

SIEMENS FLOPPY DISK DRIVE MAINTENANCE MANUAL

Manual Order Number: 9800967-01

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PREFACE

This manual provides information about the Siemens OEM Floppy Disk Drive FDD 100-8. This manual has been duplicated with permission from Siemens.

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SECTION 1 INTRODUCTION

GENERAL

This manual provides information on the description, capabilities, operation, and theory of operation information for the Floppy Disk Drive (Figure 1-1).

SCOPE

The contents of this manual are intended to be used for customer introduction to the disk drive, as a training document for customer engineers requiring detailed theory of operation information and for installation and maintenance information.

DESCRIPTION

The disk drive is a low-cost, random access storage device, which uses a floppy disk as the storage medium. The single, removable disk cartridge will store up to 6.4 megabits of double-density unformatted data, 3.2 megabits of single-density data, or 1.94 megabits using the compatible IBM System 3740 format. The disk drive is also compatible with the IBM System 32 format. Because of its small size and weight, installation can be accomplished in almost any convenient location or orientation. For data accessing the disk is divided into 77 tracks, and each track can be subdivided into as many as 32 sectors. A stepper motor positions the read/write head at the track to be

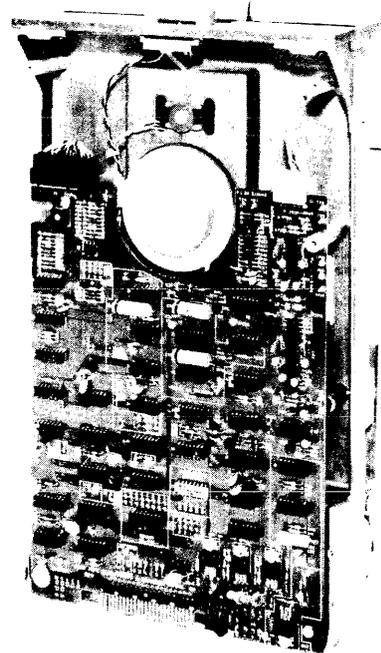


Figure 1-1. Floppy Disk Drive

accessed. Index and sector holes punched into the disk are sensed photoelectrically to produce sector and index pulses that permit accessing of individual sectors of a track. When the optional write-protect slot in the protective envelope is uncovered the write-protected condition is sensed photoelectrically, and write operations are inhibited.

Up to eight drives can be interfaced to a single host controller. The controller controls disk drive selection, head loading, track addressing, and read/write data transfers.

When a disk cartridge is inserted and the access door is closed, the drive spindle rotates the disk at 360 revolutions per minute. When selected, the drive accepts a head load command, causing the read/write head to be loaded to the disk. With the drive selected, sector/index pulses, write-protect status, track 00 position status, and a read/write ready status is supplied to the controller. At the desired track, a data transfer operation is performed; read-to the controller, write-from the controller, depending on the state of the write command.

During a write operation (disk not write-protected), write data is input to the write circuits. For each write data pulse received, a flux reversal is recorded on the disk by the read/write head.

During a read operation, each recorded flux reversal is sensed by the read/write head, converted to a raw data pulse and supplied to the controller.

Applications for the Flexible Disk Drive include:

- Key Entry Systems
- Point-of-Sale Recording Systems
- Word Processing Systems
- Batch Terminal Data Storage
- Small Business Systems Data Storage
- Microprogram Loading and Error Logging
- Minicomputer Programs and Auxiliary Data Storage

The drive provides random accessing of data with greater performance and reliability and is an excellent alternate product to paper tape, reel-to-reel tapes, card equipment, cassettes, and cartridge drives.

DISK CARTRIDGE

The disk cartridge is an 8-inch-square plastic protective envelope, in which the floppy disk is sealed. The protective envelope contains apertures for spindle loading, head contact, sector/index detection, and optional write-protect detection, (see Figure 1-2).

The recording media is a magnetic-oxide-coated flexible mylar disk sealed within the plastic envelope for protection, self-cleaning, and ease of handling. The disk should be handled and stored in clean environments, free from magnetic influences.

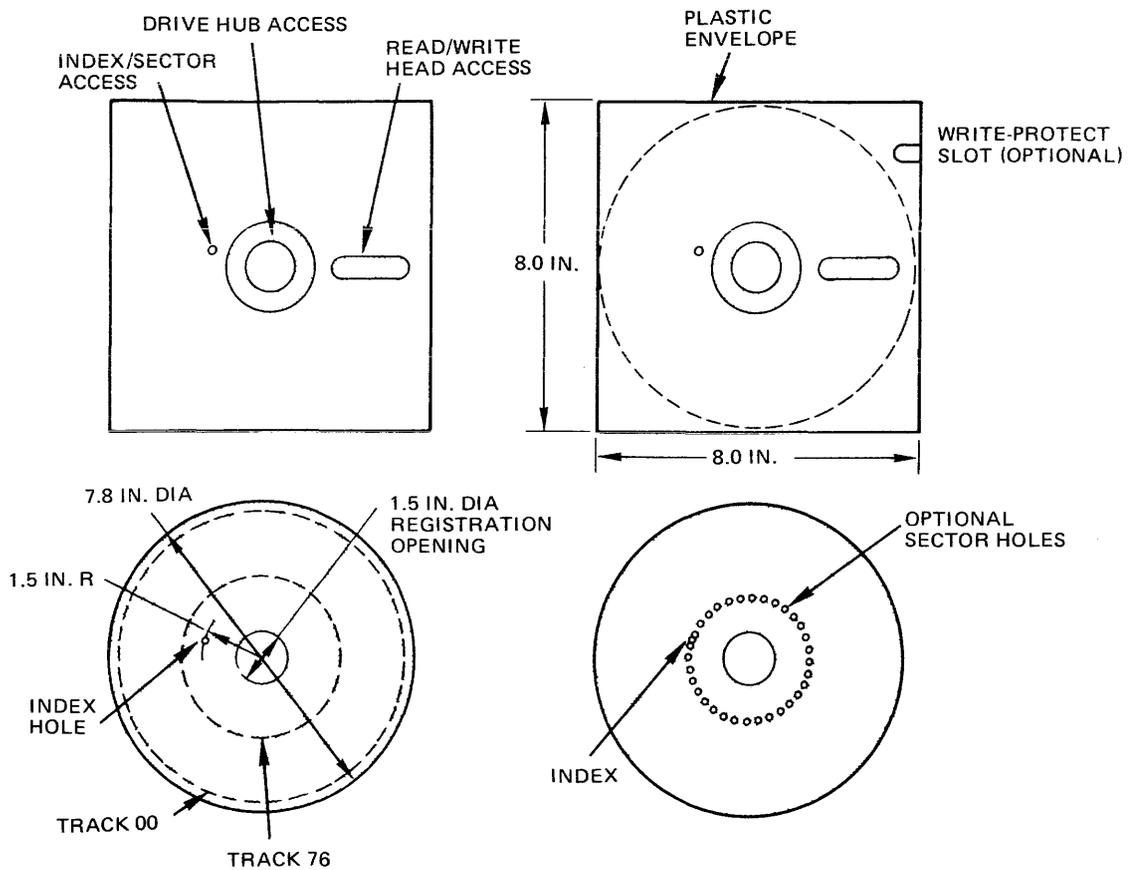


Figure 1-2. Floppy Disk and Protective Envelope

At no time should the surface of the media be touched, or the surface of the envelope be written on. When not in use, the disk cartridge should be returned to its protective storage envelope.

For reliable operation, flexible disks should be stabilized in the same environment as the using disk drives, for a period of at least five minutes, prior to installation. The recommended flexible disk meets the requirements of the following documents:

- X3138/77-118 American National Standard for Single-Sided Unformatted Flexible Disk Cartridge
- GA21-9190 IBM One-Sided, Original Equipment Manufacturing Information.
- ECMA/TC 19/77/16 Data Interchange on 200 mm Disk Cartridges using double frequency recording at 13,262 ftprad on one side.

Floppy disk characteristics are listed in Table 1-1.

Table 1-1. Floppy Disk Characteristics

Function	Characteristics
Disk Type	ANSI Standard
Disk Diameter	7.88 inches
Disk Thickness	0.003 inch
Rotational Speed	360 rpm
Rotational Period	166.67 ms
Average Latency	83.33 ms
Tracks	77
Track Density	48 tpi
Bit Density	3268 bpi (single density) 6536 bpi (double density)

Note: For minimum runout the floppy disk should be loaded while the spindle is turning.

RECORDING FORMAT

The recording format is dependent upon requirements of the controller. The track and sector organization of data is dependent on the format.

Encoding Scheme

The drive allows double-density or single-density encoding schemes. In double-density recording, each bit cell is 2 microseconds wide, in single-density recording, each bit cell is a 4 microseconds wide (see Figure 1-3).

Track Format

The flexible disk contains 77 tracks. The first (outside) track is track 00, and the last (inside) track is 76. During the write operation, a tunnel-erase coil in the read/write head erases the outside edges of the data just written, narrowing the data track. In this manner, a guard band is established to protect the data from adjacent track crosstalk when reading.

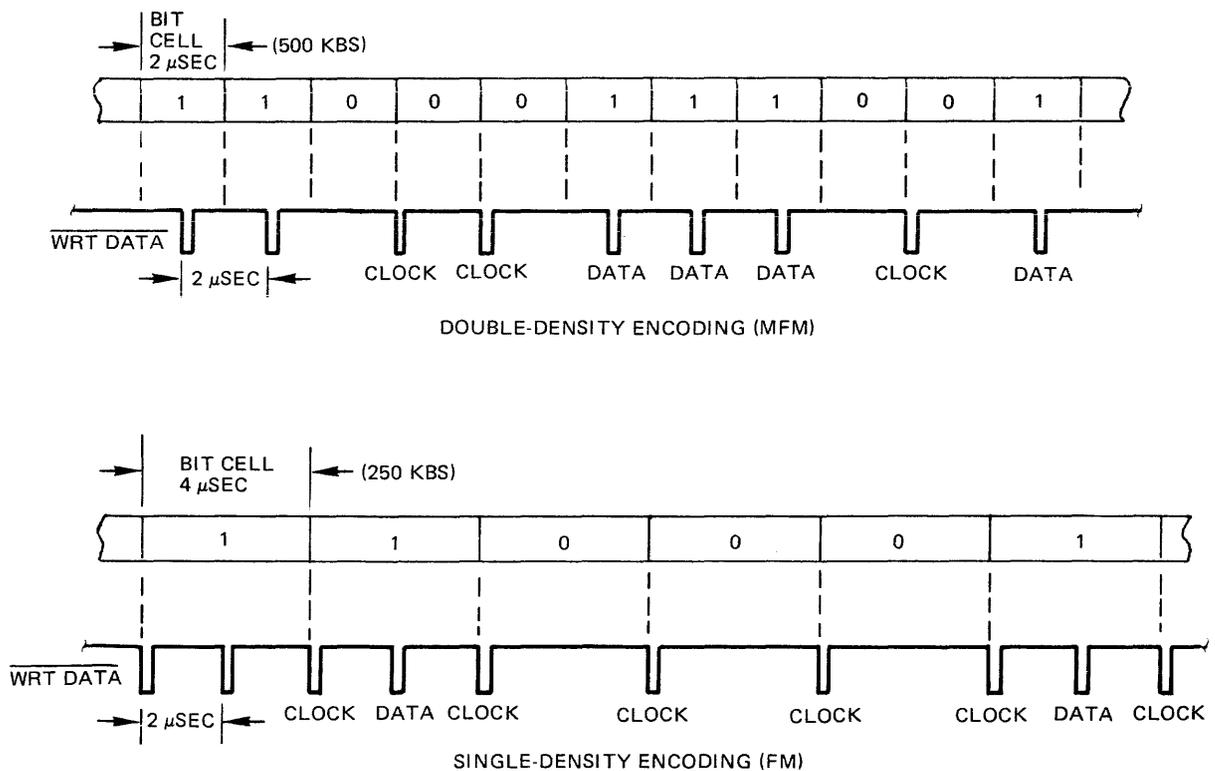


Figure 1-3. Single and Double Density Encoding

Sector Format

The number of sectors in each track is determined by the application, and can range from 1 to 32, depending on whether the soft-sector or hard-sector flexible disk is being used.

When soft sector operation is required, only one index hole is punched in the flexible disk. With this disk, the controller uses the index pulse to define the sectors. When hard sector operation is required, the flexible disk used contains the index hole plus 32 sector holes spaced equidistant around the disk (see Figure 1-2).

The index hole is punched midway between sector holes 31 and 0. The double-pulse of sector 31 and index alerts the controller that the next pulse starts sector 0. The index and sector holes are sensed photoelectrically, providing the pulses supplied to the controller.

Sector Content

The format of each sector is determined by the application. Normally, preambles and postambles containing a stream of coded bytes are written at the beginning and end of each sector, to provide data synchronization. Following the preamble of each new track, an identification (ID) field is written containing the track and sector numbers. Following the ID field, data bytes are written.

32-Sector Format

This format is not the most efficient OEM format due to the number of gaps required between data records. The IBM 3740 format requires even more gaps but is accepted as the most compatible. A typical 32-sector format is shown in Figure 1-4.

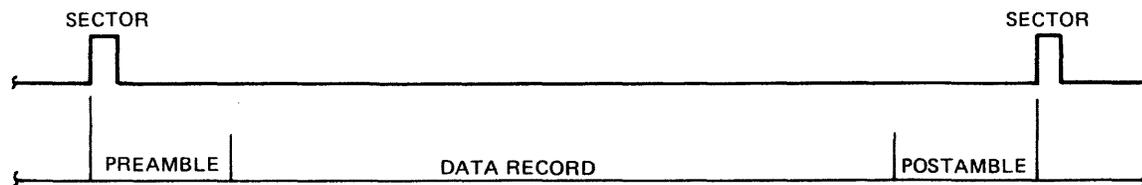


Figure 1-4. 32-Sector Format

IBM 3740 Format

There are two IBM 3740 formats; Data Set Label and Track. The disk drive is compatible to both formats.

Track 00 contains only Data Set Labels that identify the type of information stored in tracks 01 through 76. Tracks 01 through 73, 75, and 76 are allocated 26 sectors, each containing 128 data bytes. A data set may be one or more sectors, including overflow to other on-line disk drives. In the drive, only tracks 01 through 73 are normally used. Track 74 and 75 are reserved as spares to be used when other tracks become flawed, and track 76 is not used. The IBM 3740 format is shown in Figure 1-5. For detailed information on the IBM 3740 data format and initialization, refer to IBM Publication GA21-9190.

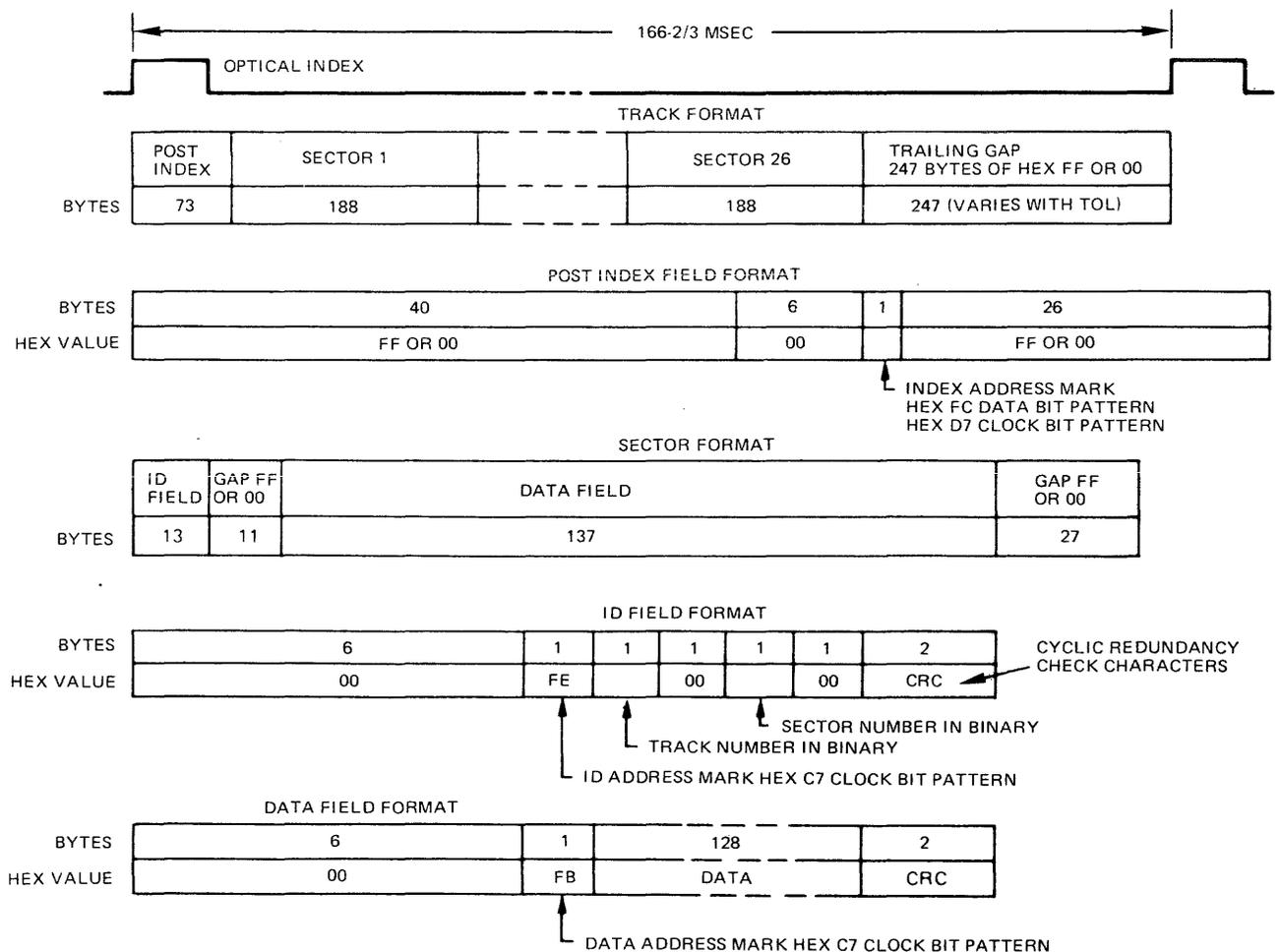


Figure 1-5. IBM 3740 Format

DISK DRIVE ASSEMBLY

The disk drive assembly can be installed in a standard 19-inch RETMA rack; two horizontally, or four vertically. The drive can also be mounted in a table-top for top loading applications.

The disk drive comprises three major assemblies:

- Printed Circuit Board (Electronics)
- Main Deck Assembly
- Carrier Assembly

Printed Circuit Board

All electronic circuitry required to convert the digital data input and output to and from analog data for the read/write head and head positioning information is contained on one circuit board. Interface and DC connectors can be provided. Logic is TTL with selected discrete and IC Components. The electronics perform the following functions:

- Read Chain
- Write Chain
- Ready Generation
- Index Detection
- Stepper Motor Control
- Interface Drivers and Receivers
- Write-Protect (Option)
- Index/Sector Separator (Option)
- FM Data Separator (Option)
- Binary Select (Option)
- Negative 5 Volt Regulator (Option)

Main Deck Assembly

The main deck assembly is the principal supporting assembly and contains the following subassemblies:

- Drive System - Spindle Drive motor, drive belt and pulley to rotate spindle at 360 rpm.
- Positioning System - Stepping motor, lead screw and carriage, head pressure arm and pressure pad to accurately drive and position the read/write head to the desired track.
- Read/Write System - Single-gap magnetic recording head with tunnel-erase feature. Read/write head is contact type.
- Disk Cartridge Guide and Ejector - Provides positive positioning and locking of disk cartridge allowing proper placement of the disk cone. Spring-loaded ejection provides fast, positive, disk cartridge removal.
- Optional Sensing - Index and write-protect sensing by independent LED and phototransistor sensing circuits. Also track 00 sensing on late production units.

Carrier Assembly

The carrier assembly is a secondary frame which pivots from the main deck assembly and includes the following subassemblies:

- Disk Centering Cone - Precisely centers and grips the floppy disk to the spindle.
- Head Load Mechanism - Solenoid, head pressure arm and pad. Exerts and sustains force, by the spring-loaded pressure pad, to constrain the disk cartridge to the platten and the read/write head.
- Access Handle - Pushbutton latch release mechanism. Also releases spring-loaded lock to discharge disk cartridge.

OPTIONS-FEATURES

The Floppy Disk Drive may be ordered with basic configuration operating capabilities, or may be ordered to include any or all available options. Each option offers unique operating features. Several options have connections designed into the main printed circuit board, for low-cost customer enhancement.

Write-Protect

The write-protect option provides a write-inhibit function when a write-protect floppy disk cartridge is used and the photosensing circuit is installed. The stored data is protected only if the cartridge write-protect slot is present. With the slot covered, all write functions are enabled.

Binary Select

The Binary Select option permits any one of up to eight disk drives to be selected. With the option installed, SELECT lines are not dedicated but are used to contain a binary select code. The SELECT 0 line is used to enable/disable unit selection, while the SELECT 1, SELECT 2, and SELECT 3 lines contain a binary code between 0 and 7. When the SELECT 0 line is low (true), a decoder in the Binary Select option logic decodes the select code from the controller.

Radial Select

In the basic configuration, the disk drive does not accept commands from the controller, and does not supply status signals to the controller, until selected. The purpose of this option is to allow commands to be accepted and status signals to be supplied, each over separate lines, without the drive selected. The following signals can be optionally configured for radial operation:

- STEP and STEP IN (Step Command)
- HDL D (Head Load Command)
- READY (Ready Status)
- INDEX and SECTOR (Index and Sector Pulses)

When dedicated lines are provided for these signals, the disk drive need not be selected by the controller. Each line must be assigned a separate pin number on the interface connector. Spare pins are provided for this purpose.

The unit is modified for Radial Select operation by changing jumpers between the existing etch pads. The etch pads are located on the main printed circuit board.

Hard Sector

In the basic configuration, the use of a hard sector disk causes the INDEX line to produce one index pulse and 32 sector pulses per each disk revolution.

With the Hard Sector option installed, the index and sector pulses are separated and supplied to the controller on independent INDEX and SECTOR lines.

16/8 Sector

When the Hard Sector option is installed, the addition of the 16/8 Sector option provides a 2-bit binary counter that counts down the 32 sector pulses from a hard-sector disk. This countdown permits each track to be divided into 16 or 8 sectors, instead of 32 sectors. The output of the first stage (16 sectors), or the second stage (8 sectors) is connected to the SECTOR output line to the controller.

Auto Erase

The erase turn-on and turn-off delays are internally controlled by the Erase logic. When the controller activates WRITE, the leading edge of WRITE initiates a 200-microsecond erase turn-on delay; the trailing edge of WRITE initiates a 530-microsecond erase turn-off delay.

Data Separator (FM only)

In the basic configuration, the RAW DATA line to the controller produces a pulse for each flux reversal read from the disk. Consequently, the RAW DATA input contains both clock and data pulses. For this reason, the controller must have circuits that separate the clock and data pulses.

The Data Separator option is installed for the disk drive to operate in the single-density encoding mode (FM) only. When installed, this option separates the data and clock pulses input over the RAW DATA line. Data pulses are supplied to the controller over an FM SEP DATA line, and synchronized clock pulses over an FM SEP CLK line. Proper operation of the Data Separator option is based on a format with no missing clock pulses.

-5V Regulator

In the basic configuration, the controller must provide -5 volts, ± 5 percent at 0.08 amperes to each disk drive. When this exact voltage is not able to be supplied by the controller, the -5V Regulator option permits operation with a negative voltage input within the range of -7 to -16 volts.

Auto Head Load

In the basic configuration, the controller issues a $\overline{\text{HDLD}}$ command after the unit has been selected. When the AUTO HEAD LOAD option is installed, the read/write head is automatically loaded when the unit is selected, and is automatically unloaded when the unit is deselected.

Etch pads are provided that permit elimination of the requirement for the $\overline{\text{HDLD}}$ command; by installing jumpers between the desired etch pads.

Activity Indicator

In the basic configuration, the activity indicator is on when the head is loaded. The Activity Indicator option provides a means of substituting for the $\overline{\text{HDLD}}$ status signal, one of the following status signals:

- $\overline{\text{IN USE}}$ (signal from controller)
- $\overline{\text{SELECT}}$
- $\overline{\text{RDY}}$

Etch pads are provided on the main printed circuit board.

Time Domain Filter

In the basic configuration, the RAW DATA output from the crossover detector in the read logic, may contain zero crossings caused by high resolution interface noise. The time domain filter accepts the RAW DATA, compares the clock and data pulses and outputs a positive pulse for each time crossover.

PCB Assembly Option Configurations

The main printed circuit board can be supplied in any one of 16 option configurations, as listed in Table 1-2.

Table 1-2. PCB Assembly Option Configurations

Assembly No.	-5V Reg.	Hard Sector 32, 16, 8	Data Sep	Binary Sel
001				
008	X			
014		X		
016		X		
022			X	
024			X	
030		X	X	
032	X	X	X	
038				X
040	X			X
046		X		X
048	X	X		X
054			X	X
056	X		X	X
062		X	X	X
064	X	X	X	X

SPECIFICATIONS

A comprehensive list of principal specifications are provided in Table 1-3. The list defines both single-density and double-density characteristics, both disk drive and interface logic levels, and all physical and electrical parameters.

