

**M222XD2 DISK DRIVES**  
**OEM MANUAL**

**FUJITSU LIMITED**  
*Communications and Electronics*  
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# CHAPTER 1 GENERAL

## 1.1 Introduction

The M222XD2 disk drive is a compact (3.5-inch micro-floppy size), and highly reliable fixed disk drive developed for random access file in small computers, word processors, and terminals.

The storage capacities (unformatted) of the M2225D2, M2226D2 and M2227D2 are 25.62MB, 38.43MB and 51.24MB respectively.

## 1.2 Features

### (1) Compact size

Since the disks are 95 mm (3.74 in) in outer diameter and are driven by a DC motor directly connected to the spindle, the unit is extremely compact in size: 101.6 mm (4.00 in) (width) × 41.3 mm (1.63 in) (height) × 146 mm (5.75 in) (depth).

### (2) Large capacity

Since four disks are assembled in the disk enclosure (DE), the maximum unformatted storage capacity is up to 51.24 megabytes.

### (3) High reliability

Heads, disks, and positioner are sealed to prevent contamination, and the air inside the DE is kept clean by a breather filter and recirculation filter. These features increase reliability by reducing the chance of contamination.

### (4) No preventive maintenance

Any preventive maintenance is not necessary.

### (5) DC power

Only DC voltages of +12 V and +5 V are required.

### (6) Vertical or horizontal installation

The drive may be installed in a system cabinet either vertically or horizontally, except the horizontal position with the PCA on top and the vertical position on end.



(7) Low power consumption

The power consumption is 7.5 W (Steady State). This low power consumption enables the drive to be used in a very wide environmental temperature range (5 to 45°C).

(8) Low noise

The drive's low noise output, approx. 43 dB (A-scale weighting) even during seeking, makes it ideal for office use.

(9) Low vibration

The drive has four rubber vibration isolators, which minimize the transfer of motion.

(10) Highly integrated electronics

Microprocessor, LSIs and surface mount technology are utilized for the PCA to achieve high reliability and high integration. Head IC is located on head arms to amplify the small signal. Read errors are reduced by increasing the signal to noise ratio.

## CHAPTER 2 SPECIFICATIONS

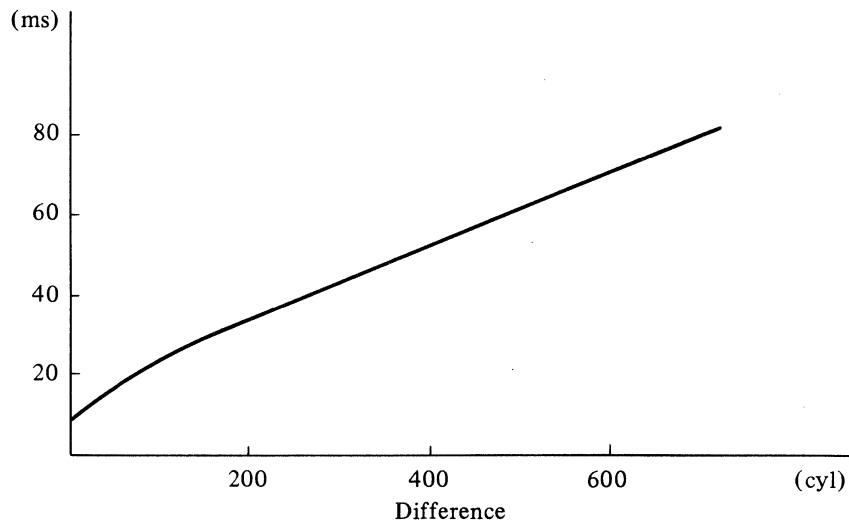
### 2.1 Functional Specifications

**Table 2.1 Functional specifications**

Specifications	Model	M2225D2	M2226D2	M2227D2
Total storage capacity				
Unformatted	(MB)	25.62	38.43	51.24
Formatted (*)	(MB)	20.15	30.22	40.30
Storage capacity/track				
Unformatted	(B)	10,416		
Formatted (*)	(B)	8,192		
Number of disks		2	3	4
Number of heads (R/W)		4	6	8
Number of cylinders		615		
Number of tracks/cylinder		4	6	8
Recording density	(BPI)	14,845		
Track density	(TPI)	834		
Transfer rate	(KB/s)	625		
Rotational speed	(rpm)	3,600		
Average latency time	(ms)	8.3		
Recording method		MFM		
Positioning time	Min (ms)	8		
	Ave (ms)	35		
	Max (ms)	75		
Input Voltage		+12 V±5% 0.45 A (max 2.3 A) + 5 V±5% 0.42 A		
External size				
Width × Height × Depth	(mm)	101.6×41.3×146 (W/O Panel dimension)		
Weight	(kg)	1.0		

(\*) 256 bytes/sector for 32 sectors/track

### 2.1.1 Positioning time



### 2.1.2 Start and stop time

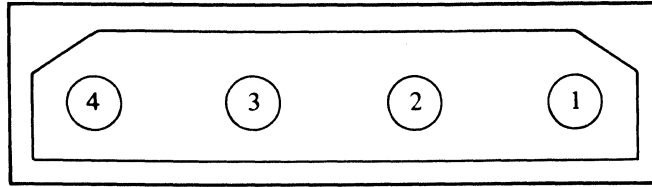
Start time (time from when power is turned on until the drive is ready) is 15 seconds or less and stop time (time to completely stop when power is turned off) is 25 seconds or less.

## 2.2 Environmental Conditions

Temperature	Operating	5°C to 45°C
	Non-operating	-40°C to 60°C
	Gradient	15°C/h or less
Relative humidity	Operating	20% to 80% RH
	Non-operating	5% to 95% RH
		No condensation
Vibration	Operating	Less than 0.2G (3 to 60 Hz) 2 min × 30 cycles (sinusoidal waveform)
	Non-operating (power-off state after installation)	Less than 0.4G (3 to 60 Hz) 2 min × 30 cycles (sinusoidal waveform)
Shock	Operating	Less than 3G (maximum 10 ms)
	Non-operating During transportation and storage	Less than 40G (maximum 10 ms)
Altitude above sea level	Operating	
	Non-operating time	12,000 m or below

## 2.3 Power Requirements

### (1) Power connector pin assignment



From cable side

1	+12 V
2	+12 V RTN
3	+5 V RTN
4	+5 V

### (2) Input voltage tolerance and current

	Input Voltage	Peak Current	Average Current
+12 V	+12 V $\pm$ 5%	2.3 A max. (at seeking)	0.45 A <sub>TYP</sub>
+5 V	+5 V $\pm$ 5%	–	0.42 A <sub>TYP</sub>

