

PRODUCT SPECIFICATION
FOR
WREN[™] I DISK DRIVE
MODEL 9415-5

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PRODUCT SPECIFICATION
FOR
WRENTM I DISK DRIVE
MODEL 9415-5

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1.0 SCOPE

This specification describes the Control Data Corporation Model 9415-5 WREN Disk Drive. This 5 1/4-inch member of the rigid disk family utilizes the Seagate Type interface and is available in 21.7 and 36.2 megabyte unformatted capacities. The basic model configurations are 9415-5-21 and 9415-5-36.

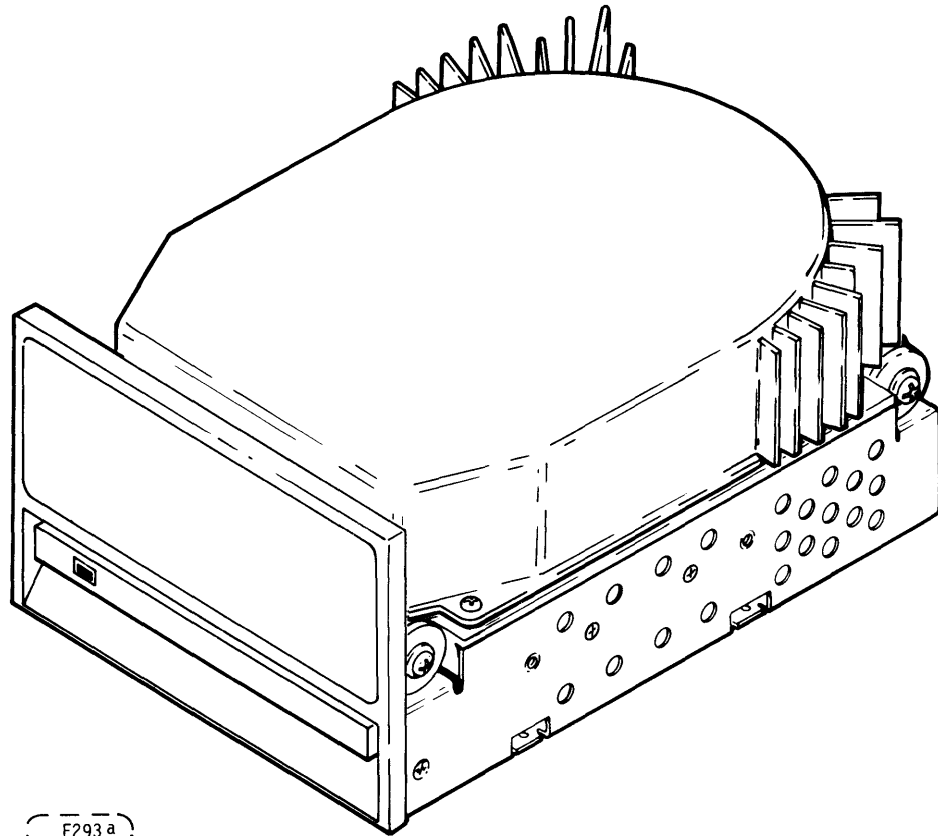


FIGURE 1. THE 9415-5 WREN I

2.0 APPLICABLE DOCUMENTS

2.1 STANDARDS

The 9415-5 WREN I has been developed as a system peripheral to the highest standards of design and construction. The drive, however, must depend upon its host equipment to receive adequate power and environment in order to provide 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 of the device to ensure specified performance and compliance with all applicable regulations.

The 9415-5 WREN I shall comply with CDC standards as noted in the appropriate sections of this specification.

In addition to the CDC standards, the 9415-5 WREN I shall be recognized by UL as a component under UL 478 and be certified by CSA as a component under CSA Standard C22.2 No. 154-1957 and meet the requirements of DIN IEC 380/VDE 0806/8.81.

The 9415-5 WREN I, as delivered, is designed for system integration prior to utilization. As such, the 9415-5 WREN I is supplied as a component and is not subject to standards imposed by FCC Rules and Regulations, Part 15, Subpart J governing EMI of computing devices. However, the 9415-5 WREN I tested as delivered, does comply with Class A of the referenced FCC regulations.

2.2 DOCUMENTATION

The following documentation is available for field support of the 9415-5 WREN I.

- 77715950 OEM Manual
- 77715975 Hardware Maintenance Manual

3.0 GENERAL DESCRIPTION

The WREN I 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.

3.0 Continued

The WREN I is designed to record and recover data on up to three 5 1/4 inch (130 mm) fixed disks; it does not contain removable media capability.

The 9415-5 WREN I interface consists of a 34-pin command interface cable and a 20-pin data interface cable which is compatible with the Seagate Disk Drive interface. The 34-pin command interface is designed to allow daisy-chained or radial connections to 9415-5 WREN I.

The head, disk and actuator chamber (HDA) is environmentally sealed at the factory. Air is recirculated within the HDA and passes through an absolute filter to ensure the maintenance of a contamination-free disk/actuator environment.

Refer to Figure 2 for an exploded view of the WREN I. NEVER disassemble the WREN HDA. This exploded view is for information only. Servicing items in the upper sealed environmental enclosure (heads, media, actuator, etc.) requires special facilities. The printed circuit boards and hardware external to the sealed area may be replaced without special facilities. Any disassembly of this type should be in accordance with the Hardware Maintenance Manual Volume 2.

The WREN I utilizes a dedicated landing zone at the innermost radius of the media thus eliminating the possibility of destroying or degrading data by not landing in the data zone.

The WREN I includes a mechanical shipping lock (40 g's) (Figure 2) that eliminates actuator movement during shipment. An automatic carriage restraint (25 g's) minimizes actuator movement when the device is powered down and during normal handling.

The WREN I decodes Track 0 location from the dedicated servo surface thereby eliminating mechanical transducer adjustment.

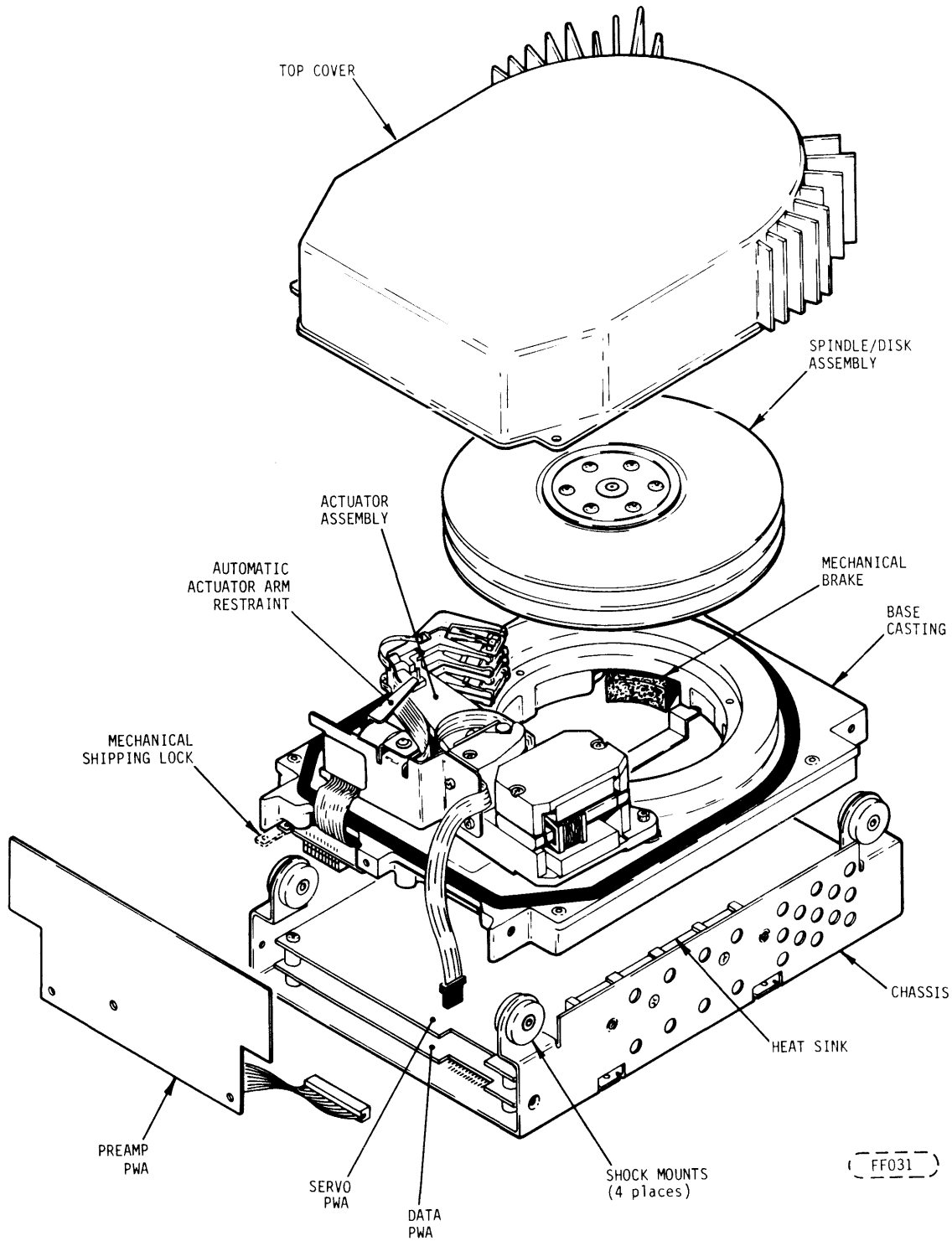


FIGURE 2. 9415-5 WREN I

4.0 FEATURES

4.1 STANDARD FEATURES

- Industry Standard interface
- Multiple capacities
- Sealed head, disk, and actuator chamber
- No preventive maintenance required
- LSI circuitry for high reliability
- Low audible noise for office environments
- Vertical (side) or horizontal (bottom) mounting
- Low power consumption
- Rotary voice coil actuator
- Operator and Installation Guide Level-1
- Mechanical Shipping Lock
- Terminators
- Automatic Actuator Arm Restraint
- Shock mounts
- Dedicated head landing zone
- Spindle brake

4.2 OPTIONAL CONFIGURATIONS

The following optional capacities are available from the factory for the 9415-5 WREN I:

- Model 9415-5-21 21.7 MB
- Model 9415-5-36 36.2 MB

4.3 OPTIONAL ACCESSORIES (See Section 13.0)

The following accessories are available for WREN I.

- Maintenance Manual Volume 2.
- Front Panel Kit.
- WREN I Power Supply.
- Top Mount PWA Adapter

5.0 PERFORMANCE CHARACTERISTICS

9415-5 WREN I Model Capacity (unformatted)

- 9415-5-21 21,779,856 Bytes
2 Disks per Drive
3 Data Surfaces
- 9415-5-36 36,299,760 Bytes
3 Disks per Drive
5 Data Surfaces

Data Capacity Parameters (unformatted)

Bytes/Track	10,416 Bytes
Bytes/Surface	7,259,952 Bytes (Note 1)
Tracks/Surface	697 (Note 2)
Tracks/Inch	800 TPI
Bits/Inch	9,550 BPI

Track Format	
Soft Sectored	User Defined

Recording Mode	MFM Encoded Data
----------------	------------------

Data Transfer Rate	5.0 Megabits/sec (625 Kilobytes/sec)
--------------------	--------------------------------------

Data Interface	MFM Encoded Data
----------------	------------------

Rotational Speed	3600 r/min $\pm 1.0\%$
------------------	------------------------

Average Latency	8.33 ms
-----------------	---------

Step Pulse Rate Maximum	8 μ s between Steps
-------------------------	-------------------------

Step Pulse Rate Minimum	200 μ s between Steps (Note 3)
-------------------------	------------------------------------

Single Track Seek Time	MAXIMUM 9 ms (Note 4) TYPICAL 5 ms
------------------------	---------------------------------------

Average Seek Time(See 5.1.1)

(Step Pulse Rate: Less Than 80 μ s Between Steps)	MAXIMUM 45 ms (Note 4) TYPICAL 40 ms
---	---

5.0 Continued

Maximum Seek Time (697 Tracks) (Step Pulse Rate: Less Than 80 μ s between Steps)	MAXIMUM 90 ms (Note 4) TYPICAL 80 ms
--	---

Note 1: Based on 697 cylinders.

Note 2: See Media Characteristics, paragraph 8.0.

Note 3: See Step pulse description, paragraph 11.1.5.

Note 4: The maximum is specified over the worse 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.