Table 1-3. Principal Specifications

Function	Characteristics	
	<u>Single-Density</u>	<u>Double-Density</u>
Disk Type	ANSI Standard	ANSI Standard
Storage Capacity (Unformatted)		
Per Disk	3.2 megabits	6.4 megabits
Per Track	41.7 kilobits	83.4 kilobits
Tracks	77	77
Track Density	48 Tracks Per Inch	48 Tracks Per Inch

Table 1-3. Principal Specifications (Continued)

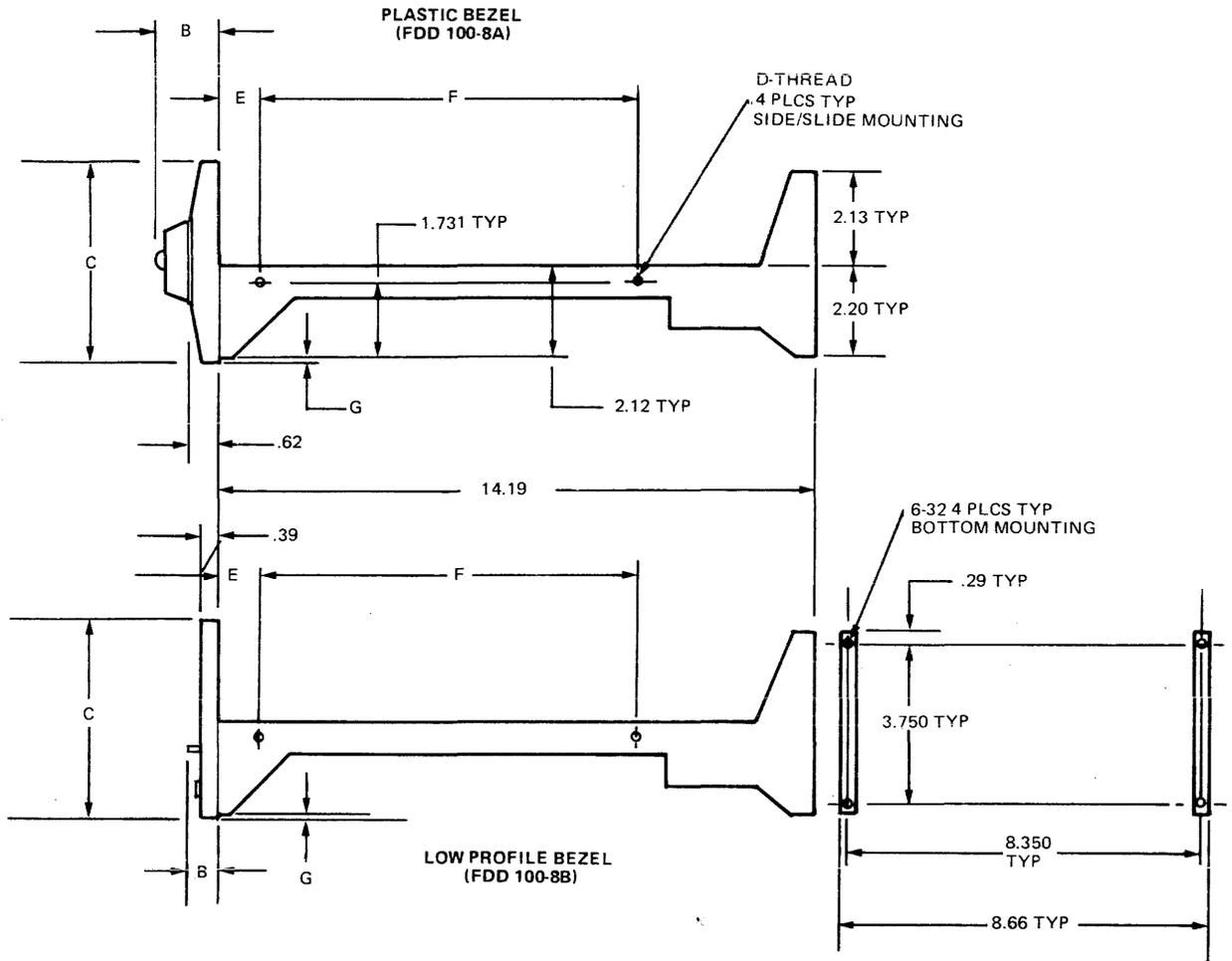
Function	Characteristics	
Recording Density Track 00 (Outside) Track 76 (Inside) Recording Method Rotational Speed Rotational Latency Average Maximum	<u>Single -Density</u>	<u>Double -Density</u>
	1836 bpi (3672 fci) 3268 bpi (6536 fci)	3672 bpi (3672 fci) 6536 bpi (6536 fci)
Access Time Track-to-Track Track 0 - Track 76 38-Track Move Settling Time Head Engage Time Data Transfer Rate Erase/Write Recovery Time	<u>Single -Density</u>	<u>Double -Density</u>
	6-8 milliseconds 456 milliseconds 226 milliseconds 14 milliseconds 25 milliseconds	6-8 milliseconds 456 milliseconds 226 milliseconds 14 milliseconds 25 milliseconds
Read/Write Head Read/Write-to-Erase Gap Spacing Track Width Tunnel Erase Width Spacing Between Tracks	Single-gap with tunnel-erase 0.035 inch 0.013 inch 0.006 inch (on either side of track) 0.02083 inch	

Table 1-3. Principal Specifications (Continued)

Function	Characteristics								
Track Centerline Radius	$2.029 + \frac{76 - N}{48}$, where N = track number (0-76)								
Logic Levels Disk Drive	Logical 1 (True) = +2.5V to +5.5V Logical 0 (False) = 0.0V to +0.4V								
Interface	Logical 1 (True) = 0.0V to +0.4V Logical 0 (False) = +2.5V to +5.5V								
AC Input Power Standard Optional	<table style="border: none;"> <tr> <td style="border: none;">}</td> <td style="border: none;">120V ± 10% 60 Hz ± 0.5 Hz</td> </tr> <tr> <td style="border: none;">}</td> <td style="border: none;">120V ± 10% 50 Hz ± 0.5 Hz</td> </tr> <tr> <td style="border: none;">}</td> <td style="border: none;">220V ± 10% 60 Hz ± 0.5 Hz</td> </tr> <tr> <td style="border: none;">}</td> <td style="border: none;">220V ± 10% 50 Hz ± 0.5 Hz</td> </tr> </table>	}	120V ± 10% 60 Hz ± 0.5 Hz	}	120V ± 10% 50 Hz ± 0.5 Hz	}	220V ± 10% 60 Hz ± 0.5 Hz	}	220V ± 10% 50 Hz ± 0.5 Hz
}	120V ± 10% 60 Hz ± 0.5 Hz								
}	120V ± 10% 50 Hz ± 0.5 Hz								
}	220V ± 10% 60 Hz ± 0.5 Hz								
}	220V ± 10% 50 Hz ± 0.5 Hz								
Voltage Dropout	100%, 10 milliseconds once each 600 seconds								
Motor Current (Max) Start Run	<table style="border: none;"> <tr> <td style="border: none;">}</td> <td style="border: none;">1.0 ampere for 120 volts AC</td> </tr> <tr> <td style="border: none;">}</td> <td style="border: none;">0.6 amperes for 220 volts AC</td> </tr> <tr> <td style="border: none;">}</td> <td style="border: none;">0.5 amperes for 120 volts AC</td> </tr> <tr> <td style="border: none;">}</td> <td style="border: none;">0.3 amperes for 220 volts AC</td> </tr> </table>	}	1.0 ampere for 120 volts AC	}	0.6 amperes for 220 volts AC	}	0.5 amperes for 120 volts AC	}	0.3 amperes for 220 volts AC
}	1.0 ampere for 120 volts AC								
}	0.6 amperes for 220 volts AC								
}	0.5 amperes for 120 volts AC								
}	0.3 amperes for 220 volts AC								
DC Input Power	+24 volts ± 5%, 1.6 amperes maximum + 5 volts ± 5%, 1.0 amperes maximum								
Minus Voltage Standard Optional	-5 Volts ± 5%, 0.08 amperes maximum -7 to -16 volts (with -5V Regulator option installed)								
Reliability MTBF MTTR	6000 hours (after initial 200 hours) Less than 20 minutes								
Read Errors Recoverable Non-recoverable (after 10 tries)	Less than 1 in 10 ⁹ Less than 1 in 10 ¹²								

Table 1-3. Principal Specifications (Continued)

Function	Characteristics	
Environmental	<u>Operating</u>	<u>Non-Operating</u>
Temperature	50° to 100°F (10° to 38°C)	32° to 150°F (0° to 65°C)
Relative Humidity	20% to 80% without condensation	5% to 90%, without condensation
Altitude	-1000 to +10,000 feet	-1000 to +45,000 feet
Heat Dissipation	300 BTU/Hour	NA
Dimensions and Weight		
Dimensions	See Figure 1-6	
Weight	11.5 pounds (plastic bezel) 12.5 pounds (low profile)	



DESK TOP/RACK MOUNTING USING HOLES IN SUB PLATE UNDER 10.51 LONG PLASTIC BEZEL (FDD 100-8A)

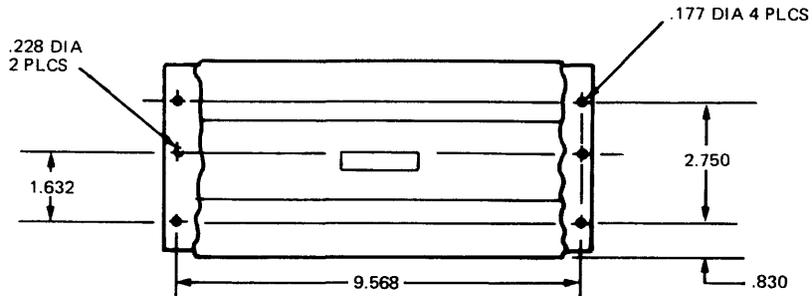


Figure 1-6. Physical Dimensions and Mounting Provisions

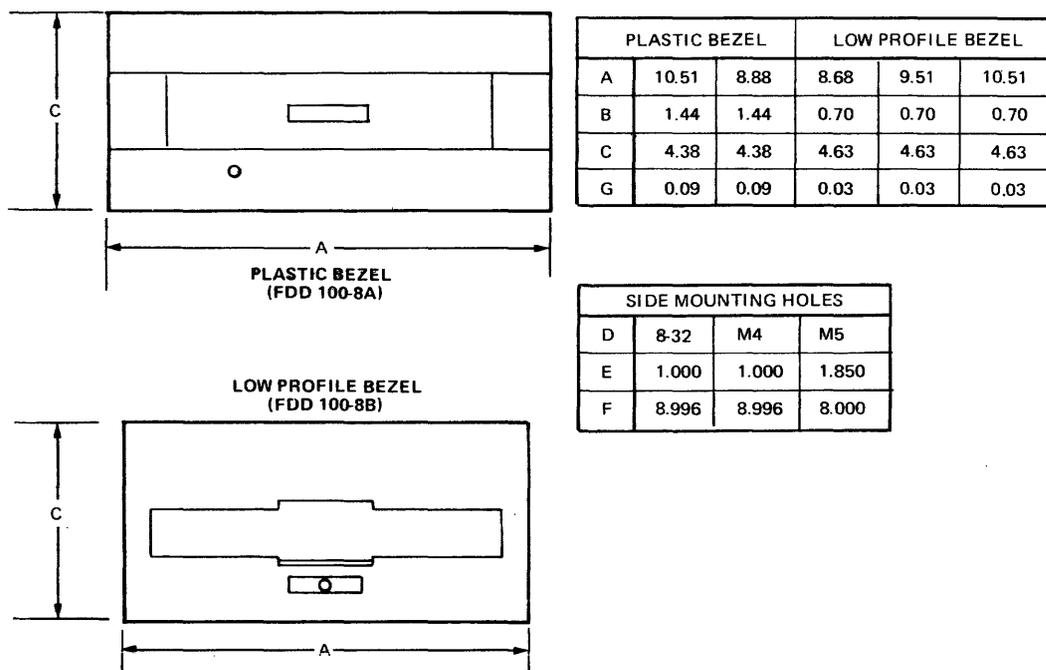


Figure 1-6. Physical Dimensions and Mounting Provisions
(Continued)

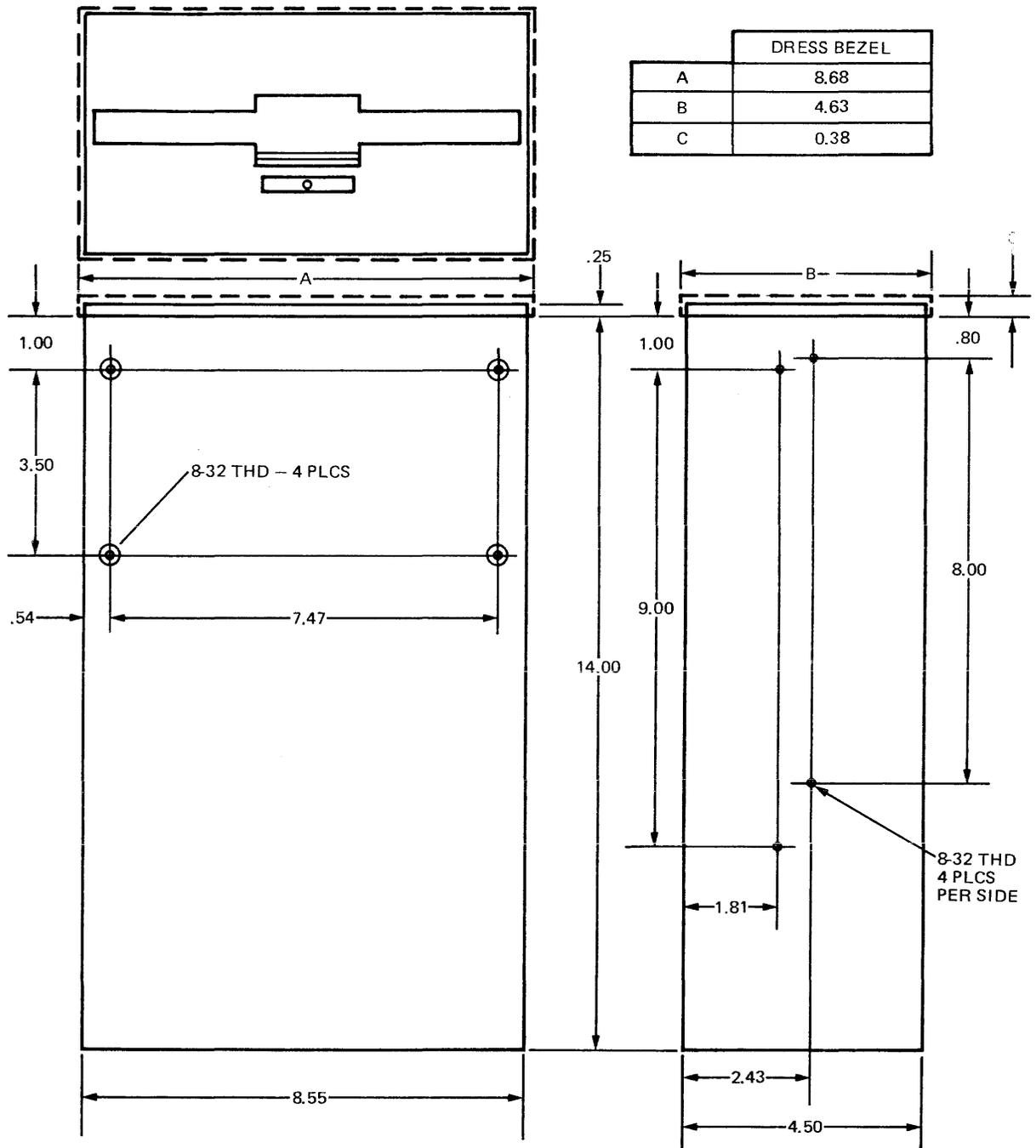


Figure 1-7. Physical Dimensions and Mounting Provisions (FDD 100-8C)



SECTION 2 OPERATION

GENERAL

The Floppy Disk Drive operates under complete control of the host controller, after a floppy disk has been manually inserted. A front panel indicator is provided to indicate operating status.

DAILY OPERATION

The operating environment and the operator's careful handling of the disk drive and the floppy disks enhance the appearance, and greatly extend the operating life of the equipment.

Floppy Disk Handling and Storage

The floppy disk is the data storage medium. The disk is sealed in a protective envelope, in which are access holes for the read/write head, index and sector holes, disk centering hole, and optional write-protect slot (see Figure 2-1).

For external error-free operation of the disk drive, the following disk handling practices are recommended:

- Prior to use, place in same operating environment as disk drive, for at least 5 minutes
- Never - place heavy objects on envelope
 - write on protective envelope, only on label
 - touch disk surface while handling
 - attempt to clean disk surface
- Always - return floppy disk to storage envelope when not in use.

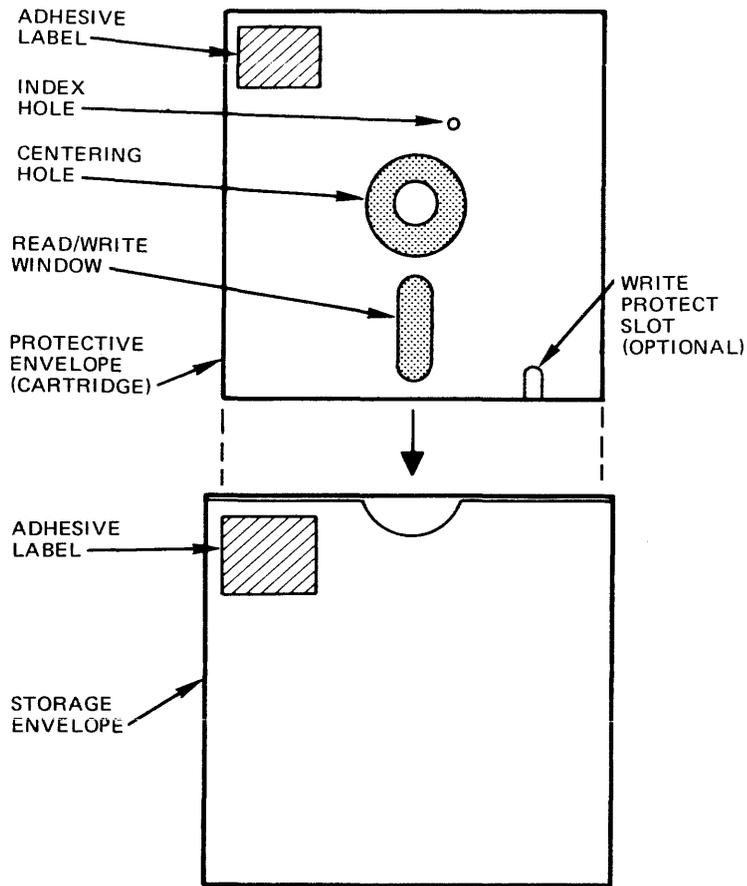


Figure 2-1. Floppy Disk and Storage Envelope

Floppy Disk Loading and Unloading

Correct loading of the floppy disk is essential for proper operation of the disk drive.

The disk is sealed in the protective envelope with an adhesive label in the outside left corner. Refer to Figure 2-1. The disk drive will not operate if the floppy disk is loaded upside-down. The correct load conditions are shown in Figure 2-2.

Loading and unloading procedures for the disk drive are listed in Table 2-1.

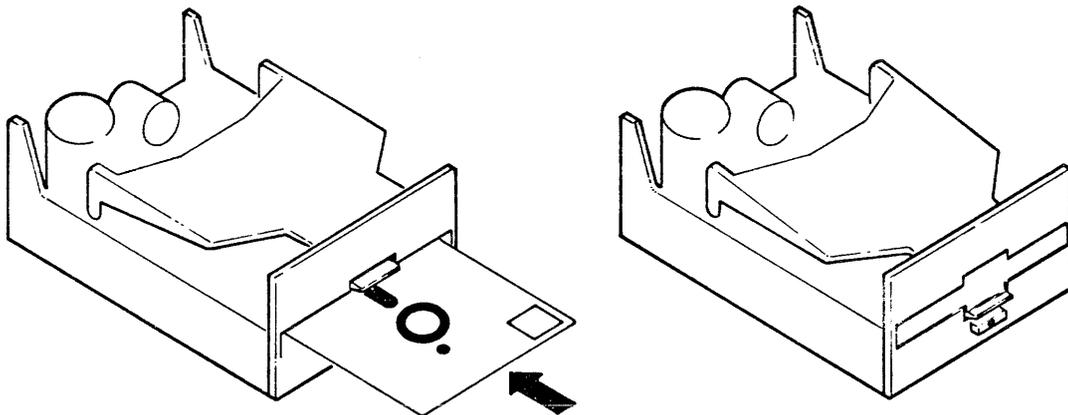


Figure 2-2. Floppy Disk Loading

Table 2-1. Floppy Disk Loading and Unloading

Action	Reaction
Press front panel pushbutton	Front panel unlatches and raises to open position. Spindle cone removed from drive cone. Disk cartridge released from spring-loaded latched condition.
Insert floppy disk, label up, into slot fully until stopped	Disk cartridge correctly positioned over drive spindle and firmly latched in spring-loaded condition
Lower front panel until latched	Spindle cone lowers and centers disk with firm pressure. Disk rotates normally with interlock closed.

Write-Protect (Option)

The write-protect option guards against the destruction of stored data by circuit malfunctions or during test and operations. A read and write disk cartridge will have no open slot punched in the cartridge, or the slot will be covered with an adhesive opaque tab. A read-only disk cartridge will have an open punched slot ready for light sensing by the write-protect circuit.

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SECTION 3
THEORY OF OPERATION

GENERAL

This section contains descriptive information on each function of the disk drive and detailed theory of operation. The information is intended to serve as a training guide for technical personnel requiring in-depth knowledge of the disk drive.

The disk drive contains three major systems, as shown in Figure 3-1:

- Control System
- Positioning System
- Read/Write System

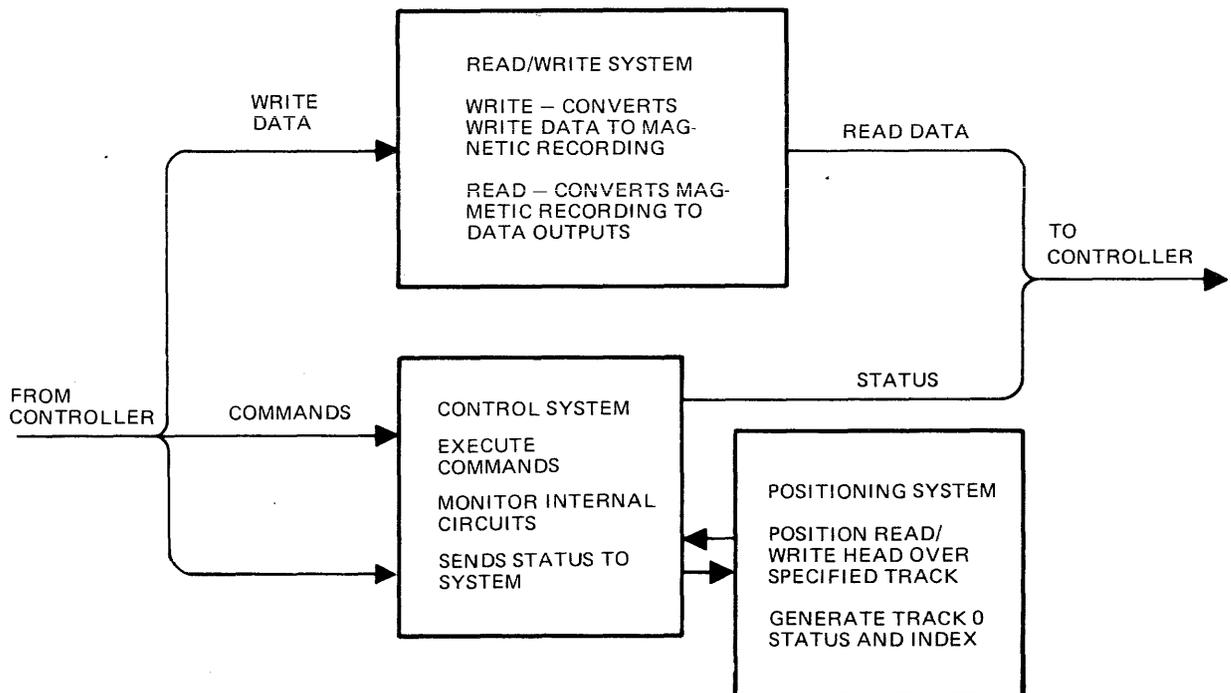


Figure 3-1. Floppy Disk Drive, Simplified Block Diagram

CONTROL SYSTEM

The control system provides the interface circuitry between the disk controller and the disk drive. The operational status is monitored and reported to the disk controller. The disk controller addresses a disk drive for on-line operation by activating a unique select line. Commands are then received and executed by the selected disk drive. This technique allows multiple disk drive units to share common interface lines, while remaining individually selectable.

Command Execution

Commands are received by the disk drive in the form of a low-level interface signal which designates one of the following operations:

- $\overline{\text{SELECT}}$ Places disk drive on-line with controller
- $\overline{\text{STEP}}$ Enables read/write head positioning
- $\overline{\text{STEP IN}}$ Determines read/write head direction
- $\overline{\text{HEAD LOAD}}$ Places disk recording surface in contact with
 $(\overline{\text{HDLD}})$ read/write head
- $\overline{\text{WRITE}}$ Enables write current to turn on and inhibits
 $(\overline{\text{WRT}})$ read output
- $\overline{\text{LOW CURRENT}}$ Reduces current in read/write head on inner
 $(\overline{\text{LOI}})$ tracks
- $\overline{\text{WRITE DATA}}$ Enables write data transfer from controller to
 $(\overline{\text{WRT DATA}})$ disk drive

$\overline{\text{SELECT}}$ and $\overline{\text{HDLD}}$ commands must precede a read or write operation. $\overline{\text{SELECT}}$ enables all input/output gates, while $\overline{\text{HDLD}}$ positions the read/write head for writing or reading on the floppy disk.

$\overline{\text{STEP}}$ moves the read/write head to either a higher or lower track position depending on the $\overline{\text{STEP IN}}$ line. Since relative track positioning is used, the disk controller maintains current track position and generates the number of pulses necessary to achieve a new track position. Once positioned, the disk controller initiates a read or write operation.

In a Write operation, the disk drive records the data in the same encoding method presented by the disk controller.

Status Sensing

Five disk drive status signals are gated to the I/O lines when the disk controller selects a disk drive.

- $\overline{\text{WRITE PROTECT}}$ (WRT PROTECT) Hardware write-protect condition exists (if write-protect disk used)
- $\overline{\text{TRACK 00}}$ Read/write head positioned at track 00
- $\overline{\text{INDEX}}$ Start of new track
- $\overline{\text{SECTOR}}$ Start of new sector (if sector disk used)
- $\overline{\text{READY}}$, Signifies disk drive is operational

$\overline{\text{READY}}$ and $\overline{\text{WRT PROTECT}}$ are static level status signals. Ready status indicates a floppy disk is loaded and up to operating speed. Write-protect status indicates write data cannot be recorded on the disk. Index status occurs once per disk revolution. Track 00 status is available for initializing the disk controller track address register. This signal is developed from a phototransistor when the carriage is mechanically aligned with track 00, and the stepper motor is at phase A.

POSITIONING SYSTEM

The positioning system responds to $\overline{\text{STEP}}$ pulses received from the disk controller, by moving the read/write head one track position per pulse. The following functions accomplish this operation.

- Stepper Motor Control
- Stepper Motor
- Carriage Assembly

Stepper Motor Control

The step motor control converts serial $\overline{\text{STEP}}$ pulses to a 2-bit count-up or count-down sequence. Each decode energizes one of the stepper motor windings, causing a 15-degree rotation of the motor shaft (one track position).

Stepper Motor

The variable-reluctance stepping motor provides precision positioning of the read/write head. The stepper motor is energized by +24 volts dc and operates in either Detent or Positioning mode.

In the Detent mode, an internally generated magnetic field holds the rotor in a fixed position. To move from detent, one of three control lines is grounded, driving the rotor to the next detent. Sequentially grounding control windings causes the rotor shaft to rotate through detent positions at a maximum rate of 133 steps per second. A lead screw on the exposed rotor shaft converts rotary movements to linear movement to drive the carriage assembly.

Carriage Assembly

The carriage assembly rides on a lead screw while a fixed way prevents the carriage from skewing. The way serves as a guide while the lead screw drive performs the in and out positioning.

The read/write head, attached to the carriage assembly, contacts the recording surface when the $\overline{\text{HDLD}}$ command is issued. This command releases a spring-loaded head load arm that moves the floppy disk into contact with the read/write head.

READ/WRITE SYSTEM

The read/write system records encoded data during a Write operation, and retrieves data during a Read operation. The write ($\overline{\text{WRT}}$) signal from the controller designates a Read when high or a Write when low.