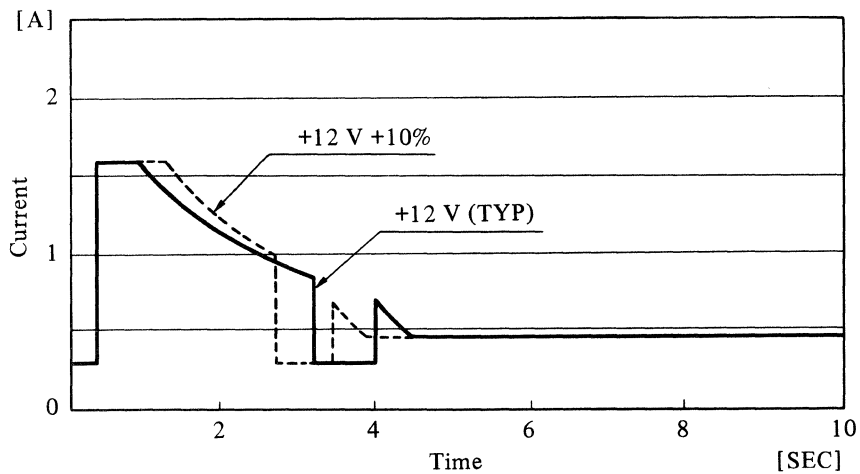
The above values are voltages at the power connector of the drive.

### (3) Power consumption

Steady state 7.5 W

### (4) Current waveform

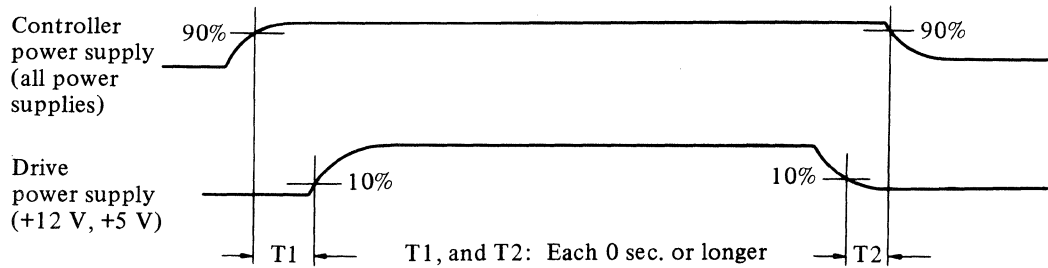
+12 V current waveform (for reference)



(5) Power on/off sequence

If the Write Gate signal from the controller is off before applying or removing power, the voltages (+12 V, +5 V) to the drive need not be sequenced. That is, recorded data will not be destroyed nor will mechanical or electric problems occur. To maintain the Write Gate signal in the off state at the time of drive power-on or -off, the basic sequence between the power supply of the controller and drive is as follows:

(a) Basic sequence



**Note:**

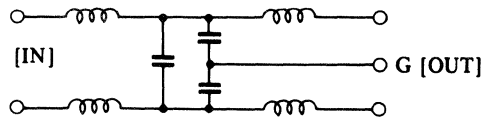
The power supplies of the drive (+12 V, +5 V) need not be sequenced.

(b) If the controller and the drive share a common supply and the Write Gate interface signal is determined only by +5 V, power sequencing is unnecessary. This is so because the +5 V level is monitored within the drive.

(6) Others

To eliminate AC line noise, a noise filter of the specifications given below should be incorporated in the AC input terminal of the drive power supply.

Attenuation characteristic; 40 dB or greater at 10 MHz  
 Circuit configuration; T type shown below is recommended.



## 2.4 Reliability

### (1) Mean Time Between Failures (MTBF)

The estimated MTBF of this drive during its life time is 30,000 hours after an initial 3-month period.

**Note:**

The MTBF is defined as follows.

$$\text{MTBF} = \frac{\text{Operating time (hours)}}{\text{The number of equipment failures from all field sides}}$$

Operating time is the total time duration during which the power is ON.

Failure of the equipment means failure that requires either repairs, adjustments, or replacement. Mishandling by the operator, failures due to bad environmental conditions, power trouble, controller trouble, cable failures, or other failures not caused by the equipment are not included.

### (2) Mean Time To Repair (MTTR)

MTTR is the average time taken by a well-trained service mechanic to diagnose and repair a unit malfunction. This drive is designed for a MTTR of 30 minutes or less.

### (3) Service life

Overhaul of this drive is not required for the first five years.

### (4) Power loss

Integrity of the data on the disk is guaranteed against all forms of abnormal DC power failure except a power failure during writing.

## 2.5 Error Rate

Errors detected upon initialization and replaced by an alternate record are not included in the error rate.

### (1) Recoverable error rate

A recoverable error is one which can be read correctly within 16 retries and should not exceed 10 errors per  $10^{11}$  bits read.

### (2) Non-recoverable error rate

Errors that cannot be recovered within 16 retries should not exceed 10 errors per  $10^{13}$  bits read.

(3) Positioning error rate

The rate of positioning errors recoverable by one retry is 10 errors or less per  $10^7$  seeks.

(4) Media error

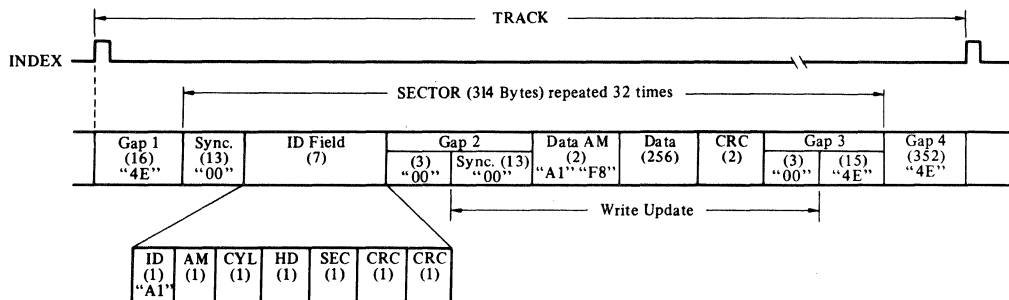
(a) Cylinder 0, Heads 0 ~ 7 are defect free.

(b) The number of defective sectors in the M222XD2 are as follows:

M2225D2 ..... maximum 25  
M2226D2 ..... maximum 38  
M2227D2 ..... maximum 51

## 2.6 Track Format

The track format is a soft sector method. The drives are shipped with the following format.



1. Track capacity = 10416 bytes (nominal)
2. Numbers in parentheses are bytes.
3. Numbers in quotes are the hexadecimal bit pattern.
4. When MSB of Head byte in ID field is "1", it indicates that this sector is the defective sector. (No defect will occur at HD0 to HD7 areas on Cylinder "0".)
5. The 2 LSB's of AM byte in ID field are used for Cylinder high.  
These values are:  
FE = 0 to 255 cylinders  
FF = 256 to 511 cylinders  
FC = 512 to 614 cylinders
6. Track capacity = 8192 bytes (256 bytes  $\times$  32 sectors)
7. Sector interleave factor is "4". Sequential ID Fields are sector numbered 0, 8, 16, 24, 1, 9, 17, 25, 2, 10, 18, 26, ... etc.
8. CRC Code  $X^{16} + X^{12} + X^5 + 1$
9. When shipped from the factory the data areas are all "0"s.
10. The "A1" pattern is made unique by violating the encode rules of MFM by omitting one clock bit. This marks the address mark pattern unique to any other serial bit combination that could occur on the track. See the following figure for make up of the "A1" byte.

