

PRODUCT SPECIFICATION
FOR
WRENTM III HH ESDI
MODEL 94216

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THIS SPECIFICATION OUTLINES THE PRODUCT
CHARACTERISTICS AND PERFORMANCE CRITERIA
OF THE 94216 WREN III HH ESDI.

SPECIFIC MODEL AVAILABILITY CAN BE CONFIRMED
BY YOUR CDC OEM SALES REPRESENTATIVE.

SUMMARY

The CDC WREN Peripheral family is composed of the following members. For specific information on each member, refer to the appropriate documents.

NAME	MODEL NUMBER *	PRODUCT SPECIFICATION	INTERFACE	CAPACITY (MEGABYTES)
WREN II	94155-XX	77715909	CDC 506 (ST506 COMP.)	48, 57, 67, 77 or 86
WREN II	94156-XX	77738019	ESDI	46, 67 or 86
WREN II	94151-YY	77738208	SCSI (SASITM Subset)	25 to 80
WREN II HH	94205-XX	77738161	CDC 506 (ST506 COMP.)	30, 41 or 51
WREN III	94166-XXX	77738212	ESDI	101, 141 or 182
WREN III	94161-YYY	77738270	SCSI **	79, 110 or 142 (256 Byte) 86, 121 or 155 (512 Byte) 89, 124 or 160(1024 Byte)
WREN III HH	94211-YY	77765250	SCSI **	91 (512 Byte)
WREN III HH	94216-XXX	77765276	ESDI	106
WREN IV	94171-YYY	77738386	SCSI **	307 (512 Byte)

* XX(X) denotes unformatted drive capacity in megabytes. For example, Model number 94166-182 is a WREN III with ESDI Interface and an unformatted capacity of 182 megabytes.

YY(Y) denotes formatted drive capacity.

** These drives allow the user to format to any integer data block size between 256 and 2048 bytes. At the factory, drives are formatted with 512 byte data block size, with capacity dependent on number of data heads as shown.

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1.0 SCOPE

This specification describes the Control Data Corporation Model 94216 WREN III Half Height (HH) Disk Drive. (Figure 1.0-1) This high capacity, high performance, member of the 5 1/4 inch WREN rigid disk family incorporates the half height WREN III Head/Disk Assembly with performance information given in Section 5. The Model 94216 supports Enhanced Small Device Interface (ESDI).

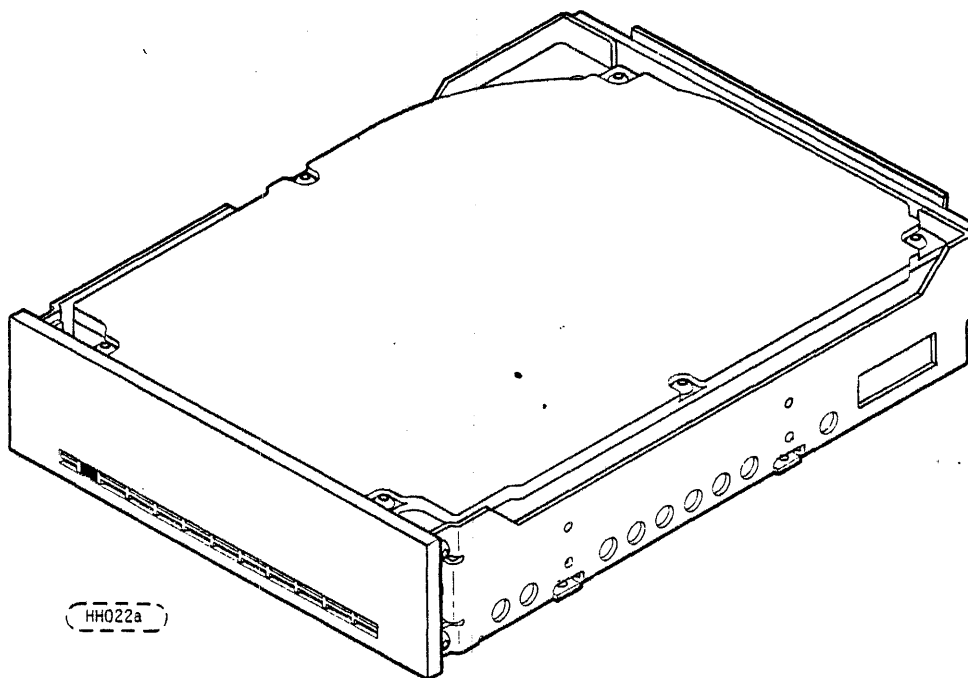


FIGURE 1.0-1. 94216 WREN III HH

2.0 APPLICABLE DOCUMENTS

2.1 STANDARDS

The WREN III HH has been developed as a system peripheral to the highest standards of design and construction. The WREN III HH depends upon its host equipment to provide adequate power and environment in order to achieve optimum performance and compliance with applicable industry and governmental regulations. Special attention must be given in the areas of safety, power distribution, shielding, audible noise control, and temperature regulation.

2.1 (continued)

The WREN III HH complies with CDC standards as noted in the appropriate sections of this specification.

The WREN III HH is a UL Recognized component per UL 478 and a CSA Certified component per CSA C22.2 No. 154-M1983. It also meets the requirements of DIN IEC 380/VDE 0806/8.81.

The WREN III HH, as delivered, is designed for system integration before use. It is supplied as a Class A Computing Device per the FCC Rules and Regulations, Part 15, Subpart J governing EMI of computing devices.

CAUTION

To avoid potential repair problems, observe the following precautions:

- Labels must not be put over the breather holes on the top of the drive.
- If a label has been placed over the breather holes, do not poke holes thorough the label, as the filter underneath is certain to be damaged, allowing contamination to enter. REMOVE THE LABEL. Do not use solvents to remove the adhesive residue. Small amounts of solvent may migrate down the breather holes and contaminate the disk.
- CDC/MPI factory installed labels must not be removed from the drive or covered with additional labels, as they contain information required when repairing.
- DC power should not be switched on to the drive by plugging an electrically "live" DC source cable into the drive power connector. This practice adversely affects the reliability of the connector contacts.

2.2 DOCUMENTATION

2.2.1 Applicable Documents

The documents listed below are referenced in this specification.

77765278	OEM Manual
77738076	CDC ESDI Specification

2.2.2 Reflected Changes

Changes to individual pages of this specification are reflected in the revision letter at the top right corner of the page, after the part number. The revision letter applies to that page only and does not change unless a change was made on the page, in which case it takes the latest revision letter of the specification. In comparing different revisions of the specification, note that the pages with the same revision letters as the specification were the ones changed to achieve that particular specification revision.

3.0 GENERAL DESCRIPTION

The WREN III HH is a member of a family of low cost, high performance, highly reliable, random access storage devices designed to meet the needs of the OEM marketplace.

The WREN III HH is designed to record and recover data on three 5-1/4 inch (130 mm) fixed disks. It does not have removable media capability.

The Model 94216 WREN III HH supports the Enhanced Small Device Interface (ESDI) as described in Control Data's ESDI Specification (77738076). This product specification was created to be used in conjunction with this industry standard interface specification. The information contained in these two documents defines the product performance characteristics and the interface characteristics of the Model 94216 WREN III HH.

The WREN III HH is designed to support the Serial Mode of ESDI Operation.

3.0 (continued)

The Head/Disk/Actuator Assembly (HDA) is environmentally sealed at the factory. Air is recirculated within the HDA through a nonreplaceable filter to maintain a contamination free HDA environment.

Refer to Figure 3.0-1 for an exploded view of the WREN III HH. NEVER disassemble the WREN HDA. This exploded view is for information only. Servicing items in the sealed environmental enclosure (heads, media, actuator, etc.) requires special facilities. The printed wiring assemblies and hardware external to the sealed area may be replaced without special facilities.

The WREN III HH uses a dedicated landing zone at the innermost radius of the media thus eliminating the possibility of destroying or degrading data by landing in the data zone.

The WREN III HH incorporates an automatic shipping lock which prevents potential damage to the heads and disks caused by movement during shipping and handling. The shipping lock is automatically disengaged when power is applied to the drive.

The WREN III HH decodes Track 0 location from the dedicated servo surface thereby eliminating mechanical transducer adjustments and related reliability concerns.

The WREN III HH uses a high performance actuator assembly consisting of a low inertia, balanced, patented, straight arm design which provides excellent performance with minimum power dissipation.

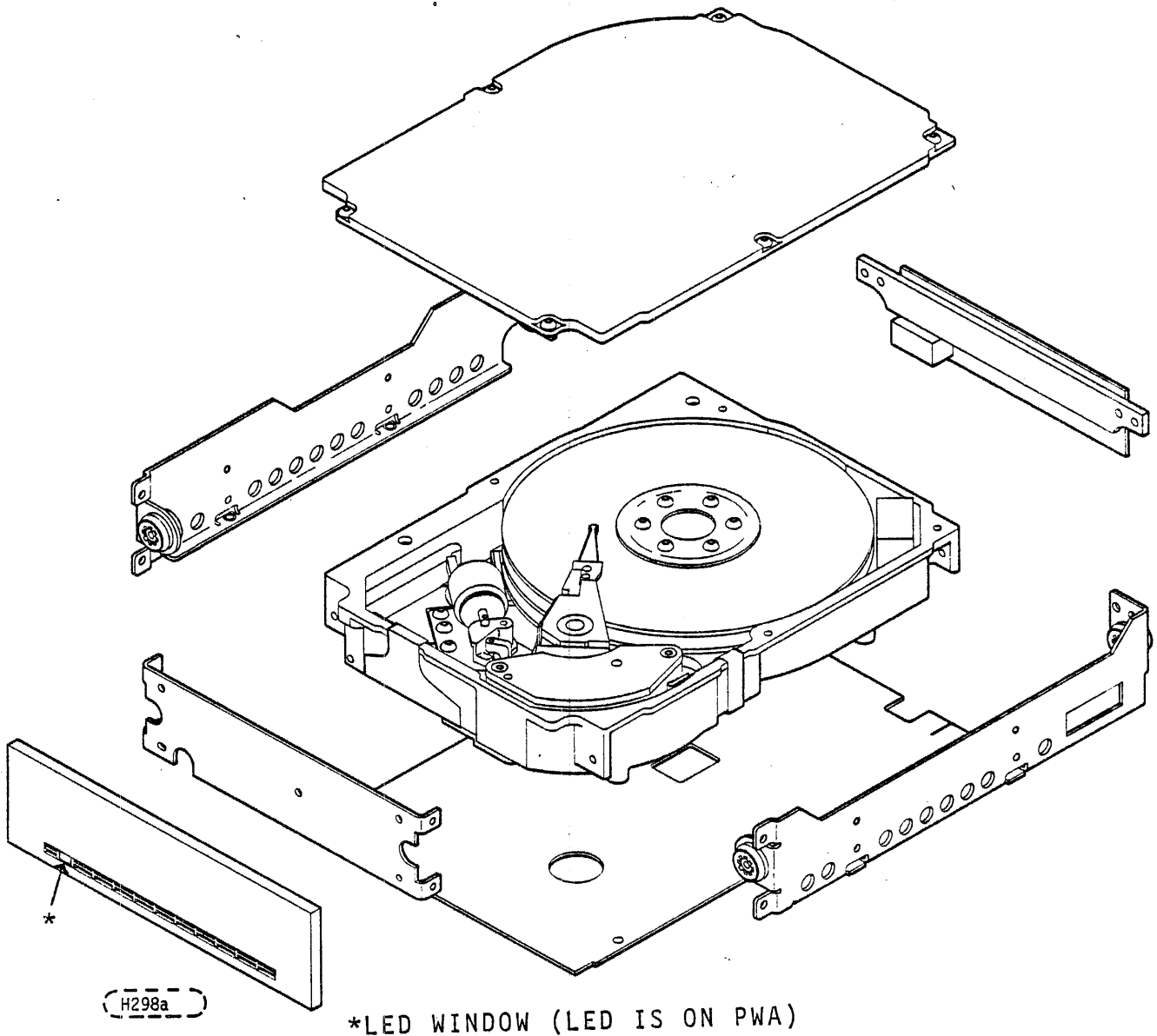


FIGURE 3.0-1. MODEL 94216 WREN III HH

4.0 FEATURES

4.1 STANDARD FEATURES

The Model 94216 WREN III HH has the following standard features:

- Industry standard interface
- Data recovery circuitry contained in the drive
- Multiple capacity configurations
- Sealed head, disk, and actuator (HDA) chamber
- No preventive maintenance required
- LSI circuitry for high reliability
- Low audible noise for office environments
- Vertical or horizontal mounting
- Low power consumption
- Balanced low mass rotary voice coil actuator
- Automatic shipping lock
- Accessible Terminators
- Integral HDA shock and vibration isolation mounts
- Dedicated head landing zone
- Dynamic spindle braking
- 106 MB (unformatted) capacity

4.2 OPTIONAL CONFIGURATIONS

The following options are incorporated at the time of manufacture when specified for delivery. (See Section 12.0.)

- Front Panel with indicator lens (red) (see Figure 3.0-1)
- Single Unit Shipping Pack
- Soft Sector Operation
- OEM Manual

4.3 OPTIONAL ACCESSORIES (USER INSTALLED)

The following accessories are available to the user to facilitate his needs. All kits may be installed in the field. (See Section 13.0.)

- Front Panel Kit and indicator lens (red) (see Figure 3.0-1)
- Single Unit Shipping Pack Kit
- OEM Manual

5.0 PERFORMANCE CHARACTERISTICS

Model 94216 WREN III HH capacity

- Model 94216-106 106,905,600 Bytes (unformatted)
 94,371,840 Bytes (formatted*)
 3 Disks per Drive
 5 Data Surfaces

Data Capacity Parameters (Unformatted)

Maximum Number of Data Heads	5
Bytes/Track	20,880 Bytes
Bytes/Surface	21,381,120 Bytes
Tracks/Surface	1024 Tracks
Tracks/Inch	960 TPI
Bits/Inch	19,058 BPI
Recording Code	2,7
Data Transfer Rate	10.0 Megabits/sec
Data Bit Clock Period(R _{RC}) (Reference/Read Clocks)	100 ns ± 1.0%
Read Propagation Delay	7 to 9 Bit Times
Write Propagation Delay	4 to 6 Bit Times

*Based on 36 sectors with 512 Data Bytes each.
 Consideration for defect management not included.

5.0 PERFORMANCE CHARACTERISTICS (continued)

Data Interface	NRZ Encoded Data
Rotational Speed	3597 r/min $\pm 0.5\%$
Rotational Period	16.68 ms $\pm 0.5\%$
Average Latency	8.34 ms
Single Track Seek Time	Typical 4 ms - NOTE 3 Maximum 6 ms - NOTES 1 & 2
Average Seek Time	Typical 18 ms - NOTE 3 Maximum 20 ms - NOTES 1 & 2
Maximum Seek Time (1024 Tracks)	Typical 35 ms - NOTE 3 Maximum 40 ms - NOTES 1 & 2

NOTE 1: See Seek Command Description 11.2.1.5.

NOTE 2: Maximum times are specified over the worst case conditions of temperature, voltage margins and drive orientation. All seek times include settle time. When comparing seek times, care should be taken not to mix typical seek times with maximum seek times. The only true comparison is with system benchmark tests.

NOTE 3: Typical seek values are measured under nominal conditions of temperature, voltage, and horizontal orientation as measured on a representative sample of drives. All seek times include settle time.

5.1 ACCESS TO DATA CHARACTERISTICS

5.1.1 Seek Time

Seek time is defined as the elapsed time from the receipt of a seek command until the drive signals the controller that it is ready to perform another seek or read/write function on the new cylinder. Average seek time is determined by dividing the sum of the times for all possible movements by the total number of movements. See also paragraph 11.2.1.5.

5.1.2 Spindle Speed and Latency

The spindle speed is 3597 \pm 0.5% r/min. The speed tolerance includes motor performance and motor control circuit tolerances.

The average latency time is 8.34 milliseconds, based on a nominal disk speed of 3597 r/min. The maximum latency time is 16.76 milliseconds based on a minimum disk speed of 3579 r/min.

5.2 READ DATA TRANSFER RATE

The read serial data transfer rate is 10.0 Megabits per second.

5.3 START/STOP TIME

The WREN III HH will become ready less than 28 seconds after application of DC power. Stop time will be less than 30 seconds after removal of DC power.

There is no power control switch on the WREN III HH.

6.0 RELIABILITY SPECIFICATIONS

The following reliability specifications assume correct host/drive operational interface, including all interface timings, power supply voltages, and environmental requirements.

