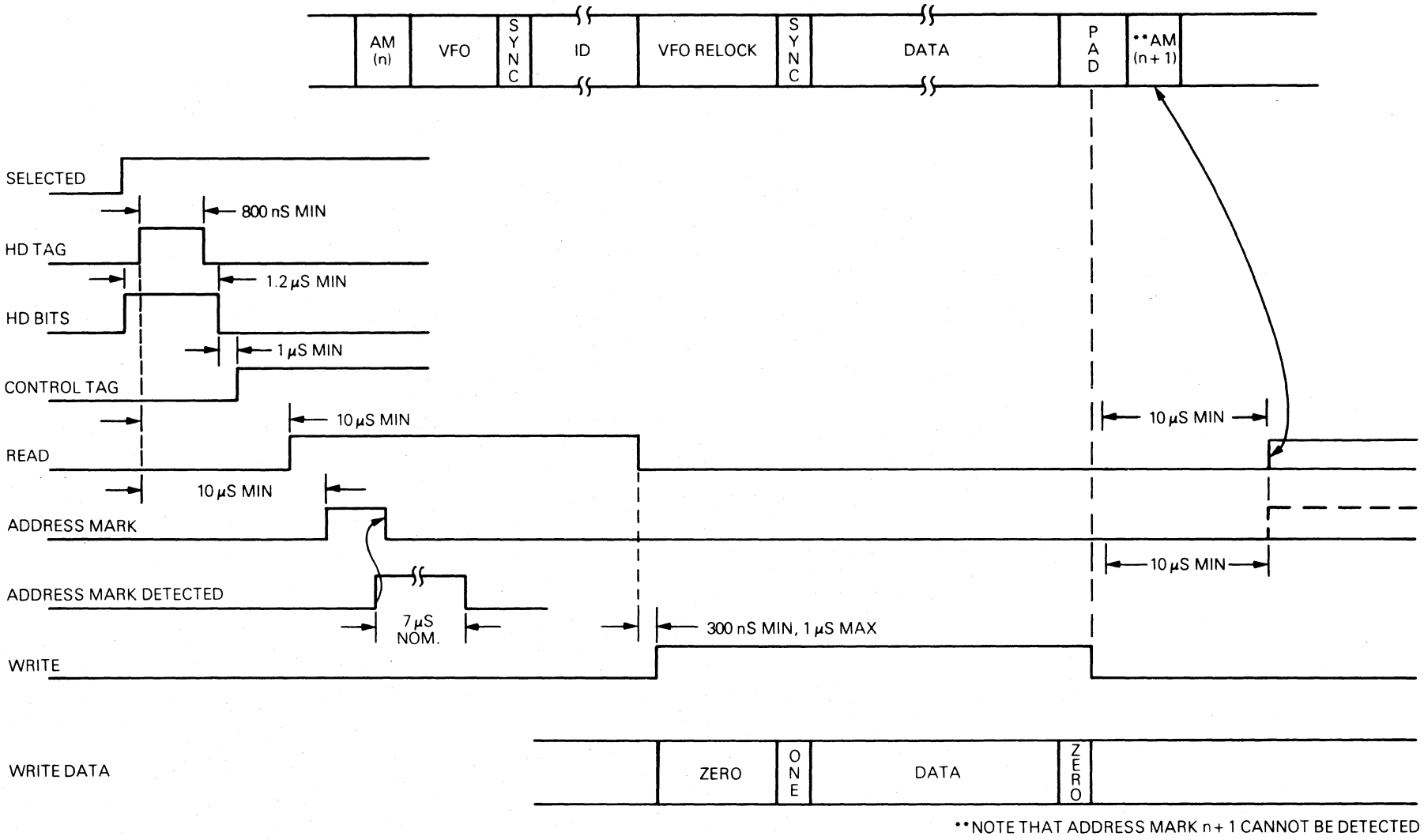


Figure 8-12. Write Using Address Mark Sectoring (Format E)