	0		1		2		3		4		5		6		7	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
"A1" Data Bits	1		0		1		0		0		0		0		1	
"A1" Clock Bits	0		0		0		0		1		0		1		0	
Normal encoded pattern without dropped clock																
Encode pattern with dropped clock																



## CHAPTER 3 CONFIGURATION

### 3.1 Outer View

Figure 3.1 shows the outer view of this drive.

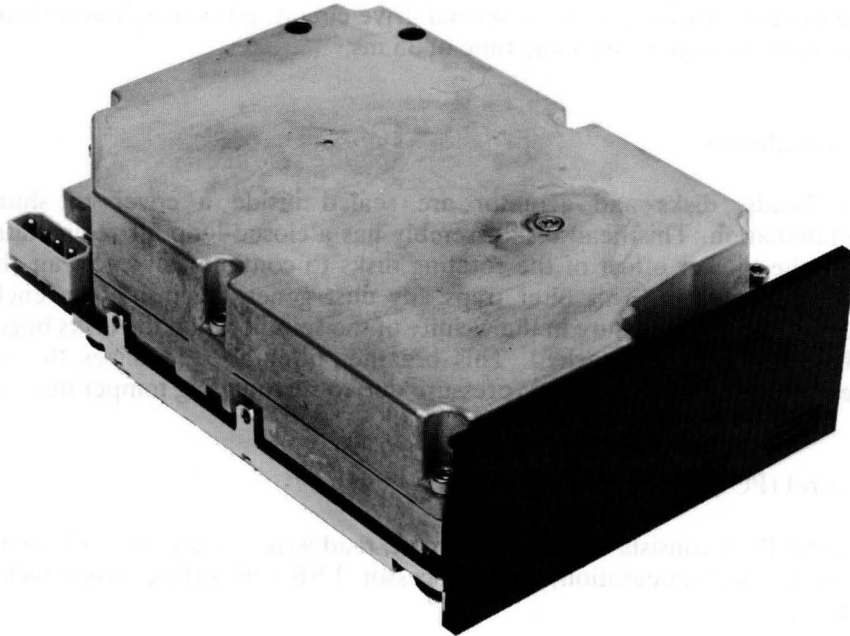


Figure 3.1 Outer view

### 3.2 Mechanical Configuration

This drive consists of disks, heads, spindle motor, actuator, cover, breather filter, recirculation filter, base, and control PCA.

#### (1) Disks

Disks are 95mm in outer diameter and 25mm in inner diameter. Durability is designed for over 10,000 starts and stops.

#### (2) Head

The heads are in contact with the disks when the disks are not moving, but automatically float when the rotation reaches a certain speed. The number of heads (R/W) is four in the M2225D2 and six in the M2226D2, and eight in the M2227D2.

(3) Spindle motor

The disks are turned by a direct-drive DC motor. The motor attains a very precise rotational speed: 3600 rpm,  $\pm 1\%$ . This precision is achieved through a feedback circuit which includes Hall IC mounted within the motor assembly.

(4) Actuator

This assembly consists of optical encoder motor, band actuator, and head arm.

The carriage working with the special drive circuit, gives increased reliability and a very short average positioning time of 35 ms.

(5) Air circulation

The heads, disks and actuator are sealed inside a cover to shut out any contamination. This head disk assembly has a closed-loop air recirculation system using the blower effect of the rotating disks to continuously cycle air through the recirculation filter. This filter traps any dust generated inside the enclosure. To prevent negative pressure in the vicinity of the spindle when the disks begin rotating, a breather filter is attached. This breather filter also equalizes the internal air pressure with the atmospheric pressure due to surrounding temperature changes.

(6) Control (PCA)

Control PCA consists of interface circuit, read/write circuit and seek control circuit. To realize high integration, microprocessor, LSIs and surface mount technology are utilized.

### 3.3 Cables

The recommended cable connector specifications are listed in Table 3.1.

**Table 3.1 Cable connector specifications**

Connector	Name	Spec. No.	Manufacturer
Cable A (34P)	Cable connector	FCN-767J034-AU/1 or 88373-3 or 3463-0001	FUJITSU AMP 3M
	Drive card edge	—	—
	Cable	455-248-34 or 171-34	SPECTRA-STRIP ANSLEY
Cable B (20P)	Cable connector	FCN-767J020-AU/1 or 88373-6 or 3461-0001	FUJITSU AMP 3M
	Drive card edge	—	—
	Cable	455-248-20 or 171-20	SPECTRA-STRIP ANSLEY
Power cable	Cable connector	1-480424-0	AMP
	Drive connector	68946	DUPONT
	Contact	170121-4	AMP
	Cable	AWG 18 ( +5 V, RTN) AWG 18 (+12 V, RTN)	—

# CHAPTER 4 INSTALLATION

## 4.1 Outer Dimensions

Figure 4.1 shows the outer dimensions and mounting dimensions. All dimensions are in millimeters.