Read Error Rates	
Soft Read Errors (Recoverable)	Less than 1 in 10^{10} bits transferred
Hard Read Errors (Unrecoverable)	Less than 1 in 10^{12} bits transferred
Seek Errors	Less than 1 in 10^6 seeks
MTBF	40,000 hours
Service Life	5 years or 30,000 hours
Preventive Maintenance	None required

6.1 ERROR RATES

The error rates stated in this specification assume the following:

- a. WREN III HH is operated per this specification using DC Power as defined in this specification (see section 7.2).
- b. The Data Format is employed fulfilling the requirements of the WREN III HH as outlined and in the CDC ESDI specification (77738076).
- c. Errors caused by media defects or host system failures are excluded from error rate computations. Refer to paragraph 8.0, Media Characteristics.

6.1.1 Read Errors

Before determination or measurement of read error rates:

- a. The data which is to be used for a measurement of read error rates must be verified as being written correctly on the media.
- b. All media defect induced errors must be excluded from error rate calculations.

A recoverable read error is one that can be read correctly in 2 sets of 10 retries. After 10 retries, a recalibrate (RTZ) and reseek to the suspected cylinder must be accomplished. The recoverable read error rate for any read operation shall be less than one error in 10^{10} bits read.

An unrecoverable read error is one that cannot be read correctly in 2 sets of 10 retries. The unrecoverable read error rate for any read operation shall be less than one bit in 10^{12} bits read.

Retries should use a combination of early and late data strobes as well as plus and minus actuator offsets.

6.1.2 Environmental Interference

When evaluating systems operation under conditions of Electromagnetic Interference (EMI), the performance of the WREN III HH within the system shall be considered acceptable if the WREN III HH does not generate an unrecoverable condition.

An unrecoverable error, or condition, is defined as one which:

1. Is not detected and corrected by the WREN III HH itself; or
2. Is not capable of being detected from the error or fault status provided through the WREN III HH/system interface; or
3. Is not capable of being recovered by normal WREN III HH or system recovery procedures without requiring operator intervention.

6.1.3 Write Errors

Write errors can occur as a result of the following: Write data not being presented correctly, media defects, environmental interference, or equipment malfunction. Therefore, write errors are not predictable as a function of the number of bits passed.

If an unrecoverable write error occurs because of an equipment malfunction in the WREN III HH, the error is classified as a failure affecting MTBF. Unrecoverable write errors are those which cannot be corrected within two attempts at writing the record with a read verify after each attempt, (excluding media defects).

6.1.4 Seek Errors

A seek error is defined as a failure of the WREN III HH to position the heads to the addressed track when the correct information has been presented to the WREN III HH. This condition must be determined by the controller by reading headers. There shall be no more than one recoverable seek error in 10^6 physical seek operations. A recoverable seek error is a positioning error which can be corrected by the host issuing a Recalibrate command and then reseeking to the addressed track. Unrecoverable seek errors are classified as failures for MTBF calculations.

6.2 RELIABILITY AND SERVICE

6.2.1 Mean Time Between Failure

The Mean Time Between Failure (MTBF) shall exceed 40,000 hours for the WREN III HH. MTBF is defined as "Operating Hours" divided by the "Number of Equipment Failures".

"Operating Hours" means total power on hours less any time when the WREN III HH is not functioning properly. "Equipment Failure" means any stoppage or substandard performance of the equipment because of equipment malfunction, excluding stoppages or substandard performance caused by operator error, adverse environment, power failure, host adapter failure, cable failure, or other failure not caused by equipment.

The term equipment failure implies that maintenance is required because of a hardware failure.

6.2.2 Preventive Maintenance

No routine scheduled preventive maintenance shall be required.

6.2.3 Service Life

The WREN III HH shall have a useful service life of five years or 30,000 hours, whichever occurs first, before requiring factory refurbishment. Depot repair or replacement of major parts will be permitted during the lifetime (6.2.4).

6.2.4 Service Philosophy

Special equipment is required to repair the WREN III HH HDA. Repairs may be performed only at a properly equipped and staffed depot service and repair facility.

6.2.5 Installation

The WREN III HH is designed, manufactured, and tested with a "Plug in and Play" installation philosophy. This philosophy minimizes the requirements for highly trained personnel to integrate the WREN III HH into the OEM's system, whether in a factory or field environment.

6.2.6 Service Tools

No special tools are required for site installation or recommended for site maintenance. Refer to paragraph 6.2.4. The depot repair philosophy of WREN III HH precludes the necessity for special tools. If field repair of items external to the HDA is desired, a 6 point Torx driver is required (T10). It may be purchased through most commercial tool catalogs.

7.0 PHYSICAL/ELECTRICAL SPECIFICATIONS

7.1 AC POWER REQUIREMENTS: None

7.2 DC POWER REQUIREMENTS

The voltage and current requirements for a single WREN III HH are shown in the following table. Values indicated apply at the drive power connector.

TABLE 7.2-1. DC POWER REQUIREMENTS

Voltage		+5 V	+12 V
Regulation		$\pm 5\%$	$\pm 5\%$ 2*
Noise Immunity	3*	100 mV	100 mV
Maximum Operating Current	1*	0.9 A	1.7 A
Typical Idle Current	1* 4*	0.6 A	1.0 A
Maximum Starting Current (Peak)		1.0 A	4.5 A
Delayed Motor Start (Max)	5*	1.0 A	0.8 A

1* Measured with average reading DC ammeter.

2* A $\pm 10\%$ tolerance is permissible during power up. The $\pm 5\%$ must be maintained commencing with unit ready.

3* Noise is specified as periodic and random distribution of frequencies covering a band from DC to to 10 MHz. Values given are peak to peak measurements

4* See +12 V current profile level T6 in Figure 7.2-1.

5* This condition occurs when the Motor Start Option is enabled and the drive has not yet received a Start Motor command.

Table 7.2-1 General Notes:

1. At powerup, the motor current regulator will limit the 12 volt current to a peak value of less than 4.5 amperes.
2. Minimum current loading for each supply voltage is not less than 30% of the maximum operating current shown in Table 1.
3. The +5 and +12 volt supplies shall employ separate ground returns.
4. Where power is provided to multiple drives from a common supply, careful consideration for individual drive power requirements should be noted. Where multiple units are powered on simultaneously, the peak starting current must be available to each device. (Ref. Table 1).

7.2.1 Power Sequencing

Power sequencing is not required for the WREN III HH. The WREN III HH protects against inadvertent writing during power up and down. Daisychain operation requires that power be maintained on the terminated WREN III HH to ensure proper termination of the peripheral I/O cables.

7.2.2 12 V - Current Profile

Figure 7.2-1 identifies the WREN III HH 12 V current profile. The current during the various times is as shown:

- T1 - Power is initially applied to the WREN III HH and the spindle begins to accelerate under current limiting.
- T2 - The spindle continues to accelerate under current limiting conditions.
- T3 - The arm restraint solenoid is released.
- T4 - The spindle is up to speed.
- T5 - The autovelocity adjust sequence and controller self test is performed.
- T6 - Velocity is set and the WREN III HH is ready for reading and writing.
- T7 - Power is removed from the WREN III HH.

NOTE

All times and currents are typical. See Table 7.2-1 for maximum current requirements.

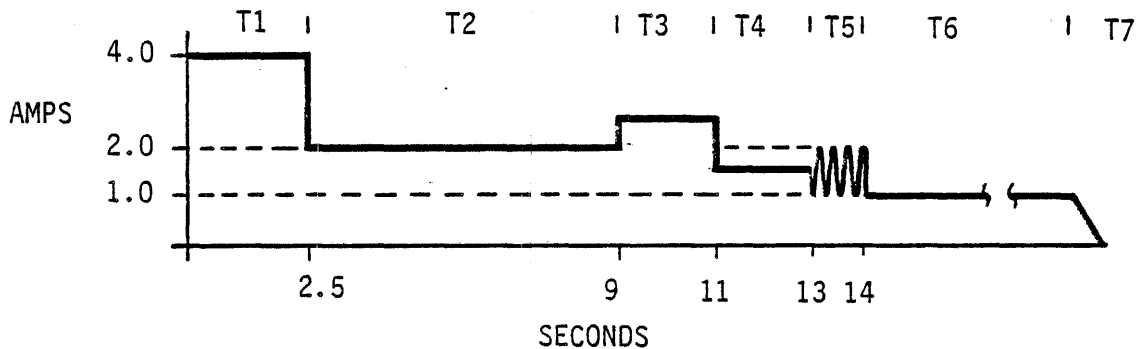


FIGURE 7.2-1. TYPICAL WREN III HH +12 V CURRENT PROFILE

7.3 HEAT/POWER DISSIPATION

Each WREN III HH will dissipate no more than 25 watts of DC power average. Typical power dissipation under idle operating conditions is less than 15 watts.

7.4 ENVIRONMENTAL LIMITS

Temperatures and humidity specifications preclude condensation on any WREN III HH part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7°F (14.8°C). Corresponding maximum Wet Bulb temperature is 82°F (28°C).

7.4.1 Temperature

a. Operating

50°F to 122°F (10°C to 50°C) operating ambient with a maximum gradient of 18°F (10°C) per hour. Above 1000 feet (305 metres) altitude the maximum temperature is derated linearly to 112°F (44.4°C) at 10,000 feet (3048 metres). Cabinet packaging designs must provide ample air circulation around the WREN III HH to ensure environmental limits are not exceeded as a result of heat transfer from other system components. Operating ambient for specification purposes is defined as the environment immediately surrounding the WREN III HH. The temperature of the HDA is restricted to a maximum of 142°F (61.4°C) during operation as shown in Figure 7.4-1. System cooling consideration should avoid large thermal gradients between points A and B. (See Figure 7.4-1).

b. Transit

-40° to 158°F (-40° to 70°C) package ambient with a maximum gradient of 36°F (20°C) per hour. This specification assumes that the WREN III HH is packaged in the shipping container designed by CDC for use with WREN III HH.

c. Storage

14° to 130°F (-10° to 54°C) device ambient with a maximum gradient of 27°F (15°C) per hour.

7.4.2 Relative Humidity

- a. Operating
8% to 80% relative humidity with a maximum gradient of 10% per hour.
- b. Transit
5% to 95% relative humidity.
- c. Storage
8% to 90% relative humidity.

7.4.3 Effective Altitude (Sea Level Reference)

- a. Operating
-1000 to +10,000 feet (-305 to +3048 metres)
- b. Transit
-1000 to +40,000 feet (-305 to +12,210 metres)
- c. Storage
-1000 to +10,000 feet (-305 to +3048 metres)

7.4.4 Shock and Vibration

Shock and vibration limits specified in this document are measured directly on the WREN III HH chassis. If the WREN III HH is installed in an enclosure to which the stated shock and/or vibration criteria is applied, resonances may occur internally to the enclosure resulting in WREN III HH movement in excess of the stated limits. If this situation is apparent, it may be necessary to modify the enclosure to minimize WREN III HH movement.

The limits of shock and vibration defined within this document are specified with the WREN III HH mounted by any of the four methods shown in Figure 7.4-2.

7.4.4.1 Shock

- a. Operating - Normal

Equipment, as installed for normal operation, shall comply with the complete specified performance while subjected to intermittent shock not exceeding 2.0 g at a maximum duration of 10 ms (half sinewave). Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

7.4.4.1 (continued)

b. Operating - Abnormal

Equipment, as installed for normal operation, shall not incur physical damage while subjected to intermittent shock not exceeding 10.0 g at a maximum duration of 10 ms (half sinewave). Shock occurring at abnormal levels may promote degraded operational performance during the abnormal shock period. Specified operational performance will continue when normal operating shock levels resume. Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

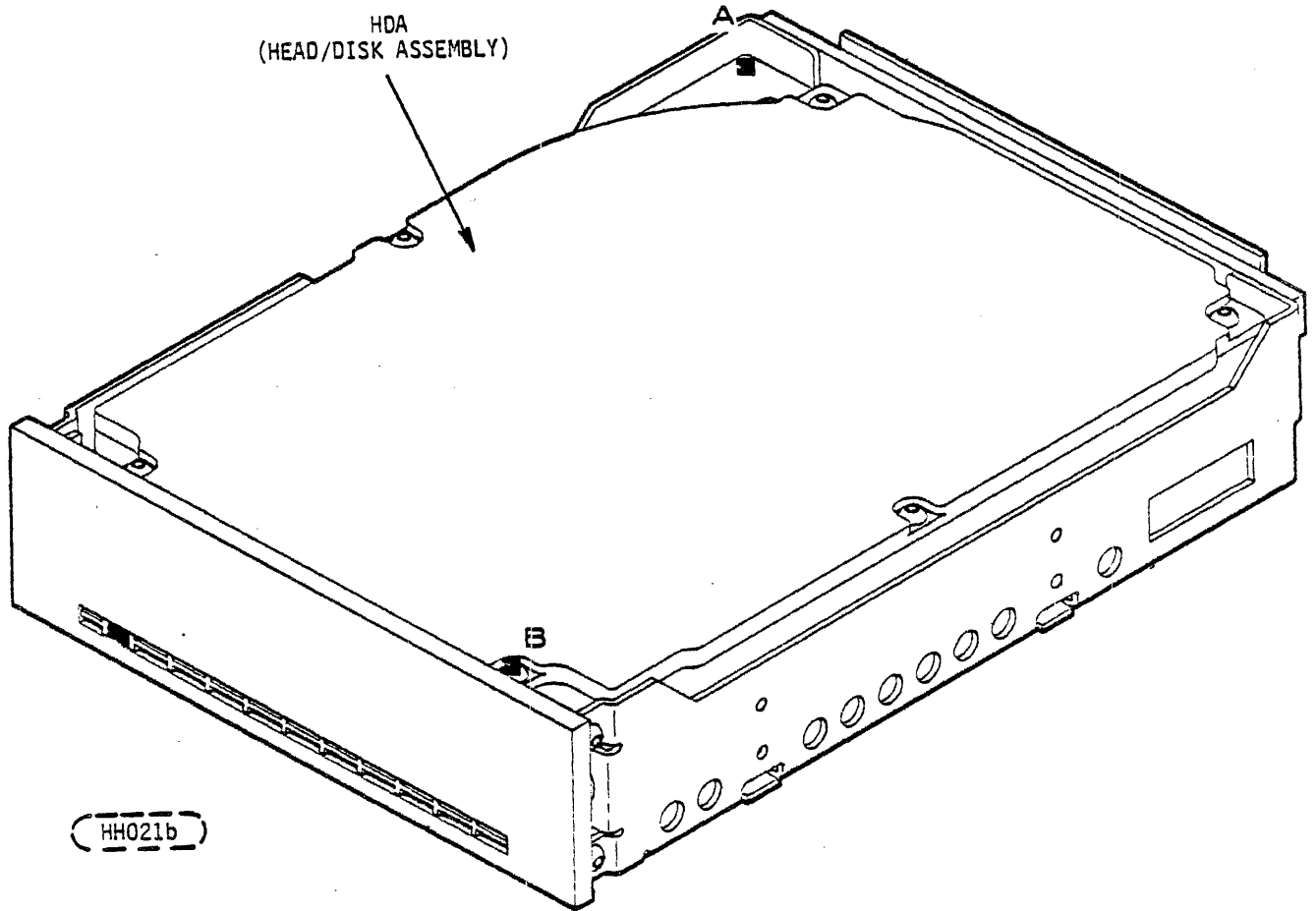
c. Nonoperating

The limits of nonoperating shock shall apply to all conditions of handling and transportation. This includes both isolated devices and integrated equipment.