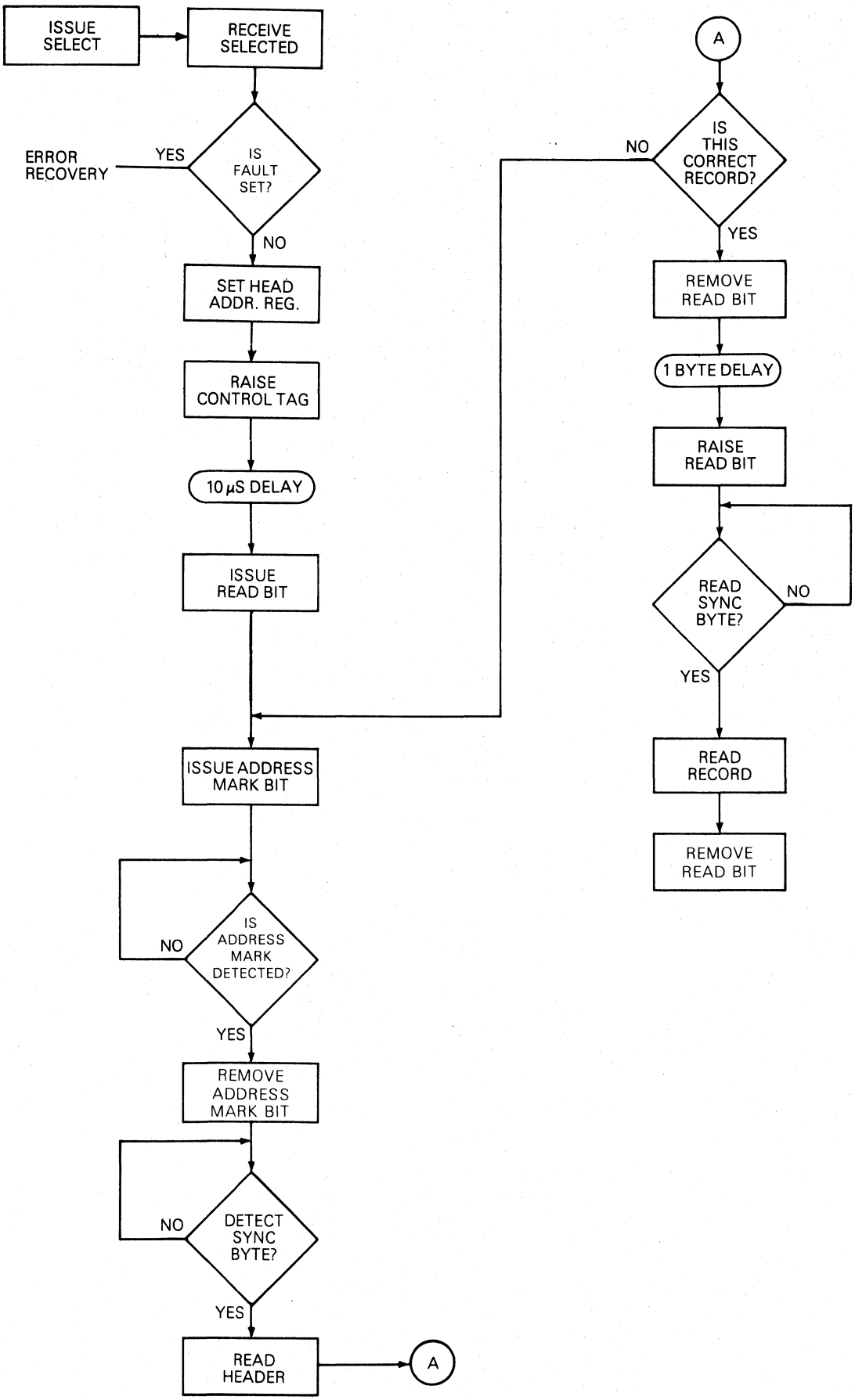


Figure 8-13. Read Using Address Marks