5.1 ACCESS TO DATA CHARACTERISTICS

5.1.1 Seek Time

Seek time is defined as the time required from the receipt of a seek or position command by the WREN I 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 time for all possible movements by the total number of movements.

5.1.2 Spindle Speed and Latency

The spindle speed is 3600 $\pm 1\%$ r/min. The speed tolerance includes motor performance and motor control circuit tolerances.

The average latency time is 8.33 milliseconds, based on a nominal disk speed of 3600 r/min. The maximum latency time is 16.83 milliseconds based on a minimum disk speed of 3564 r/min.

5.2 READ DATA TRANSFER RATE

The nominal read serial data transfer rate is 5.0 Mbits per second.

5.3 START/STOP TIME

The WREN I will become ready less than 35 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 drive.

6.0 RELIABILITY SPECIFICATIONS

The following reliability specifications assume correct host/drive operational interface has been implemented, including all interface timings, power supply voltages, environmental conditions, and appropriate data-handling circuits in the host system.

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	Mature MTBF = 15,000 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. That the WREN I is operated per this specification utilizing the CDC provided accessory power supply or its equivalent.
- b. That a data format is employed fulfilling the requirements of the WREN I as outlined in Section 12.0.

6.1 Continued

- c. That errors caused by media defects or host system failures are excluded from error rate computation. Refer to paragraph 8.0, Media Defect Recognition.
- d. That all read/write operations are accomplished with the same physical orientation of the drive. (Refer to paragraph 7.5.1.)
- e. Writing is performed using Write Precompensation. (Refer to paragraph 11.3.1.)
- f. That the WREN I is operated using adequate data recovery/Phase Lock Oscillator (PLO) design supplied by the user.

6.1.1 Read Errors

Prior to the determination of 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 reread correctly in 2 sets of 10 retries. After 10 retries, a recalibrate (RTZ) and seek to desired address 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 after 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.

6.1.2 Environmental Interference

When operating at low effective data transfer rate, (that is, random access of single short records) the effective error rate may be expected to exceed the specified limits due to environmental interference. Excluding environmental interference, the recoverable read error rate shall be no more than one error in eight hours of operation.

When evaluating systems operation under conditions of EMI the performance of the WREN I within the system shall be considered acceptable if the device does not generate an unrecoverable error, or incur an unrecoverable condition.

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

1. Is not detected and corrected by the device itself;
2. Or is not capable of being detected from the error or fault status provided through the device/system interface;
3. Or is not capable of being recovered by normal device 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. As such, 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 I, the error is classified as a failure affecting MTBF. Unrecoverable write errors are those which cannot be corrected within four attempts at writing the record with a read verify after each attempt, (excluding identified media defects).

6.1.4 Seek Errors

A seek error is defined as a condition where the drive fails to position the heads to the addressed track provided the correct stepping information has been presented to the WREN I. 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. Unrecoverable seek errors are classified as failures for MTBF calculations.

6.2 RELIABILITY AND SERVICE

6.2.1 Mean Time Between Failure

The Mature Mean Time Between Failure (MTBF) shall exceed 15,000 hours for the 9415-5 WREN I. MTBF is further defined as the "Operating Hours" divided by the "Number of Equipment Failures".

"Operating Hours" means total power on hours less any maintenance time. "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, controller failure, cable failure, or other failure not caused by equipment. To establish a meaningful MTBF, operation hours must be greater than an average of 5200 hours per drive and shall include field performance data from all field sites.

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 9415-5 WREN 1 shall have a useful service life of five years or 30,000 hours, whichever occurs first, before requiring factory overhaul. Depot repair or replacement of major parts will be permitted during the lifetime (6.2.4).

6.2.4 Service Philosophy

Due to the sophisticated design and special equipment required to repair the WREN I HDA, repairs may only be effected at a properly equipped and staffed depot service and repair facility. Although WREN 1 is designed for depot repair service, some items may be replaced in the field as defined in the Volume 2 Maintenance Manual.

6.2.5 Installation

The WREN I is designed, manufactured, and tested with a "Plug-in and Play" installation philosophy. Basically, this philosophy minimizes the requirements for highly trained personnel to integrate a WREN I into the OEM's system, whether in a factory or field environment. An Operator and Installation Guide is provided to facilitate installation.

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 1 precludes the necessity for special tools. Should field repair of items external to the HDA be desired, two sizes of 6 point TORX drivers are required. They may be ordered through CDC by the following part numbers;

- PN 1226 3628 - T9
- PN 1226 3629 - T15

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 I are shown in the following table. Values indicated apply at the drive power connector.

TABLE 1. DC POWER REQUIREMENTS

Voltage	+5 VDC	+12 VDC
Regulation	+5%	+5% (2)
Ripple	50 mV	100 mV
Maximum Operating Current (1)	0.9 A	2.2 A
Typical Operating Current (1)	0.7 A	1.8 A
Maximum Starting Current (Peak)	1.4 A	4.5 A

(1) Measured with average reading DC ammeter.
 (2) A 10% tolerance is permissible during power up. The +5% must be maintained commencing with unit Ready.

Note 1: At power-up, the motor current regulator will limit the 12 volt current to a peak value of less than 4.5 amps.

Note 2: Minimum current loading for each supply voltage is not less than 30% of the maximum operating current shown in Table 1.

Note 3: The +5 and +12 volt supplies shall have separate returns.

Note 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 (Refer to Table 1.)

7.2.1 Power Sequencing

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

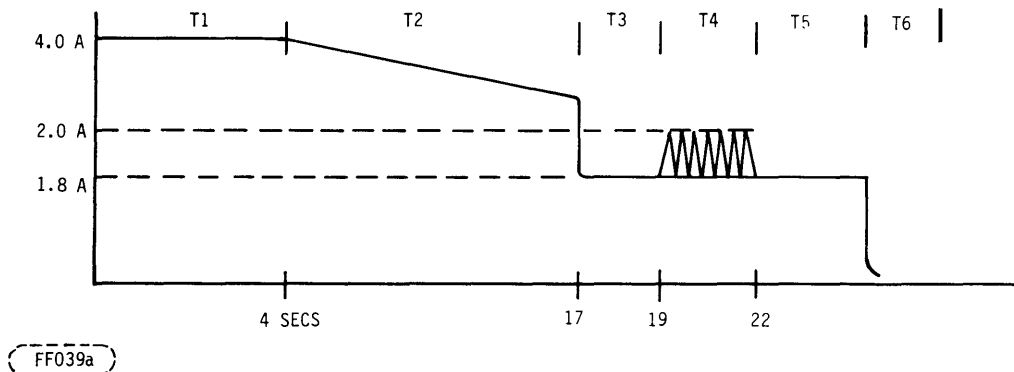
7.2.2 12 V - Current Profile

Figure 3 identifies the WREN I 12 VDC current profile. The current during the various times is as shown:

- T1 Power is initially applied to the drive the spindle brake is released and the spindle begins to accelerate under current limiting.
- T2 The spindle continues to accelerate, but current is less than the current limit.
- T3 The spindle is up to speed (3600 RPM).
- T4 The auto-velocity adjust sequence is performed.
- T5 Velocity is set and the drive is ready for reading and writing.
- T6 Power is removed from the drive.

NOTE

All times and currents are typical. See Table 1 for worst case current requirements.



FF039a
 FIGURE 3. TYPICAL 9415-5 WREN I +12 V CURRENT PROFILE

7.3 HEAT/POWER DISSIPATION

Each WREN I will dissipate no more than 31 watts (108 BTU's per hour) of DC power average. Typical power dissipation under nominal conditions is 25 watts.

7.4 ENVIRONMENTAL LIMITS

Temperatures and humidity specifications preclude condensation on any drive part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7° F (14.8° C).

7.4.1 Temperature

a. Operating

50° to 114.8° F (10° to 46° C) operating ambient with a maximum gradient of 18° F (10° C) per hour. Above 983 feet (300 meters) altitude the maximum temperature is derated linearly to 104° F (40° C) at 6562 feet (2000 meters). Cabinet packaging designs must provide ample air circulation around the WREN I to ensure environmental limits are not exceeded as a result of heat transfer from other system components. The temperature of the base deck should not be allowed to exceed 135° F.

Operating ambient for specification purposes is defined as the environment immediately surrounding the WREN I.

7.4.1 Continued

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 drive is packaged in the shipping container designed by CDC for use with the WREN I.

c. Storage

14° to 122° F (-10° to 50° C) device ambient with a maximum gradient of 27° F (15° C) per hour.

7.4.2 Relative Humidity

a. Operating

20% to 80% relative humidity with a maximum gradient of 10% per hour.

b. Transit

5% to 95% relative humidity.

c. Storage

10% to 90% relative humidity.

7.4.3 Effective Altitude (Sea Level Reference)

a. Operating

-983 to +9,830 feet (-300 to +3000 meters)

b. Transit

-983 to +9,830 feet* (-300 to +3000 meters)

c. Storage

-983 to +9,830 feet (-300 to +3000 meters)

*Suitable for Commercial Air Freight Transportation

7.4.4 Shock and Vibration

Shock and vibration limits specified in this document are measured directly on the drive chassis. If the WREN I 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 I movement in excess of the stated limits. If this situation is apparent, it may be necessary to add shock or isolation mounts to the enclosure to minimize WREN I movement.

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 G at a maximum duration of 10 ms (half sine wave). Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

b. Operating - Abnormal

Equipment, as installed for normal operation, shall not incur non-recoverable errors or exhibit damage while subjected to intermittent shock not exceeding 10 G at a maximum duration of 10 ms (half sine wave). Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second. Operator intervention will not be required. This assumes that normal system recovery routines are available.

c. Non-Operating

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

7.4.4.1 Continued

1. Manual Shipping Lock Not Activated (Unlocked)

Equipment subjected to intermittent shock not exceeding 25 G at a maximum duration of 10 ms (half sine wave) shall not exhibit any form of device damage or performance degradation. Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

2. Manual Shipping Lock Activated (Locked)

Equipment subjected to intermittent shock not exceeding 40 G at a maximum duration of 10 ms (half sine wave) shall not exhibit any form of device damage or performance degradation. Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

d. Packaged

The WREN I as packaged by CDC for van or air freight shipment shall withstand drop test from 48 inches (1219.2 mm) against a concrete floor or equivalent. See Figure 4.

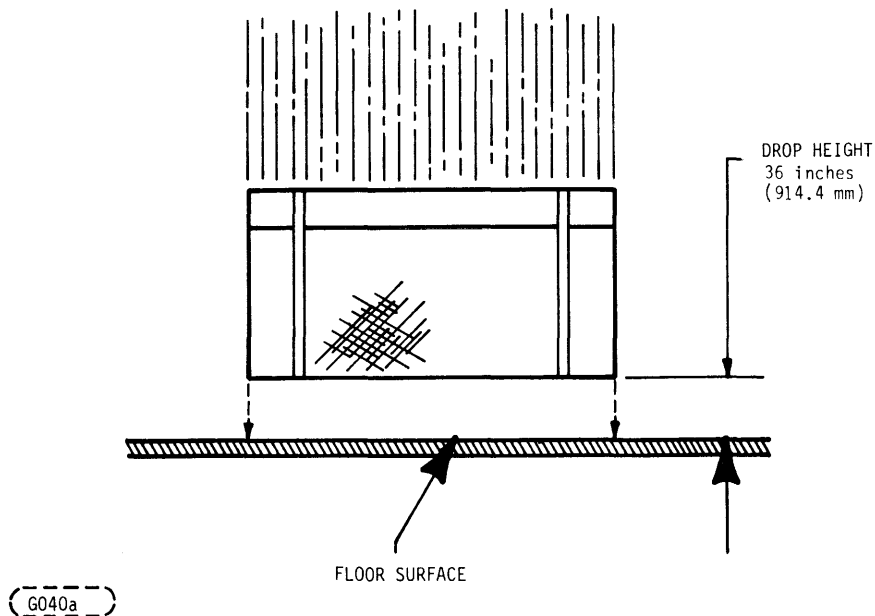


FIGURE 4. FLAT DROP TEST

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 subject 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 without operator intervention 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. Non - Operating

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

1. Manual Shipping Lock Not Activated (Unlocked)

Equipment shall not incur damage or degraded performance as a result of continuous vibration not exceeding

15 minutes of duration at major resonant frequency

5-10 Hz @ 0.010 inches displacement

10-500 Hz @ 0.5 G

Vibration may be applied in the X, Y, or Z axis.