Read/Write Operation

The read/write head is essentially an electromagnet that can concentrate a high magnetizing force over a very small area of the adjacent recording surface. When recording, the flux field is alternated to magnetize the disk with the desired bit pattern. The read/write head also contains a tunnel-erase electromagnet, The function of which is to erase the edges of the recorded track as data is being written. The width of the track is narrowed to approximately 0.013-inch by this technique, to minimize the effect of data previously written on the track and possible crosstalk between tracks.

When reading, the read/write electromagnet operates as a sensor. A flux reversal on the recorded track induces a voltage across the electromagnet coils. This voltage is amplified and conditioned to recover the recorded information.

FUNCTIONAL DESCRIPTION

The disk drive is a mass memory device featuring a removable floppy disk and contact recording. The 250 khz/bit transfer rate provides a high speed transfer of data between the disk drive and a host disk controller. Multiple disk drives may be connected in a radial or daisy-chained configuration with individual selection and status monitoring.

The disk drive requires operator intervention only for loading and unloading the flexible disk; after which the disk controller remotely operates the unit. Input ac and dc power, control signals and write data are supplied by the controller; the disk drive responds with operating status and read data. A detailed functional block diagram is shown in Figure 3-2.

The disk drive comprises the following functional systems:

- Spindle Drive System
- Spindle System
- Read/Write Head Positioning System
- Head Load System

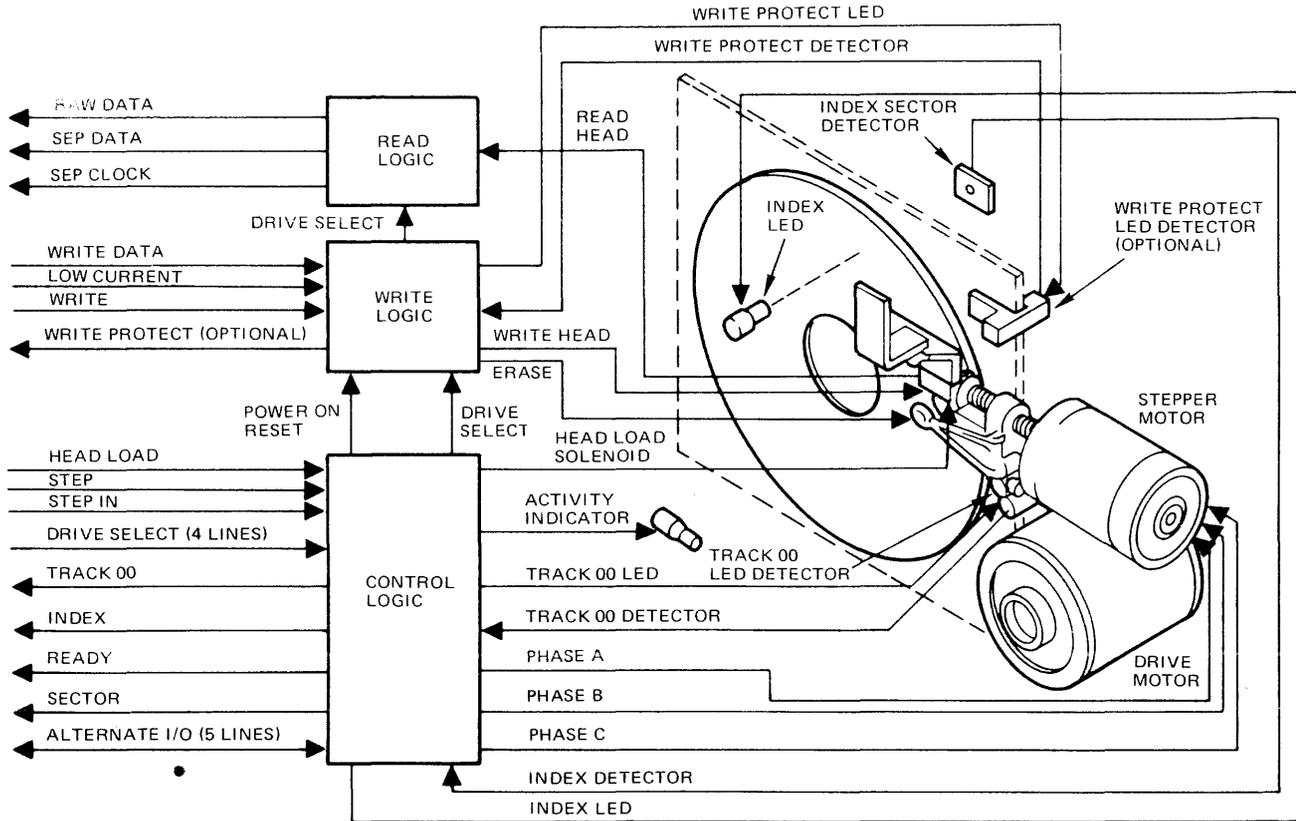


Figure 3-2. Detailed Functional Block Diagram

Spindle Drive System

The spindle drive system provides rotational movement of the spindle using a single-phase motor selected to match primary power of the host system. Various drive motors are available that accommodate primary power requirements of 120 and 220 volts ac at 50 or 60 Hertz.

Rotation of the spindle is provided by a belt and pulley connected to the drive motor rotor shaft (see Figure 3-3). The drive pulley is selectable for either 50 or 60 Hz input power for rotational speed of 360 revolutions per minute. A floppy disk is engaged with the spindle drive hub by the spindle system centering cone.

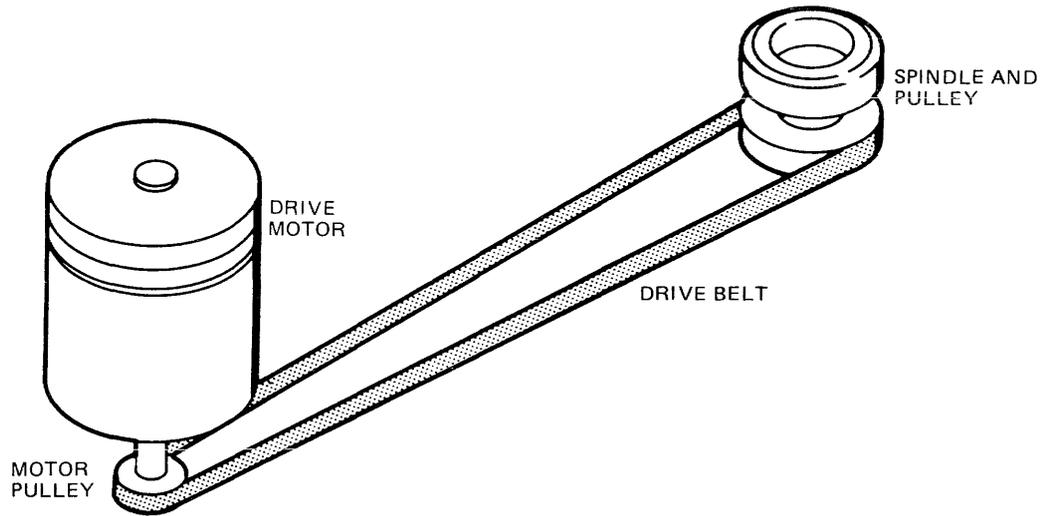


Figure 3-3. Spindle Drive System

Spindle System

The spindle system consists of a spindle and a centering cone mounted on the deck and carrier, respectively. In the unload position, the centering cone carrier is pivoted open creating an aperture through which the floppy disk is inserted. In this position, the centering cone is lifted, disengaging the disk from the spindle hub.

To load a disk, the operator inserts the floppy disk then closes the handle, which latches the carrier in the operating mode. The centering cone (see Figure 3-4) is attached to the carrier and is an open-splined non-metallic device that performs two functions:

- Aligns the disk media to the spindle hub
- Engages the disk media to the spindle drive system

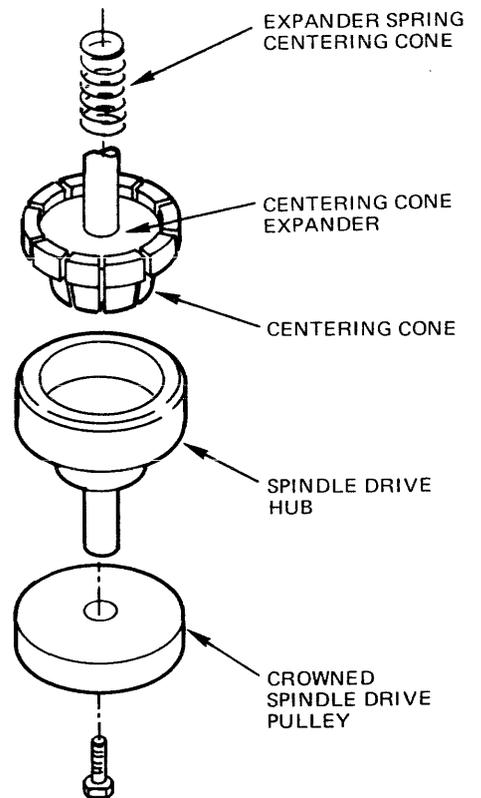


Figure 3-4. Spindle System

As the carrier is pivoted to the load position, the centering cone enters the floppy disk center. Just prior to the fully closed position of the handle, the centering cone expander is automatically activated to expand the centering cone, which grips and aligns the floppy disk to the spindle, thus centering the disk on the spindle.

Read/Write Head Positioning System

The positioning system comprises a carriage assembly, a read/write head and a bidirectional stepper motor and lead screw (see Figure 3-5). The stepper motor rotational movements are converted to linear motion by driving the lead screw and carriage assembly.

The read/write head carriage rides on the lead screw shaft and is held in horizontal alignment. When the stepper motor is pulsed, the lead screw rotates clockwise or counterclockwise, moving the carriage in or out, respectively.

The stepper motor has three pairs of windings. In Detent, current flows in one winding and maintains the rotor in electromagnetic detent. For positioning, the windings are driven sequentially, causing the rotor to rotate through detent positions until the STEP commands are halted. The rotor then locks in that position, with the last winding being driven. The sequence in which the stepper motor windings are pulsed dictates rotational direction and, subsequently, higher or lower track addressing from a relative position.

Head Load System

The head load system is, basically, a solenoid driver and a solenoid. When activated by the HDLD command, the spring-loaded head load pad is released and brings the recording surface of the floppy disk into conformance with the head.

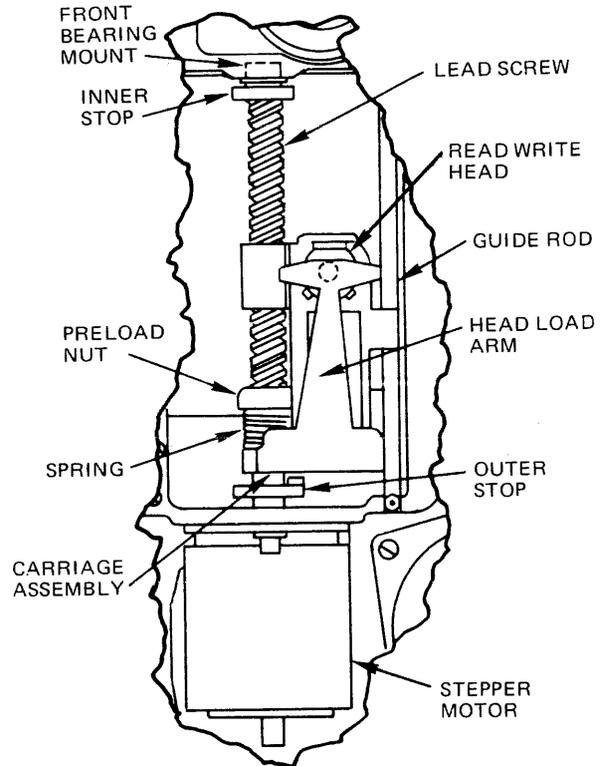


Figure 3-5. Read/Write Head Positioning System

To minimize disk surface and read/write head wear, the $\overline{\text{HDLD}}$ command is gated with $\overline{\text{SELECT}}$. In the deselect or Idle mode, head loading is automatically disabled. The $\overline{\text{HDLD}}$ command requires a 25-millisecond execution time.

Control and Data Timing

Figure 3-6 shows the sequence of control and data timing requirements.

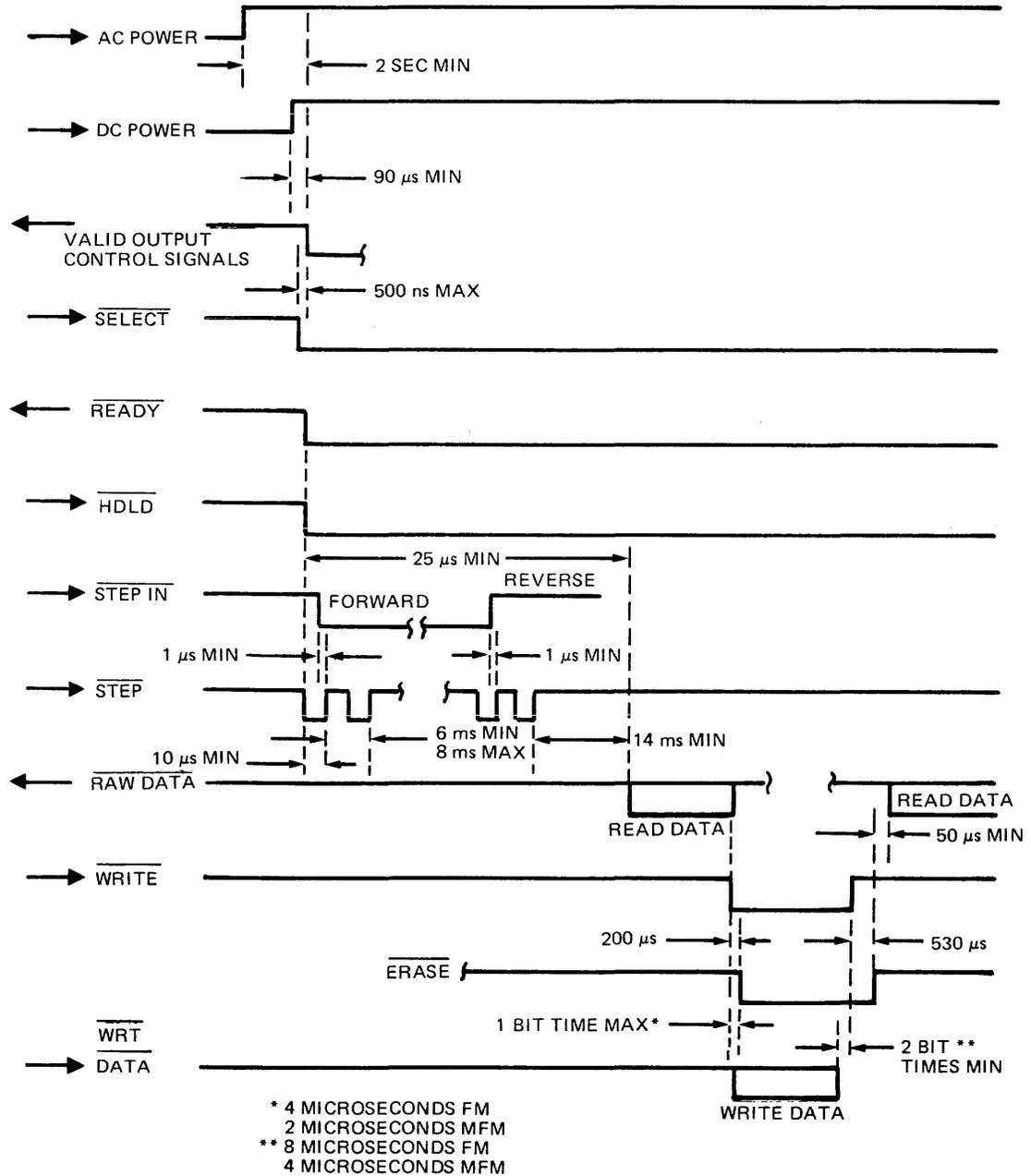


Figure 3-6. Control and Data Timing

LOGIC CONVENTIONS

The disk drive uses standard 5-volt TTL logic, where a voltage more positive than +2.4 volts (turn-on threshold) is considered a logical one (high), and a voltage more negative than +0.4 volts (turn-off threshold) is considered a logical zero (low).

Interface signal logic levels are inverted by line receivers and line drivers for use by the disk drive and the controller, respectively. For all interface signals, a voltage more positive than +2.4 volts (turn-off threshold) is considered a logical zero, and a voltage more negative than +0.4 volts (turn-on threshold) is considered a logical one (see Figure 3-7).

The logic symbology used in the disk drive is shown in Figure 3-8. Each element is described and all conditions are defined.

DETAILED LOGIC DESCRIPTION

The detailed logic description is divided into three major functions:

- Control Logic
- Read/Write Head Positioning Logic
- Read/Write Logic

CONTROL LOGIC

The control logic contained in the disk drive performs three prime functions:

- Accepts controller $\overline{\text{SELECT}}$ command and enables all interface logic
- Detects and provides index and optional sector pulses

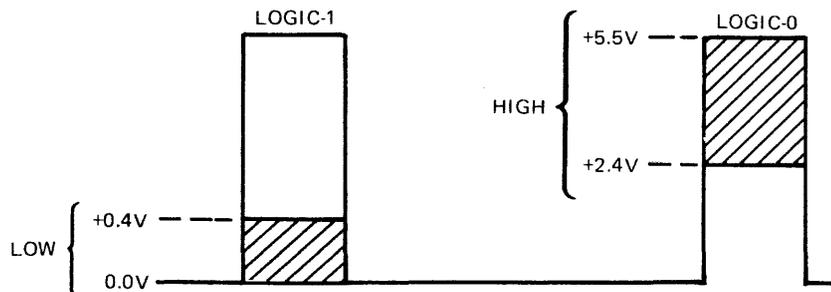
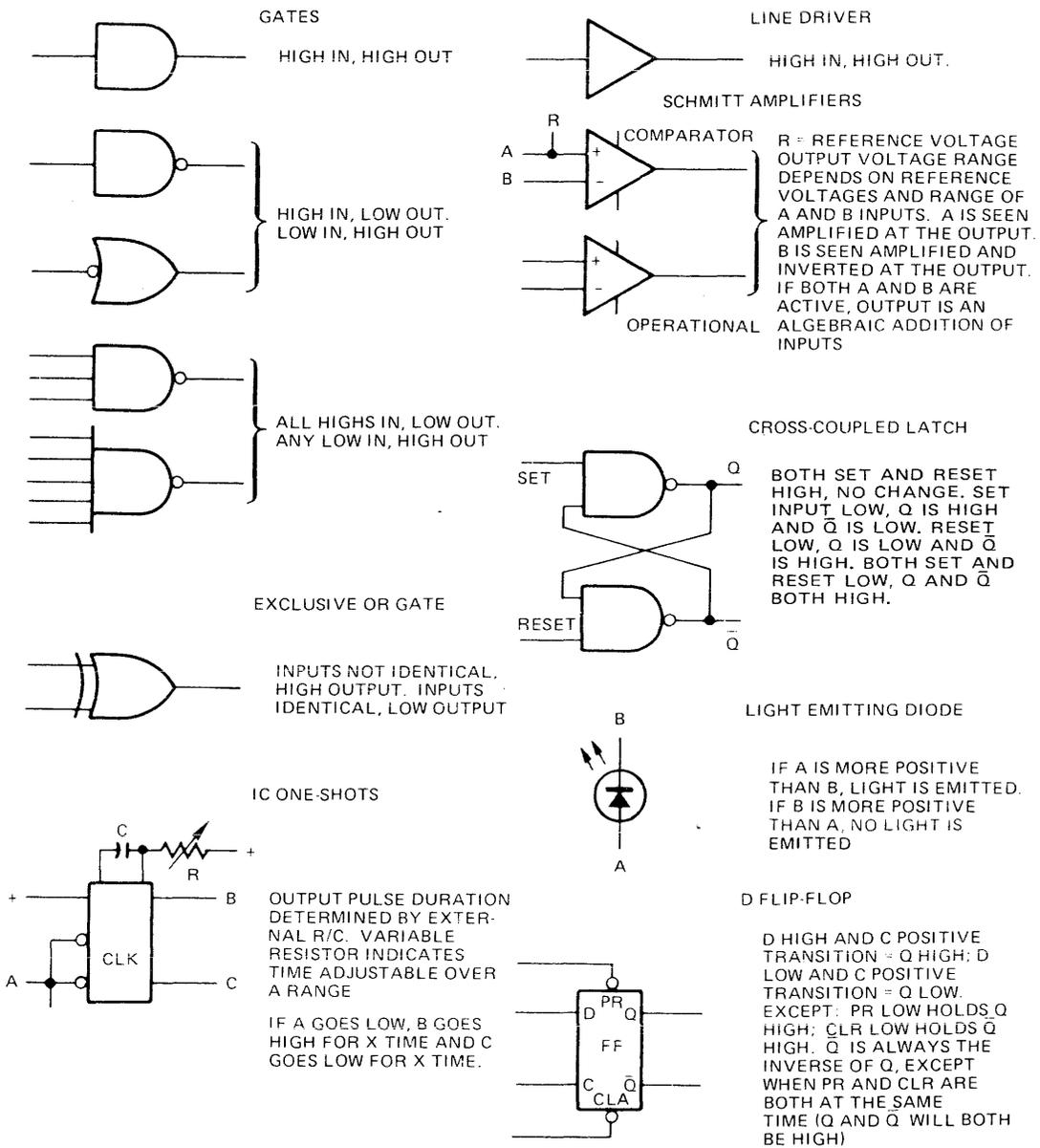


Figure 3-7. Interface Logic Levels



NOTE: LOCATION DESIGNATORS ON IC's, TRANSISTORS, AND CONNECTORS REFER TO THE FDD 100-8B. DESIGNATORS FOR THE FDD 100-8C ARE SHOWN IN PARENTHESES WHEN DIFFERENT FROM THE FDD 100-8B.

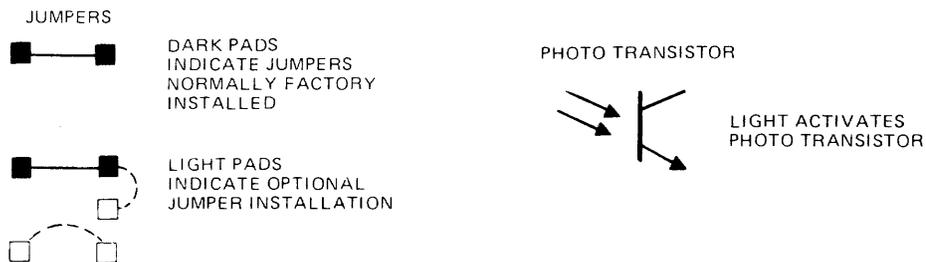


Figure 3-8. Logic Symboly

- Monitors flexible disk rotation to develop a ready status for the Controller.

Select

When SELECT is inactive (high), the select logic inhibits all interface input receivers and output drivers to and from the disk drive. The select logic is primarily comprised of inverter-driver 5D and Exclusive-OR gate 3C (see Figure 3-9).

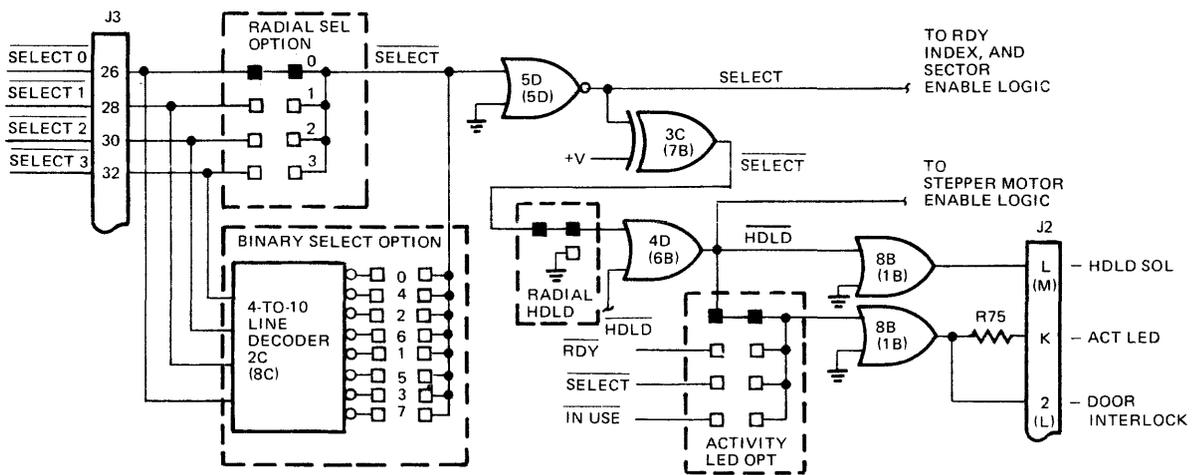


Figure 3-9. Select Logic

When SELECT is inactive, gate 5D outputs a low SELECT signal to inhibit all ready, index sector, write-protect, and track 00 logic. Exclusive-OR gate 3C outputs a high SELECT to inhibit all head load and step logic.

As shipped from the factory, a jumper plug is installed between the "0" Radial Select pads, causing SELECT 0 to drive 5D. This assigns physical address 0 to the disk drive. One of three other addresses can be assigned, SELECT 1, SELECT 2, or SELECT 3, by removing the jumper between the "0" pads and installing it between the desired Radial Select pads. Only one jumper can be connected to the disk drive. With the Radial Select feature, up to four disk drives can be connected in daisy-chain fashion.

Binary Select (Option)

The Binary Select option allows up to eight disk drives to be daisy-chained to the controller, with addresses 0 through 7. The option is comprised of 4-to-10 line decoder 2C, and eight sets of jumper pads (see Figure 3-9).

When $\overline{\text{SELECT 0}}$ is inactive, the decoder is inhibited and all outputs are high. When $\overline{\text{SELECT 0}}$ is active, the decoder is enabled and only one low output is produced. The decoder accepts a binary coded address on three select lines, $\overline{\text{SELECT 1}}$ through $\overline{\text{SELECT 3}}$, and decodes them to produce a low output decimal equivalent corresponding to the desired address.

The jumper plug is removed from the radial select option and installed between the pads desired to assign the independent physical address of the disk drive. Table 3-1 indicates the logic state of the $\overline{\text{SELECT}}$ lines for selecting each drive.

Table 3-1. Disk Drive Selection

$\overline{\text{SELECT 1}}$	$\overline{\text{SELECT 2}}$	$\overline{\text{SELECT 3}}$	Drive Selected
1	1	1	0
0	1	1	1
1	0	1	2
0	1	1	3
1	1	0	4
0	1	0	5
1	0	0	6
0	0	0	7

0 = Inactive state of interface signal (high)

1 = Active state of interface signal (low)

Index/Sector Detection

A light-emitting diode (LED) and phototransistor are physically positioned in the disk drive to sense the index and sector (optional) holes in the floppy disk. If the Hard Sector option is installed, a 32-sector disk should be used. Index pulse detection logic is shown in Figure 3-10.

The index detection logic is comprised of an LED and phototransistor, a comparator and an output line driver. The negative input to comparator 7B is driven by the output of the activated phototransistor. Resistor R46 supplies bias current to the LED.