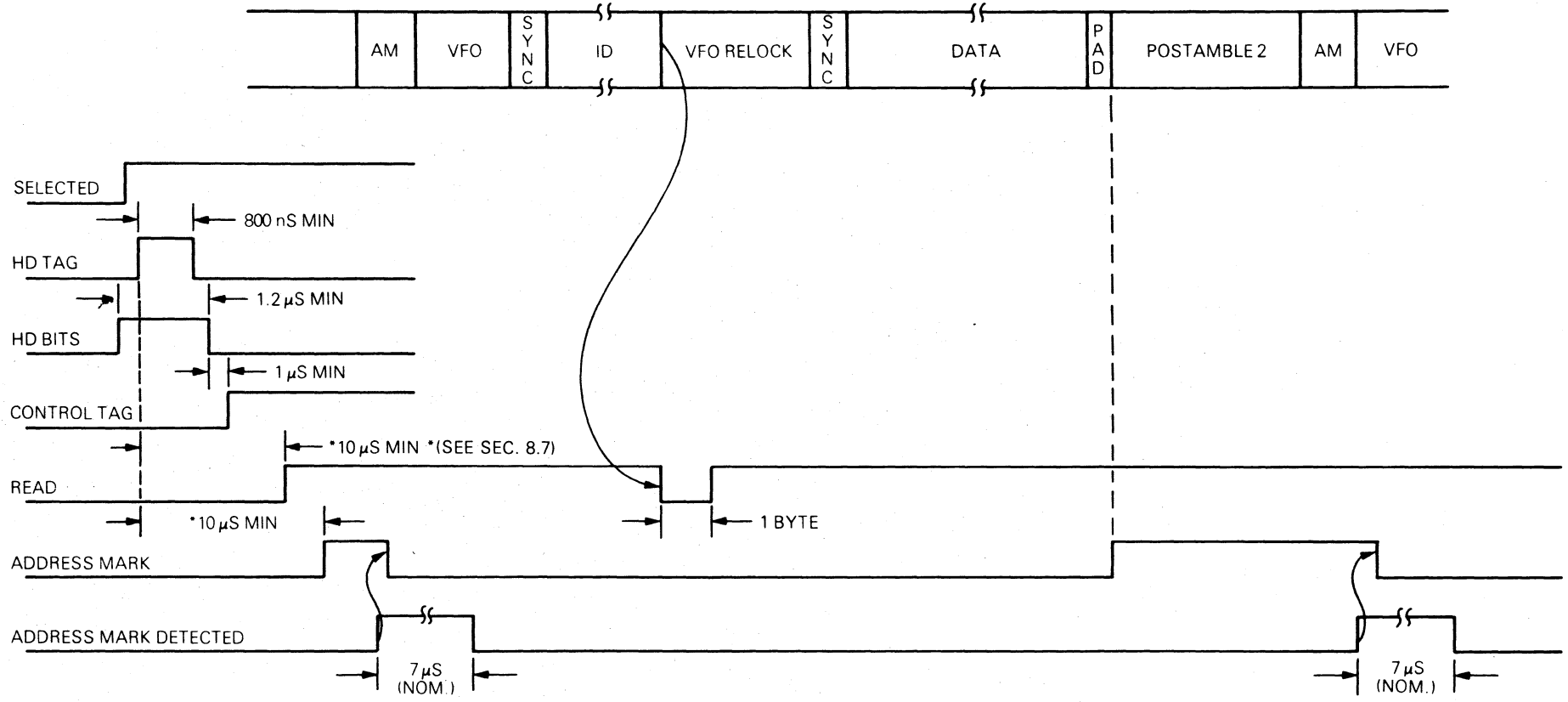


Figure 8-14. Read Using Address Mark Sectoring (Format C)