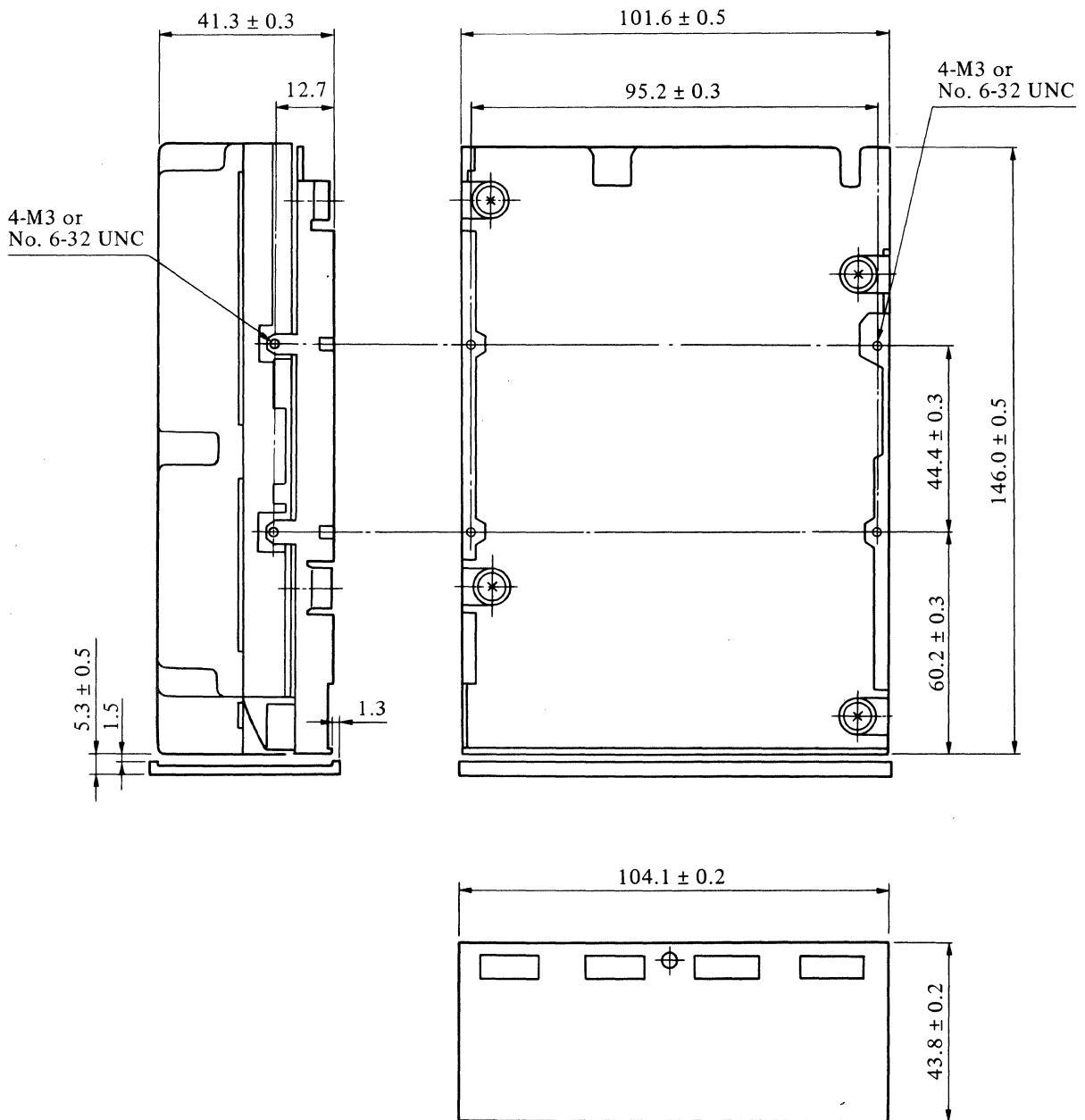


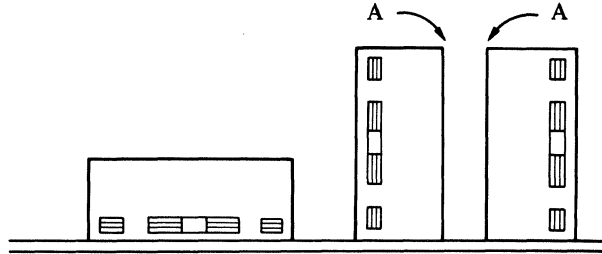
Figure 4.1 Outer dimensions

## 4.2 Notes on Installation

### (1) Installation direction

The drive may be installed as following figure. In this case, installation horizontal rate shall be within 20 degrees.

However, when inclines as the disk side comes lower side (direction of A), installation horizontal rate shall be within 5 degrees.

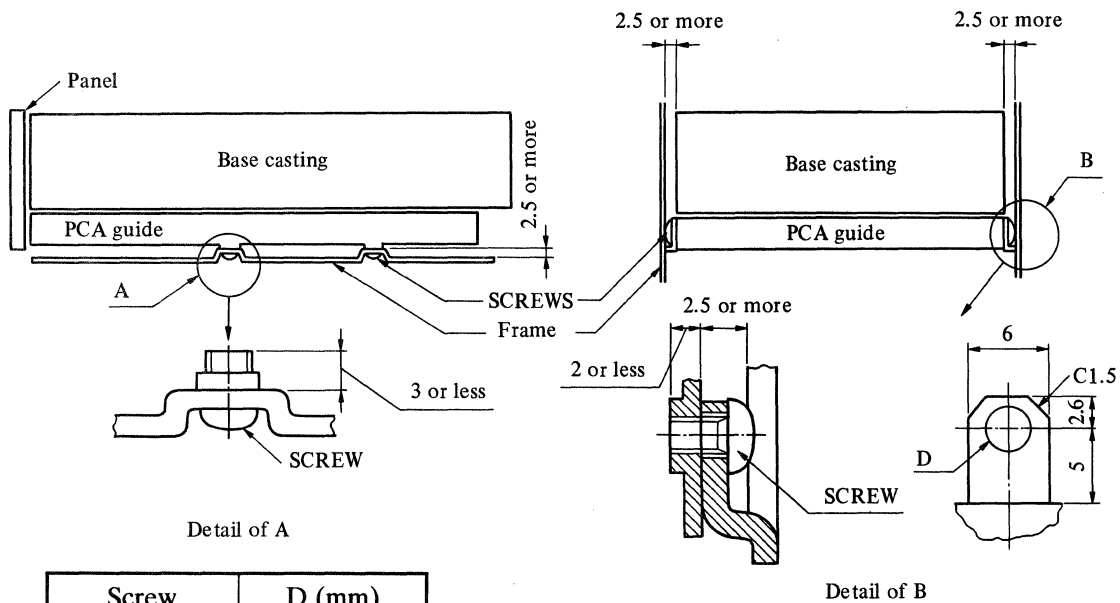


### (2) Frame structure

In case that the drive is fixed at bottom threads, embossed frame can be used as shown below (detail of A). However, when the drive is fixed at side threads, the frame should be designed according to detail of B as shown below.

#### CAUTION:

Screw length for fixing drive differs is mounting method, at bottom thread and side threads.



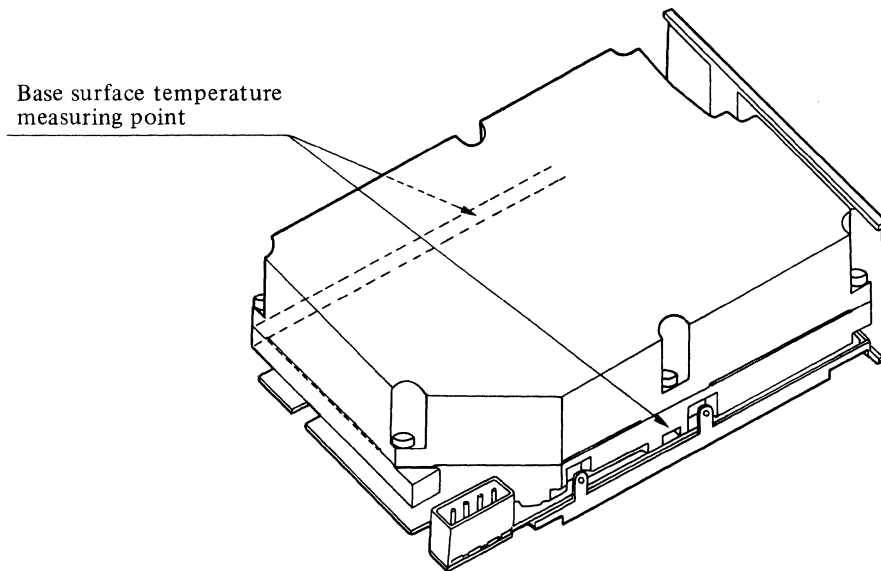
Screw	D (mm)
M3	$\phi 3.6$
No. 6-32UNC	$\phi 4$

