Micropolis 1528

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

1.53 GBytes
SCSI Interface

Product Description

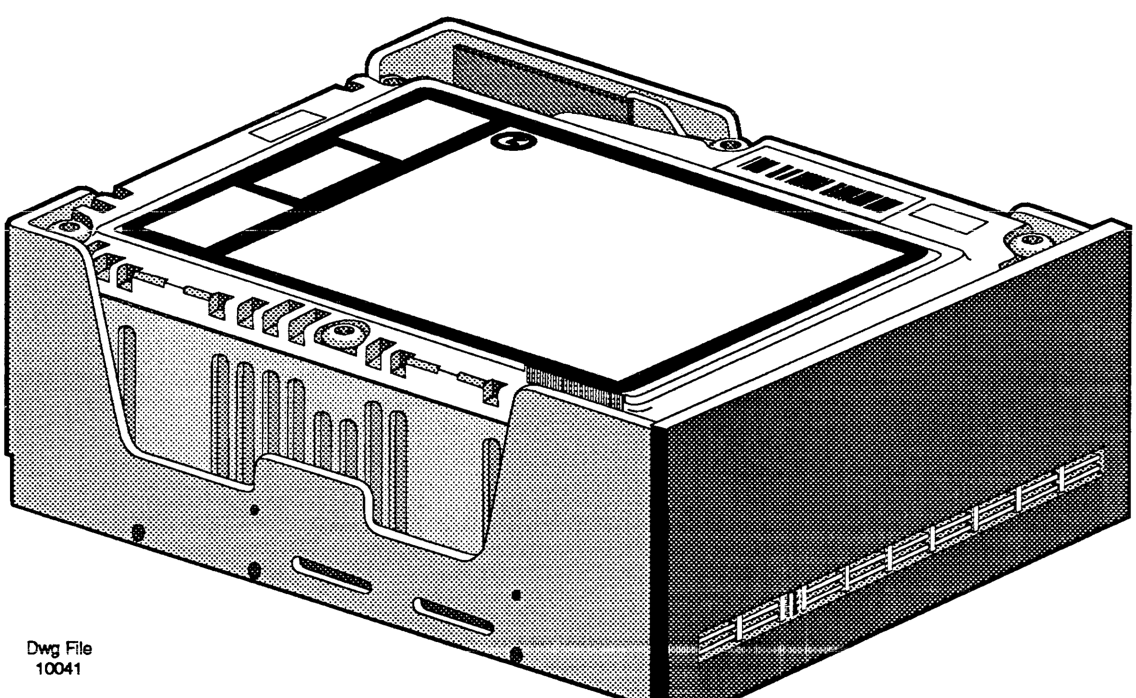
MICROPOLIS

Micropolis 1528

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

1.53 GBytes
SCSI Interface

Product Description



Dwg File
10041

Document No. 105389 Rev B

PREFACE

This Product Description, intended for use by engineers, designers, and planners, describes the typical characteristics of Micropolis model 1528S (single-ended interface) and model 1528D (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.

21211 Nordhoff Street
Chatsworth, CA 91311

Phone: (818) 709-3300
FAX: (818) 709-3396
Telex: 651486

Table of Contents

(Intentionally blank)

Section 1. Description

Micropolis 1528S (single-ended) and 1528D (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.

Refer to Appendix C for additional information pertaining to the differential interface.

Features of the 1528

Large Capacity

- Up to 1.53 gigabytes (unformatted) per drive; up to 10.71 gigabytes per controller when using a maximum of seven drives.

High Performance

- 14.5-millisecond average seek time makes the drive ideally suited to the demands of multi-user, multi-tasking systems or graphic-intensive applications.
- 23.3 megabit per second data storage 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 to provide exceptional protection during shipment, installation, and operation.
- Positive media protection is achieved during spin down (due to a STOP UNIT command or power off) 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 1528 (continued)

Full SCSI Implementation

- SCSI-2 Command Set supported by a high-performance, on-board intelligent SCSI controller.
- Sophisticated SCSI N-Segment read-ahead algorithm dramatically improves the response time for sequential read operations.
- Synchronous mode supports a data transfer rate of up to 5.0 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 1.8 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 256 to 4000 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.

Characteristics

General Performance Specifications

Seek Time (including settling time)	
Track-to-Track	4 msec (2 msec read)
Average	14.5 msec
One-Third Stroke (maximum)	15.5 msec
Maximum	28.6 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
Media Transfer Rate	23.33 MHz
Data Transfers at interface:	
Synchronous	5.0 MBytes/sec
Asynchronous	1.8 MBytes/sec

General Functional Specifications

Data cylinders	2100
Spindle speed (rpm)	3600
Speed variation (%)	± 0.5

Capacity

Unformatted

MBytes/Unit	1531.1
Data Surfaces	15
Disks	8
Cylinders	2100
Bytes/Track	48,608
MBytes/Surface	102.07

Formatted *	1024-Byte Format:	512-Byte Format:
MBytes/Unit	1398.0	1342.3
Cylinders	2094	2094
Sectors/Track	44	84

* Based on typical cylinder-oriented sparing (user programmable); see Appendix A for a detailed explanation of the capacity calculation.

Characteristics (continued)

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	10°C to 50°C (50°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.

	Operating	Storage
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	21 Watts (71.7 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 45 dBA (5.7 Bels

Reliability

Errors (these figures reflect basic HDA error rates)

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	(82.6mm)
	Width	5.75 in	(146.1 mm)
	Depth	8.00 in	(203.2 mm)
Bezel:	Height	3.38 in	(85.9 mm)
	Width	5.88 in	(149.4 mm)
	Depth	0.185 in	(4.7 mm)
Drive Weight (typical):		8.2 lbs	(3.7 kg)

Major Components

The 1528 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 velocity profile generation.
- Servo circuits control positioner speed and accuracy.
- 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 a separate microprocessor, 256K of RAM data buffer, and VLSI controller circuits.