Equipment subjected to nonrepetitive shock not exceeding 32.0 g at a maximum duration of 10 ms (half sinewave) shall not exhibit device damage or performance degradation. Shock may be applied in the X, Y, or Z axis.

d. Packaged

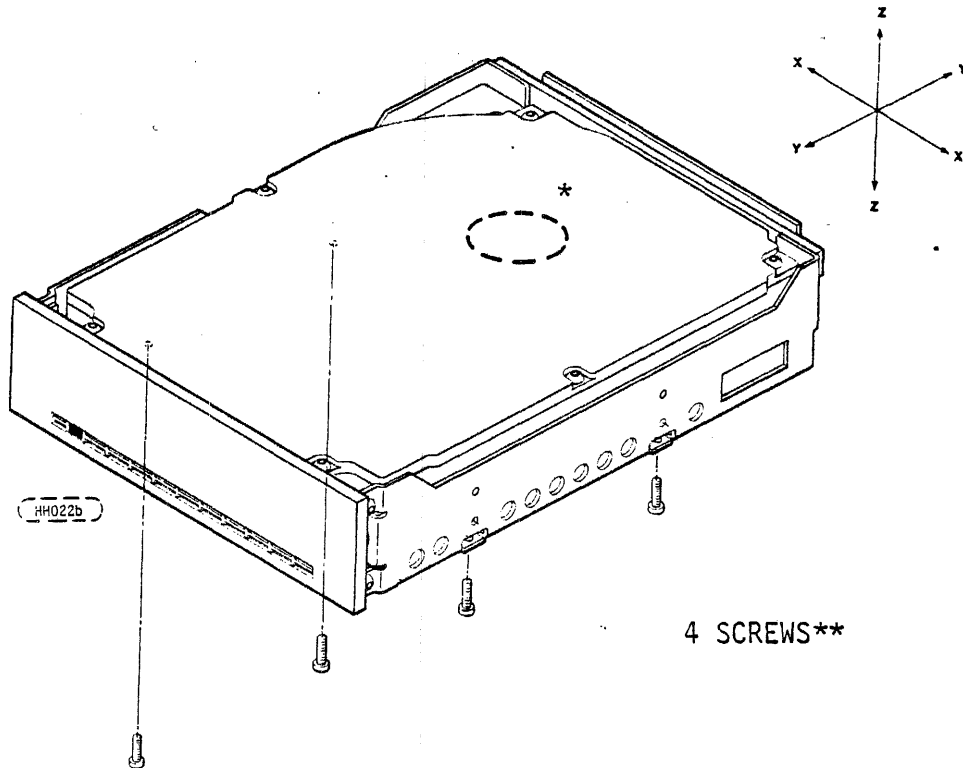
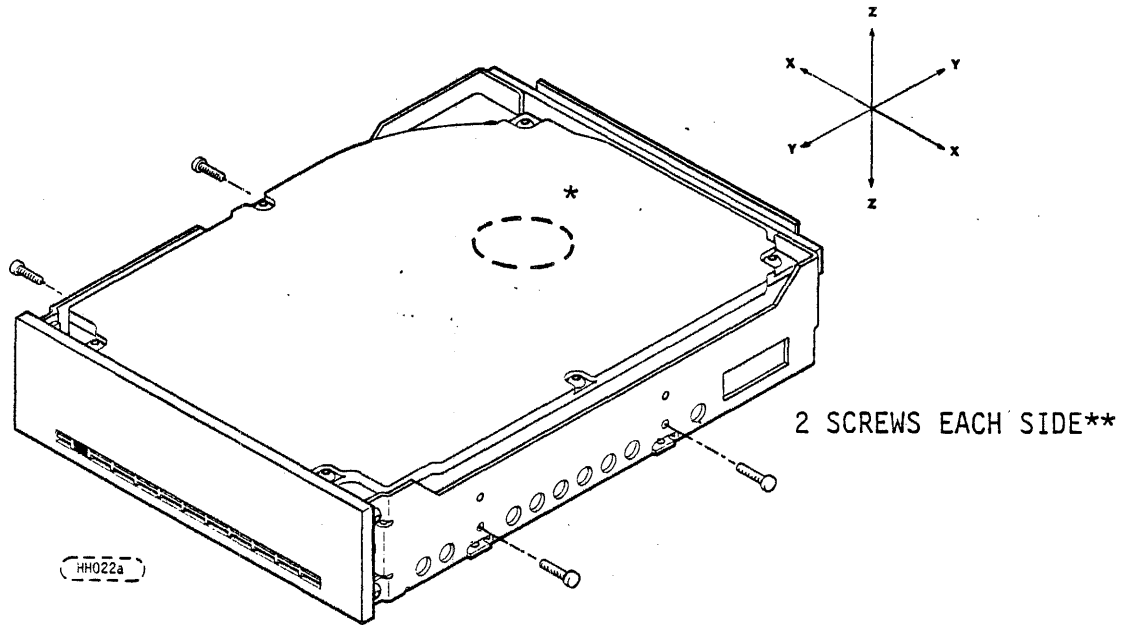
The WREN III HH as packaged by CDC for commercial freight shipment shall withstand drop test from 42 inches (1070 mm) against a concrete floor or equivalent. This applies to the single unit pack only.



■ HDA TEMPERATURE MONITORING LOCATIONS

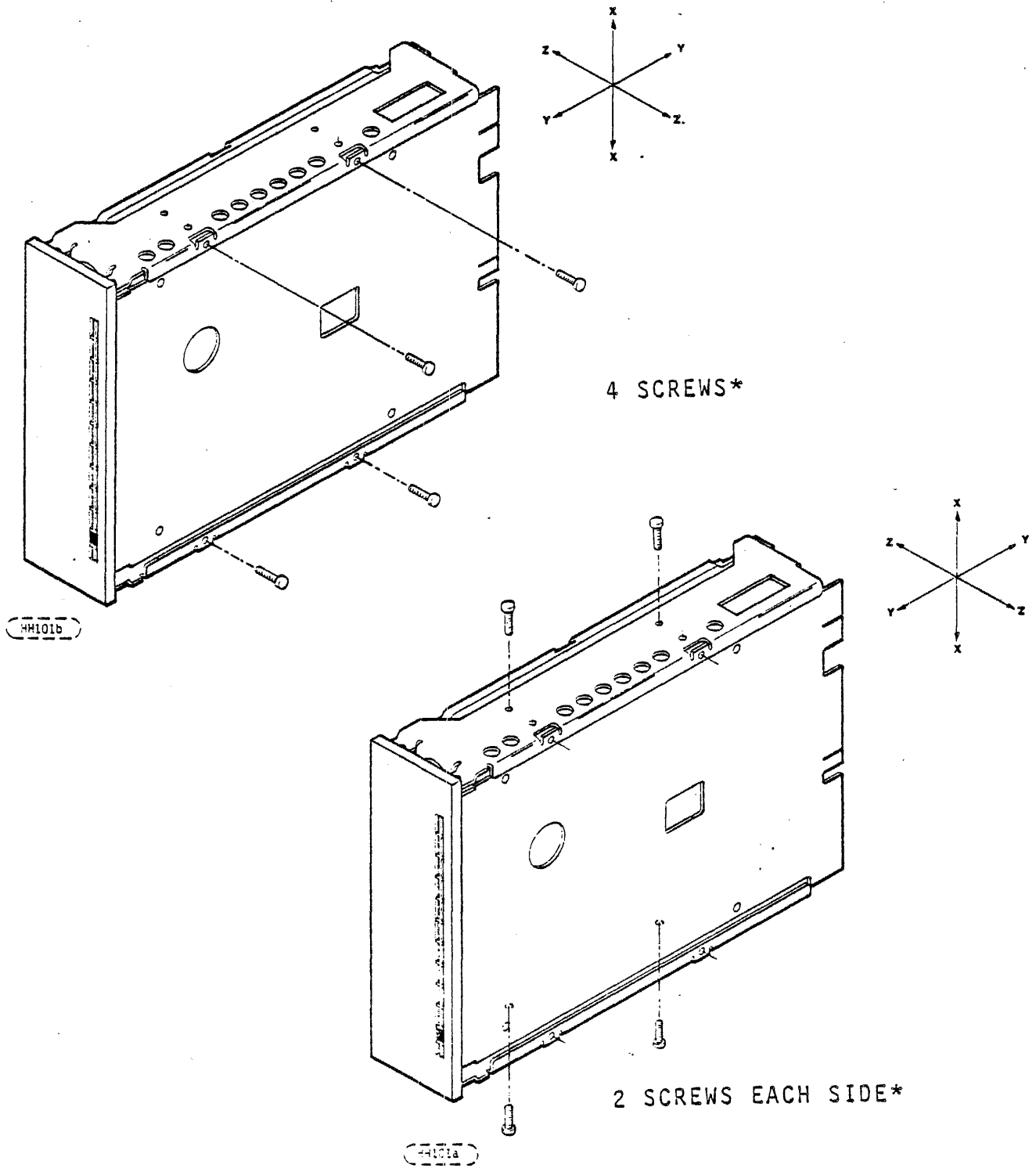
Points A and B should not exceed 142°F (61.4°C) during operation. Large thermal gradients between Points A and B should be avoided.

FIGURE 7.4-1. HDA TEMPERATURE MONITORING LOCATIONS



*Breather Hole Area. Do not obstruct Air Flow.
**Mounting depths given in Figure 7.5-1.

FIGURE 7.4-2. RECOMMENDED HORIZONTAL MOUNTING



* Mounting depths given in Figure 7.5-1.

FIGURE 7.4-2. RECOMMENDED VERTICAL MOUNTING

7.4.4.2 Vibration

- a. Operating - Normal
 Equipment as installed for normal operation, shall comply with the complete specified performance while subjected to continuous vibration not exceeding
 5-22 Hz @ 0.010 inches displacement
 22-500 Hz @ 0.25 g
 Vibration may be applied in the X, Y, or Z axis.

- b. Operating - Abnormal
 Equipment as installed for normal operation, shall not incur physical damage while subjected to periodic vibration not exceeding
 15 minutes of duration at major resonant frequency
 5-22 Hz @ 0.010 inches displacement
 22-500 Hz @ 0.50 g

Vibration occurring at these levels may promote degraded operational performance during the abnormal vibration period. Specified operational performance will continue when normal operating vibration levels are resumed. This assumes system recovery routines are available. Abnormal vibration may be applied in the X, Y, or Z axis.

- c. Nonoperating
 The limits of nonoperating vibration shall apply to all conditions of handling and transportation. This includes both isolated devices and integrated equipment.

Equipment shall not incur physical damage or degraded performance as a result of continuous vibration not exceeding
 5-22 Hz @ 0.040 inches displacement
 22-500 Hz @ 1.0 g
 Vibration may be applied in the X, Y, or Z axis.

7.4.5 Air Cleanliness

The WREN III HH is designed to operate in a typical office environment with minimal environmental control.

7.5 MECHANICAL SPECIFICATIONS

The following nominal dimensions are exclusive of the decorative front panel accessory. Refer to Figure 7.5-1 for detailed mounting configuration dimensions.

Height: 1.625 in 41.3 mm
 Width: 5.75 in 146.05 mm
 Depth: 8.1 in 205.7 mm
 Weight: 4.2 pounds 1.9 kilograms

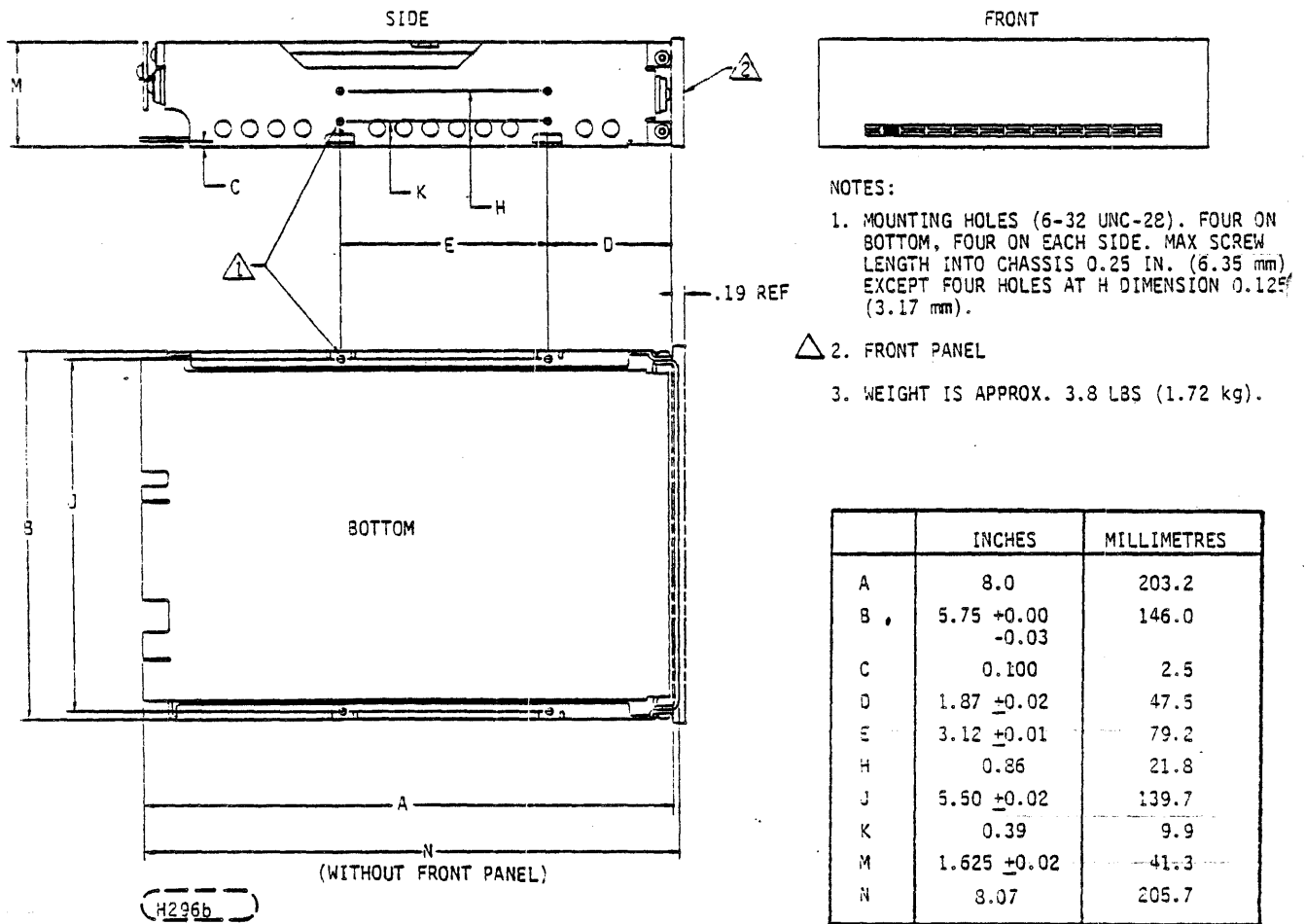


FIGURE 7.5-1. MOUNTING CONFIGURATION DIMENSIONS

7.5.1 Drive Orientation

Only two WREN III HH mounting orientations are permitted: disks in the horizontal plane and disks in the vertical plane see Figure 7.4-2. Horizontal mounting with the front raised at an angle of 15° is acceptable. Mounting with either end down (front or rear) or upside down is not permissible. It is recommended that data written in a given orientation be read in that same orientation.

7.5.2 Cooling

Cabinet cooling must be designed by the customer so the ambient temperature immediately surrounding the WREN III HH will not exceed temperature conditions specified in 7.4.1. Specific consideration should be given to make sure adequate air circulation is present around the PWAs at the rear of the drive.

8.0 MEDIA CHARACTERISTICS

8.1 MEDIA DESCRIPTION

The media used on the WREN III HH has a diameter of approximately 5 1/4 inches (130 mm). The aluminum substrate is coated with a thin film magnetic material, overcoated with a proprietary protective layer for improved durability and environmental protection.

Each data surface has a total of 1024 tracks and is capable of recording 21,381,120 bytes of unformatted data.

Media defects are characterized as correctable or uncorrectable depending on the type and magnitude of the media flaw. Various error correction codes may be implemented. The code chosen should be consistent with Control Data media testing and certification methods. WREN III HH media certification is performed using the following standards.:

1. An error burst of 11 bits or less is a correctable error.
2. An error burst greater than 11 bits in length is an uncorrectable error.

Host systems using the WREN III HH should have, as a minimum, resident capabilities to recognize and map defective tracks and perform track reallocation routines.

At the time of shipment from the point of manufacture, the WREN III HH recording surfaces meet the following requirements.

1. 1024 total tracks per surface.
2. Track 0 to be error free on each data surface.
3. 30 defects per surface maximum.
4. Cumulative defects not to exceed 1 per megabyte, based on total available drive capacity.

9.0 DEFECT AND ERROR MANAGEMENT

The WREN III HH, as delivered, complies with this specification. The read error rate and specified storage capacity are not dependent upon use of defect management routines. However, a carefully chosen defect management plan can significantly enhance overall system performance.

Identified defects are recorded on the defects list tracks per CDC ESDI specification (section 5.5 and 6.5). It is recommended that these known defects be reallocated during the initial format operation. Sector reallocation is suggested because, in general, it is more efficient and may offer significant performance improvement. Error Correction Code (ECC) should be used to correct additional flaws as they occur. ECC is recommended since most of the defects are recoverable with ECC. If ECC is not used, defects are usually unrecoverable and need to be reallocated as they are discovered.

