PRODUCT DESCRIPTION

Micropolis 1320 Series

5 1/4-Inch Winchester-Disk Drives

MICROPOLIS

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DOCUMENT No. 101400 REV B-3

PREFACE

This Product Description, intended for use by engineers, designers, and planners, describes the typical characteristics of the Micropolis 1320 Series of 5 1/4-inch Winchester-Disk Drives. The information contained in this document reflects current Micropolis design and experience, and is subject to change without notice.

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SECTION 1. DESCRIPTION

Micropolis 1320 Series high-performance 5 1/4-inch Winchester-disk drives provide OEMs with high-capacity storage and very fast access times. They are fully compatible with the industry-standard ST506/ST412 interface and are designed to meet the needs of diverse applications environments. The 1320 Series is available in the following configurations:

Model Number	Disks per Drive	Data Surfaces per Drive	Capacity (Unformatted)
1323	3	4	42.7 MBytes
1323A	3	5	53.3 MBytes
1324	4	6	64.0 MBytes
1324A	4	7	74.7 MBytes
1325	5	8	85.3 MBytes

1.1 FEATURES OF THE 1320 SERIES

- High-performance positioner delivers a 28-millisecond average seek time for quicker access to data and higher system throughput.
- Unique FASEEK feature buffers step pulses at high speed while simultaneously accelerating the positioner to optimum velocity starting with the first Step pulse. Positioner velocity is continuously adjusted to optimize seek time.
- Standard ST506/ST412 interface permits use with existing controllers.
- ST506 form-factor and mounting provisions ensure easy incorporation into current system packages.
- Rugged chassis-within-a-chassis construction suspends the HDA (Head/Disk Assembly) on shock/vibration isolators to provide exceptional protection during transportation, installation, and operation.
- Balanced rotary positioner is protected from shock and vibration, and permits the drive to be mounted in any orientation.
- Positive media protection upon spin-down is provided by applying the spindle-motor brake and retracting and locking the positioner in a data-free landing zone.
- The HDA is free of active electronic components.
- Board-swap design results in MTTR of less than 15 minutes.
- Microprocessor-based, adaptive electronics eliminates adjustment and periodic maintenance and improves overall reliability.
- Provides up to 85.3 MBytes capacity (unformatted) per drive; total system capacity is 340.8 MBytes per controller when using four 1325 drives.

1.2 CHARACTERISTICS

General Performance Specifications

Seek Time (including settling time) *

Track-to-Track	6 msec
Average **	28 msec
One-Third Stroke **	31 msec
Maximum	62 msec

* Assumes step pulses at a rate of 1 pulse per 20 usec or faster.
** See Appendix A.

Rotational Latency

Average	8.33 msec
Nominal Maximum	16.67 msec

Start Time	25 seconds maximum to Drive Ready
Stop Time	15 seconds nominal

General Functional Specifications

Cylinders	1024
Encoding Method	MFM
Spindle Speed (rpm)	3600
Speed Variation (%)	±0.5
Transfer Rate (MBits/sec)	5.00

General Physical Specifications

Drive:	Height	3.25 in	(82.6 mm)
	Width	5.75 in	(146 mm)
	Depth	8.00 in	(203 mm)
Bezel:	Height	3.38 in	(85.7 mm)
	Width	5.88 in	(149 mm)
	Depth	0.185 in	(4.7 mm)
Drive Weight:		6.0 lbs	(2.7 kg) nominal

1.2 CHARACTERISTICS (continued)

Capacity

Unformatted

	Model Number				
	1323	1323A	1324	1324A	1325
Unit Total MBytes	42.7	53.3	64.0	74.7	85.3
Data Surfaces/Heads	4	5	6	7	8
Disks	3	3	4	4	5
MBytes per Surface	10.67				
Cylinders	1024				
Bytes per Track	10,416				

Formatted (MFM format; see Section 5 for format parameters)

32 Sectors; 256 Bytes per Sector:

	Model Number				
	1323	1323A	1324	1324A	1325
Unit Total MBytes	33.6	41.9	50.3	58.7	67.1
MBytes Per Surface	8.39				
Bytes Per Track	8192				

33 Sectors; 256 Bytes per Sector:

	Model Number				
	1323	1323A	1324	1324A	1325
Unit Total MBytes	34.6	43.3	51.9	60.6	69.2
MBytes Per Surface	8.65				
Bytes Per Track	8448				

Vibration

Operating (the drive can be operated and subjected to vibration up to the following levels, and will meet error specifications shown on page 1-5)

5- 40 Hz	0.006 inches, peak-peak
40-300 Hz	0.5 G peak

Non-Operating (the drive will sustain no damage if subjected to vibration up to the following levels)

Packaged (in original Micropolis shipping container)

5- 10 Hz	0.2 inches, peak-peak
10- 44 Hz	1 G peak
44- 98 Hz	0.01 inches, peak-peak
98-300 Hz	5 G peak

Unpackaged

5- 31 Hz	0.02 inches, peak-peak
31- 69 Hz	1 G peak
69- 98 Hz	0.004 inches, peak-peak
98-300 Hz	2 G peak

Shock

Operating (the drive can be operated and subjected to shock up to the following levels, and will meet error specifications shown on page 1-5)

1/2 Sinusoidal	5 msec, 3 G peak
	20 msec, 1 G peak

Non-Operating (the drive will sustain no damage if subjected to shock up to the following levels)

Packaged (in original Micropolis shipping container)

Free-fall drop	36 inches
1/2 Sinusoidal	20 msec, 50 G max

Unpackaged

Free-fall drop	0.75 inches
Topple test	1.5 inches
1/2 Sinusoidal	5 msec, 40 G max
	11 msec, 20 G max
	20 msec, 15 G max
	50 msec, 15 G max
	100 msec, 20 G max

1.2 CHARACTERISTICS (continued)

Environmental Requirements

	Operating	Storage
Ambient Temperature	10°C to 46°C (50°F to 115°F)	-40°C to 65°C (-40°F to 149°F)
Relative Humidity	10% to 80% non-condensing	10% to 80% non-condensing
	26.7°C (80°F) maximum wet bulb non-condensing	26.7°C (80°F) maximum wet bulb non-condensing
Altitude	-200 ft to 10,000 ft	-1000 ft to 50,000 ft
Thermal Shock	2°C/5 Minutes (3.6°F/5 Minutes)	24°C/Hour * (43.2°F/Hour)

* This gradient should not be exceeded when moving the drive from storage to operation.

Power Dissipation (nominal voltage)

Stand-by	28 Watts; 96 BTU/hr
Positioning	38 Watts; 130 BTU/hr

Acoustic Noise Less than 51 dBA (sound pressure)

Reliability

Soft Read Errors	$\leq$ 10 in 10^{11} bits read
Hard Read Errors	$\leq$ 10 in 10^{13} bits read
Seek Errors	$\leq$ 10 in 10^{7} seeks
Unit MTBF	35,000 Power-On Hours

Maintainability

MTTR	Less than 15 minutes

1.3 MAJOR COMPONENTS

The 1320-series disk drive consists of a mechanical assembly and an electronics package.

1.3.1 Mechanical Assembly

The mechanical assembly consists of the outer Frame, the sealed HDA, and the Brake/Solenoid Assembly.

Head/Disk Assembly (HDA)

The die-cast HDA is suspended within the die-cast outer Frame. This chassis-within-a-chassis design isolates the HDA from mechanical shock during shipping and operation and protects it from mounting stress which may occur when the drive is installed in the system envelope. An aluminum cover seals the HDA to create a contaminant-free clean area containing the servo and data heads, platters, platter spindle, and voice-coil positioner. There are no active electronic components within the HDA. Electrical connection between the HDA and the circuit boards is accomplished via flexible circuits.

Air-Filtration System

Air is circulated throughout the clean area by disk rotation-induced flow. A ducted air-filtration system draws the air through a filter. The sealed area breathes to the outside via another filter for pressure equalization.

Drive Motor

Spindle rotation is provided by a quiet, direct-coupled, brushless DC motor. Switching information for the electronic commutator is supplied by three Hall-effect sensors mounted within the drive-motor assembly.

Positioner System

The 1320-series positioner consists of a balanced, rotary voice-coil/swing-arm assembly. In conjunction with the closed-loop positioner-servo electronics, this system provides superior positioning speed and accuracy and continuous on-track monitoring for greater data protection. Susceptibility to external shock and vibration is minimized, and the drive may be mounted in any orientation. Position reference is obtained from tracks recorded on a dedicated servo surface.

The positioner system provides positive media protection upon spin-down by retracting and locking the positioner in a data-free landing zone and applying the spindle-motor brake, shortening deceleration time.

1.3.2 Electronic Components

An LED and three printed-circuit boards (the Motor Control Board; the Device Electronics Board; and the Preamplifier Board) packaged within the drive envelope comprise the electronic components. The LED is located on the bezel and lights whenever the drive is selected by the host system. (See Section 3.3, Drive Addressing and Interface Termination.)

