Rigid Disk Drive Specification Manual

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MMI DISK DRIVE SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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INTRODUCTION

The purpose of this manual is to introduce the Microcomputer Memories, Inc. (MMI) family of Winchester disk drives and to provide operating requirements and specifications.

GENERAL DESCRIPTION

MMI disk drives feature 3.78-inch (96mm) nonremoveable Winchester disks that provide unformatted data storage of 12.75 megabytes in two-disk models and 25.5 megabytes in four-disk models.

The drives can be mounted in three different bracket sizes: 3.5-inch, 5.25-inch half-height and 5.25-inch full-height. Each of these brackets conform to industry-standard mounting dimensions.

All models contain a standard Seagate ST-412 interface for control and data communications with the host controller. Table 1 summarizes the MMI disk drive models.

Table 1. MMI Disk Drive Models

	BRACKET SIZE		
NO. OF DISKS	3.5-Inch	5.25-Inch Half-Height	5.25-Inch Full-Height
2	Model M112	Model M212	Model M312
4	Model M125	Model M225	Model M325

The 3.5-inch rigid disk drive provides the following advantages:

- Smaller footprint
- Less weight
- Greater shock resistance
- Lower power requirement
- Less heat generation
- ST-412 interface
- Space for extra shock protection
- Common parts
- 12,000 hour MTBF

MMI disks contain 306 cylinders, are soft-sectored, and rotate at 3,600 rpm. They do not contain any prewritten data for use by drive control electronics, such as embedded servo information at index or read/write sync data outside the normal data tracks. This prevents write faults and seek errors from affecting normal drive operation.

Each recording surface is attended by a moveable read/write head that exchanges serial modified-frequency modulation (MFM) data at a rate of 5 megabits per second. The head positioner is a linear actuator that is driven by an open loop stepper motor. For greater accuracy, the stepper motor does not detent at half-step positions. Drive mechanics do not allow the head positioner to step the heads out beyond cylinder 0 during seek errors. This feature ensures seek error recovery by a recalibration to cylinder 0.

Disks and heads are sealed within an impact-resistant aluminum enclosure that provides an ultra-clean air environment and prevents contamination.

Drive electronics consist of a single circuit board containing a microprocessor, clock, RAM, ROM, and the necessary seek, read/write, and interface logic. The microprocessor controls all drive activities, including spindle speed, stepper motor sequencing, the seek profile, and the receipt and transmission of MFM data. In addition to these tasks, the microprocessor monitors momentary drive events and reports fault conditions by flashing a modulated fault code on a red LED indicator on the front panel. Drive electronics require +5 and +12 VDC input power; no AC power is required.

In summary, MMI disk drives combine the latest in Winchester technology with overall mechanical simplicity to provide a compact, highly-efficient storage device that may be easily integrated into a wide variety of computer systems.

SPECIFICATIONS

Table 2 lists specifications for MMI Winchester disk drives.

Table 2. Specifications

CHARACTERISTIC	SPECIFICATION
Design Specifications	
Number of disks	2 or 4
Number of heads	4 (two-disk) 8 (four-disk)
Number of tracks	1,224 (two-disk) 2,448 (four-disk)
Number of cylinders	306
Media	Oxide or plated
Heads	Monolithic (MnZn)
Head positioner	Stepper motor
Performance Specifications	
Storage capacity	
Unformatted	
Per drive	12.75 megabytes (two-disk) 25.50 megabytes (four-disk)
Per surface	3.19 megabytes
Formatted	
Per drive	10 megabytes (two-disk) 20 megabytes (four-disk)
Per surface	2.5 megabytes
Per track	8,192 bytes

Table 2. Specifications (continued)

CHARACTERISTIC	SPECIFICATION
Performance Specifications (continued)	
Transfer rate	5 megabits per second
Access times (includes head settling)	
Average access	75 milliseconds
Maximum	210 milliseconds
Track to track	18 milliseconds
Latency	8.3 milliseconds
Functional Specifications	
Rotational speed	3,600 revolutions per minute
Recording density	10,943 bits per inch (BPI)
Track density	588 tracks per inch (TPI)
Areal density	6.43 megabits per square inch
Encoding method	Modified-frequency modulation (MFM)
Power Requirements	
Input voltage	+ 5 VDC ±5% @ 0.8 Amps typical +12 VDC ±5% @ 0.7 Amps typical
Max. start (10 sec.)	2 Amps - 12 V 1 Amp - 5 V
Maximum ripple	100 mv P-P (0 to 500 Hz) 50 mv P-P (500 Hz to 5 MHz) with resistive load at operating current
Heat dissipation	12 watts average

Table 2. Specifications (continued)

CHARACTERISTIC	SPECIFICATION
Environmental Limits	
Operating temperatures	40° F to 115° F 4° C to 46° C
Storage temperatures	-40° F to 140° F -40° C to 60° C
Relative humidity	8% to 80% (non-condensing)
Maximum wet bulb	78° F (26° C)
Shock	
Operating	12 G 11 ms half sine wave
Non-operating	50 G 11 ms half sine wave
Vibration	
Operating	5 to 60 Hz 0.006-inch P-P 60 to 500 Hz 1 G
Non-operating	5 to 30 Hz 0.05-inch P-P 30 to 500 Hz 2 G
Reliability	
Error rates	
Soft read errors	1 per 10^{10} bits read
Hard read errors	1 per 10^{12} bits read
Seek errors	1 per 10^{6} bits read
Mean time between failures (MTBF)	12,000 hours
Mean time to repair (MTTR)	30 minutes
Preventive maintenance	None
Service life	5 years

PHYSICAL DIMENSIONS

Table 3 lists the physical dimensions of MMI disk drive models; figures 1, 2, 3 and 4 show the mounting dimensions.

MMI recommends that drives be mounted vertically on either side or horizontally with the printed circuit board facing down. Do not mount a drive horizontally with the printed circuit board facing up. To ensure vibration isolation, a clearance of at least 0.1-inch must be provided between the the top cover of the drive and the host frame and between the printed circuit board and the host frame.

There are eight mounting holes, four on the bottom and two on each side, for mounting the drive in an enclosure.

Note: When mounting a drive, make sure that the four chassis mounting screws do not protrude inside the frame more than 0.09 inch.

Table 3. Physical Dimensions

Model	Height	Width	Depth	Weight
M112	1.625 inches (41.3 mm)	4.0 inches (101.6 mm)	5.75 inches (146.0 mm)	2.0 pounds (0.91 KG)
M125	1.775 inches (43.84 mm)	4.0 inches (101.6 mm)	5.75 inches (146.0 mm)	2.1 pounds (0.95 KG)
M212	1.625 inches (41.3 mm)	5.75 inches (146.0 mm)	8.0 inches (203.2 mm)	2.5 pounds (1.13 KG)
M225	1.775 inches (43.84 mm)	5.75 inches (146.0 mm)	8.0 inches (203.2 mm)	2.4 pounds (1.09 KG)
M312	3.250 inches (82.6 mm)	5.75 inches (146.0 mm)	8.0 inches (203.2 mm)	2.7 pounds (1.22 KG)
M325	3.250 inches (82.6 mm)	5.75 inches (146.0 mm)	8.0 inches (203.2 mm)	2.6 pounds (1.18 KG)

