FUJITSU

M2247E/M2248E
M2249E

Disk Drives
Engineering Specification

REVISION RECORD

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CHAPTER 1 GENERAL DESCRIPTION

1.1 Introduction

The M2247/48/49E disk drives are compact (mini-floppy size), inexpensive, and highly reliable fixed disk drives developed for random access files in small computers, word processors, and terminals.

The storage capacities (unformatted) for the models are: 181.5 MB for the M2247E, 285.3 MB for the M2248E, and 389.0 MB for the M2249E.

The drive interface is an Enhanced Small Disk Interface (ESDI), with high data integrity and intelligent diagnostics. It has superior freedom in sending self-recognition data, and in structuring systems.

1.2 Features

(1) Compact size

Since the disks are 130 mm (5.12 in.) in outer diameter and are driven by a DC motor directly connected to the spindle, the drive is extremely compact in size:

146 mm (5.7 in.) (W) × 83 mm (3.3 in.) (H) × 203 mm (8.0 in.) (D)

(2) High speed positioning

Using a rotary voice coil motor for head positioning results in high speed positioning.

(3) High reliability

The Whitney-type heads, disks, and positioners are completely sealed in the disk enclosure (DE), which has breather and recirculation filters to keep the air clean, thereby increasing reliability and preventing head crashes.

(4) No preventive maintenance

(5) DC power

The direct-drive DC motor requires no adjustment for line frequencies (50 Hz/60 Hz) or input power voltages (100 V, 115 V, 220 V or 240 V).

(6) 5.25-inch mini-floppy disk drive size compatibility

Because its physical size is the same as that of a mini-floppy disk drive, this drive can replace a mini-floppy disk drive without cabinet redesign.

(7) Vertical or horizontal installation

The drive may be installed in its cabinet either vertically or horizontally. (See Section 4.2).

(8) Low power consumption

The power consumption is 38 W (typical). This low power consumption enables the drive to be used in a wide environmental temperature range (5°C to 45°C) without a cooling fan.

(9) Low noise

The drive's low noise output, approx. 45 dB (A-scale weighting) even during seeking, makes it ideal for office use.

(10) Low vibration

The drive has four rubber vibration isolators, which minimize the transfer of shock and vibration to the disk enclosure.

(11) LSI and microprocessor controlled

LSI integrated circuits and a microprocessor are used on the main printed circuit board to achieve high reliability.

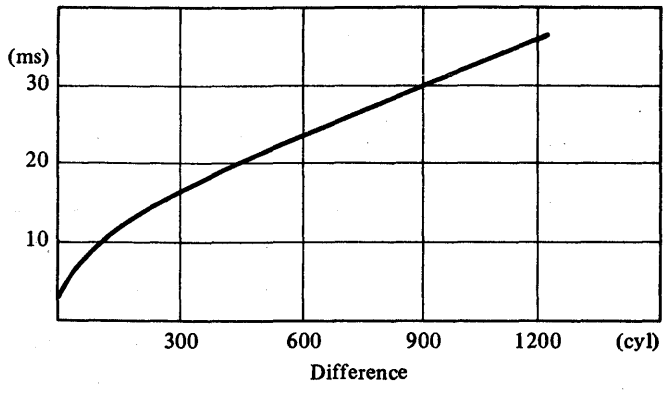
CHAPTER 2 SPECIFICATIONS

2.1 Functional Specifications

Specification \ Model	M2247	M2248	M2249
Total storage capacity			
Unformatted (MB)	181.5	285.3	389.0
Formatted*1	142.5	224.0	305.5
Storage capacity/track			
Unformatted (B)	20,864		
Formatted*1 (B)	16,384		
Number of disks	4	6	8
Number of heads (R/W)	7	11	15
Number of cylinders	1243	1243	1243
Number of tracks/cylinder	7	11	15
Number of sector	Selectable, 16 to 64		
Recording density (BPI)	19,295		
Track density (TPI)	1,267		
Transfer rate (KB/s)	1,250		
Rotational speed (rpm)	3,600		
Average latency time (ms)	8.3		
Recording method	RLL (1/7)		
Positioning time Min. (ms)*3	4		
Avg. (ms)	18		
Max. (ms)	35		
Input voltage*2	+12 V±5%, 2.5 A (max. 5.0 A) + 5 V±5%, 1.6 A		
Ripple*4	+5 V/+12 V, 50 mVp-p		
External size Width×height×depth (mm)	146 × 83 × 203 (146×83×208 with front protector installed) (150×86×208 with front panel installed)		
Disk size (mm)	Outer diameter 130, Inner diameter 40		
Weight (kg)	3.5		

*1 256 bytes/sector for 64 sectors
*2 Meets voltage tolerance for unit power supply connectors
*3 Including settling time
*4 High frequency noise 100 mVp-p max.

2.1.1 Positioning time



2.1.2 Start and stop time

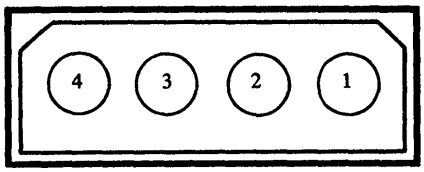
Start time (time from when power is turned on until the unit is ready) is 20 seconds or less, and stop time (time to completely stop when power is turned off) is 15 seconds or less using dynamic braking to prevent disk and head wear.

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 (max. wet bulb 29°C)
	Non-operating	5% to 95% RH (max. wet bulb 29°C) Moisture must not condense.
Vibration	Operating	Less than 0.2G (3 to 100 Hz) 2 min × 30 cycles (sinusoidal waveform)
	Non-operating (power-off state after installation)	Less than 0.4G (3 to 100 Hz) 2 min × 30 cycles (sinusoidal waveform)
Shock	Operating	Less than 2G (maximum 10 ms)
	Non-operating	Less than 20G (maximum 10 ms)
Altitude above sea level	Operating	0 m to 3,000 m
	Non-operating time	0 m to 12,000 m

2.3 Power Requirements

(1) Power connector pin assignment



View from cable side of connector

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

(2) Input voltage tolerance and current

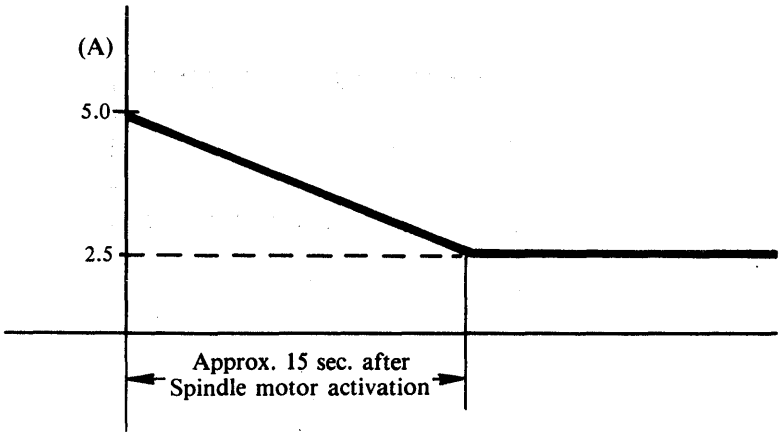
	Input voltage	Peak current	Average current
+12 V	+12 V ±5%	5.0 A	2.5 A
+ 5 V	+ 5 V ±5%	–	1.6 A

(3) Power consumption

Steady state 38 W

(4) Current waveforms

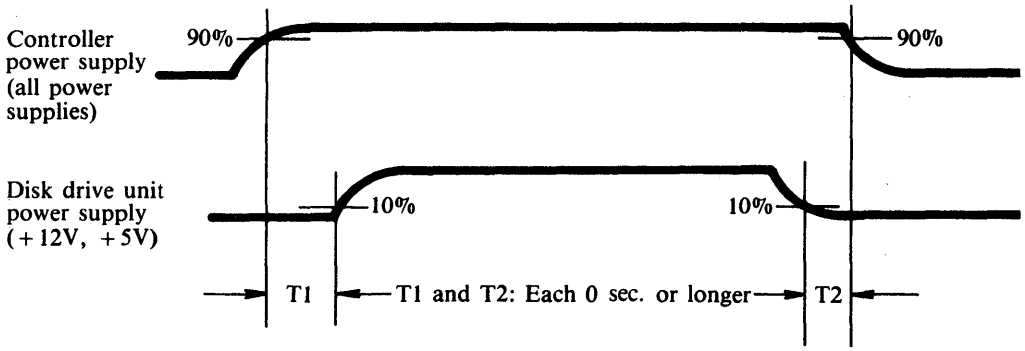
+12 V current waveform (for reference)



(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:

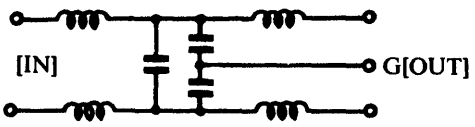
The power supplies of the drive (+12 V, +5 V) need not be sequenced in this case.

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 characteristics: 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 the drive during its life time is 30,000 hours after an initial 3-month period.

Note:

The MTBF is defined as follows.

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

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

Failure of the equipment means failure that requires 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 technician to diagnose and repair a drive malfunction. The drive is designed for a MTTR of 30 minutes or less.

(3) Service life

Overhaul of the 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. Refer to Section 2.3.5.

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 which can be read correctly within 16 retries should not exceed 10 errors per 10^{11} bits read.

(2) Non-recoverable error rate

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

(3) Positioning error rate

The rate of positioning error recoverable by one retry is 10 or less per 10^{7} seeks.

(4) Media defects

a. Cylinder 0, Head 0 and 1 are defect free.

