





## CHAPTER 1 INTRODUCTION

- 1.1 General Description
- 1.2 Specifications
  - 1.2.1 Performance specifications
  - 1.2.2 Functional specifications
  - 1.2.3 Physical specifications
  - 1.2.4 Reliability specifications

## CHAPTER 2 OPERATION OF MAJOR COMPONENTS

- 2.1 System Operation
- 2.2 Electronic Circuits
- 2.3 Rotation Mechanism
- 2.4 Positioning Mechanism
- 2.5 Read/Write Head

## CHAPTER 3 ELECTRICAL INTERFACE

- 3.1 Signal Interface
  - 3.1.1 Cabling method and input line termination
  - 3.1.2 Line driver and line receiver
  - 3.1.3 Input signal lines
  - 3.1.4 Output signal lines
- 3.2 Power Interface

## CHAPTER 4 FUNCTIONAL OPERATION

- 4.1 Power On Sequencing
- 4.2 Drive Selection
- 4.3 Track Accessing
- 4.4 Side Selection
- 4.5 Read Operation
- 4.6 Write Operation
- 4.7 Special Operations
  - 4.7.1 Internal write current switch
  - 4.7.2 Internal switch filter

## CHAPTER 5 PHYSICAL INTERFACE

- 5.1 Signal Connectors (J1/P1)
- 5.2 DC Power Connector (J5/P5)
- 5.3 Location of Interface Connectors



## CHAPTER 6 CUSTOMER INSTALLATION OPTIONS

- 6.1 Loading Heads With Drive Select Signal "AND" Head Load Signal
- 6.2 Loading Heads With Head Load Signal (Selecting Drive is Accomplished By Means Of Drive Select Signal)
- 6.3 Loading Heads With Head Load Signal (Selecting Drive is Accomplished By Means Of Drive Select Signal "AND" Head Load Signal)
- 6.4 Radial Ready
- 6.5 Radial Index
- 6.6 In Use Alternate Input (Activity LED)
- 6.7 Write Protection Option Use
- 6.8 Disk Change (Alternate Output)
- 6.9 Side Selection Using Direction Select
- 6.10 Side Selection Using Drive Select
- 6.11 Door Lock Latch
- 6.12 Two-Sided
- 6.13 Write Current Switch
- 6.14 Ready Standard/Ready Modified
- 6.15 Head Load Latch
- 6.16 Door Lock Condition
- 6.17 Motor Start

## CHAPTER 7 DRIVE PHYSICAL SPECIFICATIONS

- 7.1 Drive Dimensions
- 7.2 Mounting Recommendations
- 7.3 Mounting
- 7.4 Air Flow

## CHAPTER 8 ERROR DETECTION AND CORRECTION

- 8.1 Write Error
- 8.2 Read Error

## CHAPTER 9 RESHIPMENT PRECAUTIONS

## CHAPTER 10 TYPE REFERENCES TO BE STATED WHEN ORDERING

- 10.1 Table Listing Changes in Type Reference Designations



## CHAPTER 1 INTRODUCTION

The Mitsubishi M2896 Flexible Disk Drives is a half-height double-side, disk drive employing a high-performance, economical, standard 8-inch diskette, providing the device with high reliability and the medium with a long service life to meet customer requirements.

- Main Features -

- o Half-high thickness and reduced depth as compared to standard 8-inch drive, keeping high performance double-sided double-density operations of M2894.
- o Brush-less and belt-less direct-drive DC spindle motor with no AC power supply, for simpler maintenance.
- o High quality and long life Mn-Zn read/write heads, requiring less or no write precompensation, enables interchangeability with IBM systems.
- o Enhanced tracking ability of the medium surface provided by a new type patented circular gimbal spring suspension of the read/write heads with lower loading pressure, same as the Mitsubishi M2894 FDD.
- o Equipped with head load/unload mechanism, and media tap-tap life reaching many hundreds of thousand load/unload operations for the same point of a track. Heads are unloaded for both sides during waiting, eliminating unnecessary contact with medium.
- o Media need not be specifically specified or designated by a special brand name. Diskette quality variation affects the performance of the drive only negligibly.
- o Reliable media interchangeability by larger window timing and off-track margins, and full coverage of environmental temperature and humidity ranges.
- o Further high reliability employing control logic by LSI.



## 1.1 General Description

- The M2896 flexible disk drive is the 1 to 1.2 megabyte formatted memory capacity disk drive, employing two magnetic heads for recording on both sides of the medium, at double density, thus providing a capacity four times higher than 250 kilobytes offered by conventional single-side, standard density drives.
- The M2896 reads and writes on an 8-inch diskette, either one or both sides, and in single or double density, and media-compatible with IBM diskettes 1,2 and 2D or equivalent.
- The M2896 is plug-compatible to the Industrial Standard interface and same options with Shugart SA850/850R.
- The M2896 provides a stabilized, soft media contact by using an entirely new circular gimbal spring in the mechanism for holding the magnetic heads with lower loading pressure. Thus, excellent read/write operation and a long service life are offered. This mechanism significantly reduces the effects of jacket deformation or variations in thickness, thereby stabilizing read and write performance. Thus, it is unnecessary to select a special maker's product any more.
- The magnetic read/write heads core are consisted of Mn-Zn ferrites, enabling a higher performance. The slider has a high-precision, pinhole-free sliding surface. The four corners and edges of the slider are smoothly blended and finished so that no stress is given to the medium, providing wear resistance and thus a prolonged service life.
- The M2896 head loading mechanism uses a closed-loop electronic damping system employing a magnetic sensor. The magnetic heads load on the medium surface so softly that almost no scratchin is caused by repeated loading and unloading (tap-tap). (Many hundreds of thousands of tap-tap tests at the same point on the same track cause no error on the track and adjacent tracks.)
- The M2896 can be mounted in a standard 19-inch RETMA rack as a set of parallel units.
- Two M2896's can be mounted in a standard 8 inch FDD space.



1.2 Specifications

1.2.1 Performance specifications (Table 1-1)

Table 1-1 Performance Specifications

	Single Density	Double Density
<b>Memory capacity</b>		
Unformatted		
Disk (kilobytes)	800	1600
Surface (kilobytes)	400	800
Track (bytes)	5208	10,416
Formatted (bytes/sector)*	128 x 26 sectors	256 x 26 sectors
Disk (kilobytes)	499.2	998.4
Surface (kilobytes)	249.6	499.2
Track (bytes)	3328	6656
<b>Transfer rate (kilobyts per second)</b>		
	250	500
<b>Average latency time (Milliseconds)</b>		
		83
<b>Access time (milliseconds)</b>		
Track to track		3
Average		91 (Including step time of 3 milliseconds and settling time)
Settling time		15
Head-loading time		35
<b>Motor-start time (milliseconds)</b>		
		500

\* example shown



## 1.2.2 Functional Specifications (Table 1-2)

Table 1-2 Functional Specifications

	Single Density	Double Density
Recording density (Bit per inch)	3408	6816
Magnetic flux inversion density (FCI)	6816	6816
Encoding method	FM	FM
Track density (tracks per inch)		48
Number of cylinders		77
Number of tracks		154
Number of heads		2
Rotation speed (rpm)		360 +3% (instantaneous)
Rotation period (milliseconds)		166.7 +2%
Index		1
Media	8-inch Flexible Disk Cartridge equivalent to IBM diskette 1,2, or 2D	



1.2.3 Physical Specification (Table 1-3)

Table 1-3 Physical Specifications

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DC power requirements	
+5 V	+5 V $\pm$ 5%, 0.8 A typical
+12 V	+24 V $\pm$ 10%, 0.8 A typical

---

Operating environmental conditions	
Ambient temperature	41 <sup>o</sup> F to 109 <sup>o</sup> (5 <sup>o</sup> C to 43 <sup>o</sup> )
Relative humidity	20% to 80% (Maximum wet bulb temperature: 84 <sup>o</sup> F (29 <sup>o</sup> C) )
Vibration	0.25 g (10 to 100 Hz)

Non-operating environmental conditions	
Ambient temperature	-14 <sup>o</sup> F to 122 <sup>o</sup> F (-10 <sup>o</sup> C to 51 <sup>o</sup> C)
Relative humidity	20% to 80% (Without condensation)
Vibration	2 g (10 to 100 Hz)

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Heat dissipation	79 BTU/hour typical (23 watts)
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Physical dimensions	(Except for front panel)
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Physical dimensions	(Except for front panel)
Height	2.25 inches (57 mm)
Width	8.55 inches (217 mm)
Depth	12.40 inches (315 mm)

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Front panel dimensions	2.25 x 8.55 x 0.39 inches (57 x 217 x 10 mm)
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Weight	7.8 lbs (3.5 kg)
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## 1.2.4 Reliability Specifications (Table 1-4)

Table 1-4 Reliability Specifications

MTBF	10,000 POH or more (Note 1)
MTTR	30 minutes
Unit life	5 years or 20,000 energized hours, whichever comes first
Media life	
Rotational life	$3.5 \times 10^6$ pass/track or more
Tap-tap	$10^5$ or more on the same spot of a track
Error rate	
Soft read error	$10^{-9}$ bit (Note 2)
Hard read error	$10^{-12}$ bit
Seek error	$10^{-6}$ seek

Note 1) POH: Power On Hours

Note 2) With two retries



## CHAPTER 2 OPERATION OF MAJOR COMPONENTS

## 2.1 System Operation

The M2896 Flexible Disk Drive consists of a mechanism to rotate the medium, two read/write heads, an actuator to position the read/write heads on tracks, a solenoid to load and unload the read/write heads on the medium, and electronic circuits to drive these components.

The rotation mechanism rotates a medium at 360 rpm. The medium is inserted in the drive and is clamped by the collet and spindle connected to the direct-drive DC motor. The positioning actuator positions the read/write heads to the desired track on the medium to perform a read or write operation. The heads are unloaded for both sides of the medium during non-operations.

## 2.2 Electronic Circuits

The circuits to drive all mechanisms in the disk drive are mounted on a printed-circuit board. The circuits on the printed-circuit board include:

- o Line driver and receiver, sending and receiving signals to and from the host system;
- o Drive selection circuit;
- o Index detection circuit;
- o Head-positioning actuator drive circuit;
- o Head-loading solenoid drive circuit;
- o Read/write circuit;
- o Write protect circuit;
- o Track 00 detection circuit;
- o Drive ready detection circuit;
- o Head selection circuit;
- o In use, door lock circuit, and panel indicator LED drive circuit.

The spindle DC motor is driven by a control circuit on another printed-circuit board attached to the motor.