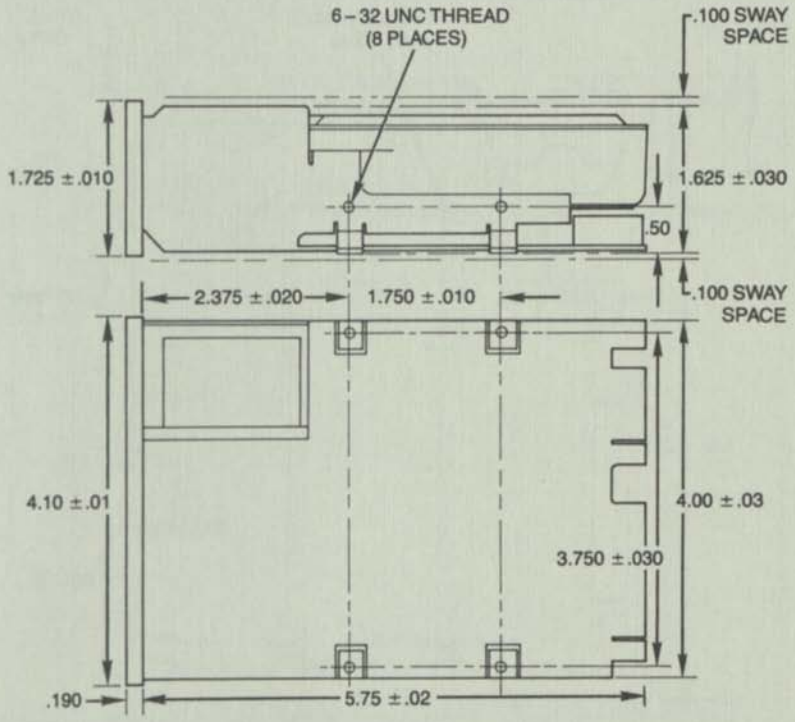


Figure 1. M112 Mounting Dimensions

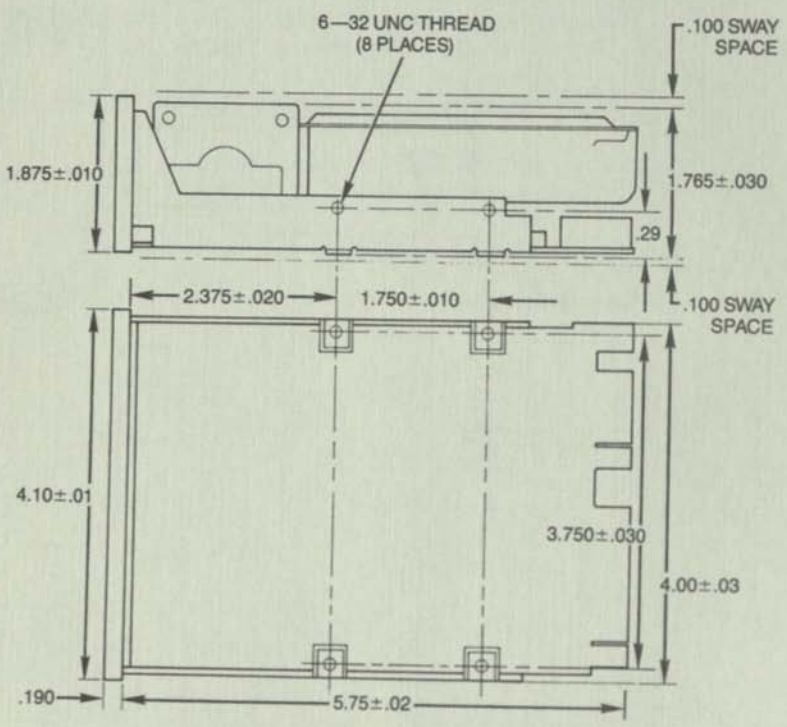


Figure 2. M125 Mounting Dimensions

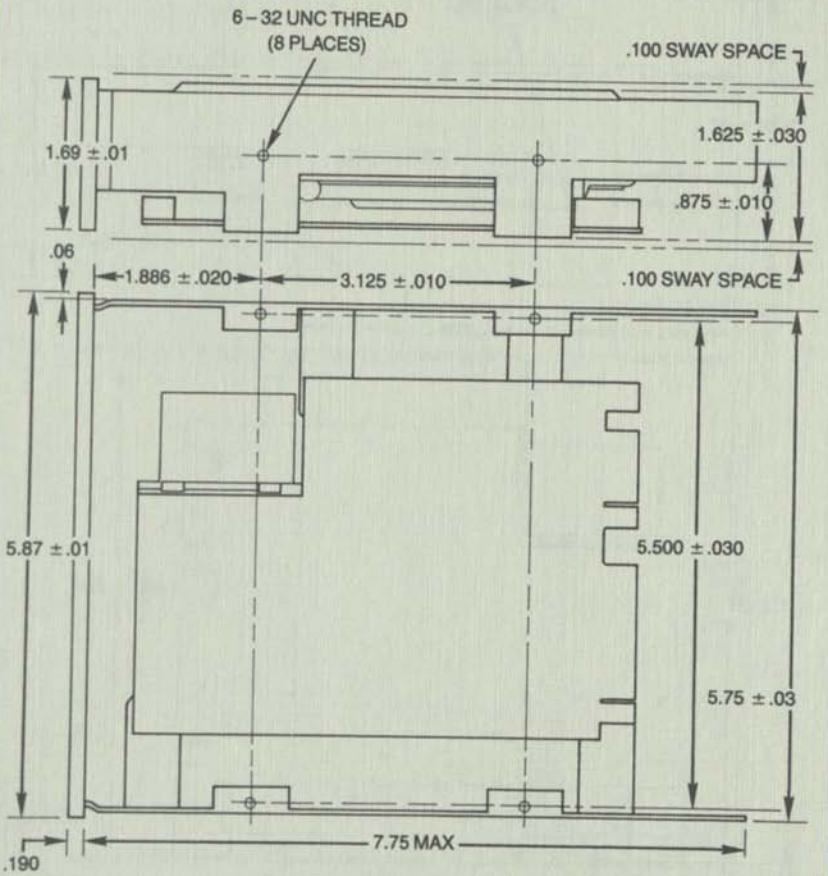


Figure 3. M212/M225 Mounting Dimensions

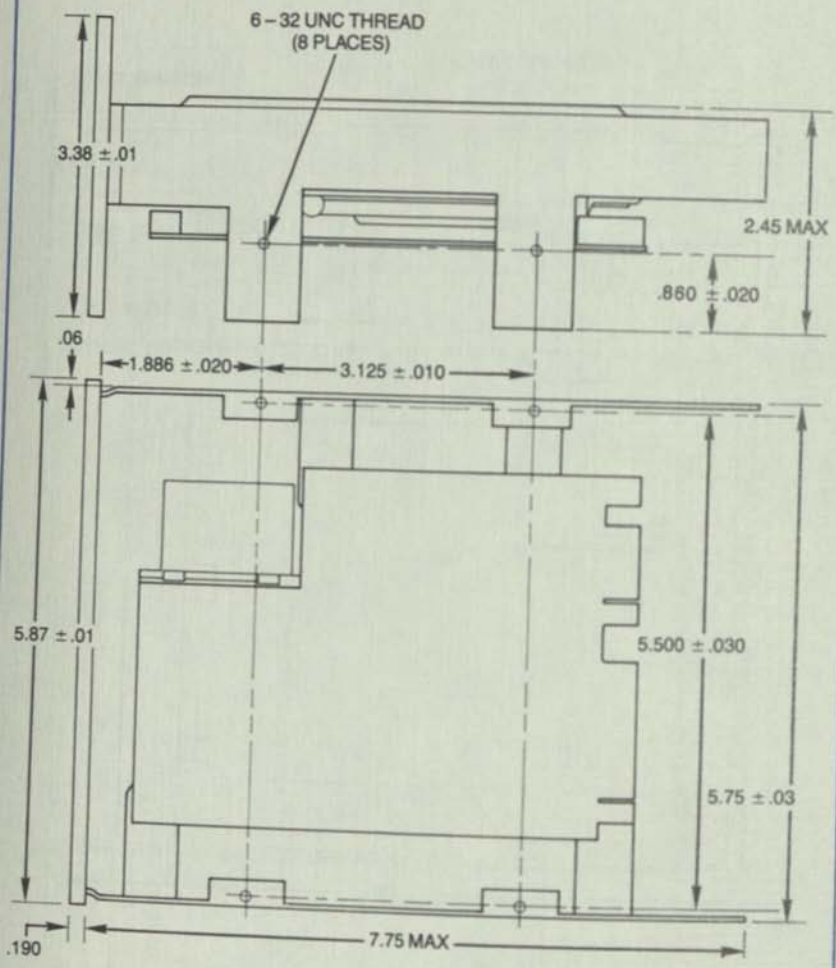


Figure 4. M312/M325 Mounting Dimensions

DRIVE ASSEMBLIES

MMI disk drives consist of three major assemblies (see figure 5): head/disk assembly, printed circuit board assembly, and chassis assembly.

