Micropolis 1548

5 1/4-Inch Full-Height
Rigid Disk Drive

2.0 GBytes
SCSI Interface

Product Description

MICROPOLIS

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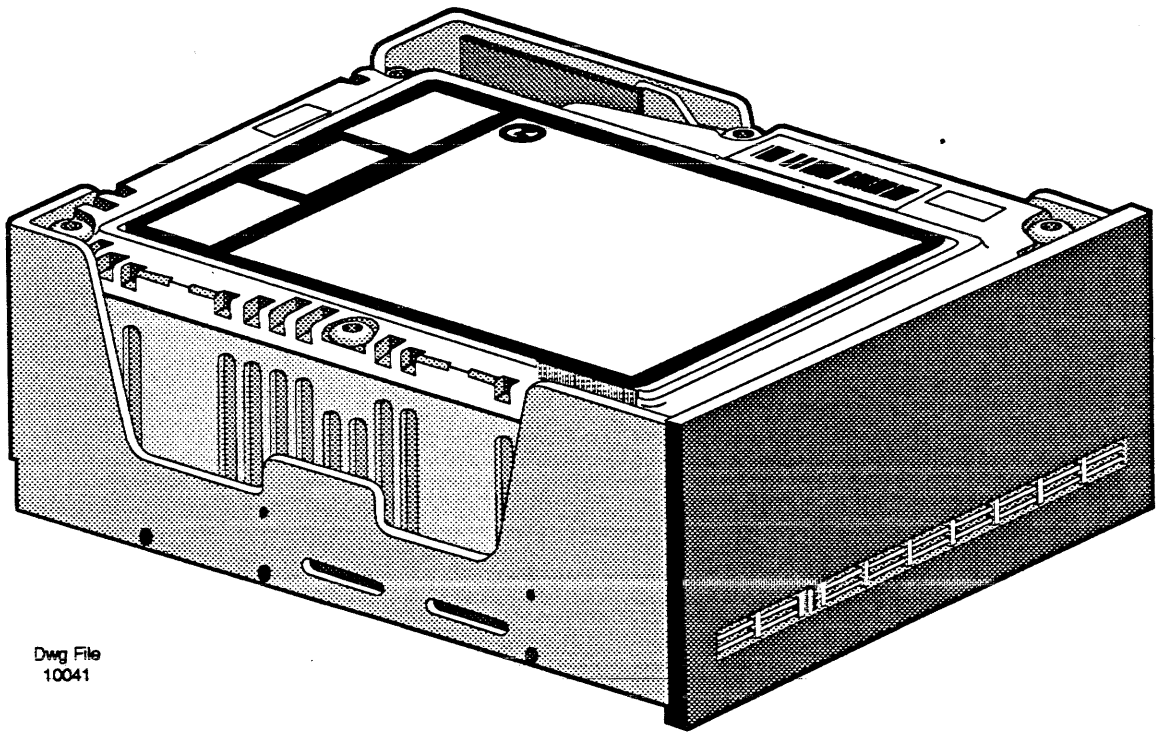

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PREFACE

This Product Description, intended for use by engineers, designers, and planners, describes the typical characteristics of Micropolis model 1548S (single-ended interface) and model 1548D (differential interface), 5 1/4-inch, full-height, rigid disk drives.

This Product Description contains information which reflects current Micropolis design and experience, and is subject to change without notice.

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Table of Contents

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Section 1. Description

Micropolis 1548S (single-ended) and 1548D (differential) high-performance, 5 1/4-inch, full-height Rigid Disk Drives provide OEMs with random-access, high-speed data storage and meet the needs of diverse applications environments. These drives are compatible with the "ANSI CCS" and "SCSI-2" versions of the industry-standard Small Computer System Interface (SCSI) specification.

Throughout this Product Description the term "1548 drive" or "1548" refers to characteristics common to both the single-ended and differential drives. See Appendix A for additional information pertaining to the differential interface.

Features of the 1548

High Capacity

- Up to 2.0 gigabytes (unformatted) per drive; up to 14 gigabytes per host adapter when using a maximum of seven drives.

High Performance

- 14.0-millisecond average seek time makes the drive ideally suited to the demands of multi-user, multi-tasking systems or graphics-intensive applications.
- 24 to 38 megabit-per-second internal data recording and retrieval rate for fast handling of large files, especially in graphics environments or for loading and saving large data bases.
- Digital servo provides faster and more accurate positioning by adapting to dynamically changing environmental parameters.

High Reliability

- 150,000-hour MTBF design uses advanced features like the one-piece rotary positioner, switching regulator amplifier, and lower power circuitry.
- Rugged dual-chassis construction suspends the HDA (head/disk assembly) on shock/vibration isolators which provides exceptional protection during shipment, system installation, and operation.
- Positive media protection is achieved during spin down (due to a STOP UNIT command or power off condition) by automatically retracting and locking the positioner in a data-free landing zone.
- Center Servo – with the servo head placed in the middle of the disk stack, the highest possible positioner accuracy is provided within a broad range of environments.

Features of the 1548 (continued)

Full SCSI-2 Implementation

- The SCSI-2 Command Set is supported by a high-performance, on-board intelligent SCSI controller.
- Sophisticated multi-segment read-ahead algorithm dramatically improves response time for sequential read operations.
- SCSI-2 Tagged Command Queuing greatly increases performance by allowing the drive to optimize the execution sequence of command strings (from single or multiple Initiators).
- Synchronous mode supports a data transfer rate of up to 10 megabytes per second on the SCSI bus thereby improving bus utilization in multi-tasking environments.
- Asynchronous mode supports a data transfer rate of up to 4 megabytes per second on the SCSI bus.
- Performance is enhanced by low SCSI command overhead. Intelligent features such as read-ahead and sophisticated buffer management make maximum use of the 256K dual-ported data buffer, which has full parity for data integrity.
- Supports the disconnect/arbitrate/reconnect operation.
- Programmable sector sizes from 180 to 4096 bytes in 1-byte increments.
- Automatic error recovery.
- In-line defect management (sector slipping) provides maximum throughput.
- Buffer Full Ratio and Buffer Empty Ratio maximize SCSI bus utilization.
- Available with differential drivers and receivers.
- Supports spindle synchronization for high transfer rate subsystems and fault-tolerant arrays.

Characteristics

General Performance Specifications

Seek Time (including settling time)	
Adjacent Track	2.5 msec
Average	14.0 msec
One-Third Stroke (maximum)	14.5 msec
Full Stroke	29.0 msec
Rotational Latency	
Average	8.33 msec
Nominal Maximum	16.67 msec
Start Time (to Drive Ready)	20 seconds maximum
Stop Time	20 seconds maximum
Internal Data Rate	24 to 38 MHz
Data Transfers at interface:	
Synchronous	up to 10 MBytes/sec
Asynchronous	up to 4 MBytes/sec

General Functional Specifications

Data cylinders (unformatted)	2,099
Spindle speed (rpm)	3600
Speed variation (%)	± 0.5

Capacity

Unformatted	
MBytes/Unit	2,000
Data Surfaces	15
Disks	8
Cylinders	2,099
Bytes/Track	Variable
MBytes/Surface	133.3
Formatted **	512-Byte Format:
MBytes/Unit	1,748
Cylinders	2,089
Sectors/Track	Variable

** Based on typical sparing (user programmable).

Vibration

Operating (The drive can be operated and subjected to vibration up to the following levels, and will meet error specifications 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

Range 1 (meets error specifications on page 1-5)

1/2 Sinusoidal	2 G peak, 11 msec

Range 2 (no component damage or data corruption)

1/2 Sinusoidal	8 G peak, 11 msec

NOTE: Shock levels exceeding Range 1 will result in deterioration of drive performance for the duration of those shock levels, but the drive will return to normal operating specifications after the shock period has passed.

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

Characteristics (continued)

Environmental Limits

	Operating	Storage
Ambient Temperature	5°C to 50°C (41°F to 122°F)	–40°C to 65°C (–40°F to 149°F)
Temperature Gradient, max	2.0°C/5 Minutes (3.6°F/5 Minutes)	24.0°C/Hour * (43.2°F/Hour)

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

Relative Humidity	10% to 90% non-condensing	10% to 90% 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	–1,000 ft to 50,000 ft

Power Dissipation (typical drive, nominal voltage)

Stand-by	19 Watts (64.8 Btu/hr)
Positioning (average) **	24 Watts (81.9 Btu/hr)

** This value is for 1/3-stroke seeks with an 8-millisecond idle period between seeks to simulate a typical system environment.