10.0 INTERFACE CABLING REQUIREMENTS/OPTIONS

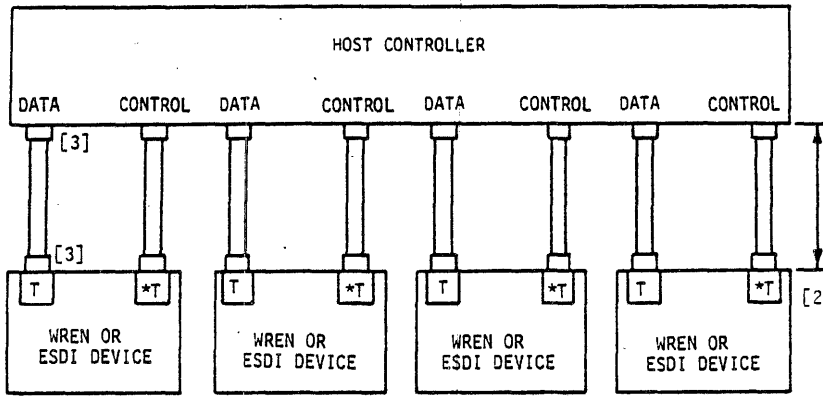
10.1 RADIAL CONFIGURATION

Interface cabling options for the WREN III HH are shown in Figure 10.2-1. View A shows each drive interfaced to its own control cable, which allows interfacing an arbitrary number of drives and a variety of system operational techniques. Each drive has its data cable and control cable connected to the host controller. The length of each individual cable must not exceed 10 feet (3.0 metres). Terminator resistors must be installed in the host controller for each data cable and for each control cable. For this configuration, a terminator resistor pack must be installed in each WREN III HH Disk Drive.

10.2 DAISYCHAIN CONFIGURATION

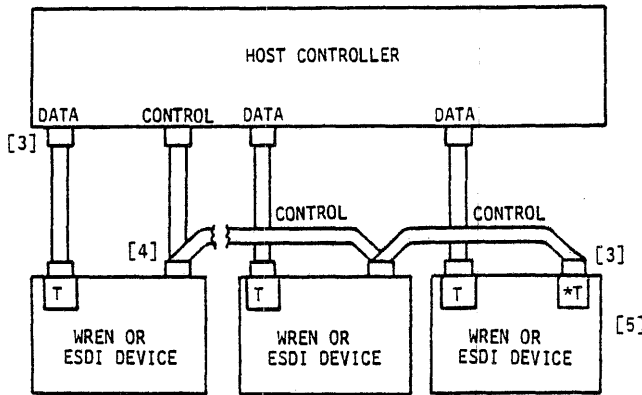
A daisychain configuration connects a maximum of seven drives in parallel on a common control cable. (See paragraph 11.1.1). Only the drive selected by the host system has its control signals enabled through this common interface. View B of Figure 10.2-1 illustrates a daisychain of WREN III HH Disk Drives or other ESDI devices. A terminator resistor pack is required in the host controller for each data cable. Only the last ESDI device in the daisychain requires a terminator resistor pack for the control cable. Terminator resistor packs for the control cable of other drives must be removed. See Figure 10.3-1 for location of the terminator pack. The total combined control cable length (from the controller to the first drive, to the second and subsequent drives) must be not more than 10 feet (3.0 metres).

Refer to paragraph 11.1.1 for logical drive selection.



EACH CONTROL CABLE LENGTH MUST NOT EXCEED 10 FEET (3.0 m). EACH DATA CABLE LENGTH MUST NOT EXCEED 10 FEET (3.0 m).

VIEW A



TOTAL CONTROL CABLE LENGTH MUST NOT EXCEED 10 FEET (3.0 m). EACH DATA CABLE LENGTH MUST NOT EXCEED 10 FEET (3.0 m).

VIEW B

T* INDICATED REMOVABLE TERMINATOR RESISTOR PACK. WREN DATA PORTS ARE PERMANENTLY TERMINATED.

HH057a

- [2] NUMBER OF DEVICES DEPENDS ON HOST ADAPTER CAPABILITY.
- [3] CLOSED END TYPE CONNECTOR USED.
- [4] OPEN END TYPE CONNECTOR USED.
- [5] A MAXIMUM OF 7 DEVICES MAY BE INTERCONNECTED.

FIGURE 10.2-1. INTERFACE CABLING OPTIONS

10.3 DC POWER AND SYSTEM GROUND CABLE AND CONNECTOR INFORMATION

The WREN III HH receives DC power through a 4 pin right angle connector (see Table 2 for pin assignment) mounted on the main circuit board (see Figure 10.3-1). Recommended part numbers of the mating connector are provided, but equivalent parts may be used (See Table 3).

TABLE 2. DC INTERFACE

POWER LINE DESIGNATION	PIN NUMBER
+12 V	J2-01
+12 V Return	J2-02
+5 V Return	J2-03
+5 V	J2-04

TABLE 3. MATING PARTS

TYPE OF CABLE	CONNECTOR	CONTACTS (20-14 AWG)
18 AWG	AMP 1-480424-0	AMP 60619-4 (Loose Piece) AMP 61117-4 (Strip)

System Ground Quick Connect Terminal

System ground may be connected to the Quick connect terminal shown in Figure 7.2-2. Recommended part numbers for this connector and the mating ground cable connector are listed, but equivalent parts may be used.

Drive Connector Terminal

AMP P/N 61664-1

Cable Connector Terminal

AMP P/N 62137-2

10.4 DATA CABLE AND CONNECTOR

The I/O connector for the data interface is a 20 pin board edge connector (Figure 10.3-2 and 10.3-3). The odd pins are located on the front (component side) of the printed circuit board. The even pins are on the noncomponent side of the main printed circuit board. A key slot is provided between pins 3 and 5. CDC recommends keying this connector to prevent installing it upside down. However, the WREN will not be damaged if the connector is installed upside down. Figure 11.2-1 shows signal names and pinouts.

10.4 (continued)

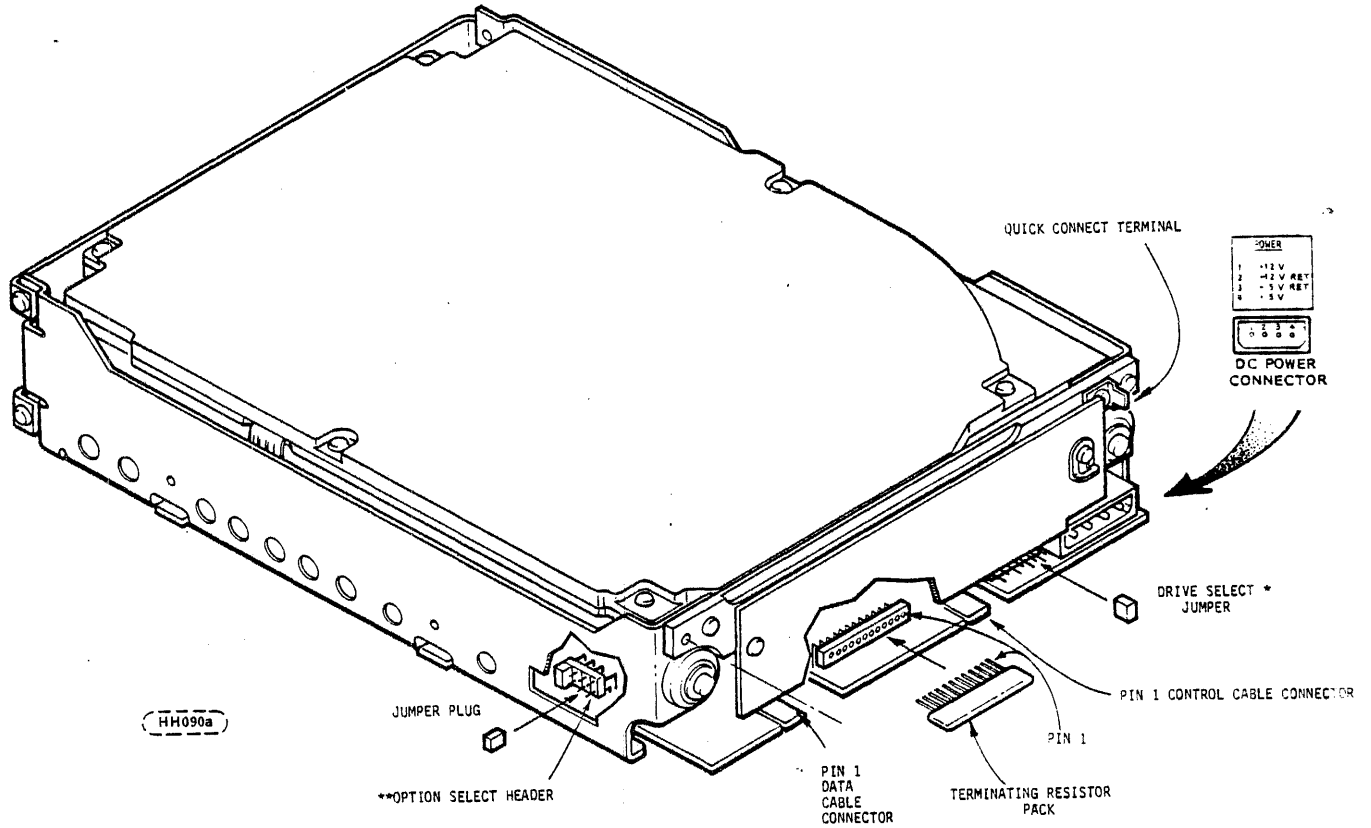
Recommended part numbers for the mating connector are included below, but equivalent parts may be used.

CONNECTOR (20 PIN)
 3M-3461-0001
 AMP 88373-6

STRAIN RELIEF
 3M-3448-54

CABLE
 Flat Cable (Stranded AWG 28) 3M-3365-20
 Flat Cable (Stranded AWG 28) 3M-3517-20 (Shielded Cable)

KEY
 AMP 583274-1
 3M-3439-2



* See Figure 11.2-3 for details
 ** See Figure 12.1-1 for details

FIGURE 10.3-1. I/O CONNECTION

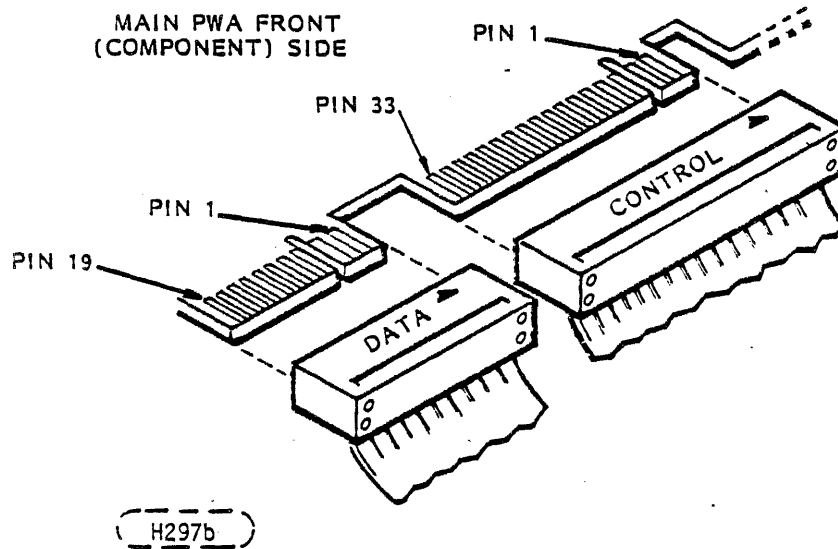


FIGURE 10.3-2. CABLE CONNECTION

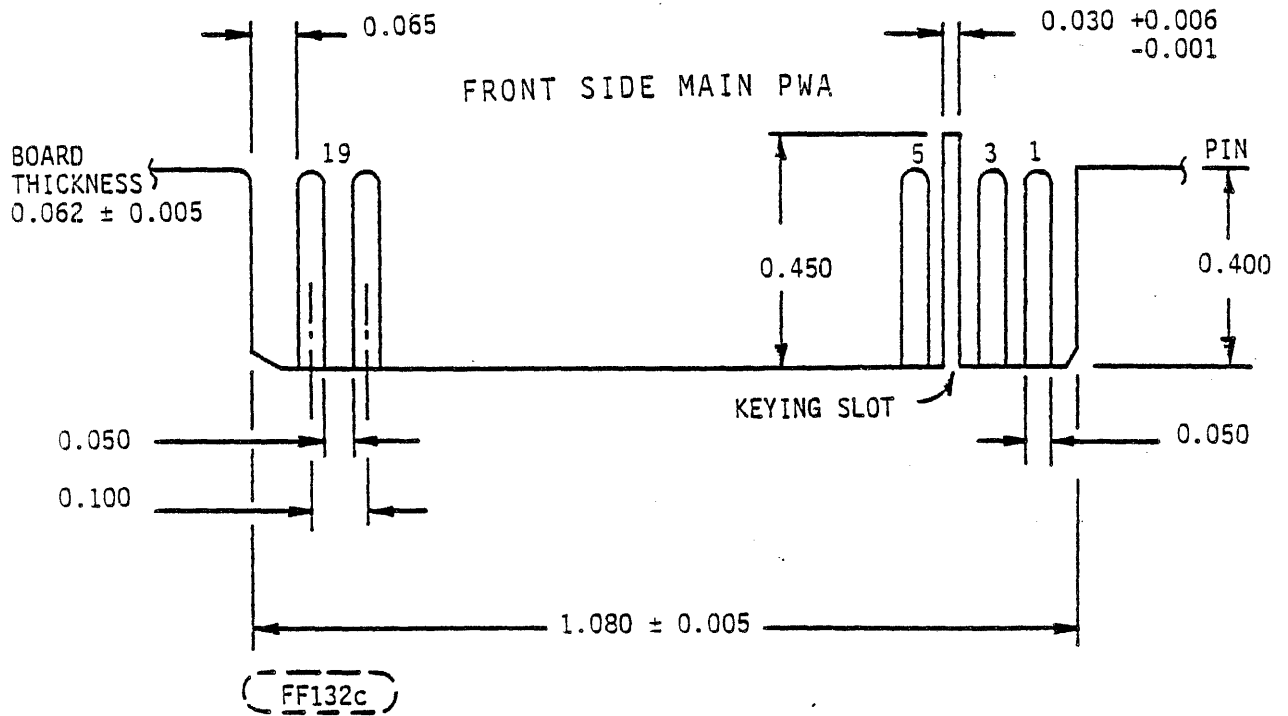


FIGURE 10.3-3. DATA CABLE INTERFACE

10.5 CONTROL CABLE AND CONNECTOR

The I/O connector for the control interface is a 34 pin board edge connector. The odd pins are located on the front (component) side of the main printed circuit board and are connected to the ground plane. The even pins are on the noncomponent side of the printed circuit board. A key slot is provided between pins 3 and 5. (See Figure 10.3-2 and 10.5-1) CDC recommends keying this connector to prevent installing it upside down. However, the WREN will not be damaged if the connector is installed upside down.

Recommended part numbers for the mating connector are provided, but equivalent parts may be used.

CONNECTOR (34 PIN)

3M-3463-0001

AMP 88373-3

STRAIN RELIEF

3M-3448-56

KEY

AMP 583274-1

3M-3439-2

CABLE

Flat Cable (Stranded AWG 28) 3M-3365-34

Flat Cable (Stranded AWG 28) 3M-3517-34 (Shielded Cable)

Spectra Strip Twist'n Flat 455-248-34 (Stranded AWG 28 Twisted Pair)

10.6 INTERFACE DRIVERS/RECEIVERS

The WREN III HH uses two types of signals; single ended and balanced differential. The data and clock signals use balanced differential drivers and receivers. All other signals use single ended drivers and receivers.