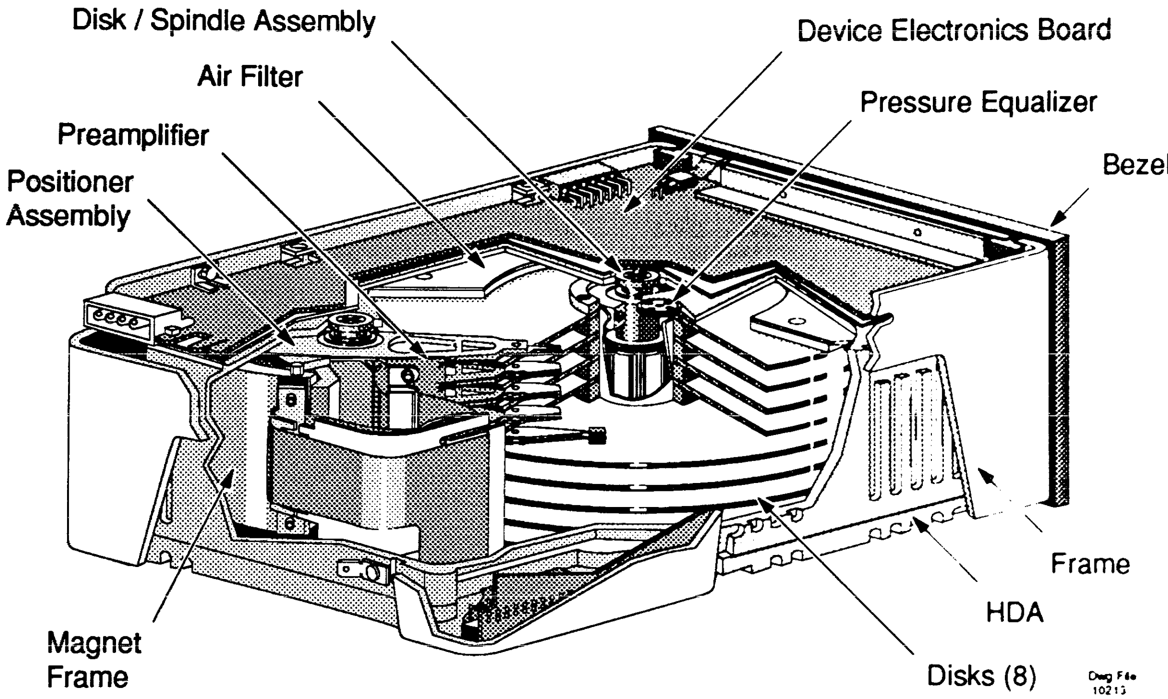


Figure 1-1. Mechanical Organization

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.

  The 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 1528 drives are designed to provide contamination control within the sealed Head/Disk Assembly (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 maximum pressure recovery and filter 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.

- 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.

(Intentionally blank)

Section 2. Single-Ended Interface

Interface and Power Connector Pin Assignments

The 1528 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 110011 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 C 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.

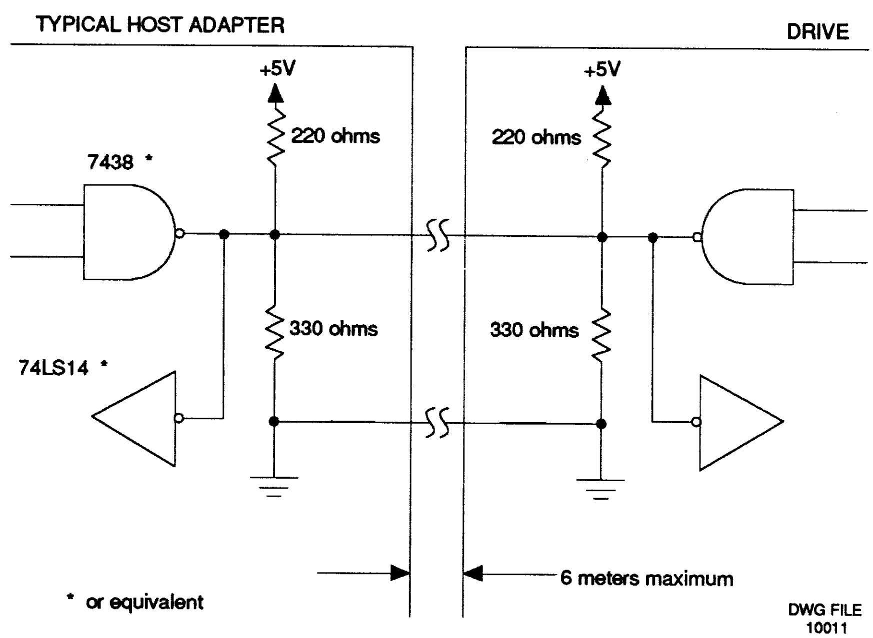


Figure 2-1. Single-Ended Driver/Receiver Combination

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 1528 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, refer to Micropolis SCSI Implementation document 110011 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 Micropolis SCSI Implementation document 110011 and the ANSI SCSI Standard.

Table 2-4. Command Set

Command Name	Operation Code (Hex)
FORMAT TRACK (Micropolis Unique)	E4
FORMAT UNIT *	04
INQUIRY	12
MODE SELECT	15
MODE SENSE	1A
READ(6)	08
READ(10)	28
READ BUFFER	3C
READ CAPACITY	25
READ DEFECT DATA	37
READ LONG	3E
READ LONG (Micropolis Unique)	E8
REASSIGN BLOCKS	07
RECEIVE DIAGNOSTIC RESULTS	1C
RELEASE	17
REQUEST SENSE	03
RESERVE	16
REZERO UNIT	01
SEARCH DATA HIGH	30
SEARCH DATA EQUAL	31
SEARCH DATA LOW	32
SEEK(6)	0B
SEEK(10)	2B
SEND DIAGNOSTIC	1D
START/STOP UNIT	1B
TEST UNIT READY	00
VERIFY	2F
WRITE(6)	0A
WRITE(10)	2A
WRITE AND VERIFY	2E
WRITE BUFFER	3B
WRITE LONG	3F
WRITE LONG (Micropolis Unique)	EA

* On a new drive, it is recommended that you execute the FORMAT UNIT command before storing data. Generic MODE SELECT values have been set at the factory. You may choose to adjust these parameters to meet your own individual system requirements.

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 1528).

Command Summary

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

FORMAT TRACK, E4h, causes the drive to format one physical track according to the parameters set with the MODE SELECT command. Note that this command is vendor unique and is not intended for normal systems or applications usage.

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.

MODE SELECT, 15h, enables the Initiator to specify or change drive parameters. Note that MODE SELECT is a complementary command to the MODE SENSE command.