For a detailed, functional theory of operation, see the 1320 Series Maintenance Manual, Micropolis No. 101420.

Motor Control Board

The Motor Control board accepts control signals from the Device Electronics board to drive the spindle motor and operate the brake solenoid. The Motor Control board also provides power amplification for the voice-coil positioner motor.

Device Electronics Board

The Device Electronics board provides overall control functions for the drive. Its microprocessor-based logic controls power-up and power-down sequencing and velocity-profile generation. The positioner-servo electronics controls the speed and accuracy of the positioned, while driver and receiver circuits provide for transmission and reception of control, data, and status signals across the interface.

Preamplifier Board

The Preamplifier board controls the transfer of read/write MFM data and provides termination for the read/write head flexible circuits as they exit the HDA clean area.

The Preamplifier board provides head selection, read preamplification, write-current drivers, servo preamplification, and read/write fault-detection circuitry.

SECTION 2. INTERFACE

2.1 INTERFACE AND POWER CONNECTOR PIN ASSIGNMENTS

The 1320 interface is pin- and function-compatible with the established industry standard for 5 1/4-inch Winchester-disk drives. Electrical interface between the drive and the controller is accomplished via interface connectors J1 and J2 on the Device Electronics board and power connector J3 on the Motor Control board. J4 and J5 are HDA and Frame ground connectors respectively; system characteristics determine the proper ground connection.

The physical characteristics of the connectors are described in Section 3. Figure 3-1 shows the locations of J1, J2, J3, and J4. Table 2-1 lists the signals on Control Signal Connector J1; Table 2-2 lists the signals on Data Transfer Connector J2.

TABLE 2-1. CONTROL SIGNAL CONNECTOR J1 PIN ASSIGNMENTS

J1 Connector Pin		Signal Name	Source
Signal	Ground		
2	1	Reserved	-
4	3	HEAD SELECT 2^2/	Host
6	5	WRITE GATE/	Host
8	7	SEEK COMPLETE/	Drive
10	9	TRACK Ø/	Drive
12	11	WRITE FAULT/	Drive
14	13	HEAD SELECT 2^0/	Host
16	15	Reserved (to J2 pin 7)	-
18	17	HEAD SELECT 2^1/	Host
20	19	INDEX/	Drive
22	21	READY/	Drive
24	23	STEP/	Host
26	25	DRIVE SELECT 1/	Host
28	27	DRIVE SELECT 2/	Host
30	29	DRIVE SELECT 3/	Host
32	31	DRIVE SELECT 4/	Host
34	33	DIRECTION IN/	Host

Recommended Cable: 3M Scotchflex 3365/34

Mating Connector: 3M Scotchflex 3463-0001 (key slot between pins 4 and 6)

Note: The slash (/) symbol following any signal indicates that the signal is low true (see Section 2.2).

TABLE 2-2. DATA TRANSFER CONNECTOR J2 PIN ASSIGNMENTS

J2 Connector Pin Signal	J2 Connector Pin Ground	Signal Name	Source
1	2	DRIVE SELECTED/	Drive
3	4	Reserved	-
5	6	Reserved	-
7	8	Reserved (to J1 pin 16)	-
9	10	Reserved	-
-	11	Ground	-
-	12	Ground	-
13	-	MFM WRITE DATA+	Host
14	-	MFM WRITE DATA-	Host
-	15	Ground	-
-	16	Ground	-
17	-	MFM READ DATA+	Drive
18	-	MFM READ DATA-	Drive
-	19	Ground	-
-	20	Ground	-

Recommended Cable: 3M Scotchflex 3365/20

Mating Connector: 3M Scotchflex 3461-0001 (key slot between pins 4 and 6)

Power is supplied to the drive via AMP MATE-N-LOK Connector J3. The two voltages in Table 2-3 are $\pm 5\%$, measured at the drive's power connector. Suggested wire size is 18 AWG (minimum) for all pins. The recommended mating connector is AMP 1-480424-0; recommended pins are AMP 350078-4.

TABLE 2-3. DC POWER CONNECTOR J3 PIN ASSIGNMENTS

J3 Pin	Voltage
1	+12 VDC
2	+12 Return
3	+ 5 Return
4	+ 5 VDC

See Section 4 for power requirements.

2.2 INTERFACE ELECTRICAL CHARACTERISTICS

Figure 2-1 summarizes the electrical characteristics of the TTL signals on Control Signal Connector J1. These signals control the drive and transfer drive status to the host controller. The signals are low true at the interface (indicated by "/"), high true into drivers and out of receivers, and have the following logic levels:

True = 0.0V to +0.4V @ 48 mA (maximum)
False = +2.5V to +5.25V @ 250 uA (open collector)

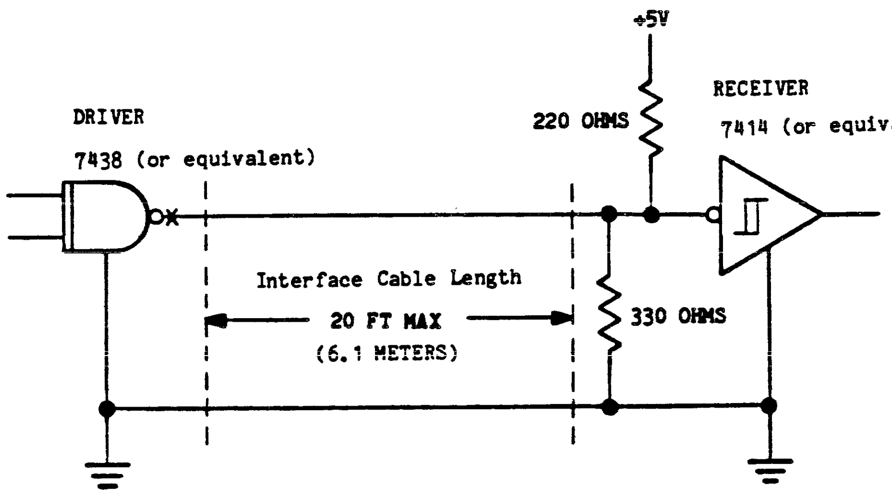


Figure 2-1. Control Signal Electrical Characteristics

Figure 2-2 summarizes the electrical characteristics of the differential signals on Data Transfer Connector J2. These signals contain read or write data. The signals are high true into drivers and out of receivers and have EIA RS-422 levels. A TTL-level DRIVE SELECTED/ status line is also provided at J2 to inform the host system of the selection status of the drive.

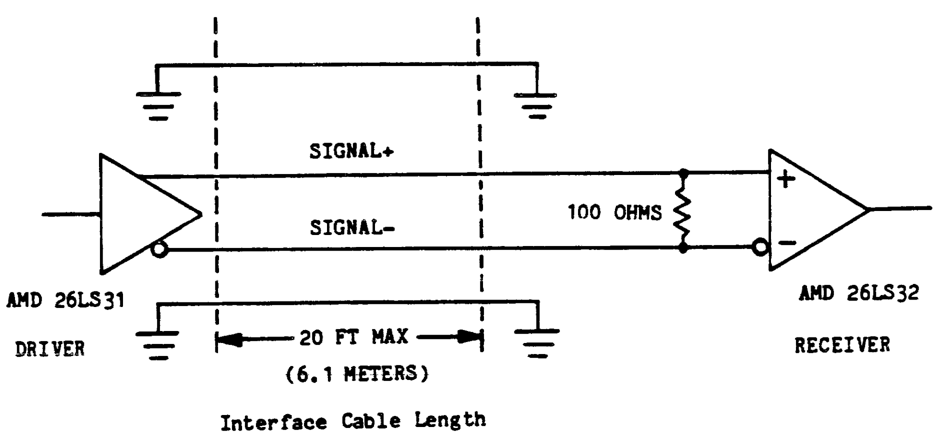


Figure 2-2. Data Transfer Signal Electrical Characteristics

2.3 INTERFACE SIGNAL DESCRIPTIONS

2.3.1 Control Signal Connector J1 - Input Signals

DRIVE SELECT 1/ through DRIVE SELECT 4/ (Pins 26, 28, 30, 32)

When active, or logically true, the corresponding (selected) drive accepts control signals from the host and enables status and read-data output lines. Only one Drive Select line may be active at any given time.

Jumpers on the Device Electronics board are used to specify the address of each drive; see Figure 3-2. In multiple 1320 systems, where several drives are connected to a common controller/formatter, each drive must have its own unique address.

DIRECTION IN/ (Pin 34)

This line defines which direction the read/write heads will move when the Step line is pulsed.

a. If DIRECTION IN/ is false, the direction is defined as "out." If a pulse is applied to the Step line, the read/write heads will move away from the center of the disk, toward Cylinder Ø.

b. If DIRECTION IN/ is true, the direction is defined as "in." If a pulse is applied to the Step line, the read/write heads will move toward the center of the disk, toward Cylinder 1023.

DIRECTION IN/ must remain stable until after the last Step pulse of the sequence has been issued.