(3) Ambient temperature

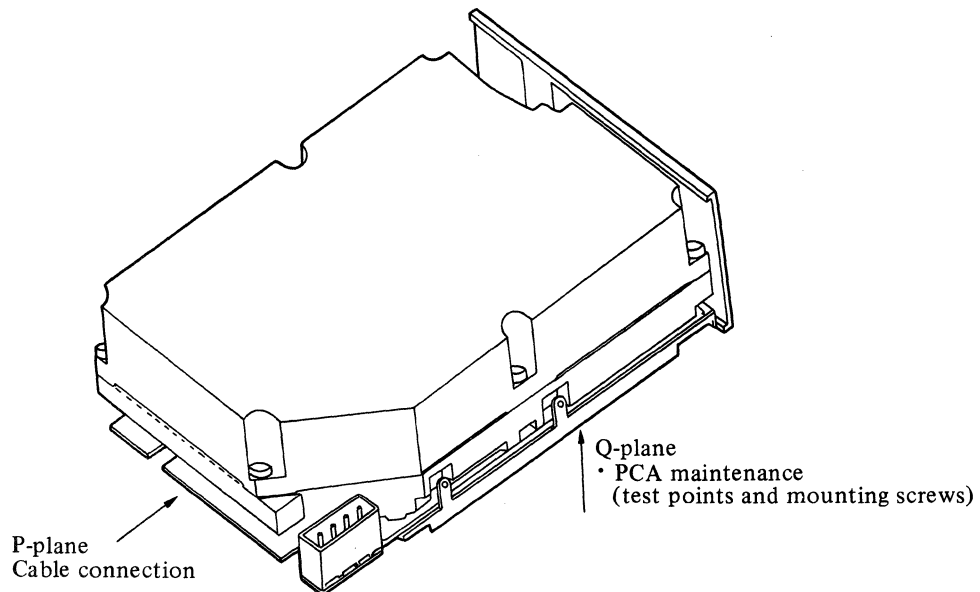
The operating temperature range of the drive is specified at a distance of 3 cm from the drive.

The operating temperature should not exceed 45°C with considering cooling air flow. To satisfy above condition, the base surface temperature under the Ready condition should not exceed 60°C.

The PCA should be cooled especially with proper air circulation in the cabinet.



(4) Service area

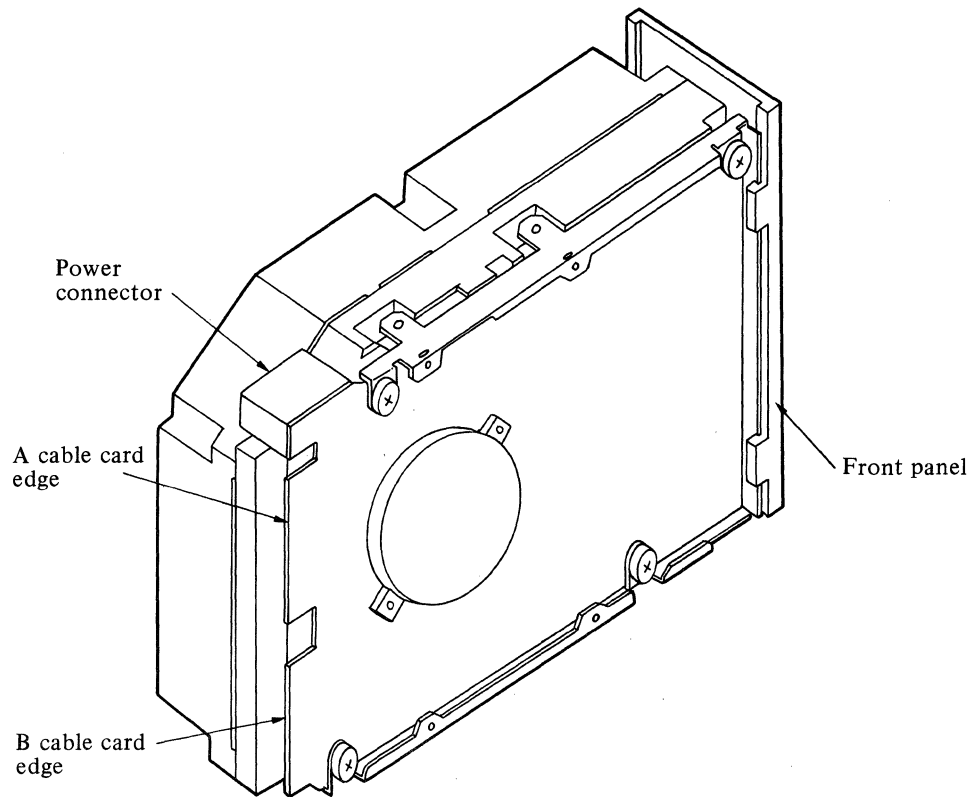


### 4.3 Cable Connection

The drive is interfaced to a system through three connectors.

#### 4.3.1 Drive connectors location

Figure 4.2 shows the location of A and B cable edge connectors and power connector.



**Figure 4.2 Drive connectors**

### 4.3.2 Connection

#### (1) Daisy chain connection

Connection of drive to its controller is shown in Figure 4.3. The A Cable (control signals) must be connected in series and the B Cable (R/W signals) in parallel. The termination of control signal must be performed only at the last drive.