Acoustic Noise

Idling	Less than 38 dBA (5.0 Bels)
Seeking	Less than 43 dBA (5.5 Bels)

Reliability

Errors	
Soft Read	≤ 10 in 10^{11} bits read
Hard Read	≤ 10 in 10^{13} bits read
Seek	≤ 10 in 10^{7} seeks
Unit MTBF	150,000 Power-On Hours

Characteristics (continued)

Maintainability

MTTR	Less than 15 minutes

General Physical Specifications

Drive:	Height	3.25 in	(82.6 mm)
	Width	5.75 in	(146.1 mm)
	Depth	8.00 in	(203.2 mm)
Bezel:	Height	3.380 in	(85.9 mm)
	Width	5.880 in	(149.4 mm)
	Depth	0.185 in	(4.7 mm)
Drive Weight:		8.2 lbs	(3.7 kg)

Major Components

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

The general organization of the major components is shown in Figure 1-1.

Printed Circuit Board

The Device Electronics board provides overall control and data functions for the drive.

- Microprocessor-based logic controls power-up sequencing, power-down sequencing, and interface command and status handling.
- Digital Signal Processor (DSP) based servo circuits control the positioner.
- Driver and receiver circuits provide for the transmission and reception of control, data, and status signals across the interface.
- Data read/write circuits direct data flow onto and off the disks.

This circuitry also contains the SCSI interface and intelligent controller. This includes the main microprocessor, 256K of RAM data buffer, and (VLSI) system logic circuits. The 1548 design features a total of two microprocessors.

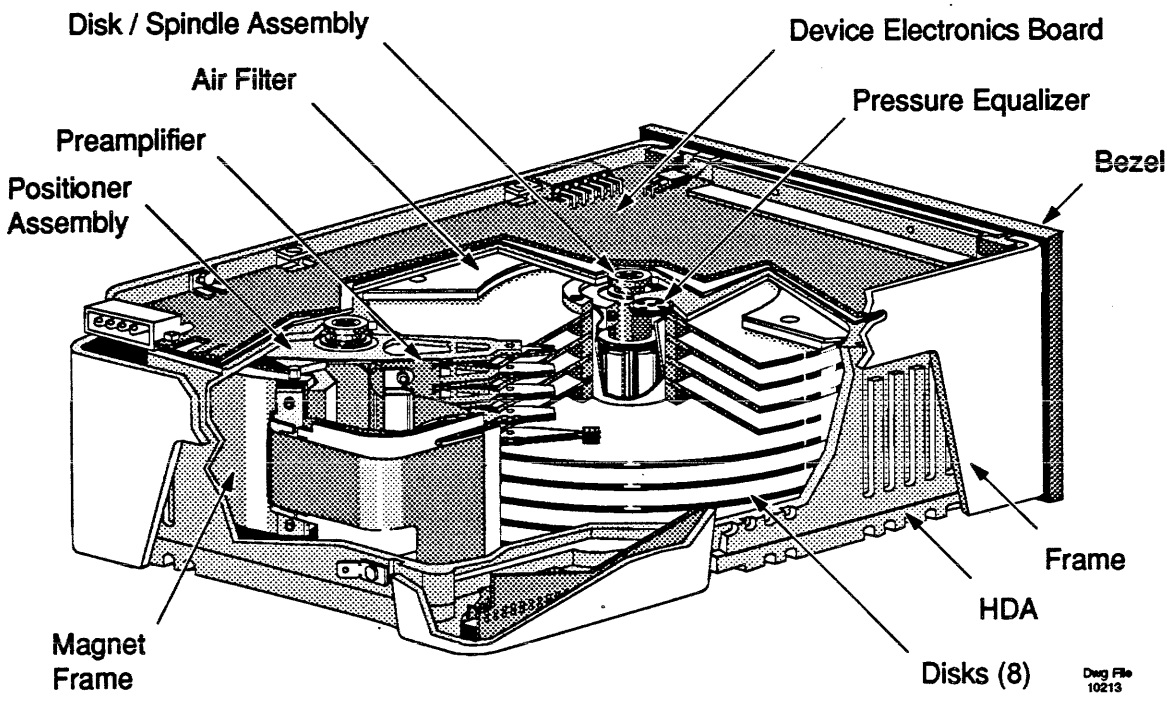

Figure 1-1. Mechanical Organization

Mechanical Assembly

The mechanical assembly consists of a sealed head/disk assembly (HDA) and an outer frame.

a. Head/Disk Assembly (HDA)

The HDA consists of a die-cast structure which contains virtually all of the drive's mechanical components.

Two die-cast members create a sealed, clean area. Components included in the clean area are the servo head and data heads, magnetic disks, and the rotary positioner.

Electrical connection between the mechanical components in the clean area and the Device Electronics board is made with flexible circuits.

- Disk/Spindle Assembly

  Eight magnetic disks are mounted on the spindle assembly, which includes a three-phase brushless DC motor (commutated by three Hall-effect sensors). The casting supports each end of the spindle.

Mechanical Assembly (continued)

- Head Assembly

  Each drive has one servo head assembly and fifteen data head assemblies. The data head assemblies fly over the disk surface on an "air bearing" created by the rotation of the disks. The heads rest on the disk surfaces (i.e., the landing zone) when the disks are not rotating.

- Positioner Assembly

  The positioner is a balanced rotary voice-coil motor mechanism with a moving coil. Each end of the positioner shaft is supported by the casting. The servo head and data heads are attached to the head-arm assemblies mounted to the pivot housing. The motor torque rotates the positioner about its axis of rotation. Rotation is constrained to keep the heads over the safe operating area of the disk via limit stops.

  Position reference is made to tracks recorded on the disk surface nearest the center of the disk stack (i.e., center servo). Position information is recorded on these tracks in a "modified dibit" format.

  An area of the disk which is not used for data storage is reserved for landing the heads. When power is removed from the drive, the positioner is automatically retracted to that landing zone, and a latch is activated to prevent the positioner from leaving the landing zone. Thus, no operator intervention is necessary when shipping a drive or when shipping the equipment in which a drive is installed.

  Read/write and servo preamplifier assemblies are mounted on the rotary positioner near the heads. These assemblies contain the read signal preamplifiers, read/write head-select circuits, write current drivers, and the servo signal preamplifier.

- Air Filtration System

  The 1548 drives are designed to provide contamination control within the sealed HDA throughout the life of the drive with zero maintenance.

  Air within the HDA is continuously recirculated and filtered through a high efficiency filter. Air is ducted to and from the filter for optimum pressure utilization and filtration efficiency. Air within the HDA may only enter the drive through a high-efficiency breather filter.

Mechanical Assembly (continued)

- Recording Media

  Eight aluminum disks, each 130 millimeters (5 1/4 inches) in diameter, are mounted on the spindle assembly. The recording surface on each disk is a thin coating of magnetic material with a very durable overcoat..

- Braking

  The heads contact an area of the disk surface which is not used for data storage when the disks are not spinning and during start and stop cycles. Dynamic braking is used to stop the spindle quickly.

b. Frame (Outer Chassis)

The HDA is suspended within the outer frame on shock isolators/absorbers. This method of construction protects the HDA from mounting-related distortion or stress, and shock and vibration.

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Section 2. Single-Ended Interface

Interface and Power Connector Pin Assignments

The 1548 drive is compatible with the "ANSI CCS" and "SCSI-2" versions of the Small Computer System Interface (SCSI) specification proposed by the American National Standards Committee; see Micropolis Document #110366 for full command protocol.

The electrical interface between the drive and the host system is accomplished via five connectors: Signal Connector J1 (Table 2-1), Multi-Function Connector/Jumper Block J2, and Power Connector J3 (Table 2-2); and Ground Connectors J4 and J5 on the Head/Disk Assembly (HDA) and outer Frame respectively. See Figure 3-1 for the connector locations. See Appendix A for differential interface specifications.

Table 2-1. Single-Ended Cable Pin Assignments

J1 CONNECTOR PIN				
Signal	Ground	SIGNAL NAME	DESCRIPTION	SOURCE
2	1	–DB(0)	Data Bus 0	I / T
4	3	–DB(1)	Data Bus 1	I / T
6	5	–DB(2)	Data Bus 2	I / T
8	7	–DB(3)	Data Bus 3	I / T
10	9	–DB(4)	Data Bus 4	I / T
12	11	–DB(5)	Data Bus 5	I / T
14	13	–DB(6)	Data Bus 6	I / T
16	15	–DB(7)	Data Bus 7	I / T
18	17	–DB(P)	Data Bus Parity	I / T
20	19	GROUND	–	–
22	21	GROUND	–	–
24	23	GROUND	–	–
26	–	TERMPWR	Terminator Power	I / T
28	27	GROUND	–	–
30	29	GROUND	–	–
32	31	–ATN	Attention	I
34	33	GROUND	–	–
36	35	–BSY	Busy	I / T
38	37	–ACK	Acknowledge	I
40	39	–RST	Reset	I
42	41	–MSG	Message	T
44	43	–SEL	Select	I / T
46	45	–C/D	Control/Data	T
48	47	–REQ	Request	T
50	49	–I/O	Input/Output	T

NOTES: I = Initiator, T = Target

Pin 26 provides optional +5V; see Page 3-3

All odd pins, except for pin 25, should be connected to ground. Pin 25 should be left open.

The "–" sign next to a signal name means active low.

Power is supplied to the drive via AMP MATE-N-LOK Connector J3; see Section 4 for power requirements.