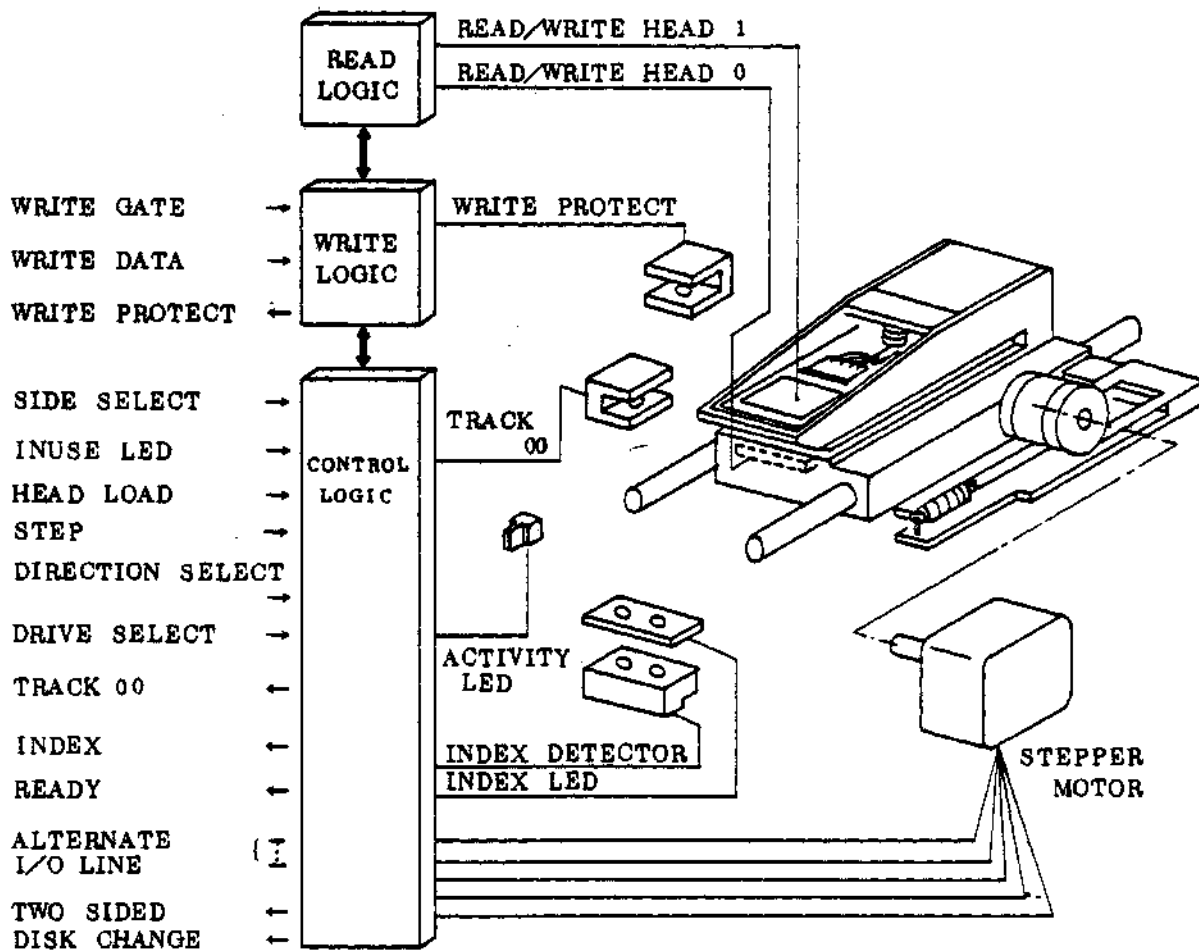


Figure 2-1 M2896 Functional View



### 2.3 Rotation Mechanism

The disk is rotated via the spindle at a speed of 360 rpm by a DC direct-drive brushless motor.

### 2.4 Positioning Mechanism

The read/write head is positioned as follows: The head carriage assembly is connected to a steel band hooked on the capstan on the 4-phase PM-type stepping motor. The capstan is located near the spindle, and a 3.60 turn of the stepping motor moves the read/write head a distance of one track to the specified direction.

### 2.5 Read/Write Head

The head incorporates three ferrite head cores; erase head cores for erasing the space between the tracks (tunnel erase) are arranged at both sides of the read/write core. Both of the two facing heads, interposed with a disk, are moved by the head-loading solenoid and load on, or contact, the disk.

Each head is mounted on an adequately compliant, circular gimbal spring so that they correctly follow the track to maximize the signal reproduction from the disk. This surface tracking of the circular gimbal head minimizes stress on the disk surface and contributes to an improved diskette service life, with lower loading pressure.



CHAPTER 3 ELECTRICAL INTERFACE

There are two electrical interfaces: signal interface and power interface.

The signal interface transmits and receives control signals and read/write data to and from the M2896 or the host system through the J1/P1 connector.

The DC power interface feeds power, via the J5/P5 connector, to the electronic circuits (a printed-circuit board) and to the stepping motor that drives the mechanism for positioning the read/write heads, door-lock magnet and the spindle motor.

The signals and pin arrangement of these two types of interfaces are shown in Tables 3-1 and 3-2.

Table 3-1 DC Power Connector Pin Arrangement (J5/P5)

Power Voltage	Pin Number
+23 V DC	1
+24 V GND (Return)	2
DC GND	3
(Not Used)	4
+5 V DC	5
+5 V GND (Return)	6



Table 3-2 Signal Connector Pin Arrangement (J1/P1)

Signal Name	Signal Pin Number	Pin Number	Ground Return Pin Number	Option
ALTERNATE I/O	2		1	-WRITE CURRENT SWITCH
ALTERNATE I/O	4		3	
ALTERNATE I/O	6		5	
ALTERNATE I/O	8		7	-TRUE READY
ALTERNATE I/O	10		9	-TWO-SIDED
ALTERNATE I/O	12		11	-DISK CHANGE
-SIDE SELECT	14		13	
ALTERNATE I/O	16		15	-IN USE
ALTERNATE I/O	18		17	-HEAD LOAD/ (MOTOR START)
-INDEX	20		19	
-READY	22		21	
(NOT USED)	24		23	
-DRIVE SELECT 1	26		25	
-DRIVE SELECT 2	28		27	
-DRIVE SELECT 3	30		29	
-DRIVE SELECT 4	32		31	
-DIRECTION SELECT	34		33	
-STEP	36		35	
-WRITE DATA	38		37	
-WRITE GATE	40		39	
-TRACK 00	42		41	
-WRITE PROTECT	44		43	
-READ DATA	46		45	
(NOT USED)	48		47	
(NOT USED)	50		49	



### 3.1 Signal Interface

The signal interface is classified into control signals and data signals. These interface signal lines are all at TTL levels. The signal level meaning and characteristics are as follows:

- o True = Logical "0" = VL 0 V to +0.4 V  
Iin 40 mA maximum
- o False = Logical "1" = VH + 2.5 V to +5.25 V  
Iin 0 mA
- o Input impedance = 150 Ohms

#### 3.1.1 Cabling method and input line termination

The M2896 cable connection uses a daisy chain system. Ribbon cables or twisted-pair cables are connected with multiple connectors, enabling a maximum of 4 drives to be connected.

These drives are controlled in a multiplex system using drive select lines so that any one drive can be accessed.

Fig. 3-1 shows the cabling method and input line termination.

The M2896 input signal lines must be terminated in a maximum of 8 lines, if alternate input is included, except for the drive select lines. In order to operate the drive correctly, the termination must be at the drive connected to the end of the interface cable farthest from the host system.

The M2896 allows a detachable resistor module to be mounted on its printed-circuit board to terminate these input signal lines.

The drive is delivered from the factor with a resistor module on the printed-circuit board. This terminator resistor must be removed from all the drives except the one that connects to the end of the interface cable.

The termination may be ended at the outside. To do so, connect the input signal lines to 150-ohm, 1/4-watt resistors, and tie the other lead to +5 V DC. In this external termination method, the resistor must be mounted near the drive connected to the end of the cable. When the cable end connector is open, terminate with this connector.

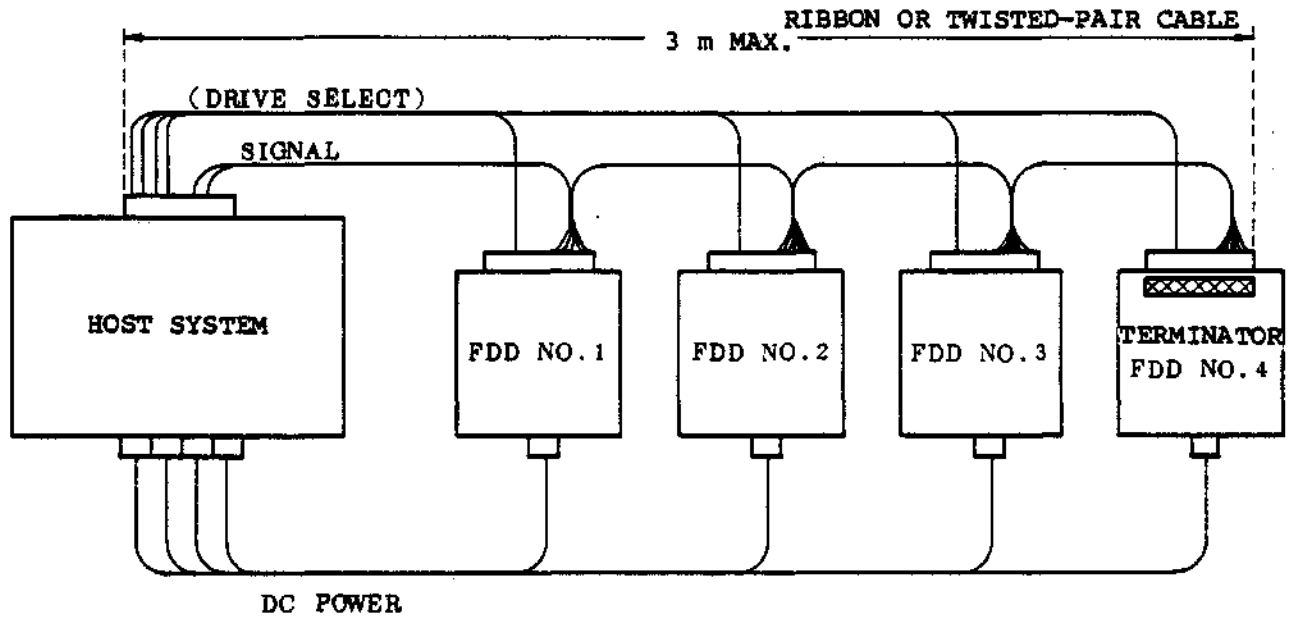


Fig. 3-1 Cabling Method (Schematic Diagram)

3.1.2 Line driver and line receiver

The recommended interface circuit for the line driver and line receiver in the host system and the drives are shown in Fig. 3-2.

The preferred line receiver circuit is a Schmitt trigger circuit having a hysteresis characteristic at switching level in order to improve anti-noise properties in the interface line.