STEP/ (Pin 24)

This control line causes the read/write heads to move. The direction they move in is defined by the Direction In line.

A seek operation is performed by specifying the direction of movement and issuing a sequence of Step pulses. Each Step pulse causes the read/write heads to move one cylinder. Any change in the Direction In line must be made at least 100 nanoseconds before the leading edge of the first Step pulse. The Direction In line must remain stable until after the last Step pulse of the sequence has been issued.

2.3.1 Control Signal Connector J1 - Input Signals (continued)

STEP/ (continued)

After the last Step pulse has been received, the Drive Select line may be dropped and another drive may be selected, permitting overlapped seeks. General seek timing is shown in Figure 2-3.

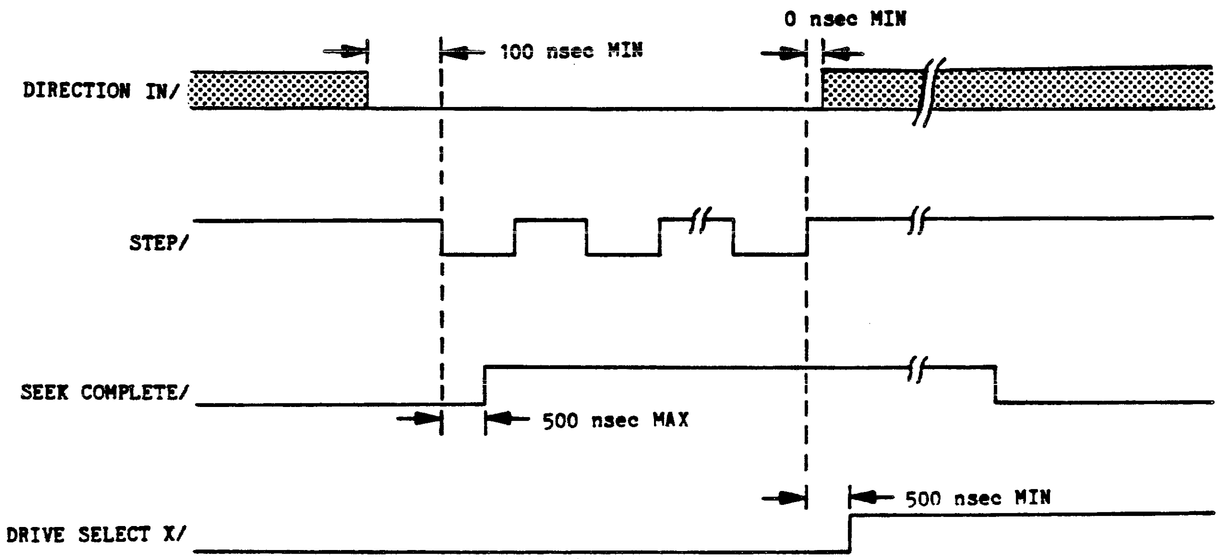


Figure 2-3. General Seek Timing

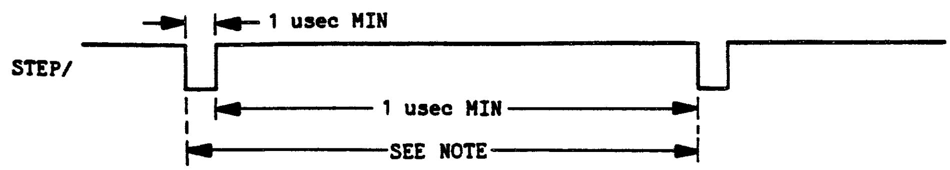
Seeking is performed in a buffered mode. SEEK COMPLETE/ goes false upon receipt of the first Step pulse, and the drive immediately begins seeking. Additional pulses received before completion of the seek are buffered into a counter. Positioner velocity is continuously recomputed to optimize seek time while the drive accepts additional Step pulses.

When the drive has finished seeking and has settled on the desired track, SEEK COMPLETE/ goes true. The drive is now ready to read, write, or accept another seek command.

Optimum 1320 performance is achieved when Step pulses occur at a rate of 1 pulse per 20 microseconds or faster. Step pulse timing is shown in Figure 2-4.

2.3.1 Control Signal Connector J1 - Input Signals (continued)

STEP/ (continued)



NOTE: Total period may be between 2 and 200 microseconds or greater than 1 millisecond.

Figure 2-4. Step Pulse Timing

Step pulse counts which exceed the cylinder range of the drive are automatically truncated; that is:

- If the sum of current position and number of step pulses received exceeds 1023, the positioner will stop at Cylinder 1023.
- If the sum of current position and number of step pulses received is less than zero, the positioner will recalibrate to Cylinder Ø and assert the TRACK Ø interface line.

The drive provides for fast recalibration by automatically performing a recalibrate operation if the number of outward Step pulses issued exceeds the number of tracks on the drive (e.g., greater than 1024). The positioner automatically stops at Track Ø, whose location is encoded into the servo surface at the time of manufacture. The entire operation is typically performed within the maximum time of a normal seek, and is much faster than conventional "Step, Test for Track Ø, and Repeat" recalibration techniques.

WRITE GATE/ (Pin 6)

When WRITE GATE/ is true, Write Data is recorded on the selected surface. Read Data is invalid while WRITE GATE/ is true.

When WRITE GATE/ is false, writing is inhibited and Read Data from the selected surface is transmitted on the Read Data lines.

Read Data is valid within eight microseconds after WRITE GATE/ goes false after a write operation. See Figure 2-7 for Read/Write Timing.

HEAD SELECT 2^0/, 2^1/, and 2^2/ (Pins 14, 18, 4)

These lines provide selection of each individual read/write head in a binary-coded sequence. Table 2-4 shows the head-select sequence for the Head Select lines (refer to Figure 2-5 for timing).

TABLE 2-4. HEAD SELECTION

Head Select Line			Data Head Selected				
2^2	2^1	2^0	1323	1323A	1324	1324A	1325
0	0	0	0	0	0	0	0
0	0	1	1	1	1	1	1
0	1	0	2	2	2	2	2
0	1	1	3	3	3	3	3
1	0	0	-	4	4	4	4
1	0	1	-	-	5	5	5
1	1	0	-	-	-	6	6
1	1	1	-	-	-	-	7

0 = False
1 = True

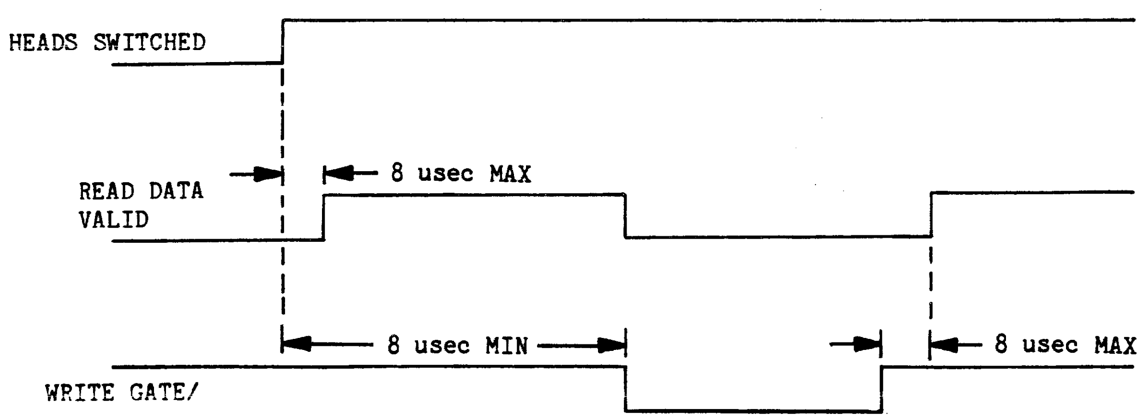


Figure 2-5. Head Selection Timing

2.3.2 Control Signal Connector J1 - Output Signals

The TTL output signals control the drive and transmit drive status to the host controller. All the J1 output signals are enabled by the Drive Select line. Figure 2-1 shows the driver/receiver combination used in the 1320 for control output signals.

TRACK Ø/ (Pin 10)

This signal is true only when the selected drive's read/write heads are positioned over Track Ø (the outermost data track). It is false when they are over any other track.

INDEX/ (Pin 20)

An Index pulse is generated once per revolution of the disk (every 16.67 milliseconds) to indicate the beginning of each track. This signal is normally false and makes the transition to logical true for a period of approximately 200 microseconds. Only the transition from high to low (leading edge) is valid. See Figure 2-6.

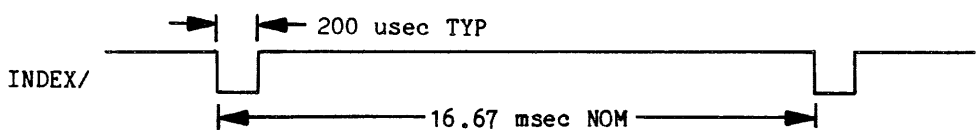


Figure 2-6. Index Timing

READY/ (Pin 22)

READY/ is true after the drive is up to speed and has positioned the read/write heads over Track Ø. Typically, READY/ becomes true within 20 seconds after power-on.