- The suggested wire size is 18 AWG (minimum) for all pins.
- The recommended mating connector is AMP 1-480424-0; the recommended pins are AMP 350078-4.

The voltages listed in Table 2-2 are ± 5%, measured at the drive's power connector.

Table 2-2. DC Power Connector J3 Pin Assignments

Pin	Voltage	Pin	Voltage
1	+12	3	+ 5 Return
2	+12 Return	4	+ 5 V

Single-Ended Interface Electrical Characteristics

Interface control and status signals are digital (open collector TTL) using industry-standard transmitters and receivers which provide a terminated, single-ended system.

Figure 2-1 summarizes the electrical characteristics of the signals at Connector J1.

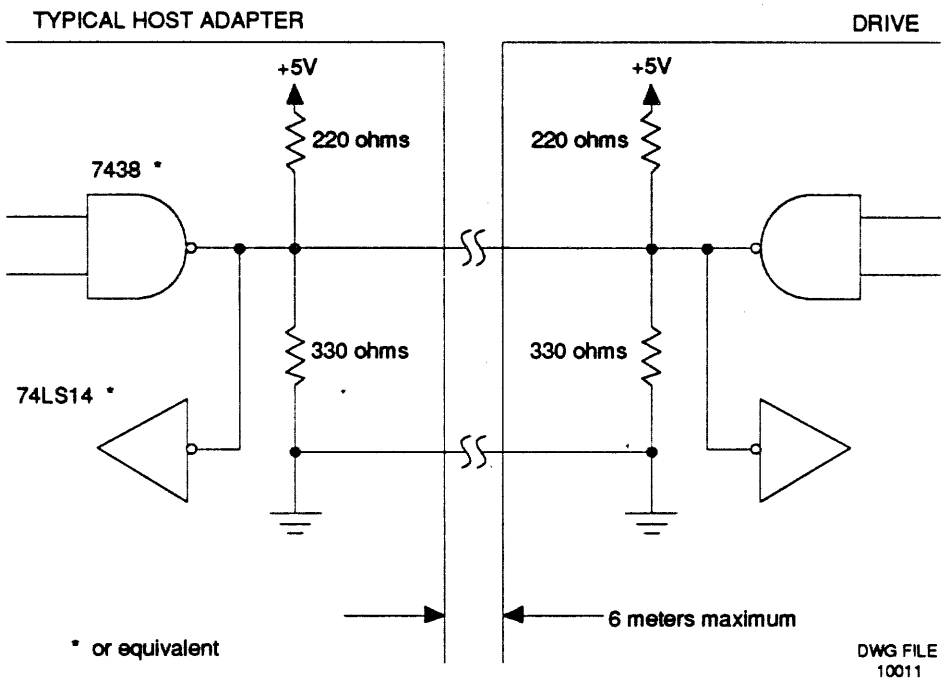

Figure 2-1. Single-Ended Driver/Receiver Combination

The assigned signals are terminated with 220 ohms to +5V (nominal) and 330 ohms to ground at each end of the cable. All signals use open-collector or three-state drivers.

Single-ended drivers and receivers allow a maximum cable length of six meters (primarily for connection within a cabinet).

Signal transmission requires a single 50-conductor cable. A characteristic impedance of 100 (± 10%) ohms is recommended for unshielded flat or twisted-pair ribbon cable.

a. Input Characteristics

Each of the drive's signal receivers has the following characteristics when measured at the interface connector.

1) Signal true = 0.0 VDC to 0.8 VDC.

2) Maximum total input load = –0.4 milliamps at 0.5 VDC.

3) Signal false = 2.0 VDC to 5.25 VDC.

4) Minimum input hysteresis = 0.2 VDC.

b. Output Characteristics

Each driven signal has the following characteristics when measured at the interface connector.

1) Signal assertion = 0.0 VDC to 0.5 VDC.

2) Minimum driver output capability = 48 milliamps (sinking) at 0.5 VDC.

3) Signal negation = 2.5 VDC to 5.25 VDC.

c. Terminator Power (TERMPWR at Pin 26)

Terminator Power has the following requirements:

V_{Term} = 4.25 VDC to 5.25 VDC.

800 milliamps minimum source drive capability, with 1.0 amp recommended current limiting (e.g., a fuse).

1.0-milliamp maximum bus loading (except for the purposes of providing power to an internal terminator).

The 1548 disk drive provides keyed connectors to prevent accidental grounding or misconnection of terminator power.

SCSI Bus Signals

There are a total of eighteen SCSI bus signals. Nine of the bus signals are for control, and nine are for data. (Note that the data signals include the parity signal option.)

Signal Descriptions

ACK: The **Acknowledge** signal is driven by an Initiator to show acknowledgment of a REQ/ACK data-transfer handshake.

ATN: The **Attention** signal is driven by an Initiator that indicates the Attention condition.

BSY: **Busy** is an "OR-tied" signal that shows the bus is in use.

C/D: The **Control/Data** signal is driven by a Target to indicate whether Control or Data information is on the Data Bus. True = Control.

DB: Eight **Data-Bit** signals, DB(0) through DB(7), plus a parity-bit signal, DB(P), form the Data Bus. DB(7) is the most significant bit and has the highest priority during the Arbitration phase. Bit number, significance, and priority decrease to DB(0). A data bit is defined as 1 when the signal value is true and is defined as 0 when the signal value is false.

Data parity DB(P) is odd. The use of parity is a system option (i.e., a system is configured so that all the SCSI devices on a bus generate parity and have parity detection enabled, or all the SCSI devices have parity detection disabled or not implemented). Parity is not valid during the Arbitration phase.

I/O: The **Input/Output** signal is driven by a Target that controls the direction of data movement on the Data Bus *with respect to an Initiator*. True indicates input to the Initiator. This signal is also used to distinguish between Selection and Reselection phases.

MSG: The **Message** signal is driven by a Target during the Message phase.

REQ: The **Request** signal is driven by a Target to indicate a request for a REQ/ACK data transfer handshake.

RST: **Reset** is an "OR-tied" signal that indicates the Reset condition.

SEL: The **Select** signal is used by:

- An Initiator to select a Target.
- A Target to reselect an Initiator.

Signal Values

Signals may assume true or false values. There are two methods of driving these signals. In both cases, the signal is actively driven true.

- In the case of OR-tied drivers, the driver does not drive the signal to the false state, rather the bias circuitry of the bus terminators pulls the signal false whenever it is released by the drivers at every SCSI device. If any driver is asserted, then the signal is true.
- In the case of non-OR-tied drivers, the signal may be actively driven false, or negated.

In this product description, wherever the term negated is used, it means that the signal may be actively driven false, or it may be simply released (in which case the bias circuitry pulls it false), at the option of the implementor.

The advantage to actively driving signals false is that the true-to-false transition occurs more quickly, and noise margins may be somewhat improved.

OR-tied Signals

The BSY signal and the RST signal are OR-tied only. In the normal operation of the bus, these signals are simultaneously driven true by several drivers.

No signals other than BSY, RST, and DB(P) are driven at the same time by two or more drivers, and any signal other than BSY and RST may employ OR-tied or non-OR-tied drivers. DB(P) is not driven false during the Arbitration phase.

Note that there is no operational problem in mixing OR-tied and non-OR-tied drivers on signals other than BSY and RST.

Signal Sources

Table 2-3 shows which type of SCSI device is allowed to originate each signal. No attempt is made to show if the source is driving asserted, driving negated, or is passive. All SCSI device drivers which are not active sources are in the passive state.

The RST signal may be originated by any SCSI device at any time and is therefore not shown in Table 2-3.

For further information on the operation of the SCSI interface, see document #110366 (SCSI Implementation in Micropolis "MZR" Products) and the ANSI SCSI Standard.

Signal Sources (continued)

Table 2-3. Signal Sources

Bus Phase	Signals				
	BSY	SEL	C/D; I/O; MSG; REQ	ACK/ATN	DB (7-0; P)
Bus Free	None	None	None	None	None
Arbitration	All	Winner	None	None	SCSI ID
Selection	I&T	Initiator	None	Initiator	Initiator
Reselection	I&T	Target	Target	Initiator	Target
Command	Target	None	Target	Initiator	Initiator
Data In	Target	None	Target	Initiator	Target
Data Out	Target	None	Target	Initiator	Initiator
Status	Target	None	Target	Initiator	Target
Message In	Target	None	Target	Initiator	Target
Message Out	Target	None	Target	Initiator	Initiator

All: The BSY signal is driven by all SCSI devices that are actively arbitrating.

SCSI ID: A unique data bit (the SCSI ID) is driven by each SCSI device that is actively arbitrating; the other seven data bits are released (i.e., not driven) by this SCSI device. Parity bit DB(P) may be undriven or driven to the true state, but is never driven to the false state during this phase.

I&T: The BSY signal is driven by the Initiator, the Target, or both, as specified in the Selection phase and the Reselection phase.

Initiator: If the signal is driven, it is driven by the active Initiator only.