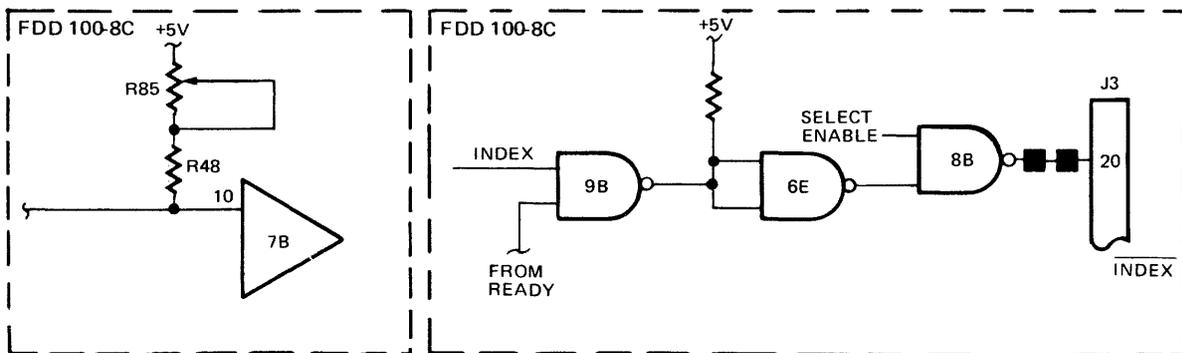
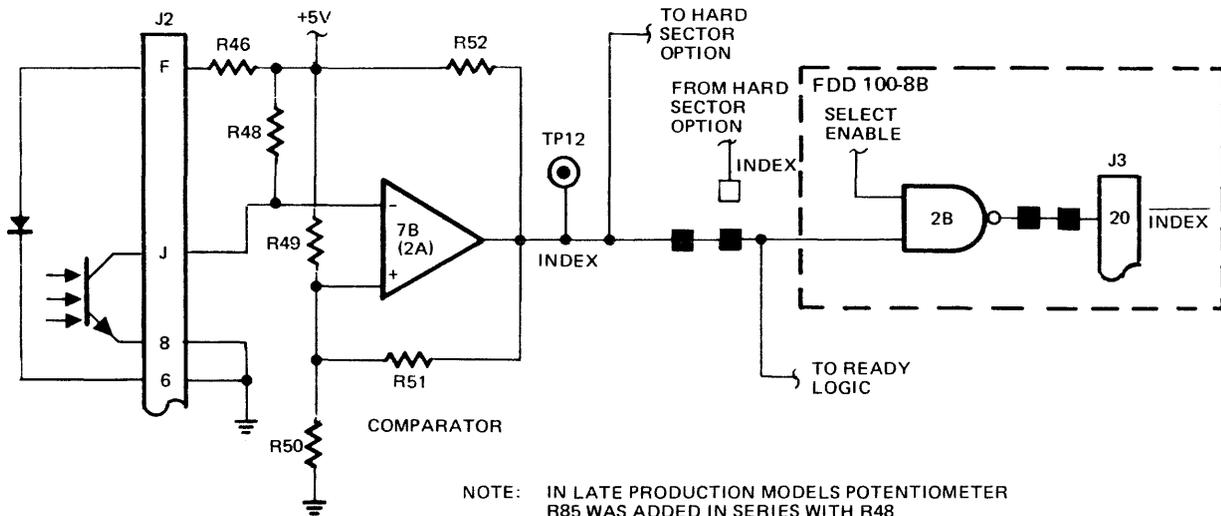


Figure 3-10. Index Detection Logic

When the media blocks the LED output from the phototransistor, the input to the comparator is high. When the index hole is sensed, the input to the comparator is low. Resistors R49, R50 and R51 provide a positive reference threshold voltage of +2.5 volts. For each index hole sensed, the comparator output is a positive INDEX pulse, nominally 1.7 millisecond in duration, and occurring once per disk revolution. The INDEX pulse is input to interface line driver 2B and inverted to provide a low $\overline{\text{INDEX}}$ signal to the controller. Figure 3-11 shows index pulse timing.

Hard Sector (Option)

With the Hard Sector option installed, and by using a 32-sector floppy disk, the comparator provides 32 SECTOR pulses, equally spaced 5.2 milliseconds apart, during each disk revolution, plus an INDEX pulse that occurs halfway between sector pulses 31 and 0.

Refer to Figure 3-12.

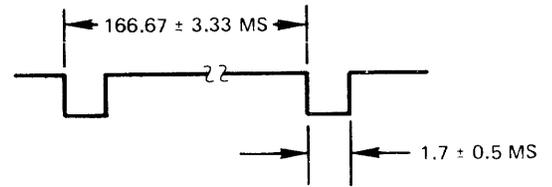


Figure 3-11. Index Timing

The positive-going leading edge of the INDEX pulses from the comparator (Figure 3-12) triggers one-shot 8C to produce a 0.4 millisecond pulse, and complement. The positive-going trailing edge of the complement (\overline{Q}), triggers one-shot 7C which times for 3.6 milliseconds. After being triggered by SECTOR pulse 31, the one-shot is timing out. During this period, the INDEX pulse occurs, and one-shot 7C can not be triggered.

The output of $\overline{\text{INDEX}}$ gate 6C drives INDEX gate 6C and resets flip-flop 5C of the 16 or 8 Sector divider logic. The output of INDEX gate 6C is input to interface $\overline{\text{INDEX}}$ line driver 2B and the Ready logic. SECTOR Gate 6C provides the SECTOR pulse inputs to interface $\overline{\text{SECTOR}}$ line driver 2B if the 32-sector jumper is installed.

The output of SECTOR gate 6C also drives the clock input to the 16 or 8 Sector option, if it is installed. Divide-by-2 flip-flop 5C produces 8 and 16 SECTOR pulses per disk revolution. If the 16 sector jumper is installed, 16 pulses per revolution are sent to the controller by interface SECTOR driver 2B. If the 8 sector jumper is installed, 8 pulses per revolution will be provided to the controller. Figure 3-13 shows $\overline{\text{INDEX}}$ and $\overline{\text{SECTOR}}$ timing.

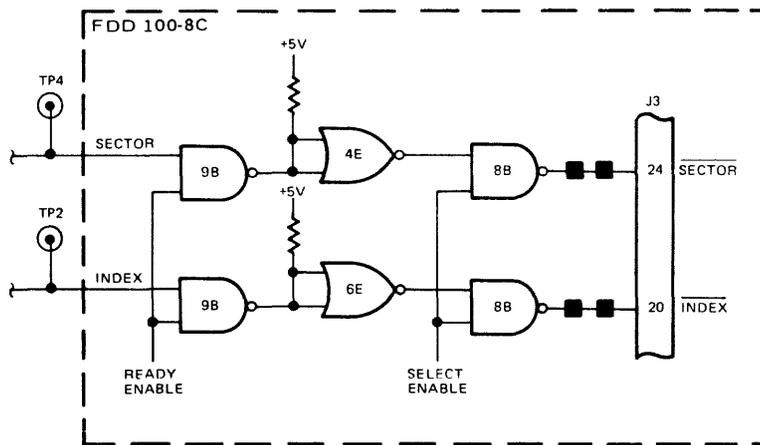
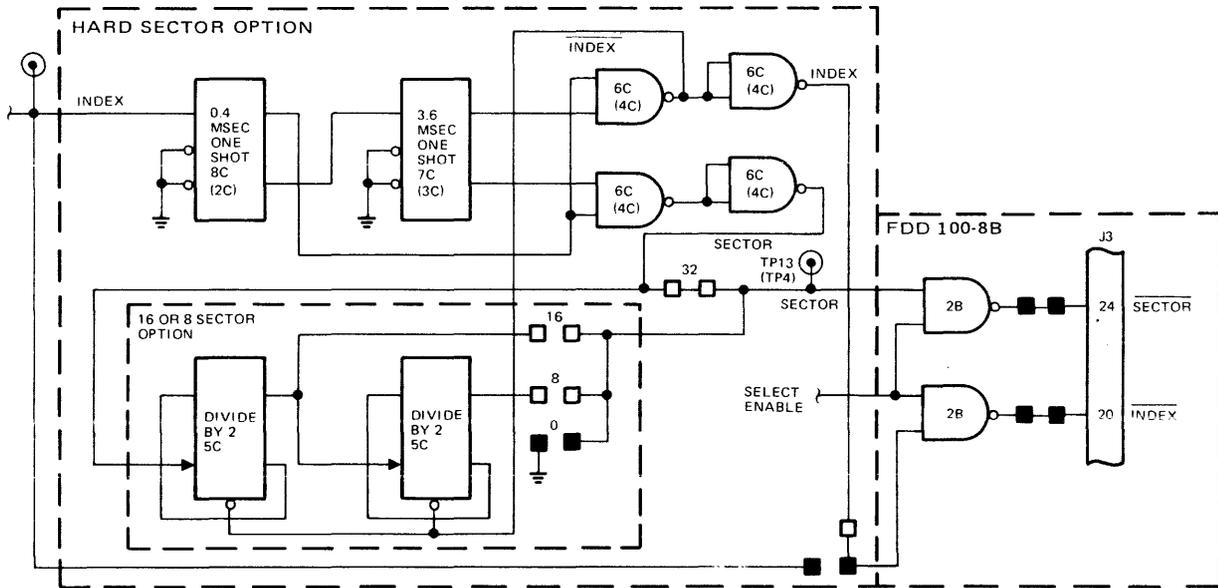


Figure 3-12. Hard Sector and 16/8 Sector Option Logic

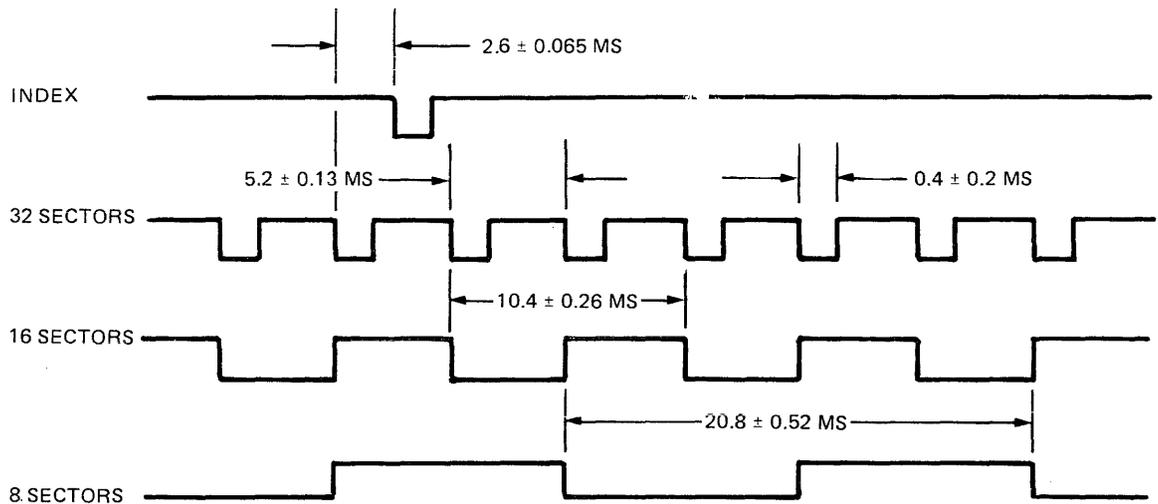


Figure 3-13. INDEX/SECTOR Timing

Ready

The Ready logic is used to monitor the INDEX pulse for the rotational speed of the flexible disk. When the required disk speed is reached, the READY status is sent to the controller. Once per revolution, the INDEX pulse is input to retriggerable one-shot 2A, whose nominal time is 445 milliseconds (see Figure 3-14).

When the input INDEX pulses are greater than 445 milliseconds apart, the disk has not yet reached 62.5 percent of operating speed and ready counter 1A is reset by pulses from one-shot 2A.

When the INDEX pulses are less than 445 milliseconds apart, the one-shot output remains high, allowing the counter to advance. After three consecutive INDEX pulses have clocked the counter (stabilized speed), $\overline{\text{RDY}}$ gate 4B provides a low active output to inhibit input gate 4C and drive the output of Ready gate 4B high. The output of this gate connects to interface READY driver 2B, providing a low active signal to the controller.

If the Radial Index/Sector option is connected, the SELECT signal is not required to enable the INDEX and SECTOR interface drivers. If the Radial Ready option is connected, the SELECT signal is not required to enable the $\overline{\text{READY}}$ interface driver. In both conditions, the disk drive need not be selected by the controller until the disk is up-to-speed and ready. The Activity LED option can be connected to use

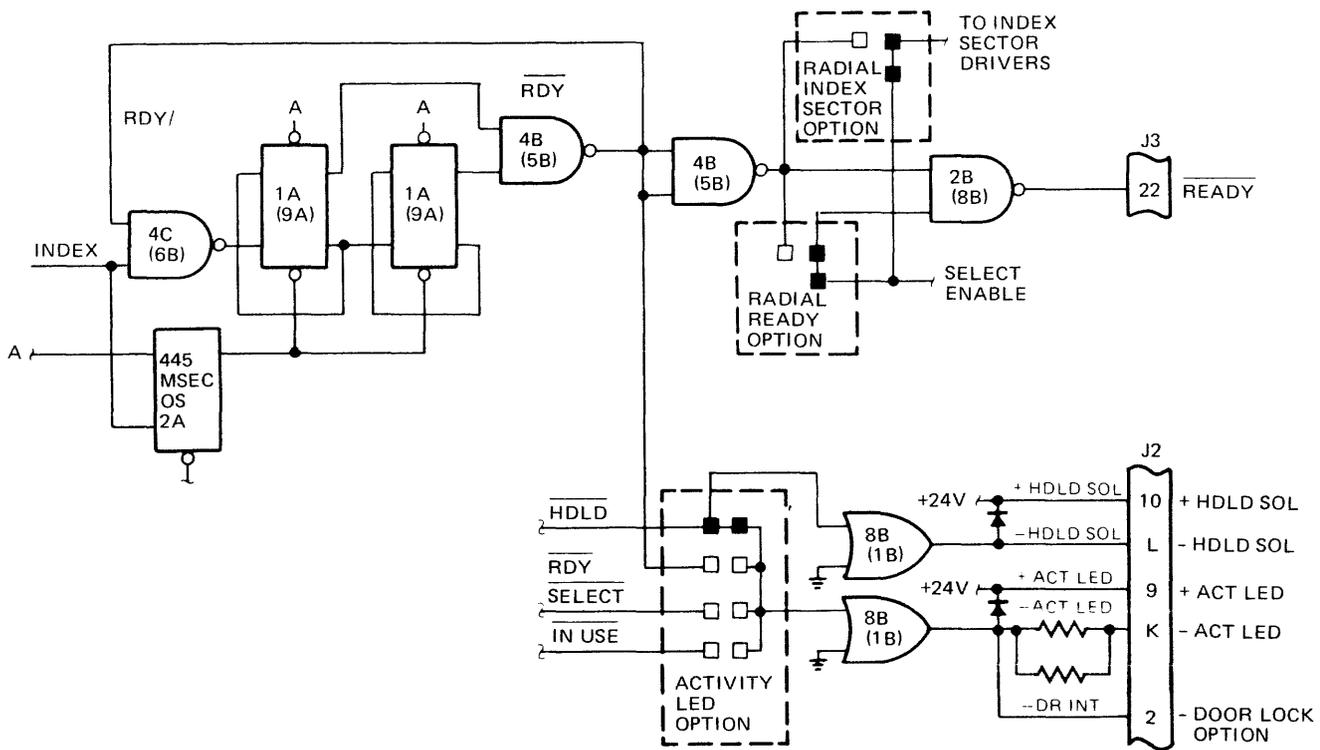


Figure 3-14. Ready Logic

the $\overline{\text{RDY}}$ signal to alert the operator when the unit is up-to-speed and ready. Enabled at the same time, is the head load solenoid logic and the door lock option (available on low profile models only).

Activity Indicator

The activity indicator is an LED, mounted on the plastic front panel bezel or in the door push open button on low profile drives. It can be optionally connected to indicate one of four disk drive signals: $\overline{\text{HDLD}}$, $\overline{\text{RDY}}$, $\overline{\text{SELECT}}$ or $\overline{\text{IN USE}}$. Refer to Figure 3-14.

As supplied from the factory, the $\overline{\text{HDLD}}$ command enables the LED. When $\overline{\text{HDLD}}$ is inactive, ACT LED driver 8B outputs a high and the LED remains off. When $\overline{\text{HDLD}}$ is active, this driver outputs a low, the resistor supplies bias current, and the LED is turned on.

In lieu of $\overline{\text{HDLD}}$, the activity LED can be turned on by any one of three different inputs (see Figure 3-14). The $\overline{\text{IN USE}}$ signal is a controller status input.

Door Lock

The door lock option (when installed) is active when the activity indicator is on. When active, this option prevents the operator from opening the door. Refer to Figure 3-15. This option is available only on low profile model disk drives.

READ/WRITE HEAD POSITIONING LOGIC

The read/write head positioning logic performs three prime functions:

- Activates head load/unload solenoid
- Detects position of read/write head at track 00 and signals controller
- Activates stepper motor and determines direction of read/write head movement, in response to controller commands

The head is loaded, track position is determined, and the stepper motor moves the read/write head in and out over the surface of the rotating floppy disk. The head is stopped over the accessed track and read or write operations are performed. If the write protect option is installed, and if a write-protect disk cartridge is used, the slot detection logic inhibits all write operations.

Head Load

The function of the head load logic is to accept the $\overline{\text{HDLD}}$ command from the controller and energize the head load solenoid. The energized solenoid releases the head load arm which, by means of a spring-loaded pressure pad, gently forces the media against the read/write head. The head logic is comprised of interface input and drivers required to enable the stepper motor drive logic, drive a solenoid, turn on the front panel activity indicator, and energize the door lock (option) (see Figure 3-15).

When $\overline{\text{SELECT}}$ is active and $\overline{\text{HDLD}}$ is not active, OR gate 4D is inhibited and outputs a high. OR gate 8B provides a high output and the solenoid is not energized.

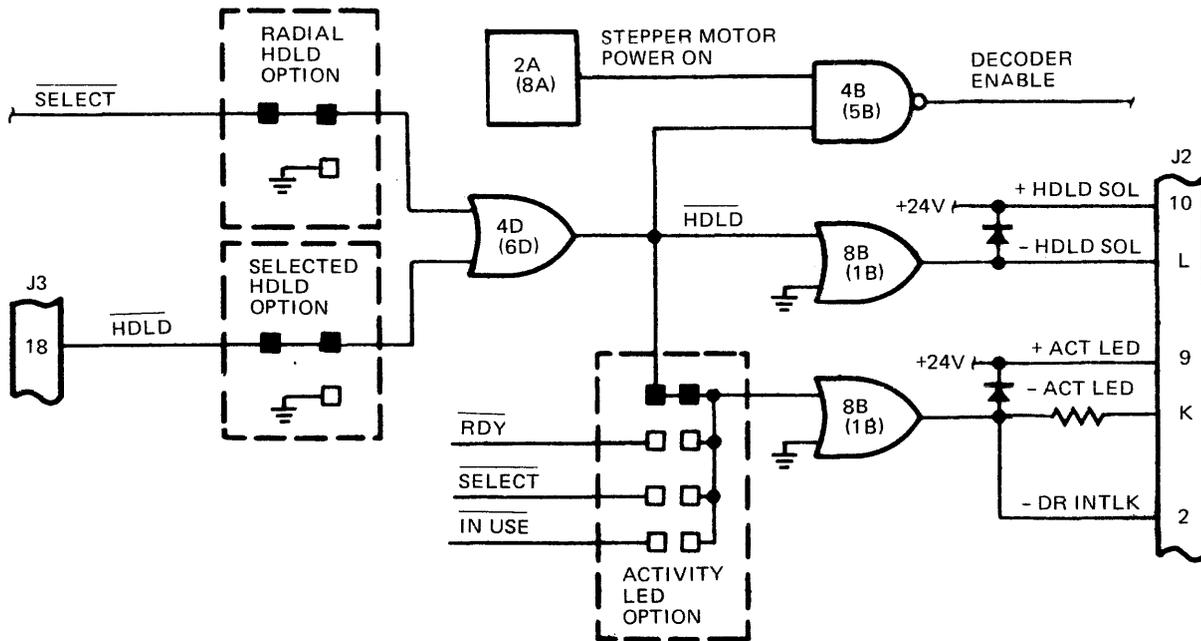


Figure 3-15. Head Load Logic

When $\overline{\text{SELECT}}$ and $\overline{\text{HDLD}}$ are both active, OR gate 4D is enabled and outputs a low to OR gate 8B to energize the solenoid. Decoder Enable gate 4B is also enabled and power is applied to the stepper motor.

Track 00 Switch

The track 00 logic monitors the position of the read/write head and signals the controller when the head is at track 00.

On early production disk drives, the logic is comprised of a single-pole double-throw (SPDT) microswitch, a debounce latch and the drivers necessary to supply the signal to the controller.

The microswitch, mounted on the deck assembly, is activated by the carriage. The outputs of the switch provide the set and reset inputs to latch 1B. The normally open contacts of the microswitch are closed and the output of latch 1B is low, enabling NOR gate 3B (see Figure 3-16).

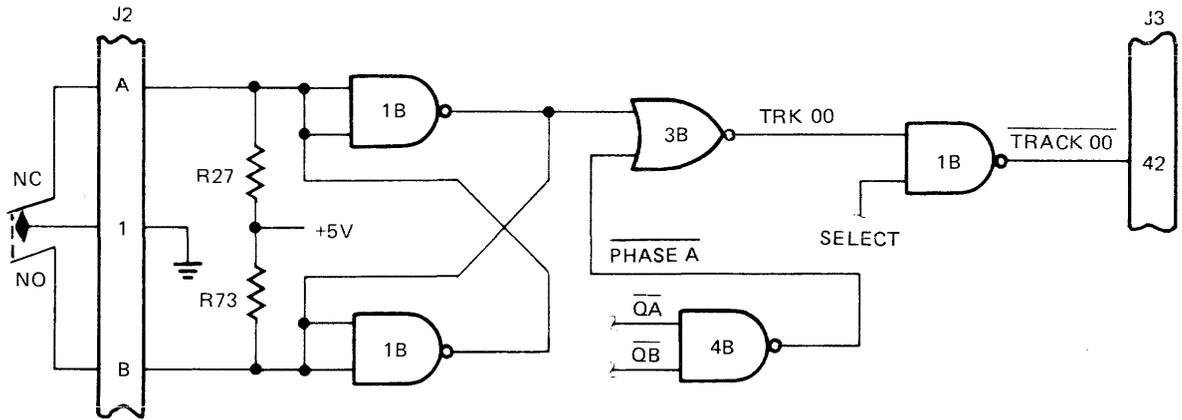


Figure 3-16. Track 00 Logic (Mechanical)

On late production drives a photoswitch and comparator replaced the earlier micro-switch and debounce latch. The photoswitch is shown mounted on the deck assembly and is inactivated by a tab on the carriage blocking the LED output. The output of Comparator 7B is low enabling NOR gate 3B (see Figure 3-17).

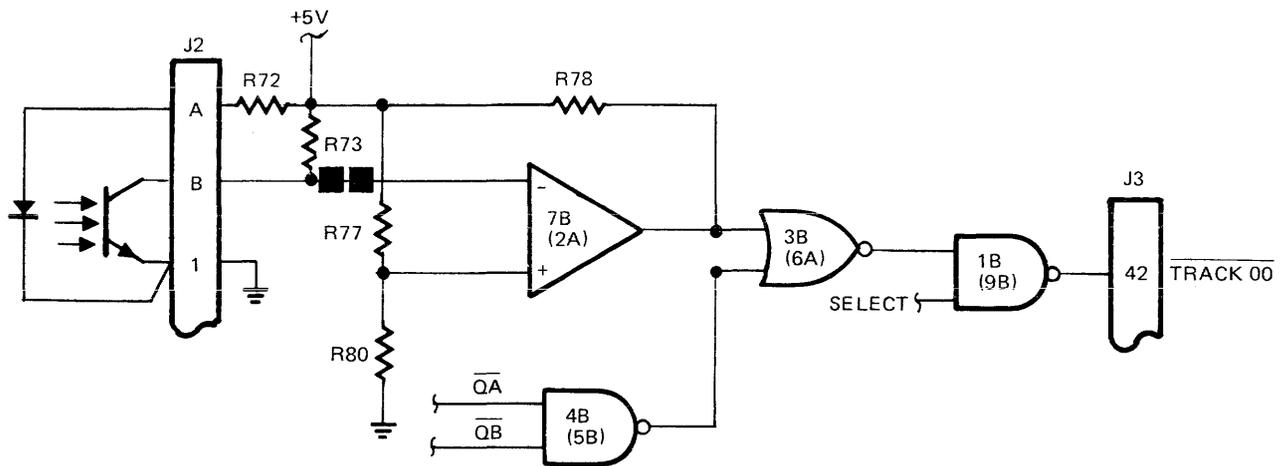


Figure 3-17. Track 00 Logic (Optical)

Phase A of the stepper motor control is decoded by NAND gate 4B providing a low active enable for the Track 00 detection logic at the other input of NOR gate 3B. The high output of NOR gate 3B enables gate 1B to send an active track 00 signal to the host controller.

When phase A goes low, the output of gate 4B goes high, inhibiting NOR gate 3B. The TRACK 00 signal goes high indicating the read/write head is beyond track 00. Refer to timing diagram Figure 3-18.

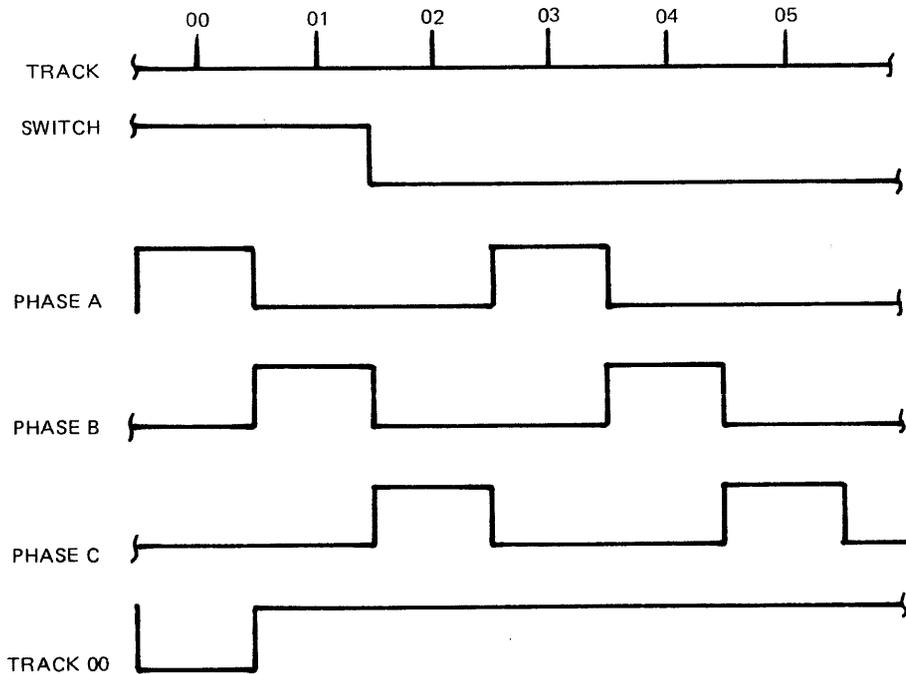


Figure 3-18. Track 00 Timing

Stepper Motor Drive

The positioning logic performs all stepper motor drive functions. The logic causes the head to move one track distance for each active $\overline{\text{STEP}}$ command, and in a direction determined by the high or low state of the $\overline{\text{STEP IN}}$ command. The positioning logic comprises interface gates, a 3-state up-down counter, a counter-decoder, stepper motor drive logic and a stepper motor power-on one-shot.