When READY/ and SEEK COMPLETE/ are true, the selected drive is ready to read, write, or seek. When READY/ is false, seeking or writing data to the disk is inhibited.

WRITE FAULT/ (Pin 12)

When this signal is true, it indicates that a fault condition exists at the drive. Writing is inhibited until the condition no longer exists.

The following fault conditions are detected:

a. Write Fault - One or more of the following conditions has been detected while WRITE GATE/ is true:

   - Defective head.
   - No Write Data transitions.
   - No write current.

b. Write Unsafe Fault - WRITE GATE/ is true while SEEK COMPLETE/ is false, or the heads are not positioned at nominal track center.

c. Power Loss Fault - DC voltages out of tolerance.

d. Spindle Servo Fault - Correct spindle speed cannot be reached or maintained.

e. Positioner Fault - Servo fault prevents the completion of a seek operation.

Fault conditions c, d, or e signal a serious malfunction. The positioner retracts, the spindle motor shuts down, and the READY/ signal goes false.

When jumper W1 is installed, faults are latched in the drive until they are cleared by a select-to-deselect transition that lasts no less than 50 microseconds in each state. When W1 is out, fault conditions are not latched.

A Write Fault caused by an out-of-tolerance DC voltage is reset automatically when the voltage is restored to nominal.

SEEK COMPLETE/ (Pin 8)

The Seek Complete signal goes true when the read/write heads have settled on the desired track at the completion of a seek. Reading or writing when SEEK COMPLETE/ is false will cause a Write Fault.

SEEK COMPLETE/ will go false for either of two reasons:

a. Within 500 nanoseconds (typical) after the leading edge of a Step pulse (or the first of a series of Step pulses).

b. When recalibration is initiated (by the drive logic) at power-on.

2.3.3 Data Transfer Connector J2 Signals

All data transfer lines between the drive and the host system utilize differential drivers and receivers. Two pairs of balanced signals are used to transfer data: MFM WRITE DATA+/- and MFM READ DATA+/-. Figure 2-2 shows the driver/receiver combination used in the 1320 for data transfer signals.

MFM WRITE DATA+/- (Pins 13, 14)

This pair of signals defines the transitions to be written on the disk. When WRITE GATE/ is active, MFM WRITE DATA+ going more positive than MFM WRITE DATA- will cause a flux reversal on the track under the selected head. Figure 2-7 shows the Write Data timing.

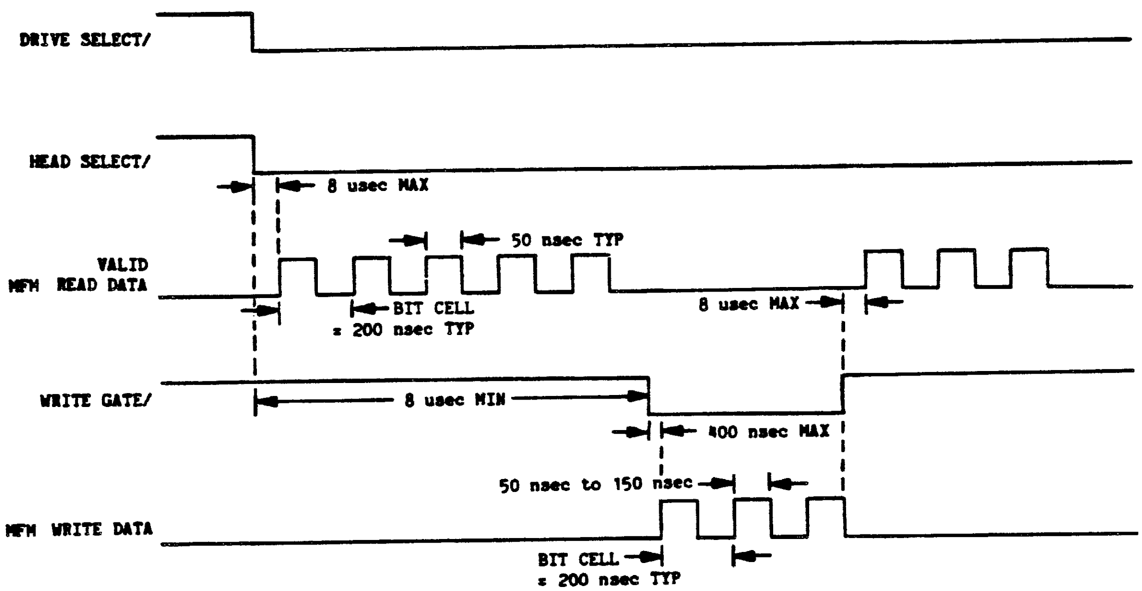


Figure 2-7. Read/Write Data Timing

See Section 5.3 for details on write precompensation.

MFM READ DATA+/- (Pins 17, 18)

Data read from the selected surface is transmitted to the host system via the differential pair of Read Data lines. While WRITE GATE/ is inactive, a transition of the MFM READ DATA+ line going more positive than the MFM READ DATA- line represents a flux reversal on the track under the selected head. Refer to Figure 2-7.

DRIVE SELECTED/ (Pin 1)

This status line (at J2) informs the host system of 1320 selection status. The Drive Selected line is the output of a TTL open-collector gate, driven as shown in Figure 2-1. The signal goes active when the 1320 is configured as drive X (where X is 1, 2, 3, or 4) and DRIVE SELECT X/ is true. Configuring the 1320 as drive X requires installation of the relevant address jumper: DS1, DS2, DS3, or DS4. Drives are shipped configured as drive 1. Selection takes place when a match occurs between DRIVE SELECT X/ and the drive configuration.

2.4 GENERAL TIMING REQUIREMENTS

The timing diagram shown in Figure 2-8 illustrates the sequence of events (with associated timing restrictions) for proper operation of the 1320. A recalibrate to Track Ø is initiated automatically at DC power-on.

Note: The start/stop frequency is not restricted during normal operations; however, the drive should be allowed to run for at least 90 seconds after start-up during qualification or life testing.

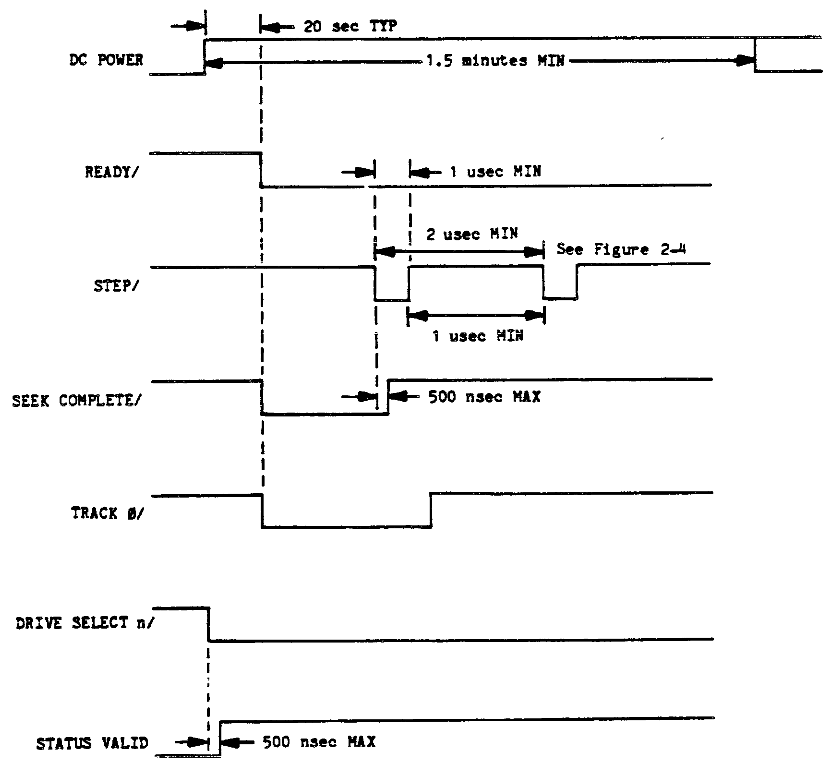


Figure 2-8. General Control Timing Requirements

SECTION 3. INSTALLATION

3.1 PHYSICAL INTERFACE

The electrical interface between the 1320-series drive and the host system is accomplished via five connectors: J1, J2, J3, J4, and J5. The connectors and their recommended mating connectors are described below.

3.2 POWER AND INTERFACE CABLES AND CONNECTORS

Figure 3-1 shows the locations of the power and interface connectors. Pin assignments for J1, J2, and J3 are listed in Section 2.1.