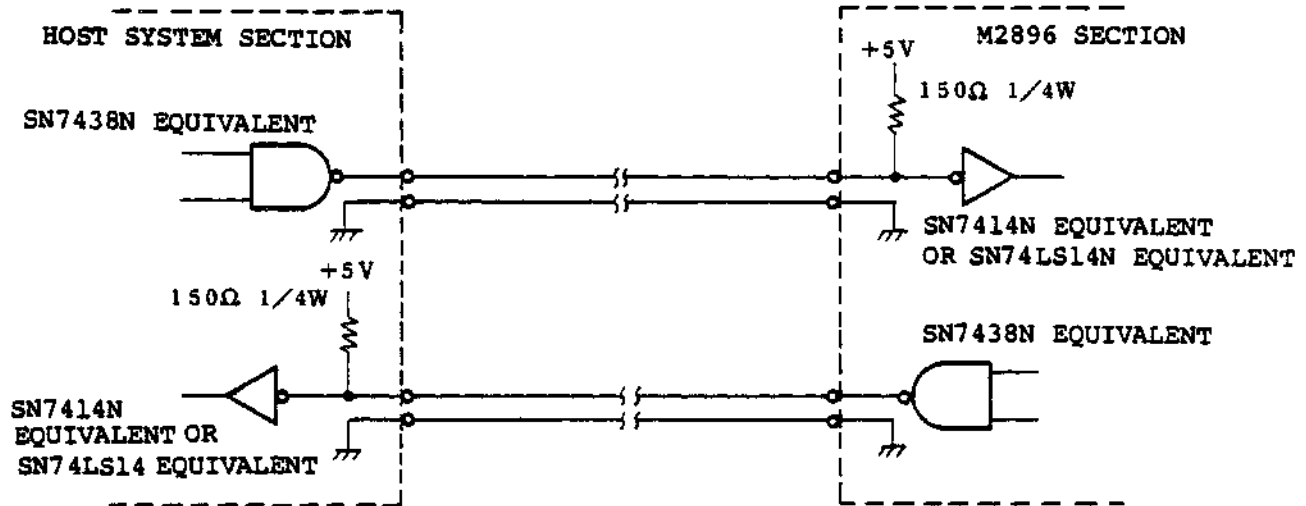


Fig. 3-2 Interface Circuit Recommended for Line Driver and Line Receiver

### 3.1.3 Input signal lines

The M2896 has 12 input signal lines. Of these, 9 lines are standard and 3 lines are options in accordance with customer requirements.

There are two types of input signals; one is multiplexed in a multi-drive system and the other performs a multiplex operation.

The multiplex operating signals are:

- o Drive select 1
- o Drive select 2
- o Drive select 3
- o Drive select 4

(1) Drive select 1 to 4

When these drive select lines are at the logical "0" level, a multiplexed input/output line becomes active to enable the read/write operation. These 4 separate input signal lines, drive select 1 to 4, are provided to make it feasible to drive connect 4 drives to one system and multiplex them



to one another. Traces DS1, DS2, DS3 and DS4 on the M2896 printed-circuit board are used to determine the drive select line to which the individual drives should correspond to become active. These changes of trace connections are made through jumpers. The jumpers are set to DS1 at factory shipment and so must be changed to other lines as required.

(2) Side select

This interface line is used to select, which disk surface of the diskette should be read or written. When this line is logical "1", the head at Side 0 is selected. A line at logical "0" selects the head at Side 1.

When the polarity of the side select signal is reversed, the read/write operation must be delayed 100 us before execution. When a write operation is completed, the side select signal polarity reversal must be delayed 720 us. The reason for this is as follows: The head uses a tunnel erase system and therefore the core gaps physically disagree between those in the read/write head and erase head. This, in turn, causes a timing difference between the areas at the data writing operation and erasing operation on the disk surface. This is corrected within the M2896 by delaying the erase current cutoff for several hundred microseconds. So, during this delay time, the head select must not be reversed.

(3) Direction select

When step signal pulses are given, this interface line signal controls the direction, inward or outward, in which the read/write head moves.

When this signal is logical "1", the read/write head moves toward the outside of the disk. Logical "0" moves the head in the reverse direction.

In the jumper select option, this interface line can time-share two operations: direction select during a track access operation and side select during a read/write operation.

The line then becomes effective as side select signal 14 ms after the track access operation is completed (after the last step signal pulse has been sent).



This option is described in detail in section 6.10.

The direction select line must be reversed 1 us or more before the leading edge of the first step pulse. It must be reversed again 25 us or more after the leading edge of the last step pulse.

(4) Step

This interface line is a pulse signal to move the read/write head in the direction defined by the direction select line.

Each time a signal pulse is given to the step line, the read/write head moves by one track.

This line normally maintains a logical "1" level; the step operation starts from the leading edge of a negative-going pulse (reversal from logical "1" to logical "0").



## (5) Write gate

At logical "0", this interface line makes the write driver active, and the data given to the write data line is written on the disk surface that has been side-selected. At logical "1", the line makes the write driver inactive to enable the read data logic. The verified read data, however, are not obtained during 590 us (MIN.) after the write gate becomes inactive.

Refer to section 4, Fig. 4-4 for the timing.

## (6) Write data

This interface line receives data to be written on the diskette. This line, normally at logical "1", reverses the write current at the leading edge (reversal from logical "1" to logical "0") of the data pulse (negative-going pulse) and writes data bits.

This line is enabled when the write gate is at logical "0".

Fig. 3-3 shows the write data timing.

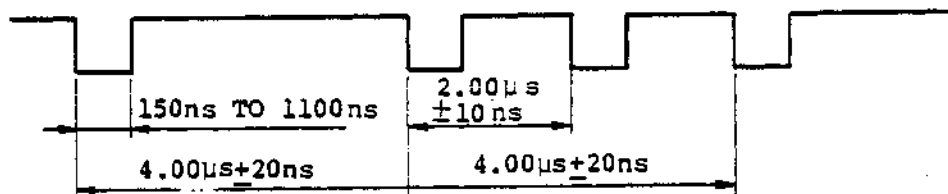


Fig. 3-3 Write Data Timing (FM Encoding)



(7) Head load (alternate input option)

This interface line is an option selected by the customer. When the diskette is inserted, the door is closed and this line goes to logical "0", the read/write head loads on the disk surface. The read/write operation must be performed 35 ms or more after the head load line has become active. Using this signal enables the spindle motor start/stop to be controlled. In this case, head loading must be effected with the in-use signal. Refer to section 6.1 for details of this option.

(8) In use (alternate input option)

This interface is an option selected by the customer. When this interface line is at logical "0", the front panel indicator LED lights and the door can be locked. In addition, the drive select "OR" in use for these functions are available.

Refer to section 6.6 for details.

When the head load signal is used for MOTOR START, this signal can be used for head load.

(9) Outside write current switch (alternate input option)

This interfaces line is an option selected by the customer.

This line at logical "1" for tracks 00 to 43 provide a large write current. Logical "0" in the range of tracks 44 to 76 gives a small write current.

The current switch is designed to reduce the read data bit shift magnitude in the inner tracks.

In the standard M2896, the track number is counted and current switching is performed by an internal circuit.

See section 6.13 for a detailed description of this signal.

3.1.4 Output signal lines

Five standard output signal lines are available from the M2896. In addition, two output line options and six alternate output lines can be selected.



(1) Index

This interface line is normally maintained at logical "1". Each diskette turn (166.7 ms period) provides a 1 to 8 ms width output at logical "0". This signal indicates the start of a track on the rotating diskette. Because the index hole on the jacket is located differently on the single and two-sided diskettes, the drive has two detectors to find the index for whichever diskette is inserted.

Fig. 3-4 shows the index signal timing.

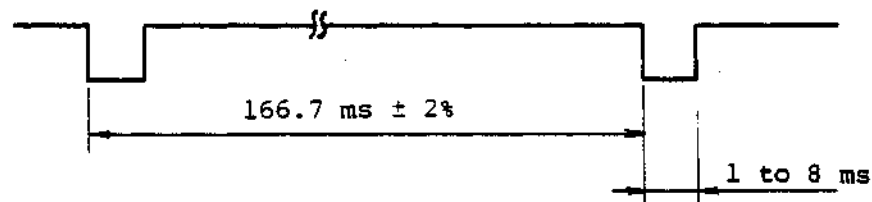


Fig. 3-4 Index Timing

(2) Track 00

When this interface line is at logical "0", it indicates that the read/write head in the drive is positioned to track 00. When the selected drive output is at logical "1", it indicates that the read/write head is positioned at a location other than track 00.

(2) Ready

When this interface line is at logical "1", the door is open or the diskette is not inserted into the drive. When the diskette is inserted into the drive, the door is closed, the index hole is correctly detected, DC power (+5 V and +24 V) is supplied, and thereafter the index is detected two or more times, then logical "0" (ready) occurs. During a single-sided diskette is inserted, if the read/write head at Side 0 is selected, this signal is logical "0", but at Side 1 selection, logical "1" is generated. For two-sided diskettes, logical "0" is maintained independently of side selection.

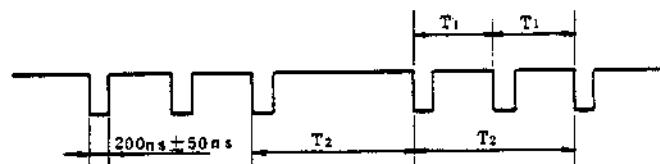
For a further description, refer to section 6.14.



## (4) Read data

This interface line causes the read/write head to read the data stored on the diskette surface and to output raw data (data and clock synthesis) converted to a pulse signal.

This line is normally at logical "1", but sends logical "0" (negative-going pulse) output pulses during the read operation. Fig. 3-5 shows the timing variation for the usual diskette and the allowance for bit shifts.



$T_1 = 2.00 \mu\text{s} \pm 400 \text{ ns}$  (Jitter due to rotation variation is not included.)

$T_2 = 4.00 \mu\text{s} \pm 800 \text{ ns}$  (Jitter due to rotation variation is not included.)

Fig. 3-5 Read Data Timing (FM Encoding)

## (5) Write protect

This interface signal informs the host system that a diskette with a write protect notch is inserted into the drive. Inserting the write-protected diskette into the drive generates a logical "0". When this signal is at logical "0", a write operation on the diskette is inhibited even when the write gate line is active.

## (6) Disk change (alternate output option)

Refer to section 6.8.

## (7) Two-sided (alternate output option)

Refer to section 6.12.

## (8) Alternate I/O pins

These interface pins are options selected by the customer. Use of the pins is described in section 6.

## (9) True ready (alternate output option)

When power is applied to the DC motor and the motor rotates at the rated rpm (READY condition),



and if, furthermore, the seek is completed, logical "0" occurs  $23 \pm 5$  ms from the leading edge of the last step pulse. In addition, a logical "1" is generated 10 us or less from the leading edge of the first step pulse.

3.2 Power Interface

The M2896 requires two types of DC power supplies and no AC supply.

The printed-circuit board and stepping motor require +5V and +24 V supplies.

DC power is supplied through connector J5/P5 attached with the bracket on the printed-circuit board. Two DC voltage specifications are shown in Table 3-3, and the pin arrangement of connector J5/P5 is shown in Table 3-1.