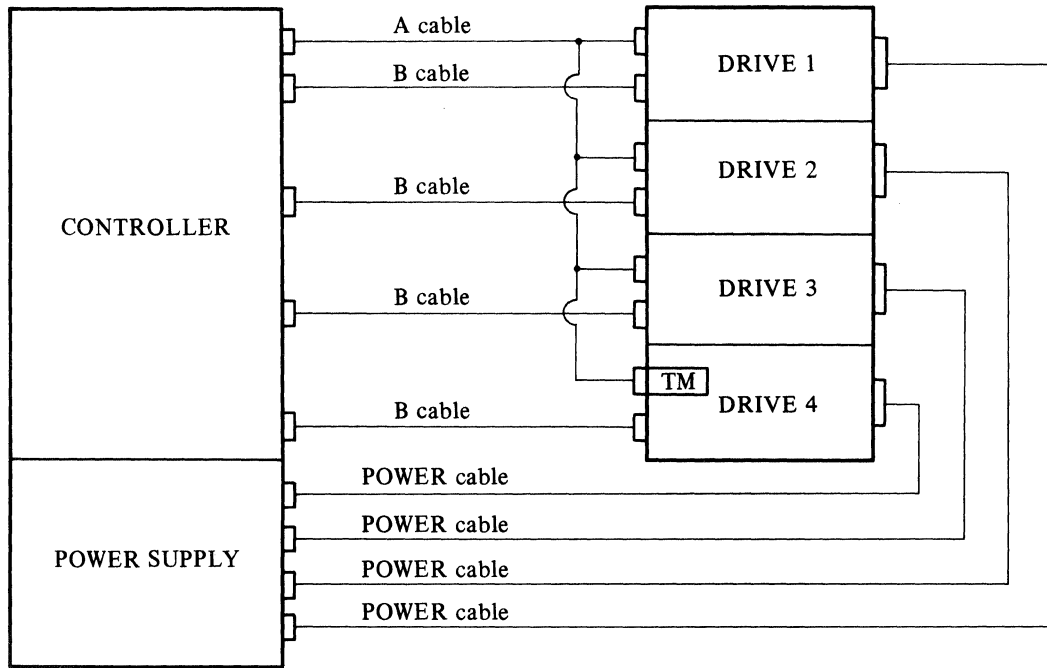


Figure 4.3 Daisy chain connection



(2) Radial connection

Connection of drive to its controller is shown in Figure 4.4. The A Cable (control signals) and the B Cable (R/W signals) must be connected in parallel. The termination of control signal must be performed at the all drives.

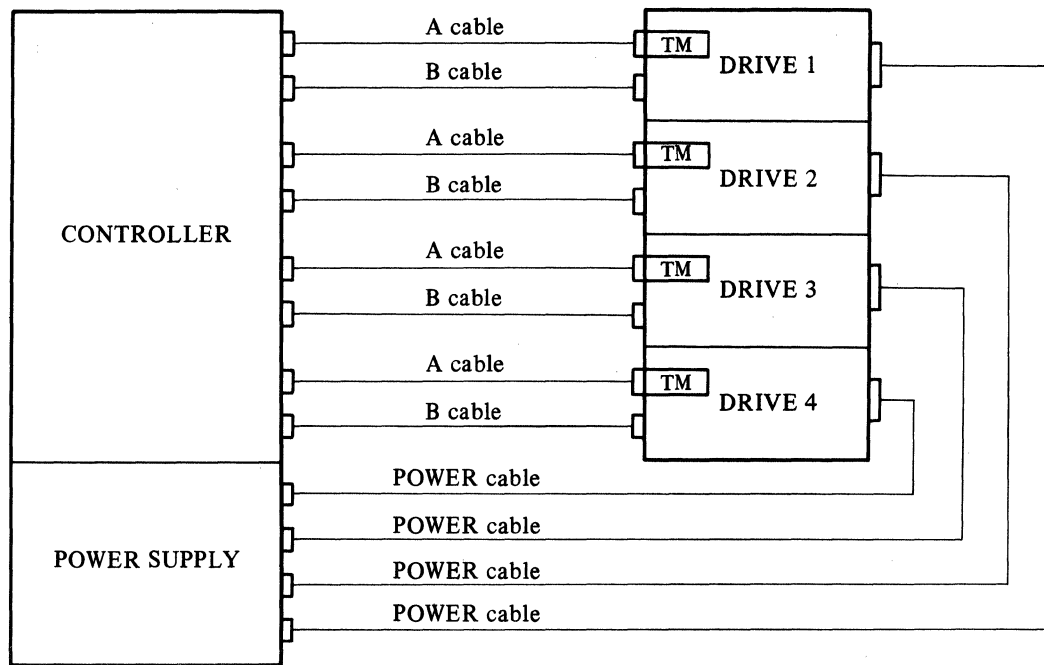


Figure 4.4 Radial connection

4.4 Driver/Receiver

The interface signals are terminated as in Figure 4.5. The total control cable length in a multi-drive configuration should not exceed the specification.

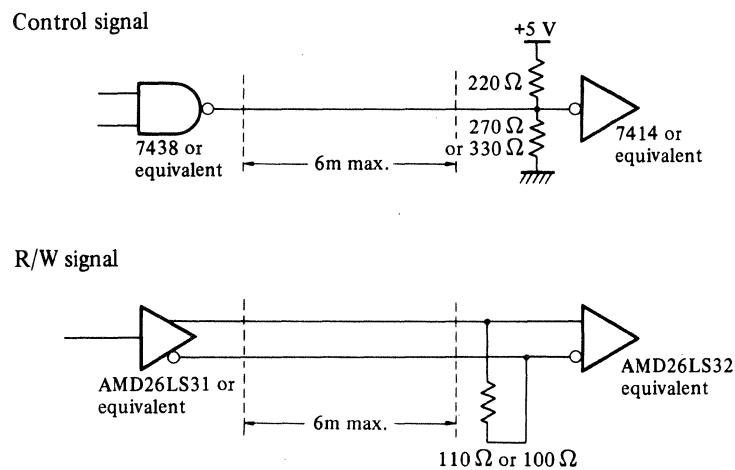
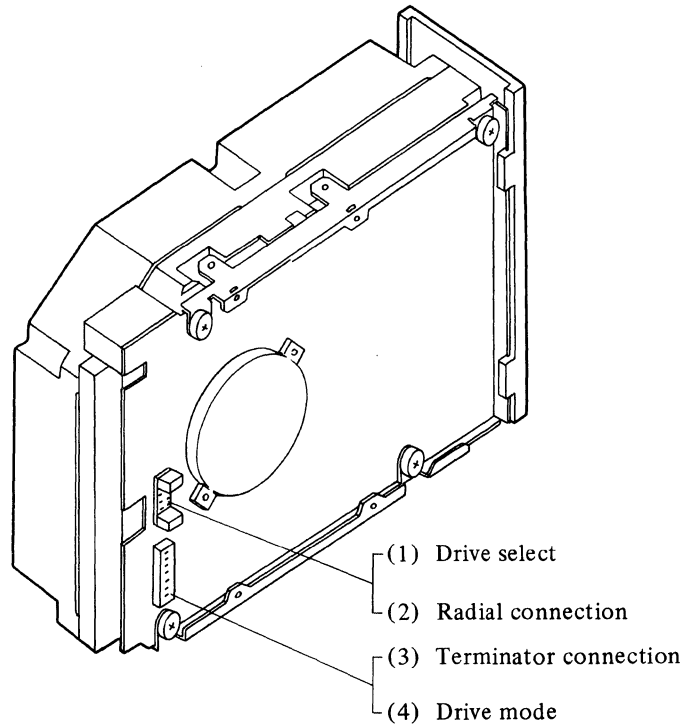


Figure 4.5 Driver/Receivers

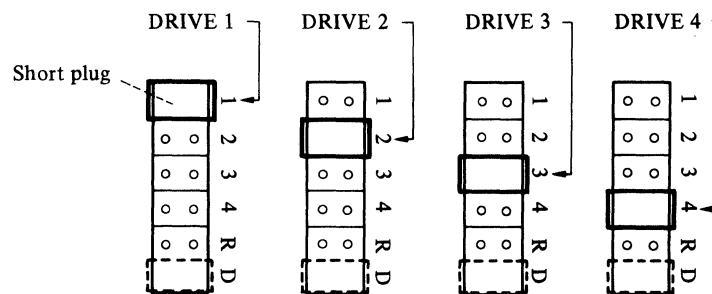
## 4.5 Switch Setting

The functions and assignment procedures of a switch are described below.