M2247E ... 180 or Less (48 per Surface)
M2248E ... 280 or Less (48 per Surface)
M2249E ... 380 or Less (48 per Surface)

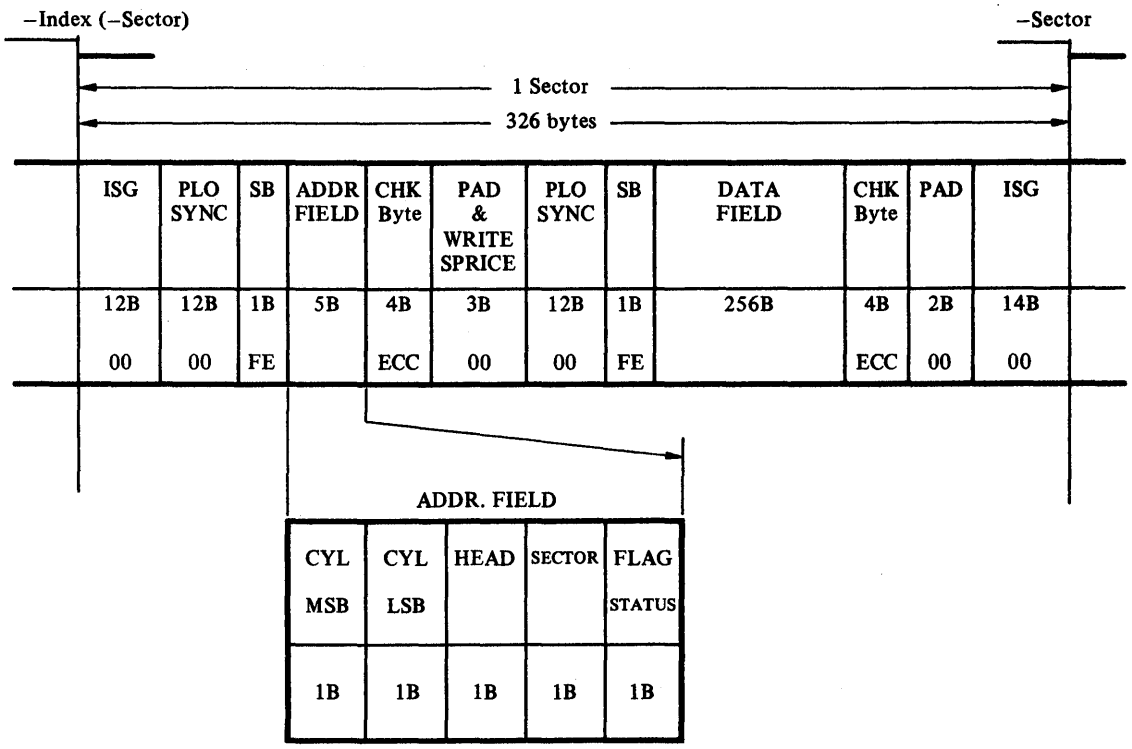
c. The maximum defect length is 32 bytes.

d. All defects are recorded on a label and on the media per the ESDI specification. (See Section 2.7.)

2.6 Data Format

There are two types of data format–fixed length sector format and soft sector format. Recommended formats are given below.

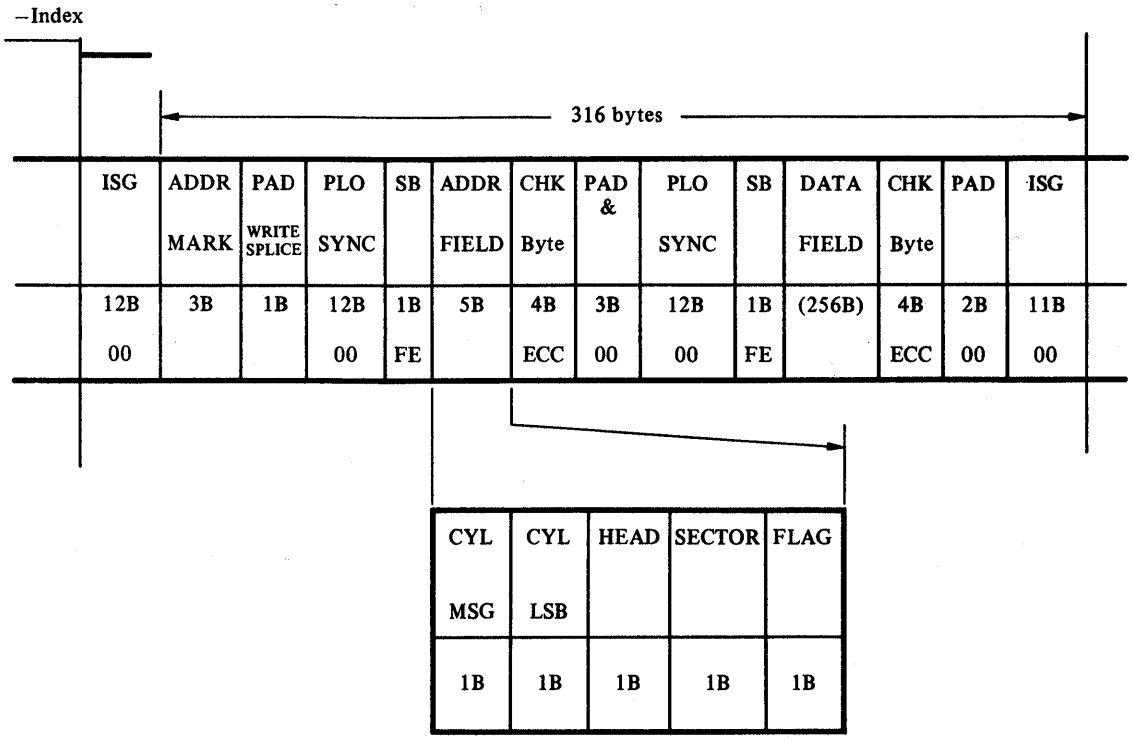
2.6.1 Fixed length sector format



Notes:

1. The above formats are for 64 sectors/track.
2. The PLO sync field and Inter Sector Gap (ISG) byte numbers are given by the Request Configuration command.
3. All byte numbers other than for the address field are minimum numbers.

2.6.2 Soft sector format

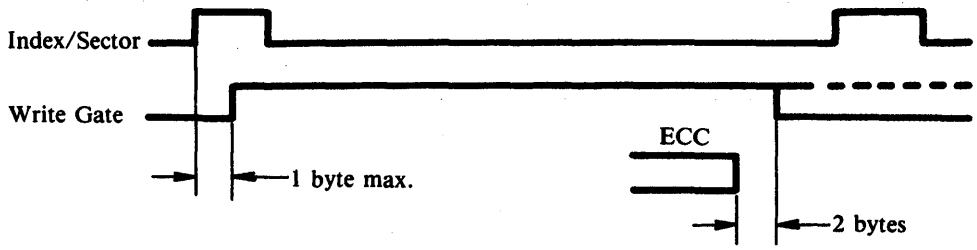


Notes:

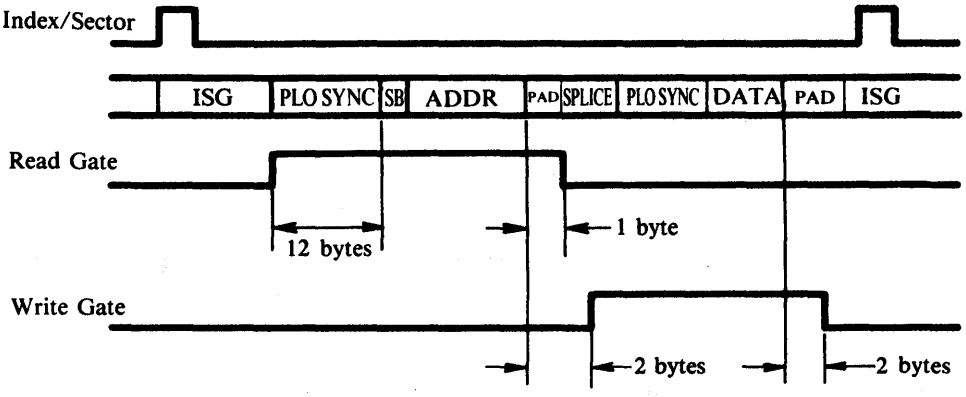
1. The PLO sync field and ISG byte numbers are given by the Request Configuration command.
2. The data field is specified by the controller.
3. All byte numbers other than for the address field are minimum numbers.

2.6.3 Fixed length sector read/write timing

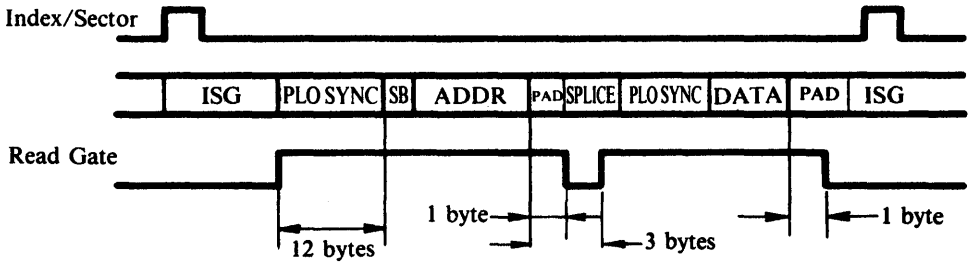
(1) Format Write



(2) Data Write

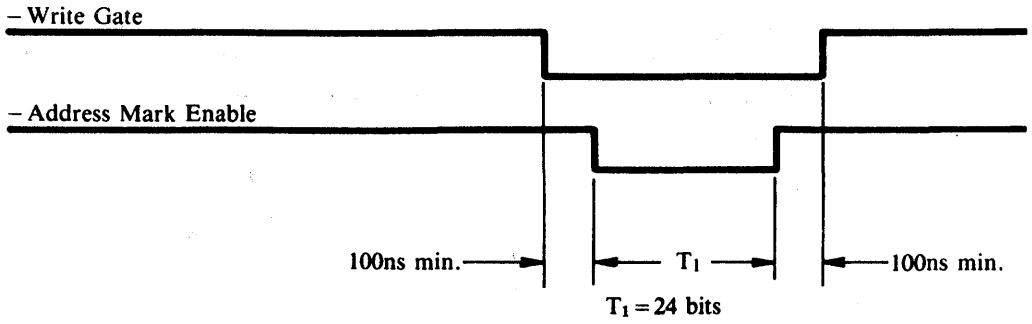


(3) Data Read

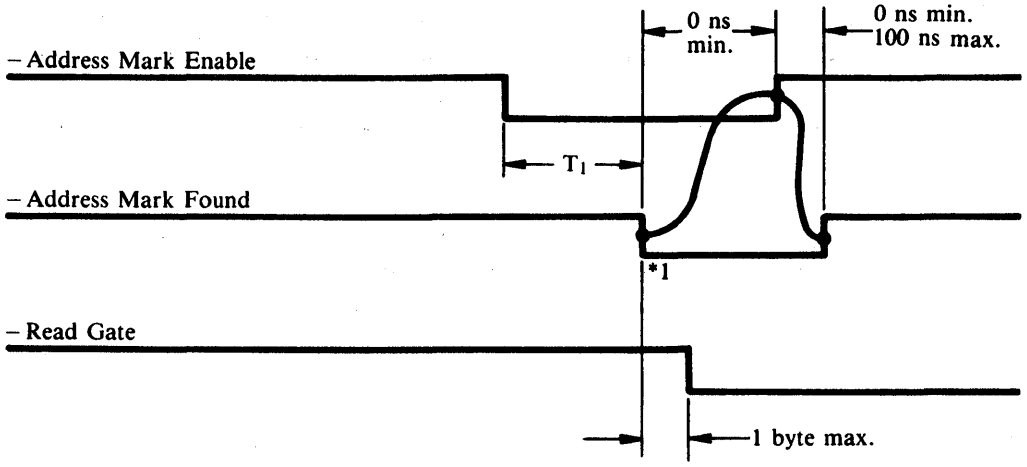


2.6.4 Soft sector read/write timing

(1) Address Mark Write



(2) Address Mark Read



T_1: 24 bit times minimum

*1: Shows the last position of the address mark

2.7 Media Defect List Format

When the unit leaves the factory, a printed media defect list for each drive is sent with it. This information is also written into the media. Formats are described below.