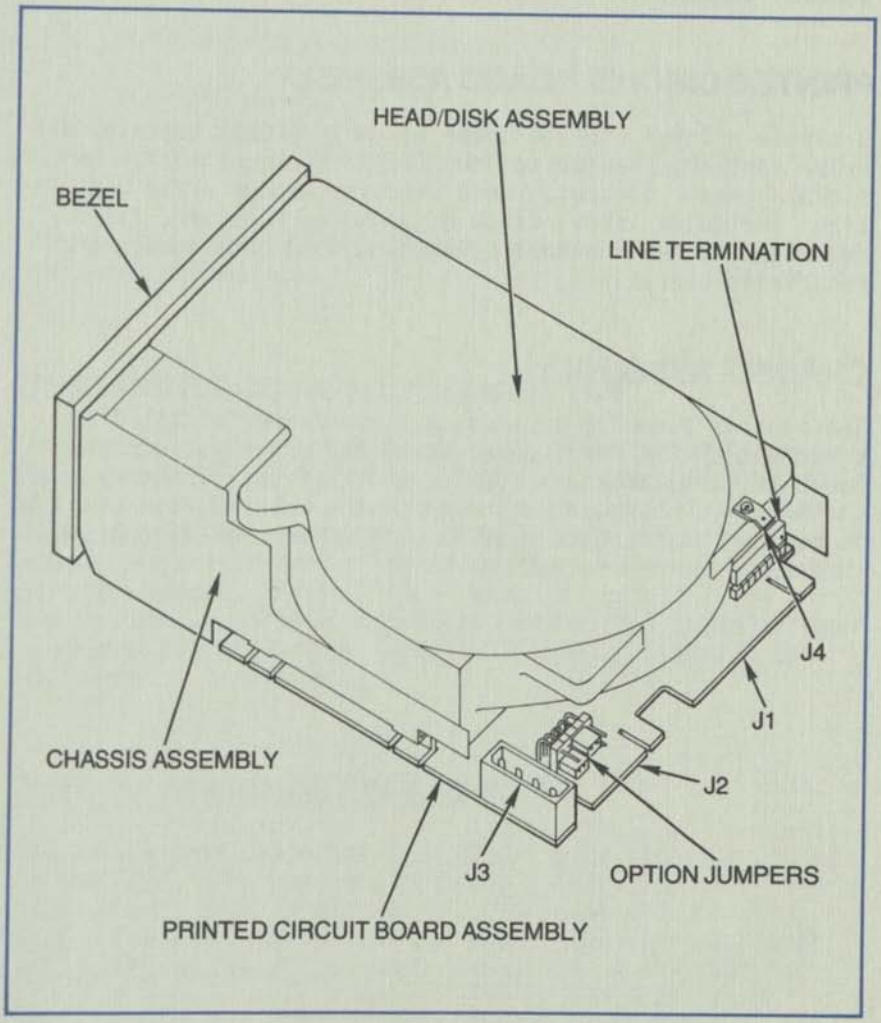


Figure 5. Drive Assemblies

HEAD/DISK ASSEMBLY

The head/disk assembly (HDA) is a factory-sealed chamber that contains the head positioner, head assembly, spindle motor, and disk media. In addition to sheltering these components from changes in the outside environment, the HDA features an integral air filtering system that maintains a clean environment and permits ambient pressure equalization without contaminate entry.

PRINTED CIRCUIT BOARD ASSEMBLY

A single printed circuit board assembly (PCBA) contains all drive control, read/write and interface electronics. Under microprocessor control, these circuits manage drive activities, including index, track 0, drive up to speed, fault detection, drive and head selection, head positioning and read/write operations.

CHASSIS ASSEMBLY

The chassis assembly provides a rigid frame for all drive components. The front panel bezel and drive select/drive fault LED indicator are mounted on the front of the chassis, the HDA is shock-mounted on top of the chassis, and the PCBA is mounted on the bottom of the HDA. The chassis contains threaded mounting holes.

PHYSICAL INTERFACE

The physical interface between the controller and the disk drive is via four connectors (shown in figure 5):

- J1/P1 control signal connector
- J2/P2 data signal connector
- J3/P3 DC power connector
- J4/P4 chassis ground connector

This section describes each of these connectors and provides connector dimensions.

J1/P1 CONTROL SIGNAL CONNECTOR

The control signal connector is a 34-pin edge connector at J1 on the PCBA. The pins are numbered 1 through 34 with the odd-numbered pins located on the component side of the PCBA. Pin 34 is located on the end of the connector that is closest to the J2 data signal connector. All odd-numbered pins are ground. A key slot is provided between pins 4 and 6. The recommended mating connector (P1) is AMP ribbon connector P/N 88373-3 or Molex 15-35-1341. Figure 6 shows J1 connector dimensions.

J2/P2 DATA SIGNAL CONNECTOR

The data signal connector is a 20-pin edge connector at J2 on the PCBA. The pins are numbered 1 through 20 with the odd-numbered pins located on the component side of the PCBA. Pin 20 is located on the end of the connector that is closest to the J3 DC power connector. A key slot is provided between pins 4 and 6. The recommended mating connector (P2) is AMP ribbon connector P/N 88373-6 or Molex P/N 15-35-1201. Figure 7 shows J2 connector dimensions.

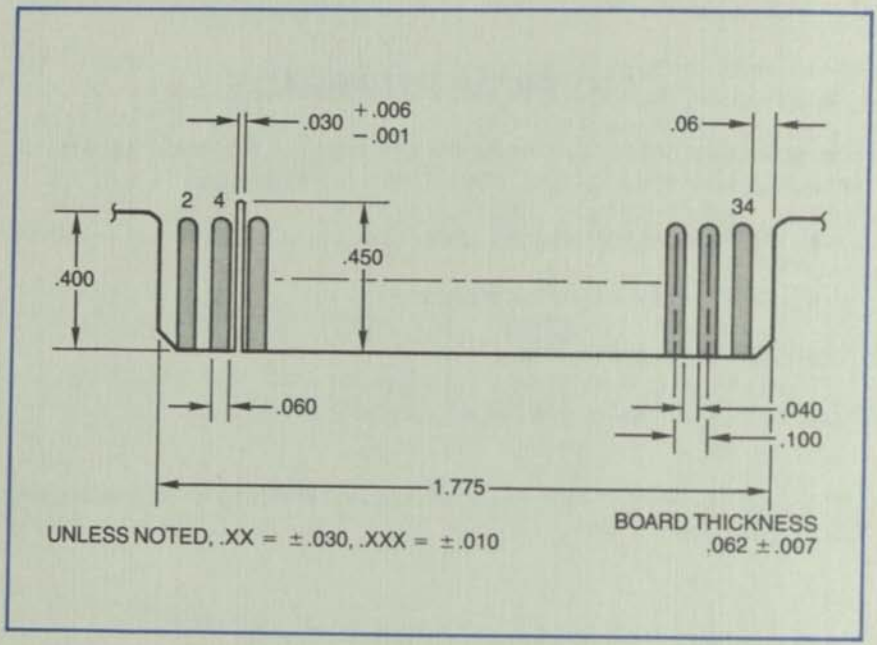


Figure 6. J1 Connector Dimensions

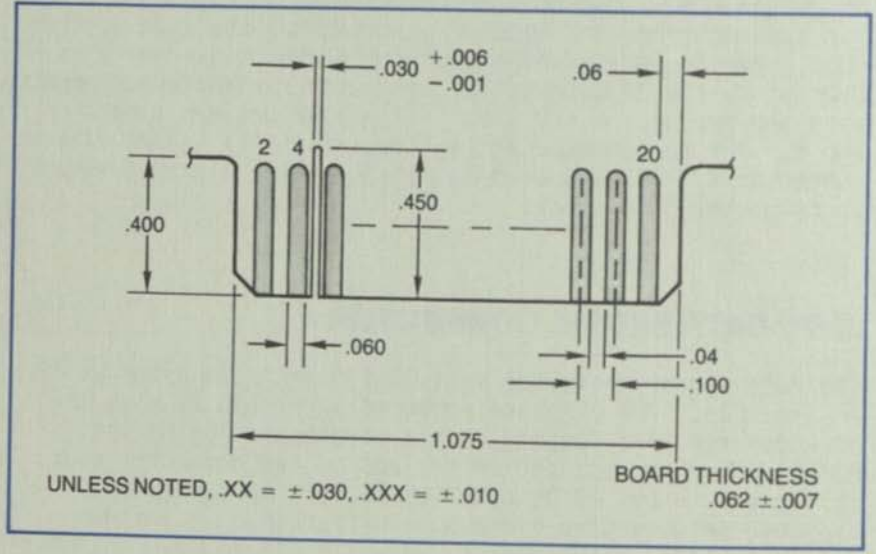


Figure 7. J2 Connector Dimensions

J3/P3 DC POWER CONNECTOR

The DC power connector is a 4-pin AMP Mate-N-Lok connector P/N 350211-1 at J3 on the component side of the PCBA. The recommended mating connector (P3) is AMP P/N 1-408424-0 utilizing AMP pins P/N 350078-4 (strip) or P/N 61173-4 (loose piece). Figure 8 shows J3 pin numbers; table 4 lists DC power requirements.