Table 3-3 DC Power Specifications

DC voltage	Voltage Variation	Current	Maximum ripple voltage (peak-to-peak)
+5 V DC	+0.25 V	0.8 A TYP.	100 mV
	(+5%)	1.0 A MAX.	
+24 V DC	+2.4 V	0.8 A TYP. 1.0 A MAX.	200 mV
	(+10%)	(NOTE)	

NOTE; 1.3 A MAX. when motor starts. (typically 10 ms)





## CHAPTER 4 FUNCTIONAL OPERATION

## 4.1 Power On Sequencing

To operate the M2896, DC power must be turned on. Read/write operation must not be performed within 0.5 second after the DC power supply is turned on to allow the diskette rotation to stabilize and to become the system ready.

After DC power turn on, probably the read/write head is not correctly positioned on the track. Before a read/write operation, make sure to perform a step-out operation with the controller until the track 00 signal is detected at the interface line to enable the read/write head to be positioned correctly.

Fig. 4-1 shows the power on sequence timing.

## 4.2 Drive Selection

The M2896 uses a daisy chain cabling system in which multiple drives connect to single cable. The selection of individual drives is actuated when the drive select line goes active. Only the drive whose selection line is active can communicate with the host system. When multiple drives are connected, the select line at the drive side must be set to a different number for each drive. If the same number is set in more than one drive, the interface output signals mutually interfere and operating errors occur.

## 4.3 Track Accessing

The seek operation moves the read/write head inward or outward to the desired position as determined by the polarity of the "direction" signal, using the "step" signal to move the head. To move plural tracks, step pulses should be emitted until the heads reach the desired tracks. Head motion starts with the leading edge of a step pulse. Fig. 4-2 shows the operation timing.

## 4.4 Side Selection

The heads located on both sides of the diskette are selected by the "side select" signal. When the side select line is high, the head at Side 0 is selected; when it is low, the head at Side 1 is selected.



#### 4.5 Read Operation

Fig. 4-3 shows the timing relationship required for a read operation. These timing specifications are necessary for an accurate read operation to be performed. FM or MFM is used for coding data to be stored on the diskette. FM is used for single density, and MFM for double density recording. Sophisticated PLO data separator is recommended for data interchangeability with other system or drives.

Fig. 4-5 shows the coded data timing.

#### 4.6 Write Operation

Fig. 4-4 shows the timing relationship required for a write operation. These timing specifications must be followed for an accurate write operation to be performed.

Either FM or MFM can be used for encoding write data. The M2896 incorporates high performance read/write heads having good contact stability between the head and diskette. It is therefore unnecessary, when writing data with MFM (double density), to apply precompensation that corrects bit shift effect at write operation. But to harmonize with other precompensated systems, a maximum of 200 ns write precompensation may be applied.



## 4.7 Special Operations

The M2896 is provided with a write current switch that effectively reduces the bit shift value of read data pulses from the diskette, and is also provided with a function, in the drive, to generate signals that make the data separator timing margin high even if the host system does not have an interface signal for post compensation, called a switch filter, compensating read amplifier frequency band.

More specifically, the track numbers are sorted in the drive circuit, with an LSI counter, so that the write current is switched at track 44 or above, and the switch filter is activated at track 60 or above.

In order for these functions, the counter must cause the read/write heads to be moved to track 00, so that the contents are initialized to track 00 under each of the following conditions:

- o Drive power is turned on,
- o Seek error occurs

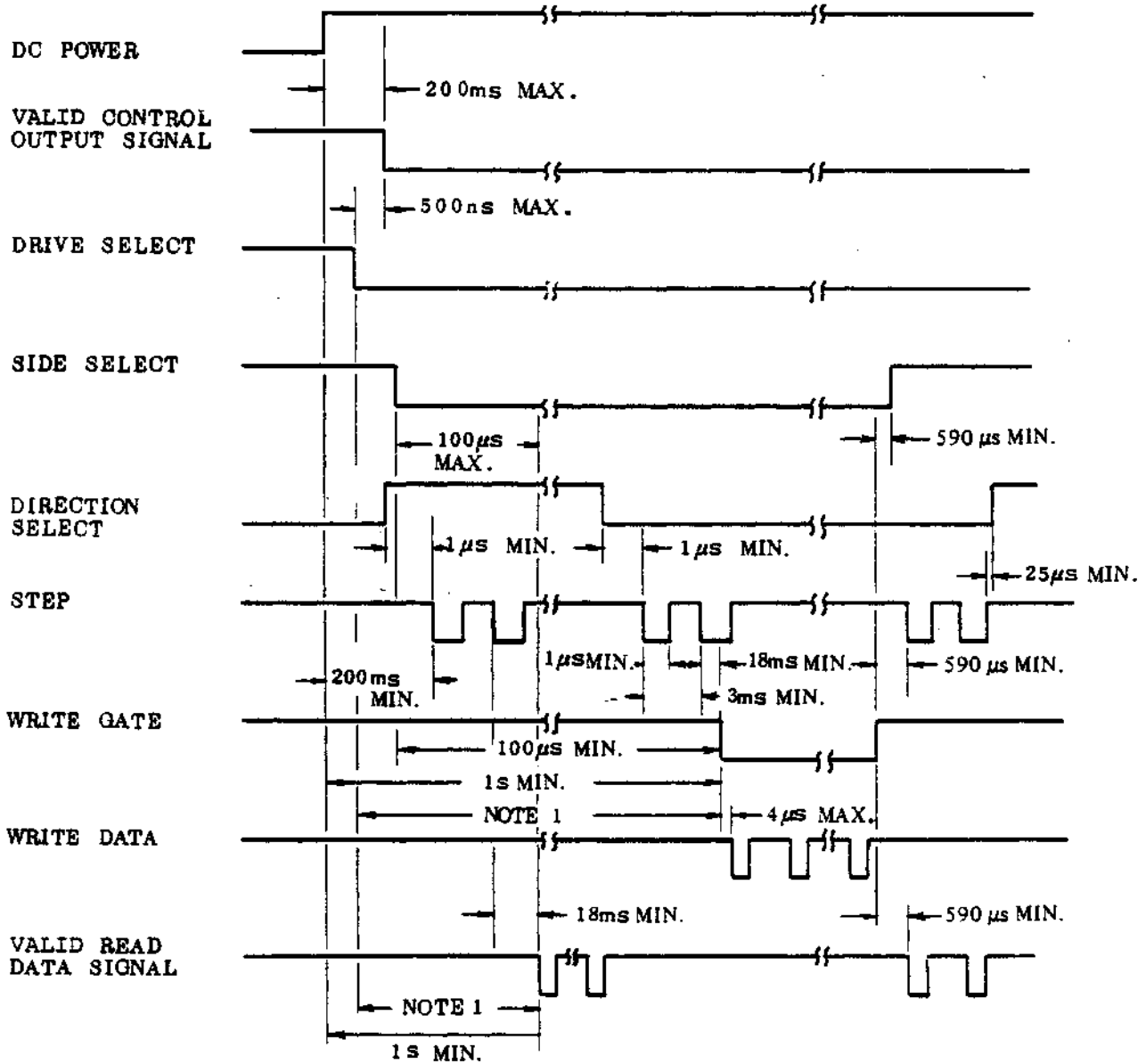
These conditions in which the track number that the host system tries to access is not clear. In any case other than power turn-on, in which the read/write head positioned-track numbers in each drive are clear, there are no errors between the counter in the drives and the host system. In such a case, it is unnecessary to move the read/write head to track 00 to initialize counters of the drives.

### 4.7.1 Internal write current switch

By connecting the trace "SI" on the M2896 printed-circuit board, write current can be increased for tracks 00 to 43 and decreased for tracks 44 to 76.

### 4.7.2 Internal switch filter

The LSI on the M2896 printed-circuit board decreases the gain in the high area in the read preamplifier frequency bandwidth for tracks 00 to 59, and increases it for tracks 60 to 76, thereby effecting a decrease in bit shift variation.



NOTE 1: Refer to section 6 Customer installation options.