SECTION 9
SMD INTERFACE SIGNAL LEVELS

9.1 BUSSED OR SIGNAL CABLE

Type	30 Pair. Twisted Flat Cable
Spectra Strip	P/N 36T-6028-7B-05-100
Wire Size	28 AWG, 7 Strands
Impedance	100 OHMS, ±10% line to line
Termination	56 OHMS (See Figure 9-1)
High Level	0V (Ground)
Low Level	−0.40V Max., −0.26V Min. at Receiver input (includes Max. Line loss)
Logical States	P Line High; M Line Low — Logic 1 P Line Low; M Line High — Logic 0
Maximum Cable Length	100 Ft. Cumulative

9.2 RADIAL OR DATA CABLE

Type	26 conductor, flat cable with ground plane and drain wire CDS P/N 19706-026
Wire Size	28 AWG, 7 strand
Impedance	130 OHM, ±15Ω
Termination	82 OHMS ±5% (See Figure 9-2)
High Level	0V (Ground)
Low Level	−0.62V Max., −0.26V Min. (Includes Max. Line loss)
Logical States	P Line High: M Line Low — Logical 1 P Line Low; M Line High — Logical 0
Maximum Cable Length	50 Ft.

9.3 RECOMMENDED LINE RECEIVERS AND DRIVERS

Line Receivers: (Ref. Fig. 9-1 and 9-2)	Signetics	SN75107A
	Signetics National	SN75108A
Line Driver: (Ref. Fig. 9-1 and 9-2)	Texas Inst.	SN75110A
	Fairchild	SN75110J

9.4 MATING CONNECTORS

Bussed (Signal) Connector	CDS P/N 17266-060
Radial (Data) Connector	CDS P/N 17266-026
Terminator	CDS P/N 19315-001