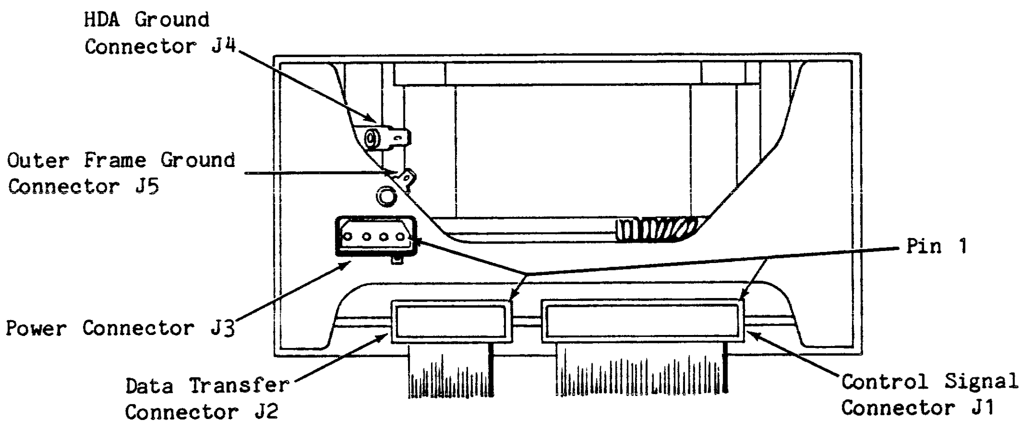


Figure 3-1. Power and Interface Connections

The signal interface connection is made through connectors J1 and J2 on the Device Electronics board. The control cable interconnects the controller and J1; the data cable interconnects the controller and J2.

<u>Control Signal Connector J1</u>

J1 is a 34-pin board-edge connector on the Device Electronics board. The signals on this connector control the drive and transfer drive status to the host controller.

Recommended Cable: 3M Scotchflex 3365/34

Mating Connector: 3M Scotchflex 3463-0001
(key slot between pins 4 and 6)

Data Transfer Connector J2

J2 is a 20-pin board-edge connector on the Device Electronics board. The signals on this connector contain read or write data.

Recommended Cable: 3M Scotchflex 3365/20

Mating Connector: 3M Scotchflex 3461-0001
(key slot between pins 4 and 6)

DC Power Connector J3

J3 is a 4-pin, keyed AMP MATE-N-LOCK connector on the Motor Control board. DC power (+5V and +12V) is supplied to the drive via this connector.

Mating Connector: AMP 1-480424-0
Pins: AMP 350078-4

Suggested Wire Size: 18 AWG

Ground Connectors J4 and J5

1/4-inch spade lugs J4 and J5 are provided for grounding; system characteristics determine the proper ground connection. J4 is located on the HDA, near the left-hand shock mount (as viewed from the rear of the drive). J5 is located on the Outer Frame near Power Connector J3.

Mating Connector: AMP 62187-1 or equivalent

3.3 DRIVE ADDRESSING AND INTERFACE TERMINATION

Figure 3-2 shows the locations of the four drive-select jumpers and the interface terminator on the Device Electronics board.

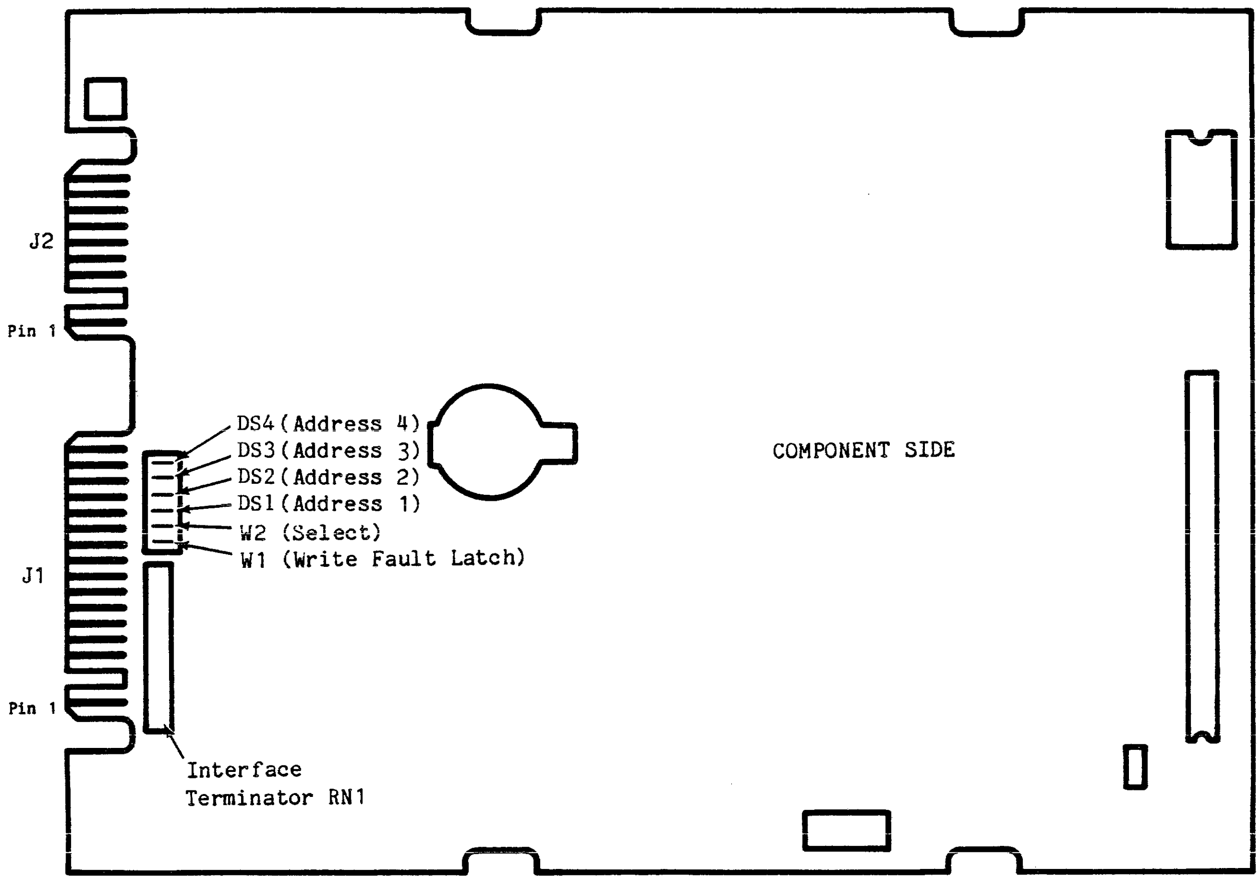


Figure 3-2. Drive-Address Jumpers and Interface Terminator

- The drive-select jumpers are identified as DS1, DS2, DS3, and DS4 (for Drive Select 1, 2, 3, and 4, respectively). Only one drive-select jumper is installed on a drive, and it is addressed as drive 1 at the factory. Each Drive Select interface line connects the correspondingly addressed drive to the host controller/formatter. In multiple-drive systems, each drive must have its own unique address.

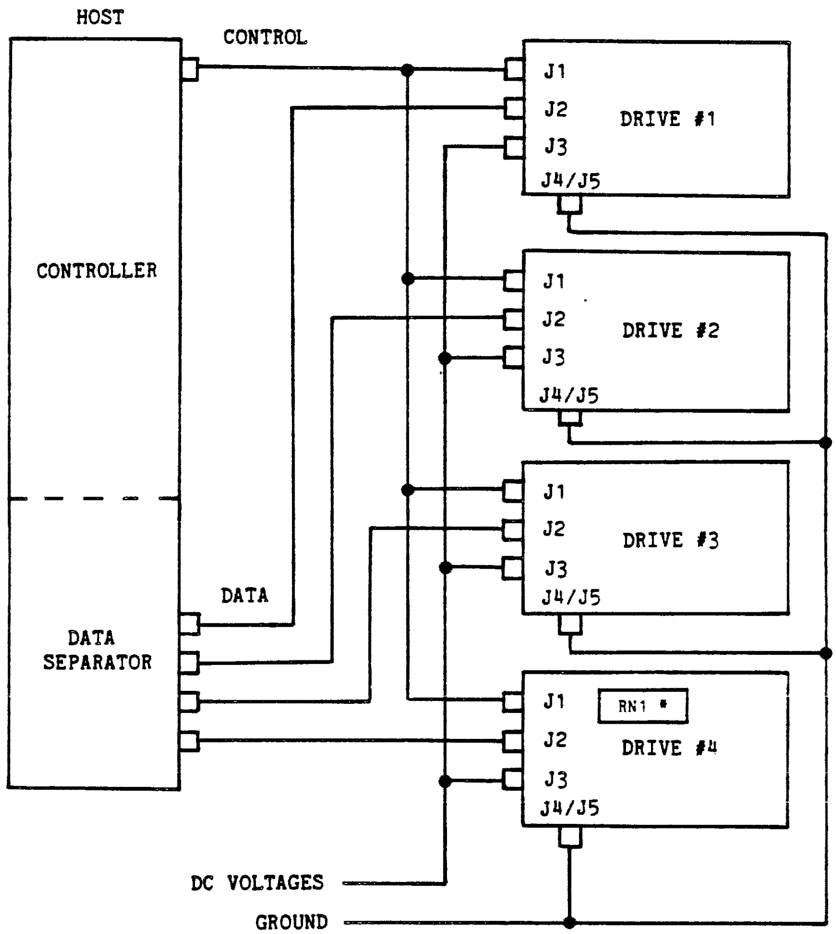
- Terminator RN1 provides proper termination for the interface lines. When daisy-chaining multiple 1320 disk drives, the terminator is installed only in the last drive on the daisy chain.