J4/P4 CHASSIS GROUND CONNECTOR

The chassis ground connector is a faston AMP P/N 61761-2. The recommended mating connector (P4) is AMP P/N 62187-1.

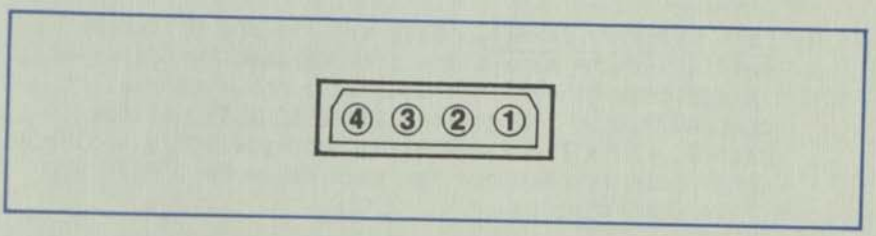


Figure 8. J3 Connector Pin Numbers

Table 4. DC Power Requirements

J3 CONNECTOR	DESCRIPTION	CURRENT AMPS	
		Maximum	Typical
Pin 4	+5 VDC ±5%	1.0	0.8
Pin 3	+5 VDC return		
Pin 1	+12 VDC ±5%*	2.0**	0.7
Pin 2	+12 VDC return		

* ±10% at power on or while seeking; ±5% while reading or writing

** Occurs only during power up sequence

ELECTRONIC INTERFACE

The electronic interface between the controller and the drive consists of the following signals:

- Control signals (J1/P1). Control signals are open collector TTL digital signals (low = 'true'). Since the DRIVE SELECT lines enable multiplexing of control signals, the control signal cable may be daisy-chained into a multiple-drive configuration containing up to four drives with the last drive in the chain providing the input signal terminations.

- Data signals (J2/P2). Data signals are differential read and write data signals as defined by EIA RS-422. In addition to data signals, this cable carries an open collector TTL digital DRIVE SELECTED status signal. Data lines cannot be multiplexed; a separate data cable is required for each drive in a multiple-drive configuration.

- DC power (J3/P3) and chassis ground (J4/P4). These lines provide the +5 and +12 VDC input voltages and ground.

Tables 5 lists the pin assignments for these connectors. Figures 9 and 10 show the interconnection cabling between the controller and the drive. Figure 11 shows the typical cabling for a four-drive system.

Table 5. Pin Assignments

CONNECTOR	PIN NUMBER Signal	PIN NUMBER Ground	SIGNAL TYPE	I/O	SIGNAL NAME
J1/P1	2	(1)	S	I	Reduce Write Current (not used)
	4	(3)	S	I	Head Select 2^2
	6	(5)	S	I	Write Gate
	8	(7)	S	O	Seek Complete
	10	(9)	S	O	Track 0
34-Pin	12	(11)	S	O	Write Fault
Ribbon	14	(13)	S	I	Head Select 2^0
Daisy-	16	(15)	-	-	Reserved (to J2-7)
Chain	18	(17)	S	I	Head Select 2^1
	20	(19)	S	O	Index
	22	(21)	S	O	Ready
	24	(23)	S	I	Step
	26	(25)	S	I	Drive Select 1
	28	(27)	S	I	Drive Select 2
	30	(29)	S	I	Drive Select 3
	32	(31)	S	I	Drive Select 4
J1/P1	34	(33)	S	I	Direction In
J2/P2	1	(2)	S	O	Drive Selected
	3	(4)	-	-	Reserved
	5	(6)	-	-	Reserved
	7	(8)	-	-	Reserved (to J1-16)
20-Pin	9	(10)	-	-	Reserved
Ribbon	11	(12)	-	-	Ground
Radial	13		D	I	+ Write Data
	14		D	I	- Write Data
	15	(16)	-	-	Ground
	17		D	O	+ Read Data
	18		D	O	- Read Data
J2/P2	19	(20)	-	-	Ground
J3/P3	1			-	+ 12V D.C. In
	2			-	+ 12V D.C. Return
Radial	3			-	+ 5V D.C. Return
J3/P3	4			-	+ 5V D.C. In