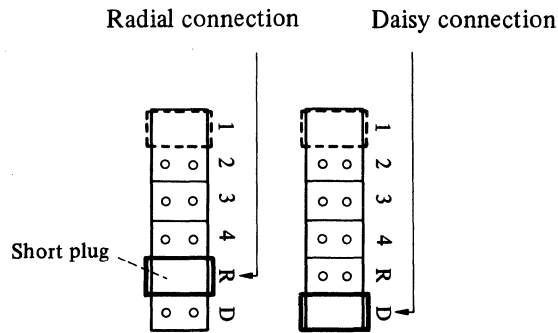
### (1) Drive select

Set one of the drive number (1 to 4) with the short plug as follows.



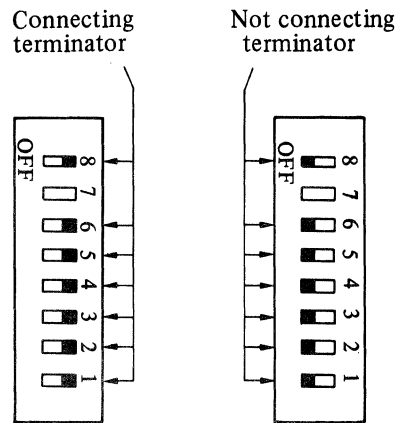
(2) Radial/daisy connection setting

Set either radial or daisy connection as follows.



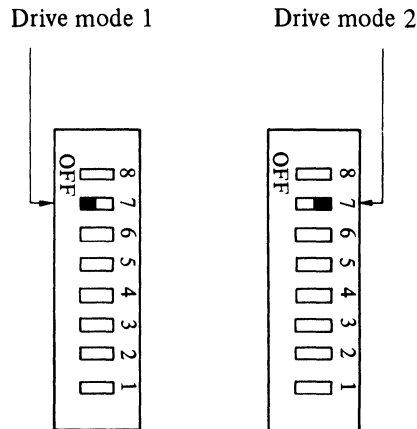
(3) Terminator connection

When all switches other than SW7 are set to ON, the terminator is connected.  
When all switches other than SW7 are set to OFF, the terminator is not connected.



#### (4) Drive mode selection

Drive mode 1 is selected to set SW7 to OFF and Drive mode 2 is selected to set SW7 to ON.



To keep the high positioning accuracy, this drive renews the positioning compensation data during the normal operation. This drive has two mode, Drive mode 1 and 2, for this operation.

##### ① Drive mode 1

Select Drive mode 1 when the function of the connected controller satisfies following two items.

- Read or Write operation instruction after Drive Select must be issued after confirming Seek Complete signal from the drive.
- Drive Select signal must be turned off when the drive is not accessed even if only one drive is connected.

For this mode, the drive renews the compensation data after Drive Select signal becomes false. During this operation, Seek Complete signal is false. Then the controller changes Drive Select signal to true, and the read and write operation is executed after Seek Complete signal becomes true.

##### ② Drive mode 2

When the controller does not have the function specified in ① above, select Drive mode 2.

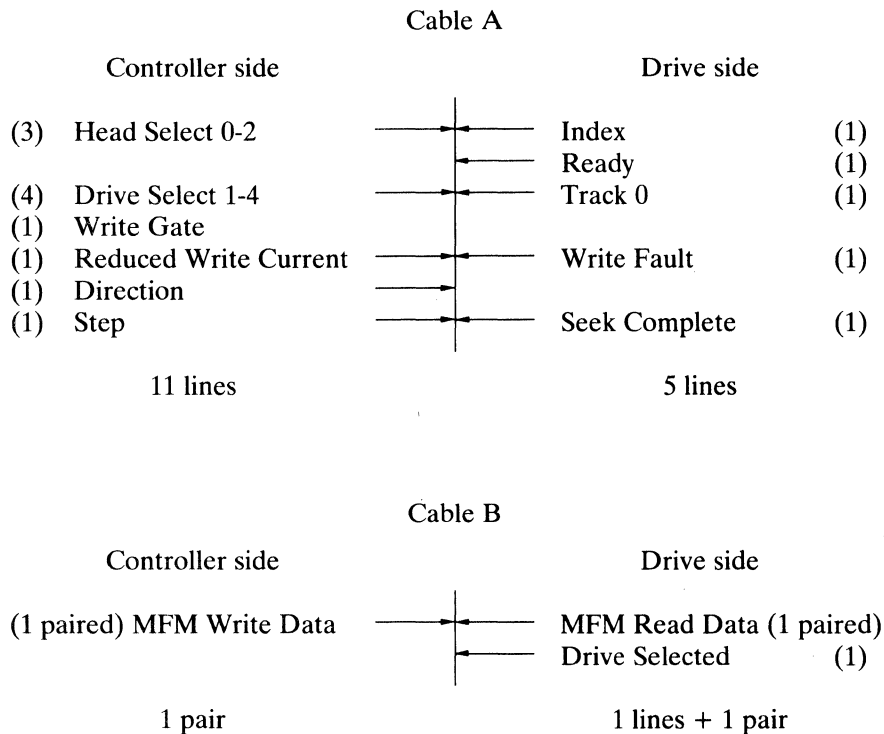
In this mode, when the drive detects the renewal requirement for the positioning compensation data, the drive stops to send data on 2/7 RD data line and waits the retry operation instruction (read retry and recalibration) from the controller, then executes the renewal operation at the recalibration operation. Seek Complete signal is in false state for 1 second maximum.

When the drive receives Seek command before executing the retry operation, the drive executes the renewal operation for the compensation data. In this case, Seek Complete signal is in false state for 1 second maximum.

## CHAPTER 5 INTERFACE

This chapter describes the physical and logical conditions of the signals transferred through the interface between the drive and the controller. The timing is specified at the driver/receivers of the drive.

### 5.1 Signal Lines



### 5.2 Input Signals

- (1) Head Select 0 to 2

These signal lines are used to select one of the data heads in the drive.

- (2) Drive Select 1 to 4

These signal lines are used to select from one of four drives in a multi-drive configuration and validate the input/output signals of the selected drive.

(3) Direction

This signal line is used to determine the seek direction of the data heads when the step pulses are sent to the disk drive. When this signal is true, seek is performed inward (away from Track 0); when false, seek is performed outward (toward Track 0).

(4) Step

This signal moves the data heads one track per pulse in the direction indicated by the Direction signal. These are two stepping modes as follows:

(a) Slave step mode

When the step pulse rate is between 5 kHz and 3 MHz, the seek operation does not commence until all the step pulses have arrived and responds with the Seek Complete signal after completing all seeks.