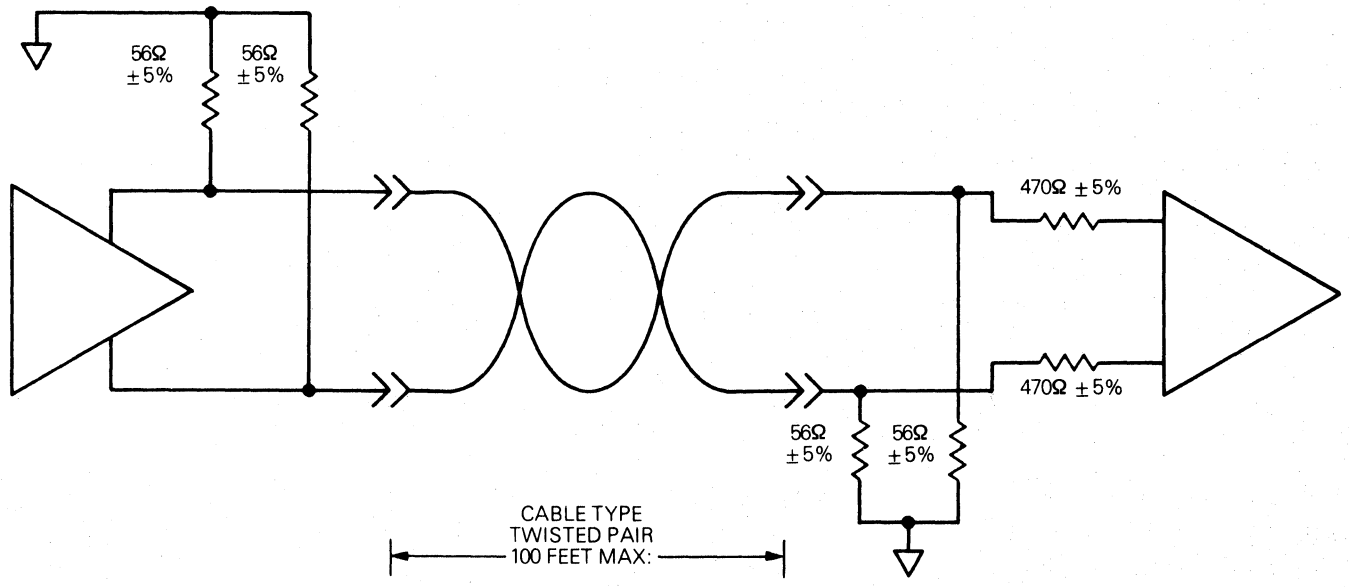
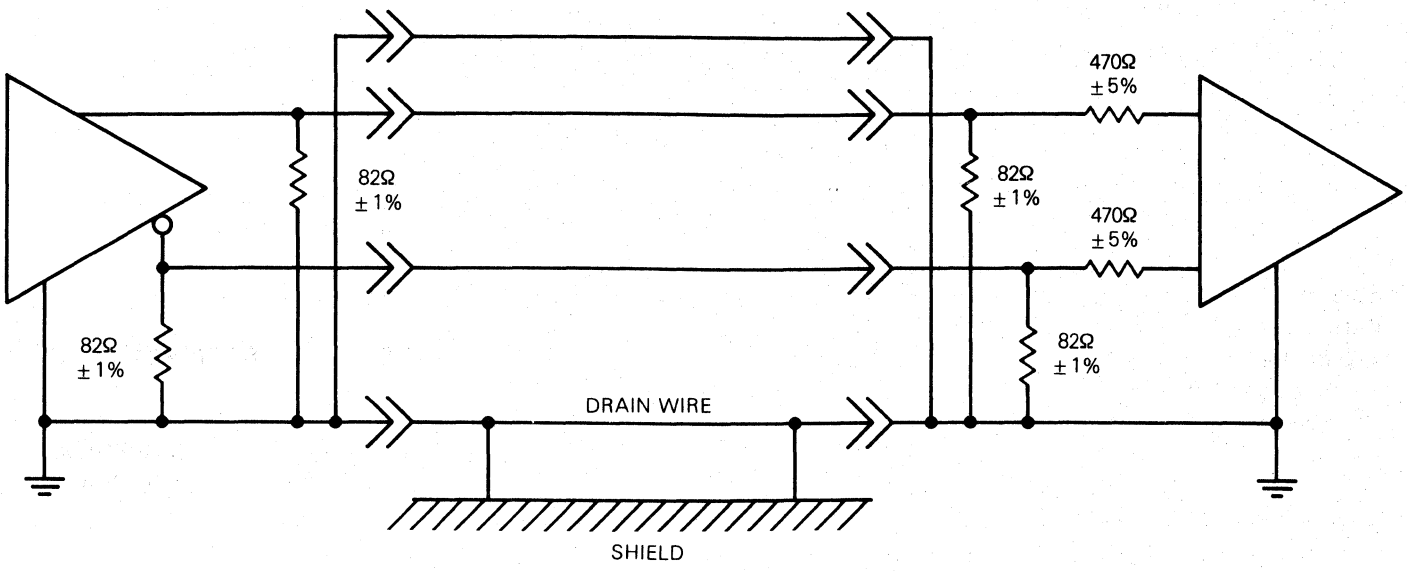


Figure 9-1. Bussed (Signal) Cable Recommended Driver/Receiver Cable Termination Circuit



50 FT. MAX. OF FLAT CABLE HAVING 130 ± 13 OHMS CHARACTERISTIC IMPEDANCE.

Figure 9-2. Recommended Driver/Receiver Cable Termination Circuit for Read/Write Data and Clock

Table 9.1 HUNTER Signal Levels (Bus Cable)