S-Single Ended D-Differential I-Drive Input O-Drive Output

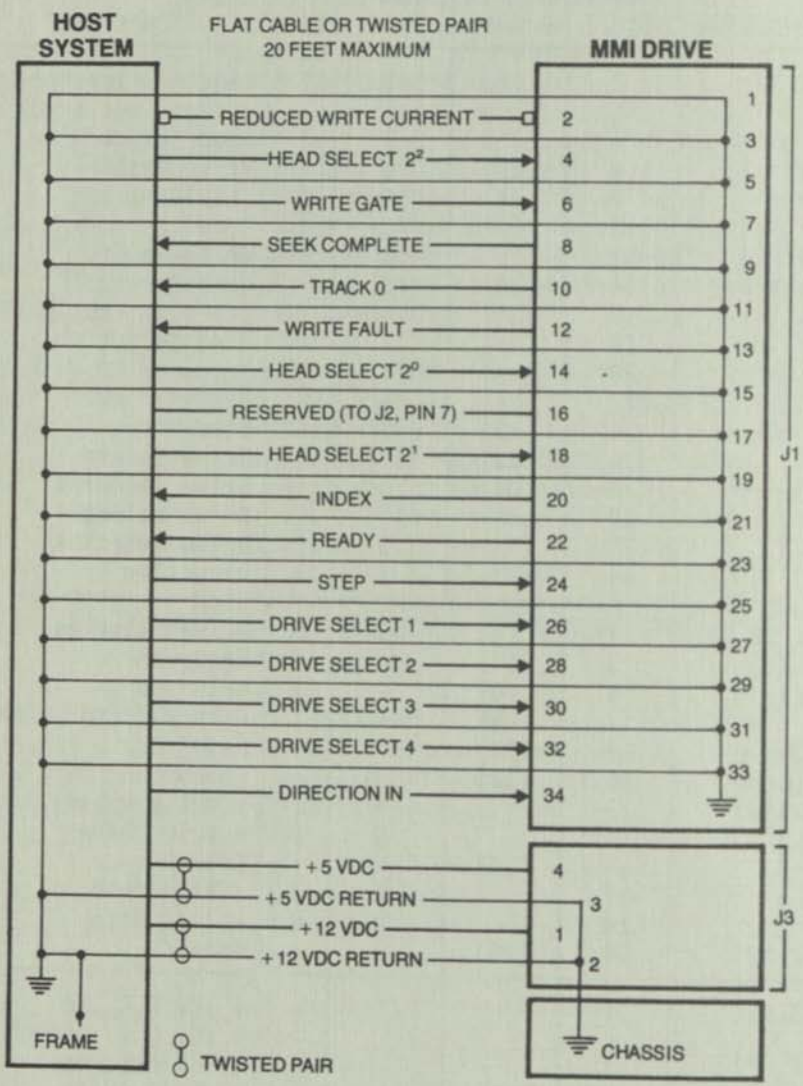


Figure 9. J1/P1 Control Signal Cabling

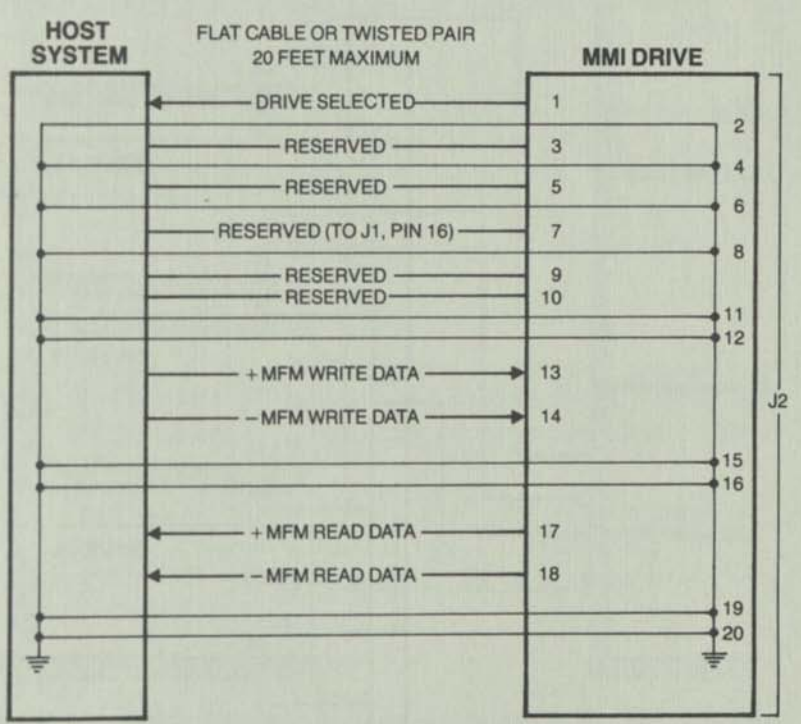


Figure 10. J2/P2 Data Signal Cabling

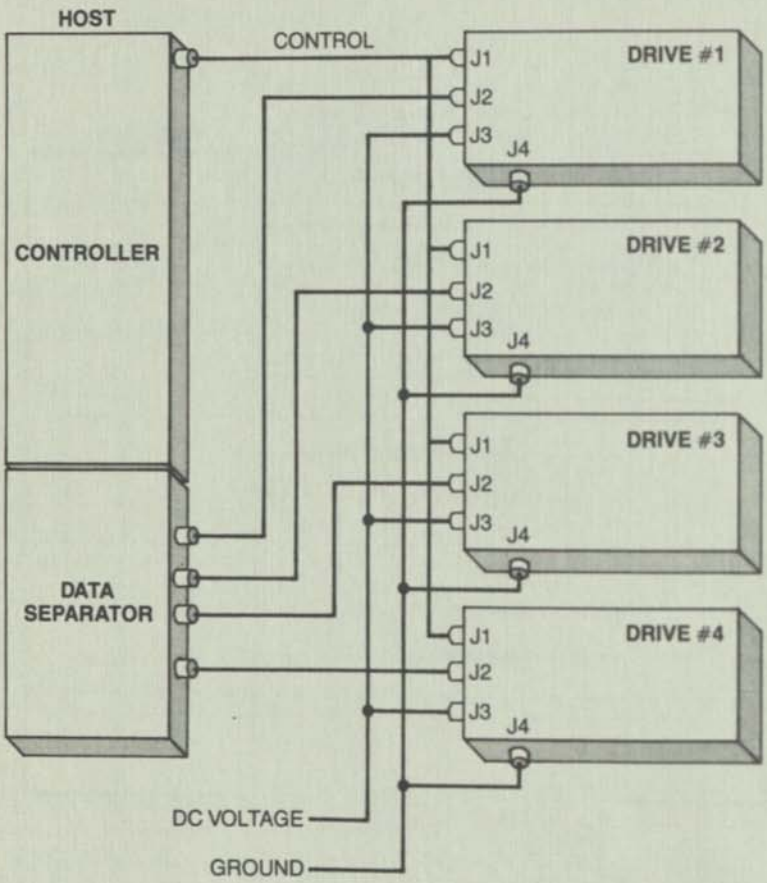


Figure 11. Cabling for Four-Drive System

CONTROL SIGNALS

Control signals have the following electrical specifications:

TRUE:	0.0 VDC to 0.4 VDC @ I = -30mA	(open collector driver)
FALSE:	2.5 VDC to 5.25 VDC @ I = +250μA	(Schmitt trigger TTL input)

There are two kinds of control signals: input and output. Input control signals come from the controller and are sent to the drive; output control signals come from the drive and are sent to the controller.

Input Control Signals

Input control lines consist of REDUCED WRITE CURRENT, WRITE GATE, HEAD SELECT 2^0, 2^1 and 2^2, DIRECTION IN, STEP, and DRIVE SELECT 1 to 4. This section describes the signals on each of these lines.

Note: All input lines in 10 megabyte models (except REDUCED WRITE CURRENT) share a 220/330 ohm resistor pack for line termination. 25 megabyte models use active termination.

REDUCED WRITE CURRENT

Since drive logic controls the write current internally, this line is not supported or terminated in MMI drives.

WRITE GATE

When WRITE GATE is true, stepping is prohibited and the selected head can write data on the disk. When WRITE GATE is false, the selected head can read data from the disk.

HEAD SELECT 2^0, 2^1 AND 2^2

A combination of the signals on these lines select the active read/write head:

2^2	2^1	2^0	Selected Head
False	False	False	0
False	False	True	1
False	True	False	2
False	True	True	3
True	False	False	4
True	False	True	5
True	True	False	6
True	True	True	7

DIRECTION IN

When DIRECTION IN is true, the heads move inward toward the center of the disk when the STEP line is pulsed. When DIRECTION IN is false, the heads move outward toward cylinder 0 when the STEP line is pulsed. The DIRECTION IN signal must not change while step pulses are issued; there is no set-up time required.

STEP

When STEP pulses low (true), the read/write heads move in the direction indicated by DIRECTION IN. The leading edge of the pulse deactivates SEEK COMPLETE (see figure 12).

There are two valid seek methods:

- Slow seek. A STEP pulse rate of 1 to 15 milliseconds places the drive into the slow seek mode, wherein head movements are in discrete 3 millisecond steps. In this mode, the trailing edge of each step pulse causes the heads to step in or out one cylinder. Figure 13 shows slow seek timing.

  Note: A seek to track 340 moves the read/write heads to a special area inside of the innermost cylinder, called the landing zone. MMI recommends that the controller move the read/write heads to the landing zone before removing drive input power.