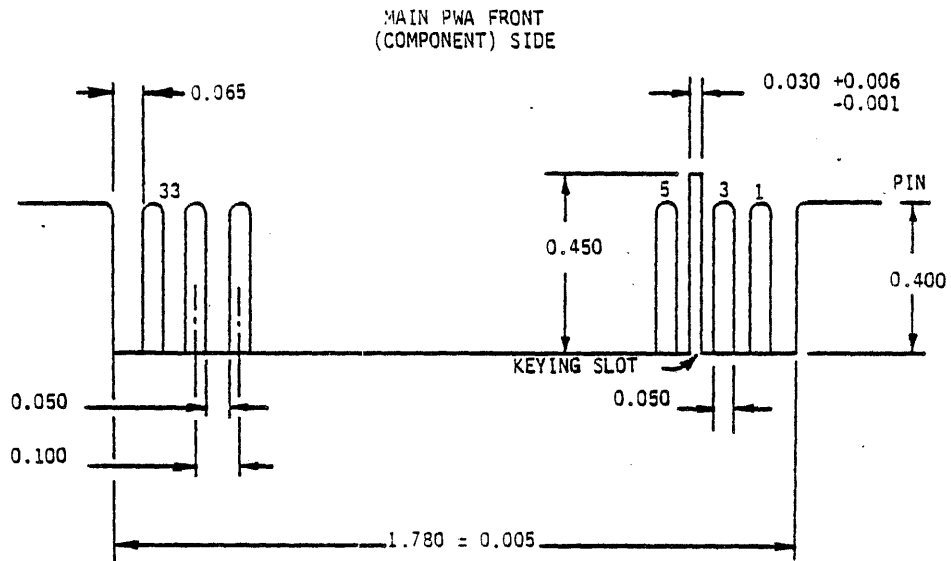
10.6.1 Single Ended Drivers/Receivers

10.6.1.1 Transmitter Characteristics

The WREN III HH uses the 7406 open collector hex inverter buffer/driver to transmit status to the host. This driver is capable of sinking a current of 40 mA with a low level output voltage of 0.7 V. (See Figure 10.6-1).

10.6.1.2 Receiver Characteristics

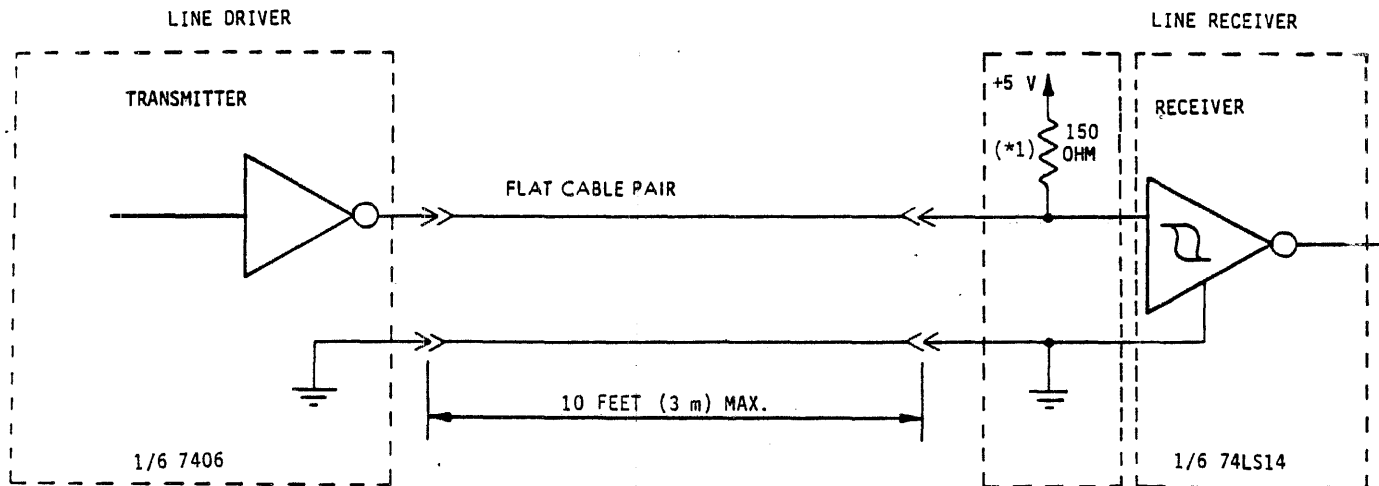
The WREN III HH uses the 74LS14 Hex Inverter with hysteresis gate as a line receiver. The input of each receiver is terminated in a 150 ohm pullup resistor as shown in Figure 10.6-1.



NOTE: TOLERANCE ± 0.010 in. EXCEPT WHERE OTHERWISE NOTED.

H146b

FIGURE 10.5-1. CONTROL CABLE INTERFACE



(*1) PART OF REMOVABLE RESISTOR PACK.*

INTERFACE SIGNALS LEVELS AND LOGICAL SENSE AT THE WREN I/O CONNECTOR ARE DEFINED AS FOLLOWS:

LOGIC LEVEL	DRIVER OUTPUT	RECEIVER INPUT
HIGH (NEGATED) (0)	$\geq 2.5 \text{ V}; \leq 5.25 \text{ V}$	$\geq 2.0 \text{ V}; \leq 5.25 \text{ V}$
LOW (ASSERTED) (1)	$\leq 0.7 \text{ V}; \geq 0.0 \text{ V}$	$\leq 0.8 \text{ V}; \geq 0.0 \text{ V}$

THE DIFFERENCE IN THE VOLTAGES BETWEEN INPUT AND OUTPUT SIGNALS IS DUE TO THE LOSSES IN THE CABLE.

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FIGURE 10.6-1. SINGLE ENDED TRANSMITTERS AND RECEIVERS
(*See Figure 10.3-1)

10.6.1.3 Terminator Characteristics

The terminator is a resistor module that plugs into a socket in the last drive in a daisychain as shown in Figure 10.3-1. Each drive is furnished with a terminator. Terminators must be removed from all except the last drive on the cable prior to daisychain operation. (See Figure 10.2-1.) An equivalent terminator must be provided in the controller on each input signal line from the drive to the controller. Only the Control cable resistor module is removable.

10.6.2 Balanced Differential Drivers/Receivers

10.6.2.1 Transmitter Characteristics

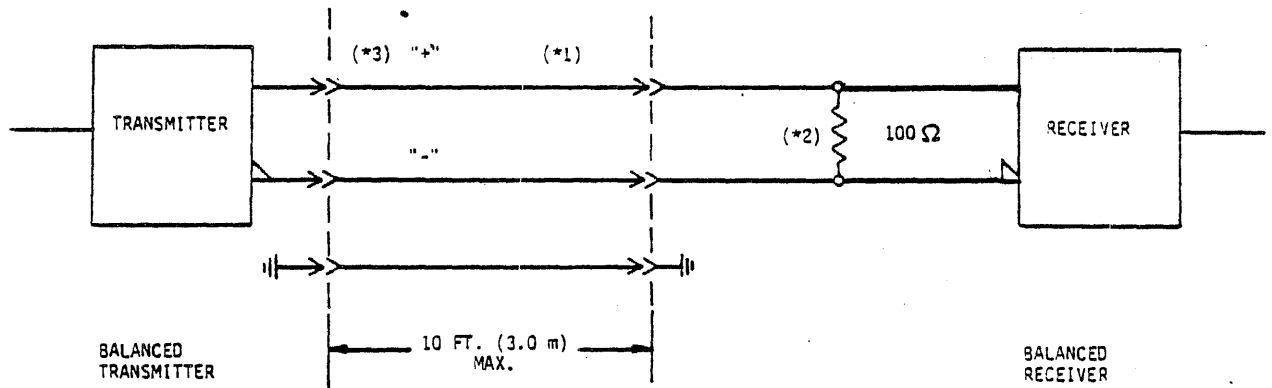
The WREN III HH uses 75158 or equivalent type balanced differential drivers. An assertion on the interface is defined when the "+" output is more positive than the "-" output. (See Figure 10.6-2.)

10.6.2.2 Receiver Characteristics

The WREN III HH uses 75157 or equivalent type balanced differential receivers terminated per Figure 10.6-2. An assertion on the interface is defined when the "+" input is more positive than the "-" input. (See Figure 10.6-2.)

10.6.2.3 Terminator Requirements

Each differential receiver in the drive is terminated with a 100 ohm resistor. (See Figure 10.6-2.) An equivalent terminator must be provided in the controller on each input signal line from the drive to the controller.



(*1) CABLE SHALL BE FLAT CABLE 3M-3365-20 OR EQUIVALENT

(*2) TERMINATOR RESISTORS ARE LOCATED AT ALL RECEIVER INPUTS. THESE SIGNALS MUST BE RADIALLY CABLED.

(*3) NOMINAL "-" LINE OV
 NEGATION ASSERTION
 NOMINAL "+" LINE

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FIGURE 10.6-2. BALANCED DIFFERENTIAL DRIVERS/RECEIVERS

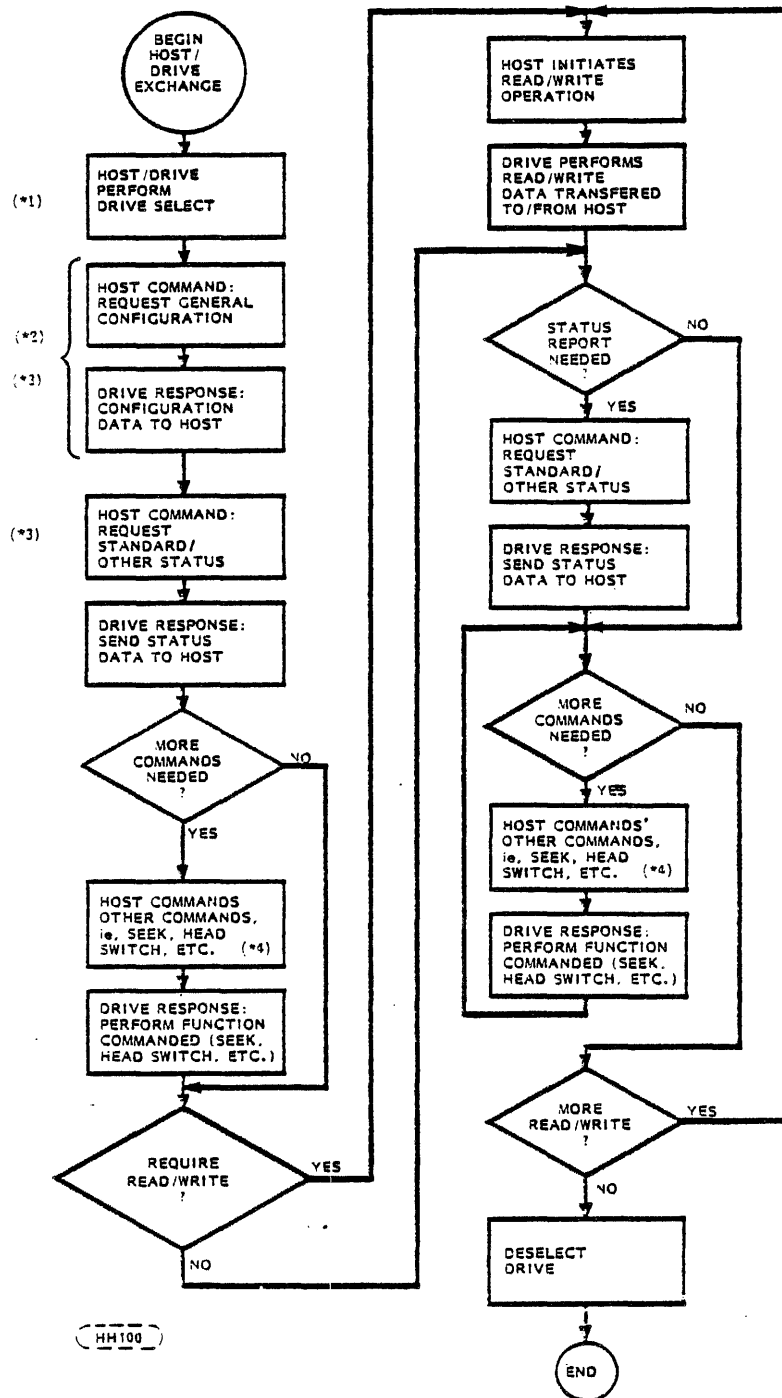
11.0 SERIAL MODE INTERFACE DESCRIPTION AND OPERATION

11.1 GENERAL INTERFACE OPERATION PRINCIPLES

Figure 11.1-1 shows a typical operational sequence of the ESDI WREN III HH on the serial mode interface. The sequence is described in the following paragraphs.

At application of power, two options are possible (see Section 12): immediate motor start or motor start by interface command. In either case, as soon as power is applied the host can try to communicate with the WREN III HH. In the first case, the WREN III will not respond until the spindle is up to speed and the Ready and Command Complete lines are asserted by the drive. In the second case the drive will respond to any of five commands (see Table 11.2-4), one of which is the Motor Start command. Once commanded to start the motor, the drive starts the motor and then does not respond further until after it asserts Ready (motor up to speed) and Command Complete. Whether Ready is asserted or not, the host should select the drive and send a Request General Configuration command and the Request Standard Status command. If the drive never comes ready, it will respond properly to the Request Standard Status command, but will not perform any of the other commands. It will, however, assert Command Complete to indicate that it did receive the command.

A typical, normal, up and running operating sequence is: host selects drive, host (optionally) sends Request Standard Status command, drive sends status data to host controller (if requested), host commands some action such as a Seek, Head Switch, etc., drive performs requested seek, etc., sending any data required back to the host, drive asserts Command Complete (after each command performed), host initiates and drive performs read and/or write function, host sends more commands or deselects drive. The host can deselect while a seek or other long operation is being performed and reselect to continue operations with the drive when the drive asserts Command Complete.



(HH100)

- (*1) SEE FIGURE 11.2 - 2 FOR DETAIL SELECT TIMING
- (*2) SEE FIGURE 11.2 - 4 FOR DETAILED TIMING OF SIGNALS INVOLVED IN THESE COMMAND/RESPONSE OPERATIONS.
- (*3) THESE COMMANDS MAY OR MAY NOT BE PERFORMED EACH TIME DRIVE SELECTION OCCURS.
- (*4) DESELECTION OF DRIVE WILL LIKELY OCCUR DURING LONG OPERATION (SUCH AS SEEK).

FIGURE 11.1-1. TYPICAL NORMAL OPERATION SEQUENCE

11.1.1 Drive Selection

Drive selection operates as follows. Timing waveforms are shown in Figure 11.2-2.

1. Operation is initiated by the host when it asserts Drive Select 0, Drive Select 1 and Drive Select 2 (J1/P1) in a binary coded configuration representing the interface ID of the device to be selected (ID possibilities are 1 through 7. See Figure 11.2-3).
2. In response, the drive asserts Drive Selected (on J2/P2) to indicate to the host that the device selection is accepted.
3. The host continues to assert the three Drive Select lines as long as is necessary to complete the requirements of the command(s) and any Read/Write operations.
4. When the host negates the three Drive Select lines, the drive responds by negating the Drive Selected line.

11.1.2 Command/Control/Response Operation

Once the drive is selected, the host communicates control commands to the drive and receives configuration/status responses from the drive using a set of request/acknowledge/command complete interlocking signals called "handshake protocol." Timing waveforms for these command/drive response exchanges are shown in Figure 11.2-4.

Commands sent to control the drive are sent serially, 16 bits per command (plus 1 bit for parity). Command configuration/status responses from the drive to the Host are sent serially, 16 bits (plus 1 bit parity) per response. Each bit is sent in accordance with the handshake protocol shown in Figure 11.2-4.

11.1.2.1 Commands

Up to 16 different 16 bit commands are available though not all represent valid commands for the WREN III HH. The implemented commands are listed in Table 11.2-2. The command set is decoded from bits 15-12 as shown in Figure 12b of the CDC ESDI Interface Spec. There are two command types:

1. commands using bits 11-8 coded as command modifier
2. commands using bits 11-0 as a parameter value (a quantity rather than a code).

Table 5 following Table 12b of the CDC ESDI Interface Spec lists the different commands and indicates which of the two formats shown in Figure 12b the command uses. Also indicated is whether or not configuration or status data is to be returned to the host in response to the command.

Command Modifier Type

A "Command Modifier" is a code that selects one from a subset of variations on the command specified by bits 15-12. For those commands using the "Command Modifier" format, Tables 6, 7, 8, 9 and 12 of the CDC ESDI Interface Spec show the command subsets the command modifier bit codes (bits 11-8) specify.

Command Parameter Type

The description of each command using the Command Parameter format (paragraph 5.1.5.6 of the ESDI Interface Spec) gives a description of the parameter values expected in bits 11-0. For example, for the Seek command, bits 11-0 contain the cylinder number to which the drive is commanded to seek.

11.1.2.2 Configuration/Status

Details of the configuration responses possible are given in Section 11.2.1.5. Table 11.2-3 lists Request Configuration command modifiers (bits 11-8) and the configuration information they request. Table 11.2-5 gives more details of this configuration information. Command Modifier Code 0000 requests General Configuration information only as shown in Table 11.2-6. The remaining codes of Table 11.2-5 specify the configuration information to be returned.