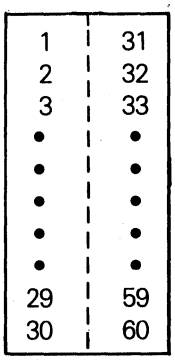
BUS INTERFACE CONNECTOR AND PINS Pin Number (J1 and J2)			
Active Low	**Active High**	**Signal Name**	**Source**
22	52	UNIT SELECT TAG	CONTROLLER
1	31	TAG 1 (SET CYLINDER)	CONTROLLER
2	32	TAG 2 (SETHDTAG)	CONTROLLER
3	33	TAG 3 (CONTROL TAG)	CONTROLLER
4	34	BUS BIT 0	CONTROLLER
5	35	BUS BIT 1	CONTROLLER
6	36	BUS BIT 2	CONTROLLER
7	37	BUS BIT 3	CONTROLLER
8	38	BUS BIT 4	CONTROLLER
9	39	BUS BIT 5	CONTROLLER
10	40	BUS BIT 6	CONTROLLER
11	41	BUS BIT 7	CONTROLLER
12	42	BUS BIT 8	CONTROLLER
13	43	BUS BIT 9	CONTROLLER
23	53	UNIT SELECT 1	CONTROLLER
24	54	UNIT SELECT 2	CONTROLLER
25	55	UNIT SELECT 3	CONTROLLER
26	56	UNIT SELECT 4	CONTROLLER
27	57	UNIT SELECT 8	CONTROLLER
18	48	INDEX	DRIVE
25	55	SECTOR	DRIVE
15	45	FAULT	DRIVE
16	46	SEEK ERROR	DRIVE
17	47	ON CYLINDER	DRIVE
14	44	OPEN CABLE DETECTOR	CONTROLLER
19	49	UNTI READY	DRIVE
20	50	ADDRESS MARK FOUND	DRIVE
28	58	WRITE PROTECTED	DRIVE
	29	POWER SEQUENCE PICK	CONTROLLER
	59	POWER SEQUENCE HOLD	CONTROLLER
30	60	TERMINATOR GRD	
21	51	BUSY (DA ONLY)	DRIVE

Table 9.2 HUNTER Signal Levels (Radial Cable)

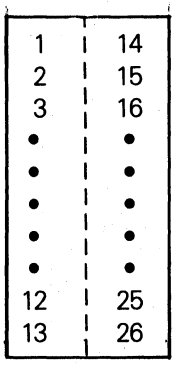
RADIAL CABLE CONNECTOR AND PINS Pin Number (J3)			
Active Low	**Active High**	**Signal Name**	**Source**
8	20	WRITE DATA	CONTROLLER
2	14	SERVO CLOCK	DRIVE
3	16	READ DATA	DRIVE
5	17	READ CLOCK	DRIVE
6	19	WRITE CLOCK	CONTROLLER
	Not Used		
10	23	SEEK END	DRIVE
22	9	UNIT SELECTED	DRIVE
12	24	INDEX	DRIVE
13	26	SECTOR	DRIVE
	7		
	18		
	1		
	15		
	4	GROUND	
	21		
	11		
	25		

WARNING

The pin number designators for the SMD interface follow the designation shown above.



60 Pin Connector



26 Pin Connector

SECTION 10
DUAL ACCESS OPTION

10.1 GENERAL

The dual access option is a feature which allows the HUNTER to be accessed from either of two controllers. Access to either drive channel, access "A", or "B", can be controlled by switches located on the Control Logic PWB. Internal logic prevents a drive from being simultaneously connected to more than one control unit at a time.

10.2 UNIT SELECTION (BOTH ACCESS ENABLED)

In a dual access system, the act of selecting a drive also reserves the unit and inhibits the alternate controller from selecting that drive. The controller awaiting drive access will receive a Busy Signal until the drive is available. A 30 microsecond pulse on the Seek End line signifies that the drive has been released. At that time, the disk drive is available for selection by either controller. In the event that both controllers "A" and "B" attempt to select a unit simultaneously, controller "A" will be allowed access. As in single access operation, the Unit Select tag must remain active during drive operation.