W1 is used for write-fault latching (see page 2-9); W2 is always installed.

3.4 DAISY-CHAINING THE 1320 DRIVE

Up to four 1320 drives may be connected to a single controller/formatter. Control and status signals on J1 are transmitted via standard, daisy-chain interconnection. Read/write data signals on J2 are transmitted via radially connected data-transfer lines.

Figure 3-3 shows the connections for a system using four, 1320 disk drives.



* Interface Terminator RN1 is installed only in the last physical drive in the control chain.

Figure 3-3. 1320 Daisy-Chain Configuration

3.5 DIMENSIONS AND MOUNTING

The 1320 drive uses industry-standard mounting for 5 1/4-inch Winchester-disk drives (the same as for 5 1/4-inch flexible-disk drives). Figure 3-4 shows the mounting-hole locations. The length of the mounting screws must be such that the screws do not penetrate the mounting holes by more than 0.25 inch. Maximum torque applied to the screws must not exceed 10 in-lbs.

Recommended orientation is vertical on either side, or horizontal with the Device Electronics board down; other mounting orientations may be used provided the ambient air temperature around the drive is kept at or below 46°C (115°F).

Inasmuch as the frame of the drive acts as a heat sink to dissipate heat from the unit, the enclosure and mounting structure should be designed to allow natural convection of heat around the HDA and frame. If the enclosure is small or if natural convection is restricted, a fan may be required.

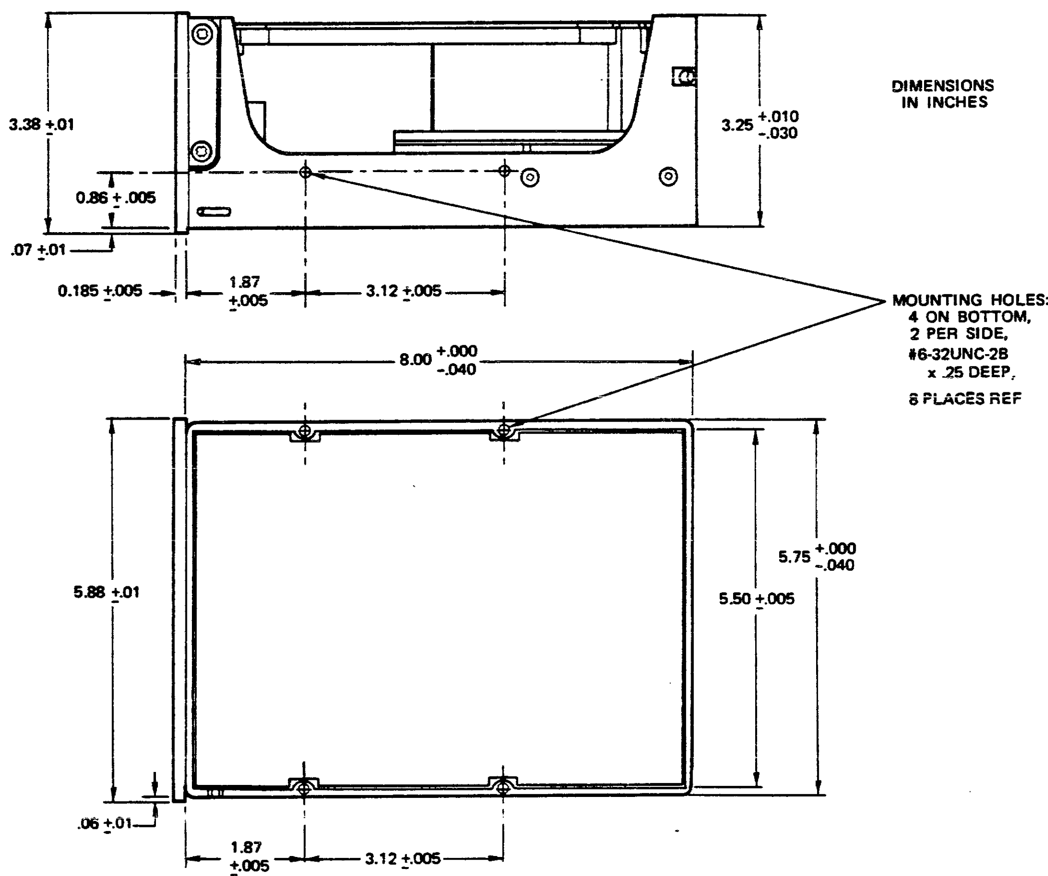


Figure 3-4. Dimensions and Mounting

SECTION 4. POWER REQUIREMENTS

4.1 POWER SUPPLY REQUIREMENTS

DC voltage and current requirements for the 1320 Series are shown below. Voltages may be applied to the drive in any sequence during power-up. Voltage verification must be performed at the drive connector. The rise time of the +5V must be less than 50 milliseconds for proper operation of the power-on reset circuits. Figure 4-1 shows the current profile for the +12V.

TABLE 4-1. DC POWER REQUIREMENTS

Voltage	Start-up		Idle		Seeking (1)		Ripple (maximum)
	Avg.	Peak	Avg.	Peak	Avg.	Peak	
+5V ±5% maximum: (2)	0.9A	0.9A	0.9A	0.9A	0.9A	0.9A	2%
+12V ±5% (3)							2%
typical: (4)	3.90A	3.90A	1.80A	1.90A	2.25A	3.10A	
maximum: (2)	4.00A	4.00A	2.00A	2.10A	2.45A	3.30A	

(1) These values are for 1/3-stroke seeks with an 8-millisecond idle period between seeks to simulate a typical system environment.

(2) Maximum values to be considered for power supply design and system integration.

(3) +5%, -10% tolerance during start-up.

(4) Typically measured values.

DC POWER PIN ASSIGNMENTS (Connector J3)

Pin	Voltage	Pin	Voltage
1	+12 VDC	3	+5 RETURN
2	+12 RETURN	4	+5 VDC

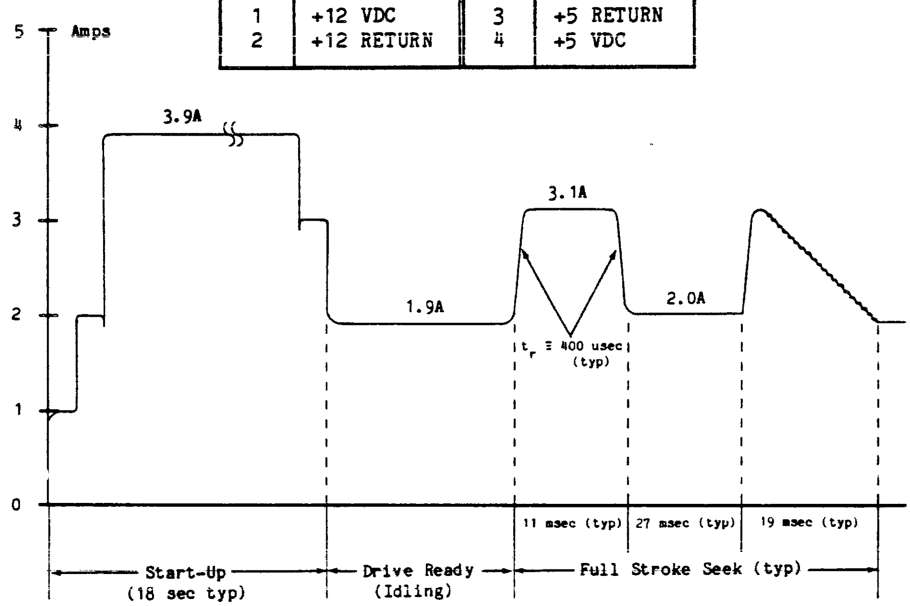


Figure 4-1. 12V Peak Current Profile (typical, 1325)

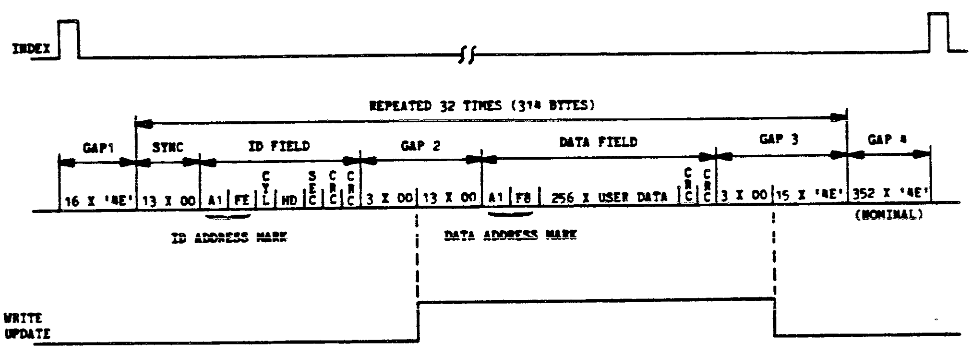
SECTION 5. DATA ORGANIZATION

NOTE

The information in this section is presented for system-level integration purposes only; the formatting is actually performed by the host controller/formatter.