Status responses supported by WREN III HH are given in Table 11.2-7. Paragraphs a through n following the table given more details of the specific status represented by each of the 16 bits of status returned.

11.1.3 Read/Write Operations

The protocol for reading from or writing to the media is different than communicating commands and status information. Read/Write data is not transferred using the Transfer Req/Transfer Ack protocol. Following is a general description of Read/Write operations. For details See Sections 5.3 and 5.4 and Figures 18, 20 and 21 of the CDC ESDI Interface Spec.

Following negation of Command Complete after the drive heads have been positioned and the desired head selected, a read or write operation may begin. The host controller monitors the Read Data line from the drive to search for the selected sector to read to or write from. The way in which the search is made depends on whether soft sector or hard sector operation is used on the drive. These two are discussed in the following paragraphs.

Soft Sector Operation

If the drive is set for soft sector operation (see Figure 12.1-1 and Table 12.1-1), the controller asserts Address Mark Enable without the presence of Write gate or Read Gate to cause the drive to search for Address Marks in the NRZ data being read from the track. When the Address Mark has been found, the drive responds to the host with Address Mark Found.

The drive synchronizes Read Clock with PLO Sync Byte in the data read and host asserts Read Gate at which point Reference Clock becomes the synchronized Read Clock and the reading of information from media commences. When the desired address is read the host continues reading the data or performs a write operation.

Hard Sector Operation

If the drive is set for drive hard sector operation, the host controller searches for Index and Sector pulses from the drive to assess its position then asserts Read Gate when it is ready to read the data stream in order to find sector address information.

When writing is to be performed, the host causes the drive to find the desired sector using one of the above procedures, negates Read Gate, asserts Write Gate, sends Write Clock (created from Reference Clock) and NRZ Write Data to the drive.

11.2 INTERFACE SIGNAL DESCRIPTION

Figure 11.2-1 shows the names and pinouts of the signals on the two interface cables. The detailed descriptions of these signals are divided into functional groups as follows:

- 11.2.1 Control Input Lines (inputs to the drive)
- 11.2.2 Control Output Lines (outputs from the drive)
- 11.2.3 Data Transfer Lines.

Defect handling by WREN III HH is described in Section 11.2.4.

11.2.1 CONTROL INPUT LINES

11.2.1.1 Drive Select

Refer to ESDI Specification Section 5.1.1.

The following characteristics apply to the Drive Select lines:

1. Logical unit designation for up to 7 drives is performed during installation by installing jumpers on pins on a connector header on the main PWA as shown in Figure 11.2-3 of this specification. The jumpers are installed in a binary coded configuration to select device address 1 through 7. Zero is not a valid address.
2. The controller shall not attempt to select the drive until 1 second after DC power is applied. The Ready output will be valid (whether asserted or negated) within 1 us after the drive is selected. Refer to Fig. 11.2-2.
3. The drive will be selected (and the Drive Selected Signal asserted) within 1 us after the Drive Select lines contain that unit's select address. The drive will be deselected (and the Drive Selected signal negated) within 1 us after the Drive Select lines contain another unit's select address.
4. The Drive Select lines must remain asserted for 1 us after a write operation.
5. When the Drive Select lines are asserted, a head change will occur per Section 11.2.2 requiring a delay before a read or write operation can be initiated. Refer to Figure 11.2-2.

11.2.1.1 (continued)

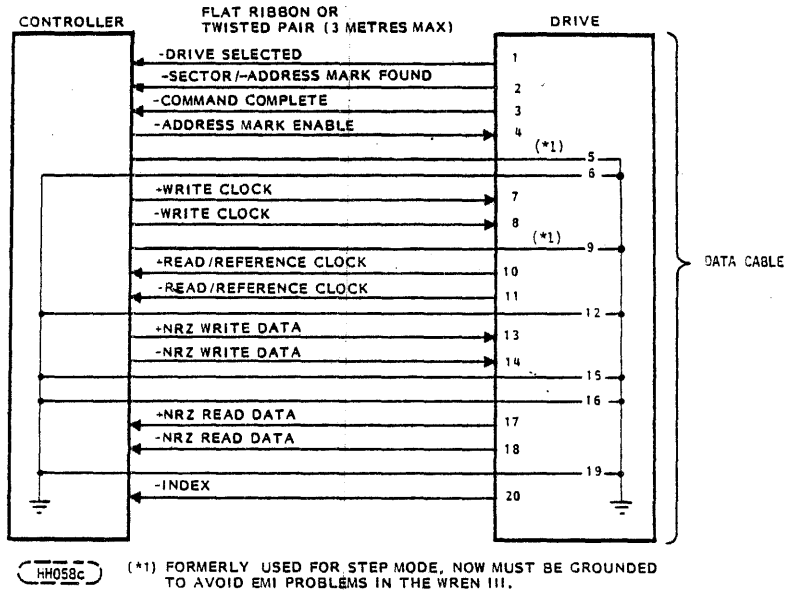
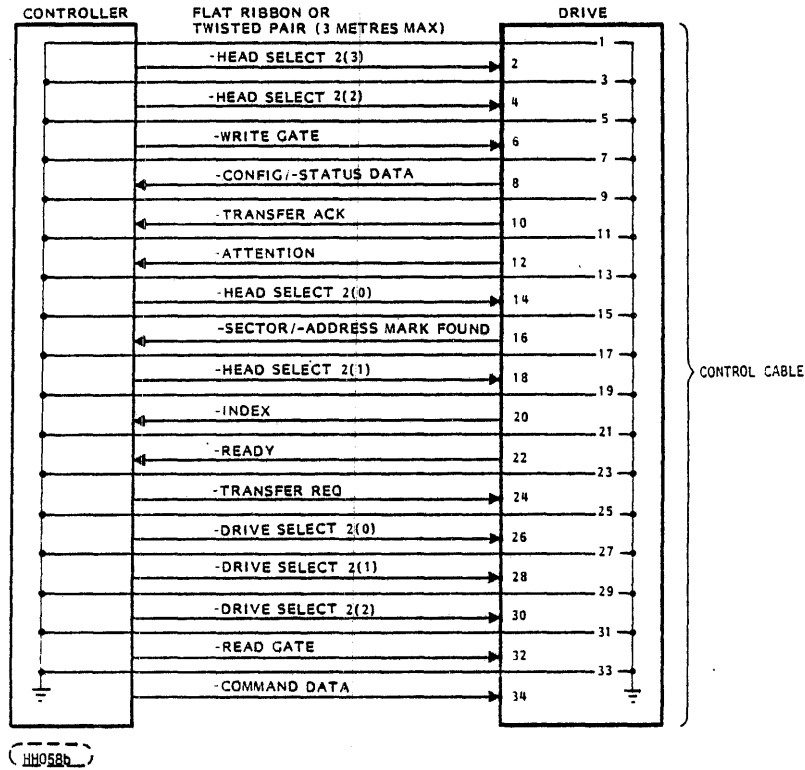


FIGURE 11.2-1. ESDI INTERFACE PINOUTS

11.2.1.1 (continued)

Install the drive select jumper(s) for the desired logical unit address. Refer to Figure 10.3-1 for location of unit select header. The logical address is selected by installing the select jumper(s) in the Drive Select header as shown in Figure 11.2-3.

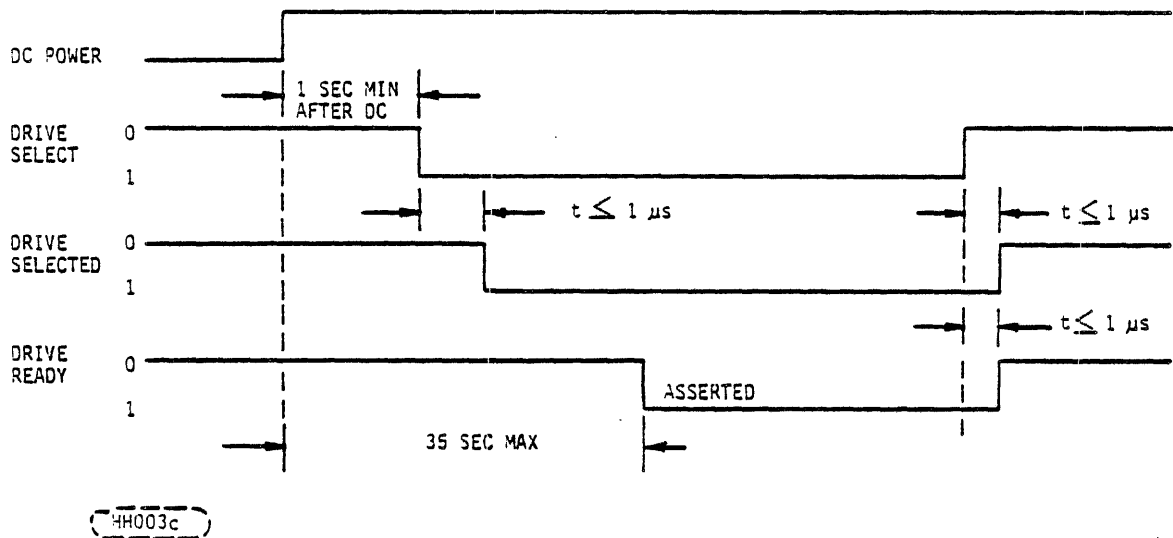


FIGURE 11.2-2. POWER TURN ON AND DRIVE SELECTION

11.2.1.2 Head Select 2(0), 2(1) and 2(2).

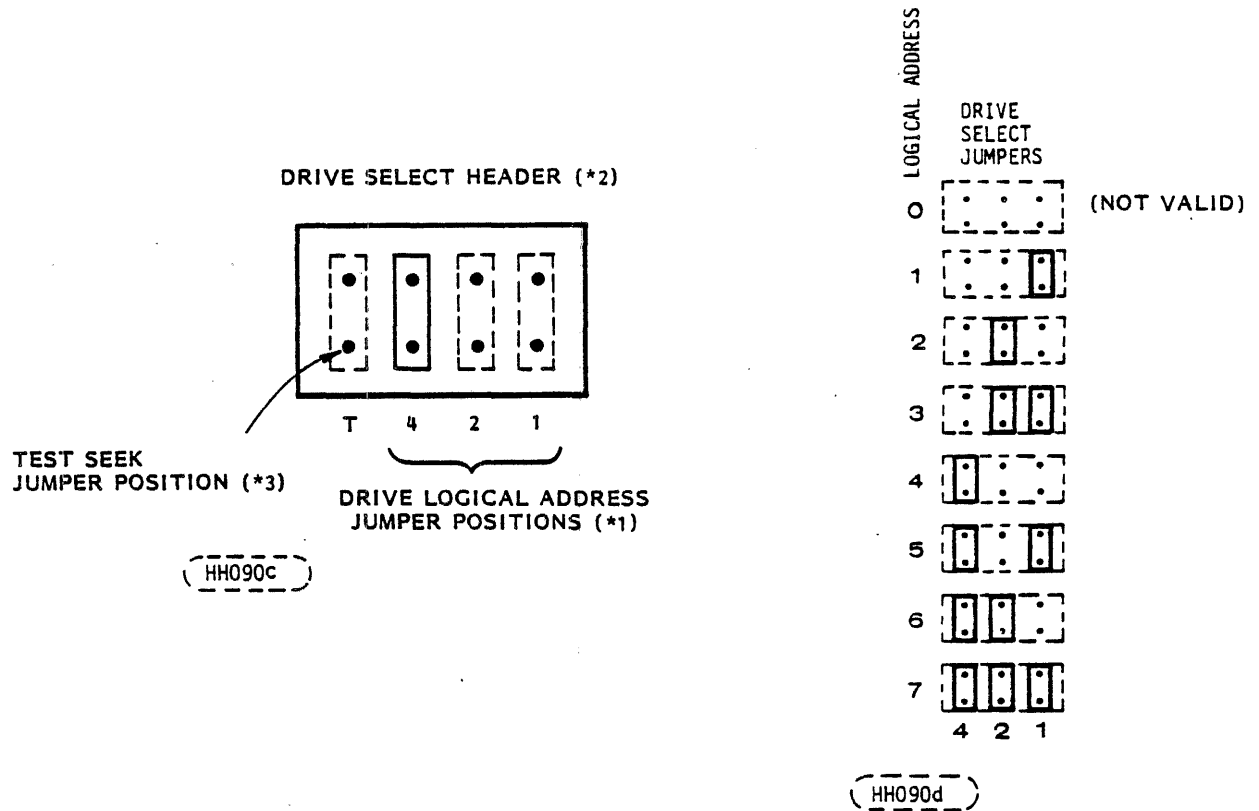
Refer to ESDI Specification Section 5.1.2.

These lines select the proper media and head for data transfer. See Table 11.2-1.

Head selection may be changed at any time following assertion of Drive Select, but must occur a minimum of 5 us before a write operation. Write Gate must be negated a minimum of 1 us before a head change. Read Data will be valid within 10 ns from a head selection (change) if the drive is selected, Read Gate is asserted, the Drive Ready line is asserted, the Command Complete line is asserted, and a PLO Sync field is present.

Neither the Drive Ready line nor the Command Complete line will change as a result of a head selection (change).

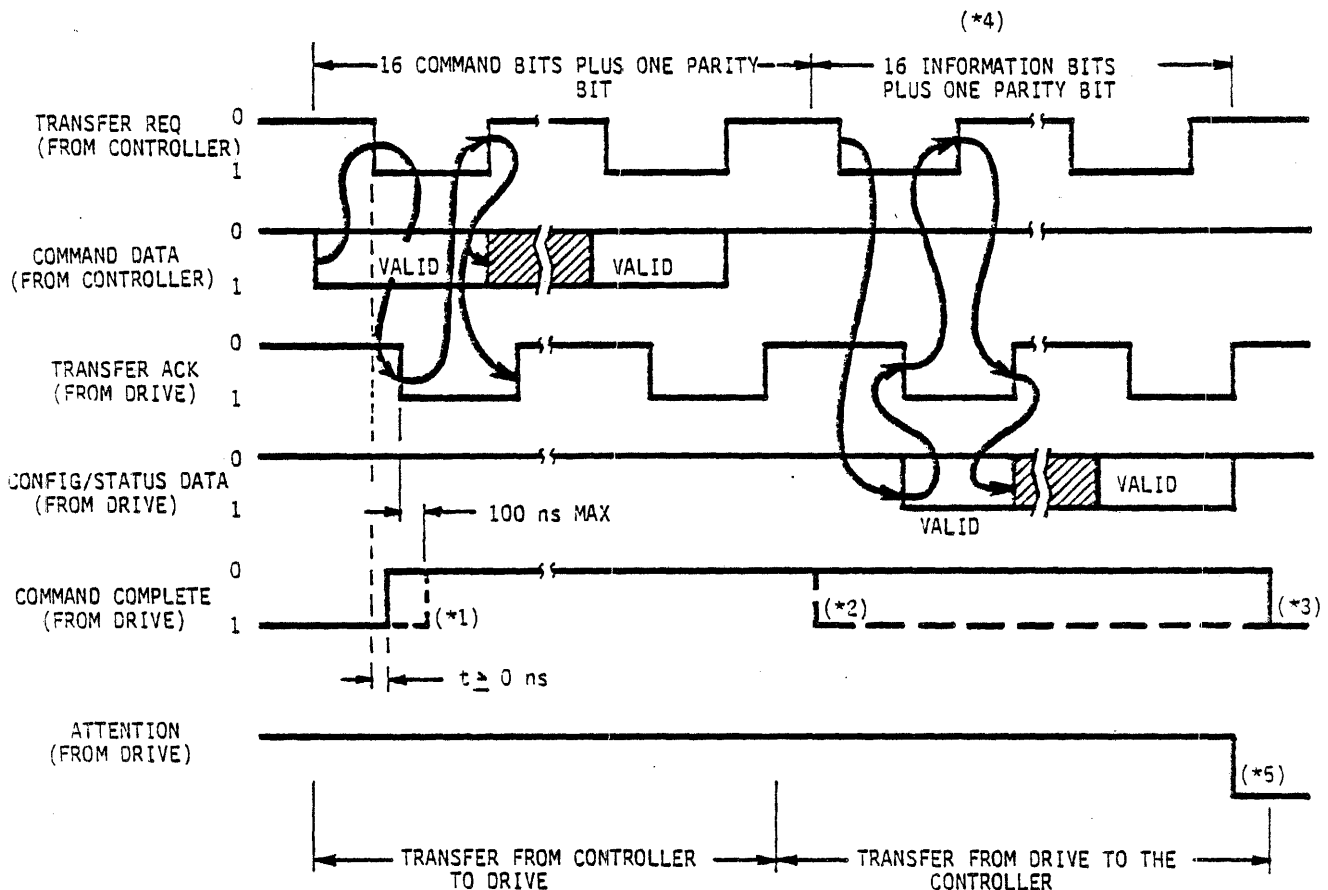
11.2.1.2 (continued)



- (*1) Drive ID is binary coded by jumper position (most significant bit on left), ie., jumper in position 4 (as shown) would be Drive Logical Address 4, no jumpers means Logical Address 0, which is not a Valid Address in the ESDI System. All possible jumper positions/Logical Addresses are shown in the left part of the figure.
- (*2) See Figure 10.3-1 for location.
- (*3) Jumper must not be installed during normal operation.