MODE SENSE, 1Ah, causes the drive to send media parameters to the Initiator. Note that MODE SENSE is a complementary command to the MODE SELECT command.

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.

Command Summary (continued)

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

READ LONG, 3Eh or E8h, causes the drive to send one block of data and its associated ECC (Error Correction Code) bytes to the Initiator.

E8h is the Micropolis unique implementation of the READ LONG command.

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 the diagnostic tests which 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.

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

SEARCH DATA HIGH, 30h, searches for the first record containing a data value which is *greater than* the specified reference.

SEARCH DATA EQUAL, 31h, searches for the first record containing a data value which is *equal to* the specified reference.

SEARCH DATA LOW, 32h, searches for the first record containing a data value which is *less than* the specified reference.

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.

Command Summary (continued)

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. Note that a jumper option is available which automatically enables the drive's spindle motor at power-on; refer to 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 or EAh, causes the drive to write one block of data and its associated ECC bytes to disk.

EAh is the Micropolis unique implementation of the WRITE LONG command.

Distinctive Features of Micropolis SCSI

While the 1528 disk 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

1528 drives are capable of transferring data at 5.0 MBytes/sec in synchronous mode and 1.8 MBytes/sec in asynchronous mode. In some configurations (e.g., short cable and fast host), the 1528 can achieve faster asynchronous transfer rates.

b. Read-Ahead

The read-ahead function causes the 1528 drive to transfer the requested block into its buffer and continue to read sequential blocks until the buffer 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.

c. Through Parity

Data integrity is maintained in the 1528 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.

d. N-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.

e. Buffer Full Ratio/Buffer Empty Ratio

Buffer full and empty ratios, 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.

f. Defect Management

The 1528 disk drive has two techniques available for defect management: track-oriented and cylinder-oriented. This section describes both methods.

Note that 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).

1) Cylinder-Oriented Defect Management (default mode)

The user may use the MODE SELECT command to enable defect allocation on a cylinder-oriented basis.

The number of spare blocks for each cylinder and the number of spare cylinders per drive is selected by the user, also via the MODE SELECT command. 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 the 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 loss of power.

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.

Distinctive Features of Micropolis SCSI (continued)

2) Track-Oriented Defect Management

The MODE SELECT command is used to enable the track-oriented defect management technique.

The number of spare blocks for each track and the number of spare cylinders per drive is selected by the user, also via the MODE SELECT command. The spare blocks selected for each track reside at the end of that track.

When a REASSIGN BLOCK command is executed, the data is reformatted on the track, 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 value of one spare block per track is more than adequate for the life of the drive.

On the remote chance that this number of spares is insufficient, the following fallback scheme is available:

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

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

Note that cylinder-oriented defect management has the following advantages over a track-oriented scheme:

- 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, as opposed to allocating spares per track, offers more efficient use of disk space, resulting in higher formatted capacities.

In summary, cylinder-oriented defect management gives the user higher performance and more data storage capacity.

Distinctive Features of Micropolis SCSI (continued)

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. Saving Mode Select Parameters

The 1528 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.

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, or there may be extra bits. Additionally, a 0 may appear as a 1, a 1 as a 0, etc.

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 1528 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

Micropolis specifies that all 1528 drives shall have no more than one defect per megabyte of unformatted capacity.

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 defects are logged on a label affixed to the drive. 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 also 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.

(Intentionally blank)

Section 3. Installation

Physical Interface

The electrical interface between the 1528 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.

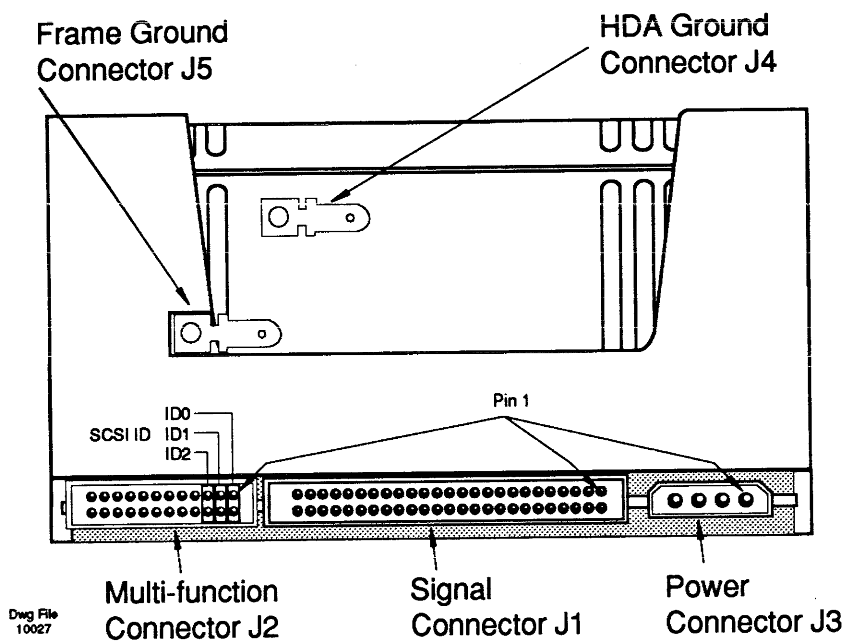


Figure 3-1. Power and Interface Connections

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 that is used for connecting the drive to a user-supplied Operator Panel; see Page 3-4.

- DC Power Connector J3

  J3 is a 4-pin, keyed, AMP MATE-N-LOCK connector on the Device Electronics board. Both +5V and +12V is 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 1528 disk 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

	JUMPERS		
SCSI ID	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.

Interface Terminator pack RN9 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 3-5.