Interface Gating

When an active $\overline{\text{STEP}}$ pulse occurs interface $\overline{\text{STEP}}$ gate 3B outputs a positive pulse driving gate 4C. If it has been enabled by an inactive $\overline{\text{STEP INHIBIT}}$, gate 4C outputs an active high signal driving OR gate 3B, which outputs a negative step pulse (see Figure 3-19).

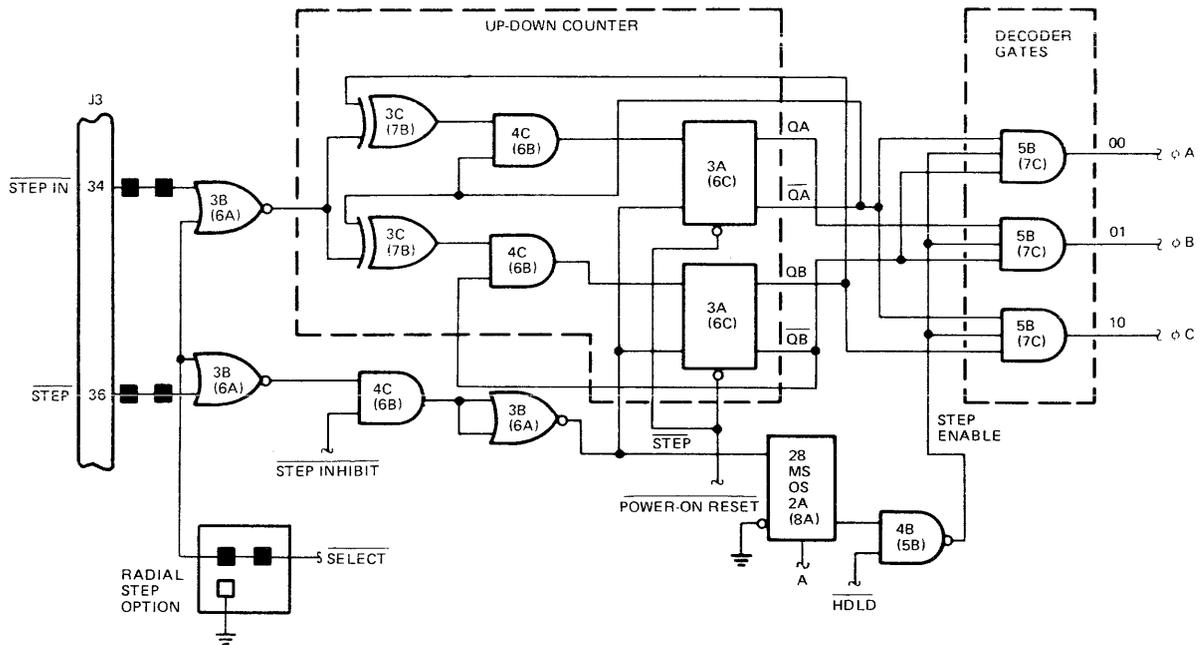


Figure 3-19. Stepper Motor Interface Gating Logic

The trailing edge of this step pulse triggers the 28-millisecond one-shot 2A causing gate 4B to output a high enabling Decoder gate 5B to apply drive power to the stepper motor.

The trailing edge of the step pulse clocks the 3-state counter, causing a count-up or count-down as determined by the $\overline{\text{STEP IN}}$ interface signal. Refer to Figure 3-20 for stepper monitoring.

If $\overline{\text{STEP IN}}$ is not active and $\overline{\text{SELECT}}$ is active, interface gate 3B outputs a low causing Exclusive-OR gates 3C of the counter to be non-inverting, setting the counter in the count-down mode.

When $\overline{\text{STEP IN}}$ becomes active, interface gate 3B outputs a high causing the Exclusive-OR gates to invert, setting the counter in the count-up mode.

Up-Down Counter

The up-down counter is comprised of Exclusive-OR gates 3C, gates 4C, and flip-flops 3A (Figure 3-19). When initial power is applied to the disk drive, the power-on reset logic resets the counter to a 00 state (phase A). If the counter is in the

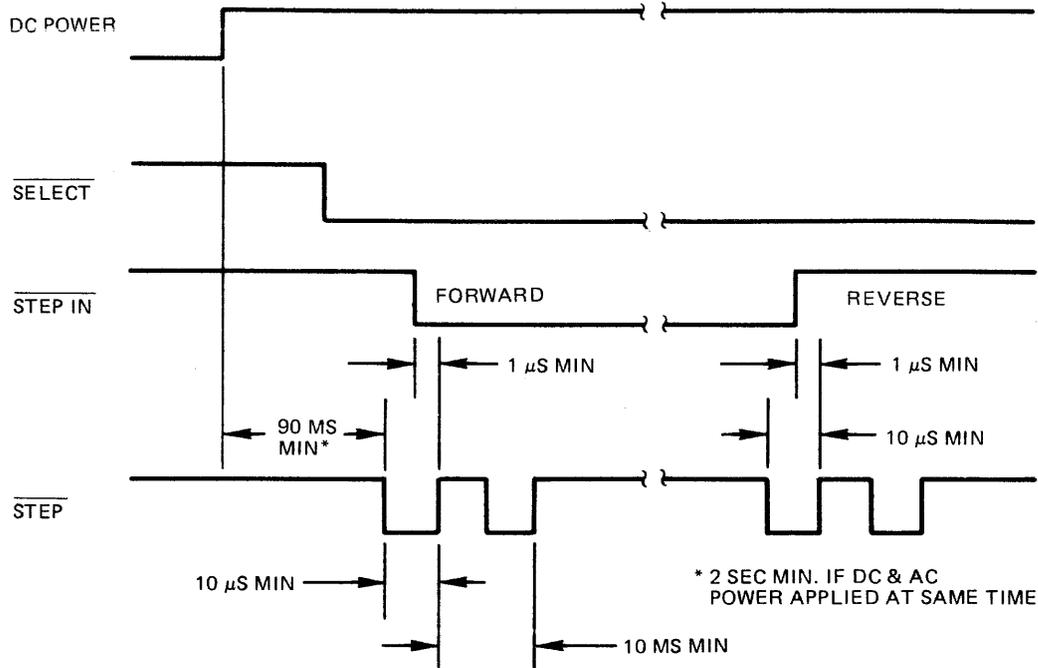


Figure 3-20. Stepper Motor Timing

count-up mode, it will advance to state 01 (phase B) when a $\overline{\text{STEP}}$ pulse occurs. The next $\overline{\text{STEP}}$ pulse advances the counter to state 10 (phase C), and the next pulse advances the count to state 00 again. Subsequent pulses will continue the cycle until the $\overline{\text{STEP}}$ command becomes inactive.

If the counter is in the count-down mode, it will decrement to state 01 on the next $\overline{\text{STEP}}$ pulse. Subsequent pulses will continue the count-down cycle until the $\overline{\text{STEP}}$ command becomes inactive.

Counter-Decoder

The decoder logic decodes the three states of the up-down counter and provides one active output to drive a single phase of the stepper motor (see Figure 3-19).

The counter-decoder logic is comprised of decoder gates 5B. Each gate enables only one of the three phases of the stepper motor drive logic. One gate enables phase A from a 00 count, one gate enables phase B from a 01 count, and the remaining gate enables phase C from a 10 count. The gates are disabled if the heads are not loaded and 28 milliseconds has elapsed since the last $\overline{\text{STEP}}$ pulse.

Stepper Motor Drivers

The stepper motor is a 3-phase motor having three independent and identical drive circuits (see Figure 3-21).

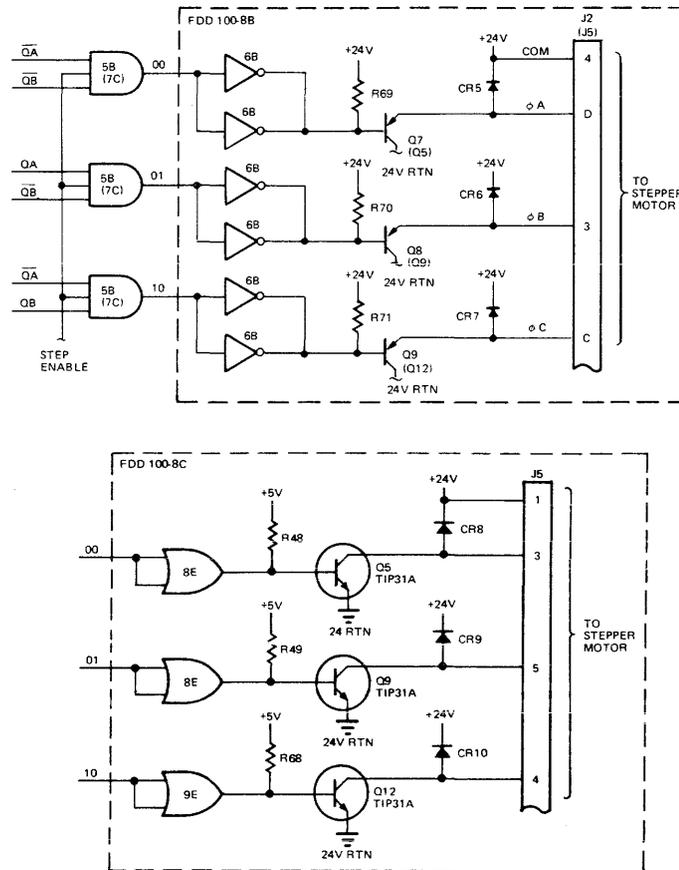


Figure 3-21. Stepper Motor Drivers Logic

Phase A drive logic is comprised of parallel drivers 6B, pull up resistor R69, emitter-follower Q7, and flyback diode CR5. When the decoder gate outputs a low (code 00 not detected), the drivers produce a high output, Q7 is cut off and phase A is not energized. When the 5B gate outputs a high (code 00 detected), the drivers produce a low output turning on Q7, and phase A is energized. When Q7 turns off, diode CR5 restricts the emitter of Q7 from going more positive than +24 volts. Each driver circuit is identical and operates in the same way to energize the corresponding phase of the stepper motor. Also shown is the circuitry for the FDD 100-8C. Operation is similar using non-inverting drivers 8E and 9E, and NPN transistors Q5, Q9 and Q12.

Stepper Motor Power-On One-Shot

Power-on one-shot 2A is retriggerable, and times out after 28 milliseconds (see Figure 3-19). At each $\overline{\text{STEP}}$ pulse the one-shot fires, the decode gates are enabled and, for 28 milliseconds, drive power is applied to the stepper motor.

Enable gate 4B OR's the output of 2A and Headload Enable gate 4D (Figure 3-15), and provides a low output when the one-shot is not timing or when the read/write head is not loaded. As a result, when the one-shot is timing, or when the head is loaded, the decode gates are enabled and power is applied to the stepper motor.

Stepper Motor

The stepper motor shaft changes 15 degrees of angular position with each $\overline{\text{STEP}}$ pulse. Three windings are provided with the center-taps connected to +24 volts drive power. The three windings are energized sequentially, producing a stepped forward or reverse action. The bidirectional shaft rotation is dependent on the sequence in which the windings are pulsed; to step the motor either clockwise (forward) or counterclockwise (reverse). A lead screw connected to the motor shaft causes the read/write head to be precisely positioned over one of 77 tracks on the disk. Track 00 is used to establish the starting point.

READ/WRITE LOGIC

The read/write logic converts digitally encoded serial data from the controller to analog flux patterns that are magnetically recorded (written) on the surface of a rotating floppy disk. The recorded data is sensed and decoded during a read operation and restored to digital read data for the controller. A common read/write head is switched to either mode by a single enable/disable command. The read/write logic performs two prime functions:

- Write controller data on the disk
- Read recorded data for the controller

Figure 3-22 shows the write initiate timing.

A write operation is initiated by the disk controller by activating the $\overline{\text{WRITE}}$, and $\overline{\text{WRT DATA}}$ interface lines. The lines remain active for the duration of the write operation to enable write data logic and tunnel erase logic. The write current

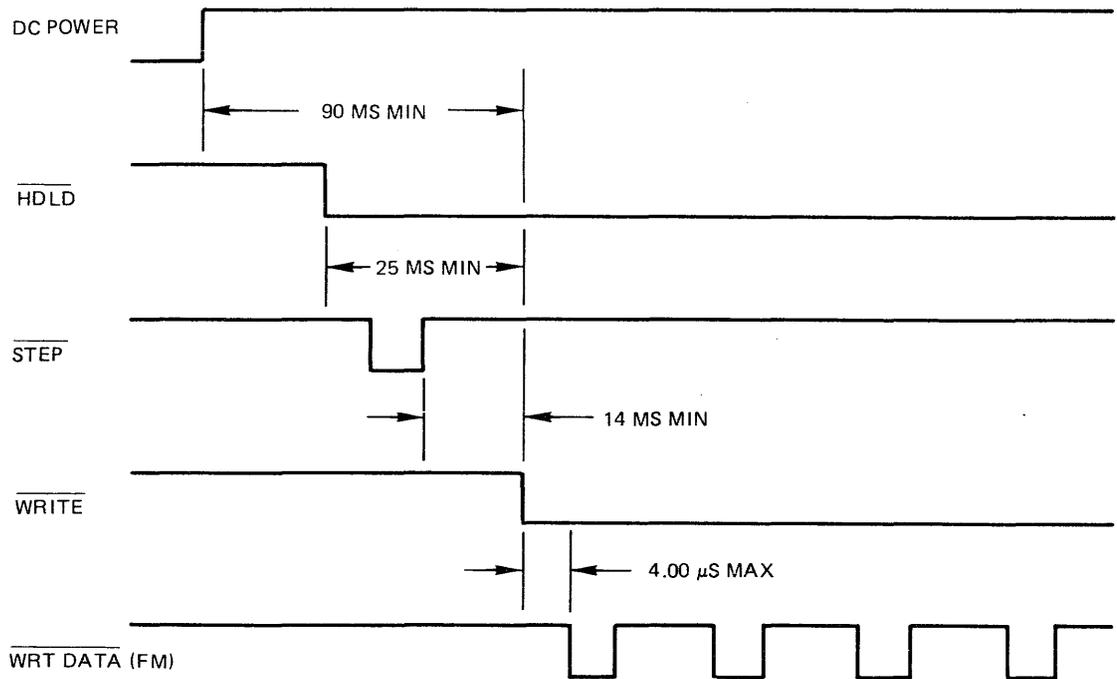


Figure 3-22. Write Initiate Timing

developed records the data, and the erase logic contains the recorded track width to 0.013-inch.

Write-Protect (Option)

When the write-protect option is installed and the disk cartridge has a write-protect slot, the disk drive disregards any WRITE command and all write logic is disabled. When the slot is covered, normal read/write operations can be performed. The write-protect cartridge is used in conjunction with a light-sensing LED/phototransistor circuit.

When a write-protect disk cartridge is used, the LED output is sensed, causing the phototransistor to provide a low output to the negative input of comparator 7B (see Figure 3-23).

The output of comparator 7B is high, providing an input to interface line driver 1B, and inhibiting write gate 4D (see Figure 3-24).

When the disk cartridge write-protect slot is covered, or a non-write-protect cartridge is used, the phototransistor is inactive, and the negative input to comparator 7B is high. The output produced is low, enabling write operations.

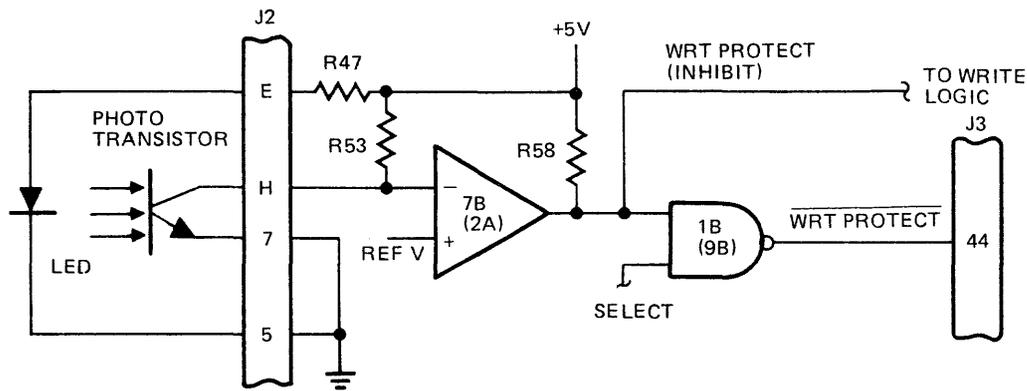


Figure 3-23. Write-Protect Logic

Write Mode

The read/write logic is switched to a Write mode by an active $\overline{\text{WRITE}}$ command followed by encoded data on the $\overline{\text{WRT DATA}}$ interface line.

Write and Erase Gating

When $\overline{\text{WRITE}}$ is active, line receiver 4D outputs a low to gate 4E. Enable gate 4D outputs a low active signal provided the head is loaded ($\overline{\text{HDLD}}$) and the write-protect option, if installed, does not sense a write-protected disk cartridge. The output produced by gate 4E is high, enabling Write flip-flop 5E, the 6E drivers and enable gate 5D. Gate 5D produces a low output to disable the step enable interface gate 4C. The high input to driver 6E switches the read/write select circuit to the write mode (see Figure 3-24).

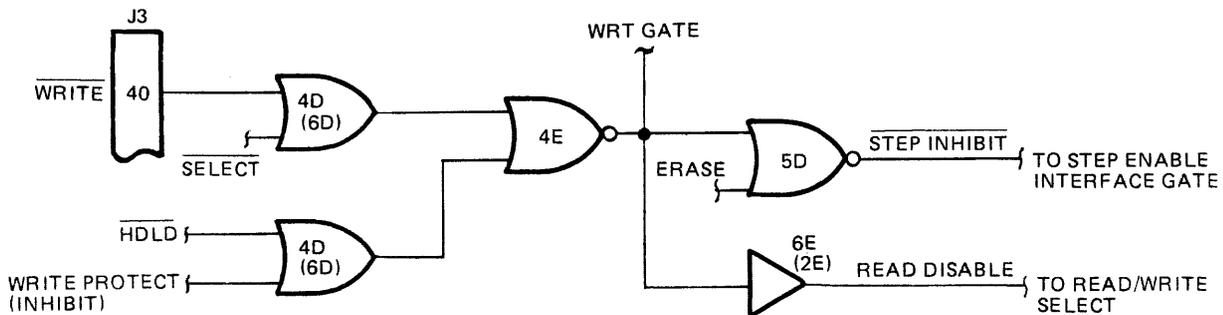


Figure 3-24. Write and Erase Gating Logic

Erase Logic

Erase Logic is comprised of one-shots 6D and 7D, flip-flop 5E, gates 4E and 5D, driver 6E, transistor Q4, resistors R10 thru R12 and R40 thru R43, and capacitors C3 and C4 (see Figure 3-25).

The purpose of the auto erase features is to provide the necessary turn-on delay between active $\overline{\text{WRITE}}$ and $\overline{\text{ERASE}}$ and the turn-off delay after $\overline{\text{WRITE}}$ goes inactive.

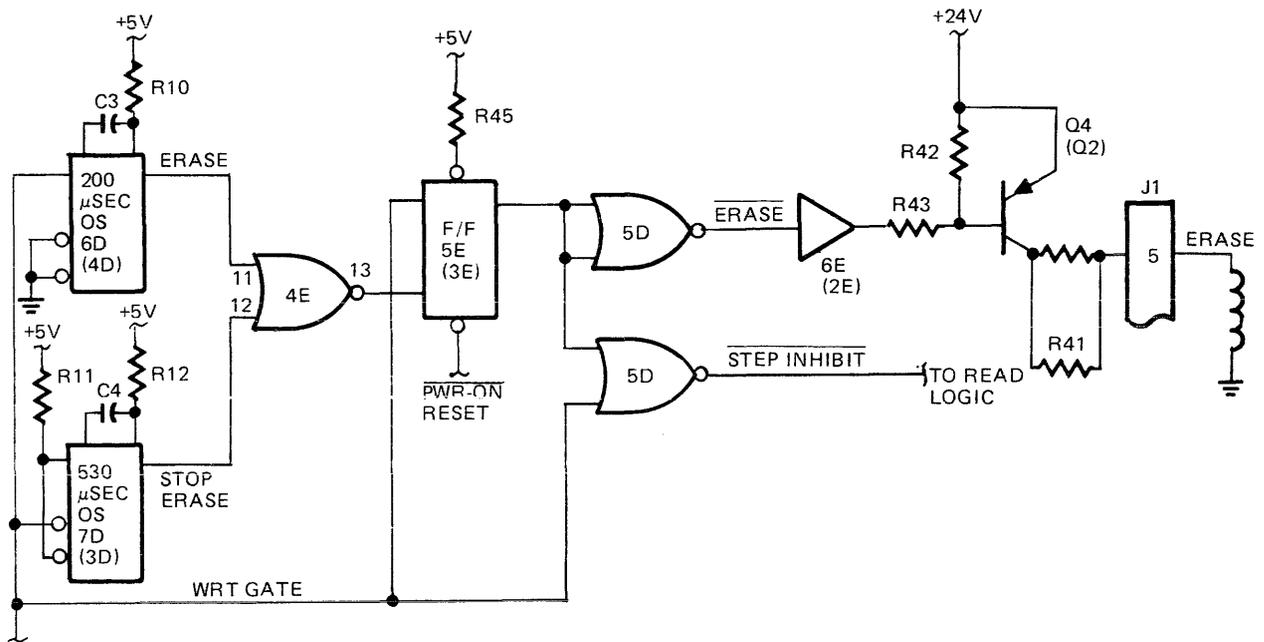


Figure 3-25. Erase Logic

When $\overline{\text{WRITE}}$ goes active, WRT goes high to trigger one-shot 6D for a 200-micro-second time-out. The one-shot output is inverted by gate 4E and the trailing edge clocks Erase flip-flop 5E on.

When $\overline{\text{WRITE}}$ goes inactive, WRT goes low to trigger one-shot 7D for a 530-micro-second time-out. The one-shot output is inverted by gate 4E and its trailing edge clocks Erase flip-flop 5E to a false state, removing erase from the 5D gates.

When $\overline{\text{ERASE}}$ is inactive, driver 6E outputs a high to bias current source transistor Q4 off. When $\overline{\text{ERASE}}$ is active, 6E outputs a low turning Q4 on. With Q4 on, +24 volts is developed across R40 and R41 causing erase current to flow through the tunnel erase coil of the read/write head.

The current is turned on 200 microseconds after an active $\overline{\text{WRITE}}$ and remains on until 530 microseconds after $\overline{\text{WRITE}}$ goes inactive. The tunnel-erased data pattern is shown in Figure 3-26.

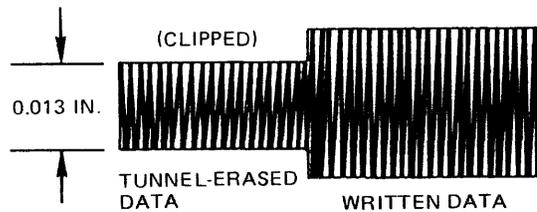


Figure 3-26. Tunnel-Erase Data Pattern

DC Unsafe

The DC Unsafe logic comprises comparator 7B, transistors Q3, Q11, Q12, zener diode CR13, resistors R8, R9, R55, R58 through R61, R81 through R84, and capacitor C58. The purpose of the DC Unsafe circuit is to monitor the +24-volt and +5-volt levels and compare each level with a precise reference voltage. If the voltage parameters are exceeded, +24 volts is turned off to disable the write and erase logic (see Figure 3-27).*

Write Current Control

The write current control logic is shown in Figure 3-28. This circuit is used to control the flow of write current through the read/write head in response to the direction determined by the $\overline{\text{WRT DATA}}$ interface line.

When the drive is not selected, write current flow is inhibited. When the drive is selected, interface line receiver 4E is enabled and gates $\overline{\text{WRT DATA}}$ to write flip-flop 5E. If the $\overline{\text{WRITE}}$ command is active, the flip-flop is enabled and the output of Q1 driver 6E is low. Current flows through CR1, CR2, R2, and R3 causing

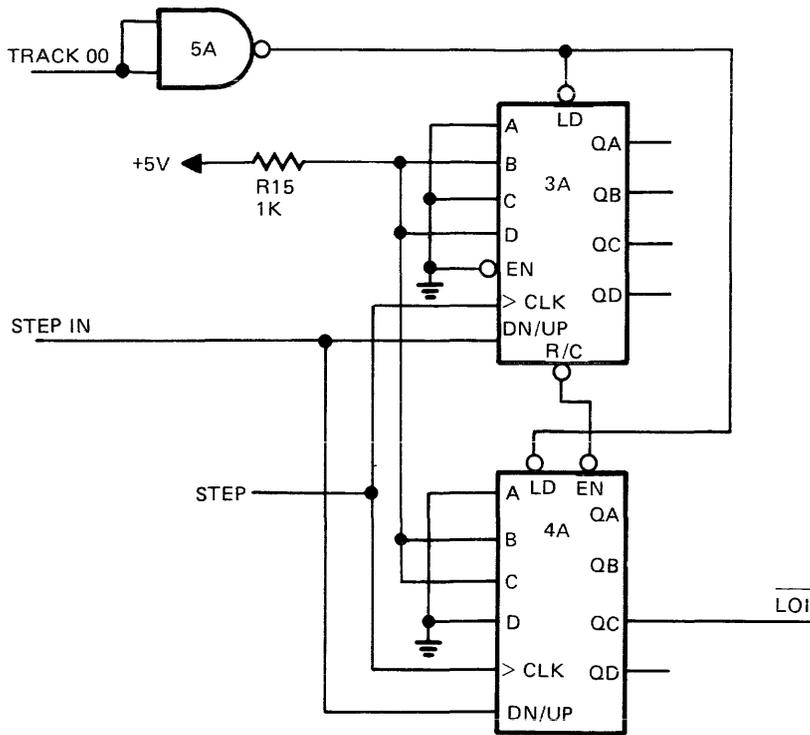


Figure 3-29. Write Current Switching (FDD 100-8C Only)

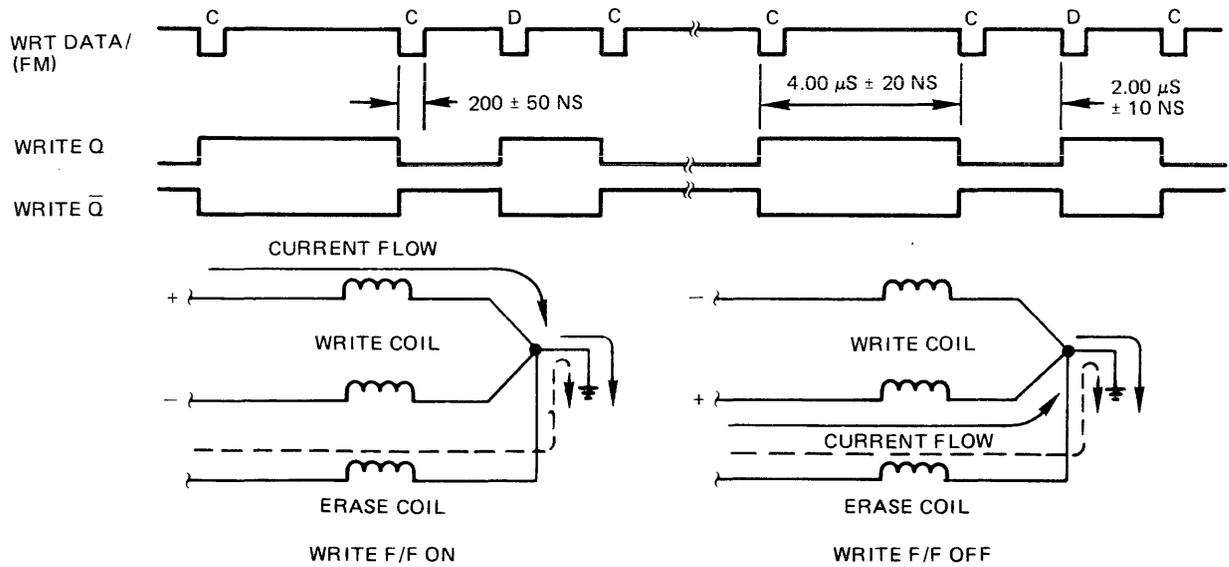


Figure 3-30. Write Current Timing

Read Mode

The read logic recovers data recorded on the disk during a write operation. After a write operation a read operation is enabled when the $\overline{\text{WRITE}}$ command becomes inactive and the 530-microsecond erase delay becomes inactive. The controller activates an initial read operation by issuing the following commands:

- $\overline{\text{SELECT}}$ - Addresses the disk drive
- $\overline{\text{HDLD}}$ - Loads the read/write head
- $\overline{\text{WRITE}}$ - Provides a high (inactive) enable signal

Figure 3-31 shows the read initiate timing.