2.7.1 Defect list (Hard copy)

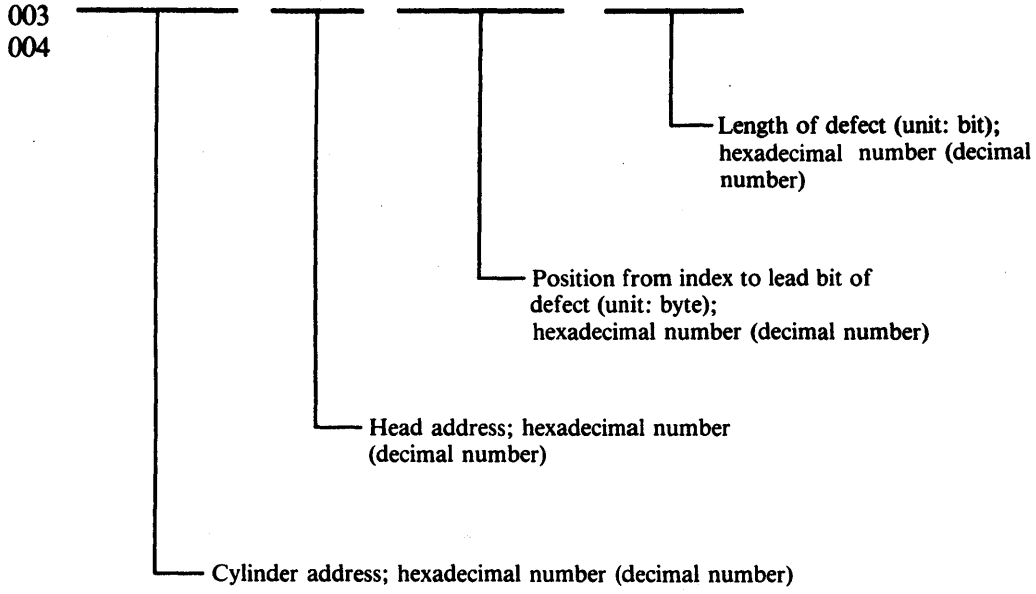
The example below shows the printed format for a defect list attached to a drive.

* * * MEDIA DEFECT LIST * * *

DATA: 87/6/1 PAGE 1

MODEL: M2249E SERIAL NO: J2101 DE NO: 003041

NO	CYLINDER	HEAD	POS/BYTES	LEN/BITS
001	00EB(0235)	00(00)	009F(00159)	008(0008)
002	0115(0277)	03(03)	0120(00288)	00B(0011)
003				
004				



2.7.2 Defect list (written on the media)

The drive defect data is written in a specified position in the media in the format standardized by ESDI. The defect list format is different from that of the data area.

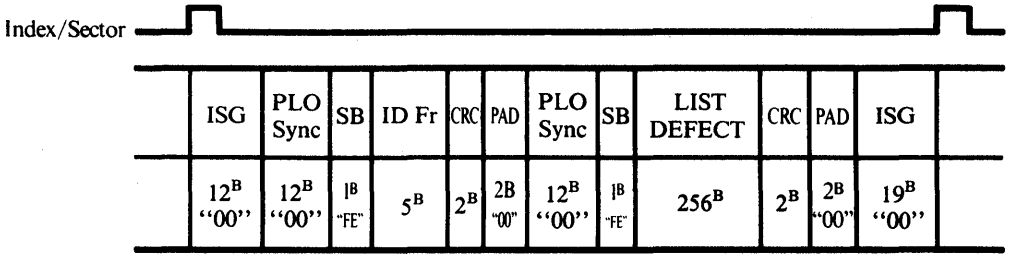
(1) Cylinder address

The same defect list is recorded on cylinders 1234 and 1242.

(2) Track format

Defect data for each surface is written into the respective defect list track. There are 64 sectors in one track, all containing the same information.

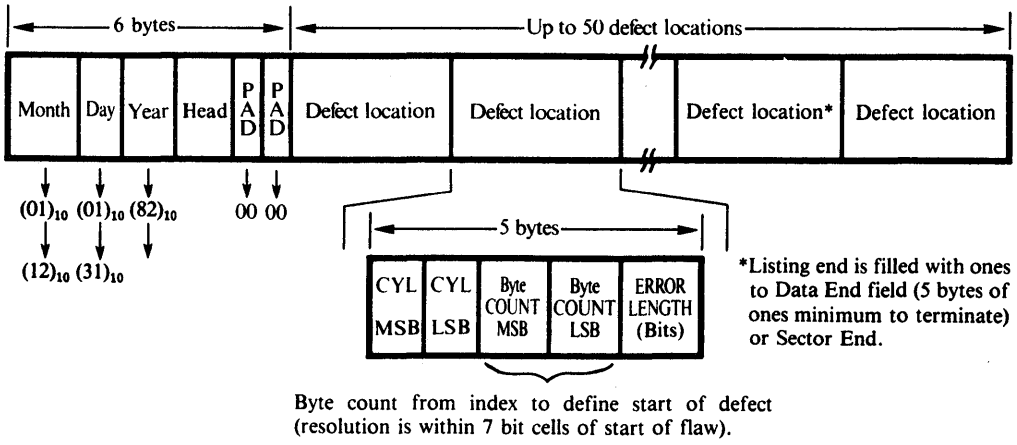
(3) Sector format



1. CRC = $X^{16} + X^{12} + X^5 + 1$ (includes sync byte; initial value = 00)

2. ID flag byte is 00.

(4) Defect data format



Note:

The fields for Month, Day and Year are represented as unsigned binary values i.e. 01−12=01−0C, 01−31=01−1F.

CHAPTER 3 CONFIGURATION

3.1 Mechanical Configuration

Figure 3.1 shows the outside view of the drive. The drive consists of disks, heads, spindle motor, actuator, cover, breather filter, recirculation filter, base, Read/Write preamplifier (PCB), and control (PCB).

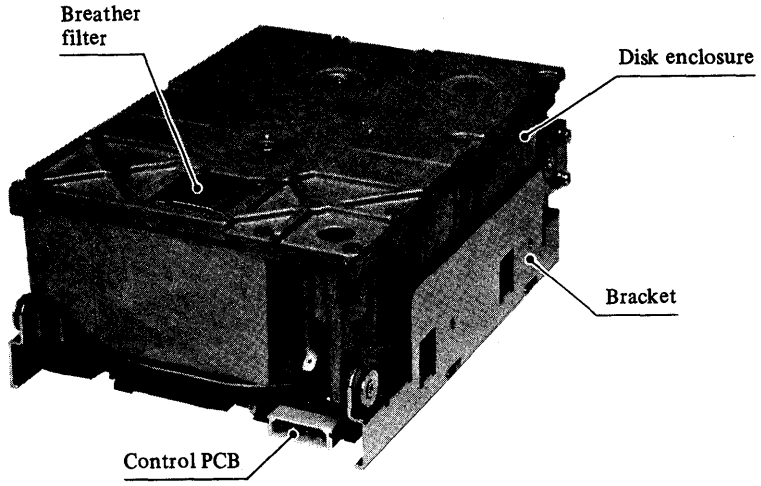


Figure 3.1 Outside view

(1) Disks

The Winchester-type disks have an outer diameter of 130 mm and inner diameter of 40 mm, and are coated with a special lubricating material. The M2247 uses four disks; the M2248, six; and the M2249, eight. The disks are good for at least 10,000 starts and stops.

(2) Heads

The Whitney-type contact start/stop heads are in contact with the disks when the disks are not moving, but automatically float when the rotation reaches nominal speed. There are 7 read/write heads in the M2247, 11 in the M2248, and 15 in the M2249. The drive has a prewritten servo pattern for head seek control and for obtaining read/write control information.

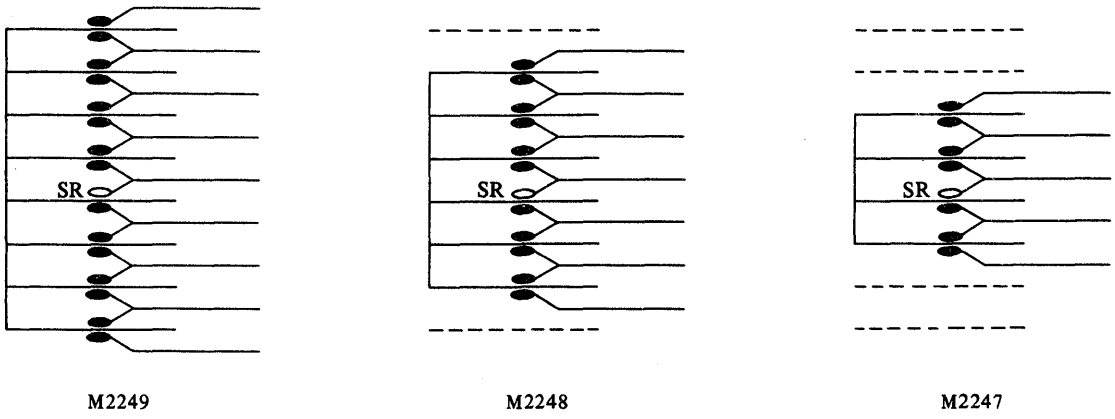


Figure 3.2 Disk/head configuration

(3) Spindle motor

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

(4) Actuator

The actuator, which has a rotary voice coil motor (VCM) structure, consumes little power and generates little heat. The head assembly on the tip of the actuator arm is controlled by electrical feedback from servo information read out through the servo head. Servo information is used as a control signal activating the actuator. It is used as track crossing information in positioning, and track following information during data write/read.

(5) Air circulation

The heads, disks, and actuator are sealed inside a cover to keep out dust and other pollutants.

This head 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) Read/write circuit

The read/write circuit uses LSIs and head ICs to prevent errors caused by external noise, and to increase data reliability.