7.4.4.2 Continued

2. Manual Shipping Lock Activated (Locked)

Equipment shall not incur damage or degraded performance as a result of continuous vibration not exceeding
15 minutes of duration at major resonant frequency
5-10 Hz @ 0.020 inches displacement
10-500 Hz @ 1.0 G

7.4.5 Air Cleanliness

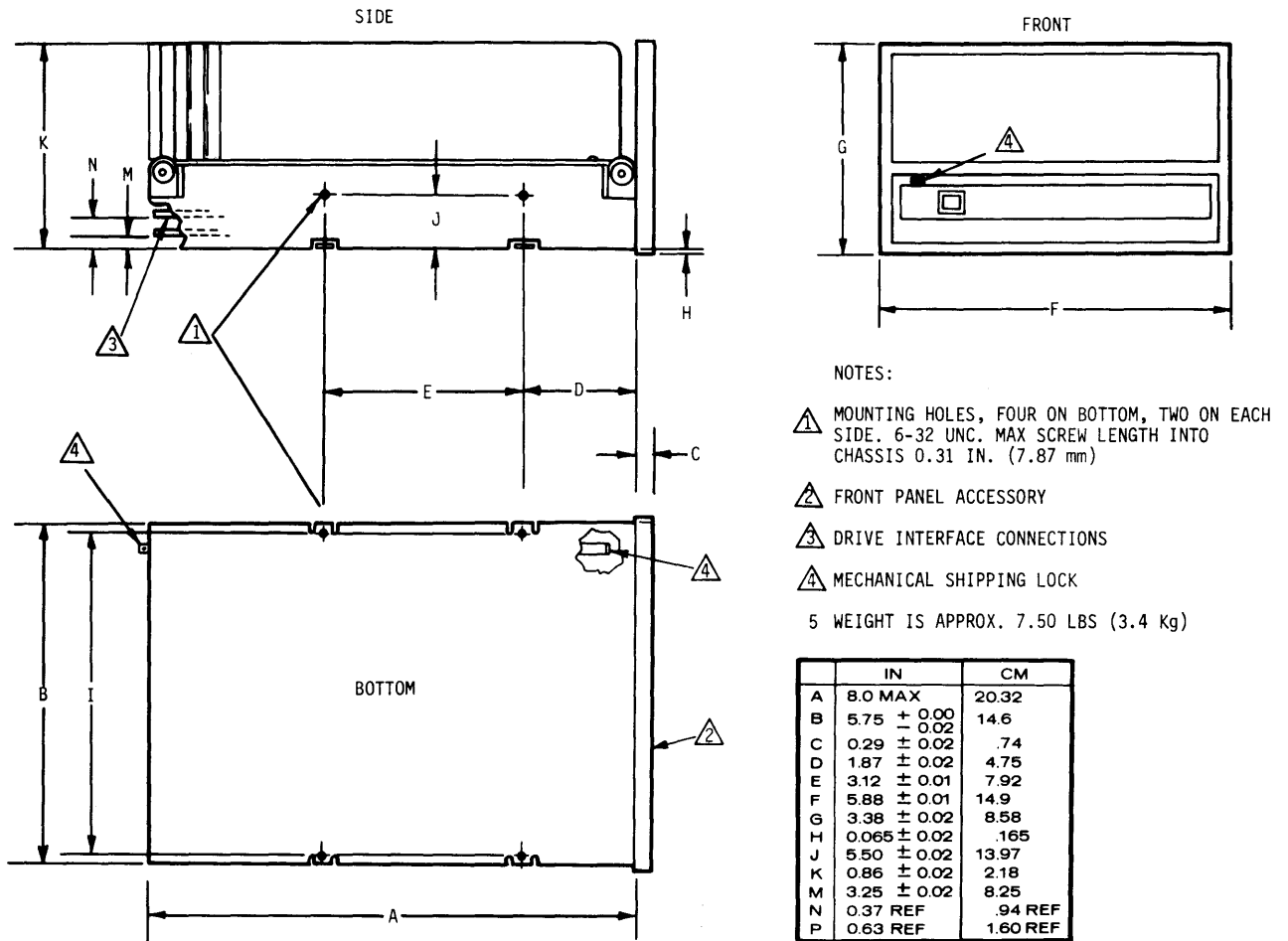
The WREN I is designed to operate in a typical office environment with minimum environmental control.

7.5 MECHANICAL SPECIFICATIONS

The following nominal dimensions are exclusive of the decorative front panel accessory. Refer to Figure 5a for detailed mounting configuration dimensions.

Height:	3.25 inches	82.55 millimeters
Width:	5.75 inches	146.05 millimeters
Depth:	8.0 inches	203.2 millimeters
Weight:	Approximately	Approximately
	7.5 pounds	3.4 kilograms

7.5 Continued



FF036

FIGURE 5a. MOUNTING CONFIGURATION DIMENSIONS

7.5.1 Drive Orientation

The WREN I can be mounted in either of two positions:

Vertical Mount - Vertical mounting (see Figure 5a, Note 4), Mechanical shipping lock must always be located on the top.

Horizontal Mount - On its electronics chassis with the sealed unit facing up.

Further details on mounting are included in the Operator and Installation Guide.

7.5.2 Cooling

The cabinet cooling must be designed by the customer so that the ambient temperature immediately surrounding the WREN I will not violate temperature conditions specified in 7.4.1.

The WREN I design uses the WREN chassis to dissipate heat. Direct contact to the internal WREN heat sink can be made through the two mounting holes on the right side of the WREN I (see Figure 5b). Good metal to metal thermal contact of this surface with the customer cabinet mounting hardware is highly recommended for optimized heat transfer. Consideration should also be given to minimizing restriction of airflow through cooling holes in the drive.

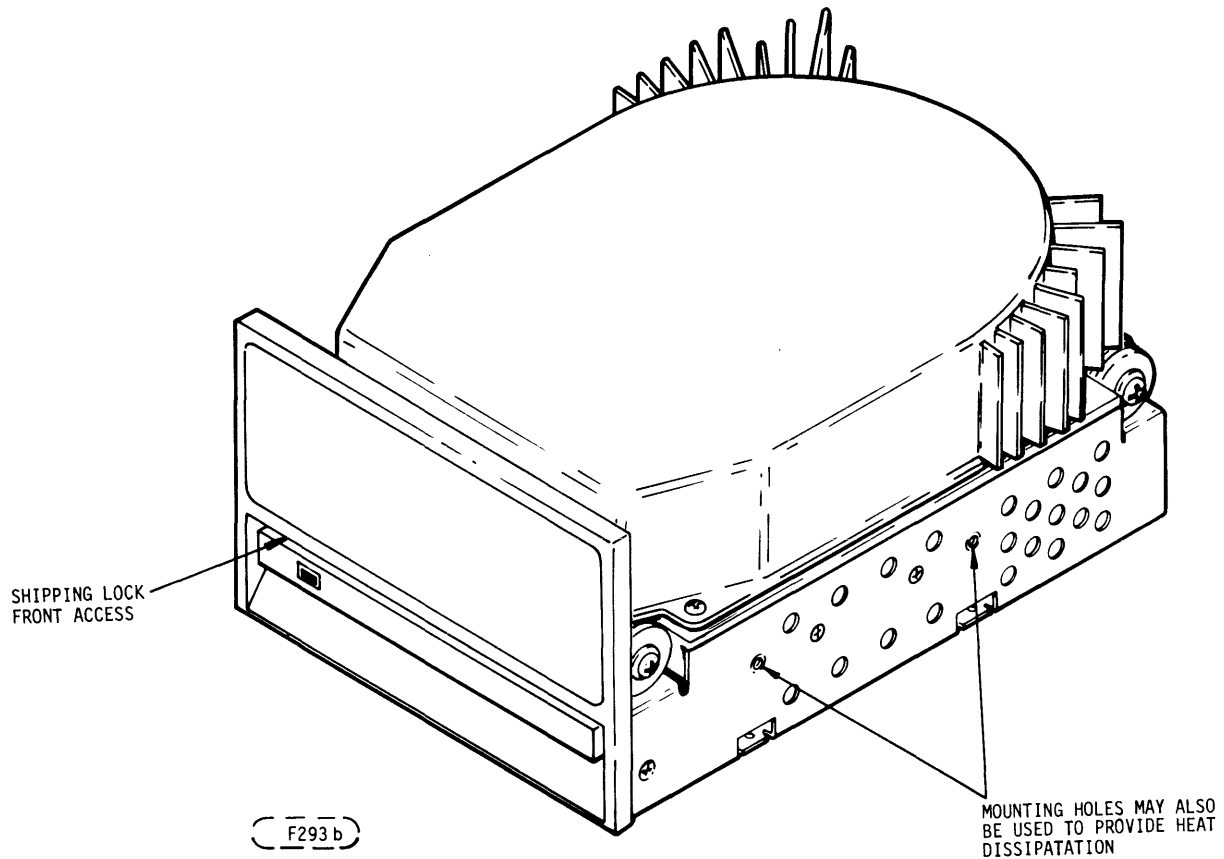


FIGURE 5b. WREN I MOUNTING

8.0 MEDIA CHARACTERISTICS

8.1 MEDIA DESCRIPTION

The media used on the WREN I has a diameter of approximately 5 1/4 inches (130 mm). The aluminum substrate is coated with ferrous oxide and lubrication to permit the heads to contact the surface when starting and stopping.

Each data surface has total of 697 tracks and is capable of recording 7,259,952 bytes of unformatted data.

Media defects are characterized as being either correctable or uncorrectable as a function of the type and magnitude of the media flaw. Various error correction codes may be implemented to correct errors in the data read from the disk. However, the code chosen should be consistent with Control Data media testing and certification methods. In the 9415-5 WREN I media certification is performed using the following standards:

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

Host systems utilizing the WREN I 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 9415-5 WREN I recording surfaces will meet the following requirements.

1. 697 total tracks per surface.
2. Track 0 to be error free on each Data surface.
3. 11 defects per surface maximum.
4. Accumulative defects not to exceed 1 per megabyte, based on total available Data capacity.

9.0 DEFECT AND ERROR MANAGEMENT

The WREN 1, as delivered, complies with all aspects of this specification. The read error rate and specified storage capacity are not dependent upon utilization of defect management routines. However, carefully chosen defect management methods can significantly enhance overall system performance. The application of error correction codes (ECC), and/or sector reallocation permits the continued use of the major portion, or perhaps all of a track when a defect is found.

ECC is highly recommended since the vast majority of defects are correctable (Ref. 8.1.1). If ECC is not utilized, then all flagged defects will be essentially uncorrectable and must be reallocated. Sector or track reallocation schemes are effective methods of relocating media defects. Sector reallocation in general is more efficient and may offer significant performance improvement.

10.0 INTERFACE CABLING REQUIREMENTS/OPTIONS

10.1 RADIAL CONFIGURATION

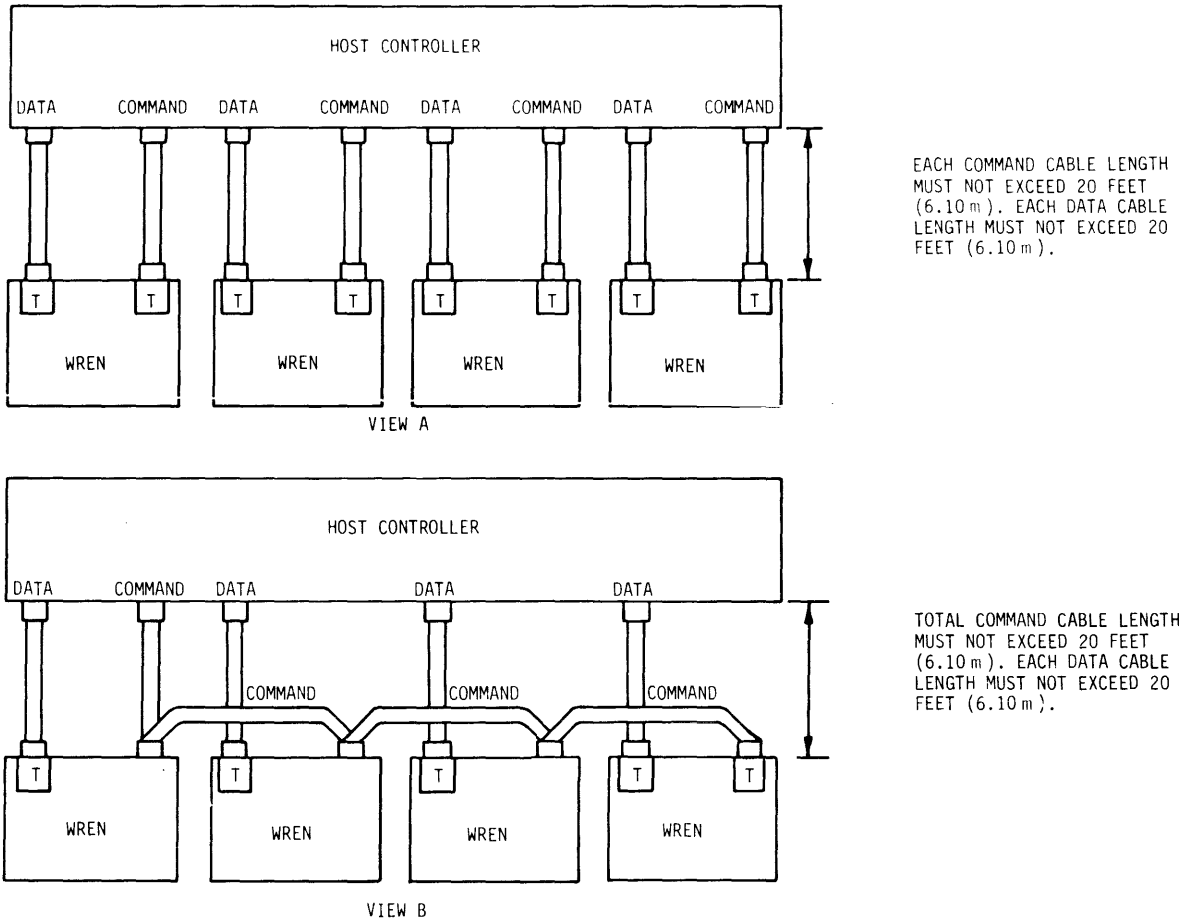
Interface cabling options for the WREN 1 are shown in Figure 6. View A of Figure 6 shows each drive interfaced to its own command cable, which, in turn, allows interfacing of any number of drives and a variety of system operational techniques. Each drive has its data cable and command cable radially connected to the host controller. The length of each individual cable must not exceed 20 feet (6.1 meters). Terminator resistors must be installed in the host controller for each data cable and for each command cable.