10.3 REMOVAL FROM RESERVE STATUS

The drive is removed from reserved status after any power up or down sequence. If the drive is online, it may be removed from reserved status either by the reserve timer or Release signal.

10.3.1 Reserve Timer

The reserve timer is a strappable option that allows the drive to maintain its reserve status for a predetermined time period after Unit Select is removed. If the option is used, release of the access will occur approximately .5 seconds following deselection of the unit. This time period may be varied by changing a resistor or capacitor in the timing circuit. If the Unit Select signal is not reissued to the drive before "time-out", the unit is free to be selected by either controller.

10.4 PRIORITY SELECT (SMD ONLY) (BUS 9 + UNIT SELECT)

If Bus 9 is true on the leading edge of Unit Select, the drive is unconditionally selected and absolutely reserved by the respective access provided that a reserve or priority select condition does not exist on the other access. This function overrides the reserve timer and gives exclusive control to that access until a Release Signal (Bus 9 + Tag 3) is issued.

SECTION 11
CONTROLS & INDICATORS

11.1 FRONT PANEL

11.1.1 Start Switch

When the sequence command from the interface is active (or when the drive is degated), this switch energizes the spindle motor. All internal power supplies are active even when this switch is off.

11.1.2 Cartridge Protect

When this switch is depressed, writing on the cartridge is inhibited. In the out position, writing is enabled. Jumpers on the CONTROL PCB select one of these types of interlock for this switch. The options are:

- The logical state of the switch will only change when the drive is not selected or when a rezero command is executed.
- The logical state of the switch will only change with the absence of a write command.
- The logical state of the switch is controlled directly by the switch.

11.1.3 Fixed Protect

When the switch is depressed, writing on any fixed disk is inhibited. In the out position, writing is enabled. Jumpers at the Control Logic PCB and the Cartridge Protect Switch also control the logical action of this switch.

11.1.4 Fault Clear

The fault clear switch will reset any fault (device check) except an emergency retract that does not remain active after the switch is depressed.

11.1.5 Status Indicator

A hexidecmial indicator on the control panel displays the drive status. It displays a single condition at a time. If multiple conditions occur, the indicator sequences through them until they no longer occur. A flashing zero indicates that the drive is in a sequence up or sequence down transition. Table 11-1 shows various conditions for the status indicator.

Table 11-1. HUNTER Front Panel Display

DISPLAY	STATUS CONDITIONING
0(flashing)	Drive sequencing up or down
0(steady)	Drive ready
1	Head unsafe
*1(flashing)	Outer guardband detector not working
2	Write current unsafe or no write transitions
3	Cylinder tag when not ready
4	Locked on alighment track
5	Read or write and not ready
6	Offset while attempting to write
7	Read and write gates on simultaneously
8	Write gate on when read only set
9	Illegal interrupt
A	Illegal cylinder requested
*A(flashing)	Drive failed to come up to speed in 1 min.
B	Outer guardband detected during track follow
*B(flashing)	Drive failed to stop spinning within 1 min.
C	Spare
*D	Emergency retract **
*D(flashing)	Emergency retract occuring prior to first seek
E	Seek incomplete: Pressing fault clear or issuing device check reset causes an automatic rezero.
*E(flashing)	Seek incomplete when attempting a first seek or a final seek
F	Cartridge not properly installed

*To recover from this error condition it is necessary to sequence down and sequence back up using the start/stop switch.

**Emergengy retract may be caused by (1) DC unsafe, (2) speed loss, (3) open spindle motor optical switch, (4) inner guardband detected, (5) loss of servo signal, or (6) seek velocity greater than 95 in/sec.

11.1.6 I.D. Plug (SMD Interface HUNTERS Only)

The I.D. plug is used to select a logical address (O-F) for the drive. (No plug installed is address F).

11.2 REAR PANEL

11.2.1 Circuit/Breaker

This controls the AC power to the disk drive.