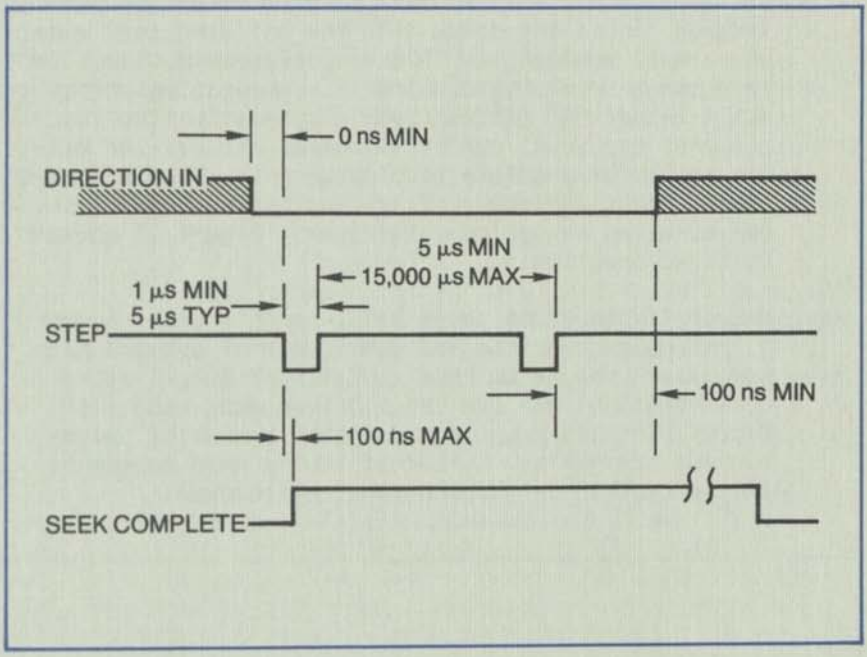


Figure 12. General Seek Timing

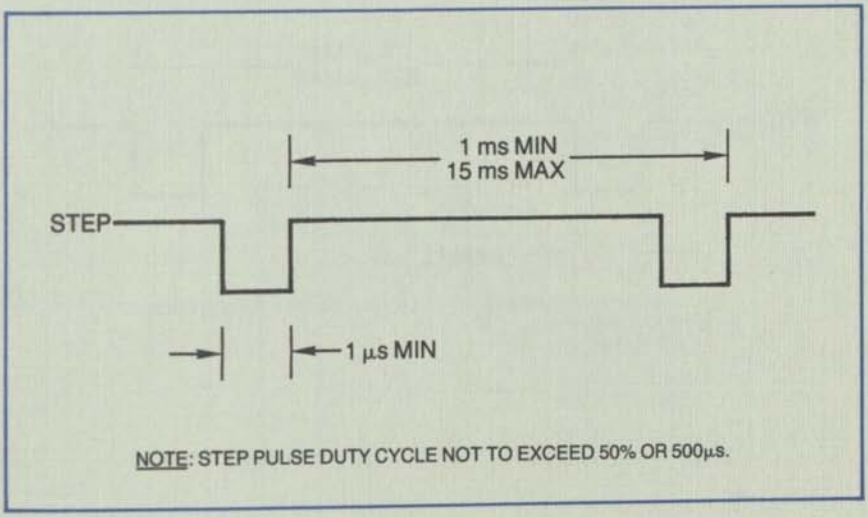


Figure 13. Slow Seek Timing

- Buffered seek. A STEP pulse rate of 5 to 200 microseconds places the drive into the buffered seek mode, where head movement is in one continuous motion. In this mode, drive logic buffers incoming step pulses until either 200 microseconds elapse after the last pulse or the total number of pulses exceeds the maximum number of possible head movements. When either of these conditions occur, drive logic executes the step pulses using an optimum algorithm. Figure 14 shows buffered seek timing.

  Note: If DIRECTION IN is false and the total number of pulses exceeds the maximum number of outward head movements, the heads move to cylinder 0 (called recalibration) and the TRACK 0 line goes true. If DIRECTION IN is true and the total number of pulses exceeds the maximum number of inward head movements, the heads move to the innermost cylinder.

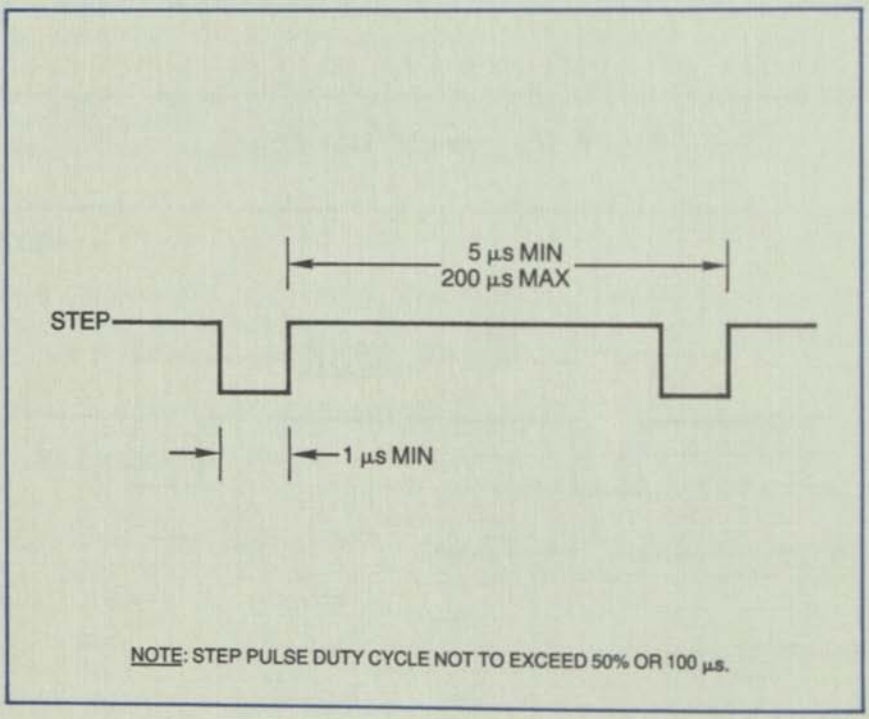


Figure 14. Buffered Seek Timing

DRIVE SELECT 1 TO 4

When the jumpered DRIVE SELECT line is true, the drive receives and responds to control signals from the controller. When the jumpered DRIVE SELECT line is false, the drive interface is disconnected and the drive cannot receive or respond to control signals from the controller. When a drive is selected and ready, the red LED on the front panel goes on.

In multiple-drive systems, it is necessary to configure each drive (maximum of four per controller) with a unique address (1, 2, 3 or 4) so that control signals can be multiplexed. To assign a specific address to a drive, a jumper plug must be placed over the appropriate pins on the PCBA. Figure 15 shows where to install the jumper plug for each address.

When the jumper on the radial mode pins is removed, the drive is placed in the radial mode of operation. In this mode, the drive receives and responds to all control signals from the controller, regardless of the signal on the jumpered DRIVE SELECT line. The signal on the jumpered DRIVE SELECT line controls the front panel LED only.

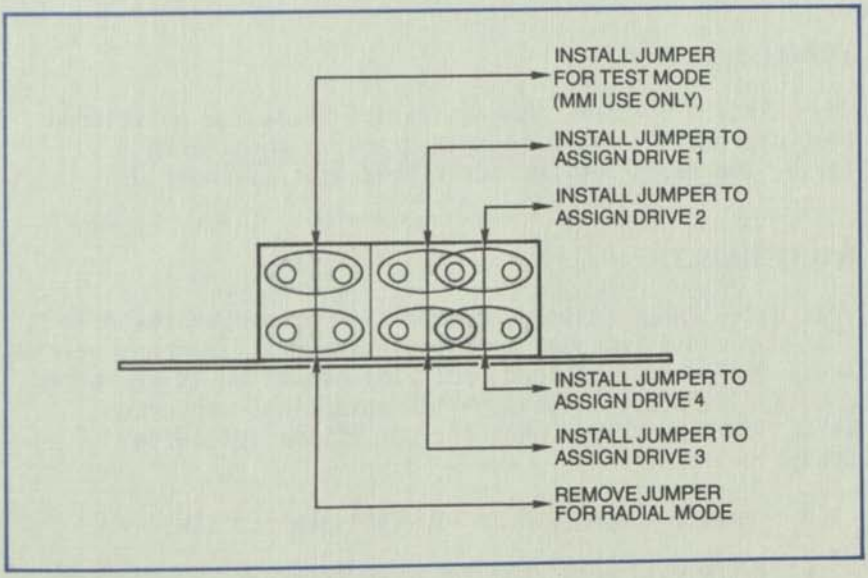


Figure 15. Jumper Options

Output Control Signals

Output control lines consist of SEEK COMPLETE, TRACK 0, WRITE FAULT, INDEX, and READY. This section describes the signals on each of these lines.

SEEK COMPLETE

When SEEK COMPLETE is true, the read/write heads are settled over the final cylinder at the end of a seek operation and read/write operations can occur. When SEEK COMPLETE is false, the read/write heads are not settled and no read/write operations can occur. SEEK COMPLETE goes false when any one of the following conditions occur:

- Drive logic initiates a recalibration during the power up sequence.
- Drive logic receives a step pulse from the controller; SEEK COMPLETE goes false within 100 nanoseconds after the leading edge of the pulse.
- Drive logic determines that a fault condition exists.

TRACK 0

When TRACK 0 is true, the read/write heads are positioned over cylinder 0 (the outermost track). When TRACK 0 is false, the heads are not positioned over cylinder 0.

WRITE FAULT

When WRITE FAULT is true, a condition exists at the drive that may cause improper writing on the disk; further writing and stepping is inhibited until the condition is corrected. When WRITE FAULT is false, write operations can occur. WRITE FAULT goes true when any one of the following conditions occur:

- Input voltages (+5 or +12 VDC) are too low.
- WRITE GATE goes true, but the drive does not receive data on the +WRITE DATA and -WRITE DATA lines.