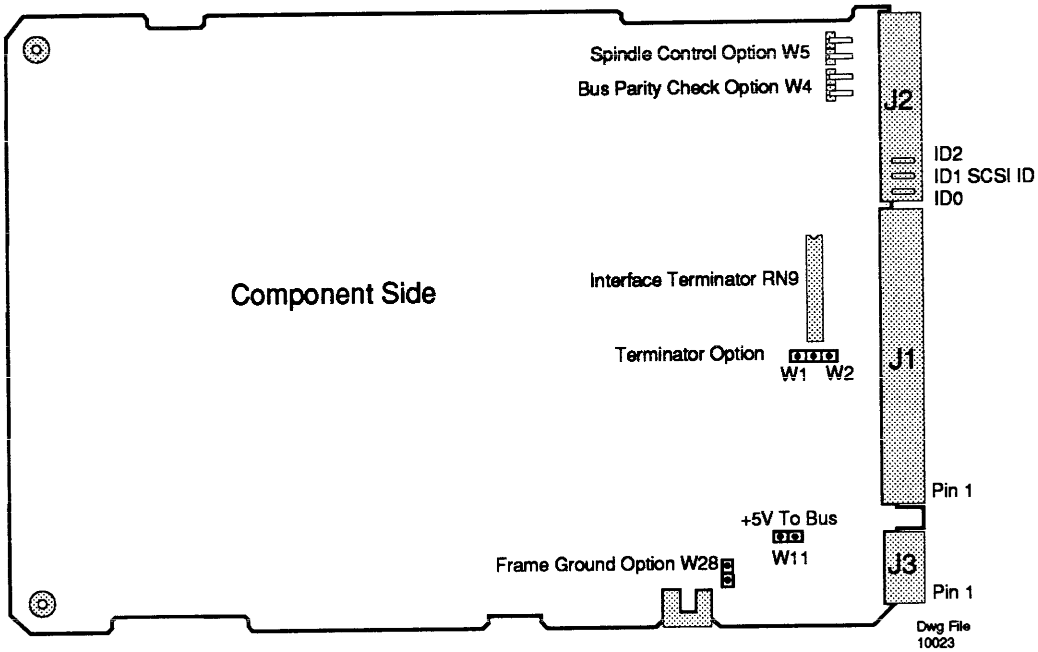


Figure 3-2. Address Jumpers and Interface Terminator

BUS Termination Power Option

A jumper is installed at W1, at W2, or at W2 and W11 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 W11.

- 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 W11, 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.

BUS Parity Check Option

W4 is used to select the parity check option.

- When a jumper is installed at W4, the drive neither generates nor detects parity.
- When a jumper is *not* installed at W4 (the factory default configuration), the drive generates parity and enables parity detection.

Spindle Control Option

W5 is used to select the spindle control option.

- When a jumper is installed at W5, the drive must wait for a START UNIT command to start the spindle motor.
- When a jumper is *not* installed at W5 (the factory default configuration), the drive automatically starts the spindle motor at power-on.

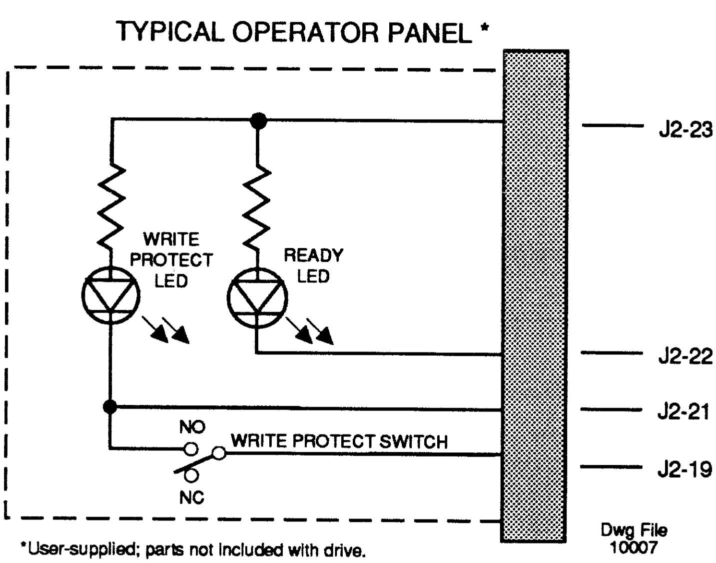
Frame Ground Option

Jumper W28 selects the frame ground option.

- When W28 is installed, frame ground is connected to logic ground.
- When W28 is *not* installed (the factory default configuration), frame ground is not connected to logic ground.

Operator Panel Option

Multi-Function Connector/Jumper Block J2 can be used to connect the drive to a user-supplied operator panel. Figure 3-3 shows the wiring diagram of a typical operator panel and the associated J2 pin connections.