None: The signal is released; that is, not driven by any SCSI device. The bias circuitry of the bus terminators pulls the signal to the false state.

Winner: The SEL signal is driven by the one SCSI device that wins arbitration.

Target: If the signal is driven, it is driven only by the active Target.

Command Set

Table 2-4 lists the Command Set for the drive. For further information on the operation of the SCSI interface, see document #110366 (SCSI Implementation in Micropolis "MZR" Products) and the ANSI SCSI Standard.

Table 2-4. Command Set

Operation Code (hex)	Command Name
40	CHANGE DEFINITION
04	FORMAT UNIT
12	INQUIRY
4C	LOG SELECT
4D	LOG SENSE
15	MODE SELECT(6)
55	MODE SELECT (10)
1A	MODE SENSE(6)
5A	MODE SENSE (10)
34	PRE-FETCH
08	READ(6)
28	READ(10)
3C	READ BUFFER
25	READ CAPACITY
37	READ DEFECT DATA
3E	READ LONG
07	REASSIGN BLOCKS
1C	RECEIVE DIAGNOSTIC RESULTS
17	RELEASE
03	REQUEST SENSE
16	RESERVE
01	REZERO UNIT
0B	SEEK(6)
2B	SEEK(10)
1D	SEND DIAGNOSTIC
1B	START/STOP UNIT
00	TEST UNIT READY
2F	VERIFY
0A	WRITE(6)
2A	WRITE(10)
2E	WRITE AND VERIFY
3B	WRITE BUFFER
3F	WRITE LONG

Definitions

In a typical system, the computer's host adapter acts as the Initiator and the peripheral device's controller acts as the Target.

This section does not attempt to distinguish between a computer and its host adapter. These functions may be separate or merged; the term "Initiator" encompasses both. Similarly, the term "Target" does not distinguish between the peripheral device and its controller, which may be separate or merged (like the 1548).

Command Summary

The following alphabetical listing gives the hex code and a brief description of each command that is supported by the drive:

CHANGE DEFINITION, 40h, provides for the selective introduction of SCSI-2 features into an operating environment (e.g., MODE SENSE/SELECT parameter lists where the lengths of these pages have changed).

FORMAT UNIT, 04h, causes the drive to format (or reformat) the media so that all data blocks can be accessed.

INQUIRY, 12h, causes the drive to transfer parameter information to the Initiator.

LOG SENSE, 4Ch, provides a means for the Initiator to manage statistical information about the drive. This information is maintained in the form of log pages and log parameters. This is a complementary command to the LOG SELECT command.

LOG SELECT, 4Dh, provides a means for the Initiator to retrieve statistical information maintained by the drive. This is a complementary command to the LOG SENSE command.

MODE SELECT (6), 15h, enables the Initiator to specify or change drive parameters. This is a complementary command to the MODE SENSE (6) command.

MODE SELECT (10), 55h, enables the Initiator to specify or change drive parameters. Note that the MODE SELECT (10) command can specify a longer Parameter List Length than the standard MODE SELECT (6) command. This is a complementary command to the MODE SENSE (10) command.

MODE SENSE (6), 1Ah, causes the drive to send media parameters to the Initiator. This is a complementary command to the MODE SELECT (6) command.

Command Summary (continued)

MODE SENSE (10), 5Ah, causes the drive to send media parameters to the Initiator. Note that the MODE SENSE (10) command can specify a longer Allocation Length than the standard MODE SENSE (6) command. This is a complementary command to the MODE SELECT (10) command.

PRE-FETCH, 34h, requests that the drive transfer the specified logical blocks to the cache memory. No data shall be transferred to the Initiator.

READ(6), 08h, causes the drive to send data to the Initiator.

READ(10), 28h, causes the drive to send information to the Initiator. Note that the READ(10) command can specify a higher Logical Block Address and a longer Transfer Length than the standard READ(6) command.

READ BUFFER, 3Ch, is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing the drive's buffer memory and SCSI bus integrity. There is no medium access with this command.

READ CAPACITY, 25h, causes the drive to send information with respect to its capacity to the Initiator.

READ DEFECT DATA, 37h, causes the drive to send defect lists, maintained by the drive, to the Initiator.

READ LONG, 3Eh, causes the drive to send one block of data and its associated ECC (Error Checking Correction) bytes to the Initiator.

REASSIGN BLOCKS, 07h, causes the drive to reassign defective logical blocks to an area on disk reserved for this purpose.

RECEIVE DIAGNOSTIC RESULTS, 1Ch, causes the drive to execute diagnostic tests that were requested/defined by the SEND DIAGNOSTIC command. Note that the drive sends analysis data to the Initiator after completion of the diagnostic tests.

RELEASE, 17h, lets the Initiator release a reserved drive.

REQUEST SENSE, 03h, causes the drive to send Sense Data to the Initiator.

RESERVE, 16h, allows the Initiator to reserve a drive for its exclusive use.

Command Summary (continued)

REZERO UNIT, 01h, causes the drive to position the heads at physical track zero.

SEEK(6), 0Bh, causes the drive to move the data heads to a specified Logical Block Address.

SEEK(10), 2Bh, causes the drive to move the data heads to a specified Logical Block Address. Note that SEEK(10) can specify a higher Logical Block Address than the SEEK(6) command.

SEND DIAGNOSTIC, 1Dh, causes the drive to perform a self test.

START / STOP UNIT, 1Bh, allows the Initiator to enable/disable the drive's spindle motor for operations. A jumper option is available which automatically enables the drive's spindle motor at power-on; see Spindle Control Option, Page 3-4.

TEST UNIT READY, 00h, provides a way for the Initiator to check the ready status of the drive.

VERIFY, 2Fh, causes the drive to verify the data which was written on disk.

WRITE(6), 0Ah, causes the drive to write data (from the Initiator) to disk.

WRITE(10), 2Ah, causes the drive to write data (from the Initiator) to disk. Note that the WRITE(10) command can specify a higher Logical Block Address and a longer Transfer Length than the standard WRITE(6) command.

WRITE AND VERIFY, 2Eh, causes the drive to write data (from the Initiator) to disk and then verify that the data is correctly written.

WRITE BUFFER, 3Bh, is used in conjunction with the READ BUFFER command as a diagnostic function for testing the drive's buffer memory and SCSI bus integrity. There is no medium access with this command.

WRITE LONG, 3Fh, causes the drive to write one block of data and its associated ECC bytes to disk.

Distinctive Features of Micropolis SCSI

While the 1548 drive is compatible with the "CCS" and "SCSI-2" versions as defined by ANSI, there are several characteristics of Micropolis SCSI that enhance its performance and functionality.

a. Data Transfers

1548 drives are capable of transferring data at up to 10 MBytes/sec in synchronous mode and 4 MBytes/sec in asynchronous mode. In some configurations (e.g., short cable and fast host), faster asynchronous transfer rates can be achieved.

b. Command Queuing

1. SCSI-2 Tagged Command Queuing

When the host allows command re-sequencingr by use of the SCSI-2 command tag messages, the drive can significantly improve data throughput to the system. The drive will receive multiple commands and execute them in a sequence which has been determined to minimize overhead associated with physical delays (seek, latency, etc.) and electrical delays (bus phase sequencing or command turn-around times).

Micropolis' unique intelligent implementation considers both seek and latency optimization for maximum command processing.

2. Untagged Command Queuing

Allows a target to accept a command from an initiator for a logical unit or target routine while a command from another initiator is being executed. Only one command can be accepted at a time.

c. Multi-Segment Read-Ahead

This function partitions the data buffer into multiple small buffers or segments. The read-ahead function causes the 1548 drive to transfer the requested block into its buffer and continue to read sequential blocks until the buffer (or segment) is filled or another command is received.

On subsequent requests for data, the buffer will be checked for the requested blocks. If the data already resides in the buffer, it will be transferred to the host and no media access will be necessary. This results in a significant improvement in performance.

Distinctive Features of Micropolis SCSI (continued)

d. Through Parity

Data integrity is maintained in the 1548 drive by maintaining parity from the SCSI interface, through the drive's buffer, to just before the point where the data byte is converted to serial form for transmission to the media.

e. Multi-Segment Data Buffer/Cache

The 256K data buffer is dynamically divided into segments with each segment holding data from different areas of the disk. This maximizes the improvement of read-ahead technology by greatly increasing the probability of a cache hit.

This feature improves the performance of all types of systems; from single threaded DOS environments to complex architectures like UNIX with its own system caches.

f. Buffer Full Ratio/Buffer Empty Ratio

Buffer Full Ratio and Buffer Empty Ratio, which are programmable under MODE SELECT, allow fine tuning of the drive's disconnect protocol to maximize the availability of the SCSI bus for use by other peripherals.

g. Automatic Read Reallocate

When enabled, this feature causes a REASSIGN BLOCK command to be issued after a pre-defined number of error recovery attempts has been exceeded during a read operation. Error handling thus occurs automatically: the errors are logged and reallocated with no host intervention required.

h. Automatic Write Reallocate

Automatic Write Reallocate controls the automatic reallocation of defective data blocks during a write operation.