11.3 INTERNAL

11.3.1 Degate Switch

This toggle switch is mounted on the Control Logic PCB. In the online position, the controller interface is enabled and the exerciser interface is disabled. In the OFFLINE position the controller is disabled and the exerciser is enabled. If it is placed in the degate position prior to AC power-up or power-down, transient signals do not disturb any other disk drive on the same controller bus. The monitoring capabilities of the exerciser are active in either position.

11.3.2 Servo Disable

This switch, located on the Servo I PCB is a customer engineering control only and should not be operated.

11.3.3 Sector Count Selection

Two IC sockets are wired to accept jumpers coded to select sector count information. They are located on the MPU PCB.

11.3.4 Error Reset Selection

This jumper, located on the MPU PCB determines if Device Check Reset resets all errors.

11.3.5 Model Straps

These jumpers are located on the MPU PCB. They identify the drive as an H-32, H-64, or H-96. No action need be taken unless the drive is upgraded.

SECTION 12
ENVIRONMENTAL CHARACTERISTICS

12.1 GENERAL

The cartridge and disk drive shall be subjected to the same environmental conditions for at least one hour before the cartridge is to be installed and used in the disk drive.

12.2 TEMPERATURE

Equipment Operational:	40°F to 104°F (4°C to 40°C) with a max. gradient of 20°F (11°C) per hour.
Equipment Non-Operational:	−40°F to 140°F (−40°C to 60°C)

Temperature Cycling: No condensation shall result.

12.3 HUMIDITY

Equipment Operational:	5% to 90% R.H., with a wet bulb temp. limit of 80°F (27°C) provided there is no condensation.
Equipment Non-Operational:	5% to 95% R.H., provided there is no condensation.

12.4 ALTITUDE

Equipment Operational:	Sea level to 6,000 feet (1800m). (Optional 10,000 foot kit available)
Equipment Non-Operational:	From 1,000 feet below sea level to 40,000 feet above sea level (−300m to 12,000m)

12.5 HEAT DISSIPATION

2170 BTU/Hour

12.6 VIBRATION

Equipment Operational:	The equipment shall withstand a peak displacement of ±0.006 in (0.15 mm) for the frequency range of 5 Hz to 60 Hz ±1g for the 60 Hz to 500 Hz range.
Equipment Non-Operational:	The equipment, without internal bracing and/or external packaging, shall withstand ±1.5g from 5 Hz to 55 Hz for one hour along each of three mutually perpendicular axes, with a 20 minute sweep time. (Except heads must be held retracted as for shipping.)

12.7 SHOCK

The equipment in non-operational status shall not suffer damage or fail to operate according to specifications, when subjected to 10 impact shocks of 5g (±10%) consisting of 3 shocks along each direction of three mutually perpendicular axes. Each shock impulse shall be a half sinc wave with a time duration of 11 ±1 ms.

12.8 DUST CONTROL

The disk drive is equipped with air filters to ensure the circulation of clean air through the disk drive. All air filtration and air moving mechanisms are completely within the assembly. The disk area is completely closed while the disk drive is operational except for designated air entrance and exit channels. Care should be taken to keep dust and dirt exposure via the service/cartridge area openings to a minimum.

SECTION 13
POWER REQUIREMENTS

13.1 AC POWER

Voltage	Frequency	Run
100-127 VAC, +10%, −15%	60 Hz ±1%	0.7KVA
100-127 VAC, +10%, −15%	50 Hz ±1%	0.7KVA
200-240 VAC, +10%, −15%	60 Hz ±1%	0.7KVA
200-240 VAC, +10%, −15%	50 Hz ±1%	0.7KVA

13.2 DC POWER

Internally generated.

13.3 TERMINATOR POWER FOR TRIDENT INTERFACE DRIVES ONLY

+5 VDC, ±5% (measured at the terminator). 150 mA per drive, +1.25A max., for bus cable terminator.

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