Controller load is reduced and controller design made easier by the on-board VFO circuit and RLL data modulation circuits.

(7) Servo circuit

The positioning and speed of the voice coil motor is controlled by the closed loop servo method, which performs feedback control based on servo information recorded on the servo surface.

(8) Spindle motor driver circuit

This circuit controls the rotational speed by comparing the output frequency of the Hall elements from the motor with the standard frequency generated by the crystal oscillator, so the rotational variation is very low.

3.2 Cables

The recommended cable connector specifications are listed in Table 3.1.

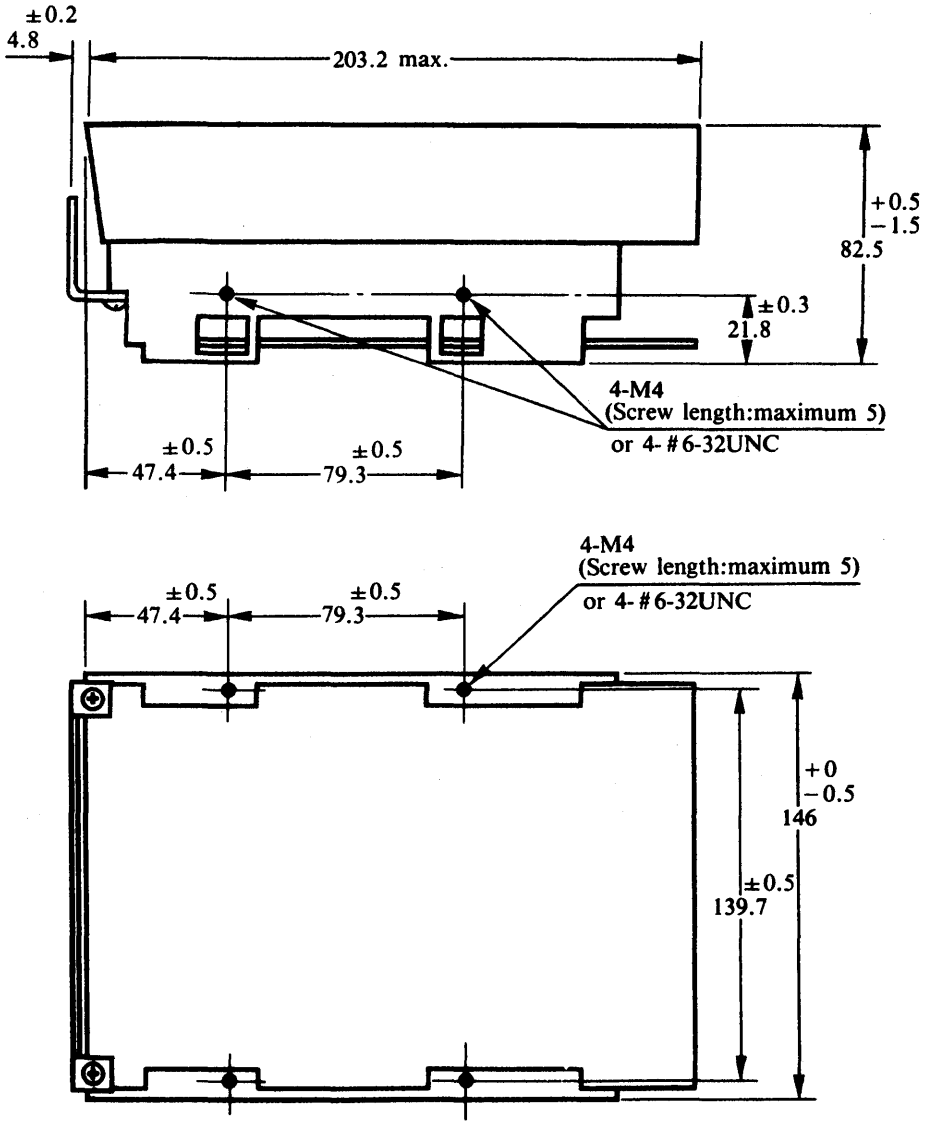
Table 3.1 Cable connector specification

Connector	Name	Spec. No.	Manufacture
A cable (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
B cable (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	69338-01	BERG
	Contact	170121-4	AMP
	Cable	AWG 18 (+ 5V, RTN) AWG 18 (+12V, RTN)	–
SG cable	Fasten receptacle for cable side	62187-1	AMP
	Fasten tab for the drive	61761-2	AMP
	cable	AWG 20	

CHAPTER 4 INSTALLATION

4.1 Outer Dimensions

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

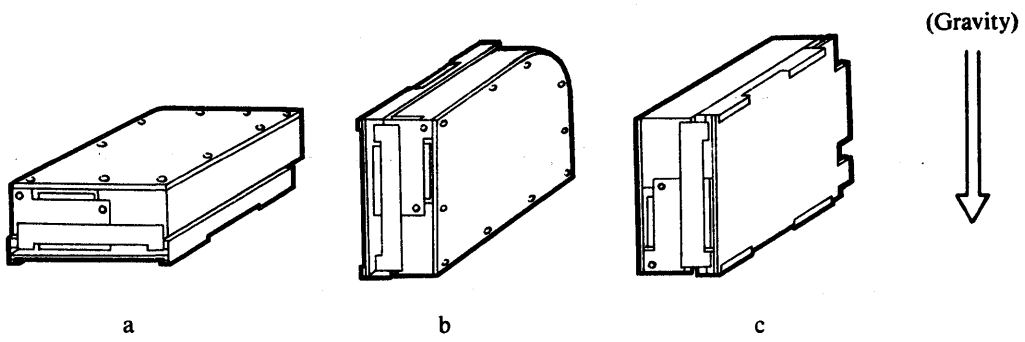


* Front panel is option.
* Different mounting dimensions may be specified for the front panel.

Figure 4.1 Outer dimensions

4.2 Notes on Installation

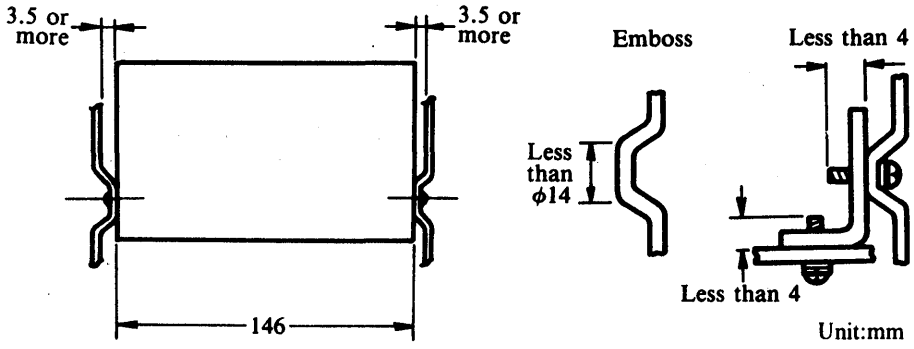
(1) Installation direction



There are three possible installation directions, and the mounting angle must be ±5° from the horizontal.

(2) Frame structure

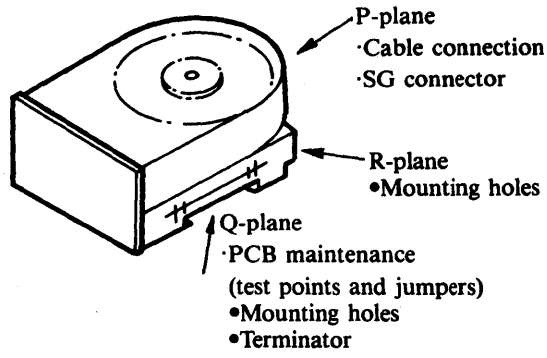
The casting/HDA (signal ground) is electrically isolated from the mounting brackets (frame ground). If this isolation is to be maintained within the system, precautions must be taken. An embossed structure (or any other structure that does not touch the aluminum base) as shown below should be used to prevent the aluminum base from touching the frame ground (FG). The mounting screws should project no more than 4 mm from the outer wall of the drive mounting bracket.



(3) Ambient temperature

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

(4) Service area



4.3 Cable Connection

4.3.1 Drive connectors location

As shown in Figure 4.2, the A and B cable edge and power connectors are accessed at the bottom rear of the drive, and the SG connector at the bottom of the base.

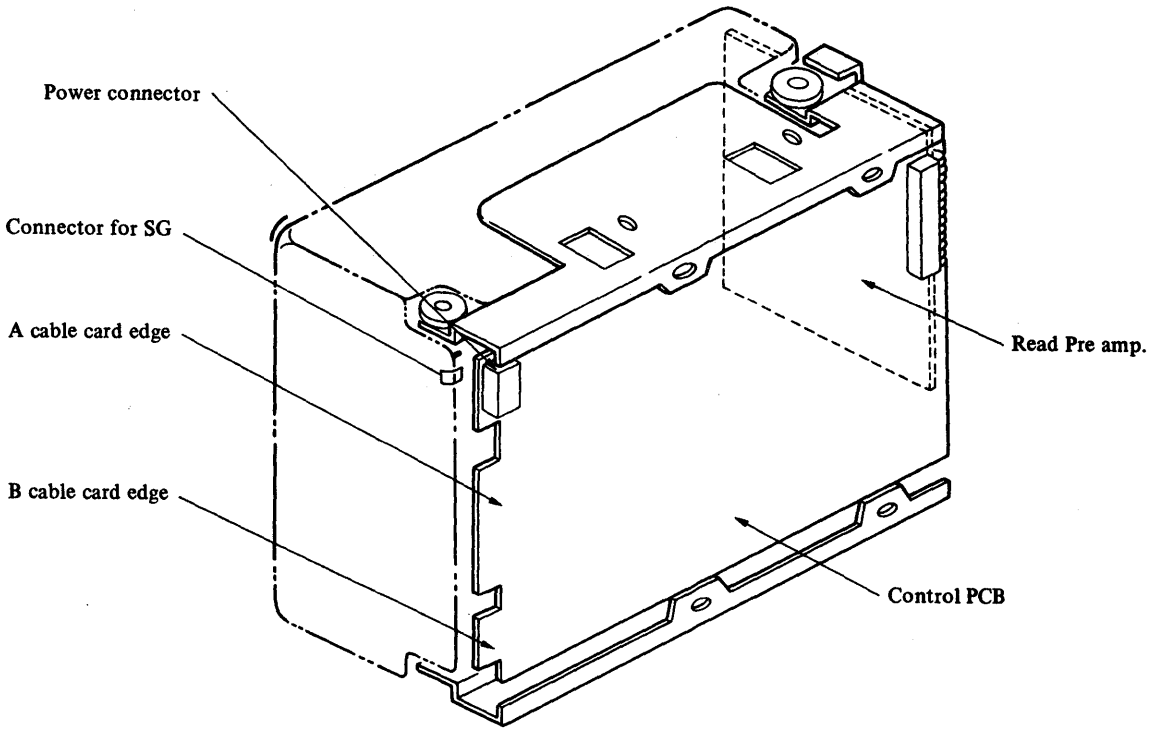


Figure 4.2 Drive connectors

4.3.2 Connection

Connection of drives to a controller is shown in Figure 4.3. In serial mode, up to 7 drives can be connected. To connect drives, the A cable (control signals) must be connected in series and the B cables (R/W signals) in parallel. The termination of control signals must be performed only at the last drive. The terminator must be removed from all but the last drive. See Figure 4.2 for terminator location.