10.2 DAISYCHAIN CONFIGURATION

A daisychain configuration incorporates parallel interfacing of the disk drives on a common command cable. A maximum of four drives may be daisychained on the command cable. Only the drive which is selected by the host system has its control and data signals enabled through this common interface. View B of Figure 6 consists of four WREN I Disk Drives. A terminator resistor pack is required in the host controller for each data cable. Only the last WREN I in the daisychain requires a terminator resistor pack for the command cable. Terminator resistor packs for the command cable of other drives are removed. See Figure 7 for location of the terminator pack. The total combined command cable length (from the controller to the first drive, to the second and subsequent drives) must not be more than 20 feet (6.1 meters).

Refer to paragraph 11.1.6 for logical drive selection.

10.3 DC CABLE AND CONNECTOR



T INDICATES TERMINATOR RESISTOR PACK.
 WREN DATA CABLES ARE PERMANENTLY TERMINATED.

FF140

FIGURE 6. INTERFACE CABLING OPTIONS

The WREN I receives DC power through a 4-pin right angle connector (see Table 2 for pin assignment) mounted on the servo circuit board (see Figure 7). Recommended part numbers for the mating connector are included below, but equivalent parts may be used (see Table 3).

10.3 Continued

TABLE 2. DC INTERFACE

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

TABLE 3.

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

10.4 DATA CABLE AND CONNECTOR

The I/O connector for the data interface is a 20 pin board-edge connector (Figures 8 and 9a). The odd pins are located on the non-component side of the printed circuit board and are connected to the ground plane. The even pins are on the component side of the printed circuit board. A key slot is provided between pins 4 and 6. CDC recommends keying this connector to prevent the possibility of installing it upside down.

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

CONNECTOR (20-PIN)

3M-3461-0001
AMP 88373-0-6

CABLE

Flat Cable (Stranded AWG 28) 3M-3365-20
Flat Cable (Stranded AWG 28) 3M-3476-20 (Shielded Cable)

KEY

AMP 583274-1
3M-3439-0000

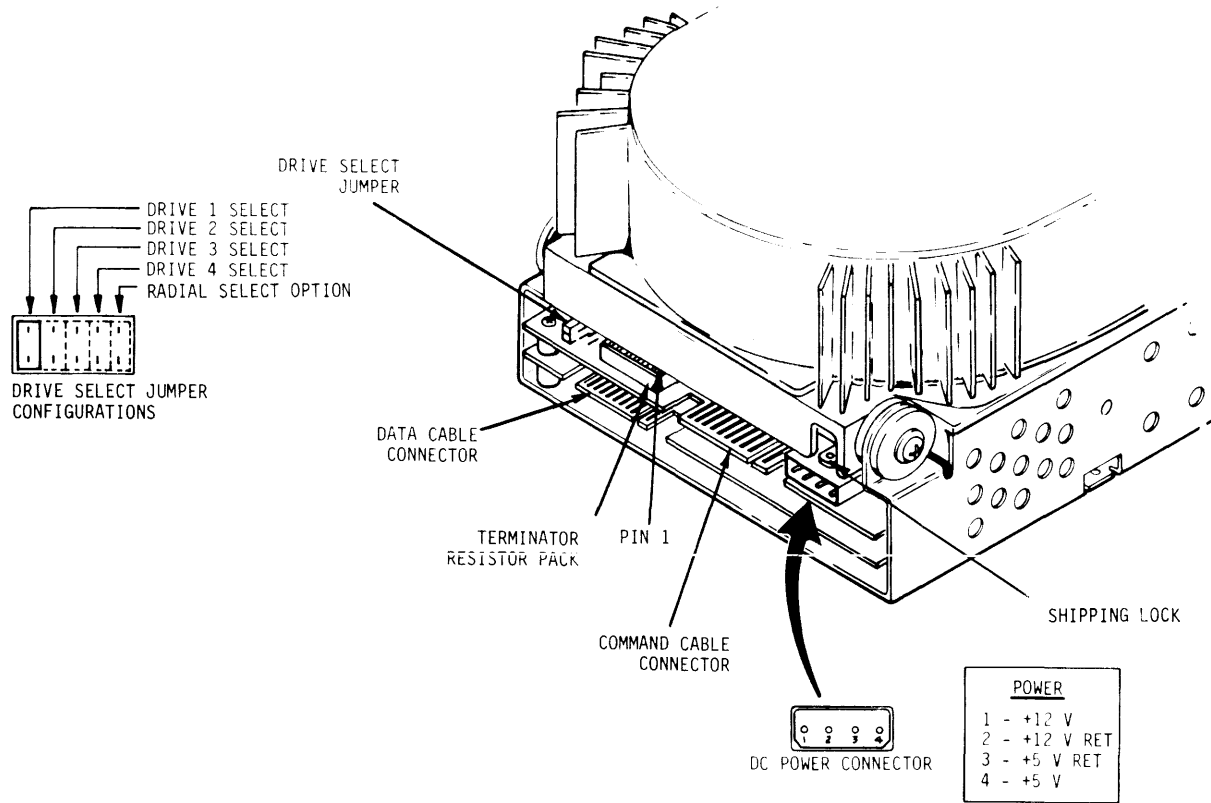
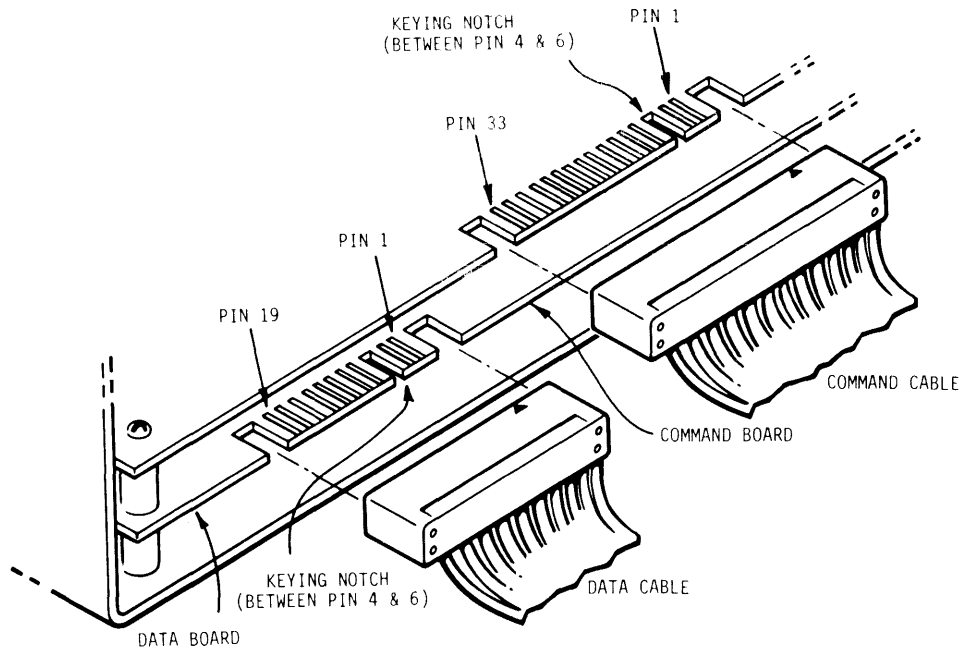


FIGURE 7. 9415-5 I/O CONNECTION

FF142b



FF274

FIGURE 8. 9415-5 CABLE CONNECTION

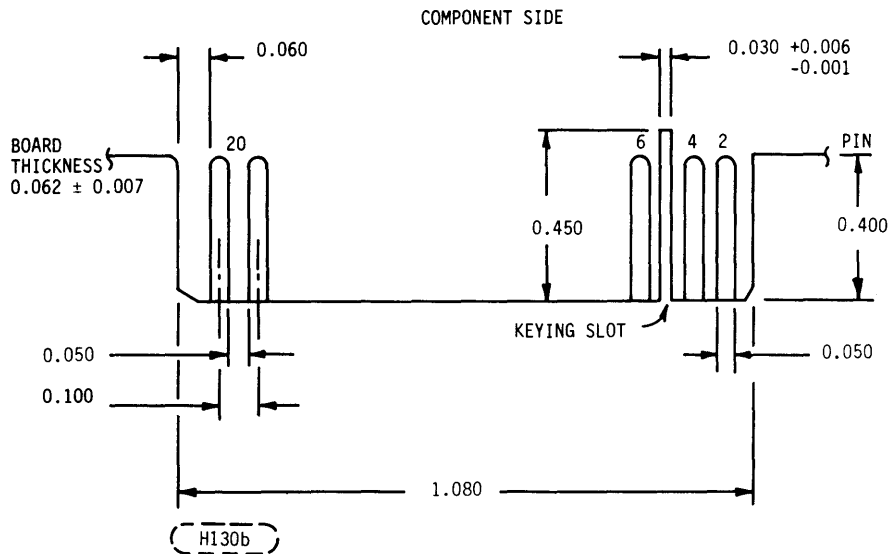


FIGURE 9a. 9415-5 DATA CABLE INTERFACE

10.5 COMMAND CABLE AND CONNECTOR

The I/O connector for the command interface is a 34-pin board edge connector. The odd pins are located on the component side of the printed circuit board and are connected to the ground plane. The even pins are on the non-component side of the printed circuit board. A key slot is provided between pin 4 and 6. (See Figures 8 and 9b.) CDC recommends keying this connector to prevent the possibility of installing it upside down.

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

CONNECTOR (34-PIN)

3M-3463-0001
AMP 88373-3

KEY

AMP 583274-1
3M-3439-0000

CABLE

Flat Cable (Stranded AWG 28) 3M-3365-34
Flat Cable (Stranded AWG 28) 3M-3476-34 (Shielded Cable)
Spectra Strip Twist'n Flat 455-248-34 (Stranded AWG 28 Twisted Pair)

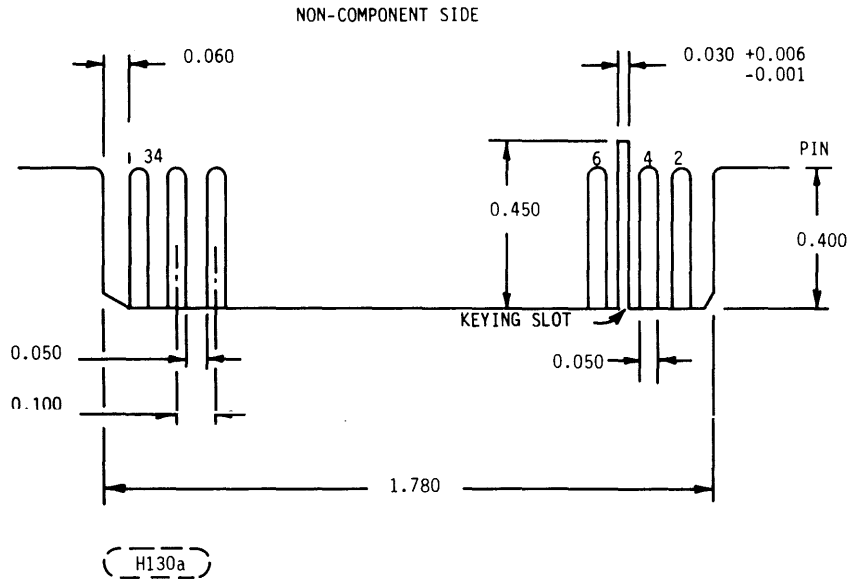


FIGURE 9b. COMMAND CABLE INTERFACE

10.6 INTERFACE DRIVERS/RECEIVERS

The 9415-5 WREN I utilizes two types of signals -- single-ended and balanced differential. The data and clock signals utilize balanced differential drivers and receivers. All other signals utilize single-ended drivers and receivers.