- Drive receives a STEP pulse when WRITE GATE is true.
- Read/write head assembly is defective.

When WRITE FAULT goes true, drive logic waits two seconds and reverifies the fault. If the fault condition still exists, the true WRITE FAULT signal is latched until input power is removed; if the fault condition is gone, WRITE FAULT goes false and the heads are recalibrated.

Note: If the drive receives a STEP pulse when WRITE GATE is true, the write fault latches until input power is removed.

INDEX

INDEX pulses true once each disk revolution (16.67 milliseconds nominal) to indicate that the beginning of track (called the index) is passing beneath the heads. Only the transition from false to true is valid. Figure 16 shows INDEX timing.

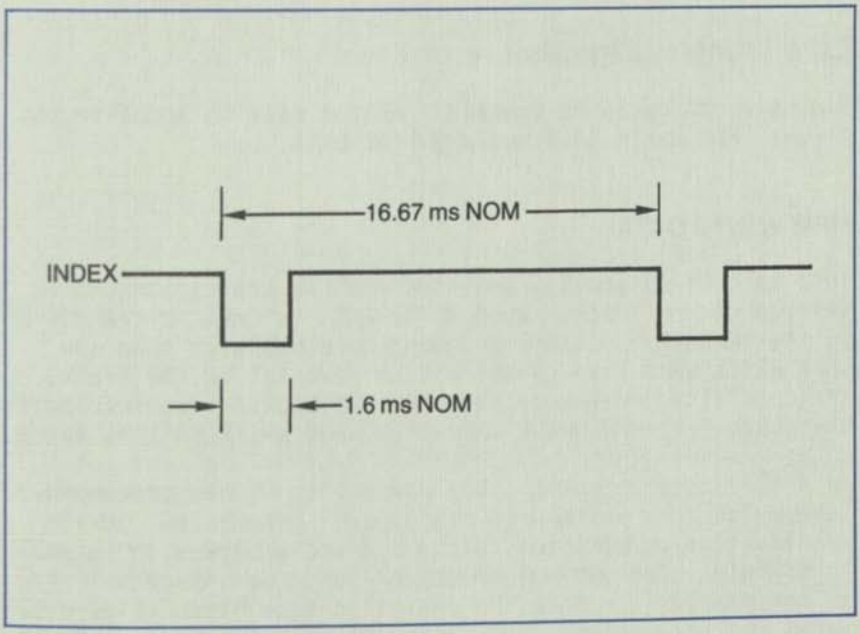


Figure 16. Index Timing

READY

When READY is true (in addition to SEEK COMPLETE being true), the drive is ready to read, write or seek and I/O signals are valid. When ready is false, all writing and seeking is inhibited. Typically, it takes about nine seconds for READY to go true after power is applied to the drive.

If a fault condition exists (READY does not go true), drive logic flashes a fault code on the front panel LED. Fault codes consist of a series of four long or short flashes. Table 6 summarizes the fault codes that can appear.

DATA TRANSFER AND DRIVE SELECTED SIGNALS

The J2/P2 connector contains data transfer lines and a DRIVE SELECTED status line. This section describes the signals on these lines.

Data Transfer Signals

Two pairs of balanced signals transfer data to and from the drive: MFM WRITE DATA and MFM READ DATA.

MFM WRITE DATA

This pair of balanced signals define the transitions to be written on the track. When WRITE GATE is true, a transition of the +MFM WRITE DATA line going more positive than the -MFM WRITE DATA line causes a flux reversal on the track. The controller must keep the -MFM WRITE DATA line more positive than the +MFM WRITE DATA line when WRITE GATE is false.

To ensure data integrity, the controller should precompensate write data written on tracks 128 through 306. Write precompensation minimizes bit shift and provides an optimal error rate. The optimum amount of precompensation is 12 nanoseconds for both the early and late bits. Figure 17 shows the bit patterns to precompensate; all other patterns should be written "on time."

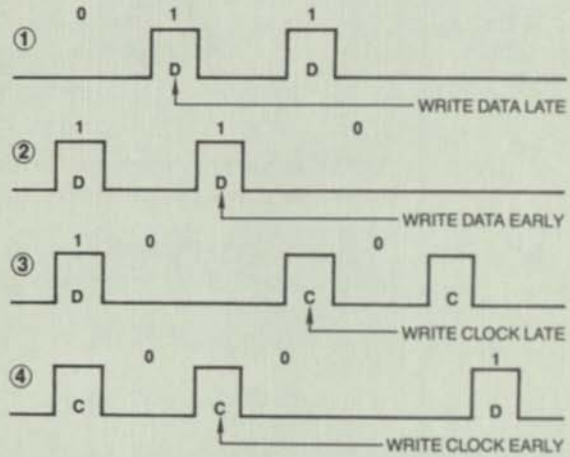
Table 6. Fault Codes

Fault No.	Flash Sequence	Description
1	S S S L	Write fault
2	S S L S	Track 0 sensor remains false when heads are at cylinder 0
3	S S L L	Track 0 sensor remains true when heads are not at cylinder 0
4	S L S S	Head positioner fault
5	S L S L	Microprocessor ROM fault
6	S L L S	Microprocessor RAM fault
7	S L L L	Microprocessor I/O fault
8	L S S S	Power up fault
9	L S S L	Spindle speed not within ±1% tolerance at end of power up
10	L S L S	Spindle speed not within ±1% tolerance during normal operation
11	L S L L	Spindle speed below 20% tolerance
12	L L S S	Motor phase sequencing fault during normal operation

L = long flash S = short flash

Fault 1 latches after two seconds (if the write fault is not corrected). Faults 2 through 7 latch as soon as they occur. Faults 8 through 12 latch after three unsuccessful attempts to recover.

When a fault latches, the fault code flashes indefinitely. Should this occur, remove power from the drive. After several seconds, reapply power. If the fault condition reoccurs, the drive may require servicing.



Writing should occur out of a shift register which is used to observe the pattern. "On time" represents a nominal delay. Early and late represent less and more delay, respectively.

Figure 17. Write Precompensation Patterns

MFM READ DATA

This pair of balanced signals transmit the data read from a track to the controller. The transition of the +MFM READ DATA line going more positive than the -MFM READ DATA line represents a flux reversal on the track of the selected head.

READ/WRITE TIMING

Figure 18 shows the necessary sequence of events (with associated timing restrictions) for proper read/write operation of the drive.

Drive Selected Signal

The DRIVE SELECTED line goes true when the drive's jumpered DRIVE SELECT line goes true. This line informs the controller that the drive's interface is connected and ready to receive control signals.

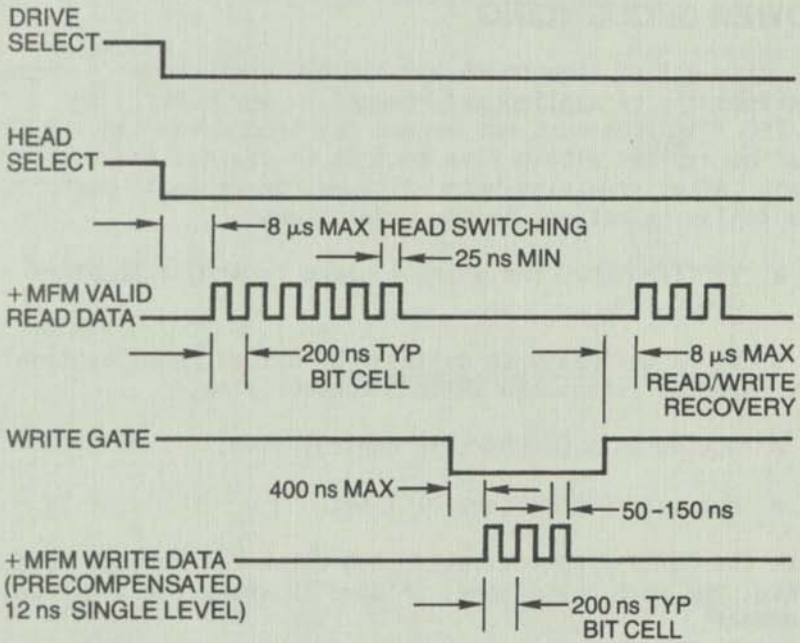


Figure 18. Read/Write Data Timing

DRIVE OPERATIONS

Drive operations consist of power sequencing, drive selection, head positioning, head selection, read operations, and write operations.