Read/Write Select

The read/write select logic circuit is shown in Figure 3-32. The source inputs to FET's Q5 and Q6 are connected to the coils of the read/write head. The output drains are connected to the inputs of preamplifier 7F. When the disk drive is operating in the Write mode, the output of WRT gate driver 6E is high. Both Q5

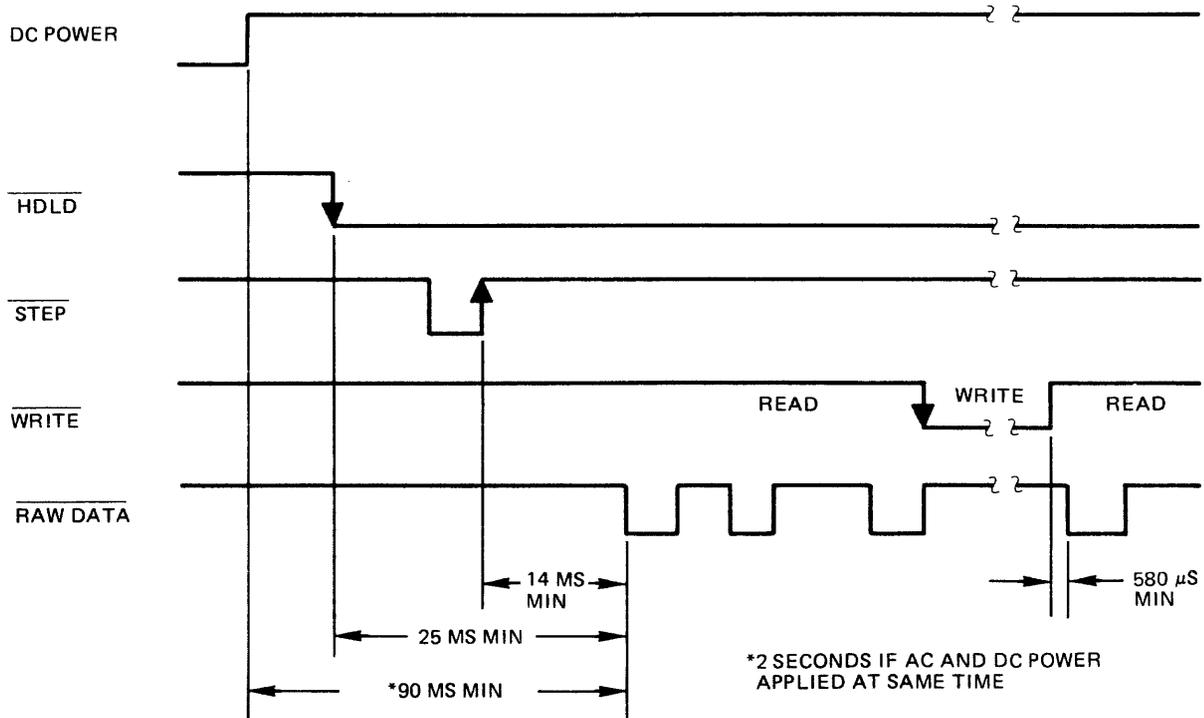


Figure 3-31. Read Initiate Timing

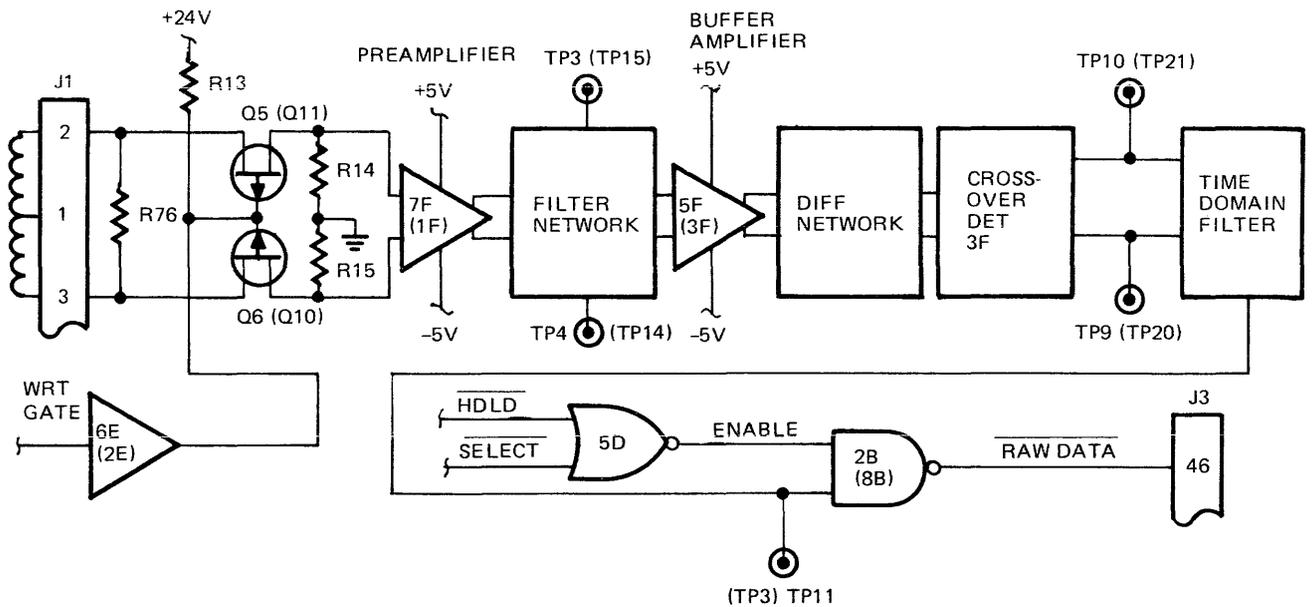


Figure 3-32. Read Logic, Simplified Diagram

and Q6 are in the off state to isolate the read coil from the preamplifier. Read damping is determined by R14 and R15 in parallel with R76.

Read Preamplifier and Filter

Read preamplifier 7F is a high-gain linear amplifier used to increase the read data signal amplitude by a nominal gain of 100. The preamplifier outputs are used to drive a 3-pole linear-phase bandpass filter network (see Figure 3-33).

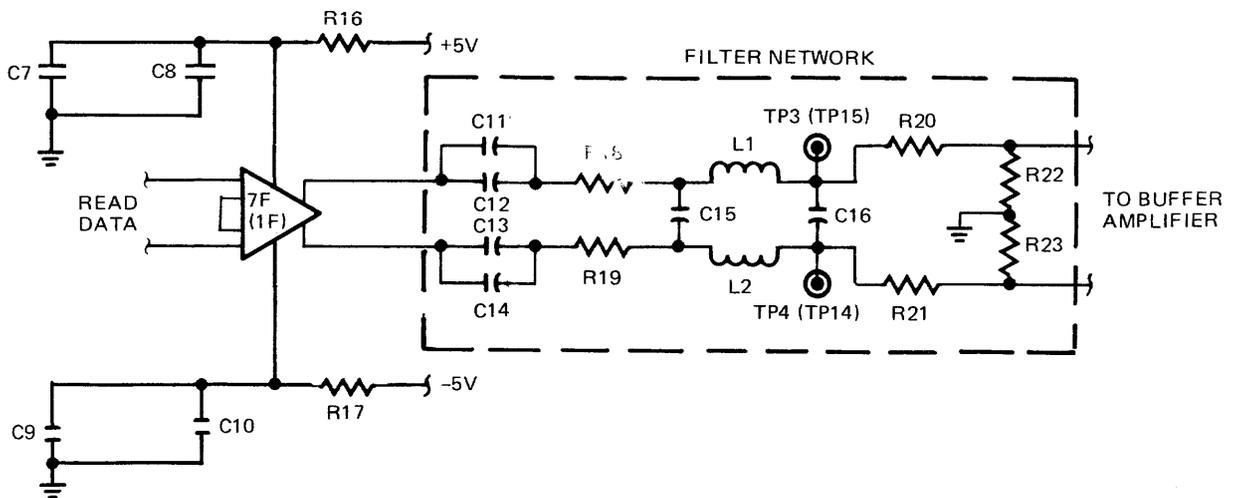


Figure 3-33. Read Preamplifier and Filter Circuit

The filter has a -3 db bandwidth of 800 kilohertz. Resistors R20 through R23 divide the output voltage to constrain the buffer amplifier within its linear range.

Buffer Amplifier and Differentiating Network

Buffer amplifier 5F has a nominal gain of 10 and isolates the read data filter, from the differentiator network (see Figure 3-34).

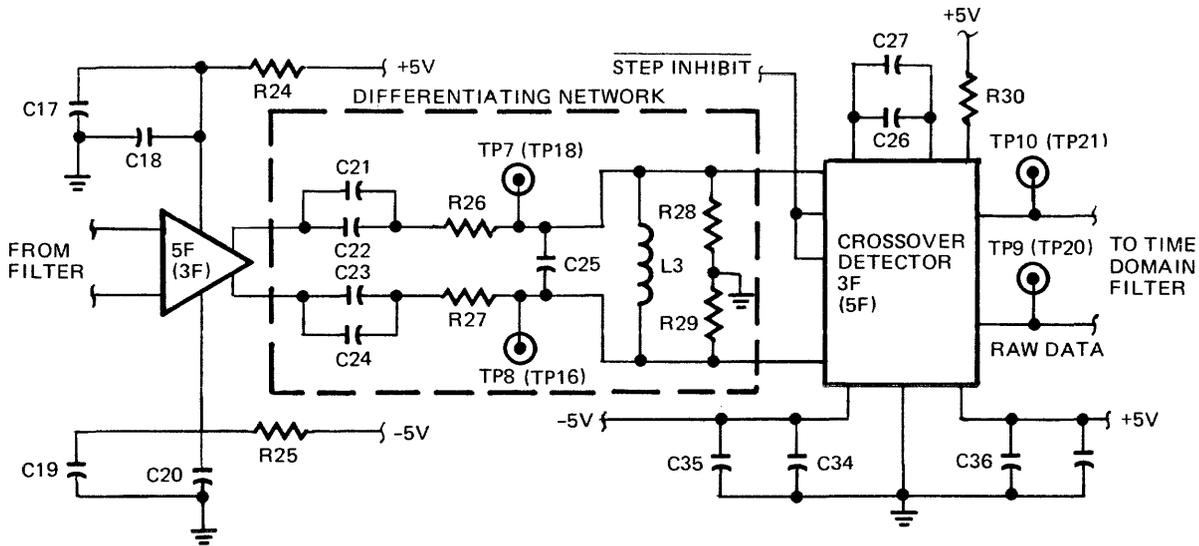


Figure 3-34. Buffer Amplifier, Differentiating Network and Crossover Detector

The differentiating network provides a 90-degree delay to convert the incoming read data signal peaks to distorted zero crossings for the crossover detector (see Figure 3-35). Capacitor C25 and inductor L3 form a parallel circuit, resonant at 750 kilohertz. Differentiator damping is by resistor R26 and R27 in parallel with R28 and R29.

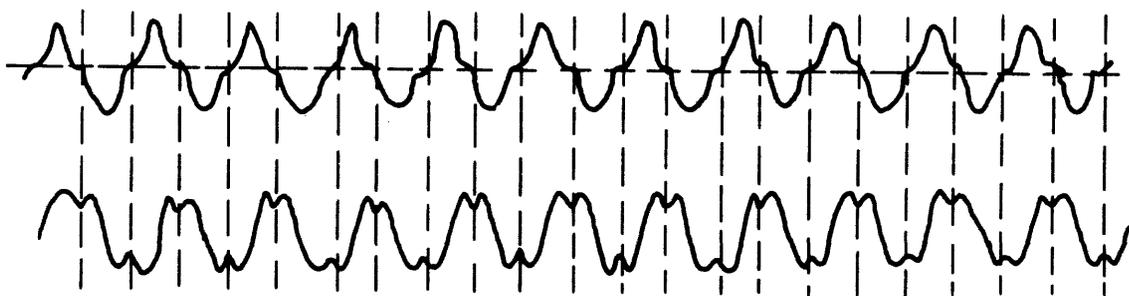


Figure 3-35. Read Data Waveforms

Crossover Detector

Crossover detector 3F is a comparator and bidirectional one-shot. The comparator is driven by the analog output of the differentiator and provides a RAW DATA pulse for each zero crossing. The one-shot outputs a nominal 1000-nanosecond pulse determined by R30, C26 and C27 (see Figure 3-33).

Time Domain Filter

The purpose of the time domain filter is to disregard false zero crossings in the RAW DATA, caused by the high resolution head-to-disk interface.

Two inputs are received from the crossover detector. The zero crossing input to flip-flop 3E is from the comparator, and the clock input is from the one-shot. The trailing edge of the one-shot clocks the input flip-flop to the state dictated by the comparator and is delayed 1,000 nanoseconds. Gating flip-flop 3E, and 2E gates, resistors R32, R33, and capacitors C28, C29 form a bidirectional one-shot, the output of which is a positive pulse for each transition produced by the input flip-flop. The positive edge of each output pulse triggers one-shot 1E to output a 200-nanosecond pulse for interface driver 2B and the Data Separator option (if installed for single-density recording). The time domain filter logic is shown in Figure 3-36.

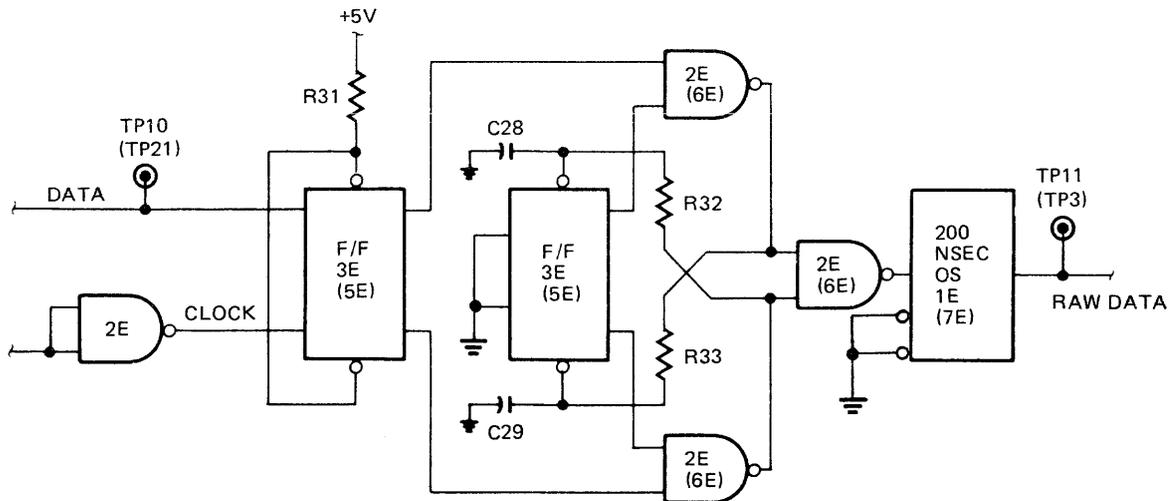


Figure 3-36. Time Domain Filter Logic

FM Data Separator (Option)

The FM Data Separator option is usable only when the disk drive is used for single-density recording. Frequency modulated (FM) encoding is defined as being a pulse train wherein a clock pulse occurs every 4 microseconds, a binary one data bit pulse occurs midway between clock pulses and no pulse occurs if the data bit is a binary zero. The logic is shown in Figure 3-37.

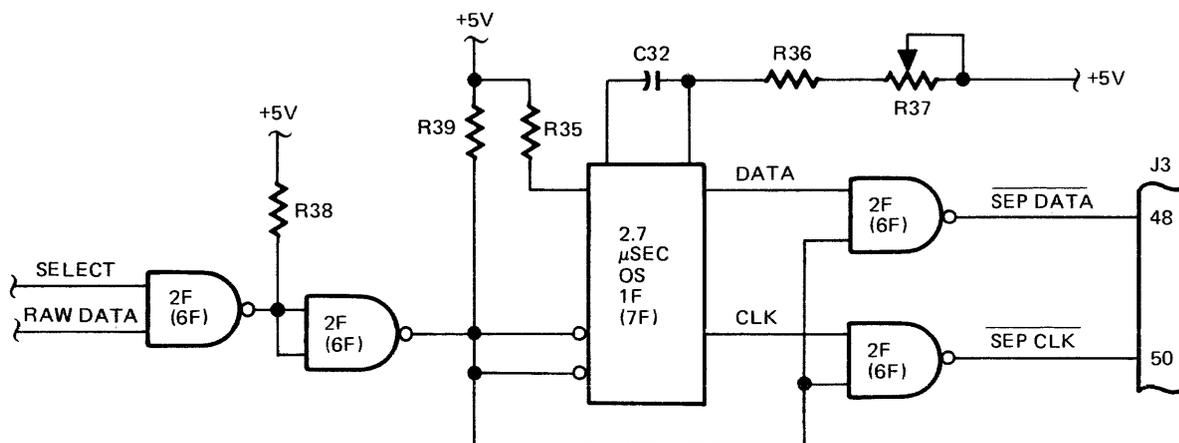


Figure 3-37. FM Data Separator (Option) Logic

The purpose of the data separator is to separate the RAW DATA pulse train of clock and data pulses into separate clock and data pulses.

When enabled by SELECT, input gate 2F inverts the pulse train from the time domain filter. The second gate reinverts the pulse train, providing low trigger inputs to one-shot 1F, and the enable inputs to the 2F interface line drivers. The trailing edge of each pulse triggers the one-shot to time for 2.7 microseconds. Therefore, since the time between a clock pulse and a data "1" pulse is 2 microseconds, the pulse that triggers the one-shot is output as the SEP CLK pulse and the next pulse is the SEP DATA pulse. Potentiometer R37 is provided to vary the time delay. Figure 3-38 shows the data separator output timing. The recommended setting for the one-shot delay is 2.7 to 2.8 microseconds. However, the user may want to vary the adjustment due to inherent delays of the particular controller used.

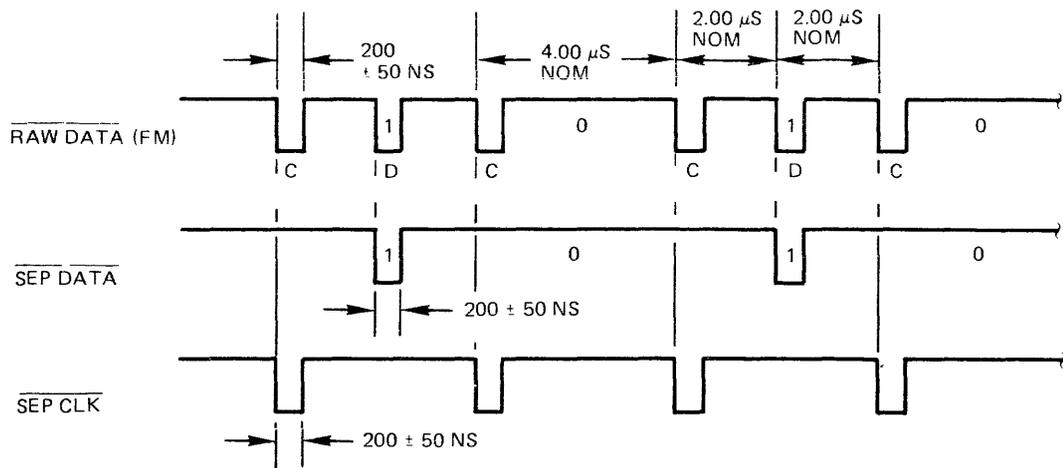


Figure 3-38. FM Data Separator Output Timing

Terminating Resistor Network

Terminating resistor network 3D (Figure 3-39), is a dual-inline IC package containing a terminating resistor network for all input interface lines. For each input line there is a 220-ohm resistor to +5 volts, and a 330-ohm resistor to ground. When the disk drives are radially connected to the controller, all drives must have the terminator IC installed. When the drives are connected in daisy-chain fashion, only the last drive must have the terminator IC installed.

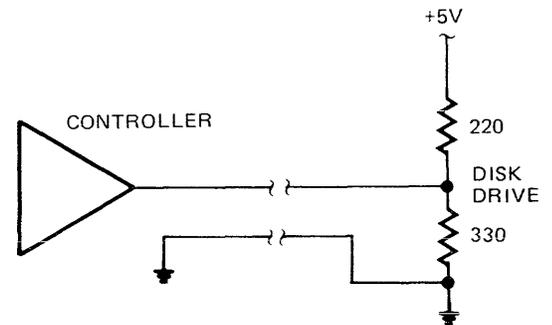


Figure 3-39. Terminating Resistor Network

-5 Volt Regulator (Option)

The disk drive logic operates from -5.0 volts $\pm 5\%$, supplied from the host controller. If this voltage is not available, the Negative Voltage Regulator option must be installed (See Figure 3-40)

When this option is installed the controller can supply an unregulated input from -7 volts to -16 volts. Regulator Q10 provides a -5 volts output, regulated to ± 5 percent.

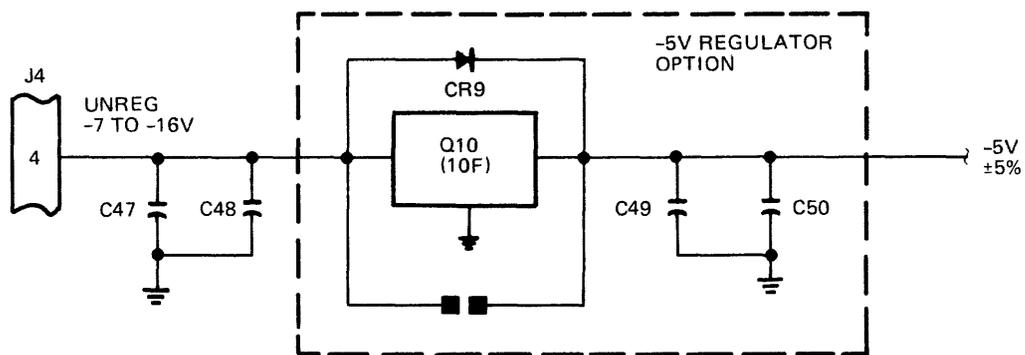


Figure 3-40. -5 Volt Regulator (Option) Diagram

SECTION 4 INSTALLATION

GENERAL

This section provides information necessary to prepare the disk drive for operational readiness. Preliminary inspection, mechanical checks and cable fabrication and verification checks are made to ensure operational integrity.

The disk drive may be configured and shipped in one of many ways, depending on customer requirements. Information for the installation of additional options and multi-drive connecting configurations, are included in this section.

INSPECTION

The disk drive is packaged in a heavy duty container, designed to ensure adequate protection during shipping and handling. When the disk drive is installed, store the container and all packing material for possible future use.

Immediately upon receipt, inspect the container for any signs of possible damage. If the container is damaged, there is a possibility that the disk drive may also be damaged. Notify both the carrier and the manufacturer after inspecting the contents.

UNPACKING

A complete inspection of the disk drive is necessary to ensure equipment acceptability. Unpack the disk drive as follows:

- a. Remove all packing material around disk drive.
- b. Remove disk drive carefully from container and place on bench surface.

- c. Remove all wrapping and internal shipping restraints.
- d. Check all items against shipping list. Report all discrepancies to manufacturer.
- e. Check all items for damage. Report all discrepancies to carrier and manufacturer. If no damage or shipping discrepancies are evident, continue to Mechanical Checks. Otherwise, hold disk drive for return to manufacturer.

MECHANICAL CHECKS

The disk drive is designed for ease of operation. Most mechanical checks can be made, without having power applied, as follows (see Figure 4-1):

- a. Place disk drive on clean bench surface with printed circuit board (PCB) on side and front panel facing checker.
- b. Manually rotate spindle pulley. Observe that spindle rotates freely and drive belt rides smooth and evenly.
- c. Press front panel release button. Observe that carrier mechanism opens to insert flexible disk cartridge, and that centering cone is released from spindle hub.
- d. Insert disk cartridge fully. Observe that spring-loaded latch is engaged and that disk cartridge is seated properly over drive mechanism.
- e. Close front panel to fully latched position. Observe that centering cone and spindle grasp flexible disk firmly.
- f. Rotate spindle drive mechanism. Observe smooth rotation of flexible disk.

CONNECTING CABLES

The disk drive is connected to the host controller by three connecting cables, the lengths of which are determined at the installation site. The ac and dc cables are independent cables requiring direct connection to each disk drive, regardless of connecting configuration. However, the interface signal cable is connected according to the various connecting configurations, and should not exceed 25 feet in length.