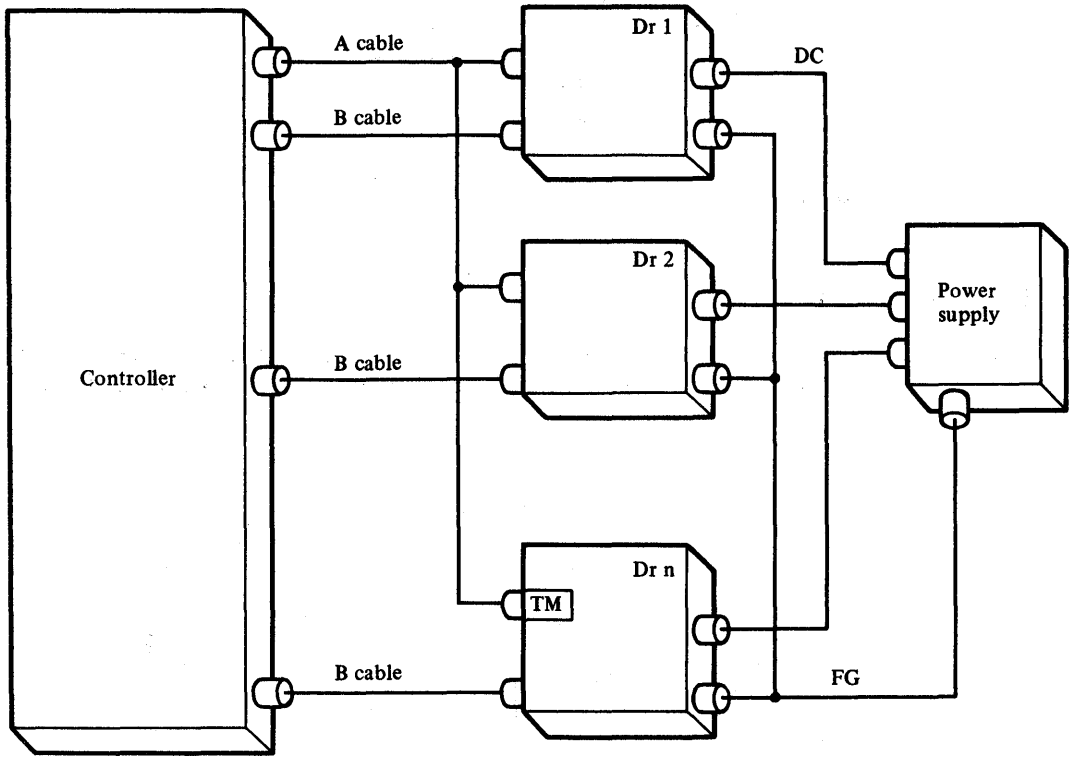


Figure 4.3 Multi-drive connection

4.4 Driver/Receiver

The interface signals are terminated as in Figure 4.4. The total control cable length in a multi-drive configuration should not exceed the specification.

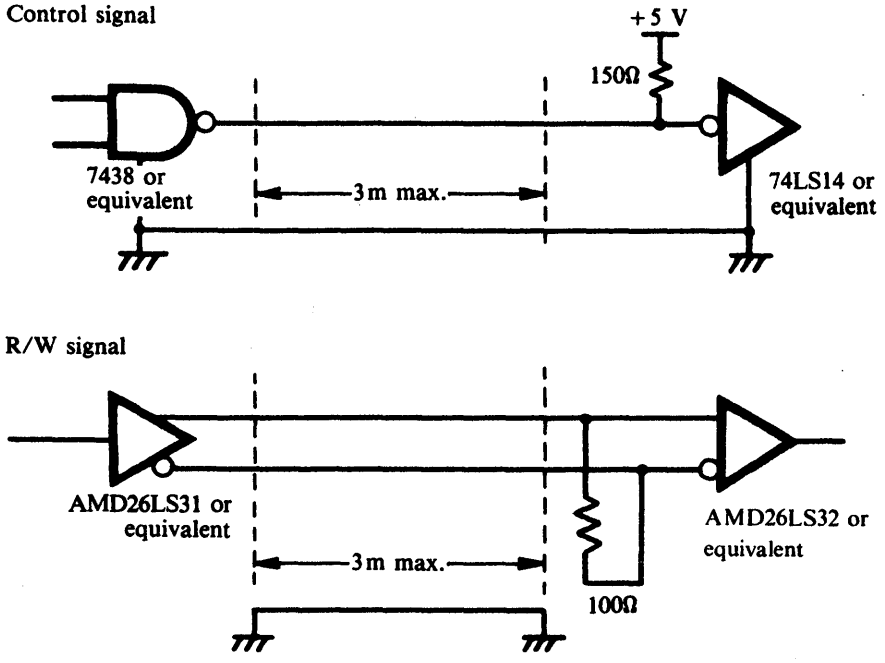


Figure 4.4 Driver/Receivers

4.5 DC Grounding

For DC ground, a fasten tab is provided as the SG connector (Figure 4.2).

4.6 Fault Lamps and Setting Plugs

4.6.1 Short circuits and fault lamp location

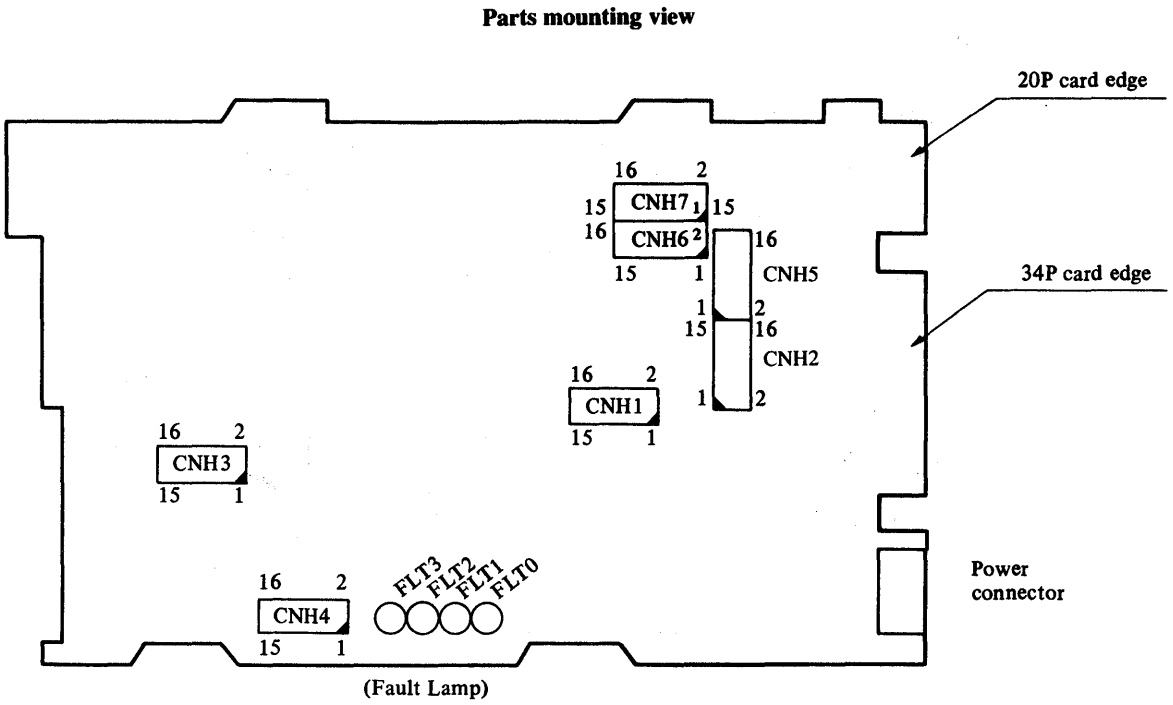


Figure 4.5 Location of check terminals and setting circuit

Short plugs are inserted as follows when shipped from the factory.

CNH7: Between 1 and 2, 7 and 8, 9 and 10, 11 and 12, and 15 and 16
CNH6: Between 1 and 2, and 15 and 16
CNH5: Between 15 and 16
CNH4: Between 11 and 12

The following settings are model specific.

CNH7:	Between 3 and 4:	M2249
	Between 5 and 6:	M2248
	No short plugs between 3 and 4, or 5 and 6:	M2247

4.6.2 Setting

(1) Drive select (drive number setting)

Location / Drive Number	CNH 6						
	1-2	3-4	5-6	7-8	9-10	11-12	13-14
1	Short	Open	Open	Open	Open	Open	Open
2	Open	Short	Open	Open	Open	Open	Open
3	Open	Open	Short	Open	Open	Open	Open
4	Open	Open	Open	Short	Open	Open	Open
5	Open	Open	Open	Open	Short	Open	Open
6	Open	Open	Open	Open	Open	Short	Open
7	Open	Open	Open	Open	Open	Open	Short

(2) Radial option

When pins 15 – 16 are shorted, the drive output signals (only A cable signals) are always enabled, regardless of Drive Select signal. Without a jumper here, the output signals are enabled only when the drive is selected.

Signal gate or not (Select signal)	CNH6
	15 - 16
No gate (radial)	Short
Gate (daisy)	Open

(3) Other settings

Setting values are valid when the power is on.

a.

Location		Function
CNH7 1 - 2	Open Short	Function for motor start control from interface: Yes No

b.

CNH7		Device type selection
3 - 4	5 - 6	
Open	Open	M2247
Open	Short	M2248
Short	Open	M2249

c.

CNH7	Sector mode setting
13 - 14	
Open	Drive hard sector (Sector)
Short	Controller soft sector (Address Mark Found)

d.