POWER SEQUENCING

MMI disk drives require +5 and +12 VDC input power. These voltages may be applied and removed in any order. The +5 VDC rise time must not exceed one second and the +12 VDC must be applied within five seconds to avoid a fault condition. After receiving both voltages, drive logic performs the following actions in the order shown:

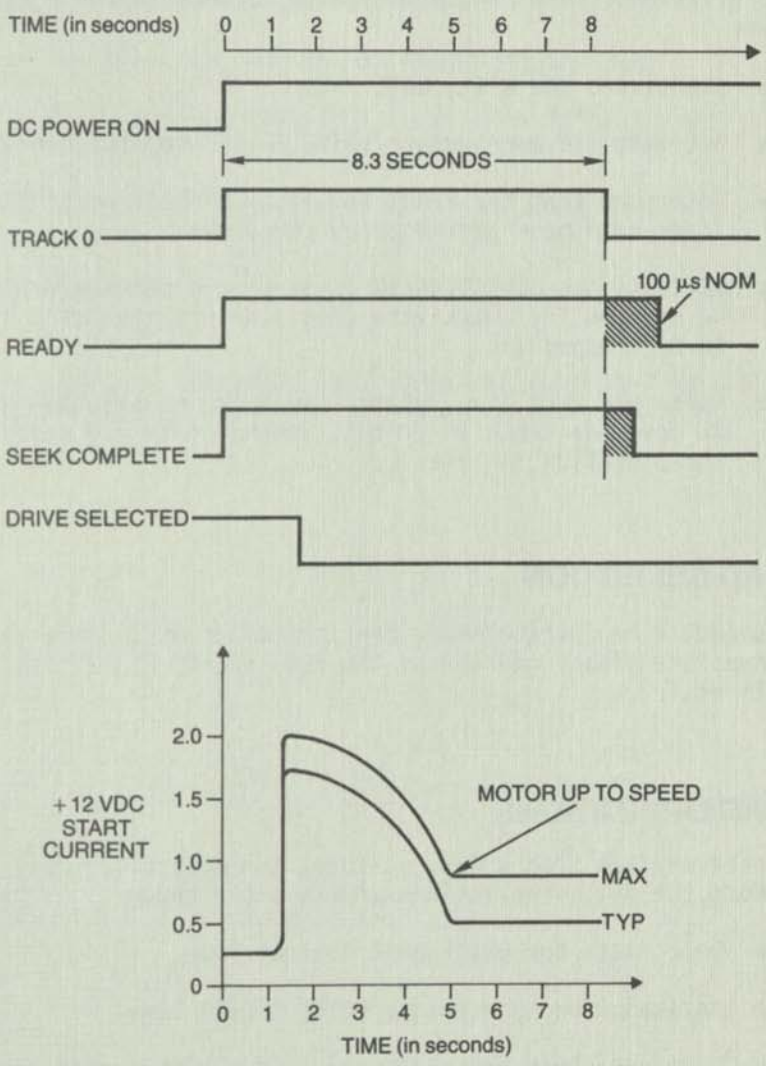
- Verifies that the spindle speed is within 1% of 3,600 rpm.
- Moves the heads to cylinder 0 (called recalibration) and activates the TRACK 0 control line.
- Activates SEEK COMPLETE control line.
- Activates READY control line.

With the READY line activated, the drive can perform read, write, and seek operations. Figure 19 shows the power up sequence.

DRIVE SELECTION

For a drive to receive and respond to control signals from the controller, the signal on its jumpered DRIVE SELECT line must be activated by the controller. When this line is activated, the red LED on the front panel goes on; when the line is deactivated, the LED goes off.

When in the radial mode of operation, the drive interface remains connected at all times, regardless of the signal on the jumpered DRIVE SELECT line. The signal on the jumpered DRIVE SELECT line controls the front panel LED only.



NOTE: THE RATE OF CHANGE OF THE LOAD DUE TO THE DRIVE IS 2.5 A/Ms.

Figure 19. Power Up Sequence

HEAD POSITIONING

To move the read/write heads to any valid cylinder, the controller must perform the following actions in the order shown:

- Deactivate the WRITE GATE control line.
- Activate the appropriate DRIVE SELECT control line.
- Make sure that the READY and SEEK COMPLETE control lines have been activated by the drive.
- Activate the DIRECTION IN line, if the heads are to be stepped in; deactivate this line, if the heads are to be stepped out.
- Pulse the STEP line. Each step pulse causes the heads to move one track in or out, depending on the state of the DIRECTION IN line.

HEAD SELECTION

To select a read/write head, the controller must place the appropriate binary address on the HEAD SELECT 2^0, 2^1 and 2^2 lines.

READ OPERATIONS

To recover data from a disk surface, the controller must perform the following actions in the order shown:

- Deactivate the WRITE GATE control line.
- Activate the appropriate DRIVE SELECT line.
- Make sure that the READY and SEEK COMPLETE control lines have been activated by the drive.
- Select the appropriate head by placing its binary address on the HEAD SELECT 2^0, 2^1 and 2^2 lines.

WRITE OPERATIONS

To write data onto a disk surface, the controller must perform the following actions in the order shown:

- Activate the appropriate DRIVE SELECT line.
- Make sure that the READY and SEEK COMPLETE control lines have been activated by the drive.
- Select the appropriate head by placing its binary address on the HEAD SELECT 2^0, 2^1 and 2^2 lines.
- Make sure that the WRITE FAULT line has not been activated by the drive.
- Activate the WRITE GATE line and place data on the +MFM WRITE DATA and -MFM WRITE DATA lines.

ADDENDUM

Some early production MMI disk drives contain a 5.25-inch printed circuit board, instead of the standard 3.5-inch board. A drive with this larger board operates the same as a drive with the smaller board, except for the following:

- Pulsing the STEP line with WRITE GATE true, does not result in WRITE FAULT going true; however, writing is inhibited.
- All write faults (except +12 VDC being too low) latch. To recover from a write fault, input power to the drive must be removed and then reapplied.
- Although the same jumper options exist (drive select, radial mode and test mode), the pins that must be jumpered are different. Figure A-1 shows where to install jumper plugs for the various options.

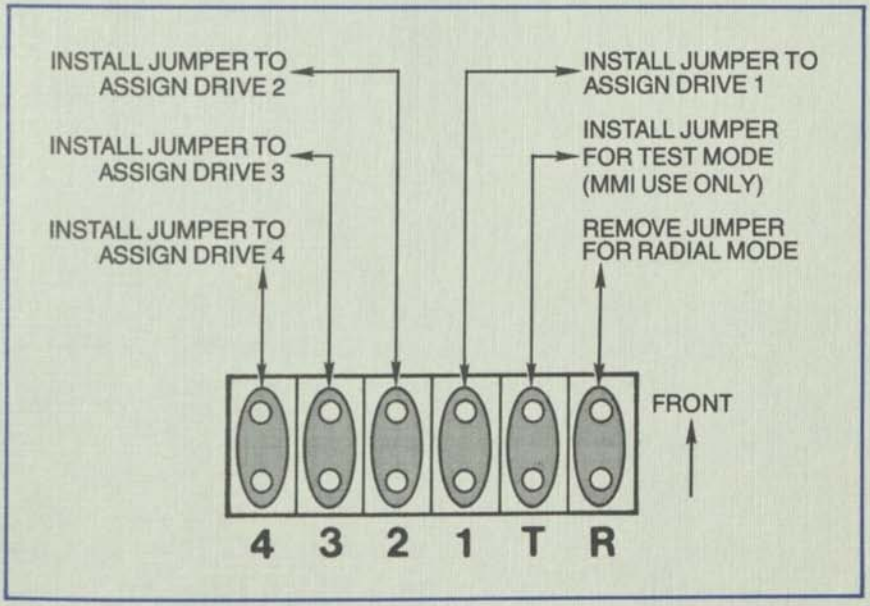


Figure A-1. Jumper Options (For 5.25-Inch PCBA)