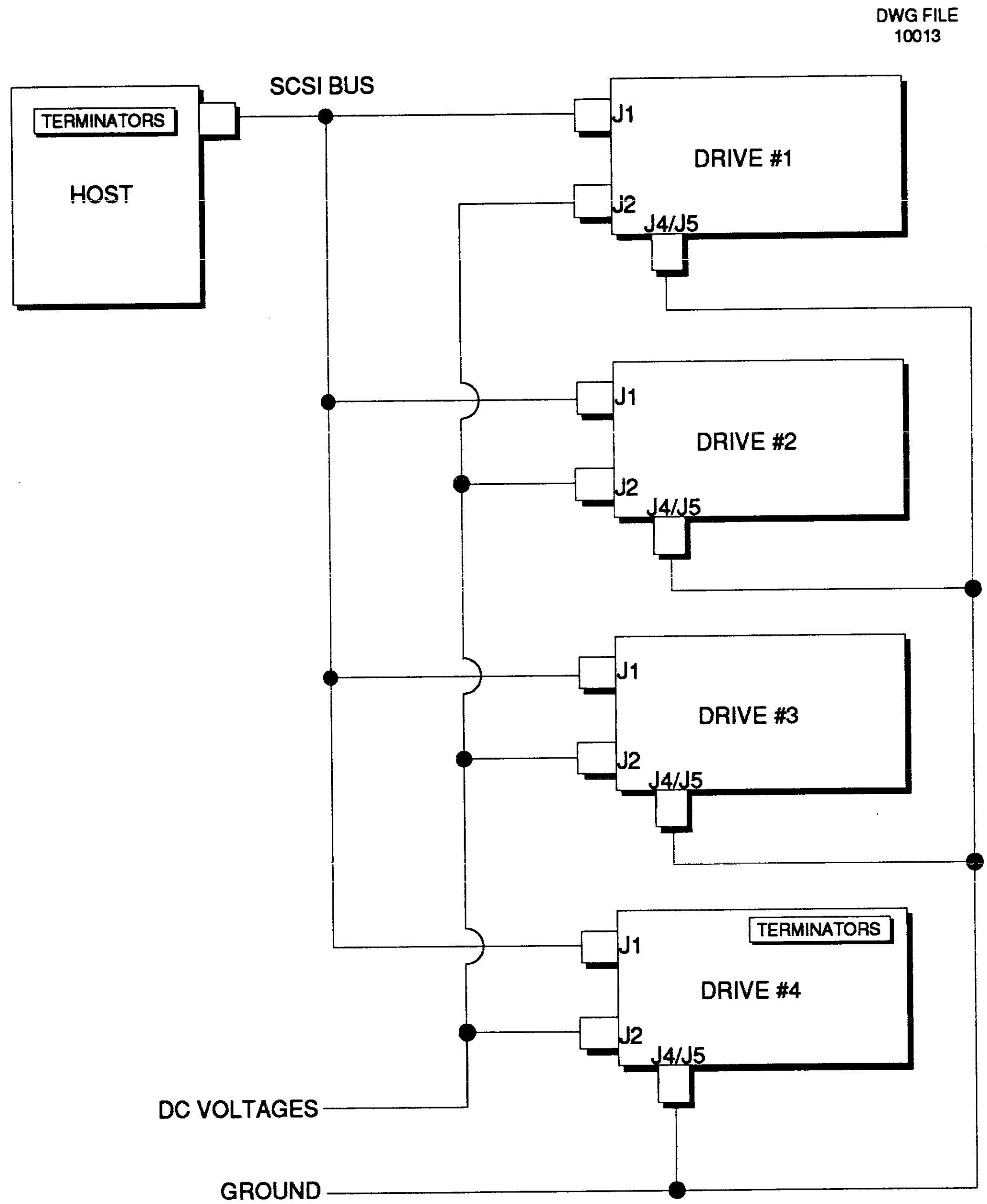


J2, PIN	FUNCTION
19	Logic ground.
20	Not used.
21	Write Protect input. Logic ground disables writing and lights the Write Protect LED.
22	Ready output. Logic ground indicates that the drive is Ready and lights the Ready LED.
23	+5V source for the LEDs.

Figure 3-3. Operator Panel Interface

Multiple-Drive Systems

Up to seven 1528 disk drives can be connected to a single host, see Figure 3-4. The figure 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 3-4. Multiple Drive Configuration

Dimensions and Mounting

The 1528 disk 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.

Inasmuch as the drive frame 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 natural convection is limited, a fan may be required.

Figure 3-5 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.

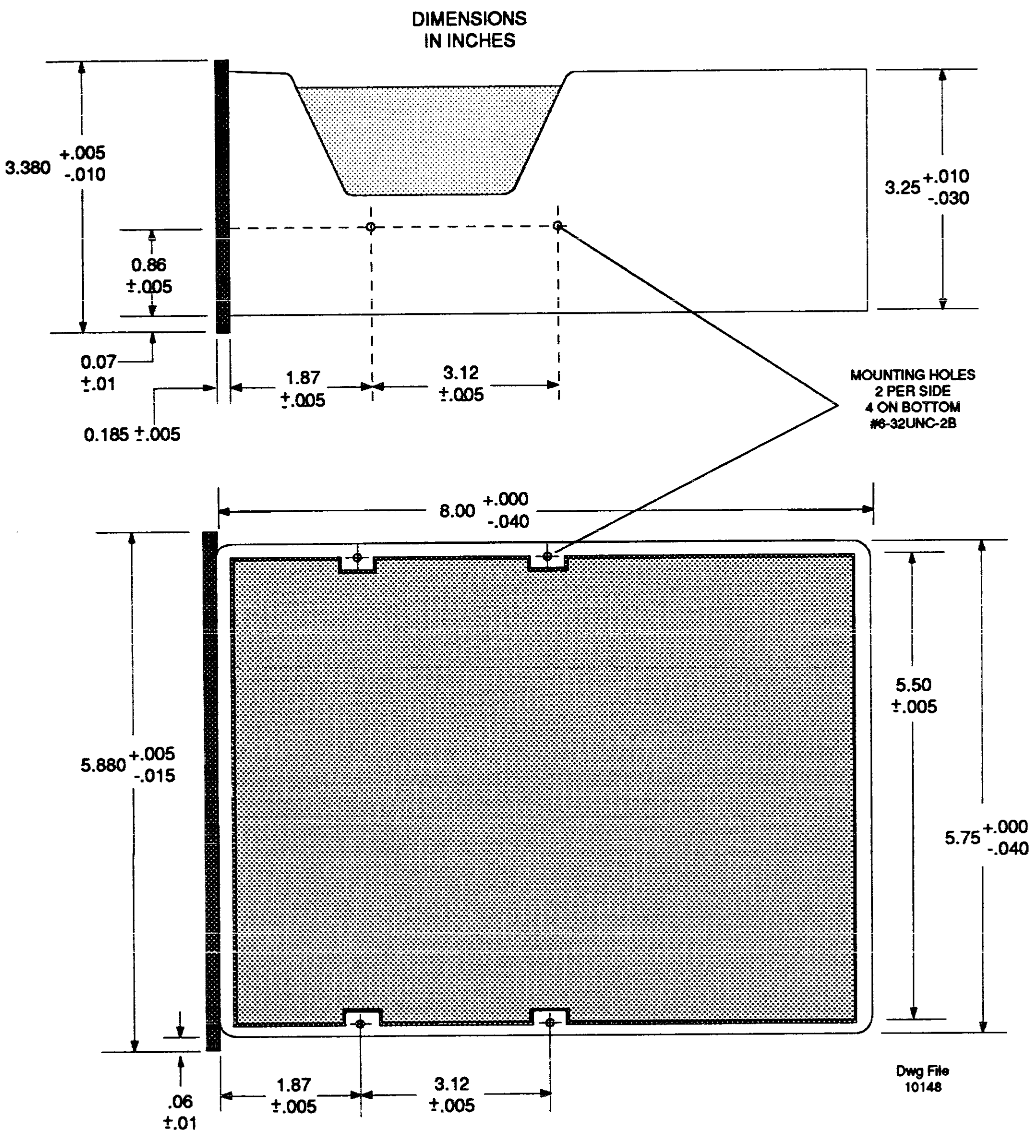


Figure 3-5. Dimensions and Mounting

(Intentionally blank)

Section 4. Power Requirements

Power Supply Requirements

DC voltage and current requirements for the 1528 disk 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 Avg.	Start-up Peak	Idle Avg.	Idle Peak	Seeking (1) Avg.	Seeking (1) Peak	Ripple (2) (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.