FIGURE 11.2-3. WREN III HH ESDI DRIVE LOGICAL ADDRESS AND TEST SEEK SELECT HEADER

11.2.1.2 (continued)



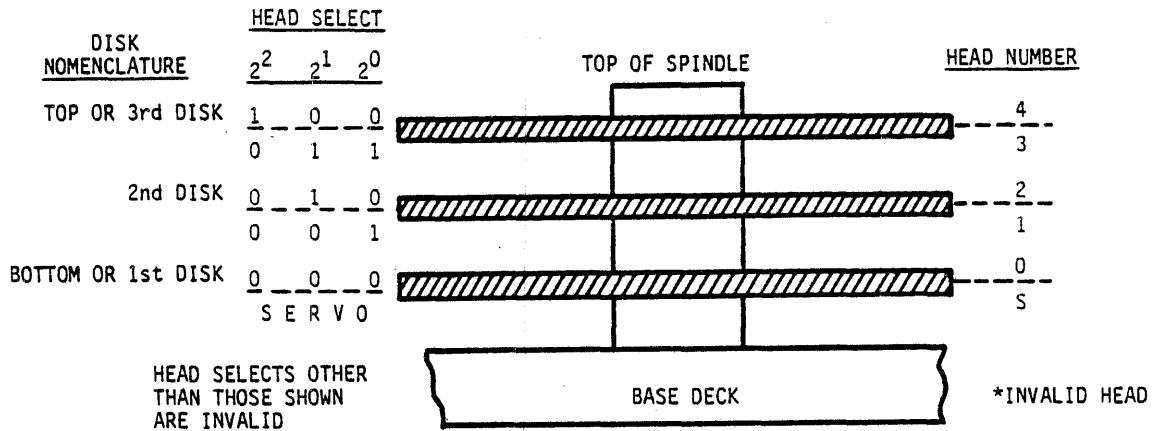
- (*1) COMMAND COMPLETE IS NEGATED FOR ALL COMMANDS TO THE DRIVE.
- (*2) COMMAND COMPLETE IS ASSERTED TO SIGNIFY COMPLETION OF EXECUTION OF A COMMAND. APPLICABLE FOR ALL COMMANDS.
- (*3) COMMAND COMPLETE IS ASSERTED TO SIGNIFY COMPLETION OF THE REQUESTED CONFIGURATION/STATUS TRANSFER.
- (*4) APPLICABLE FOR ALL REQUEST STATUS AND CONFIGURATION COMMANDS.
- (*5) IF AN ERROR WAS ENCOUNTERED DURING THE CURRENT COMMAND, ATTENTION MUST BE ASSERTED AT LEAST 100 ns BEFORE COMMAND COMPLETE IS ASSERTED.

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FIGURE 11.2-4. TYPICAL SERIAL OPERATION(S)

11.2.1.2 (continued)

TABLE 11.2-1. HEAD SELECT ENCODING



H060c

11.2.1.3 Write Gate

Refer to ESDI Specification Section 5.1.3.

11.2.1.4 Read Gate

Refer to ESDI Specification Section 5.1.4.

11.2.1.5 Command Data

Refer to ESDI Specification Section 5.1.5. (Figure 12a)

The WREN III HH responds with Transfer ACK in typically 2 us from either edge of Transfer REQ. This promotes significantly improved performance over the allowed 10 ms and should be recognized.

Command Data Bits 15 thru 12 decode into the ESDI command set. Refer to ESDI Specification Section 5.1.5.1. The 94216 WREN III HH implementation of the ESDI command set is summarized in the following table. Any ESDI command not implemented will be treated as an Invalid Command. A command transfer attempt to the drive should not be initiated until the Command Complete line from the drive is asserted just before the transfer.

11.2.1.5 (continued)

TABLE 11.2-2. SERIAL MODE COMMAND SET IMPLEMENTED

<u>SERIAL MODE COMMAND</u>	<u>IMPLEMENTED BY WREN III HH</u>
<u>Bits 15-12</u>	
(0000) SEEK	YES
(0001) RECALIBRATE	YES
(0010) REQUEST STATUS	
-STANDARD	YES
-VENDOR UNIQUE	YES
(0011) REQUEST CONFIGURATION	YES
(0100) SELECT HEAD GROUP	NO
(0101) CONTROL	
-RESET ATTENTION AND STANDARD	
STATUS 0-11	YES
-STOP MOTOR	NO
-START MOTOR	YES
(0110) DATA STROBE OFFSET - 3 LEVELS/ ONE PHYSICAL OFFSET	YES
(0111) TRACK OFFSET - 3 LEVELS/ THREE PHYSICAL OFFSETS	YES
(1000) INITIATE DIAGNOSTICS	YES
(1001) SET BYTES PER SECTOR	YES
(1110) SET CONFIGURATION	YES
(1010 thru 1101 and 1111) INVALID	NO

The following ESDI commands are recognized by the Model 94216 WREN III HH. Additional information not contained in the ESDI specification is included.

SEEK (0000):

The Seek times defined in Section 5.0 of this specification are measured from the time the last bit of the command word is received by the drive. The Command Complete signal line will be asserted when the drive has completed the Seek operation and is ready to accept the next command word or perform read/write operations.

11.2.1.5 (continued)

RECALIBRATE (0001):

The maximum time to complete the Recalibrate function is 100 milliseconds, and is measured from the time the last bit of the command word is received by the drive. The Command Complete signal line will be asserted when the Recalibrate function is completed.

REQUEST STATUS (0010):

I. REQUEST STANDARD STATUS (command modifier equals 0000)

The controller need only request standard status in response to the drive's assertion of the Attention line.

The controller asserts the Command Complete line after it has read the drive's Standard Status Word.

The controller should always first request the Standard Status in response to the assertion of the Attention line. The "Vendor Unique Status Available" bit in the Standard Status Word defines whether or not the Vendor Unique Status words are valid.

See Section 11.2.2.3 for the response to the "Request Status" Command.

II. REQUEST VENDOR UNIQUE STATUS (command modifiers 0001 through 1111)

The Vendor Unique Status consists of up to 15 unique words of status and is valid only if bit 2 of the Standard Status is a one.

This status is intended to be used only by trained field maintenance personnel and is not intended to be interpreted by disk controllers or operating systems. If this bit is detected the controller should attempt to reset Standard Status and reattempt the original function a minimum of three times before defining the drive as inoperative. After the last attempt the Vendor Unique Status words should be read by the controller and sent back to the system for a print out of these codes which may then be used by the field maintenance personnel.

11.2.1.5 (continued)

REQUEST CONFIGURATION (0011):

Configuration data is sent to the controller via the Config-Status line as a result of receiving a "Request Configuration" command. The exact Configuration Word sent is dependent upon the Configuration Word requested by the controller via the Command Modifier Bits. (See Table 11.2-5.)

See Section 11.2.2.3 for the responses to the "Request Configuration" commands listed in Table 11.2-5.

CAUTION

Configuration status cannot be requested until Command Complete is asserted. This occurs 35 seconds after the beginning of power up.

TABLE 11.2-3. SUMMARY OF CONFIGURATION INFORMATION REQUESTED

COMMAND MODIFIER BITS				<u>CONFIGURATION INFORMATION REQUESTED</u>
11	10	9	8	
0	0	0	0	GENERAL CONFIGURATION OF DRIVE AND FORMAT (See Table 11.2-6)
0	0	0	1	NUMBER OF CYLINDERS FIXED
0	0	1	0	NUMBER OF CYLINDERS REMOVABLE
0	0	1	1	NUMBER OF HEADS
0	1	0	0	MINIMUM UNFORMATTED BYTES PER TRACK
0	1	0	1	UNFORMATTED BYTES PER SECTOR (HARD SECTOR ONLY)
0	1	1	0	SECTORS PER TRACK (HARD SECTOR ONLY)
0	1	1	1	MINIMUM BYTES IN ISG FIELD
1	0	0	0	MINIMUM BYTES PER PLO SYNC FIELD
1	0	0	1	NUMBER OF WORDS OF VENDOR UNIQUE STATUS AVAILABLE
1	0	1	0	} INVALID CONFIGURATION REQUEST CODES
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	VENDOR IDENTIFICATION

11.2.1.5 (continued)

CONTROL (0101):

Refer to ESDI Specification Section 5.1.5.1.

The WREN III HH will implement the following Control Commands (as specified by the Command Modifier Bits). Any Command Modifier received which is not listed will be treated as an Invalid Command.

- a. Reset Interface Attention and Standard Status bits (Command Modifier 0000)

This command must be sent to reset the interface Attention line and the Standard Status Bits (0-11). This command should not be sent until the controller has read the Standard Status Word to determine what caused the Attention line to be asserted.

- b. Start Motor (Command Modifier 0011)

This command must be sent by the controller to turn on the spindle motor when the "Motor Control Option Implemented" General Configuration bit is asserted (see Sections 11.2.2.3 and 12). This command is not required to turn on the spindle motor if the "Motor Control Option Implemented" configuration bit is negated, and will be treated as an Invalid Command.

The interface Command Complete line will be asserted when the Control Command has been executed.

NOTE

If the "Motor Start" option is implemented (see Section 12.1), only the following five commands (Table 11.2-4) are recognized as valid before the Motor Start command is issued (i.e., while the "Spindle Motor Stopped" bit is set in the Standard Status word - see Section 11.2.2.3).

TABLE 11.2-4. COMMANDS RECOGNIZABLE BEFORE "MOTOR START"

<u>COMMAND</u>	<u>COMMAND CODE</u> (Bits 15-0)
Request Standard Status	2000H
Request Vendor Unique Status	2100H - 2F00H
Request General Configuration	3000H
Reset Interface Attention	5000H
Start Spindle Motor	5300H

Any other commands will cause Attention to be asserted and an Invalid Command Status returned.

DATA STROBE OFFSET (0110): The drive will accept all of the Data Strobe Offset Commands but will offset from nominal by only a single amount.

11.2.1.5 (continued)

TRACK OFFSET (0111):-The drive will accept all of the Track Offset Commands and can execute three physical offset levels. This command may require up to 3 milliseconds for command execution after the command word has been received.

INITIATE DIAGNOSTICS (1000):-The drive will accept this command. If an error state exists in the drive, the Attention signal will be asserted when the Command Complete signal is asserted to signify that status is available.

If no error state exists in the drive, the Command Complete signal will be asserted and the Attention signal will not be asserted.

SET UNFORMATTED BYTES PER SECTOR (1001):-All zeros in bits 0 through 11 is an invalid parameter. The maximum value in bits 0 thru 11 is 4,095 (decimal). The minimum value is 82 (decimal).

COMMAND DATA CODES 1010 THROUGH 1101 AND 1111:-These codes are invalid Command codes.

Codes 1010, 1011, 1100, 1101 AND 1111 are reserved for use by the WREN III HH. If these commands are used by the Controller, the interface Attention line will be asserted and an Invalid Command Standard Status bit will be asserted.

SET CONFIGURATION (1110)

This command provides a "soft" switch capability such that the controller can override the soft sector/hard sector option jumper plugs 2, 3, and 4 (paragraph 12.1). After power down/power up, the configuration reverts to that specified by the jumper plugs. The controller can then change the setting with the Set Configuration command. Command format is shown below.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	P
CMD FUNCTION				SOFT SWITCH NO.				SOFT SWITCH PARAMETER								
1	1	1	0	0	0	0	1	xxxx xx01 = Set Soft Sector								
								xxxx xx10 = Set Hard Sector								

11.2.1.6 Transfer Request

Refer to ESDI Specification Section 5.1.6.

11.2.1.7 Address Mark Enable

Refer to ESDI Specification Section 5.1.7.

NOTE: In the fixed sector mode, Address Mark Enable does not cause an Address Mark to be written on the media. The trailing edge of Address Mark Enable with Write Gate asserted initiates the writing of the header PLO sync field.

11.2.2 CONTROL OUTPUT LINES

11.2.2.1 Drive Selected

Refer to ESDI Specification Section 5.2.1. and Section 11.2.1.1 of this specification.

11.2.2.2 Ready

Refer to ESDI Specification Section 5.2.2.

11.2.2.3 Config/Status Data

a. Configuration Response Bits

In response to the "Request Configuration" command (see Section 11.2.1.5) 16 bits of configuration information is returned to the controller. The Command Modifier bit code (Bits 11-8) selects the specific configuration information to be returned.

TABLE 11.2-5. CONFIGURATION RESPONSE BITS

COMMAND MODIFIER BITS (11-8)	CONFIGURATION RESPONSES
0000	General configuration status information shown in Table 11.2-6 is returned.

11.2.2.3 (continued)

TABLE 11.2-5. (continued)

COMMAND MODIFIER BITS (11-8)	<u>CONFIGURATION RESPONSES</u>
0001	Number of Cylinders, Fixed - Value returned equals the maximum number of drive cylinders.
0010	Number of Cylinders, Removable - Value returned is 0 to signify no removable media.
0011	Number of Heads - Value returned in bits 15-8 is 0 to signify no removable media is present. Value returned in bits 7-0 (in decimal) is either 5, 7 or 9 and is determined by the number of R/W heads installed (i.e., model number).
0100	Minimum Unformatted Bytes per Track. Value returned is 20,880 (decimal).
0101	Unformatted Bytes per Sector. The Value will be the Integer value of 20,880 (decimal) divided by the number of Sectors per Track (see following command modifier code 0110).
0110	Sectors per Track. The default value is determined by switch settings at the time of installation (see Section 12.0). The Default value may be overridden by the Set Bytes per Sector command. See also "Set Bytes per Sector" command which results in a value of integer 20,880 divided by desired number of bytes per sector.
0111	Minimum Bytes in ISG Field Value returned in bits 15-8: 12 (decimal). Value returned in bits 7-0: 16 (decimal)
1000	Minimum Bytes per PLO Sync Field Value returned in bits 15-8: 0 Value returned in bits 3-0: 11 (decimal)
1001	Maximum number of vendor unique status words available. Value returned is 15 (decimal).
1010 thru 1110	Invalid command modifier codes when part of "Request Configuration" command.
1111	Vendor Identification

11.2.2.3 (continued)

TABLE 11.2-6. DRIVE GENERAL CONFIGURATION RESPONSE

CONFIGURATION BIT	FUNCTION	WREN III VALUE
15	NOT A MAGNETIC DISK DRIVE	0
14	FORMAT SPEED TOLERANCE GAP REQUIRED	0 (*1)
13	TRACK OFFSET OPTION AVAILABLE	1
12	DATA STROBE OFFSET OPTION AVAILABLE	1
11	ROTATIONAL SPEED TOLERANCE IS > 0.5%	0
10	TRANSFER RATE > 10 MHz	0
9	TRANSFER RATE > 5 MHz ≤ 10 MHz	1 (*2)
8	TRANSFER RATE ≤ 5 MHz	0
7	REMOVABLE CARTRIDGE DRIVE	0
6	FIXED DRIVE	1
5	MOTOR CONTROL OPTION IMPLEMENTED	1 OR 0 (*6)
4	HEAD SWITCH TIME > 15 μs	0 (*3)
3	NOT MFM	1 (*5)
2	CONTROLLER SOFT SECTORED (ADR MARK)	0 OR 1
1	DRIVE HARD SECTORED (SECTOR PULSES)	1 OR 0 } (*4)
0	CONTROLLER HARD SECTORED (BYTE CLK)	0

(*1) THE ZERO INDICATES THAT NO SPEED TOLERANCE GAPS ARE REQUIRED (EITHER BETWEEN SECTORS OR AT THE END OF A TRACK) IN THE WREN FORMAT.

(*2) SEE SECTION 5.0 OF THIS SPECIFICATION FOR EXACT VALUE.

(*3) THE ZERO INDICATES THAT THE HEAD SWITCH TIME IS LESS THAN 15 MICROSECONDS AND THAT THE COMMAND COMPLETE LINE WILL NOT BE NEGATED WHEN A HEAD CHANGE IS PERFORMED BY THE DRIVE.