When enabled, this feature causes a REASSIGN BLOCK command to be issued after a pre-defined number of error recovery attempts has been exceeded during a write operation. Error handling thus occurs automatically: the errors are logged and reallocated with no host intervention required.

Distinctive Features of Micropolis SCSI (continued)

i. Cylinder-Oriented Defect Management

Sector reallocation occurs as the result of:

- a REASSIGN BLOCK command.
- a FORMAT command with additional defects identified.
- an automatic reassignment (if the ARRE bit is 1).

The number of spare blocks per cylinder and the number of spare cylinders per drive may be selected by the user via MODE SELECT. The spare blocks selected for each cylinder are at the end of that cylinder (i.e., the maximum head).

When a REASSIGN BLOCK command is executed, the data is reformatted on the cylinder, skipping the defect, and leaving all logical blocks in their original, contiguous order. Non-volatile transaction tags are used during the process as each stage is completed so that the operation can be successfully completed even if interrupted by a power loss.

The recommended number of spare blocks per cylinder is the number of data heads divided by two and rounded up to the next highest integer. This is more than adequate for the life of the drive.

On the remote chance that the number of spares (calculated above) is insufficient, the following fall-back scheme is available:

1. If a REASSIGN BLOCK command is executed and no spare blocks remain for the cylinder, data is relocated to one of the spare cylinders.

2. The cylinder that previously held the relocated data is flagged so that any seeks to it will be referred to the formerly spare cylinder which is now holding the data.

Cylinder-oriented defect management has the following advantages:

- Managing defects on a cylinder-oriented basis means that the spare blocks for the entire cylinder must be exhausted before the data is relocated to a spare cylinder, a very unlikely occurrence.
- Allocating spare blocks per cylinder offers efficient use of disk space, resulting in higher formatted capacities.

In summary, cylinder-oriented defect management gives the user high performance and high capacity.

Distinctive Features of Micropolis SCSI (continued)

j. Saving Mode Select Parameters

The 1548 disk drive saves the set of Page 1 and Page 2 parameters determined via the MODE SELECT command for each Initiator accessing the drive. Saving the parameter set allows different Initiators to establish different parameters for a shared device in multiple-initiator systems.

For further details on saving MODE SELECT Parameters, see Micropolis Application Note 13, MODE SENSE / SELECT Functions.

k. Zero Latency Read

Zero Latency Read allows reading to start at the first good sector on a track, instead of at index, if the sector belongs to the command we are looking for. This results in significantly improved performance.

l. Write Behind Caching

Write Behind Caching allows multiple sequential writes to occur within a single revolution. This feature provides dramatically improved system performance. Write Behind Caching also allows a system to be run without logical interleave and permits full benefit to be taken of the read-ahead features of the drive.

m. Spindle Synchronization

Spindle Synchronization is provided for rotationally-locked array applications. This feature, used with mirroring and striping techniques, results in significant system and network performance gains.

Error Rates

An error may be defined as a discrepancy between recovered and recorded data. For example, bits may be missing, bits may have shifted, the state of a bit may have become inverted, or there may be extra bits.

Errors are classified as soft or hard.

- A *soft* error is defined as being recoverable within 6 retries, excluding error correction and all known media defects. It shall occur no more than 10 times in 10^{11} bits read.
- A *hard* error is defined as being unrecoverable after 6 retries. It shall occur no more than 10 times in 10^{13} bits read.

The 1548 drive supports fully-programmable automatic retries, including the use of ECC. These options, together with the defect mapping and automatic reallocation options, afford the system a high degree of protection against the effects of hard errors.

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.

At the time of manufacture, a media test system evaluates every drive and identifies each media defect location. The defective areas are identified by head address (HD), cylinder address (CYL), and number of bytes from index (BFI). A printed listing of the defects is shipped with each drive.

The list of manufacturer-found defects is stored on the drive in a reserved, write-protected area accessible by the SCSI controller. This list is known as the MDL (Manufacturers Defect List) or PList (Primary Defect List).

The entries it contains can be mapped out (reassigned) automatically during the operation by appropriate use of the format control parameter bits.

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Section 3. Installation

Physical Interface

The electrical interface between the 1548 drive and the host system is accomplished via five connectors: J1, J2, J3, J4, and J5. These connectors and their recommended mating connectors are described below. Figures 3-1 and 3-2 show the locations of the power and interface connectors.

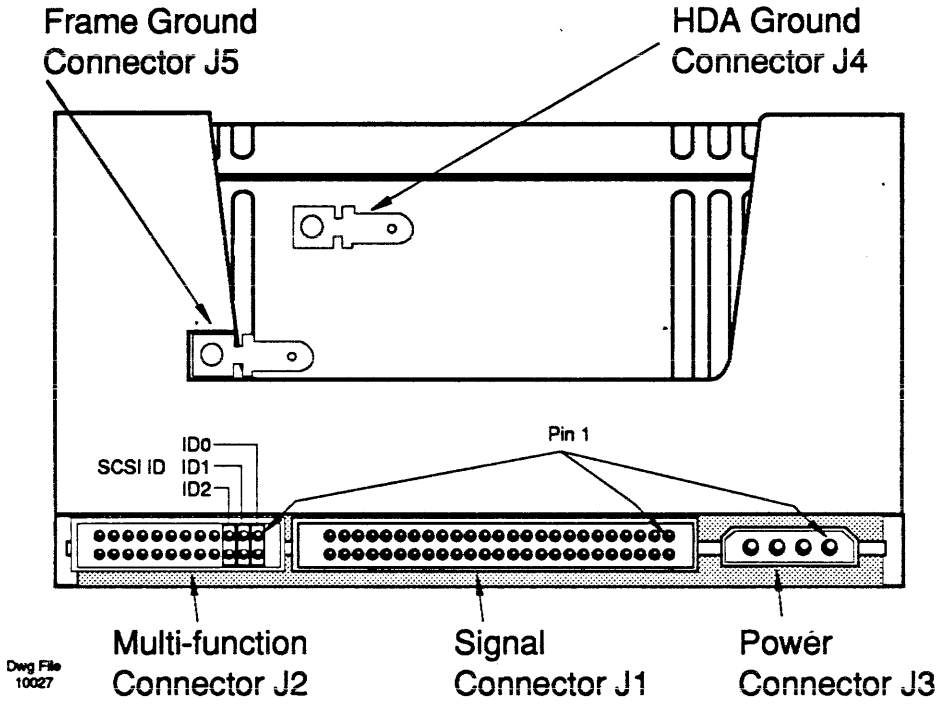


Figure 3-1. Power and Interface Connections

Power and Interface Cables and Connectors

- Signal Connector J1

  J1 is a 50-pin connector. Signal interface connection is made via this connector. The signals on J1 include the 8-bit SCSI bus and various control and handshaking lines.

  Recommended Cable: 3M Scotchflex 3365/50 or equivalent
  Mating Connector: 3M P/N 3425-3000 or equivalent

- Multi-Function Connector / Jumper Block J2

  J2 is a 24-pin, multi-function connector/jumper block.

- DC Power Connector J3

  J3 is a 4-pin, keyed, AMP MATE-N-LOCK connector. Both +5V and +12V are supplied to the drive via this connector.

  Mating Connector: AMP 1-480424-0 or equivalent
  Pins: AMP 350078-4
  Suggested Wire Size: 18 AWG

- Ground Connectors J4 and J5

  3/16-inch spade lugs J4 and J5 are provided for grounding; J4 is located on the HDA, and J5 is located on the frame. System characteristics determine proper ground connection; see Figure 3-1 for the locations of the connectors

  Mating Connector: AMP 60972-2 or equivalent

Drive Option Selection

Figure 3-2 shows the locations of the connectors, SCSI ID jumpers, option jumpers, and interface terminator packs on the Device Electronics board.

Device Addressing and Interface Termination

Up to eight devices (the host and seven targets) can be attached to the SCSI bus. The 1548 drive has three ID jumpers - ID0, ID1, and ID2. These three jumpers are used to assign one of the eight SCSI ID bits (0 through 7) to the drive; see Table 3-1.

Table 3-1. Device Addressing

SCSI ID	JUMPERS ID2	ID1	ID0
0 *	out	out	out
1	out	out	in
2	out	in	out
3	out	in	in
4	in	out	out
5	in	out	in
6	in	in	out
7	in	in	in

* Factory default configuration.

In multiple-device systems, each drive must have its own unique ID.

Drive Option Selection (continued)

Interface Terminator pack RN6 provides proper termination for the interface lines. For a multiple-drive system, the terminator pack is installed in the last drive on the cable; refer to Page 3-6.