The cables are connected directly to disk drive connectors as shown in Figure 4-1, and are identified as follows:

- J3, Interface Signals (Input Commands and Write Data, Output Status and Read Data)

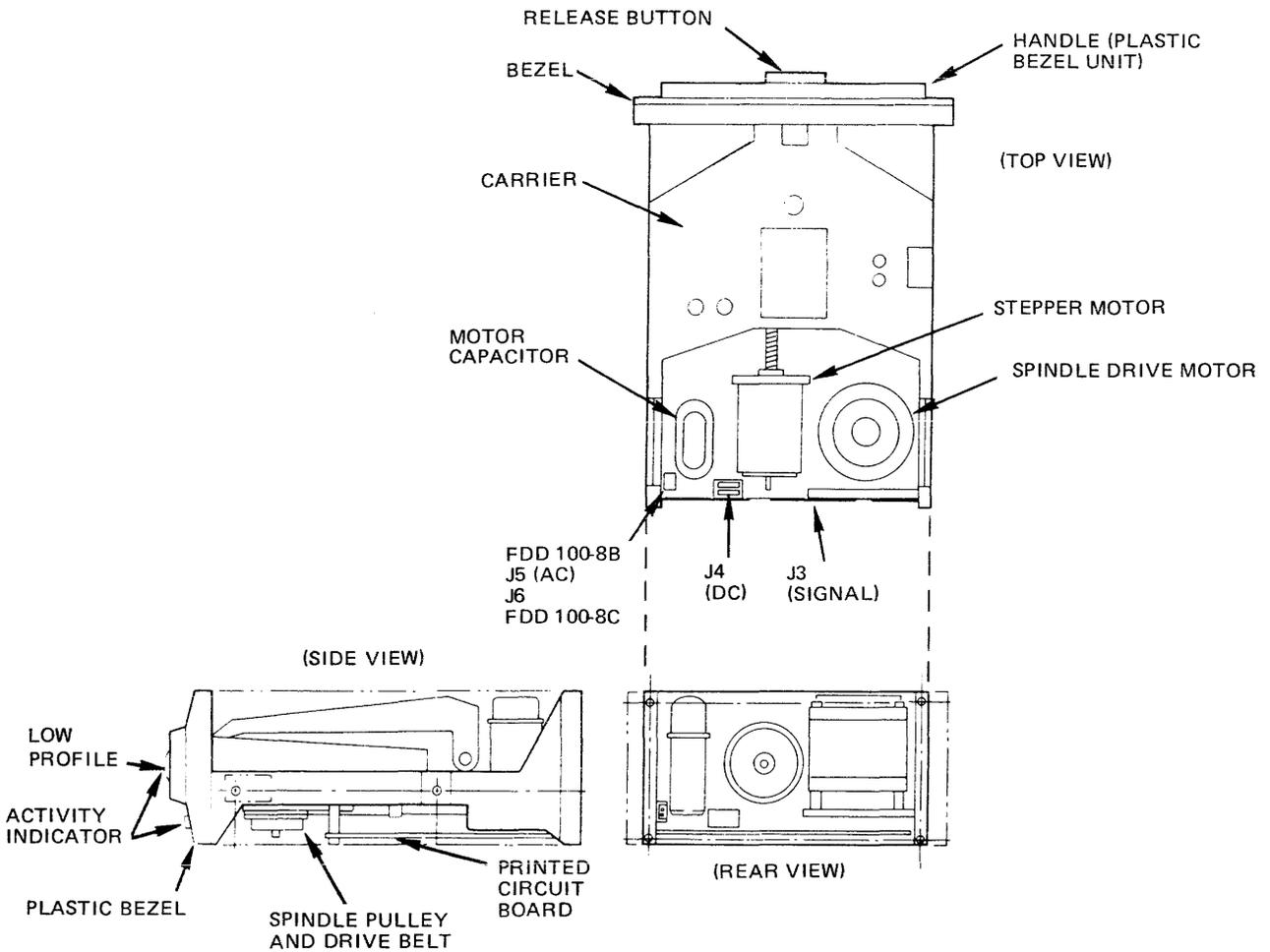


Figure 4-1. Principal Parts Location

- J4, DC Power (Electronics and Stepper Motor)
- J5, AC Power (Spindle Drive Motor)

Fabricate all cables using recommended connecting jacks, plugs and pins. All input and output lines to the interface connector J3 (signal), should be cabled using one of the two following methods:

- Twisted pair (AWG 26 or larger) with at least one twist per inch, for each signal. One wire connected to assigned signal pin on P3, and the other wire connected to signal ground at both ends. Cable length should not exceed 25 feet.
- 50-conductor flat ribbon cable. Connect alternate signal and ground wire using recommended material. Maximum ribbon cable length is 10 feet.

Using a voltohmmeter (set to measure continuity), verify that all cables have been fabricated correctly by the following checks on each connector:

- a. Check each pin with all other pins on same connector to ensure pin-to-pin short does not exist.
- b. Verify cable has no broken lines by checking each pin with corresponding pin on opposite end of cable.
- c. Adjust voltohmmeter to measure ac line voltage; apply ac power and check disconnected ac connector pins (P5) for correct input voltage. Remove ac power when check complete.
- d. Adjust voltohmmeter to measure dc voltage; apply dc power and check disconnected dc connector pins (P4) for correct input voltages. Remove dc power when check complete.

AC Power Cable

AC power is connected to the disk drive through connector J5 (AC). The input pin assignments and optional voltage/frequency requirements are listed in Table 4-1.

Table 4-1. AC Power Requirements

Pin No. (P5)	60 Hertz		50 Hertz	
	120V	220V	120V	220V
1	108-132 VAC	198-242 VAC	108-132 VAC	198-242 VAC
2	Frame Gnd	Frame Gnd	Frame Gnd	Frame Gnd
3	AC Ret	AC Ret	AC Ret	AC Ret
I_{MAX}	0.5 Amps	0.4 Amps	0.6 Amps	0.4 Amps
Frequency Tolerance	± 0.5 Hertz		± 0.5 Hertz	

AC power input connector J5 is mounted inside the frame, next to the drive motor capacitor (see Figure 4-1). The 3-pin connector is AMP P/N 1-480305-0 using pin P/N 60620-1. Recommended mating connector P5, is AMP P/N 1-480303-0 or 1-480304-0, both using pin P/N 60619-1. Figure 4-2 shows connector J5 as seen from the rear of the drive.

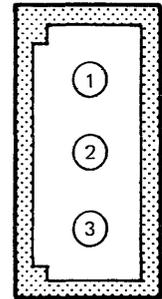


Figure 4-2. AC Connector J5

DC Power Cable

DC power is connected to the disk drive through twisted-pair at connector J4 (DC). The input pin assignments and voltage requirements are listed in Table 4-2.

Table 4-2. DC Power Requirements

Pin No. (P4)	Dc Voltage	Tolerance	Current	Maximum Ripple (p-p)
1	+24 VDC	± 1.2 VDC	1.6A Max.	100 mv
2	+24V Ret	-		-
3	-5V Ret	-		-
4	-5 VDC	+0.25 VDC	0.08A Max.	50 mv
	-7 to -16 VDC (optional with -5V regulator installed)	NA	0.10A Max.	NA
5	+5 VDC	± 0.25 VDC	1.0A Max.	50 mv
6	+5V Ret	-	-	-

DC power input connector J4 is mounted on the noncomponent side of the PCB, just below the drive motor capacitor and the stepper motor (see Figure 4-1). The 6-pin connector is AMP P/N Mate-N-Lock P/N 1-380999-0 and is soldered directly to the PCB. Recommended mating connector P4, is AMP P/N 1-480270-0 using P/N 60619-1. Figure 4-3 shows connector J4, as seen from the rear of the disk drive.

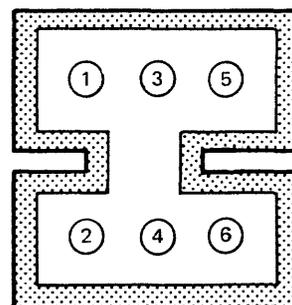


Figure 4-3. DC Connector J4

Interface Signal Cable

All controller commands, read/write data, and disk drive status signals are transferred through connector J3. Connections are made between the controller and the disk drive in either radial or daisy-chain fashion, depending on the installed configuration required.

Connector J3 is a 50-pin PCB edge-card connector, located at the rear of the disk drive (see Figure 4-1). The pins are numbered 1 through 50, with all even-numbered pins on the component side. A key slot is provided between pins 4 and 6 for connector keying. Recommended mating connectors for J3, are listed in Table 4-3.

Table 4-3. Recommended J3 Mating Connectors

Cable Type	Manufacturer	Connector P/N	Contact P/N
Twisted Pair #26 (crimp or solder)	AMP	1-583717-1	583616-5 (Crimp) 583854-3 (Solder)
Twisted Pair #26 (solder terminal)	VIKING	3VH25/1JN-5	NA
Flat Cable (Scotchflex)	3M	3415-0001	NA
	AMP	88083-1	NA

All connections to and from the read/write and control logic printed circuit board are shown in Figure 4-4.

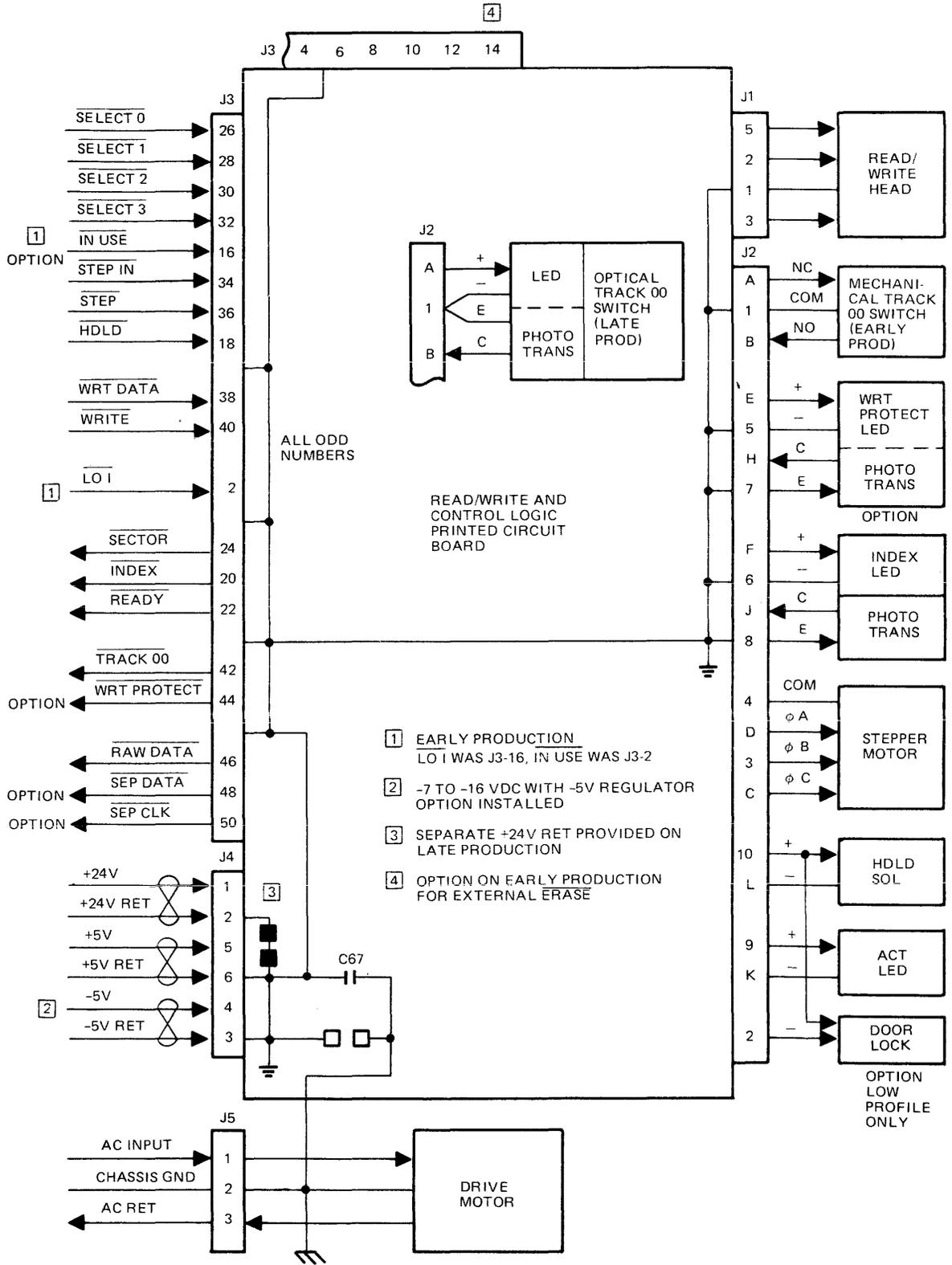


Figure 4-4. Interconnection Diagram

Figure 4-4 is provided as an interconnection diagram and shows that, except for AC power connector J5, all connections are made directly to or from the PCB. Connector J1 and J2 are for internal disk drive use.

INTERFACE SIGNAL DESCRIPTIONS

All interface signal levels are low active (0 volt), inverted by the disk drive line receivers or line drivers, and all input signals are terminated according to the system configuration used; radial or daisy chain.

Logic Levels and Termination

Interface signals to and from connector J3 have the logic levels represented by Figure 3-7 and all signal inputs are terminated as shown in Figure 3-38.

Input Signals

Input signals from the controller to the disk drive are listed and defined in Table 4-4. Logic 1 is low (active) and Logic 0 is high (see Figure 3-7).

Output Signals

Output signals from the disk drive to the controller are listed and defined in Table 4-5. Logic 1 is low (active) and logic 0 is high (see Figure 3-7).

INTERFACE TIMING

The timing for interface input/output signals is shown in Figure 3-6.

Disk drive operations begin when the disk cartridge is inserted and the access door is closed. The floppy disk begins rotating and, during the "ready" delay, the unit is selected by the controller to check the ready status.

At completion of the ready delay, $\overline{\text{READY}}$ becomes active to the controller and the controller makes $\overline{\text{HDL D}}$ active in return. After a 25-millisecond head load time the unit is in the Read mode and the read data is present on the $\overline{\text{RAW DATA}}$ line.

Table 4-4. Interface Input Signals

Signal	Definition
$\overline{\text{SELECT 0}}$ through $\overline{\text{SELECT 3}}$	<p>In the basic configuration one select line is assigned to each drive. Logic 1 (low) selects the corresponding drive and all interface logic is enabled. When the line is at logic 0 (high) all inputs are disabled except $\overline{\text{SELECT}}$ lines and all outputs except $\overline{\text{READY}}$ are disabled (see Figure 3-9).</p> <p>When the binary select option is installed, an active (low) $\overline{\text{SELECT 0}}$ enables unit selection. $\overline{\text{SELECT 1}}$, $\overline{\text{SELECT 2}}$ and $\overline{\text{SELECT 3}}$ contain a 3-bit binary code to select the unit (see Table 3-1).</p> <p>The activity indicator is turned on and the door lock option (if installed on a low profile drive) is activated if the activity indicator option is monitoring $\overline{\text{SELECT}}$.</p>
$\overline{\text{HDL D}}$	<p>Logic 1 (low) energizes the head load solenoid. The energized head load solenoid releases the head load arm to bring the media into contact with the read/write head (see Figure 3-15).</p> <p>A delay of 25 milliseconds is required after the $\overline{\text{HDL D}}$ command, before data can be read or written.</p> <p>To enable $\overline{\text{HDL D}}$ the unit must be selected. An active HDLD is not required if the selected HDLD option is installed.</p> <p>The activity indicator is turned on and the door lock option (if installed on a low profile drive) is activated if the activity indicator option is monitoring $\overline{\text{HDL D}}$.</p>
$\overline{\text{STEP}}$	<p>The trailing edge of each logic 1 (low) $\overline{\text{STEP}}$ pulse causes the read/write head to move one track distance (see Figure 3-19).</p> <p>Each pulse must remain active for at least 10 microseconds and the time between pulses must be at least 6 milliseconds and not more than 8 milliseconds for a multiple track movement (see Figure 3-20).</p> <p>The following conditions must be met to allow read/write head movement:</p> <ol style="list-style-type: none"> 1. Write operation inhibited 2. Unit selected or radial step option installed 3. $\overline{\text{HDL D}}$ active

Table 4-4. Interface Input Signals (Continued)

Signal	Definition
$\overline{\text{STEP IN}}$	<p>Logic 1 level (low) causes the read/write head to move forward (in toward track 76) and logic 0 level (high) causes the read/write head to move in reverse (out toward track 00) (see Figure 3-19).</p> <p>The signal must not change state less than 1 microsecond before the trailing edge of the $\overline{\text{STEP}}$ pulse (see Figure 3-20).</p> <p>To enable $\overline{\text{STEP IN}}$ the unit must be selected or the radial step option must be installed.</p>
$\overline{\text{WRITE}}$	<p>Logic 1 level (low) disables both the read logic and read/write head movement and causes write current to be turned on in the read/write head (see Figures 3-24 and 3-28).</p> <p>$\overline{\text{WRITE}}$ should be active 1 bit time before the first $\overline{\text{WRT DATA}}$ pulse and remain active 2 bit times after the last $\overline{\text{WRT DATA}}$ pulse (see Figure 3-22).</p> <p>Erase current is turned on 200 microseconds after $\overline{\text{WRITE}}$ becomes active (low) and is turned off 530 microseconds after $\overline{\text{WRITE}}$ becomes inactive (high) (see Figure 3-25).</p> <p>The following conditions must be met to enable $\overline{\text{WRITE}}$:</p> <ol style="list-style-type: none"> 1. Unit selected 2. $\overline{\text{HDL D}}$ active 3. If the write protect option is installed, a write-protected disk cartridge (open slot) must not be loaded.
$\overline{\text{WRT DATA}}$	<p>Transitions of the $\overline{\text{WRT DATA}}$ pulse from high to low and low to high change the polarity of the write current flow through the read/write head (see Figure 3-28).</p> <p>Low remains low for 150 to 250 nanoseconds to establish nominal data and clock pulse durations (see Figure 3-29).</p> <p>To enable $\overline{\text{WRT DATA}}$ the unit must be selected.</p>

Table 4-4. Interface Input Signals (Continued)

Signal	Definition
$\overline{\text{LOI}}$	<p>Low Input causes reduced write current on inside tracks to compensate for higher bit packing density on inner tracks (see Figure 3-28).</p> <p>$\overline{\text{LOI}}$ should be active (low) for tracks 44 through 76.</p>
$\overline{\text{IN USE}}$ (Option)	<p>This optional input can be used to turn on the activity indicator and activate the door lock option (if installed on a low profile drive) if the activity indicator option is monitoring $\overline{\text{IN USE}}$.</p>

Table 4-5. Interface Output Signals

Signal	Definition
$\overline{\text{READY}}$	<p>Active status (low) indicates AC and DC power applied and the floppy disk is rotating at 62.5 percent of speed (see Figure 3-14).</p> <p>If a floppy disk is already loaded, $\overline{\text{READY}}$ will go low nominally 2 seconds after the application of AC and DC power (see Figure 3-6).</p>
$\overline{\text{WRT PROTECT}}$ (Option)	<p>This line used only if write protect option installed. Active status (low) indicates write-protected disk (see Figure 1-2) cartridge in use and all write logic is disabled. Output available only when unit is selected (see Figure 3-23).</p>
$\overline{\text{TRACK 00}}$	<p>Active status (low) indicates that the read/write head is positioned at track 00. Output available only when unit is selected (see Figures 3-16 and 3-17).</p>
$\overline{\text{INDEX}}$	<p>Low active 1.7 millisecond pulse (see Figure 3-11) occurs once per disk revolution (see Figure 3-10).</p> <p>If the hard sector option is installed (see Figure 3-12) the pulse duration is reduced to 0.4 milliseconds nominal (see Figure 3-13).</p> <p>The index pulse timing is used to synchronize controller data format transfers.</p>

Table 4-5. Interface Input Signals (Continued)

Signal	Definition
$\overline{\text{SECTOR}}$ (Option)	<p>This line used only if the hard sector option is installed (see Figure 3-12). Low active 0.4-millisecond pulses occur 5.2 milliseconds apart indicating the start of each of the 32 sectors marked by the 32 sector holes in the soft sectored floppy disk cartridge (see Figure 1-2).</p> <p>If the 16/8 sector option is installed, a low level pulse occurs at every other sector hole (16 sector) or at every fourth sector hole (8 sector) (see Figure 3-13).</p>
$\overline{\text{RAW DATA}}$	<p>A low active pulse is produced for each flux reversal read from the disk (see Figure 3-31).</p> <p>This pulse train is restored data transferred to the controller. Each pulse width is 200 nanoseconds duration (see Figure 3-37).</p>
$\overline{\text{FM SEP DATA}}$ $\overline{\text{FM SEP CLK}}$ (Option)	<p>These lines are used only if the FM data separator option is installed. (See Figure 3-36).</p> <p>A low active 200-nanosecond pulse ($\overline{\text{FM SEP DATA}}$) is produced for each data transition in the $\overline{\text{RAW DATA}}$ pulse train (see Figure 3-37).</p> <p>A low active 200-nanosecond pulse ($\overline{\text{FM SEP CLK}}$) is produced for each clock transition in the $\overline{\text{RAW DATA}}$ pulse train (see Figure 3-37).</p>

The controller issues one or more $\overline{\text{STEP}}$ pulses, causing the read/write head to be moved one or more tracks from its initial position. During the 14 milliseconds after the second $\overline{\text{STEP}}$ pulse, the head has settled on the track and $\overline{\text{WRITE}}$ is made active, placing the disk drive in the Write mode.

After a maximum delay of 1 bit time (4 microseconds for single-density, 2 microseconds for double-density), write data is accepted on the $\overline{\text{WRT DATA}}$ line and written on the disk. Approximately 200 microseconds after $\overline{\text{WRITE}}$ goes active, $\overline{\text{ERASE}}$ is made active.

After the last write bit has been transferred to the disk drive, $\overline{\text{WRITE}}$ becomes inactive 2 bit times later. $\overline{\text{ERASE}}$ is made inactive 530 microseconds after the trailing edge of $\overline{\text{WRITE}}$.

A 50-microsecond read stabilization delay is required following a write operation, before valid read operations can be performed.

SYSTEM CONFIGURATIONS

The disk drive can be used in single-drive applications or can be connected in a multi-drive configuration for greater storage capabilities.

Single-Drive Configuration

When a single disk drive is to be used with the host controller, all cables are connected directly to the disk drive (see Figure 4-5). It is the simplest form of radial configuration. The unit can be selected to accept commands and respond with status signals. Selected head load or radial options may be installed.

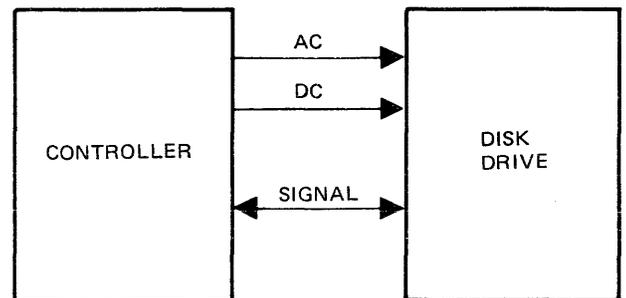


Figure 4-5. Single-Drive Configuration

In this application, all input signal lines are terminated by an integrated circuit containing the terminating networks, which are located on the printed circuit board.

Radial Select

When multi-drive applications are required, one method used is the radial select (Figure 4-6). The purpose of this type operation is to allow the disk drive to accept commands and send status signals, without having been selected. All radial options can be installed. Signal input lines are terminated in each disk drive.

Daisy-Chained Radial Select

The radial select configuration may be daisy-chained to allow a multi-drive system both select and non-select operations. This configuration is shown in Figure 4-7. Undedicated lines under select control are daisy-chained. All undedicated signal lines are terminated in the last disk drive.

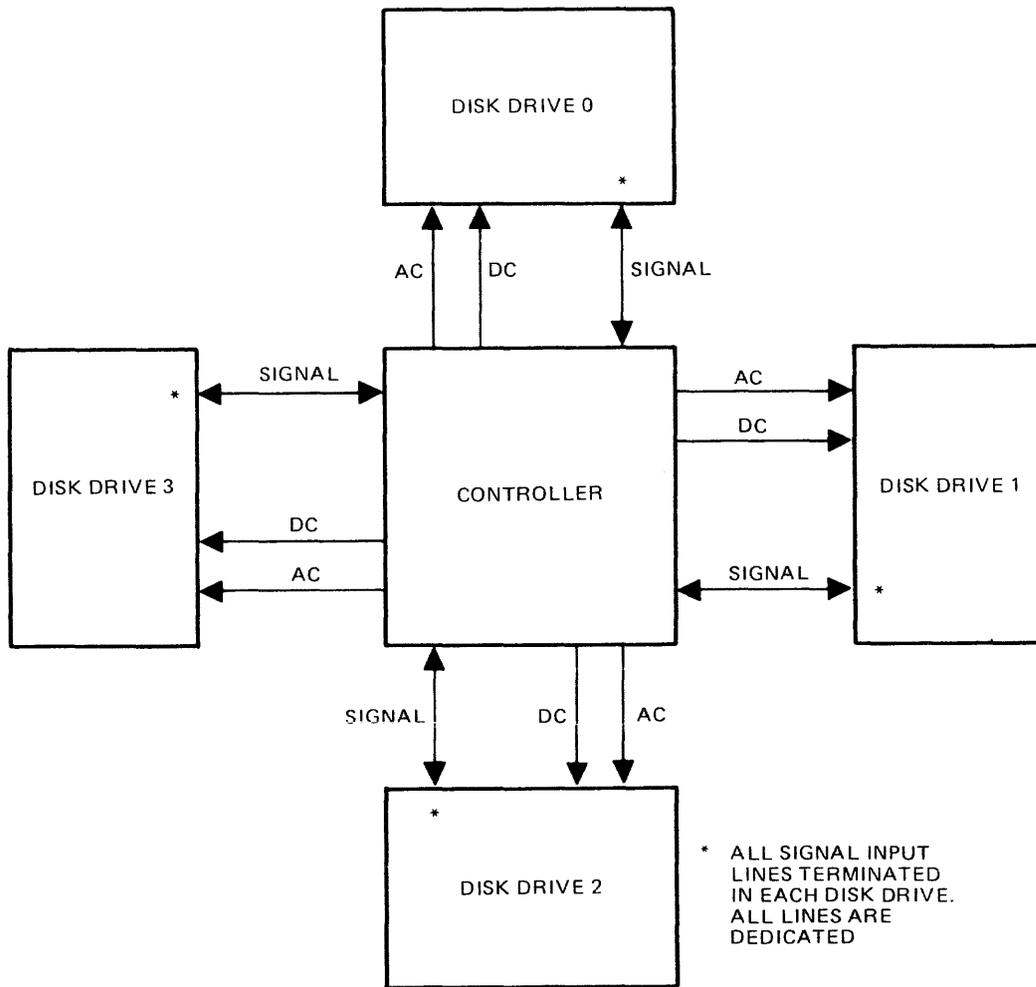


Figure 4-6. Radial Select Configuration

It is possible to install any two of the following radial options with four disk drives:

STEP, STEP IN, HDL D, READY, INDEX or SECTOR -

With two disk drives, all radial options can be installed.

Binary Select

The binary select configuration multiplexes the select lines to allow up to eight disk drives to be individually selected by a binary code. This configuration is shown in Figure 4-8. All signal lines are daisy-chained. All signal input lines are terminated in the last disk drive.