CNH7			Sector setting	
7 - 8	9 - 10	11 - 12	Sectors/Track	Bytes/Sector
Open	Open	Open	16	1304
Open	Open	Short	18	1159
Open	Short	Open	19	1098
Open	Short	Short	32	652
Short	Open	Open	34	613
Short	Open	Short	35	596
Short	Short	Open	64	326
Short	Short	Short	36	579

Note:

Valid only in hard sector mode

e.

CNH7 15 - 16	Power ON Reset Condition
Open	ATTENTION signal and bit 8 of Status byte are set at the READY state just after power-on.
Short	ATTENTION signal and bit 8 of status byte are not set at the READY state just after power-on.

f.

CNH5 15 - 16	READY LED lighting conditions
Open	Drive select signal not gated
Short	Drive select signal gated

g.

CNH3		Data Window Adjustment Early
13-14	15-16	
Open	Open	0 nS
Open	Short	2 nS
Short	Open	4 nS
Short	Short	6 nS

4.6.3 Fault lamps

Drive fault states are displayed by the fault lamps (0, 1, 2, 3).

Item	Fault lamp 3	2	1	0	State
1.	X	X	X	O	Spindle motor revolutions fewer than 90% of standard
2.	X	X	O	X	VCM over current
3.	X	X	O	O	Initial seek time out
4.	X	O	X	X	Write command during Seek operation
5.	X	O	X	O	+12 V/+5 V, less than 80% of standard
6.	X	O	O	X	Offtrack during Write operation
7.	X	O	O	O	Write Echo check
8.	O	X	X	X	Two or more head ICs selected during Write operation
9.	O	X	X	O	Seek time out
10.	O	X	O	X	Guard band detection during Seek operation
11.	O	X	O	O	Guard band detection in the linear mode
12.	O	O	X	X	Overshoot check
13.	O	O	X	O	Seek command without ONTRACK signal true
14.	O	O	O	X	Head load signal lost after READY
15.	O	O	O	O	Read and Write commands simultaneously issued or other miscellaneous faults
16.	X	X	X	△	Invalid or unimplemented command fault
17.	X	X	△	X	Interface time out fault
18.	X	X	△	△	Command data parity fault

O : On
X : Off
△ : Blinking

Note:

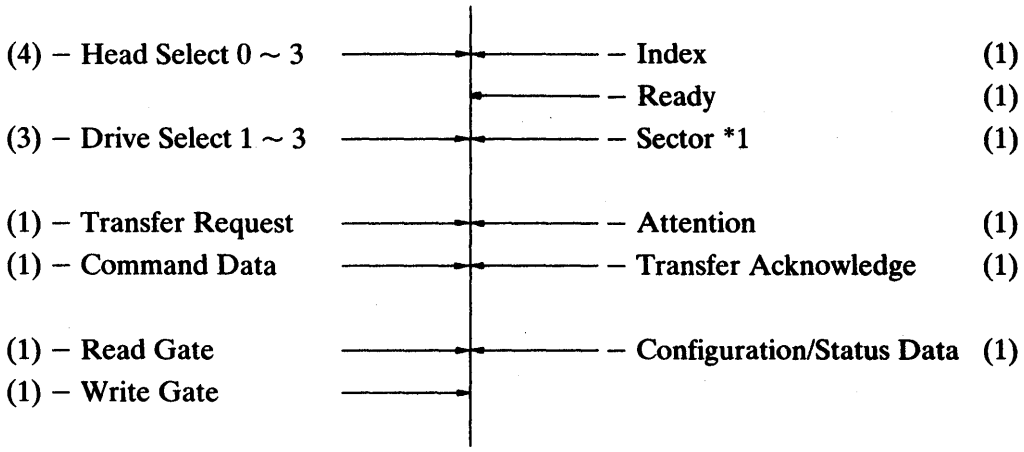
1. Reset using Attention Reset command. Items 2 and 3 can only be cleared with power off.

CHAPTER 5 INTERFACE

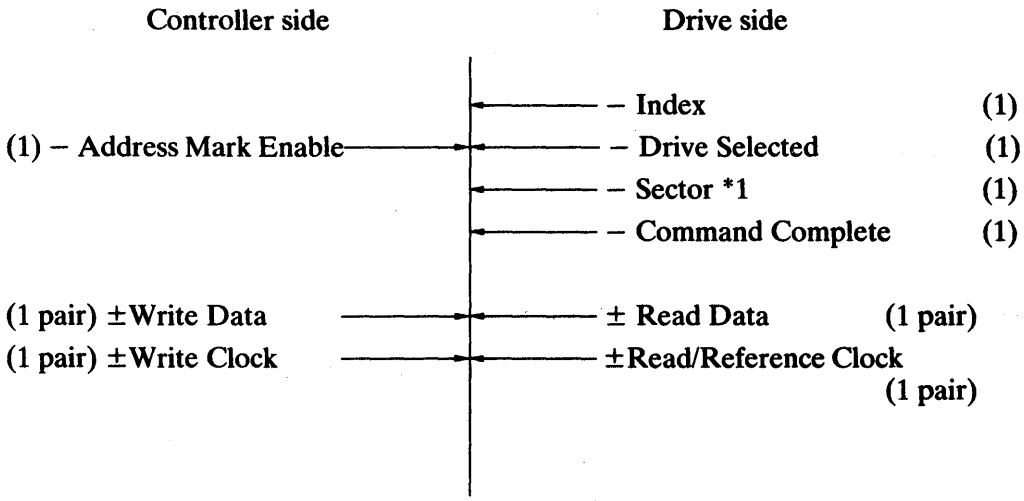
This chapter describes the physical and logical conditions of the signals transferred through the interface between the drive and the controller. The timing is specified at the driver/receiver location.

5.1 Signal Lines

A Cable



B Cable



*1 The signal line consists of sector, byte clock, or address mark found signals, selected at the drive. The above figures show sector signal being sent.

5.2 Input Signals

(1) Head Select 0 to 3

These signal lines are used to select the head address.

(2) Drive Select 1 to 3

These signal lines are used to validate the drive input/output signals. The signal line selects one of seven drives. The drive number is determined by the switch setting. When it matches the Drive Select (1 to 3) decoding signal, it indicates that the drive has been selected. The Drive Selected signal is sent on B cable. Drive number 0 does not exist.

(3) Transfer Request

When Command Data or Configuration/Status Data is transferred, this signal line is used with the Transfer Acknowledge signal as a handshake signal.

(4) Command Data

This signal line accepts commands controlling the drive. It is 16-bit sequential data with odd parity. This signal is transferred from the controller to the drive by the Transfer Request and Transfer Acknowledge signals. Transfer begins with the most significant bit.

(5) Read Gate

This signal line enables read data from the selected data head in the drive. Read data is valid 9.6 μs after the read gate is active.

(6) Write Gate

This signal line enables write current in the selected data head in the drive.

(7) Write Clock (balanced transmission)

This is a bit data cycle clock sent from the controller. The frequency is derived from the Read/Reference Clock from the drive.

(8) Write Data (balanced transmission)

This signal pair sends NRZ data to the disk from the controller, and is clocked by leading edge of the Write Clock in the drive.

(9) Address Mark Enable

This signal allows the address mark to be written when Write Gate is active, and is three bytes long. When neither the Write Gate nor the Read Gate are active, it searches for the address mark.

5.3 Output Signals

(1) Index

This negative pulse is produced once per revolution and indicates the beginning of the track.

(2) Ready

If Ready signal is active after the heads are on cylinder, the Read, Write, or Seek operations is possible on the selected drive. The Ready signal is sent on both A and B Cables.

(3) Sector/Byte Clock/Address Mark Found

One index period is divided into 16 to 64 sectors, and sent as a sector pulse. However, the number of sectors depends on switch selection. When the byte clock is necessary for the controller to obtain the various sectors, or when an address mark is used, the pulse is sent as Byte Clock or Address Mark Found. The selection depends on the drive jumper setting.

(4) Attention

This signal sends a standard status request to the controller. The signal indicates that fault or status changes have occurred, and that the Write operation is inhibited. It is reset by the control command.

(5) Transfer Acknowledge

This signal is used in Command Data and Configuration/Status signal handshake transfers in conjunction with Transfer Request. See subsection 5.2.5.

(6) Configuration/Status Data

When commands are received from the controller, this signal sends each status to the controller. This signal is 16-bit serial data with odd parity. It is transferred when a handshake occurs between the Transfer Request and Transfer Acknowledge signals. Transfer is performed beginning with the most significant bit.

(7) Drive Selected

This signal indicates that the drive number specified by the controller matches the drive number set in the drive. It indicates that the drive has been selected.

(8) Command Complete

This signal is sent even when the drive has not been selected. The gate is not enabled by the Drive Selected signal. This signal is active during the conditions given below.

a. After power-on until cylinder 0 is on track (until initial seek is complete)

b. From when Command Data is received to when the command is complete

(9) Read Data (balanced transmission)

Read Data is sent to the controller as an NRZ signal which becomes valid 9.6 μs after Read Gate. It is sent synchronized with the falling edge of Read Clock.

(10) Read/Reference Clock

This is a pulse at 1-bit intervals. The Read/Reference Clock is synchronized with the servo clock during write, and with Read Data from the data head during Read.

5.4 Command Data Format

Command data format is 17 bits, 16 bits + 1 parity, and is shown in the table below.

MSB LSB

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	P
Function bit				Modifier bit				All zeros								P
Function bit				Parameter bit												P

P : Parity (Odd)

(1) Function/Modifier/Parameter bit

Function bit				Command function definition	Modifier bit 11 to 8	Parameter bit 11 to 0	Configuration/ Status Data
15	14	13	12				
0	0	0	0	Seek	No	Yes	No
0	0	0	1	Recalibrate	No	No	No
0	0	1	0	Request Status	Yes	No	Yes
0	0	1	1	Request Configuration	Yes	No	Yes
0	1	0	0	(Reserved)	–	–	–
0	1	0	1	Control	Yes	No	No
0	1	1	0	(Reserved)	–	–	–
0	1	1	1	Track Offset	Yes	No	No
1	0	0	0	Initiate Diagnostics	No	No	No
1	0	0	1	Set Bytes/Sector	No	Yes	No
1	0	1	0	(Reserved)	–	–	–
1	0	1	1	(Reserved)	–	–	–
1	1	0	0	(Reserved)	–	–	–
1	1	0	1	(Reserved)	–	–	–
1	1	1	0	(Reserved)	–	–	–
1	1	1	1	(Reserved)	–	–	–

Notes:

1. All unused bits must be set to 0.
2. When a reserved pattern is received, an Invalid command is sent in reply.

a. Seek (0000)

Seek is performed to the cylinder specified by bits 0 to 11.

b. Recalibrate (0001)

Seek (R.T.Z.) is performed to Cylinder 0. Track Offset is reset.

c. Request Status (0010)

This command is used when the controller requires the status held by the drive. Status defined by bits 11 to 8 is sent to the controller side as 16-bit data with odd parity. In the condition shown in the following table, bits 11 to 8 are all zeros.