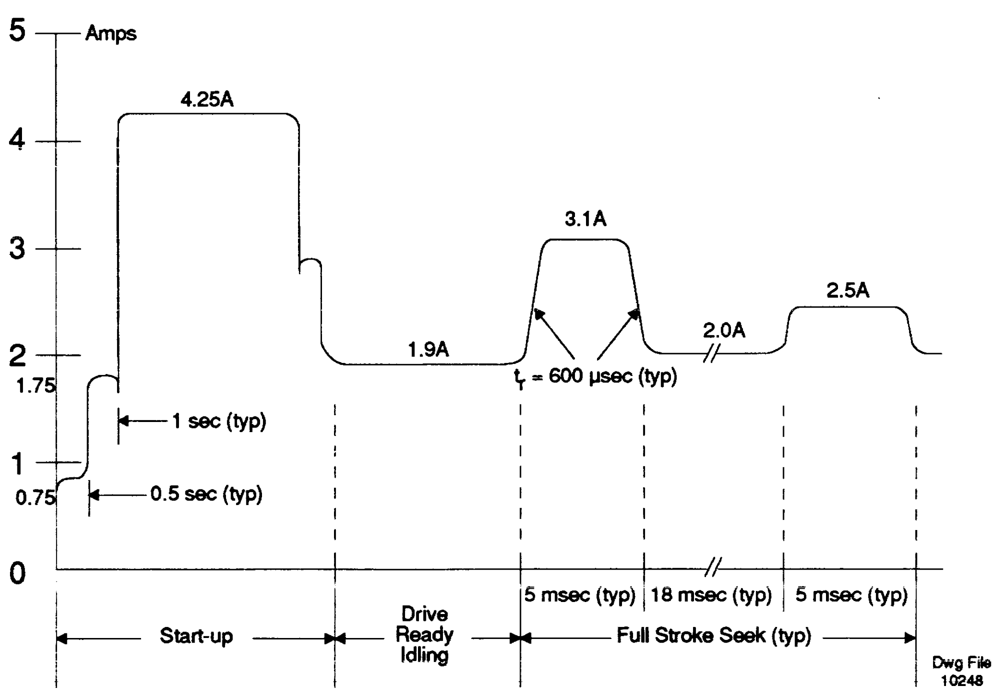


Figure 4-1. 12V Peak Current Profile (typical)

(Intentionally blank)

Section 5. Serviceability and Technical Support

Adjustments and Maintenance

The 1528 disk 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 1528, 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.

(Intentionally blank)

Appendix A. Formatted Capacity Calculation

The formatted capacity of the 1528 disk drive depends upon a number of user- selectable variables. One critical variable is sparing, either track-oriented or cylinder-oriented.

The following formula is used to calculate the formatted capacity (C) of a 1528 drive using *cylinder-oriented* sparing:

$$C = [(SPT \times HDS) - (SPARE\_SPC)] \times (2100 - 3 - SPARE\_CYL) \times (BYTES)$$

where ***SPT*** is the number of physical sectors per track.

HDS is the number of data heads.

SPARE_SPC is the number of spare sectors per cylinder. This variable is user programmable. A typical value for the 1528 drive is 8.

2100 is the number of physical cylinders.

3 cylinders are used by the drive and are not user accessible.

SPARE_CYL is the number of spare cylinders. This variable is user programmable; a typical value for sparing is 3.

BYTES is the bytes per sector (e.g., 1024, 512, etc.).

For example: A 1528 drive using 84 sectors per track, 8 spare sectors per cylinder, 3 spare cylinders, and a 512-byte format, would have the following formatted capacity:

$$C = [(SPT \times HDS) - (SPARE\_SPC)] \times (2100 - 3 - SPARE\_CYL) \times (BYTES)$$

$$C = [(84 \times 15) - (8)] \times (2100 - 3 - 3) \times (512)$$

$$C = [1260 - 8] \times 2094 \times 512$$

$$C = 1252 \times 1{,}072{,}128$$

$$C = 1{,}342{,}304{,}256 \ \textit{bytes}$$

$$C = 1342.3 \ \textit{MBytes, when truncated}$$

The calculated capacity is based on *conservative* sparing (8 spare sectors per cylinder and 3 spare cylinders). A higher capacity could have been attained had fewer spares been used.

(Intentionally blank)

Appendix B. MODE SENSE Parameter Pages - Default Values

MODE SENSE Command

The MODE SENSE command provides a means by which an Initiator may receive parameters from a Target (e.g., a 1528 drive).

The MODE SENSE Command Descriptor Block is formatted as shown:

MODE SENSE Command Descriptor Block

Byte		Bit							
Dec	Hex	07	06	05	04	03	02	01	00
00	00	0	0	0	1	1	0	1	0
01	01	Logical Unit Number			Reserved				
02	02	PCF		Page Code					
03	03	Reserved							
04	04	Allocation Length							
05	05	Vendor Unique		Reserved				Flag	Link

In response to the MODE SENSE command, the drive sends (to the Initiator) blocks of parameters that are separated into categories called pages. The 1528 drive supports five pages of changeable parameter information:

a. Error Recovery Parameters (Page Code 01h)

b. Disconnect/Reconnect Parameters (Page Code 02h)

c. Direct-Access Device Format Parameters (Page Code 03h)

d. Disk Drive Geometry Parameters (Page Code 04h)

e. Cache Control Parameters - (Page Code 38h, Micropolis Unique)

This appendix shows each 1528 drive parameter page and lists the corresponding default parameter values.

For a more detailed explanation of the MODE SENSE command, refer to Micropolis SCSI Implementation document 110011.