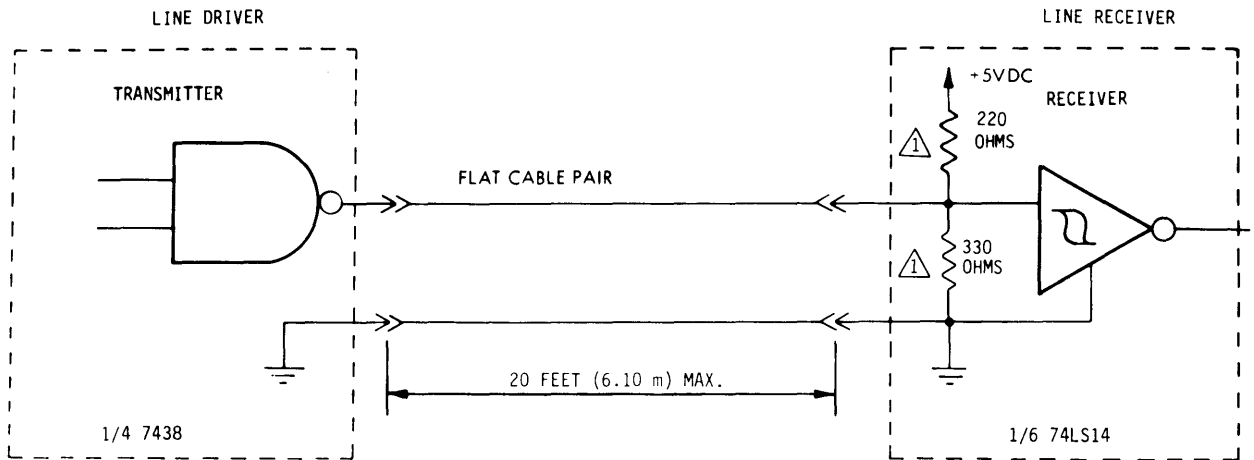
10.6.1 Single-Ended Drivers/Receivers

10.6.1.1 Transmitter Characteristics

The 9415-5 WREN I uses the 7438 open collector quad-2-input driver to transmit status to the host. This driver is capable of sinking a current of 48 mA with a low-level output voltage of 0.4 volt (see Figure 10).

10.6.1.2 Receiver Characteristics

The 9415-5 WREN I uses the 74LS14 Hex Inverter with hysteresis gate as a line receiver. The input of each receiver is terminated in 220 ohm/330 ohm resistor network as shown in Figure 10.



⚠ PART OF REMOVABLE RESISTOR PACK. (SEE FIGURE 9.)
 INTERFACE SIGNAL LEVELS AND LOGICAL SENSE AT THE WREN I/O CONNECTOR ARE DEFINED AS FOLLOWS:

LOGIC LEVEL	DRIVER OUTPUT	RECEIVER INPUT
HIGH (FALSE OR DEACTIVATED) (0)	$\geq 2.4 \text{ V}; \leq 5.25 \text{ V}$	$\geq 2.0 \text{ V}; \leq 5.25 \text{ V}$
LOW (TRUE OR ACTIVATED) (1)	$\leq 0.4 \text{ V}; \geq 0.0 \text{ V}$	$\leq 0.8 \text{ V}; \geq 0.0 \text{ V}$

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

(FF189a)

FIGURE 10. SINGLE-ENDED TRANSMITTERS AND RECEIVERS

10.6.1.3 Terminator Characteristics

The terminator consists of a resistor module which plugs into a socket in the last drive in a daisychain as shown in Figure 7. 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 6.) An equivalent terminator must be provided in the controller on each input signal line from the drive to the controller. Only the Command cable resistor module is removable.

10.6.2 Balanced Differential Drivers/Receivers

10.6.2.1 Transmitter Characteristics

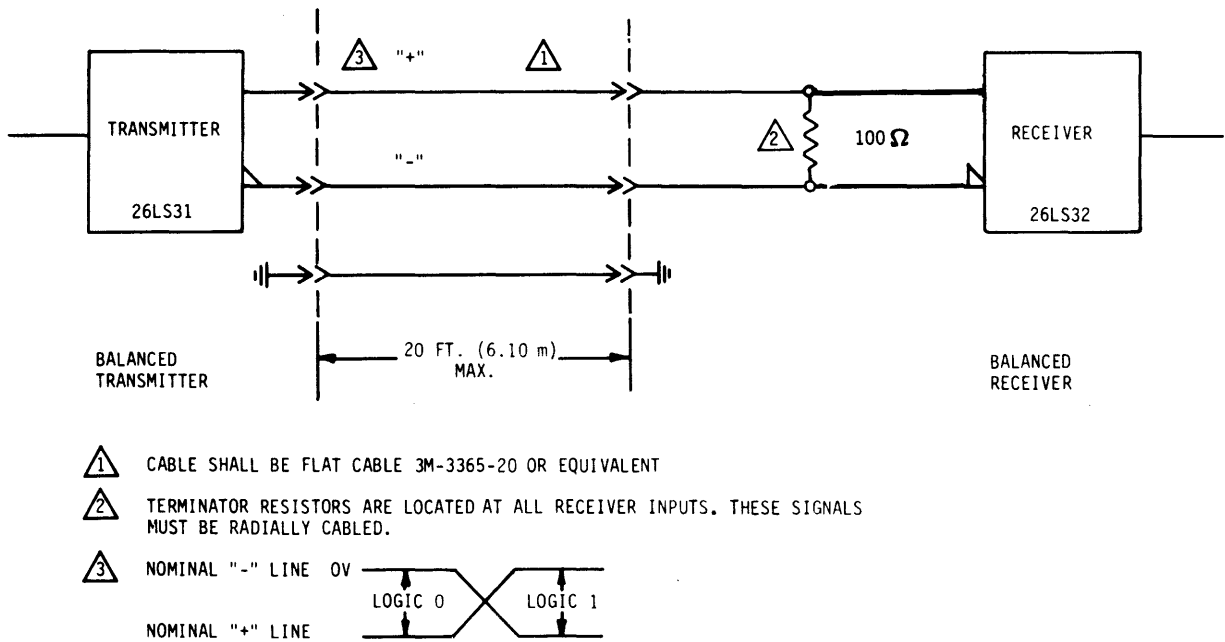
The 9415-5 WREN I uses 26LS31 type balanced differential drivers. Logic 1 on the interface is defined when the "+" output is more positive than the "-" output, per Figure 11.

10.6.2.2 Receiver Characteristics

The 9415-5 WREN 1, uses 26LS32 type balanced differential receivers terminated per Figure 11. A logic one on the interface is defined when the "+" input is more positive than the "-" input, per Figure 11.

10.6.2.3 Terminator Requirements

Each differential receiver in the drive is terminated with a 100 ohm resistor per Figure 11. An equivalent terminator must be provided in the controller on each input signal line from the drive to the controller.



(FF188a)

FIGURE 11. BALANCED DIFFERENTIAL DRIVERS/RECEIVERS

10.7 SIGNAL/CHASSIS GROUNDS

The WREN I Disk Drives are manufactured with the signal and chassis grounds common. Zero ohm resistors (designated W1 and W2) on the Data board allows modification of this relationship at the customer's option. The results of connecting/disconnecting the zero ohm resistors are listed in Table 3A. The customer can select any of these grounding options by removing W1 and/or W2.

TABLE 3A.

<u>W1</u>	<u>W2</u>	<u>RESULT</u>
X	X	Grounds common, quick connect terminal tied to common ground (as manufactured)
X	0	Grounds separate, quick connect terminal tied to chassis ground
0	X	Grounds separate, quick connect terminal tied to signal ground
0	0	Grounds separate, quick connect terminal floating

X = Connected
 0 = Not Connected

See Figure 11A for physical locations of W1 and W2 and Figure 11B for Schematic.

Zero ohm resistors are on the Data Boards of drives which are Series Code Four and above. The series code of the drive is indicated by the first two digits of the serial number, ie, 04000001.

10.7 Continued

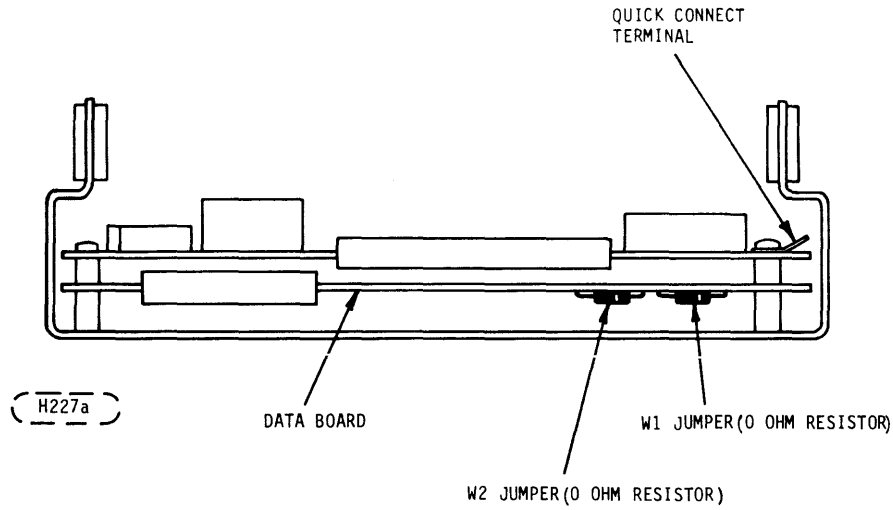


FIGURE 11A. PHYSICAL LOCATION OF W1 AND W2

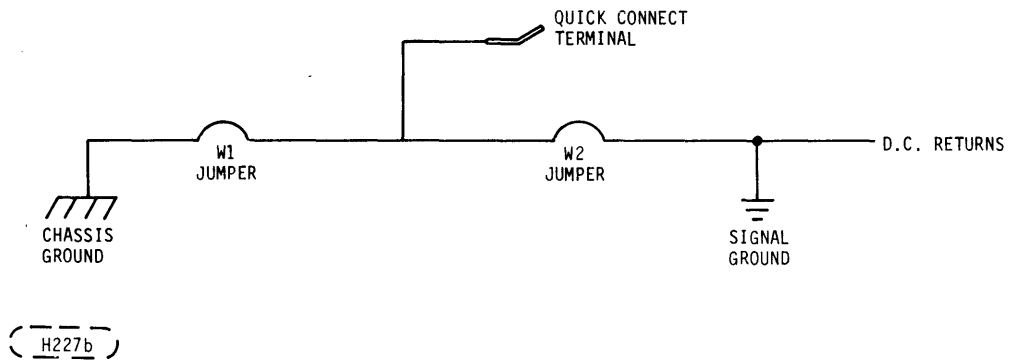


FIGURE 11B. SCHEMATIC DIAGRAM OF W1 AND W2.

11.0 DIGITAL-INTERFACE SIGNAL DEFINITIONS

The 9415-5 WREN I utilizes the two cable (command and data) interface for information transfer between it and the controller/host system. The connector pin assignment for the command cable is shown in Figure 12. The connector pin assignment for the data cable is shown in Figure 13. The signal direction, as well as type, is also shown on these figures. (All single-ended signals are true when the interface voltage level is less than 0.4 volts.)

11.1 CONTROL INPUT SIGNAL LINES (Figure 12)

11.1.1 Reduced Write Current

This signal is terminated by the drive, but is not required by the drive. The drive internally varies the write current level depending on the current track address of the Read/Write heads. Future products will utilize this line for additional head select capacity.