**Note:**

Step rates less than 5 kHz are prohibited.

(b) Return to zero mode

When 615 or more step pulses are issued in slave step mode, the data heads will move to Track 0.

(5) Write Gate

This signal line enables the write current to the selected data head in the drive. When this signal is false (logical "1"), the Read Data from the disk is transmitted to the interface.

(6) Reduced Write Current

This signal line is not used in this drive.

(7) MFm Write Data (balanced transmission)

This signal is a differential signal, and is used to determine the flux change point of the data bit written on the disk.

When +MFm Write Data goes more positive than -MFm Write Data while Write Gate is active, a flux change occurs.

During a Read, this signal should remain inactive (+MFm Write Data should be more negative than -MFm Write Data).

### 5.3 Output Signals

(1) Index

This is a pulse signal for every revolution of the disk in the selected drive.

(2) Ready

This signal is active or true when the voltages are within specification and the spindle motor has reached nominal speed. This signal is true approximately 15 seconds after power on.

(3) Track 0

This indicates the data head is stopped on track 0.

(4) Write Fault

This indicates that one of the following abnormal states occurred during writing.

(a) Either +5 V or 12 V dropped below specification.

(b) Write current was not applied to the head while Write Gate was enabled.

(5) MFM Read Data (balanced transmission)

This signal is a differential signal and is used to sent the Read Data bit from the disk to the host side. When the Write Gate is inactive, the point which indicates +MFM Read Data goes more positive than -MFM Read Data represents a flux reversal on the track of the selected head.

(6) Seek Complete

This indicates that the selected data head is positioned at the requested track. This signal includes the settling time of the head, and when it is true, read/write operations are enabled.

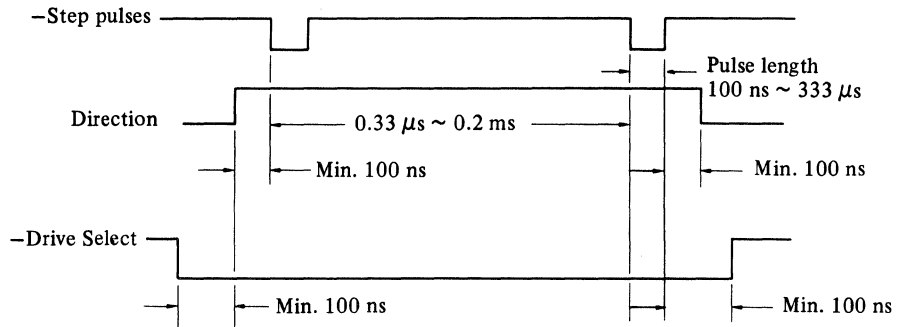
(7) Drive Selected

When the Drive Select 1-4 accords with the Drive Select Short Switch on the drive side, the drive is selected.

## 5.4 Timing Specifications

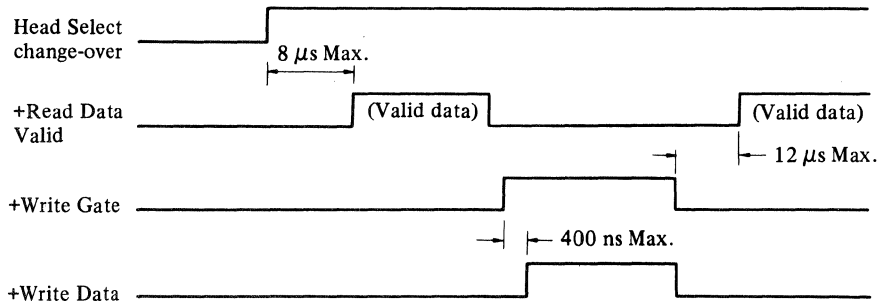
### 5.4.1 Seek timing

#### Slave step mode

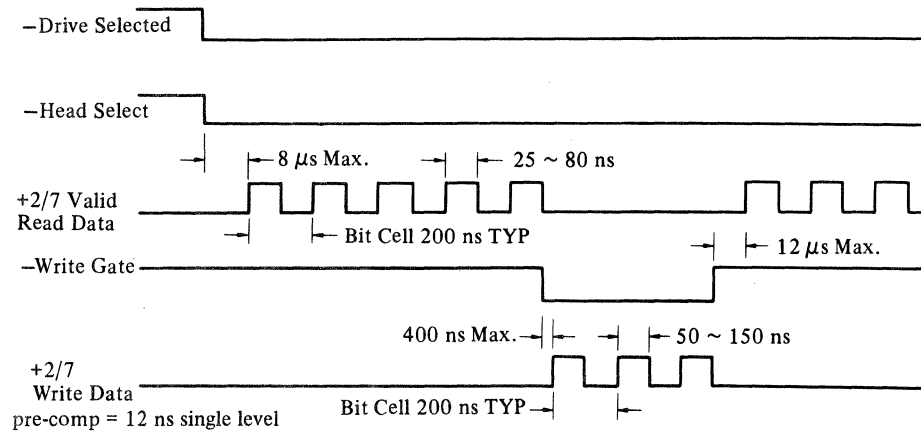


### 5.4.2 Write/Read Data timing

#### (1) Head change-over timing

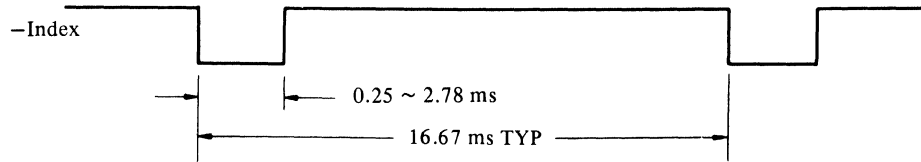


#### (2) Read/Write Data timing





### 5.4.3 Index signal timing



### 5.5 Connector Pin Assignment

#### "A" Connector (CNA)

1	GND	2	(- Reduced Write Current)
3	GND	4	- Head Select 2
5	GND	6	- Write Gate
7	GND	8	- Seek Complete
9	GND	10	- Track 0
11	GND	12	- Write Fault
13	GND	14	- Head Select 0
15	GND	16	(Reserved)
17	GND	18	- Head Select 1
19	GND	20	- Index
21	GND	22	- Ready
23	GND	24	- Step
25	GND	26	- Drive Select 1
27	GND	28	- Drive Select 2
29	GND	30	- Drive Select 3
31	GND	32	- Drive Select 4
33	GND	34	- Direction

**Note:**

The key slot is between pin 4 and 6.

## “B” Connector (CNB)

1	- Drive Selected	2	GND
3	(Reserved)	4	GND
5	(Spare)	6	GND
7	(Reserved)	8	GND
9	(Spare)	10	(Spare)
11	GND	12	GND
13	+ Write Data	14	- Write Data
15	GND	16	GND
17	+ Read Data	18	- Read Data
19	GND	20	GND

### Note:

The key slot is between pin 4 and 6.

### 5.6 Write Precompensation

Write precompensation is not necessary.