Fig. 4-1 General Control and Data Timing

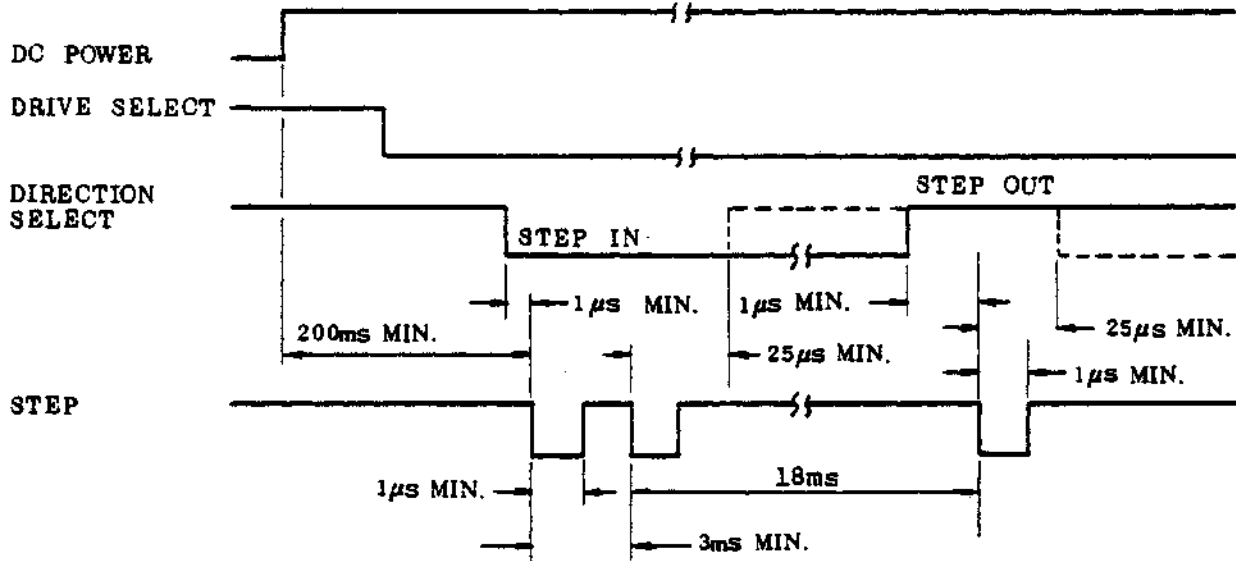


Fig. 4-2 Track Access Timing

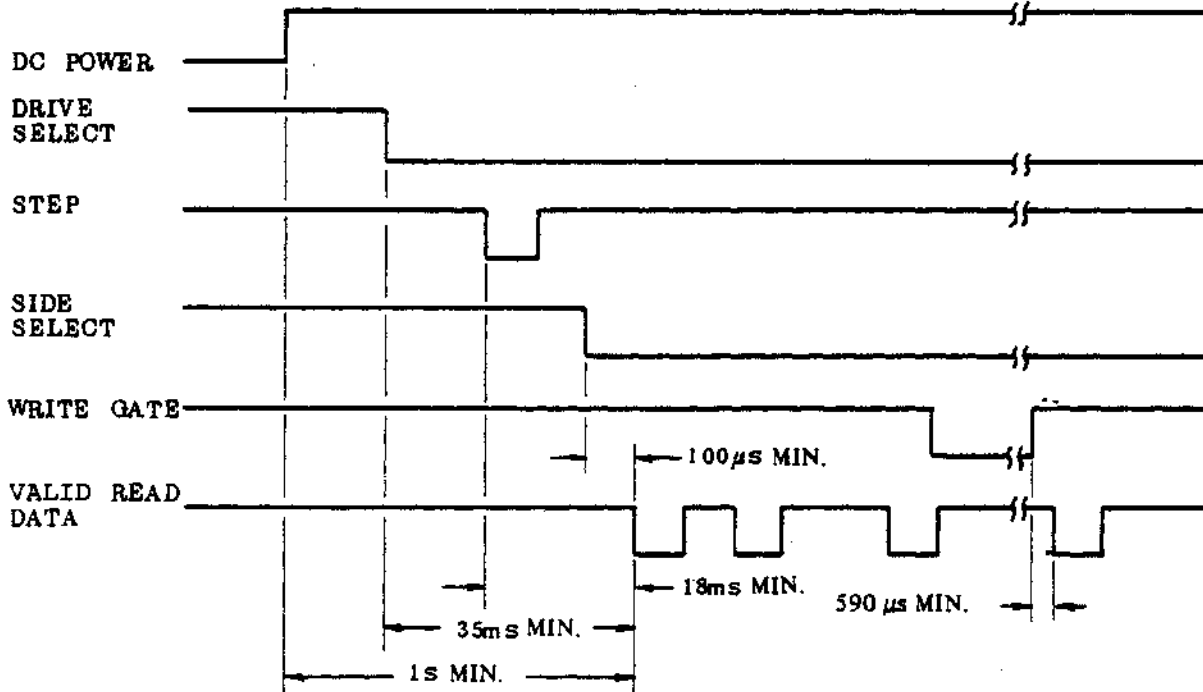


Fig. 4-3 Read Operation Start Timing

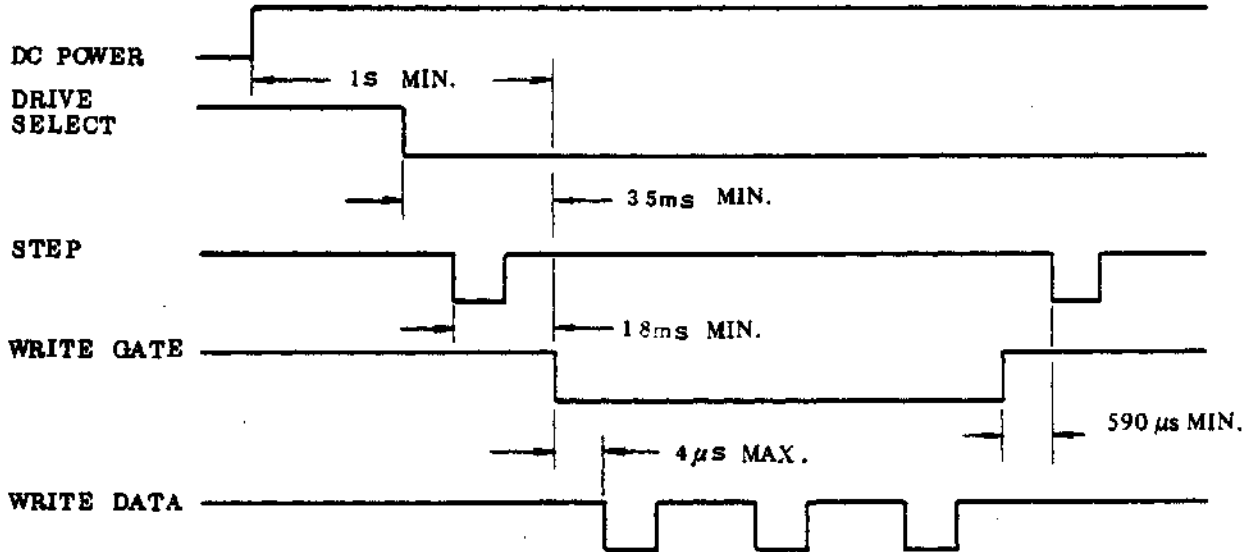


Fig. 4-4 Write Operation Start Timing

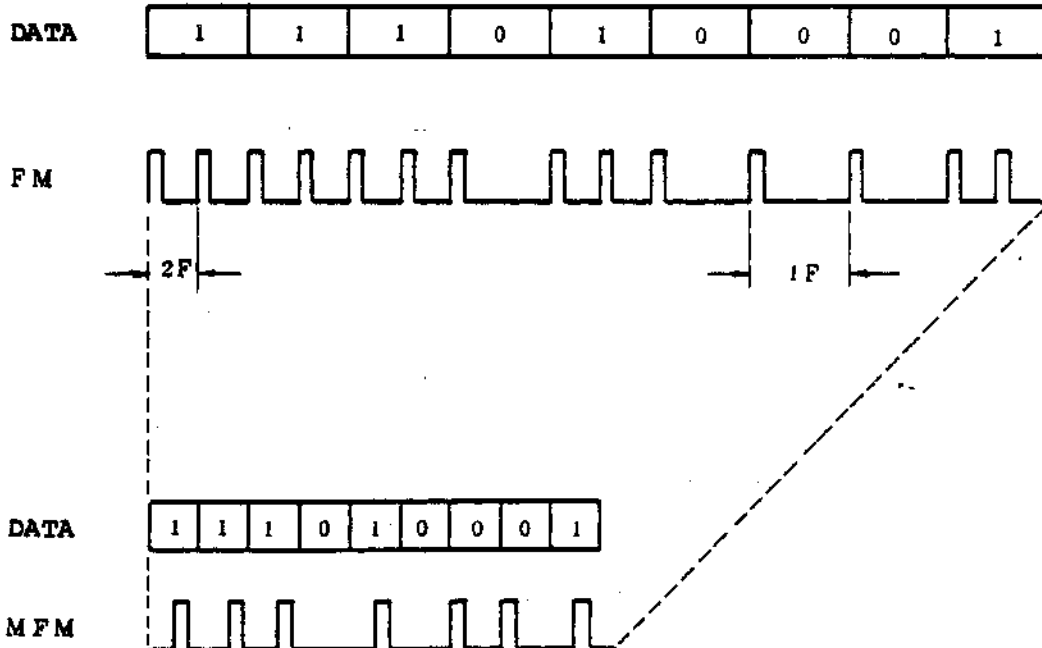


Fig. 4-5 Comparison between FM and MFM Coding Systems



CHAPTER 5 PHYSICAL INTERFACE

Electronic interfaces between the M2896 and the host system are accomplished with two connectors. The J1 connector is for signal interfaces and the J5 connector is for DC power. Connectors used for the M2896, and recommended mating connectors are described below.

5.1 Signal Connector (J1/P1)

J1 is a card-edge type, 50-pin (both sides used with 25 pins per side) connector with the component side pins even numbered (2, 4, .....50) and the solder side pins odd numbered (1, 3, ...49). There is a key slot between pin 4 and pin 6 to allow the use of a reverse-preventing key. J1 dimensions are shown in Fig. 5-1, and the recommended P1 connectors mating with J1 are shown in Table 5-1.

Table 5-1 Recommended P1 Connector Type

Cable used	Maker	Connector housing	Contact
Twisted-pair Cable No. 26	AMP	1-583717-1	583616-5 (Crimp) 583854-3 (Solder)
Flat cable	3M	3415-0001	NA

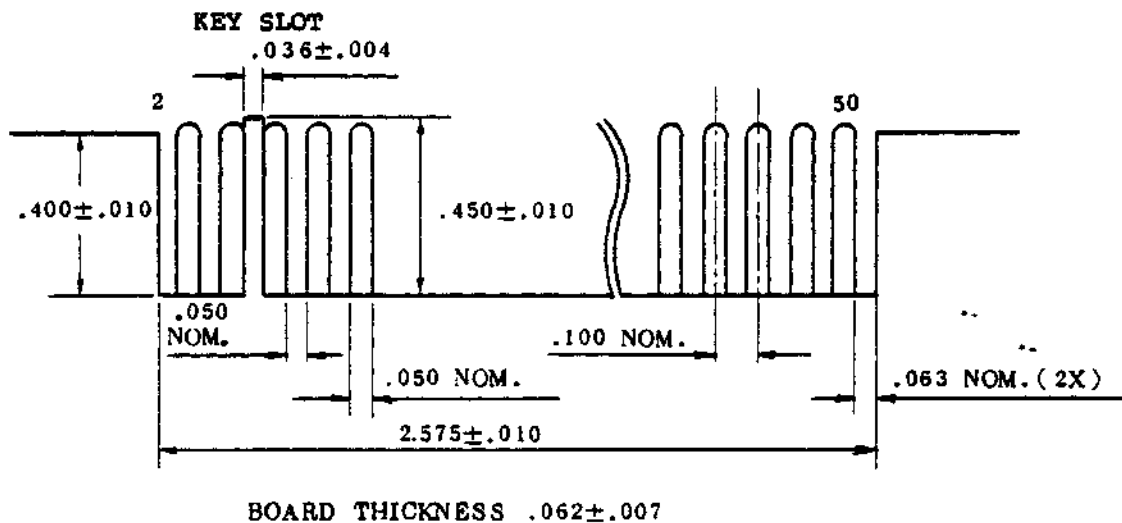


Fig. 5-1 J1 Connector Dimensions and Numbers (dimensions in inch)



5.2 DC Power Connector (J5/P5)

J5 is a DC power connector with six pins, attached to the printed-circuit board bracket.

Fig. 5-2 shows the pin arrangement for J5. The pin numbers are indicated on the component side.

Table 5-2 P5 Connector Type

Cable used	Maker	Connector housing	Contact
AWG 20 to 14	AMP	1-480270-0	60619-1

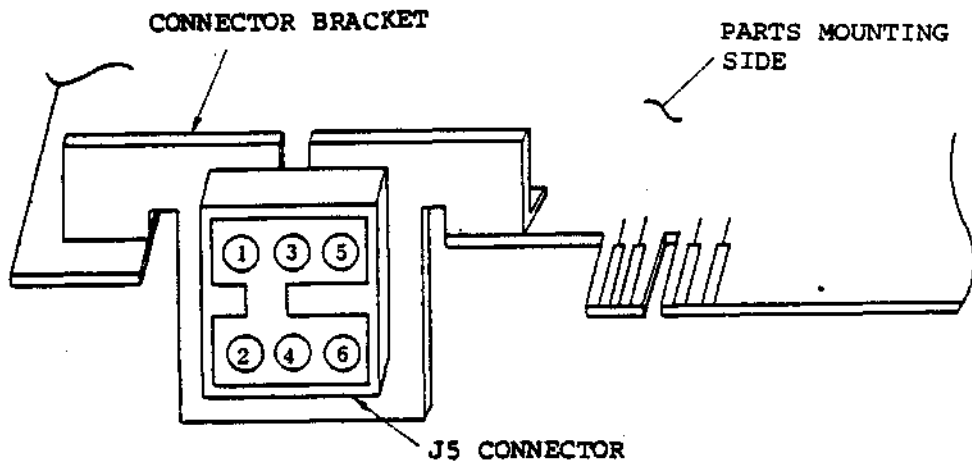


Fig. 5-2 J5 Connector Pin Arrangement





### 5.3 Interface Connector Physical Location

Fig. 5-3 shows the physical locations of the M2896 interface connectors.