11.1.2 Write Gate

Activation (logic 1) of the Write Gate signal enables the write driver and initiates recording of the contents of the Write Data lines onto the media. (Refer to Section 12.0 for timing.) The inactive state of Write Gate enables the read channel to transfer the MFM encoded data from the disk media. This line must be inactive during the transmission of step pulses to the drive.

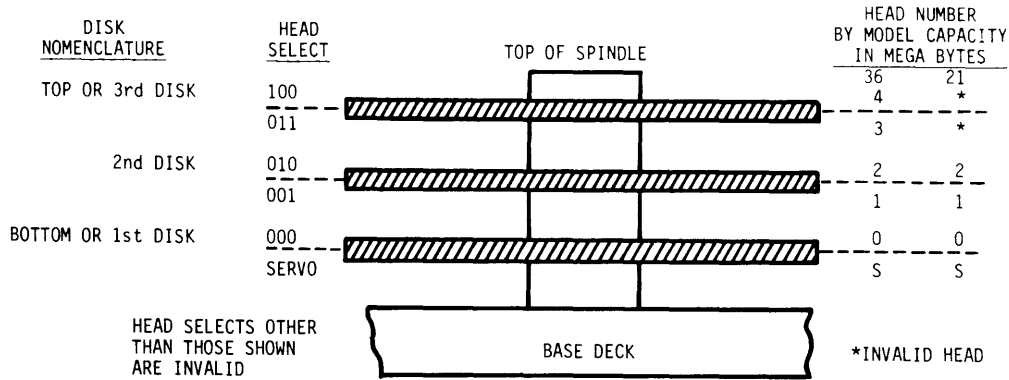
NOTE

WREN I will generate a fault if Write Gate is activated with an invalid Head Select.

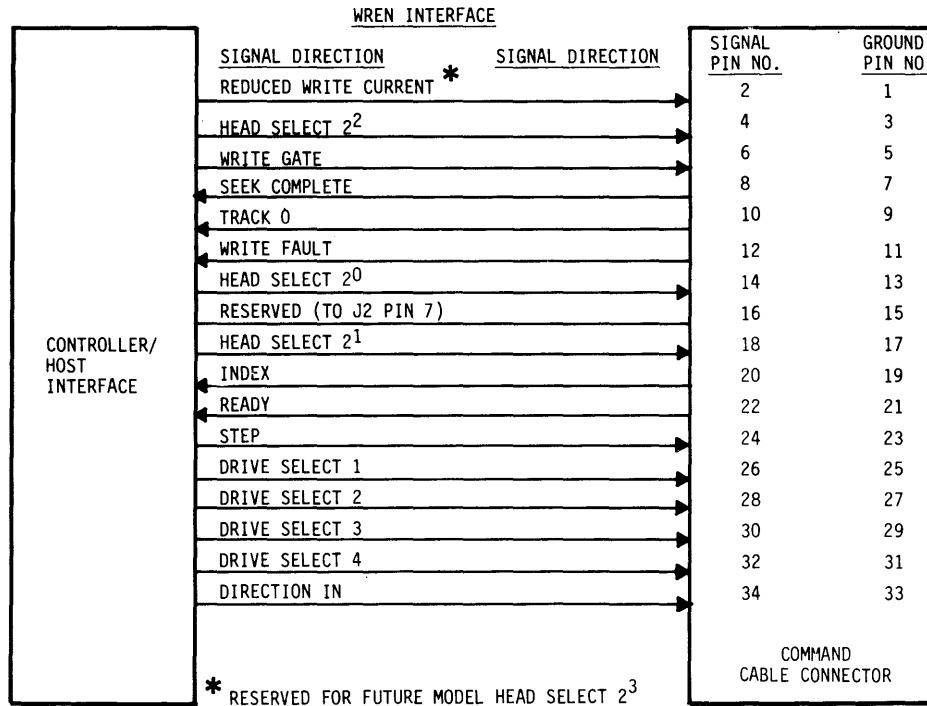
11.1.3 Head Select 2^0 , 2^1 , 2^2

These lines are used to select the proper media and head in binary coded sequence per Table 4.

TABLE 4. HEAD-SELECT ENCODING



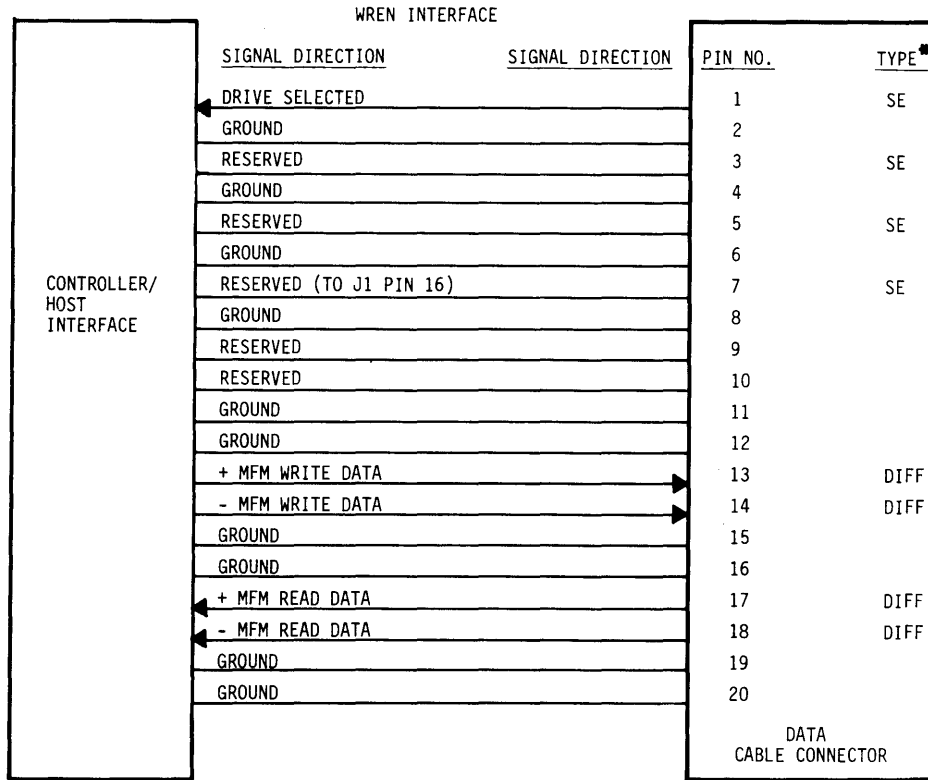
H060b



NOTE: ALL SIGNALS IN THE COMMAND CABLE ARE SINGLE ENDED SIGNALS.

FF143a

FIGURE 12. 9415-5 WREN I COMMAND CABLE INTERFACE



*SE = SINGLE-ENDED SIGNAL

DIFF = DIFFERENTIAL SIGNAL

FF141a

FIGURE 13. 9415-5 WREN I DATA CABLE INTERFACE

11.1.3 Continued

Head selection may be changed at any time following activation of Drive Select, but must occur a minimum of 5- μ s prior to a write operation. Write Gate must be deactivated a minimum of 1- μ s prior to a head change. Read Data will be valid within 5- μ s from a head selection (change) if the drive is selected, Write Gate is false, the Drive Ready line is true and if the Seek Complete line is true. (See Figure 14.)

Neither the Drive Ready line or the Seek Complete line will change as a result of a head selection (change).

11.1.4 Direction In

The state of this line determines the direction of movement of the head carriage. A logic 1 on this line signifies head-carriage movement is to be toward the higher numbered cylinders. A logic 0 on this line signifies head-carriage movement toward the low-cylinders, i.e., toward Track 0.

11.1.4 Continued

Direction In must be stable a minimum of 100 ns before each step pulse and 100 ns after the last Step pulse (see Figure 15). For controller compatibility, Direction In may be held stable until Seek Complete is received.

11.1.5 Step

This line is used in conjunction with Direction In to cause head positioner movement. Each pulse on the Step line causes the head to be moved one cylinder in the direction defined by the state of the Direction In line.

Step pulses must be a minimum of 2.0- μ s at the logic 1 or logic 0 level (see Figure 15). The minimum time between Step pulses is 8.0- μ s.

NOTE

The drive will accept step pulse rates between 8- μ s and 200- μ s. However, to meet the drive seek performance characteristics, the maximum time between Step pulses should not exceed 80- μ s. Longer Step times degrade the drive's seek performance.

For controller compatibility the drive will also accept Step pulses at a 3 ms rate; however, drive performance will be severely degraded.

The drive operates in a dynamically buffered Step mode. The R/W heads will start to move when the first Step pulse is received. The rate of head movement is partially determined by the rate of the incoming step pulses; however, the Step pulse rate is allowed to exceed the head movement rate. The Seek Complete line is used to indicate that a seek is in progress (see Figure 15). The Seek Complete line will be deactivated within 500 ns after the leading edge of the first step pulse and will be activated when the seek function is successfully completed.

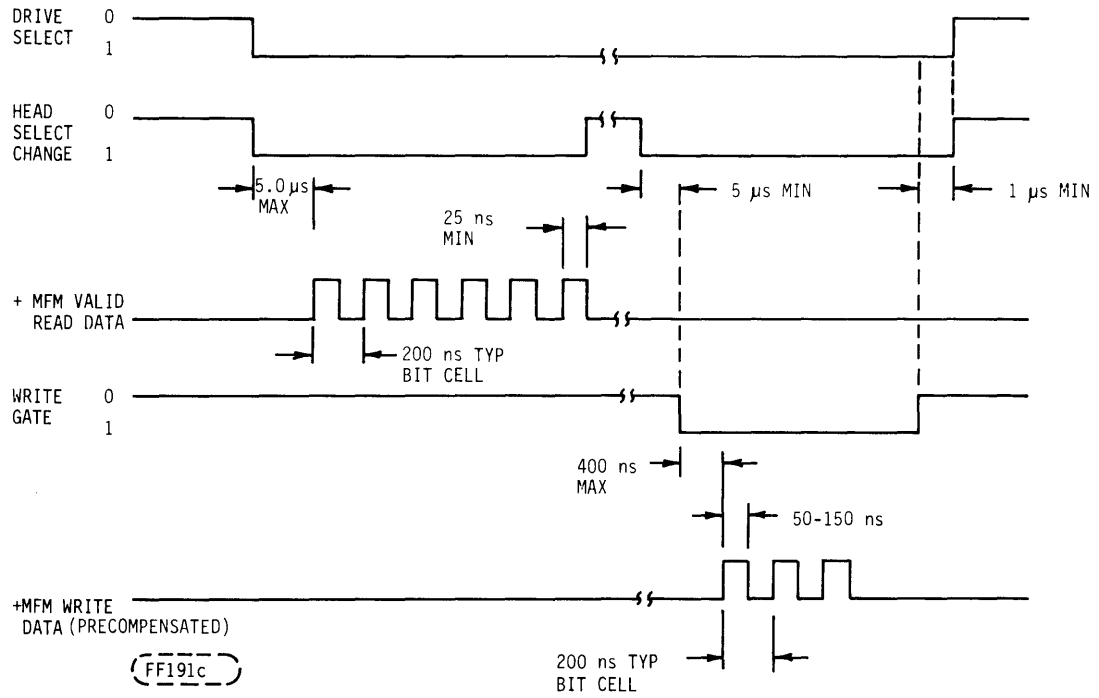
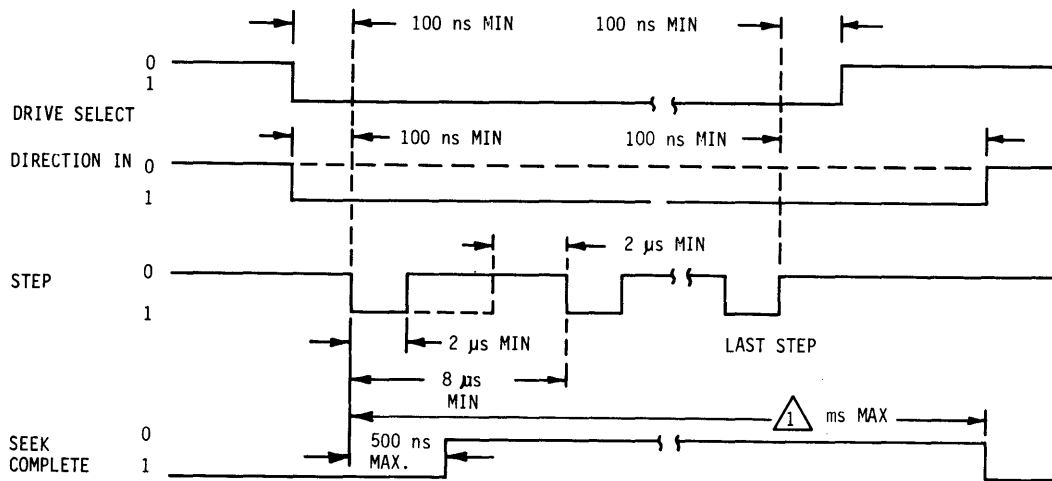


FIGURE 14. HEAD SELECT TIMING



△ -- 9 ms FOR A SINGLE TRACK SEEK (I.E., 1 STEP PULSE).
 -- SEE PERFORMANCE CHARACTERISTICS, (SECTION 5.0)

FF191b

FIGURE 15. TRACK-ACCESS TIMING

11.1.5 Continued

After the last Step pulse has been sent to the drive, the Drive Select line may be deactivated and a drive selected. The minimum time after the last Step pulse until the Drive Select or Direction In line can be deactivated is 100 ns.