5.1 TRACK FORMAT

Track format organizes data tracks into smaller, sequentially numbered blocks of data called sectors. The drive utilizes a soft-sectored format, which uses information encoded on the disk to define the beginning of each sector. This information is referred to as the identification (ID) field of the sector and typically contains the address mark, cylinder address, head address, and sector address. Additional information, such as flags for defect handling, may also be included. The ID field is followed by the user-data field. Figure 5-1 shows a widely used format for 5 1/4-inch Winchester drives.



NOTES:

1. Nominal track capacity = 10,416 bytes
2. Total data bytes/track = 256 x 32 = 8192
3. CRC Fire Code = $X^{16} + X^{12} + X^{6} + 1$
4. Bit 5 of the head byte is reserved for numbering cylinders greater than 256.
5. Bit 6 of the head byte is reserved for numbering cylinders greater than 512.

Figure 5-1. Typical Track Format

The soft-sectored format shown in Figure 5-1 is a slightly modified version of the IBM System 34 flexible-disk-drive format, which is commonly used for Winchester 5 1/4-inch drives. The encoding method used is modified frequency modulation (MFM).

a. Each track is divided into 32 sectors; each sector contains a data field 256 bytes long.

b. The starting points of both the ID field and the data field are flagged by unique characters called address marks. Each address mark is two bytes long. The first byte is a modified "A1" data pattern. The second byte is either an "FE" pattern, which defines an ID address mark, or an "F8" pattern, which defines a data address mark. The modified "A1" pattern violates MFM encoding rules by omitting one clock bit. This makes the address-mark pattern unique from any other serial bit combination. See Figure 5-2.

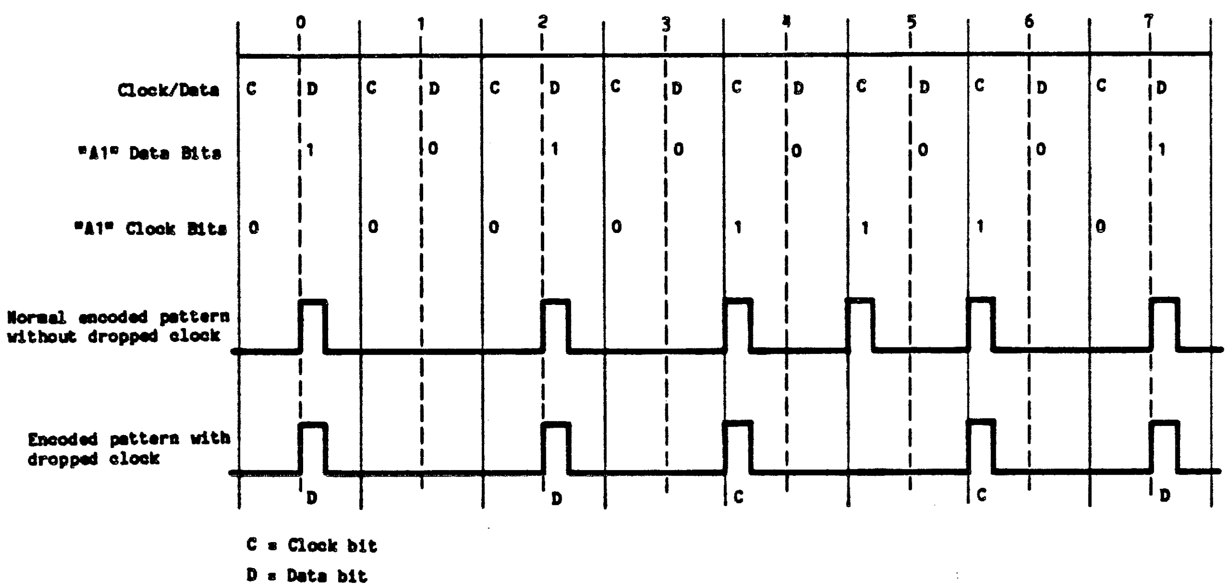


Figure 5-2. "A1" Address Mark Byte

c. For data verification, each ID field and data field is followed by a 16-bit Cyclic Redundancy Check (CRC) field. Each CRC code is unique for a particular data pattern.

d. Surrounding the ID and data fields are gaps that establish physical and timing relationships.

5.2 FORMAT PARAMETERS

This section describes the format shown in Figure 5-1 and the drive-related parameters involved in the design of a format. One of the most important drive parameters related to the design of a disk format is spindle-speed tolerance. The format shown in Figure 5-1 was designed for ±3% speed variation.

a. Gap 1

Gap 1 provides for variations in Index detection. The 16 bytes shown in Figure 5-1 relate to the tolerance associated with the magnetic index transducers used in lower-technology drives. In the 1320 Series, Index is derived from information recorded on the servo disk, and requires a tolerance of only ±1 byte.

Gap 1 may be used as a head-switch-recovery period. Sequential sectors may be read without waiting a rotational latency time. When used in this manner, an additional five bytes (corresponding to the eight-microsecond head-switching time) should be added to the Index tolerance.

b. Sync

The Sync field contains 13 bytes of zeros, which are used to synchronize the phase-locked loop and address-mark circuitry in the data separator. The minimum length of the Sync field is determined by the lock-up characteristics of the data separator in the host controller.

c. ID Field

The ID field contains information associating a unique address with the data field immediately following it. The ID field beginning is defined by the ID address mark, in which the A1 byte is specially encoded.

The ID field contains cylinder, head, and sector-address information, plus a two-byte check field for error-detection purposes. In the format shown, the check field is a standard 16-bit CRC code, although a longer Error Correction Code (ECC) may be used.

d. Gap 2

Gap 2 separates the ID field from the data field and consists of the ID field postamble and the write-splice. The three zero bytes following the ID field check bytes comprise the ID field postamble. When the data field is written, WRITE GATE/ should not be enabled until the end of this postamble, thereby protecting the ID field check bytes. The area where WRITE GATE/ is switched is called the write-splice and is approximately one byte in length. Following the write-splice is a field of 12 zero bytes used to synchronize the data separator (as described for the Sync field).

5.2 FORMAT PARAMETERS (continued)

e. Data Field

The data field contains user data. The data field beginning is defined by the data address mark, in which the A1 byte is specially encoded.

Following the data field (256 bytes in this example) is the check field. In the format shown, the check field consists of a 16-bit CRC check. Depending upon the level of system sophistication, improved performance may be achieved by using a longer ECC for the check field.

f. Gap 3

Gap 3 provides a three-byte postamble for the data field, which protects the data-field check bytes when WRITE GATE/ is turned off following a data-field write.

Gap 3 also provides a speed-tolerance gap, which prevents overwriting the ID field of the following sector when a data field is written. The minimum length of this gap is computed as:

N x 2 x (ST + WOT)

Where ST = spindle speed tolerance
WOT = write-oscillator tolerance
N = number of bytes recorded in the sector update, which in turn is calculated as follows (again using a 256-byte sector as an example):

13	data field sync
2	data address mark
256	data
2	check field
3	postamble
N = 276	bytes

> For example, assuming a 0.1% write-oscillator tolerance and a 0.5% speed tolerance, the minimum Gap 3 tolerance would be:
>
> 276 x 2 x (.005 + .001) = 3.3 bytes
>
> In practice, a longer Gap 3 tolerance is implemented to increase system reliability.

If the system design requires the ability to write physically adjacent sectors, Gap 3 must be increased by five bytes to allow for the eight-microsecond, read-after-write recovery time of the read channel.

5.2 FORMAT PARAMETERS (continued)

g. Gap 4

Gap 4 is the speed-tolerance area for the entire track, and is applicable when formatting the full track. This avoids overflowing the Index area during track-formatting operations. The actual length of the gap depends upon the exact spindle speed during the format operation, which begins writing with the first Index encountered and ends with the next Index.

$$\text{Gap 4} = (10{,}416) \times (ST + WOT) + 2 \times (\text{Index tolerance})$$

Where ST = spindle speed tolerance
WOT = write-oscillator tolerance

> For example, assuming WOT = 0.1%, ST = 0.5%, and Index tolerance = 1 byte, then
>
> $$\text{Gap 4} = (10{,}416) \times (.005 + .001) + (2) \times (1) = 64 \text{ bytes}$$

In designing a format, the usable disk area available for recording sectors is 10,416 minus Gap 4.