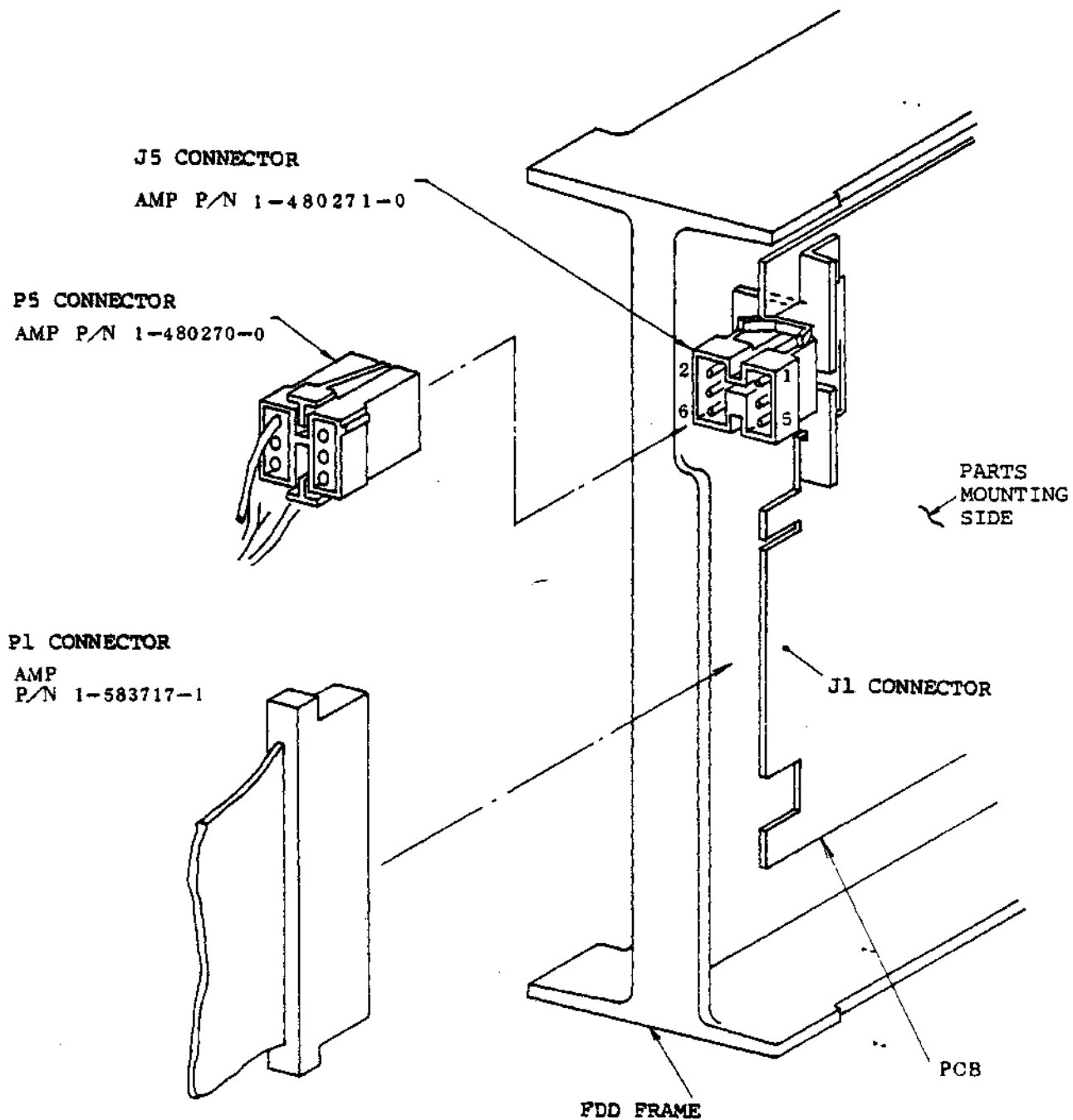


Fig. 5-3 Location of Interface Connectors





Table 6-1 Customer CUT/ADD Trace Options

Trace Designator	Location	Description	Shipped From Factory	
			Open	Short
TERMINATOR	E1	Input line terminator		Plugged
JFG	A1	Frame ground and signal ground are shorted		Plugged
JSG	A1	Frame ground and signal ground are opened	X	
DS1	D1	DRIVE SELECT 1 Input		Plugged
DS2,DS3,DS4	D1	DRIVE SELECT 2,3,4 Input	X	
1B,2B,3B,4B	D1	SIDE SELECT Option using DRIVE SELECT	X	
SE	C1	External WRITE CURRENT SWITCH	X	
SI	C1	Internal WRITE CURRENT SWITCH		Plugged
S	C1	"Keep Open"	X	
DC	C1	DISK CHANGE Option	X	
2S	C1	TWO-SIDED Status Output	X	
IT	D1	IN USE Terminator		Plugged
D	D1	Alternate Input - IN USE	X	
HI	D1	HEAD LOAD "OR" IN USE to the IN USE CIRCUIT	X	
C	D1	Alternate Input - HEAD LOAD	X	
I	D1	INDEX Output		Plugged
R	D1	READY Output		Plugged
S1	D1	SIDE SELECT Option using DIRECTION SELECT	X	
S2	D1	Standard SIDE SELECT Input		Plugged
S3	D1	SIDE SELECT Option using DRIVE SELECT	X	



Table 6-1 (Cont.)

Trace Designator	Location	Description	Shipped from factory	
			Open	Short
RS	D4	READY Standard		Plugged
RM	D4	READY Modified	X	
RFa	F2	"Don't Remove"		Plugged
RFb	F2	"Keep Open"	X	
MO	E1	MOTOR ON from HEAD LOAD	X	
MS	D1	MOTOR ON from DRIVE SELECT	X	
Z	D9	IN USE LED from DRIVE SELECT		Plugged
NP	F9	Allow Write when WRITE PROTECTED	X	
WP	F9	Inhibit Write when WRITE PROTECTED		Plugged
A	D4	Radial HEAD LOAD		Plugged
B	D3	Radial HEAD LOAD		Plugged
X	D4	Radial HEAD LOAD		Plugged
RI	D1	Radial INDEX		X
RR	D1	Radial READY		X
RI	C2	Radial INDEX		X
RR	C3	Radial READY		X
Y	E8	IN USE from HEAD LOAD	X	
V	E8	Door Lock from HEAD LOAD		X
HLL	D10	HEAD LOAD Latch	X	
DL	D10	Door Lock Latch Option	X	
HUN	C5	HEAD UNLOAD Normal	X	
HUD	C5	HEAD UNLOAD Delay		Plugged



Table 6-1 (cont.)

Trace Designator	Location	Description	Shipped	
			From Open	Factory Short
HR	C4	HOLD READY Output	X	
HY	C4	Standard READY		Plugged
M1	D1	Use J1 pin for MOTOR START	X	
M2	D1	USE J1 pin 18 for MOTOR START		Plugged
PS	C2	HEAD LOAD Anded with Standard READY		Plugged
PH	C2	HEAD LOAD Anded with HOLD READY	X	
E1	C4	"Keep Open"	X	
E2	C4	"Do not cut"		X
V1	E9	"Do not cut"		X
V2	E9	"Keep Open"	X	
V3	C5	"Do not cut"		X
V4	C5	"Keep Open"	X	
V5	E4	"Keep Open"	X	
V6	E4	"Do not cut"		X
V7	D3	"Keep Open"	X	
V8	D3	"Do not cut"		X



## 6.1 Loading Heads With Drive Select "AND" Head Load Signal

In this option, loading head is accomplished by means of drive select signal "AND" head load signal and therefore the life of heads and media is further prolonged. When the system requires the drive to perform a read/write operation, the head load line is made active (logical "0"). This causes the heads to load and the step motor to be full powered.

The write or read operation must be performed 35 ms or more after the head load line goes active.

To perform the modification for this option, set traces as follows:

- o Short-plug "C" ---- short
- o Short-plug "X" ---- open
- o Short-plug "B" ---- short
- o Short-plug "A" ---- short

## 6.2 Loading Heads With Head Load Signal (Selecting Drive is Accomplished By Means of Drive Signal)

This option enable a seek operation by drive selection without loading the heads or with the door open. In this case, as in the one above, make sure to perform the read or write operation 35 ms or more after the head load line goes active (logical "0").

This option is recommended because it provides longer media life.

To perform the modification for this option, set traces as follows:

- o Short-plug "C" ---- short
- o Short-plug "X" ---- short
- o Short-plug "B" ---- open
- o Short-plug "A" ---- short



### 6.3 Loading Heads With Head Load Signal (Selecting Drive is Accomplished By Means of Drive Select Signal "AND" Head Load Signal)

Head loading is accomplished by means of head load signals. These are independent of the drive select signals.

This option is used for a mutual copy operation between diskettes in which the need for considering head load time can be eliminated and copy time can thus be reduced. Each drive remains in the head load condition for alternate input/output pins.

The read or write operation must be performed 18 ms or more after drive selection.

In this option, the AND logic condition of the drive select signals and head load signals represents the drive select condition.

To perform the modification for this option, set traces as follows:

- o Short-plug "C" ---- short
- o Short-plug "X" ---- short
- o Short-plug "B" ---- short
- o Short-plug "A" ---- open

### 6.4 Radial Ready

This option enables the ready line of each drive to be monitored without drive selection.

To perform the modification for this option, set traces as follows:

The first drive;

- o Short-plug "R" ---- short
- o Short-plug "RR" ---- open

Others;

- o Short-plug "R" ---- open
- o Pattern "RR" ---- open
- o Connect short-plug "R" and alternate I/O pin 4, 6 or 8.



(To use alternate input/output pin No. 2, open trace "0-2" and set short-plug "SE" open).

The circuit relating to this modification is shown in Fig. 6-2.

NOTE: A stopper is controled in the power-down mode except during the seek operation.