The first Step pulse to initiate a seek should not be sent to the drive unless the Drive Ready and Seek Complete lines are both true.

NOTE

The drive will always attempt to maintain the heads over the recording zone of the media (i.e., at or between track 0 and maximum track) regardless of the number of Step pulses sent to the drive. Extra Step pulses which would position the heads outside of the recording zone or a hardware fault occurring within the drive such that the head was driven outside of the recording zone, will result in the head being automatically repositioned over track 0 if possible and the Track 0 interface line activated. If the head can be repositioned within the recording zone successfully, no fault will be signified and the Drive's Seek Complete line will be activated. It is the controller's responsibility to verify the correct head position after a seek function.

Step pulses in the reverse direction (toward track 0) used in conjunction with the interface Track 0 indication may be used to perform the recalibrate function. The procedure is as follows:

1. Select reverse direction.
2. Send one step pulse.
3. Wait until the Seek Complete signal is active.
4. Terminate the procedure if the Track 0 signal is active, otherwise repeat steps 2 through 4.

11.1.5 Continued

If the controller does not wait until Seek Complete in the above procedure, it is possible for the controller to send too many step pulses to the drive. This condition would cause the drive to position the heads at Track 0, using its internal recalibration procedure. The drive will then activate the Track 0 and Seek Complete lines.

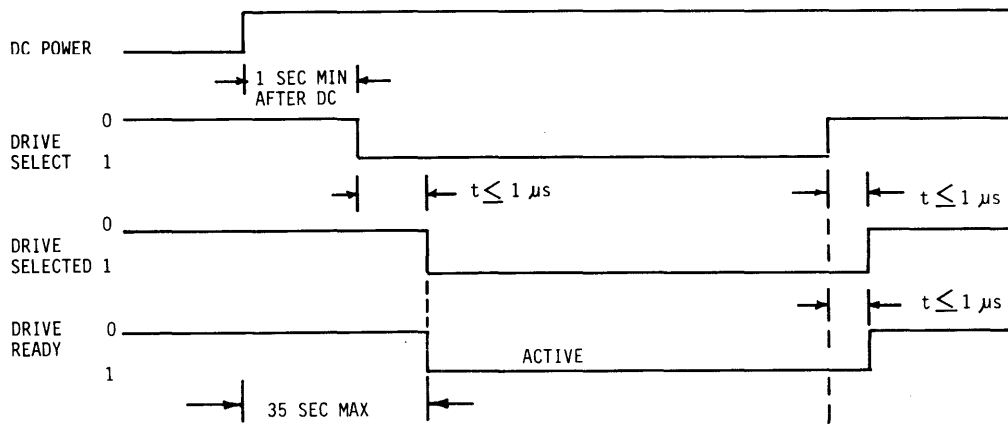
11.1.6 Drive Select--1-2-3-4

These lines are used to activate a device's drivers and receivers for up to four drives in a daisy-chained operation. The following characteristics apply to the Drive Select lines:

1. Logical unit designation is accomplished at the time of installation by setting the jumper plug located on the baseboard assembly. (See Figure 7.)
2. All command cable lines are gated with Drive Select. No data cable signal lines are gated with Drive Select.
3. Drive Select must remain active during any communication with the host controller.
4. When the radial select jumper is installed, the drive will be selected all the time.
5. The drive should not be selected until 1 second after DC power is applied. The Drive Ready input will be valid within 500 ns after the drive is selected (Drive Selected true) and after the 35 second power on delay. (See Figure 16.)
6. The drive will be selected within 1- μ s after the activation of Drive Select if the Power On sequence is complete. The drive will be deselected within 1- μ s after the deactivation of Drive Select.
7. The drive will activate the Data Cable Drive Selected signal within 1- μ s after receipt of Drive Select if the drive is selected. The drive will deactivate drive selected within 1- μ s after the Drive Select signal is deactivated. (See Figure 16.)

11.1.6 Continued

8. Drive Select must be valid 100 ns minimum before the first step pulse is received and 100 ns minimum after the last step pulse is received.
9. At the completion of a write operation, Drive Select must remain active for 1- μ s (Figure 14).
10. When the Drive Select line is activated, a head change will occur per Section 11.1.3, thus requiring a delay before a read or write operation can be initiated (Figure 14).



(FF132b)

FIGURE 16. POWER TURN ON AND DRIVE SELECTION

11.2 CONTROL OUTPUT SIGNAL LINES

11.2.1 Seek Complete

This line, when true, indicates that the Drive is selected and that the Read/Write heads are on cylinder and settled after a successful seek operation. Reading or writing should not be attempted when Seek Complete is false.

Seek Complete will be inactive (false) under the following conditions:

- a. Within 500 ns after the leading edge of a step pulse or a series of Step pulses (see Figure 15),

11.2.1 Continued

- b. while a seek is in process (Figure 15),
- c. an internal recalibration sequence (i.e., special positioning of the R/W heads to Track 0) is in process due to a power turn on condition, an error condition which forced the heads outside of the recording zone, or the receipt of an excessive number of Step pulses which would attempt to position the Read/Write heads outside of the recording zone.

When Seek Complete and Ready are true and Write fault is false, the drive is ready to seek, read or write.

11.2.2 Track 0

This line, when active, indicates that the drive is selected and that the Read/Write heads are positioned at Track 0. This signal, when inactive, indicates the selected drive's Read/Write heads are not at Track 0. This signal should only be sampled when Drive Ready and

Seek Complete signals are true to insure positioning integrity of the Read/Write heads. This signal is intended to be used in conjunction with reverse Step pulses to perform the recalibrate function, see Section 11.1.5.

11.2.3 Write Fault

Write Fault conditions detected by the drive will activate the Write Fault signal. The Write Fault signal will remain activated as long as the fault condition exists. The controller should latch this signal on the leading edge in order to ensure detecting a transient condition. The Write Fault line will be deactivated within 0.5-us from the trailing edge of Drive Select (i.e., when the unit is deselected). Writing of the disk media will be inhibited by the Drive if Write Fault is active.

A Write Fault condition will occur if Write Gate is true and either:

- a. Write current is absent; or
- b. write data is absent; or
- c. the drive is not ready; or

11.2.3 Continued

- d. an invalid head or internal multiple heads is selected; or
- e. DC voltages are grossly out of tolerance; or
- f. the Drive is not on cylinder or Seek Complete is false.

A Write Fault condition will also occur if Write Gate is false and write current is present.

This signal is in the command cable and gated with Drive Select.

11.2.4 Index

This signal occurs once per revolution (16.67 ms nom.) and its function is to indicate the physical beginning of the track. The Index Pulse width is 200- μ s nominal, (see Figure 17) and the leading edge (0 to 1) is the controlled edge. This signal is in the command cable and gated with Drive Select.

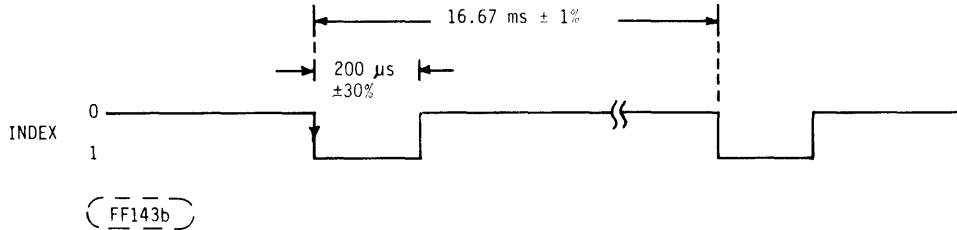


FIGURE 17. INDEX TIMING

11.2.5 Ready

A Logic 1 on this line indicates that the Drive is powered on, the disks are rotating within the speed tolerance, and the Read/Write heads are over the recording zone of the media. This line is gated with Drive Select and will be valid within 1- μ s after the Drive is selected (see Figure 16). Drive Ready will be true (assuming the drive is selected) within 35 secs after DC power is applied to the drive. This signal is not deactivated during a normal seek operation or during a head change. If this signal is true and Seek Complete is true, and Write Fault is false, the drive is ready to seek, read or write.

11.3 DATA TRANSFER LINES (Figure 13)

11.3.1 + and - MFM Write Data

MFM encoded data to be recorded on the media is supplied on these balanced differential lines. The MFM Data must be presented at a 5.0 MHz \pm 0.01% rate (see Figure 14). The transition of the + MFM Write Data line going more positive than the - MFM Data line will cause a flux reversal on the selected track if Write Gate is active and the other necessary requirements are met. MFM Write Data must conform to the conventional MFM encoding rules and must be write precompensated by ± 12 ns per the industry standard MFM data write precompensation rules. (See Figure 18.) Write precompensation is recommended on all tracks, however, write precompensation must be performed on tracks greater than track 128.

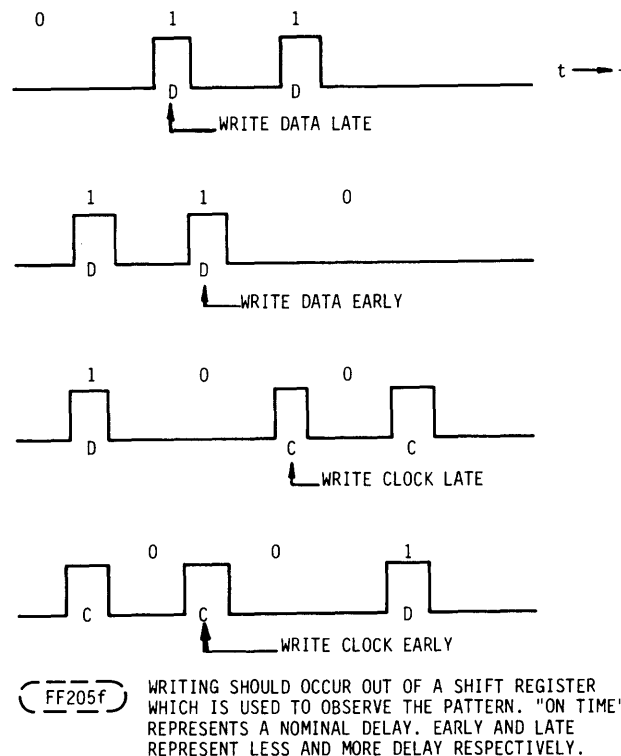


FIGURE 18. WRITE PRECOMPENSATION PATTERNS

11.3.2 + and - MFM Read Data

These balanced differential lines transmit the recovered media data in MFM format from the drive to the controller. The transition of the +MFM Read Data line going more positive than the - MFM Read Data line represents a flux reversal on the track of the selected head if Write Gate is inactive and the other necessary drive requirements are met. The timing for the MFM encoded Read Data is given in Figure 14. The Data Transfer rate of the MFM Read Data is 5.0 \pm 1.5% MHz if the MFM Write Data transfer rate was 5.0 \pm 0.01% MHz.

11.3.3 Drive Selected

This line when active (logic 1) indicates that the drive is programmed as drive X (X = 1,2,3,4) and that the Drive Select X line is activated. This line is in the radial Data Cable. The host may therefore verify that a drive was selected plus verify that one and only one drive is selected. Drive Selected will be activated within 1- μ s from the leading edge of the host Drive Select X line. Drive Selected will be deactivated within 1- μ s from the trailing edge of the host Drive Select X line. (See Figure 16.)

11.4 RESERVED SIGNAL LINES

Reserved signal lines are provided for future enhancements or Seagate interface compatibility.

The following two signal lines may be used by the controller to verify that both the Command and Data Cables are connected to the drive and the controller since these two lines are connected within the drive.