5.3 WRITE PRECOMPENSATION

It is recommended that write precompensation not be used. If the system and/or controller is such that precompensation cannot be turned off, it should be set to cut in at track 1024, or the highest possible track.

5.4 ERROR RATES

An error may be defined as a discrepancy between the drive's input write data and output read data. For example, bits may be missing, bits may have changed, or there may be extra bits. The following error rates assume that no attempts are made to read or write data in areas already identified as defective.

a. Seek errors shall not exceed 10 incorrect seeks in 10^7 total seeks.

b. Read errors (for which the written data has been verified by a read-after-write) are classified as soft or hard.

   - A soft error is defined as being recoverable within six retries, excluding error correction and all known media defects. Soft errors shall occur no more frequently than 10 errors in 10^{11} bits read.

   - A hard error is defined as being unrecoverable after six retries. Hard errors shall occur no more frequently than 10 errors in 10^{13} bits read, excluding all known media defects.

It is common practice in many systems environments to minimize the effects of hard errors by following any write operation with a read-after-write verification. This ensures that data are written safely in a defect-free area. Any failing sector is then mapped out of use by the system.

5.5 MEDIA DEFECTS

Media defects are physical characteristics of the media which result in repetitive read errors when a functional drive is operated within specified operating conditions. A single defect is defined as being less than two bytes long. A multiple defect is defined as two bytes or longer, or as a track with more than one single defect.

At the time of manufacture, a media-test system evaluates each 1320 drive and identifies the location of each media defect. The defects are logged on a label affixed to each drive. Defective areas are identified by cylinder and head address, and number of bytes from index. Defect information is also recorded on the drive; see Appendix B.

Micropolis specifies that all 1320 Series disk drives will have no more than one defect per megabyte of unformatted capacity. Additionally, Cylinder Ø shall be defect-free at the time of shipment.

SECTION 6. SERVICEABILITY AND TECHNICAL SUPPORT

6.1 ADJUSTMENTS AND MAINTENANCE

The 1320 Series drives require no adjustments or periodic maintenance. Additionally, no mechanical adjustments are required to prepare the drives for handling or shipment.

6.2 FIELD-REPLACEABLE COMPONENTS

The concept of repair by replacement of complete functional components is utilized in the 1320 Series, resulting in a MTTR of less than 15 minutes.

6.3 SERVICE DATA

See Micropolis Manual No. 101420 for complete maintenance and service data.

6.4 TECHNICAL SUPPORT

For assistance regarding spares, technical training, system integration, and applications, contact:

Micropolis Corporation
21123 Nordhoff Street
Chatsworth, CA 91311

(818) 709-3300

or

Micropolis Corporation
European Operations
210 Elgar Road
Reading, Berkshire, RG2 OPJ
England

(734) 751315

APPENDIX A. DEFINITION AND MEASUREMENT OF SEEK TIME

Proper measurement of seek time is crucial to a clear understanding of a disk drive's performance. First, however, the definition of seek time, as implied by the industry-standard ST506/ST412 interface, must be clear.

Definition of Seek Time

Seek time is measured at the SEEK COMPLETE/ interface signal and is defined as the length of time Seek Complete is false. Seek Complete goes false upon receipt of the first Step pulse and remains false while any additional Step pulses are transmitted to the drive, as well as while the positioner is moving and settling. When the heads are properly positioned for reading or writing, Seek Complete goes true.

The Step pulse rate can have a significant impact on seek time, and is not to be ignored. Most drives begin positioning after the entire burst of Step pulses have been received. This increases the seek time by the time to receive all pulses. For example, if Step pulses were sent at 20-microsecond intervals, a 200-track seek would require 4 additional milliseconds just to buffer the pulses. This would be a 13% increase in seek time for most drives in the 30 millisecond class. In the 1320 Series drives, however, the drive immediately begins seeking upon receipt of the first Step pulse (see STEP/ in Section 2.3.1), thus overlapping buffering time with positioning time; the 1320 drive does not incur a wait-time overhead for buffering Step pulses.

Measuring Seek Time

Seek time is commonly quoted as an "average" value. Average seek time is the sum of the time taken to perform all possible seeks in both directions, divided by the number of seeks.

The number of possible seeks (in both directions) for an "n" track drive is

$$(n) \times (n-1)$$

For 1024-track drives such as the Micropolis 1320 Series, there are 1,047,552 possible seeks!

Thus, the average seek time is:

$$\frac{\text{Total of the seek times for all possible seeks}}{1{,}047{,}552}$$

This method gives a true measurement of average seek time for randomly organized data.

This test is time-consuming, however, so a shorter test is frequently used:

> The average distance traveled for a random seek is one-third of the total number of tracks; the corresponding seek time is referred to as the "one-third stroke" time. This can be measured by timing a single seek, although it is better measured by taking the average of 100 or more one-third stroke seeks such that the entire positioner range is covered. The one-third stroke time and the average seek time are the same for constant-velocity positioners. This test is therefore adequate for stepper-motor type drives. For drives employing closed-loop servo systems (with positioners having non-linear velocity profiles), however, the one-third stroke time is typically up to 10% longer than the actual average value.
>
> Although the average seek time is a closer indication of system throughput for high-performance drives, either test is valid. Since the one-third stroke test is provided on most automatic test equipment and takes less time, it is generally used for quality acceptance testing and comparison of drives.

Comparing Drive Seek Times

Comparisons between seek time figures are commonly used as a way of comparing drives - as a gauge of system performance. The true measure of system performance, however, is throughput. A realistic comparison results if the average seek time is measured over the same number of tracks. For example, if two drives have the same average seek time but one has more tracks, the drive with more tracks will provide faster access to the same amount of data.

By comparing average seek times over the same number of tracks (or the same amount of data), a meaningful comparison of throughput is obtained.

APPENDIX B. DEFECT MAP FORMAT

Defective areas of media are listed on a printed label attached to the disk drive. Additionally, as a part of the manufacturing process, defect-map information is written onto the drive itself. The OEM purchaser of the drive may choose to use this data to implement an electronic method of downloading defect information to his system. Such a method would eliminate the need for manual loading from the printed defect map.

The map information is written onto the disk using a standard Xebec S1410 controller. The format used is the Xebec 32 x 256-byte sector format with no interleave. The defect information for each surface is written onto the relevant surface in a redundant manner such that the same information is written in Sector Ø of Track Ø; in Sector Ø of the maximum track (i.e., the highest track); and in Sector Ø of the maximum track minus eight tracks. Defect information is held in each sector in the format shown in Figure B-1.

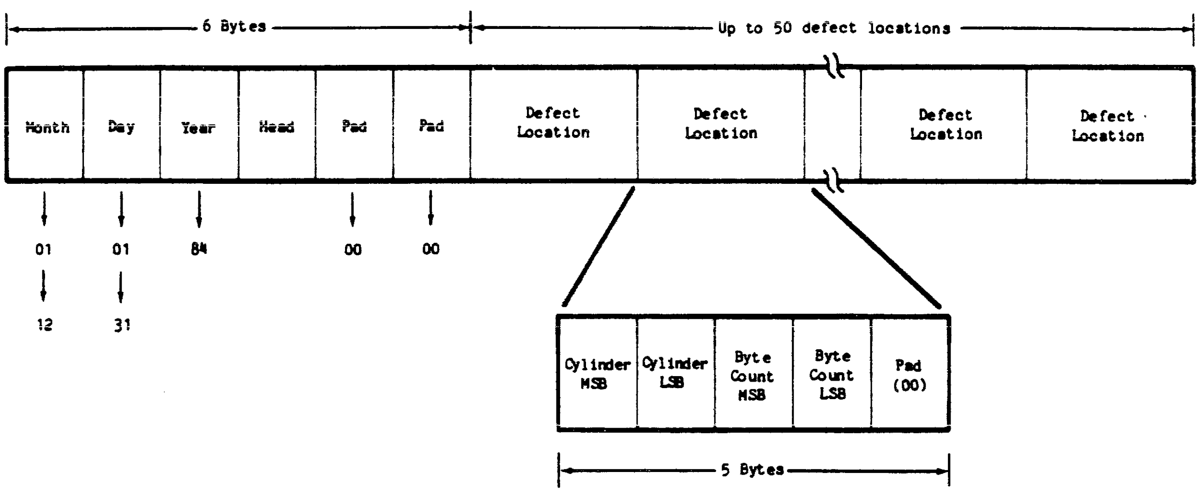


Figure B-1. Defect Information Structure

a. The first six bytes contain the ID field comprised of the month, day, and year; the head; and two zero pad bytes.

b. The remaining 250 bytes contain 50 x 5-byte groups. Each group holds a defect location or an all-ones terminator to flag the defect list end.

   - A 5-byte defect group contains, in sequence, the cylinder most significant byte (MSB); the cylinder least significant byte (LSB); the byte count from Index MSB; the byte count from Index LSB; the fifth byte contains all zeros.

   - The end of the listing for the surface is indicated by the end of the sector (i.e., 50 defects were listed) or by a minimum of five bytes (one group) of all-ones following the last defect listed.