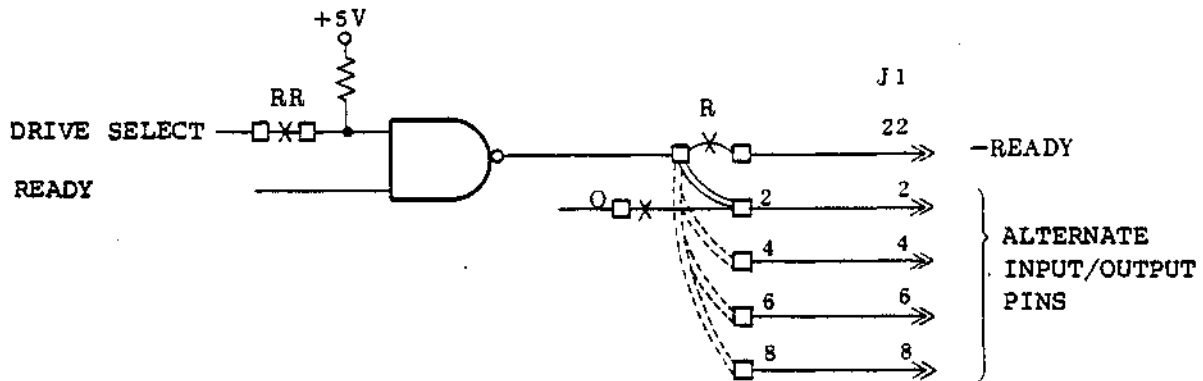


Fig. 6-2 Radial Ready Circuit

6.5 Radial Index

This option enables constant monitoring on the index line and reduces mean latency time.

To perform the modification for this option, set traces as follows:

The first drive:

- o Short-plug "I" ---- short
- o Pattern "RI" ---- open

Others;

- o Short-plug "I" ---- open
- o Pattern "RI" ---- open
- o Connect short-plug "I" and alternate I/O pin 4, 6 or 8.

(To use alternate input/output pin No. 2, open trace "0-2" and set short-plug "SE" open).

The circuit relating to this modification is shown in Fig. 6-3.



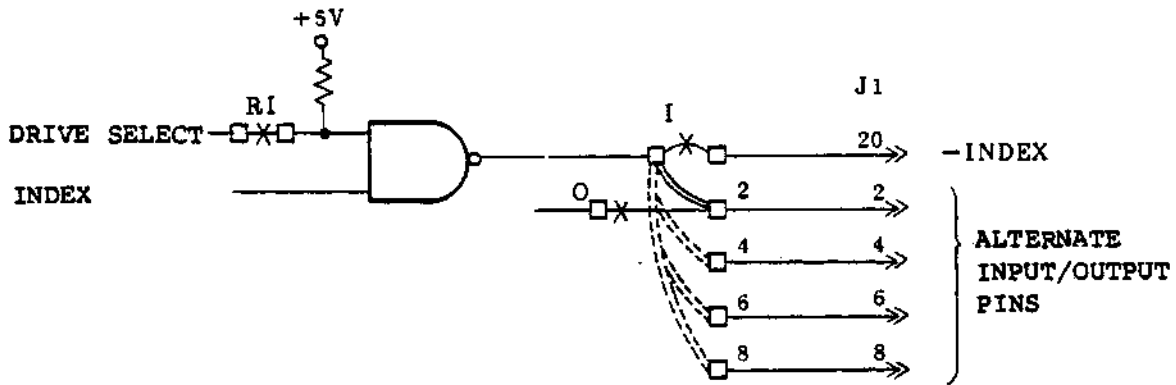


Fig. 6-3 Radial Index

6.6 In Use Alternate Input (Activity LED)

when this alternate input becomes a logical "0", the activity LED on the front panel lights and the door of the drive locks.

The conditions under which the LED lights are selected as follows by setting the short-plugs.

6.6.1 Plug settings to light LED with in use "OR" drive select signal.

- o short-plug "D" ---- short
- o Short-plug "IT" ---- short
- o Pattern "Y" ---- open
- o Short-plug "Z" ---- short

6.6.2 Plug settings to light LED with head load "OR" in use signal.

- o Short-plug "D" ---- short
- o Short-plug "IT" ---- short
- o Pattern "Y" ---- short (jumper)
- o Short-plug "Z" ---- open

Under the conditions listed above, the in use conditions are not entered when the short-plug "D" is open. These conditions are added when the in use switch (or head load latch) is used.

The circuit relating to this modification is shown in Fig. 6-4.

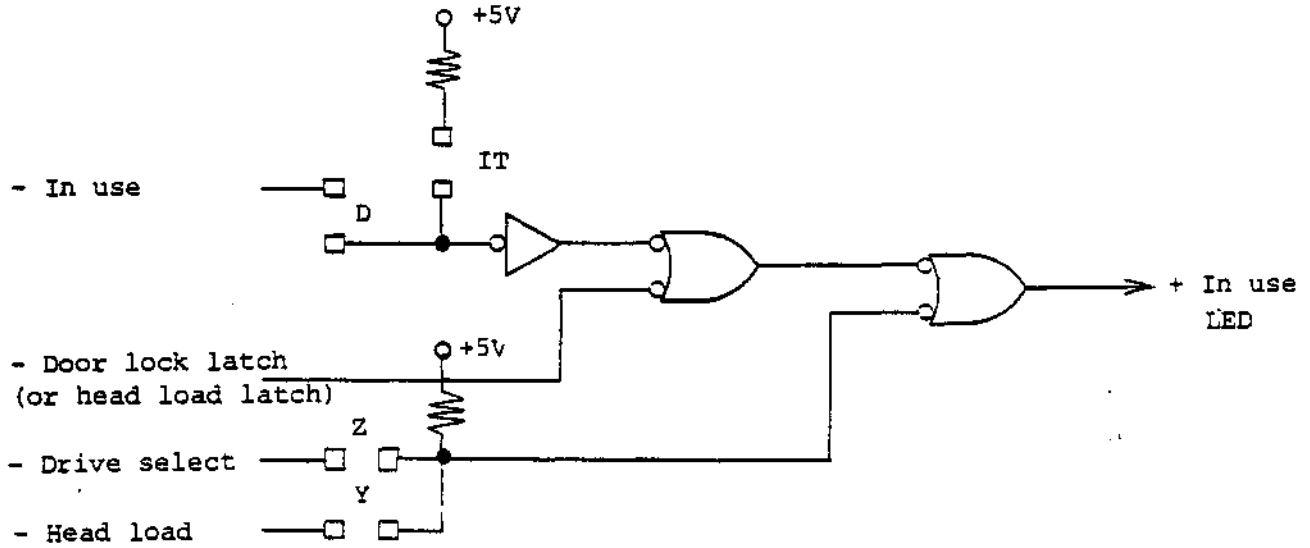


Fig. 6-4 In Use/Activity LED Circuit

### 6.7 Write Protection Option Use

When a diskette with write protect notch is inserted, the write protect is set so that writing is inhibited within the drive at delivery from the factory.

The modification for this option releases an inserted diskette with a write protect notch from write inhibition, and informs the interface that a protected diskette is inserted.

This option is used to identify a special-use diskette. To perform the modification for this option, set traces as follows:

- o Short-plug "WP" ---- open
- o Short-plug "NP" ---- short

The circuit relating to this modification is shown in Fig. 6-5.

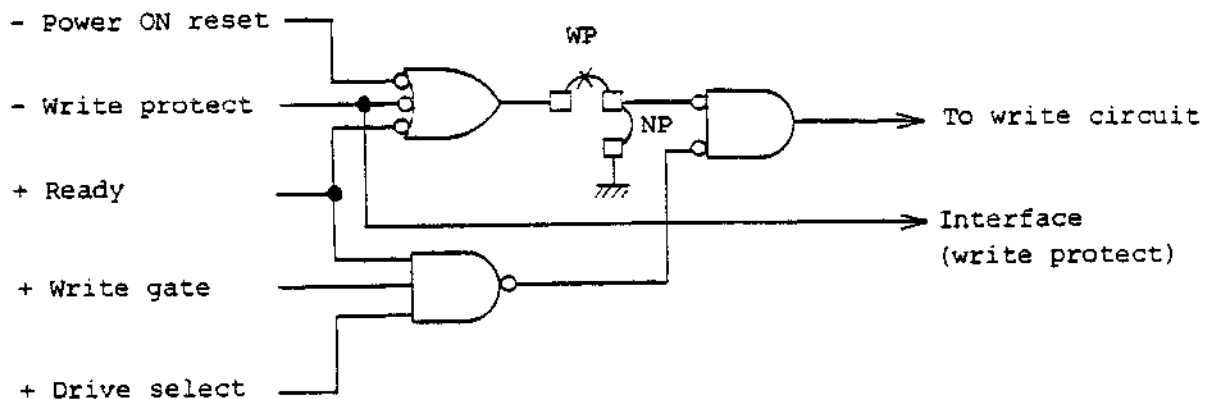


Fig. 6-5 Write Protect Circuit



### 6.8 Disk Change (Alternate Output)

When a not-selected drive becomes Ready after Not Ready (door is opened during not selected) and following drive select goes active, the line of this option goes to the logical "0" level. The line resets at the point when the drive select reverses from logical "0" to logical "1".

To perform the modification for this option, set traces as follows:

- o Short-plug "DC" ---- short

### 6.9 Side Selection Using Direction Select

The side select can also be controlled by the direction select line.

This option provides control two ways: one for controlling head motion direction during a seek operation; the other for head select control during a read/write operation.

To perform the modification for this option, set traces as follows:

- o Short-plug "S1" ---- short
- o Short-plug "S2" ---- open
- o Short-plug "S3" ---- open

### 6.10 Side Selection Using Drive Select

In a system using one or two M2896, it is possible to separate each head and assign drive addresses to them. In this event, four drive select lines are used to select four read/write heads.

To perform the modification for this option, set traces as follows:

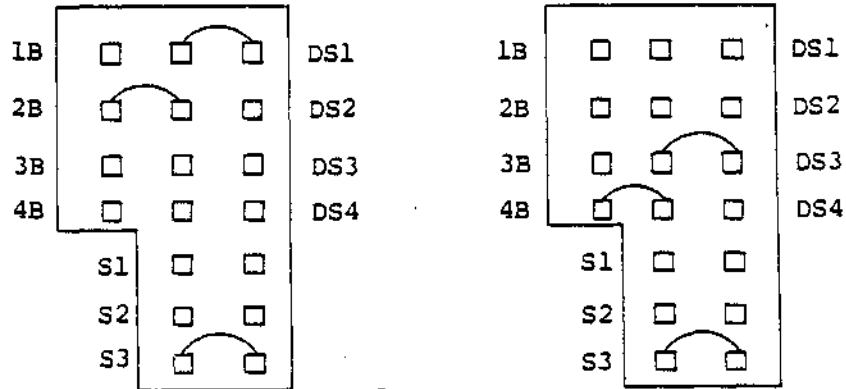
- o Both drives.
  - . Short-plug "S1" ---- open
  - . Short-plug "S2" ---- open
  - . Short-plug "S3" ---- short
- o The first drive



- . Short-plug "DS1" ---- short
- . Short-plug "2B" ---- short
- o the second drive
- . Short-plug "DS3" ---- short
- . Short-plug "4B" ---- short

The first drive

The second drive



The drive select lines then perform side select operation as follows:

- Drive select 1 selects the first drive side 0
- Drive select 2 selects the first drive side 1
- Drive select 3 selects the second drive side 0
- Drive select 4 selects the second drive side 1



### 6.11 Door Lock Latch

This option causes the door to be latched and to remain locked, under control of drive select, without maintaining In Use active.