(*4) THE APPROPRIATE BIT WILL BE ASSERTED TO INDICATE THE SIGNAL WHICH IS CURRENTLY BEING TRANSMITTED ON THE SECTOR/ADDRESS MARK FOUND SIGNAL LINES IN THE INTERFACE. THESE ARE SWITCH SELECTABLE (SEE SECTION 12.0).

(*5) INTERNAL RECORDING MECHANISM IS RLL. DRIVE REQUIRES ZEROS FOR THE PLO SYNC FIELD.

(*6) SWITCH SELECTABLE (SEE SECTION 12).

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B. Status Response Bits

In response to the "Request Status" command (see Section 11.1.5.1) 16 bits of status information is returned to the controller.

The WREN III HH will support the following standard status bits as referenced in the ESDI Specification Section 5.2.3.2.

TABLE 11.2-7. SERIAL MODE STANDARD STATUS BITS SUPPORTED

<u>Bit(s)</u>	<u>Function</u>	<u>WREN III HH Supported</u>
15, 11, 10	RESERVED AND WILL BE ZERO	YES
14	REMOVABLE MEDIA NOT PRESENT	NA (=0)
13	WRITE PROTECTED, REMOVABLE MEDIA	NO (=0)
12	WRITE PROTECTED, FIXED MEDIA	NO (=0)
9	SPINDLE MOTOR STOPPED	YES
8	POWER ON RESET CONDITIONS EXIST	YES
7	COMMAND DATA PARITY FAULT	YES
6	INTERFACE FAULT	YES
5	INVALID OR UNIMPLEMENTED COMMAND FAULT	YES
4	SEEK FAULT	YES
3	WRITE GATE WITH TRACK OFFSET FAULT	YES
2	VENDOR UNIQUE STATUS AVAILABLE	YES
1	WRITE FAULT	YES
0	REMOVABLE MEDIA CHANGED	NA (=0)

11.2.2.3 (continued)

The individual standard status bit definitions are defined as follows:

- a. Reserved - (Bits 15, 11, and 10)
These bits are reserved and will be zero.
- b. Removable Media Not Present (Bit 14)
This bit will always be a 0 for the WREN III HH drive. The WREN contains only fixed media.
- c. Write Protected, Removable Media (Bit 13)
This bit will always be zero for the WREN III HH drives.
- d. Write Protected, Fixed Media (Bit 12)
This bit will always be zero for the WREN III HH drives.
- e. Spindle Motor Stopped (Bit 9)
This bit is asserted when the spindle motor is stopped. (See also Section 12.)
- f. Power On Reset Conditions Exist (Bit 8)
This bit is asserted after a Power On Reset occurs or when an internal drive fault condition occurs which would cause an internal Power On Reset operation to occur (e.g., a momentary loss of a DC voltage, etc). This bit is intended to notify the controller that the drive has reinitialized itself for the default drive characteristics (e.g., default Number of Bytes Per Sector, etc.). The controller should read the configuration words to determine if the default drive characteristics are the desired operating conditions and/or send the required commands to the drive to set up the desired drive operating conditions. (See also Section 12 if the "Spindle Motor Control Option Implemented" is selected.)
- g. Command Data Parity Fault (Bit 7)
This bit will be asserted when a parity error is detected on the Serial Command Data received from the controller. The drive will not attempt execution of a command if a parity error is detected. The controller should reset the Standard Status and attempt to send the original command to the drive at least 3 times before defining the drive as inoperable.

11.2.2.3 (continued)

h. Interface Fault (Bit 6)

This bit will be asserted when an interface protocol violation is detected by the drive. This bit will be asserted when either the Command Word or Configuration/Status word I/O handshake protocol is violated (e.g., 10 ms handshake response limit is exceeded).

A command transfer attempt should not be initiated if the drive's Command Complete interface line is negated.

i. Invalid or Unimplemented Command Fault (Bit 5)

This bit is asserted when any of the following conditions are detected by the drive:

1. A Command Function (bits 15, 14, 13, and 12 of the command word) defined as reserved in the ESDI specification is received.
2. A Command Function plus Command Modifier defined as reserved in the ESDI specification is received.
3. A legal ESDI command which is not implemented by the drive is received.
4. A legal ESDI command with an invalid command parameter is received (e.g., illegal seek address, etc.).

j. Seek Fault (Bit 4)

This bit is asserted when the drive detects a problem with its actuator electronics or mechanism(s). This bit is asserted when the drive is unable to maintain the Read/Write heads within the recording zone of the media.

If the Seek Fault bit is asserted the controller should attempt to Reset the Standard Status, send a RTZ command and reissue the Seek command a minimum of three times before defining the drive as inoperable.

NOTE

It is the controller's responsibility to verify that a Seek Command resulted in an actuator movement to the desired physical track.

11.2.2.3 (continued)

- k. Write Gate With Track Offset Fault (Bit 3)
This bit is asserted when the drive actuator is offset from the normal On Cylinder location and the controller asserts the Write Gate signal. Writing to the drive media will be inhibited. If this bit (bit 3) is asserted the controller should return the actuator to zero offset, reset Standard Status and then reattempt the write function.
- l. Vendor Unique Status Available (Bit 2)
This bit is asserted to indicate that additional Vendor Unique Status is available in the Vendor Unique Status word(s).
- m. Write Fault (Bit 1)
This bit is asserted to indicate a Write Fault condition has occurred in the drive and further writing will be inhibited until the fault is cleared.

NOTE

The interface Attention signal will be asserted in real time when the Write Fault condition is detected. The controller should inhibit writing as soon as the Attention is detected to enable the controller to ascertain on which sector the write fault occurred.

The following conditions will create a write fault:

1. Write current in a head without Write Gate Asserted or no write current with Write Gate Asserted and Drive Selected.
2. Write Gate asserted and multiple heads selected, no head selected or heads improperly selected.
3. Write Gate and the head not "On Cylinder".
4. Write Gate and Read Gate both asserted.
5. Write Gate and power supply voltages not within tolerance.

11.2.2.3 (continued)

The controller should attempt to reset the Write Fault at least three times before defining a drive as inoperable.

- n. Removable Media Changed (Bit 0)
This bit will always be zero for the WREN III HH drives.

11.2.2.4 Transfer Ack: Refer to ESDI Specification Section 5.2.4.

11.2.2.5 Attention: Refer to ESDI Specification Section 5.2.5.

11.2.2.6 Index

This signal occurs once per revolution or 16.68 ms nominal. The asserted pulse width is 16 times the reference clock period or 1.596 us, $\pm 1.0\%$.

Refer to ESDI Specification Section 5.2.6 and Section 5.0 of this document.

11.2.2.7 Sector/Byte Clock/Address Mark Found

The WREN III HH supports the controller soft sector (ADR Mark) and drive hard sector (Sector Pulses) format modes. Refer to Section 12.0 for configuration information, and to ESDI Specification Section 5.2.7 and Section 5.0 of this document.

A. Sector (Drive Hard Sector)

Refer to ESDI Specification section 5.2.7.1. The Sector Pulse asserted pulse width is 16 times the reference clock period or 1.596 us $\pm 1.0\%$.

B. Byte Clock

Not supported by the WREN III HH.

C. Address Mark Found (Controller Soft Sector)

Refer to ESDI Specification section 5.2.7.3.

11.2.2.8 Command Complete

Refer to ESDI Specification Section 5.2.8.

Command Complete will be asserted (following a negation) in the following cases:

11.2.2.8 (continued)

1. After a drive logic initiated recalibration function has been completed.
2. After a received command has been executed with no detected error (and the heads are on cylinder).
3. After the requested information has been sent to the controller via the Config-Status line.
4. After a Command Transfer or Configuration Status Transfer or command execution has been terminated due to a detected fault condition.

11.2.3 Data Transfer Lines

Refer to ESDI Specification Section 5.3

The nominal data transfer rate is 10.0 MHz which will result in a Read/Write Clock period (T) of 100 ns in Figure 21 of the ESDI Specification.

11.2.4 Read, Write, and Format Parameters

Refer to ESDI Specification Section 5.4 except 5.4.3.5 and 5.4.4.5 which are not applicable. The intersector gap is 16 bytes long and is oriented to begin four bytes before a sector (Index) pulse.

Read propagation delay ranges between 7 and 9 bit times.

Write propagation delay ranges between 4 and 6 bit times.

The PLO Sync Field length is 11 bytes minimum. See also Configuration Data Specifications in Section 11.2.2.3 of this specification.

NOTE

Format Speed Tolerance gaps are not required for the WREN for a Fixed Sector Format (Figure 22 of the ESDI Specification).

ESDI fixed sector drives (e.g. WREN III HH) require that a PLO sync pattern be written prior to each read function boundary (see 5.1.7.2 in the ESDI Spec.). The WREN III HH will automatically write the required sync pattern but the controller must define the point at which the PLO sync pattern is to be written. A header PLO sync field write is initiated by the trailing edge of Address Mark Enable with Write Gate asserted. A header or data PLO sync field write is initiated with the leading edge of Write Gate while Address Mark Enable is negated. The format function initiated by the host must define the point at which the PLO sync pattern is to be written for each address and data field written.

11.2.5 Defects List

The WREN III HH provides media defect information in accordance with the ESDI Specification. Refer to ESDI Specification Section 5.5 for details.

12.0 OPTIONS

All options are either incorporated or packaged at the manufacturing facility.

12.1 DRIVE CONFIGURATION JUMPERS

The WREN III HH is configured by installing or removing jumper plugs from pins on a connector header on the Main PWA, which is accessed through a hole in the chassis as shown in Figure 12.1-1. Table 12.1-1 shows the configurations that can be selected.

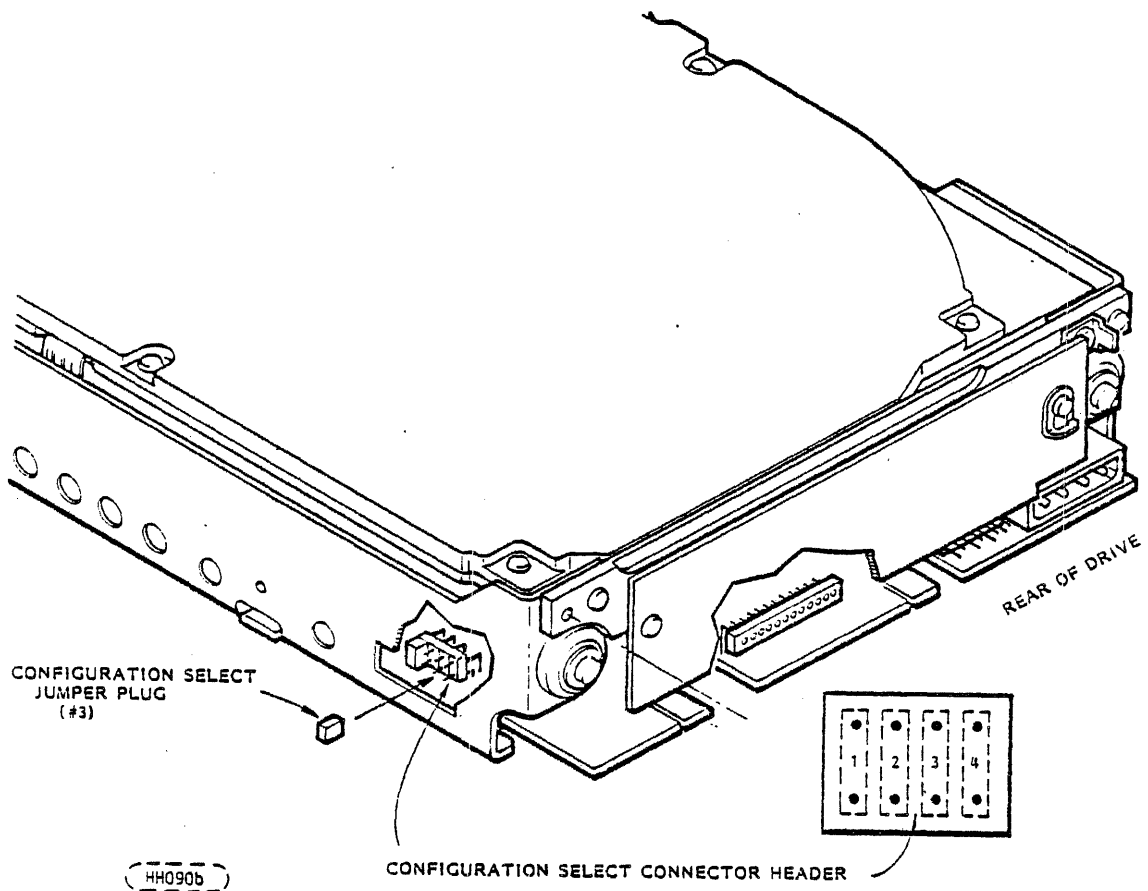


FIGURE 12.1-1. CONFIGURATION SWITCH LOCATIONS

12.1 (continued)

TABLE 12.1-1. WREN III HH CONFIGURATION OPTION SELECTION

<u>JUMPER PURPOSE</u>	<u>JUMPER</u>			<u>OPTION</u>
	<u>PLUG-1</u>	<u>PLUG-2</u>	<u>PLUG-3</u>	<u>PLUG-4</u>
MOTOR OPTION	OFF (1*)			MOTOR START ON PWR UP (2*)
	ON (1*)			MOTOR START WITH CMD (3*)
FIXED SECTOR MODE	OFF	OFF	OFF	64 SECTORS PER TRACK
SELECT AND	OFF	ON	OFF	36 SECTORS PER TRACK
DEFAULT SECTOR	ON	ON	OFF	34 SECTORS PER TRACK (2*)
SIZE	ON	OFF	OFF	35 SECTORS PER TRACK (5*)
	ON	OFF	ON	19 SECTORS PER TRACK (5*)
OR				
ADDRESS MARK	ON	ON	ON	SOFT SECTOR OPERATION (4*)
MODE SELECT				

All Other Jumper Combinations Are Undefined.

(1*) ON - Plug installed; OFF - plug removed

(2*) Drives are shipped with these configurations of installed jumper plugs.

(3*) When the jumper plug-1 is installed, a Motor ON command is required from the controller to start the spindle motor. When power is applied to the drive, the drive will generate an Attention signal and assert Standard Status Bits (Table 11.2-7, section 11.2.2.3) 8 and 9 signifying "Power On Reset Conditions Exist" and "Spindle Motor Stopped". The controller must then respond with a command to Reset the interface Attention line, and the Start Motor command in order to start the spindle motor.

NOTE

This procedure is required anytime the "Power On Reset Condition Exists" status bit is received by the controller if the "Motor Control Implemented" jumper plug is installed.

(4*) See paragraph 12.4.

(5*) 4th Qtr. 1987. Exact date TBD.

12.2 FRONT PANEL

The WREN III HH is available with a black front panel. The panel has a window through which a single red LED shows from its mounting on the Main PWA. The LED, when glowing, indicates the drive is selected. A flashing LED indicates the presence of a nonrecoverable fault. A fault indication is displayed irrespective of Drive Select status.

12.3 CUSTOM FORMATTING

The WREN III HH is formatted during production. CDC maintains custom formatting capability which can incorporate many of the unique formats used in the Winchester marketplace. A majority of special format requirements can be implemented as specified.

12.4 SOFT SECTOR OPTION

The WREN III supports the use of the soft sector format as described in the CDC ESDI Specification, 77738076, Section 5.4.4.

To implement the optional soft sector format operation, select "Address Mark" mode in the WREN III HH by installing option jumper plugs 2, 3, and 4. See Figure 12.1-1 and the table following it.

12.5 SINGLE UNIT SHIPPING PACK

The WREN III HH is normally shipped in bulk packaging to provide maximum protection against transit damage. Units shipped individually require additional protection as provided by the single unit shipping pack. Users planning single unit distribution should specify this option.

13.0 ACCESSORIES

All accessories are designed for implementation by the customer.

13.1 FRONT PANEL KIT

Same as 12.2 but includes all mounting hardware to support field installation.

13.2 SINGLE UNIT SHIPPING PACK KIT

Same as 12.5 except kit provides the necessary packing materials required to package and ship one WREN III HH device to be supplied by the user.

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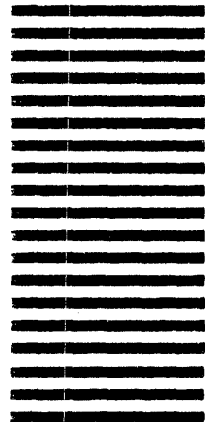
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