MODE SENSE Parameter Pages

a. Error Recovery Parameter Page (Page Code 01h)

Page Format

Byte		Bit							
Dec	Hex	07	06	05	04	03	02	01	00
00	00	PS	Reserved	Page Code = 01h					
01	01	Page Length = 06h							
02	02	AWRE	ARRE	TB	RC	EER	PER	DTE	DCR
03	03	Retry Count							
04	04	Correction Span							
05	05	Head Offset Count							
06	06	Data Strobe Offset Count							
07	07	Recovery Time Limit							

MODE SENSE Parameter Pages (continued)

Default Values

PARAMETER	DEFAULT VALUES	CHANGE-ABLE	LIMITATIONS
PS (Parameters Savable)	1	N	Page always savable
AWRE (Automatic Write Reallocation Enabled)	0	N	Not supported
ARRE (Automatic Read Reallocation Enabled)	0	Y	0 or 1
TB (Transfer Block)	1	Y	0 or 1
RC (Read Continuous)	0	Y	0 or 1
EER (Enable Early Recovery)	0	Y	0 or 1
PER (Post Error)	0	Y	0 or 1
DTE (Disable Transfer on Error)	0	Y	0 or 1
DCR (Disable Correction)	0	Y	0 or 1
Retry Count	10 (dec) 0A (hex)	Y	0 - 255 (dec) 00 - FF (hex)
Correction Span	11 (dec) 0B (hex)	Y	0 - 19 (dec) 00 - 13 (hex)
Head Offset Count	0	Y	00, 01, or FF (hex)
Data Strobe Offset Count	0	Y	00, 01, or FF (hex)
Recovery Time Limit	0	N	Not supported

b. Disconnect/Reconnect Parameter Page (Page Code 02h)

Page Format

Byte		Bit							
Dec	Hex	07	06	05	04	03	02	01	00
00	00	PS	Reserved	Page Code = 02h					
01	01	Page Length = 0Ah							
02	02	Buffer Full Ratio							
03	03	Buffer Empty Ratio							
04	04	(MSB) Bus Inactivity Limit							
05	05								(LSB)
06	06	(MSB) Disconnect Time Limit							
07	07								(LSB)
08	08	(MSB) Connect Time Limit							
09	09								(LSB)
10	0A	Reserved							
11	0B								

MODE SENSE Parameter Pages (continued)

Default Values

PARAMETER	DEFAULT VALUES	CHANGE-ABLE	LIMITATIONS
PS (Parameters Savable)	1	N	Page always savable
Buffer Full Ratio	48 (dec) 30 (hex)	Y	0 - 255 (dec) 00 - FF (hex)
Buffer Empty Ratio	48 (dec) 30 (hex)	Y	0 - 255 (dec) 00 - FF (hex)
Bus Inactivity Limit	5	Y	0 - 650 (dec) 0000 - 028A (hex)
Disconnect Time Limit	0	N	Not supported
Connect Time Limit	0	N	Not supported

MODE SENSE Parameter Pages (continued)

c. Direct-Access Device Format Parameter Page (Page Code 03h)

Page Format

Byte		Bit							
Dec	Hex	07	06	05	04	03	02	01	00
00	00	PS	Reserved	Page Code = 03h					
01	01	Page Length = 16h							
02	02	(MSB)	Tracks Per Zone						
03	03								(LSB)
04	04	(MSB)	Alternate Sectors Per Zone						
05	05								(LSB)
06	06	(MSB)	Alternate Tracks Per Zone						
07	07								(LSB)
08	08	(MSB)	Alternate Tracks Per Volume						
09	09								(LSB)
10	0A	(MSB)	Sectors Per Track						
11	0B								(LSB)
12	0C	(MSB)	Data Bytes Per Physical Sector						
13	0D								(LSB)
14	0E	(MSB)	Interleave						
15	0F								(LSB)
16	10	(MSB)	Track Skew Factor						
17	11								(LSB)
18	12	(MSB)	Cylinder Skew Factor						
19	13								(LSB)
20	14	SSEC	HSEC	RMB	SURF	Reserved			
21	15	Reserved							
22	16								
23	17								

See the default values on the opposite page.

MODE SENSE Format Parameters (continued)

Default Values

PARAMETER	DEFAULT VALUES	CHANGE-ABLE	LIMITATIONS
PS (Parameters Savable)	1	N	Page always savable by format operation
Tracks Per Zone	15 (dec) 0F (hex)	Y	15 for COS ** 1 for TOS *
Alternate Sectors Per Zone	8	Y	0 to ((sec/tk) – 1) for COS ** 0 to 3 for TOS *
Alternate Tracks Per Zone	0	N	Not supported
Alternate Tracks Per Volume	45 (dec) 002D (hex)	Y	0 - 255 (dec) 0000 - 00FF (hex)
Sectors Per Track	84 (dec) 0054 (hex)	Y	0 - 255 (dec) 0000 - 00FF (hex)
Data Bytes Per Physical Sector	512 (dec) 0200 (hex)	Y	256 - 4000 (dec) 0100 - 0FA0 (hex)
Interleave Value	1	N	Value is changeable via the FORMAT UNIT command
Track Skew	0	Y	Must be ≤ Sectors Per Track field
Cylinder Skew	28 (dec) 001C (hex)	Y	Must be ≤ Sectors Per Track field
SSEC (Soft Sector)	0	N	Soft-sector formatting not supported
HSEC (Hard Sector)	1	N	Hard-sector formatting only
RMB (Removable)	0	N	Removable media not supported
SURF (Surface)	0	N	Surface sector allocation not supported.

* TOS = track-oriented sparing
** COS = cylinder-oriented sparing

MODE SENSE Parameter Pages (continued)

d. Disk Drive Geometry Parameter Page (Page Code 04h)

Page Format

Byte		Bit							
Dec	Hex	07	06	05	04	03	02	01	00
00	00	PS	Reserved	Page Code = 04h					
01	01	Page Length = 12h							
02	02	(MSB)	Number of Cylinders						
03	03								
04	04								(LSB)
05	05	Number of Heads							
06	06	(MSB)	Starting Cylinder - Write Precompensation						
07	07								
08	08								(LSB)
09	09	(MSB)	Starting Cylinder - Reduced Write Current						
10	0A								
11	0B								(LSB)
12	0C	(MSB)	Drive Step Rate						
13	0D								(LSB)
14	0E	(MSB)	Landing Zone Cylinder						
15	0F								
16	10								(LSB)
17	11	Reserved							
18	12								
19	13								

MODE SENSE Parameter Pages (continued)

Default Values

PARAMETER	DEFAULT VALUES	CHANGE-ABLE	LIMITATIONS
PS (Parameters Savable)	1	N	Page always savable by format operation
Maximum Number of Cylinders	2100 (dec) 0834 (hex)	Y *	4 - 2100 (dec) 0004 - 0834 (hex)
Maximum Number of Heads	15 (dec) 0F (hex)	Y *	1 - 15 (dec) 01 - 0F (hex)
Starting Cylinder - Write Precompensation	0	N	Not supported
Starting Cylinder - Reduced Write Current	0	N	Not supported
Drive Step Rate	0	N	Not supported
Landing Zone Cylinder	0	N	Not supported