When the In Use line is active (logical "0"), and drive select line becomes active (logical "0"), the door is latched and a door lock condition is maintained. To release the door lock condition, make the In Use line inactive (logical "1"), and make the drive select line active.

To perform the modification for this option, set traces as follows:

- o Pattern "DL" ---- short(Jumper)
- o Short-plug "D" ---- short
- o Short-plug "HI" ---- open

### 6.12 Two-Sided

This signal discriminates which type of diskette (two-sided or single-sided) is inserted. A logical "0" is output for insertion of a two-side diskette.

To perform the modification for this option, short traces as follows:

- o Short-plug "2S" ---- short

### 6.13 Write Current Switch

By making this interface signal logical "0" for tracks 44 to 76, write current can be decreased; otherwise the current is controlled by internally.

To perform the modification for this option, set traces as follows:

- o Short-plug "SI" ---- open
- o Short-plug "SE" ---- short

When this option is not used, interface connector pin No. 2 can be used for an alternate input/output pin, with trace "0-2" disconnected.



6.14 Ready Standard/Ready Modified

This option is used to cause Ready to maintain a logical "0", when Side 1 is selected while using a single-sided medium. This option is useful when direction select is used as side select.

To perform the modification for this option, set traces as follows:

- o Short-plug "RS" ---- open
- o Short-plug "R7" ---- short

6.15 Head Load Latch

This option is used to perform head load when the drive is not selected. When the head load is latched it is necessary to cause the drive select line to be active, with the head load signal or in use signal line being active (logical "0").

To perform the modification for this option, set traces as follows:

6.15.1 When the head load signal is active and drive select is to be latched.

- . Short-plug "IT" ---- open
- . Short-plug "D" ---- open
- . Short-plug "HI" ---- short
- . Short-plug "C" ---- open
- . short-plug "X" ---- short
- . Short-plug "B" ---- open
- . Short-plug "A" ---- short
- . Pattern "DL" ---- short (jumper)
- . Pattern "HLL" ---- short (jumper)



6.15.2 When the in use signal is active and drive select is to be latched.

- . Short-plug "IT" ---- short
- . Short-plug "D" ---- short
- . Short-plug "HI" ---- open
- . Short-plug "C" ---- open
- . Short-plug "X" ---- short
- . Short-plug "B" ---- open
- . Short-plug "A" ---- short
- . Pattern "DL" ---- short(jumper)
- . Pattern "HLL" ---- short(jumper)

To release head load latch, make the head load line or in use line inactive (logical "1") and then select the drive.

6.16 Door Lock Condition

6.16.1 Door lock with in use "OR" head load signals

To perform the modification for this option, set traces as follows:

- o Short-plug "C" ---- short
- o short-plug "X" ---- short
- o Pattern "V" ---- short(jumper)
- o Pattern "Y" ---- open

6.16.2 Door lock with in use "OR" drive select signals

To perform the modification for this option, set traces as follows:

- o Short-plug "A" ---- short
- o Short-plug "Z" ---- short
- o Pattern "V" ---- open
- o Pattern "Y" ---- short(jumper)



## 6.17 Motor Start

The spindle motor is normally actuated when the DC power supply is ON and a disk is inserted, however the short-plugs may be used to set the following three conditions. Read/write operation should not be performed during the 500 ms interval required between motor start and READY.

### 6.17.1 Motor start with head load signal Plug settings

- o Short-plug "MO" ---- short
- o Short-plug "MS" ---- open

### 6.17.2 Motor start with drive select signal Plug settings

- o short-plug "MO" ---- open
- o Short-plug "MS" ---- short

### 6.17.3 Motor start with head load "AND" drive select Plug settings

- o Short-plug "MO" ---- short
- o Short-plug "MS" ---- short





CHAPTER 7 DRIVE PHYSICAL SPECIFICATIONS

This section describes the M2896 dimensions and installation procedure.

7.1 Drive Dimensions

Fig. 7-1 shows the M2896 drive dimensions, screw mounting hole locations and dimensions, and front panel dimensions.

7.2 Mounting Recommendations

The M2896 can be installed in the following directions without mechanical adjustment:

- o Vertical: Door opens to the right or left.
- o Horizontal: Door open upward.
- o Slant mounting should be within 10 degrees.

7.3 Mounting

To mount the drive, use the six screw taps on the sides of the drive or the four taps on the bottom of the drive.

See Fig. 7-1 for details of the above mounting taps and for the overall dimensions of the M2896.

7.4 Air Flow

Ensure tha the ambient temperature in the FDD case does not exceed 43 degrees while in operation.

NOTE: The ambient temperature in the FDD case is taken as that at point B in Fig. 7-2. An example of the recommended air flow is shown in Fig. 7-2, it should be referred to at system installation.



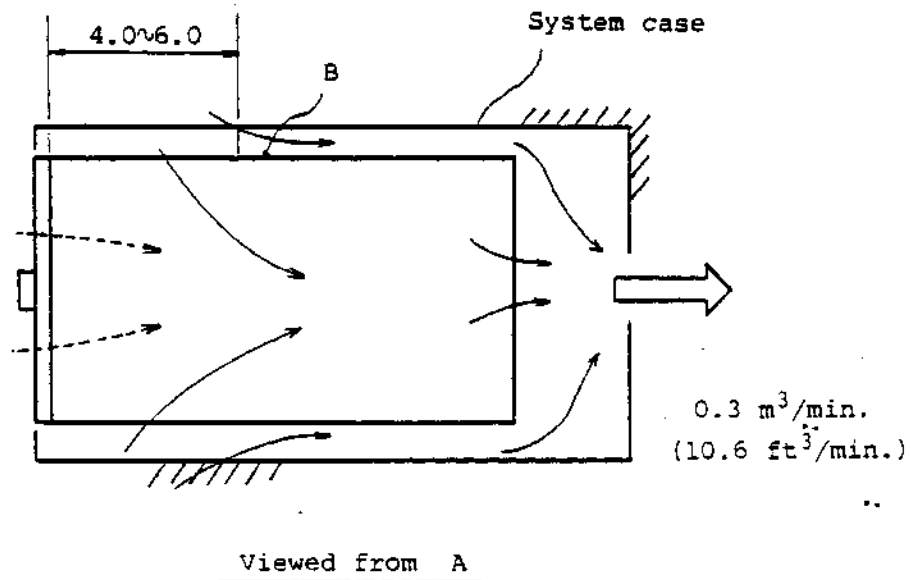
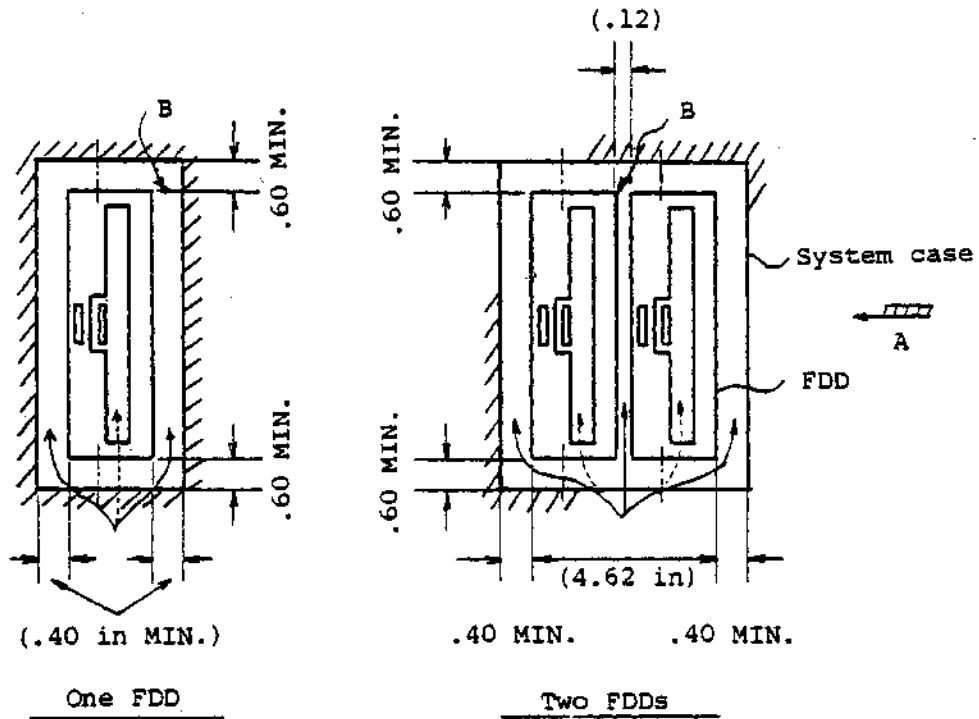


Fig. 7-2 Recommended Air Flow (dimensions in inch)



## CHAPTER 8 ERROR DETECTION AND CORRECTION

This section describes general analysis of data errors and data correction.

## 8.1 Write Error

If a write error occurs during a write operation, it will be detected on the next revolution by performing a read operation, commonly called a "write check". To correct the error, another write and write check operation must be done. If the write operation is not successful after several attempts have been made, a read operation should be attempted on another track to determine if the drive is safe. If the other track is read correctly, the track on which write failed is a defective track and operation should be changed to another track or another medium.

## 8.2 Read Error

Most read errors that occur will be "soft" errors; that is, by performing an error-recovery procedure, the data will be recovered.

Soft errors are usually caused by:

- o Airborne contaminants that pass between the read/write head and the disk medium. These contaminants will generally be removed by the cartridge self-cleaning wiper. However, in an environment with extremely large amounts of dust contamination, the disk surface may be impaired during prolonged read/write operation, causing hard errors.
- o Random electrical noise, which usually lasts for a few microseconds to several milliseconds. Spike noise, especially those caused by short-period switching regulators, affect the S/N ratio and lead to a higher frequency of re-read operations necessary for data recovery. It is therefore essential to check the noise levels of the DC power supply to the drive and of the frame ground.
- o Small defects in the written data and/or track not detected during the write operation, which may cause a soft error during a read.
- o Dust adheres to the disk surface, e.g., as a result of fingerprints, after the write operation, this may lead to temporary errors. It should be remembered however, that these temporary or transient errors will turn into hard errors if the unit is continuously operated for a long time with







CHAPTER 10 TYPE REFERENCES TO BE STATED WHEN ORDERING

10.1 Table Listing Changes in Type Reference Designations (indicated by three alphabetic characters in the secondary name chart)

M2896-63- X Y Z

Alphabetic character; mounting screw (See Fig. 7-1)

Alphabetic character: Front panel color

Alphabetic character; front panel size

X Front panel size

X	Dimensions
0	2.25 x 8.55 x 0.39 inches
1	

Y Front panel color

Y	Panel color	Handle/button color
0	Ivory-white	Ivory-white
2	Black	Black

Z Mounting screw

Z	Mounting screw specifications
U	Unified screw No. 8-32UNC x .25 DP
M	Metric screw M4 x 0.7 Screw Depth .25

NOTE: M2896-63-02U is the standard model No. Check catalog before ordering other models.



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