Bit Position	Function	Bit details	
15	(Reserved)	0	
14	Removable Media Not Present	0	
13	Write Protected (Removable Media)	0	
12	Write Protected (Fixed Media)	X (0)	
11	(Reserved)	0	
10	(Reserved)	0	
9	Spindle Motor Stopped	X (0)	
8	Power On Reset Conditions Exist	X (0)	(Note 2)
7	Command Data Parity Fault	X (0)	
6	Interface Fault	X (0)	
5	Invalid command Fault	X (0)	
4	Seek Fault	X (0)	
3	Write Gate with Track Offset Fault	X (0)	
2	Vendor Unique Status Available	0	
1	Write Fault	X (0)	
0	Removable Media Changed	0	

Notes:

1. X varies according to the drive status. Numbers in parentheses show the normal status.

2. X varies according to the plug setting at the READY state just after power-on. (Refer to the item 4.6.2.e).

d. Request Configuration (0011)

Specified drive specifications are sent to the controller. Specifications are determined by combinations of bits 11 to 8.

Command modifier bit				Function
11	10	9	8	
0	0	0	0	General Configuration
0	0	0	1	Number of Cylinders (Fixed)
0	0	1	0	Number of Cylinders (Removable)
0	0	1	1	Number of Heads
0	1	0	0	Min. Unformatted Bytes/Track
0	1	0	1	Unformatted Bytes/Sector (Hard Sector)
0	1	1	0	Sectors/Track (Hard Sector)
0	1	1	1	Min. Bytes/ISG Field
1	0	0	0	Min. Bytes/PLO Sync Field
1	0	0	1	Number of words of vender unique status available

Bit Position	⟨ Function ⟩	Bit
15	Tape Drive	0
14	Format Speed Tolerance Gap Required	0
13	Track Offset Tolerance Gap Required	1
12	Data strobe Offset Option Available	0
11	Rotational Speed Tolerance >0.5%	0
10	Transfer Rate >10 MHz	0
9	Transfer Rate > 5 MHz ≦ 10 MHz	1
8	Transfer Rate ≦5 MHz	0
7	Removable Catridge Drive	0
6	Fixed Drive	1
5	Spindle Motor Control Option Implemented	(*1)
4	Head Switch Time >15 μs	0
3	RLL Encoded (Note MFM)	1
2	Controller Soft Sectored (Address Mark)	(*2)
1	Drive Hard Sectored (Sector Pulses)	(*2)
0	Controller Hard Sectored (Byte Clock)	(*2)

*1 Determined by the setting plug of the disk drive. If the plug is set to the spindle motor control option, bit 5 is set to 1, otherwise it is set to 0.

*2 Determined by the setting plug of the disk drive. Only the bit for the specified mode is set to 1; other bits are set to 0.

e. Control (0101)

This command has the control functions shown in the table below.

Command modifier bit				Function
11	10	9	8	
0	0	0	0	Reset Interface Attention & Standard Status
0	0	0	1	(Reserved)
0	0	1	0	Stop Spindle Motor*
0	0	1	1	Start Spindle Motor*
0	1	0	0	(Reserved)
0	1	0	1	(Reserved)
0	1	1	0	(Reserved)
0	1	1	1	(Reserved)
1	X	X	X	(Reserved)

* This function is valid only when the drive is set to support spindle motor start/stop. When it is not set, rotation starts with power-on, and an invalid command is sent in reply.

f. Track Offset (0111)

This command sets offset during ontrack. The offset value and direction are selected by a combination of bits 11 to 8. Offset is reset by the Seek or R.T.Z. command.

Command modifier bit				Function
11	10	9	8	Track Offset
0	0	0	0	Restore offset to 0
0	0	0	1	Restore offset to 0
0	0	1	0	Positive offset 1
0	0	1	1	Negative offset 1
0	1	0	0	Positive offset 2
0	1	0	1	Negative offset 2
0	1	1	0	Positive offset 3
0	1	1	1	Negative offset 3
1	X	X	X	(Reserved)

g. Initiate Diagnostics (1000)

This command performs drive diagnostics. Command Complete is sent when the diagnostics terminate normally, and Attention is sent with Command Complete after it terminates abnormally.

h. Set Unformatted Bytes;024Sector (1001)

This command indicates the number of unformatted bytes per sector by bits 11-0. It is effective only when the disk drive is in the hard sector mode; it is treated as an invalid command when the disk drive is in other modes. When this command is not used, the number of sectors and that of bytes specified by the drive setting plug are effective. Once the values are set, they are retained until this command is executed again or until the power is turned off.

Sector	Bit position (bit 11 - 0)	Bytes/Sector	Remaining sector length
5	1111 1111 1111	4095	389
6	1101 1001 0101	3477	2
7	1011 1010 0100	2980	4
8	1010 0011 0000	2608	0
9	1001 0000 1110	2318	2
10	1000 0010 0110	2086	4
11	0111 0110 1000	1896	8
12	0110 1100 1010	1738	8
13	0110 0100 0100	1604	12
14	0101 1101 0010	1490	4
15	0101 0101 1110	1390	14
16	0101 0001 1000	1304	0
17	0100 1100 1011	1227	5
18	0100 1000 0111	1159	2
19	0100 0100 1010	1098	2
20	0100 0001 0011	1043	4
21	0011 1110 0001	993	11
22	0011 1011 0100	948	8
23	0011 1000 1011	907	3
24	0011 0110 0101	869	8
25	0011 0100 0010	834	14
26	0011 0010 0010	802	12
27	0011 0000 0100	772	20
28	0010 1100 1001	745	4
29	0010 1100 1111	719	13
30	0010 1011 0111	695	14
31	0010 1010 0001	673	1
32	0010 1000 1100	652	0
33	0010 0111 1000	632	8
34	0010 0110 0101	613	22
35	0010 0101 0100	596	4
36	0010 0100 0011	579	20
37	0010 0011 0011	563	33
38	0010 0010 0101	549	2
39	0010 0001 0110	534	38
40	0010 0000 1001	521	24
41	0001 1111 1100	508	36
42	0001 1111 0000	496	32
43	0001 1110 0101	485	9
44	0001 1101 1010	474	8

Sector	Bit position (bit 11 - 0)	Bytes/Sector	Remaining sector length
45	0001 1100 1111	463	29
46	0001 1100 0101	453	26
47	0001 1011 1011	443	43
48	0001 1011 0010	434	32
49	0001 1010 1001	425	39
50	0001 1010 0001	417	14
51	0001 1001 1001	409	5
52	0001 1001 0001	401	12
53	0001 1000 1001	393	35
54	0001 1000 0010	386	20
55	0001 0111 1011	379	19
56	0001 0111 0100	372	32
57	0001 0110 1110	366	2
58	0001 0110 0111	359	42
59	0001 0110 0001	353	37
60	0001 0101 1011	347	44
61	0001 0101 0110	342	2
62	0001 0101 0000	336	32
63	0001 0100 1011	331	11
64	0001 0100 0110	326	0
65	0001 0100 0000	320	64

The above table shows the Sector and Byte numbers.

Notes:

1. If the number of Sectors specified is greater than 255, the disk drive treats the Set Unformatted Bytes per Sector command as an invalid command.

2. Calculation formula:

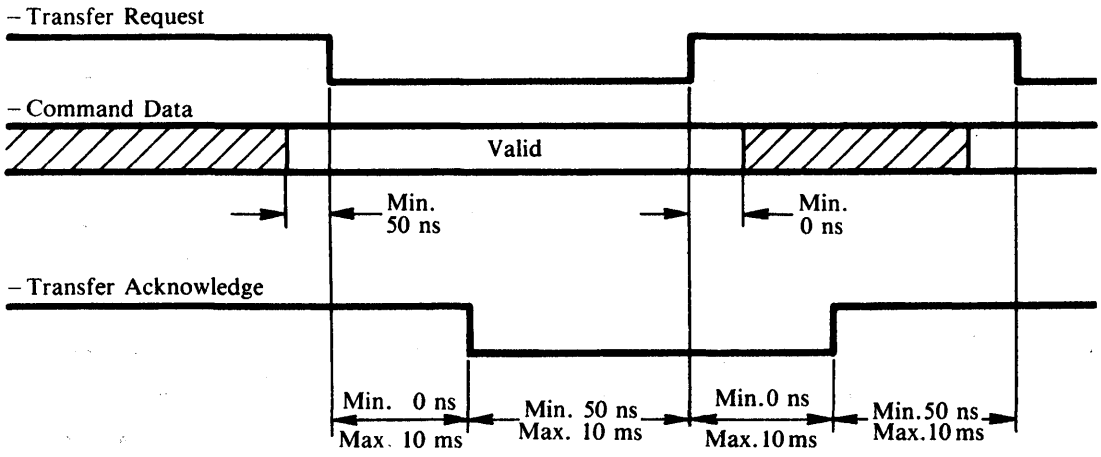
$$Y = \frac{20864}{X}$$ Absolute value: Number of bytes per sector (X = Number of sectors per track)

$$Z = 20864 - (ABS.Y) \times X \text{ Remaining sector length}$$

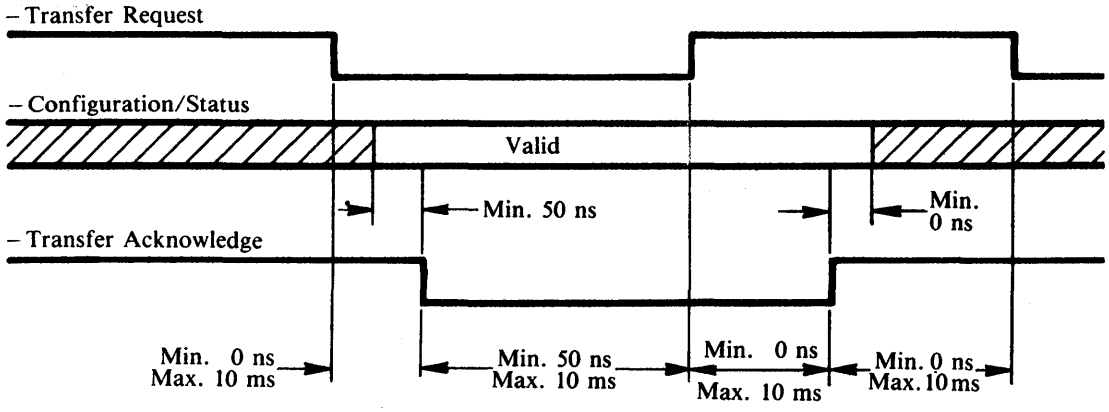
i. (1010) to (1111) are reserved.