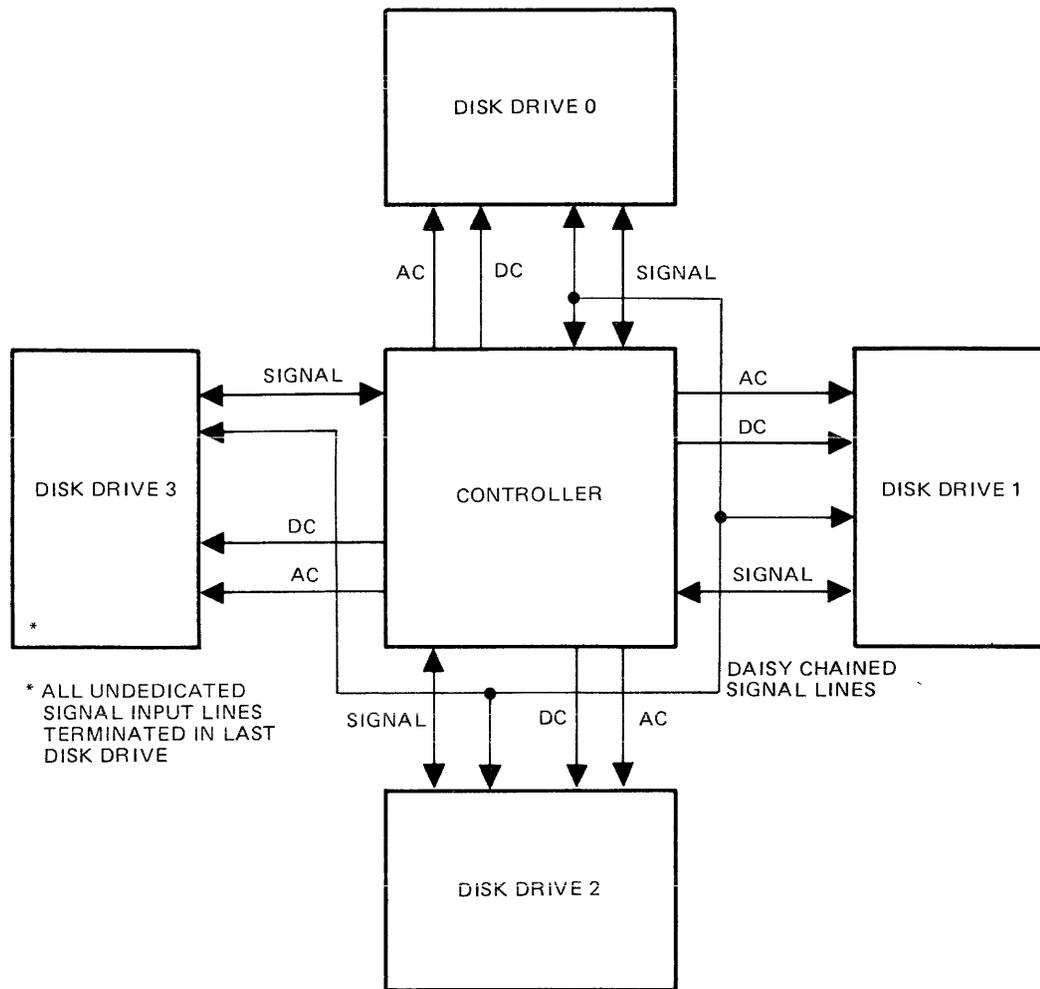


Figure 4-7. Daisy-Chained Radial Select Configuration

To select one of eight disk drives when using only four select lines the following scheme is used (refer to Table 3-1):

<u>SELECT 0</u>	= Decoder Enable
<u>SELECT 1</u>	} Binary coded from 0 through 7 to produce only one select signal
<u>SELECT 2</u>	
<u>SELECT 3</u>	

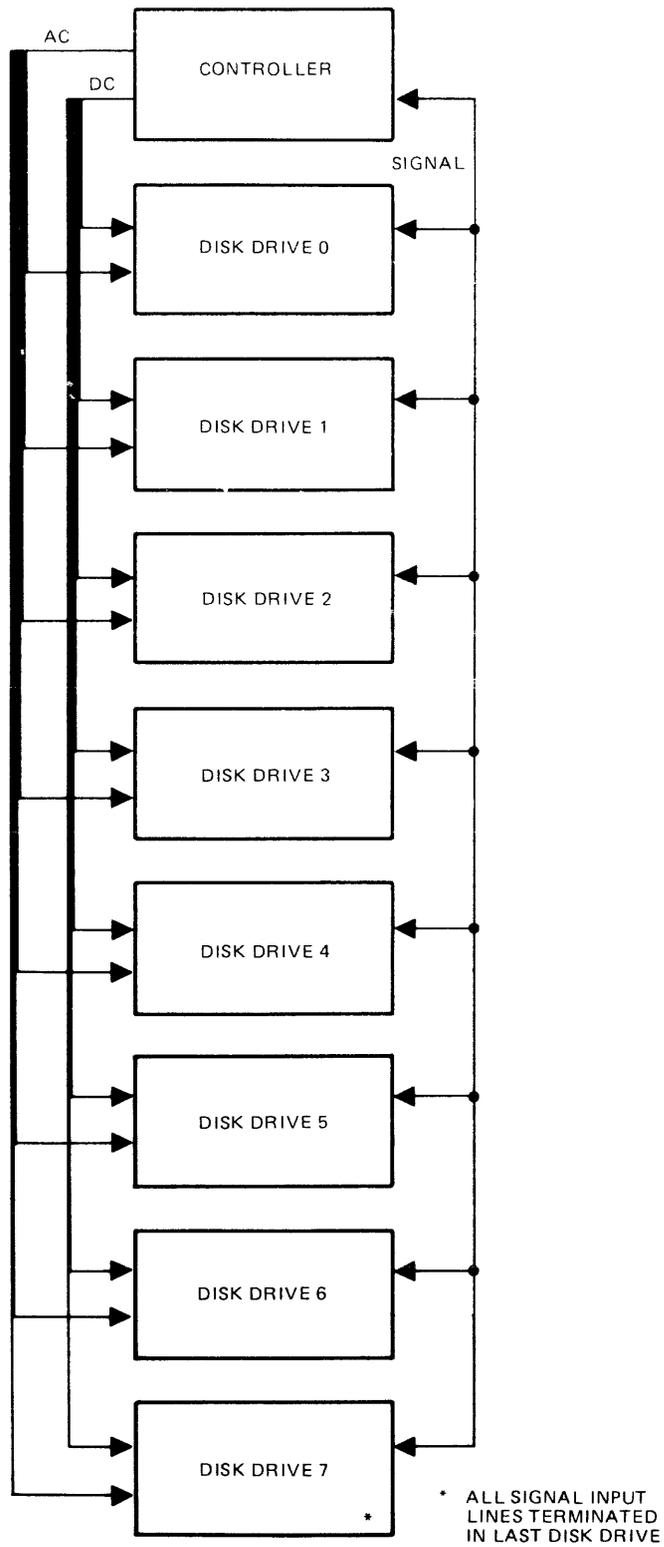


Figure 4-8. Binary Select Configuration

INTERFACE/INTERNAL OPTIONS INSTALLATION

The disk drive may be supplied with or without any options installed.

All options except door lock (low profile only) can be installed at a later date. All etched circuitry is predesigned into the PCB and low-cost option kits (components) are available.

The following paragraphs provide procedural information necessary to install the options. Figure 4-9 and 4-10 show the PCB outline and the unique manner by which an option can be installed. Refer to this illustration for the location of each option.

Note

If alternate I/O lines are assigned as an option, the resultant configuration should be checked for proper terminator resistors.

Radial Select (See Figure 3-9)

In the radial select configuration, a dedicated SELECT line is provided for each disk drive. The assigned SELECT line must be connected across the etch pads for connection to the interface.

Early production units were supplied with a trace connecting the 0 pads (disk drive 0). Later production units are supplied with a jumper assembly installed across the 0 pads. For disk drives 1, 2 or 3:

Early Production

- a. Cut the trace between the RADIAL SEL 0 pads.
- b. Install a wire jumper between the desired pads 1, 2 or 3. Typical connection shows drive number 2.

Later Production

- a. Remove jumper assembly from 0 pads.
- b. Install jumper assembly on 1, 2 or 3 pads.

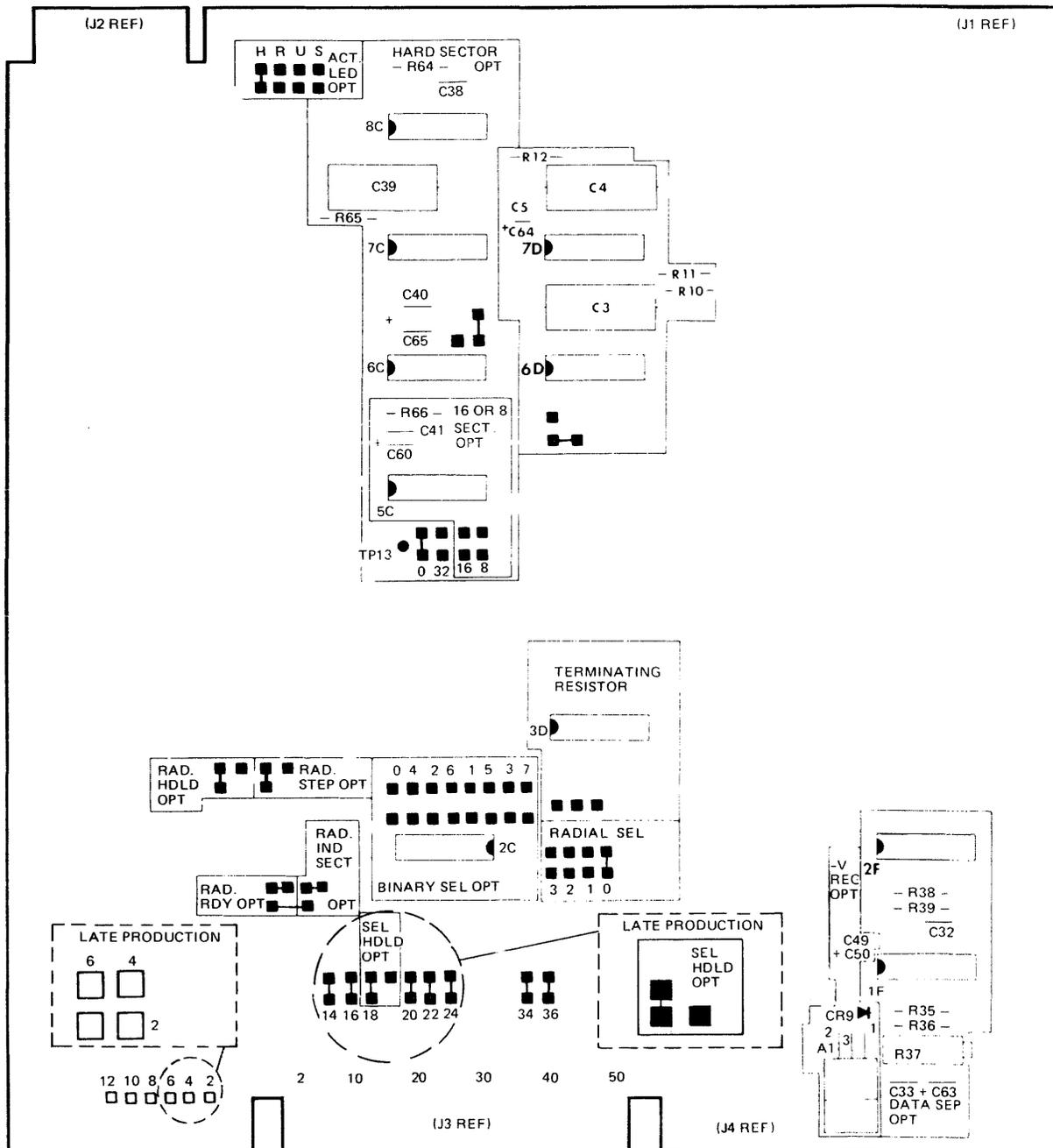


Figure 4-9. Interface/Internal Options (FDD 100-8B)

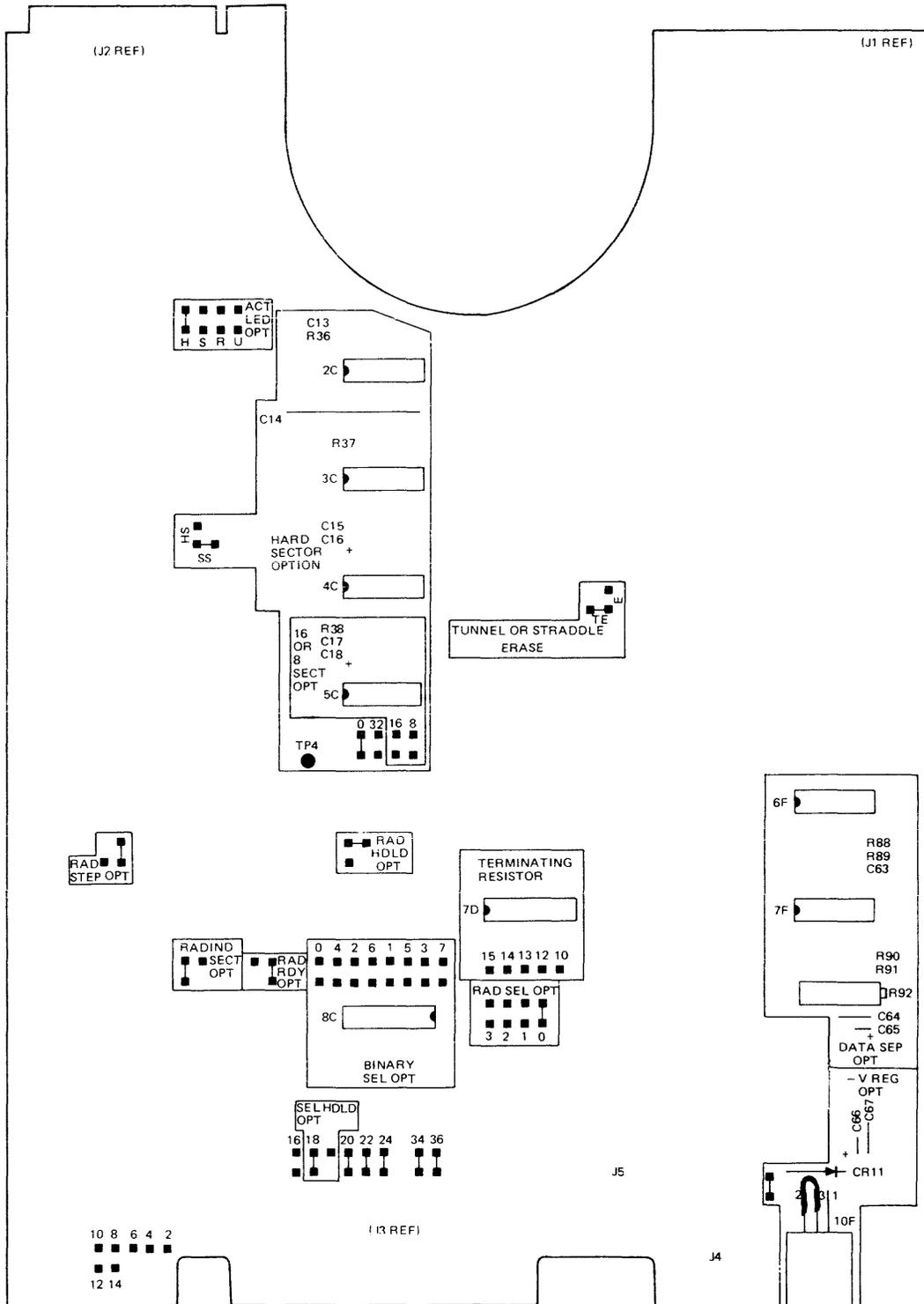


Figure 4-10. Interface/Internal Options (FDD 100-8C)

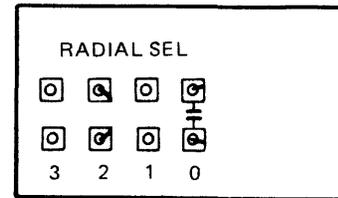
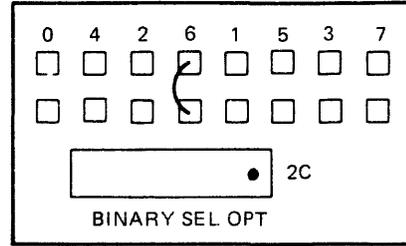
Binary Select (See Figure 3-9 and Table 3-1)

This option allows the select function to be multiplexed to a maximum of eight drives.

Early Production

To install the Binary Select option:

- a. Install components in the binary select option kit.
- b. Cut trace or remove wire jumper across RADIAL SEL terminals.
- c. Install wire jumper between BINARY SEL OPT pads of assigned disk drive number. Typical connection shows drive number 6.



Later Production:

- a. Install components in the binary select option kit.
- b. Remove jumper assembly from RADIAL SEL terminals.
- c. Install jumper assembly on BINARY SEL terminals assigning desired address.

Radial Step (See Figure 3-19)

This option allows $\overline{\text{STEP}}$ and $\overline{\text{STEP IN}}$ commands to be accepted to position the read/write head without the drive being selected.

Note

This option can not be installed if the $\overline{\text{STEP}}$ I/O line is daisy-chained to two or more disk drives.

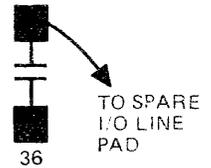
To install this option:

- a. Cut trace or remove wire jumper between vertical RAD STEP OPT pads.
- b. Install a wire jumper between the horizontal pads.



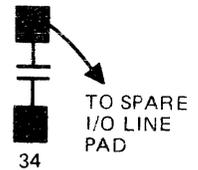
If more than one drive is configured in the system, only one drive may use J3, interface connector, pin 36 for its STEP line and each other drive must be assigned one of the spare I/O lines as follows:

- a. Cut trace or remove wire jumper between the vertical 36 pads.
- b. Install a wire jumper between the upper 36 pad and one of the spare I/O line pads



With the radial step option installed, the STEP IN line(s) may be daisy-chained or dedicated. If daisy-chained, the direction of movement of the R/W head in all drives is determined at the same time. To determine this for each individual drive, only one drive may use J3, interface connector, pin 34 for its STEP IN line and other drives must be assigned one of the spare I/O lines as follows:

- a. Cut trace or remove wire jumper between the vertical 34 pads.
- b. Install a wire jumper between the upper 34 pad and one of the spare I/O line pads.



Radial Ready (See Figure 3-14)

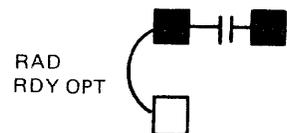
This option allows the ready status of the drive to be sent to the host controller without the drive being selected.

Note

This option can not be installed if the READY I/O line is daisy-chained to two or more disk drives.

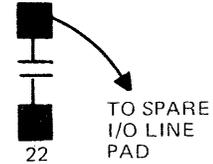
To install this option:

- a. Cut trace or remove wire jumper between RAD RDY OPT pads. (Horizontal pads on FDD 100-8B and vertical pads on 100-8C)
- b. Install a wire jumper between the vertical pads for the FDD 100-8B. (Horizontal pads for 100-8C)



If more than one drive is configured in the system, then only one drive may use J3, interface connector, pin 22 for its READY line and each other drive must be assigned one of the spare I/O lines as follows:

- a. Cut trace or remove wire jumper between the vertical 22 pads.
- b. Install a wire jumper between the upper 22 pad and one of the spare I/O line pads.



Radial Index/Sector (See Figures 3-12 and 3-14)

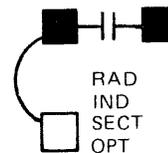
This option allows the INDEX and SECTOR pulses to be sent to the host controller whenever the unit is ready, without the drive being selected.

Note

This option cannot be installed if the INDEX and SECTOR I/O lines are daisy-chained to two or more disk drives.

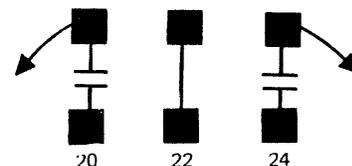
To install this option:

- a. Cut existing trace or remove wire jumper between horizontal RAD IND SECT OPT pads on FDD 100-8B (Vertical pads for 100-8C)
- b. Install a wire jumper between the vertical pads. (Horizontal pads for FDD 100-8C)



If more than one drive is configured in the system, then only one drive may use J3, interface connector, pin 20 for the INDEX line and pin 24 for the SECTOR line. Each other drive must be assigned one of the spare I/O lines as follows:

- a. Cut traces or remove wire jumpers between 20 and 24 pads.
- b. Install a wire jumper between the upper 20 pad and one of the spare I/O line pads.
- c. Install a wire jumper between the upper 24 pad and one of the spare I/O line pads.



Radial Head Load Option (See Figure 3-15)

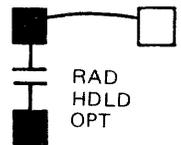
This option allows $\overline{\text{HDLD}}$ commands to be accepted to load the read/write head without the drive being selected.

Note

This option cannot be installed if the $\overline{\text{HDLD}}$ I/O line is daisy-chained to two or more disk drives.

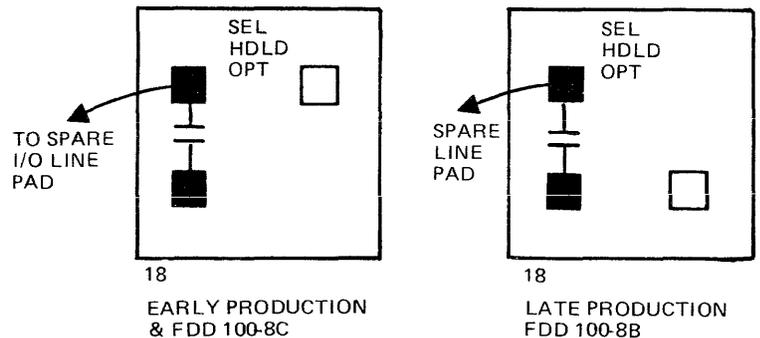
To install this option:

- a. Cut trace or remove wire jumper between vertical RAD HDLD OPT pads for the FDD 100-8D. (Horizontal for 100-8C)
- b. Install a wire jumper between the horizontal pads. (Vertical for 100-8C)



If more than one drive is configured in the system, only one drive may use J3, interface connector, pin 18 for its $\overline{\text{HDLD}}$ line, and each other drive may be assigned one of the spare I/O lines as follows:

- a. Cut trace or remove wire jumper between vertical 18 pads.
- b. Install a wire jumper between the upper 18 pad and one of the spare I/O line pads.

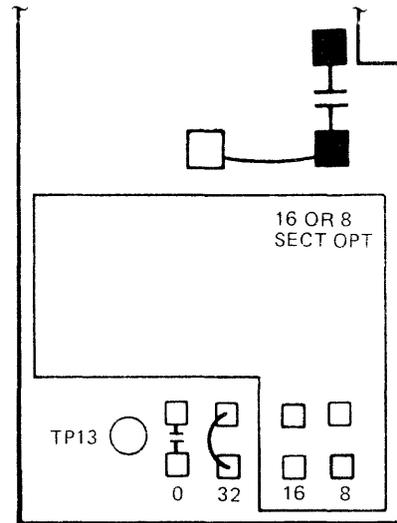


Hard Sector (See Figure 3-12)

The Hard Sector option allows the use of a 32-sector floppy disk. The 32 holes in the disk are sensed by the index hole photosensing circuit and are used to synchronize timing of write data assigned sectors of the disk.

To install the option:

- a. Install all components in Hard Sector Option Kit.
- b. Cut existing trace or remove wire jumper between vertical HARD SECTOR OPT pads. (SS pads on FDD 100-8C)
- c. Add wire jumper between the horizontal HARD SECTOR OPT pads. (HS pads on FDD 100-8C)
- d. Cut existing trace or remove wire jumper between pads 0.
- e. Install wire jumper between pads 32.



Auto Head Load Option (See Figure 3-15)

With the auto head load option installed, the read/write head is loaded as soon as the drive is selected. If automatic head loading is desired, install the option as follows:

- a. Cut trace or remove wire jumper between vertical SEL HDLD OPT pads.
- b. Add a wire jumper between the SEL HDLD OPT pads as shown on previous page.

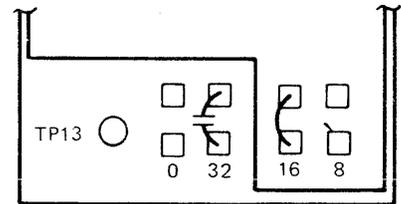
CAUTION

If the selected head load option is installed when the radial head load option is installed, the read/write head will be loaded whenever DC power is available to the drive.

16 or 8 Sector (See Figure 3-12)

The 16 or 8 Sector option allows the 32 sector pulses detected in the hard sector floppy disk, to be used for dividing down to 16 sectors or 8 sectors. The Hard Sector option must be previously installed. To install the Sector Select option:

- a. Cut existing trace or remove wire jumper between HARD SECTOR OPT pads 32.
- b. Install wire jumper between either 16 or 8 pads as desired.



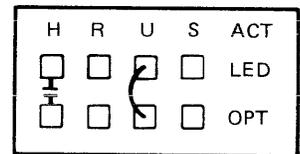
Activity Indicator Select (See Figure 3-14)

In the basic configuration of the disk drive, the front panel activity indicator is turned on when the read/write head is loaded. The purpose of the Activity Indicator Select option is to allow one of three additional uses for the indicator to indicate READY, SELECT or IN USE. Only one of these can be used at a time.

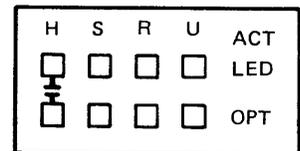
If the factory installed door lock option is installed (low profile units only) the door lock will be activated by the same signal activating the activity indicator.

Install the option as follows:

- a. Cut existing trace or remove wire between ACT LED OPT pads H (HDLD).
- b. Install a wire jumper across desired signal for activity indicator, as shown:
 1. R - READY
 2. U - IN USE
 3. S - SELECT



FDD 100-8B



FDD 100-8C

Note (See Figure 4-4)

Early production when IN USE is used, connect additional jumper from pin 2 of connector J3 to the U pads.

Later Production

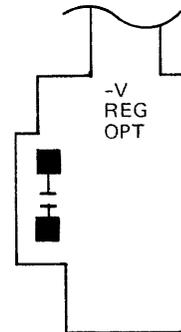
Connect to pin 16 of connector J3.

Negative Regulator (See Figure 3-39)

The disk drive logic operates from -5 volts $\pm 5\%$. If this voltage is not available the negative regulator option can be installed and the drive will operate from an unregulated -7 to -16 volt input.

To install this option:

- a. Install all components in the negative regulator option kit.
- b. Cut trace or remove wire jumper between regulator pads as shown.



FM Data Separator (See Figure 3-36)

This option is used to provide the controller with FM SEP DATA and FM SEP CLK signals from double-density FM encoding.

To install this option:

- a. Install all components in the FM Data Separator option kit.

INSTALLATION

The unit can be installed in any one of many positions, depending on operator access and available space: such as;

- Vertical - with access door opening to left or right
- Horizontal - with access door opening up
- Upright - with access door opening towards front or rear.

Mounting Dimensions

The disk drive outline and mounting dimensions are shown in Figure 1-6.



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