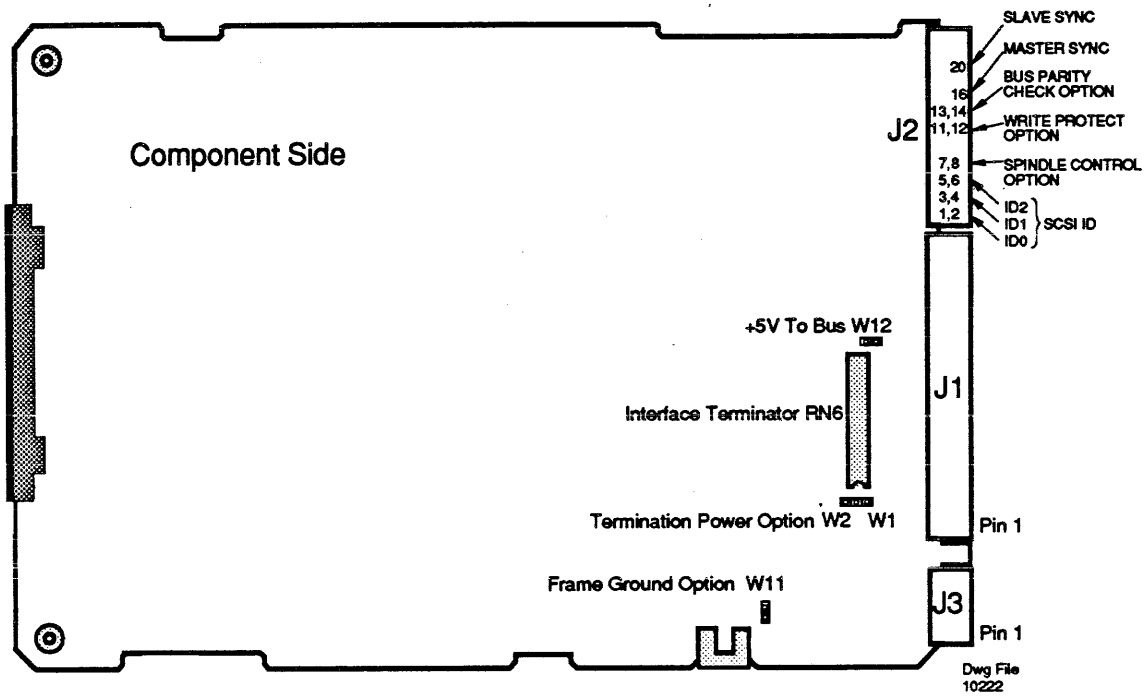


Figure 3-2. Address Jumpers and Interface Terminator

BUS Termination Power Option

A jumper is installed at W1, at W2, or at W2 and W12 to select the source of terminator power (+5V) for the SCSI Bus terminator packs on the Device Electronics board.

Do *not* install jumpers at both W1 and W12.

- When a jumper is installed at W1 (the factory default configuration), the drive provides terminator power to its on-board terminators.
- When a jumper is installed at W2, terminator power is provided by the host system via interface cable J1, pin 26 (TERMPWR); see Terminator Power, Page 2-3.
- When a jumper is installed at *both* W2 and W12, the drive provides terminator power to its on-board terminators and also to the SCSI bus via interface cable J1, pin 26 (TERMPWR); see Terminator Power, Page 2-3.

Drive Option Selection (continued)

Frame Ground Option

Jumper W11 selects the frame ground option.

- When W11 is installed, frame ground is connected to logic ground.
- When W11 is *not* installed (the factory default configuration), frame ground is not connected to logic ground.

Spindle Control Option

A jumper bridging pins 7 and 8 of J2 is used to select the spindle control option.

- When a jumper is installed, the drive must wait for an interface START UNIT command to start the spindle motor.
- When a jumper is *not* installed, (the factory default configuration), the drive automatically starts the spindle motor at power- on.

Write Protect Option

A jumper bridging pins 11 and 12 of J2 is used to select the write protect option.

- When a jumper is installed, the drive is write protected. CAUTION: The drive can still be formatted.
- When a jumper is *not* installed, (the factory default configuration), the drive is *not* write protected.

BUS Parity Check Option

A jumper bridging pins 13 and 14 of J2 is used to select the parity check option.

- When a jumper is installed, the drive neither generates nor detects parity.
- When a jumper is *not* installed, (the factory default configuration), the drive generates parity and enables parity detection.

Drive Option Selection (continued)

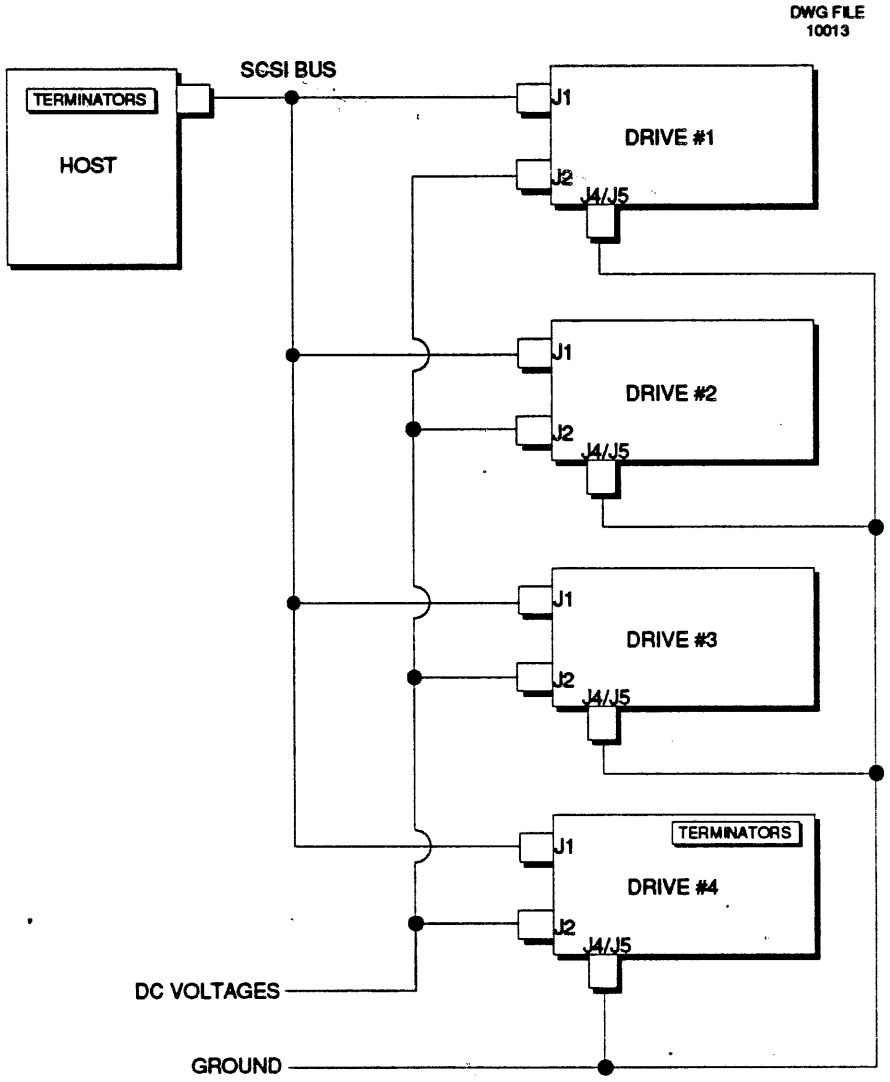
Spindle Synchronization Option

The Rotational Position Locking field (MODE SELECT command, Page Code 04h) is used to specify spindle synchronization operation; see document #110366 (SCSI Implementation in Micropolis "MZR" Products) and the ANSI SCSI Standard.

- **Unsynchronized:** If the drive is set to Unsynchronized (RPL = 00b), it ignores the SLAVE SYNC signal.
- **Slave:** If the drive is set to Slave (RPL = 01b), it does *not* generate the MASTER SYNC signal or the SLAVE SYNC signal but synchronizes its index to the SLAVE SYNC signal (J2, pin 20) supplied by an external source.
- **Master:** If the drive is set to Master (RPL = 10b), it generates the SLAVE SYNC output signal (J2, pin 20) for use directly by the slave drives.
- **Master Control:** If the drive is set to Master Control (RPL = 11b), it generates the MASTER SYNC signal (J2, pin 16). This output is used by the controller to generate the SLAVE SYNC signal (J2, pin 20) for the slave drives.

Multiple-Drive Systems

Up to seven 1548 drives can be connected to a single host. Figure 3-3 shows the connections for a system configuration using four drives.



NOTES: 1) Interface Terminators are installed only in the last physical drive in the control chain.

2) Connections J4 and J5 are provided for grounding; system characteristics determine the proper ground connection.

Figure 3-3. Multiple Drive Configuration

Dimensions and Mounting

The 1548 drive uses industry-standard mounting for 5 1/4-inch full-height Winchester disk drives (the same as 5 1/4-inch full-height flexible disk drives).

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 50°C (122°F).