5.5 Timing Specifications

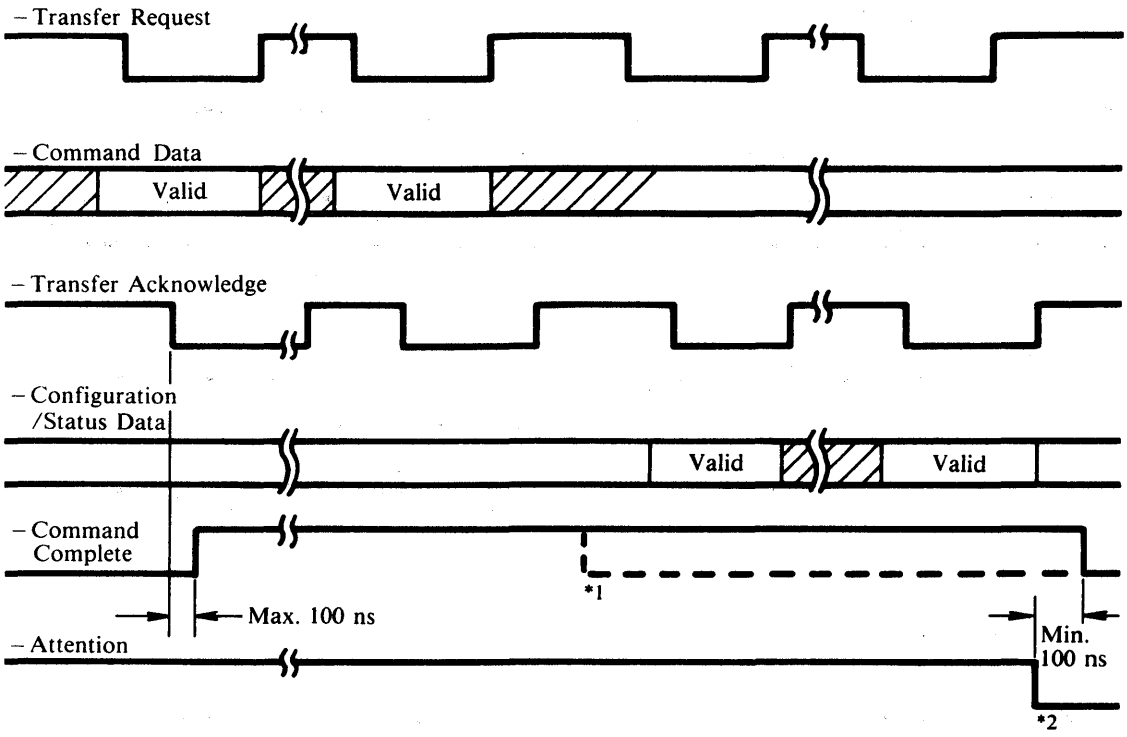
(1) Command Data



(2) Transfer Request



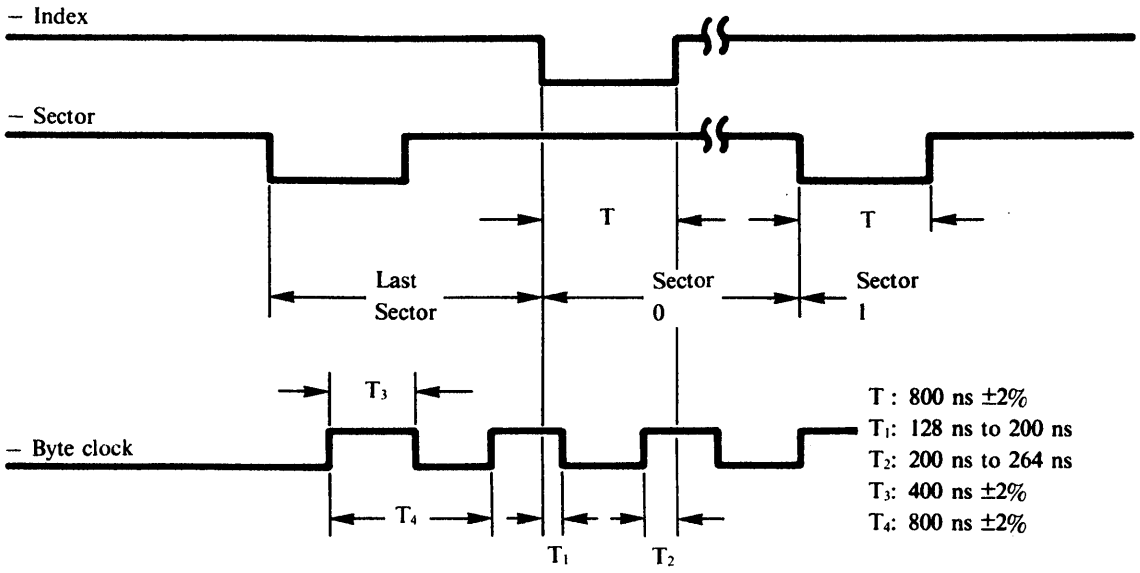
(3) Command and Configuration/Status Data



*1 When the controller does not need the response of Configuration/Status Data, Command Complete is sent when the command has been executed.

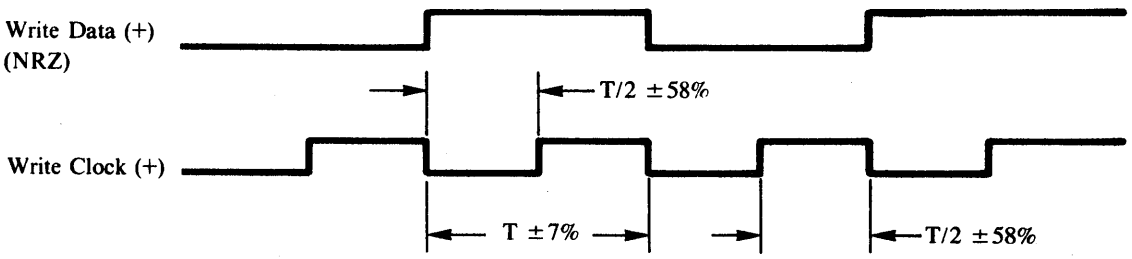
*2 Attention rises with Command Complete when an error occurs.

(4) Index/Sector/Byte Clock

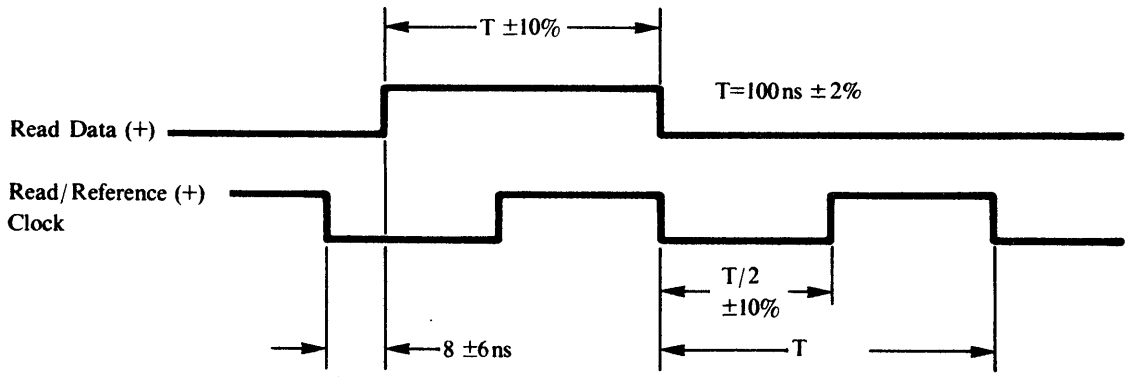


(5) Write/Read Data

a. Write Data, Write Clock



b. Read Data, Read/Reference Clock



5.6 Serial Mode Signal Lines Pin Assignment

(1) CNA signal lines pin assignment

2	−Head Select 2^3	1	GND
4	−Head Select 2^2	3	GND
6	−Write Gate	5	GND
8	−Configuration/−Status Data	7	GND
10	−Transfer Acknowledge	9	GND
12	−Attention	11	GND
14	−head Select 2^0	13	GND
16	−SEC/−AMF	15	GND
18	−Head Select 2^1	17	GND
20	−Index	19	GND
22	−Ready	21	GND
24	−Transfer Request	23	GND
26	−Drive Select 1	25	GND
28	−Drive Select 2	27	GND
30	−Drive Select 3	29	GND
32	−Read Gate	31	GND
34	−Command Data	33	GND

Notes:

1. The key pin is between pin 4 and pin 6.
2. −SEC/−BYTE CL/−AMF: Sector/Byte Clock/Address Mark Found

(2) CNB signal lines arrangement

2	−SEC/−AMF	1	−Drive Selected
4	−Address Mark Enable	3	−Command Complete
6	GND	5	−Reserved (Logical 0 level)
8	−Write Clock	7	+Write Clock
10	+Read/Reference Clock	9	Reserved (Logical 0 level)
12	GND	11	−Read/Reference Clock
14	−NRZ Write Data	13	+NRZ Write Data
16	GND	15	GND
18	−NRZ Read Data	17	+NRZ Read Data
20	−Index	19	GND

Notes:

1. The key pin is between pin 8 and pin 10.
2. −SEC/−BYTE CL/−AMF: Sector/Byte Clock/Address Mark Found

CHAPTER 6 DRIVE SPECIFICATIONS

Table 6.1 shows models and part numbers.

Table 6.1 Models and part numbers

Item	Model	Part number	Mounting screw	Formatting
1	M2247E	B03B-4945-B001A	M4	ESDI Format
2	M2248E	B03B-4945-B002A	M4	ESDI Format
3	M2249E	B03B-4945-B003A	M4	ESDI Format
4	M2247E	B03B-4945-B001A#N	#6-32UNC	ESDI Format
5	M2248E	B03B-4945-B002A#N	#6-32UNC	ESDI Format
6	M2249E	B03B-4945-B003A#N	#6-32UNC	ESDI Format

CHAPTER 7 SPARE PARTS

Table 7.1 shows spare parts and numbers.

Table 7.1 Spare parts

Item	Part name	Number
1	Control PCB	B17B-0370-0060A
2	Read/write preamplifier PCB	B17B-0390-0060A

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