* May be changed, but this value is normally left at the default value to preserve maximum capacity.

e. Cache Control Page - (Page Code 38h, Micropolis Unique)

Page Format

Byte		Bit							
Dec	Hex	07	06	05	04	03	02	01	00
00	00	PS	Reserved	Page Code = 38h					
01	01	Parameter Length = 0Eh							
02	02	Reserved	WIE	Reserved	CE	Cache Table Size			
03	03	Pre-fetch Threshold							
04	04	Maximum Pre-fetch - Absolute							
05	05	Maximum Pre-fetch - Multiple							
06	06	Minimum Pre-fetch - Absolute							
07	07	Minimum Pre-fetch - Multiple							
08	08	Reserved							
09	09								
10	0A								
11	0B								
12	0C								
13	0D								
14	0E								
15	0F								

MODE SENSE Parameter Pages (continued)

Default Values

PARAMETER	DEFAULT VALUES	CHANGE-ABLE	LIMITATIONS
PS (Parameters Savable)	1	N	Page always savable
WIE (Write Index Enable)	0	N	Not used by drive
CE (Cache Enable)	1	Y	0 or 1
Cache Table Size	0	N	Not used by drive
Pre-fetch Threshold	0	N	Not used by drive
Maximum Pre-fetch – Absolute	0	N	Not used by drive
Maximum Pre-fetch – Multiple	0	N	Not used by drive
Minimum Pre-fetch – Absolute	0	N	Not used by drive
Minimum Pre-fetch – Multiple	0	N	Not used by drive

(Intentionally blank)

Appendix C. Differential Interface

This appendix gives specific information pertaining to the Model 1528D 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 C-1 gives the differential cable pin assignments for connector J1.

Table C-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	
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 C-1 summarizes the electrical characteristics of the signals at connector J1.

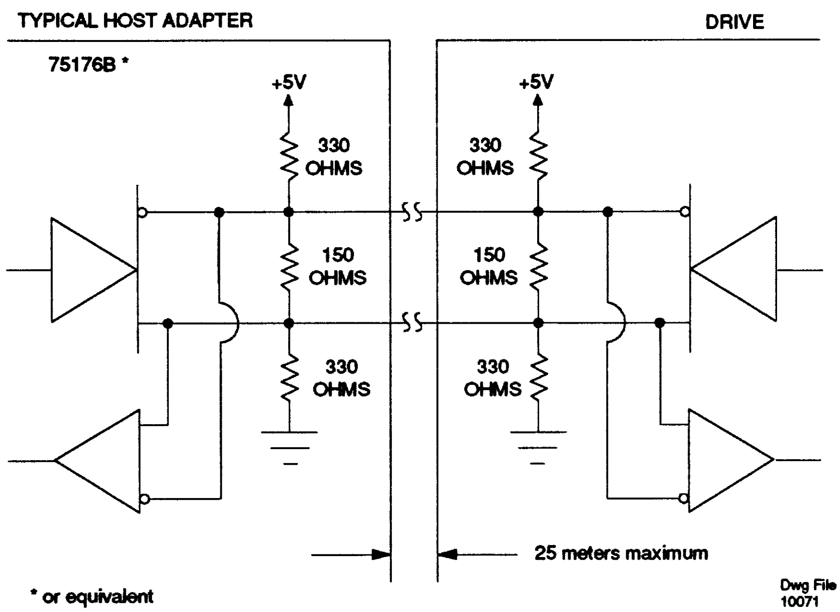


Figure C-1. Differential Driver/Receiver Combination

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 1528D drive provides keyed connectors to prevent accidental grounding or misconnection of terminator power.

Drive Option Selection

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

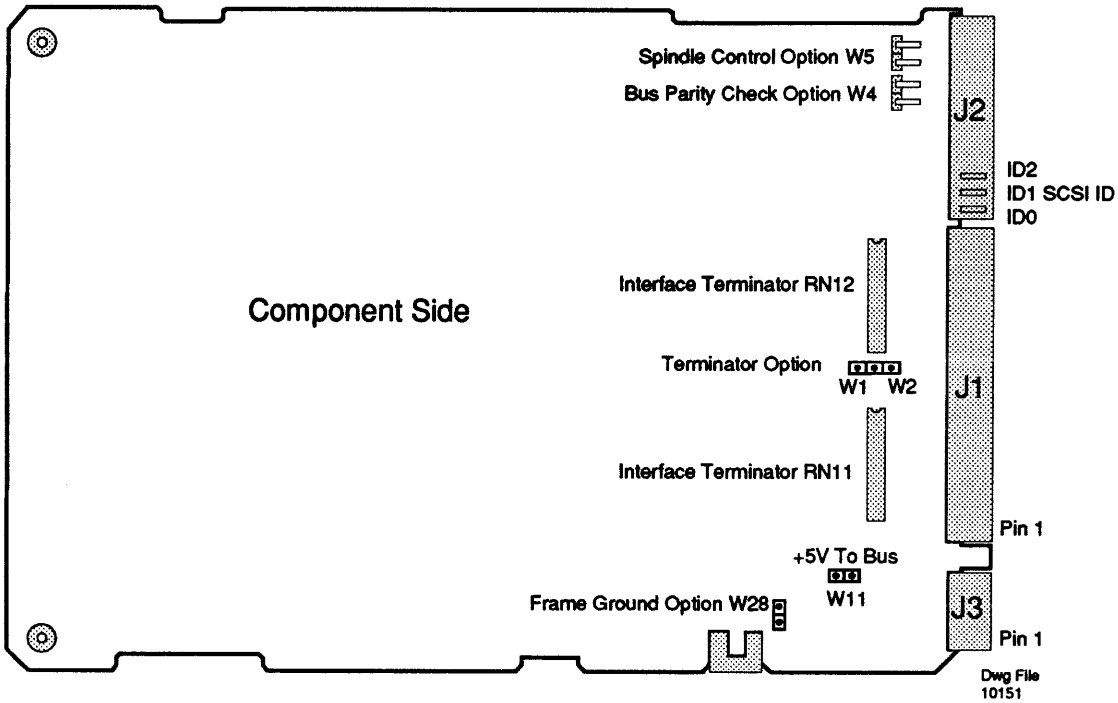


Figure C-2. Address Jumpers and Interface Terminators

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; refer to Section 3 for an explanation of the various options.