The term "ambient" becomes imprecise when referencing a drive in a system, since it is difficult to determine where the air temperature should be measured. To help resolve this confusion, Micropolis specifies that the maximum HDA casting temperature (regardless of the air temperature around the drive) is 60°C (140°F). Not exceeding this temperature will ensure that the head-to-media interface never exceeds its temperature limit.

Figure 3-4 shows the mounting hole locations.

> ***Caution***
>
> ***The mounting screws must be selected so that they do not penetrate the bottom mounting holes by more than 0.20 inches or the side mounting holes by more than 0.156 inches. Screws that are too long will short to PCBA components and/or prevent proper operation of the shock mount system.***

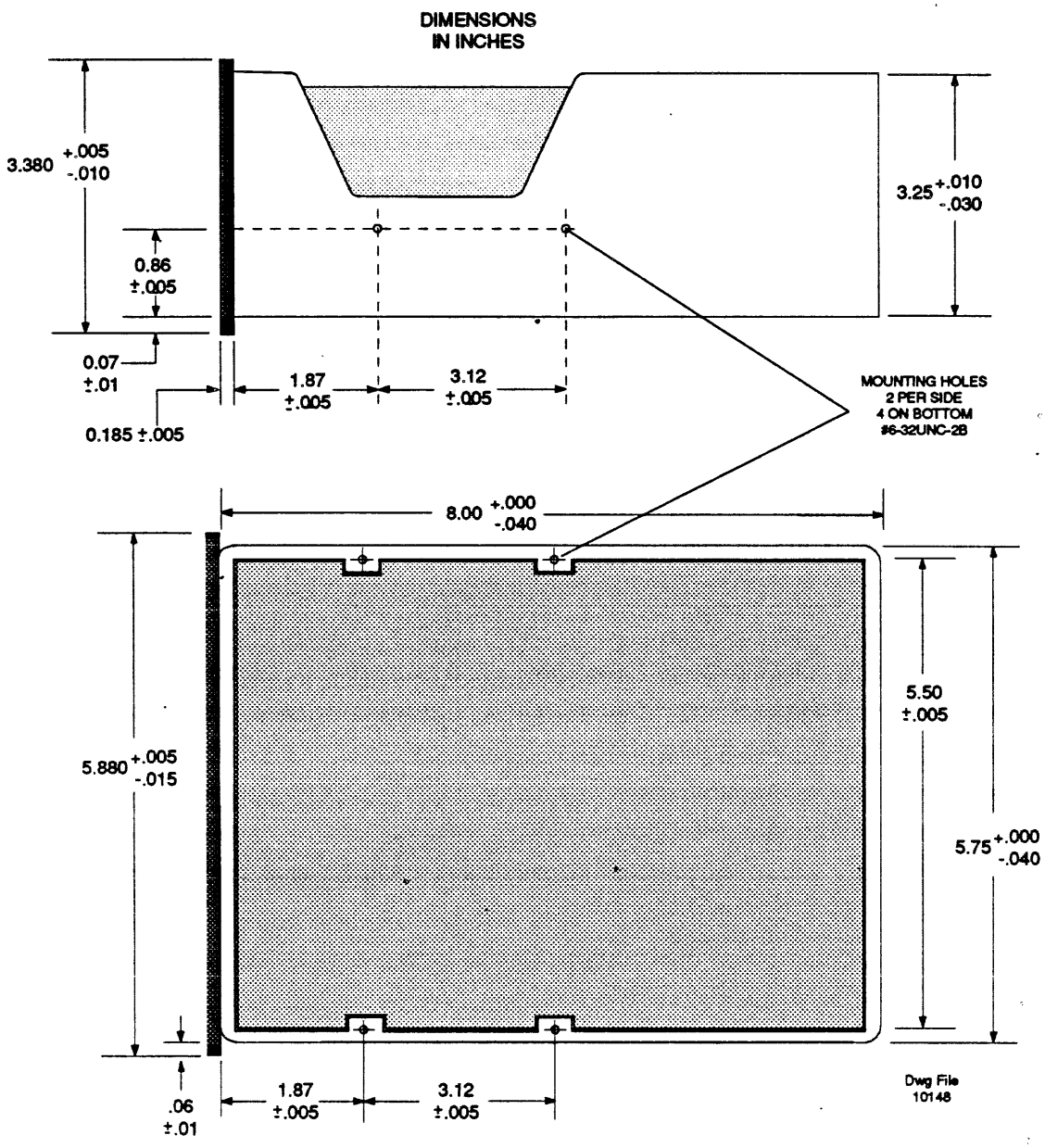


Figure 3-4. Dimensions and Mounting

Section 4. Power Requirements

Power Supply Requirements

DC voltage and current requirements for the 1548 drive are shown below. Voltages may be applied 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 one second 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 (2)
	Avg.	Peak	Avg.	Peak	Avg.	Peak	(maximum)
+5V ±5%							2%
maximum: (4)	1.5A	1.5A	1.5A	1.5A	1.5A	1.5A	
+12V ±5% (5)							2%
typical: (3)	4.25A	4.25A	1.80A	1.90A	2.25A	3.10A	
maximum: (4)	4.35A	4.35A	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) Peak-to-peak, includes noise.

(3) Typically measured values.

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

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

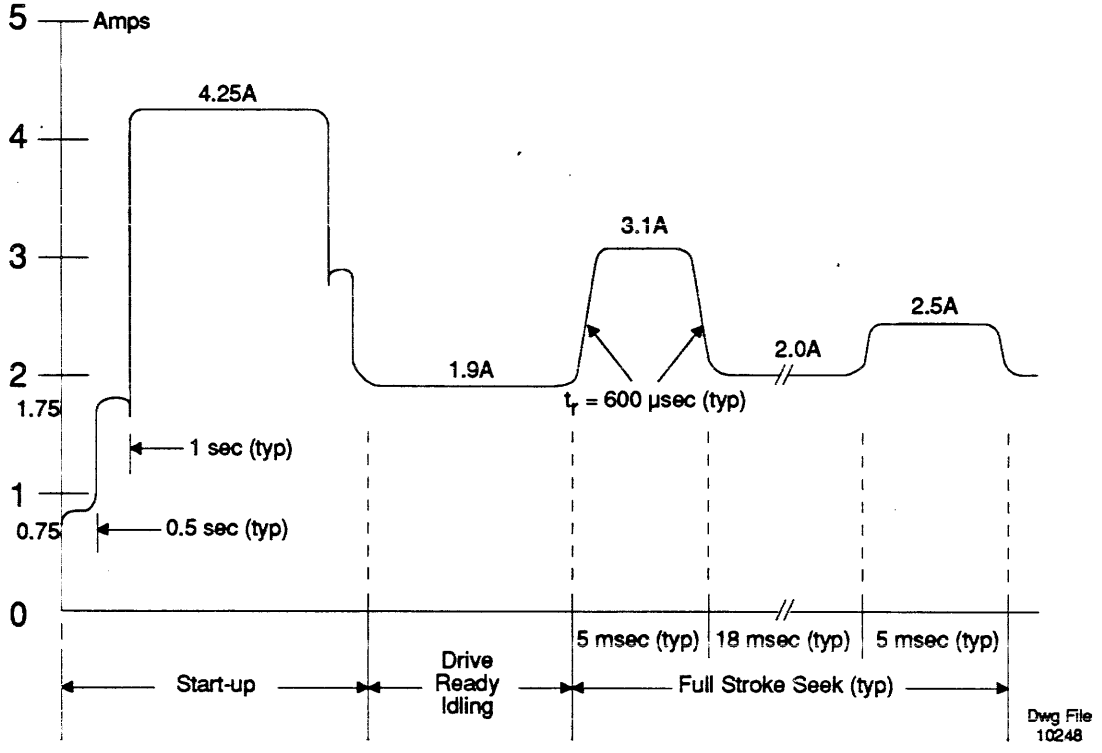


Figure 4-1. 12V Peak Current Profile (typical)

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Section 5. Serviceability and Technical Support

Adjustments and Maintenance

The 1548 drive requires no adjustments or periodic maintenance; additionally, no mechanical adjustments are required to prepare a system for handling or shipment.

Field-Replaceable Components

The concept of repair by replacement of complete functional components is utilized in the 1548, resulting in an MTTR of less than 15 minutes.

Technical Support

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

Micropolis Corporation
Product Support
21211 Nordhoff Street
Chatsworth, CA 91311

Phone: (818) 709-3325
FAX: (818) 718-7793

- or -

Reading, England: Phone: + 44 734 751315
FAX: + 44 734 868168

Munich, West Germany: Phone: + 49 89 8595091
FAX: + 49 89 8597018

Paris, France: Phone: + 33 1 69 20 15 18
FAX: + 33 1 60 11 82 25

The "+" stands for the appropriate international access code.

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Appendix A. Differential Interface

This appendix gives specific information pertaining to the 1548D drive that has a differential interface.

Note that some of the information appears elsewhere in this Product Description; the duplication is for your convenience. Additionally, any information presented in other sections of this document, but not covered in this appendix, is also applicable.

Interface Connector Pin Assignments

Table A-1 gives the differential cable pin assignments for connector J1.

Table A-1. Differential Cable Pin Assignments

Pin	Signal Name	Pin	Signal Name	Description	Source [1]
1	GROUND	2	GROUND	-	-
3	+DB(0)	4	-DB(0)	Data Bus 0	I / T
5	+DB(1)	6	-DB(1)	Data Bus 1	I / T
7	+DB(2)	8	-DB(2)	Data Bus 2	I / T
9	+DB(3)	10	-DB(3)	Data Bus 3	I / T
11	+DB(4)	12	-DB(4)	Data Bus 4	I / T
13	+DB(5)	14	-DB(5)	Data Bus 5	I / T
15	+DB(6)	16	-DB(6)	Data Bus 6	I / T
17	+DB(7)	18	-DB(7)	Data Bus 7	I / T
19	+DB(P)	20	-DB(P)	Data Bus P	I / T
21	DIFFSENS	22	GROUND	Differential Driver Enable	I
23	GROUND	24	GROUND	-	-
25	TERMPWR [2]	26	TERMPWR	Terminator Power	I / T
27	GROUND	28	GROUND	-	-
29	+ATN	30	-ATN	Attention	I
31	GROUND	32	GROUND	-	-
33	+BSY	34	-BSY	Busy	I / T
35	+ACK	36	-ACK	Acknowledge	I
37	+RST	38	-RST	Reset	I
39	+MSG	40	-MSG	Message	T
41	+SEL	42	-SEL	Select	I / T
43	+C/D	44	-C/D	Control/Data	T
45	+REQ	46	-REQ	Request	T
47	+I/O	48	-I/O	Input/Output	T
49	GROUND	50	GROUND	-	-

NOTE: [1] I = Initiator, T = Target
[2] Pins 25 and 26 provide +5V terminator power (optional).

Interface Electrical Characteristics

Differential interface signals consist of two signal lines which are denoted + SIGNAL and – SIGNAL.

A signal is defined as *true* when the + SIGNAL is more positive than the – SIGNAL.

A signal is defined as *false* when the – SIGNAL is more positive than the + SIGNAL.

Figure A-1 summarizes the electrical characteristics of the signals at connector J1.

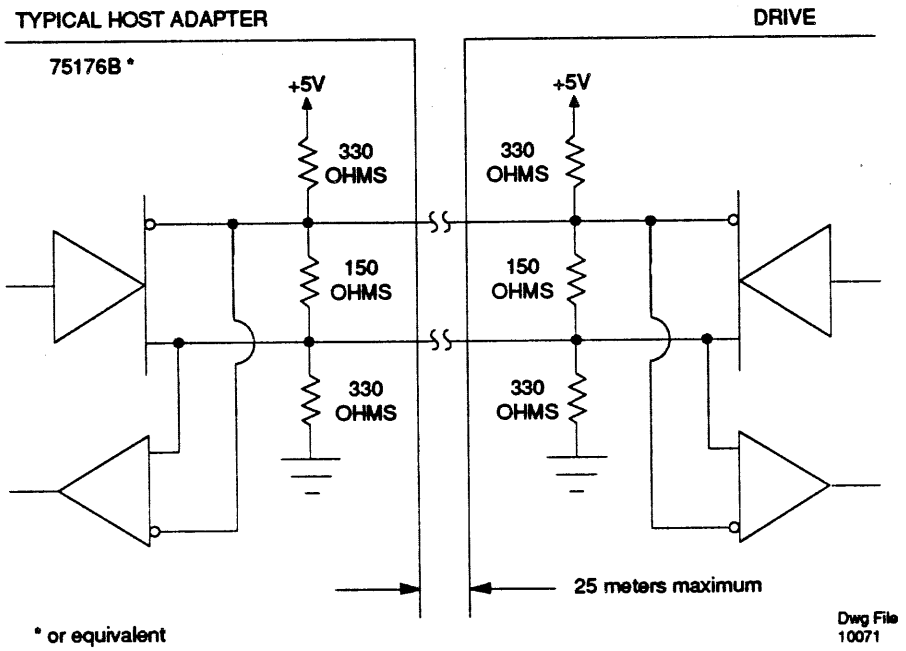

Figure A-1. Differential Driver/Receiver Combination

Differential drivers and receivers allow a maximum cable length of 25 meters.

Signal transmission requires a single 50-conductor cable.

- A characteristic impedance of 100 (± 10%) ohms is recommended for unshielded flat or twisted-pair ribbon cable.
- A minimum conductor size of 28 AWG should be employed to minimize noise effects and ensure proper distribution of optional terminator power.

A stub length of no more than 0.2 meters is allowed off the main-line interconnection within any connected equipment.

Interface Electrical Characteristics (continued)

a. Input Characteristics

Each of the drives signal receivers has the following characteristics when measured at the interface connector.

I (input current on either input) = ± 2.0 milliamps, maximum

NOTE: These characteristics include both receivers and passive drivers.

This requirement is met with the input voltage varying between -7V and +12V, with power either on or off, and with hysteresis equaling 35 millivolts, minimum.

b. Output Characteristics

Each driven signal has the following characteristics when measured at the interface connector.

V_{OL} (low-level output voltage) = 1.7V maximum at I_{OL}
where I_{OL} = 55 milliamps

V_{OH} (high-level output voltage) = 2.7V maximum at I_{OH}
where I_{OH} = –55 milliamps

V_{OD} (differential voltage) = 1.0V minimum, with common-mode voltage ranges from –7 to +12

V_{OL} and V_{OH} are measured between the output terminal and the SCSI device's logic ground reference.

c. Terminator Power (TERMPWR at Pins 25 and 26)

Terminator Power has the following requirements:

V_{Term} = 4.0 VDC to 5.25 VDC

600 milliamps minimum source drive capability with 1.0 amp recommended current limiting (e.g., a fuse).

1.0-milliamp maximum bus loading (except for the purposes of providing power to an internal terminator).

The 1548D drive provides keyed connectors to prevent accidental grounding or misconnection of terminator power.

Drive Option Selection

Figure A-2 shows the locations of the connectors, SCSI ID jumpers, option jumpers, and interface terminator packs on the Device Electronics board.

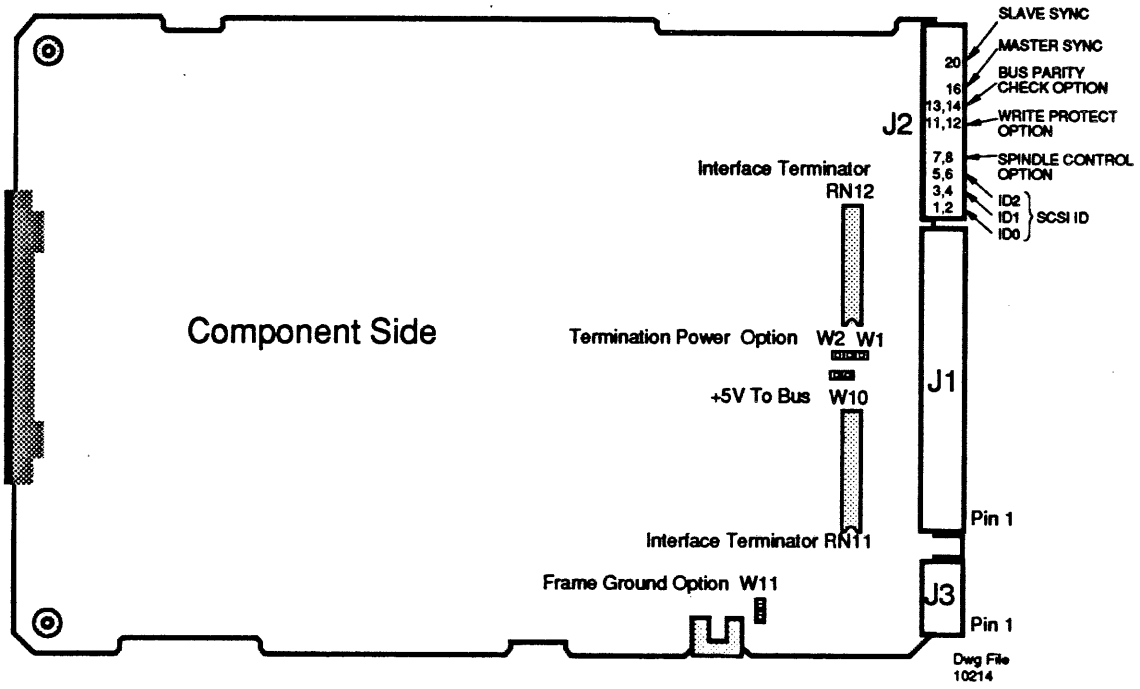

Figure A-2. Address Jumpers and Interface Terminators

Board markings identify each option. For example, when a jumper is installed at W2, Terminator Power is provided by the host system via interface cable J1, pin 26.

While the option jumpers may be positioned at locations different from the single-ended version of the Device Electronics board, the options supported are the same; see Section 3 for an explanation of the various options.