Command Cable Line

Signal Pin 16 - (Connected to Data Cable Pin 7)

Data Cable Line

Signal Pin 7 - (Connected to Command Cable Pin 16)

11.4 Continued

The following signal lines should be left as an open circuit in the controller and will be open circuit in the drive. These signal lines are spare or reserved signal lines.

Data Cable Lines

Signal Pins 3, 5, 9 and 10.

12.0 TRACK FORMAT AND DATA CONTROL TIMING

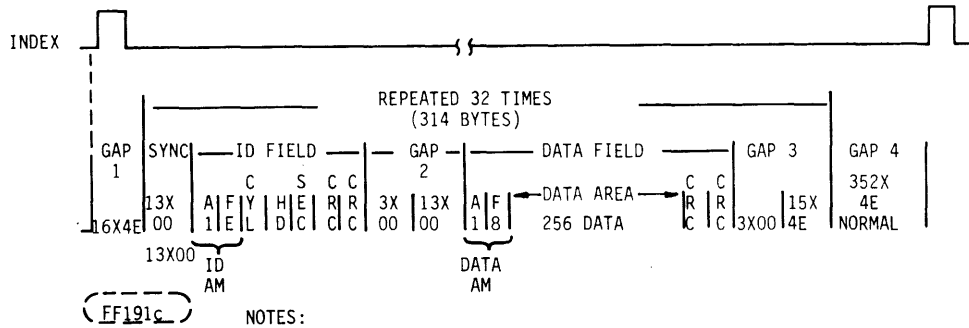
12.1 FORMAT DEFINITION

The purpose of a track format is to organize a data track into smaller sequentially numbered blocks of data called sectors. The format is a soft sectored type which means that the beginning of each sector is defined by a pre-written identification (ID) field which contains the Logical sector address plus cylinder and head information. The ID field is then followed by a user supplied data field.

Figure 19 shows a typical track format which can be used on each track. It is based on 32 sectors per track, each having 256 bytes of user data. This typical track format consists of 7 functional areas: Gap 1, Sync, ID Field, Gap 2, Data Field, Gap 3, Gap 4. These gaps and fields will be described in the following paragraphs.

12.1.1 Gap 1

Gap 1 can be used to provide a head switching recovery period and controller decision making period so that when switching from one track to another, sequential sectors may be read without waiting the entire rotational latency time (i.e., being able to read the last sector of a track, perform a head change and read the first sector of a new track). The minimum Gap 1 requirement for head switching is 4 bytes; however, for interface compatibility reasons 16 bytes should be provided.



NOTES:

1. NOMINAL TRACK CAPACITY = 10416 BYTES
2. TOTAL DATA BYTES/TRACK - 256 X 32 = 8,192
3. ACCEPTABLE CRC POLYNOMIAL = $X^{16} + X^{12} + X^5 + 1$
4. BIT 7 OF HEAD BYTE IN ID FIELD EQUALS 1 IN A DEFECTIVE SECTOR (CYLINDER 0 IS ERROR FREE).
5. BIT 5 OF HEAD BYTE RESERVED FOR NUMERING CYLINDERS GREATER THAN 256.
6. BIT 6 OF HEAD BYTE RESERVED FOR NUMERING CYLINDERS GREATER THAN 512.

FIGURE 19. TYPICAL TRACK FORMAT

12.1.2 Sync (ID Field PLO Sync Field)

The ID PLO Sync fields of all zeroes is required to allow the customer supplied controller's phase-locked oscillator/data separator to become phase and frequency synchronized with the MFM recorded data (flux reversals) on the media. The all zeroes pattern also allows the differentiation of MFM "clock bits" and MFM "data bits". 13 bytes of zeroes were chosen as a reasonable number of required PLO Sync bytes and is consistent with several existing controller designs. This number of PLO Sync bytes also allows a PLO design which is not as sensitive to "write splice area" on a disk which will be encountered when the controller is searching for an ID field.

12.1.3 ID Field

The ID field is used to provide a positive indication of the track and sector locations. The ID field is normally read by the controller and the address bytes verified prior to a data field read or write. The ID field is normally only written by the controller during a format function (Section 7.2) and thereafter only read to provide a positive indication of the sector location and establish the boundaries of the data area.

12.1.3 Continued

It is the controllers responsibility to define and interpret the ID field. One possible ID field is described in the following paragraphs.

12.1.3.1 ID AM (ID Field Address Mark)

The ID Address Mark is a unique MFM Encoded Data Pattern to signify the start of an ID field plus establish byte synchronization (i.e., the ability to partition the ensuing serial bit stream into meaningful information groupings). One recommendation for an ID Address Mark would contain two bytes. The first byte being an "A1" data pattern which is made unique by violating the MFM encoding rules by omitting one "clock" bit (refer to Figure 20). The second byte being an "FE" pattern to signify the start of the ID field.

NOTE

The "A1" data pattern with an "illegal missing clock" could be erroneously detected in a write splice area, therefore it is recommended that this unique "A1" controller decode be prefaced with at least two zero bytes of PLO Sync (i.e., the controller should not look for an "A1" unless it has detected at least two consecutive bytes of zeroes).

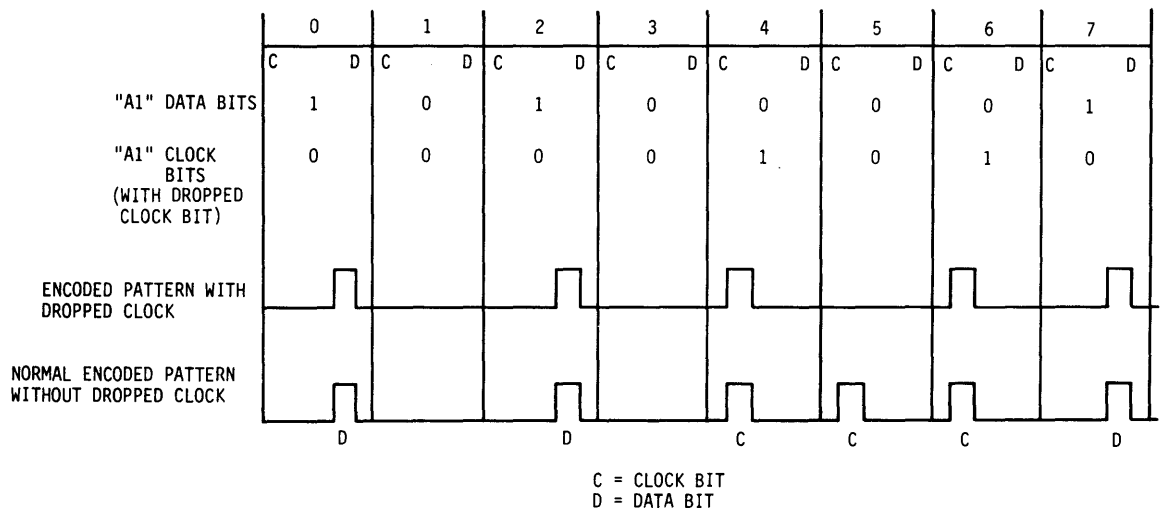


FIGURE 20. "A1" ADDRESS MARK BYTE

12.1.3.2 CYL (Cylinder Byte)

This byte contains the 8 least significant bits of the Cylinder Address. (See Head Byte description for the most significant bits of the Cylinder Address).

12.1.3.3 HD (Head Byte)

Bits 0 through 4 (5 bits) contain the Head Address.

Bit 5 of the Head Byte is used for numbering cylinder greater than 256.

Bit 6 of the Head Byte is used for numbering cylinders greater than 512.

Bit 7 of the Head Byte equals 1 for a defective sector and equals 0 for a good sector.

12.1.3.4 SEC (Sector Byte)

This byte contains the sector number to be used for the following data field.

By using this byte the controller can format a track with any desired "interleave factor" to separate logical sector addresses from the physical sector location.

12.1.3.5 CRC (2 Bytes)

Selection of an appropriate error-detection mechanism, such as a cyclic redundancy check (CRC) code, is generated by the user and applied to the ID Field for file integrity purposes. These codes are generated by the user's controller and written on the media during formatting. Data integrity is maintained by the user's controller recalculating and verifying the ID Field check codes when the ID Field is read.

An acceptable CRC Polynomial is $x^{16} + x^{12} + x^5 + 1$.

12.1.4 Gap 2

Gap 2 follows the CRC bytes of the ID field and continues to the data field address mark. As shown in Figure 19, Gap 2 consists of two components. The first component consists of three bytes of zeroes which may be used as follows:

- A. The first byte following the ID Field should be used as an ID Field pad byte and must be written by the controller to ensure proper recording and recovery of the last bits of the ID Field check codes.
- B. The next two bytes allow for controller decision making plus a byte for a write splice. The write splice will be created on the media as soon as the interface Write Gate is activated when performing a Data Field update function.

The second component of Gap 2 is 13 bytes of zeroes for the Data Field PLO Sync bytes. These bytes are required for the same reasons as the ID Field PLO Sync as described in Section 12.1.2.

12.1.5 Data Field

The Data Field is used to record the user's data fields. The contents of the Data Area within the Data Field are specified by the host system. The remaining parts of the Data Field are specified and interpreted by the user's disk controller to recover the data fields and ensure their integrity. The Data Field consists of the Data AM, the Data Area, and the Data CRC Bytes.

12.1.5.1 Data AM (Data Address Mark - 2 Bytes)

The Data Address Mark is a unique MFM Encoded Data Pattern to signify the start of a data field plus establish byte synchronization. One recommendation for a Data Address Mark would contain two bytes. The first byte being an "A1" data pattern made unique by violating the MFM encoding rules by omitting one clock bit (Figure 20). The second byte being an "F8" data pattern to signify the start of the data field. It is also recommended that the unique "A1" data pattern controller decode be prefaced by at least two zero bytes of PLO Sync (see Section 12.1.3.1 - ID Address Mark).

12.1.5.2 Data Area

The Data Area shown in Figure 19 consists of 256 bytes of Host system user data. The size of this area is determined by the controller and not restricted by the Disk Drive.

NOTE

If the Data Area size changes, the sizes of Gap 3 and Gap 4 of Figure 19 must also change proportionally.

12.1.5.3 CRC (Data Field CRC)

These codes are generated by the user's controller and written on the media with the Data Field. Data integrity is maintained by the user's controller recalculating and verifying the Data Field Check Codes when the Data Field is read. An acceptable polynomial is $X^{16} + X^{12} + X^5 + 1$.

Instead of two bytes of Data CRC, the controller may implement a multiple byte Error Correction Code (ECC) Data Field integrity System. An ECC system allows the controller the additional possibility of data field read error correction as well as read error detection. The correction/detection ability is dependent on the code chosen and the controller implementation.

12.1.6 Gap 3

Gap 3 follows the CRC bytes of the Data Area. As shown in Figure 19, Gap 3 consists of two components, a) 3 bytes of 00 and b) 15 bytes of Hexidecimal 4E.

The three bytes of 00 may be used as follows:

- A. The first byte following the Data Area should be used as a Data Area pad byte and must be written by the controller when a Data Field Write is performed to insure proper recording and recovery of the last bits of the Data Area Check Codes.
- B. The next two bytes may be used as additional pad or as an area to define a write splice which will be created when Write Gate is deactivated after a Data Field write function. The use of these bytes is determined by the controller.

The 15 bytes of hexadecimal 4E in Gap 3 following each field allows for the spindle speed variations. This allows for the situation where a track has been formatted while the disk is running slower than nominal, then write updated with the disk running faster than normal. Without this gap, or if it too small, the sync bytes or ID field of the next sector could be over written.

These bytes of hexadecimal 4E must be allowed for during the format function. The actual size of the Gap after a data field update will vary depending on the disk rotational speed when the track was formatted and when the Data Field was updated.

The 9415-5 WREN 1 will require 4 bytes in this gap for head switch recovery time to accommodate sequential sectoring. Therefore the total Gap 3 requirement for the 9415-5 WREN 1 is 4 bytes plus the bytes for speed variation. The number of speed tolerance bytes can be calculated using the total speed tolerance of $\pm 1\%$ or a total of 2% speed variation, times the number of bytes which will be updated in the data field.

The total length of hexadecimal 4E speed variation bytes required for Gap 3 is equal to $4 + 0.02 (L)$.

12.1.6 Continued

L is the length of the data field written during the update. This length will include Write Splice, Data PLO Sync, Data AM, Data Area, Data CRC, Data Pad and Data Write Splice bytes.

To calculate the minimum length of the hexadecimal 4E bytes in Gap 3 for a 256 byte data area, the data field would be 282 bytes, thus requiring 10 bytes ($4 + 0.02(282)$) of Hex 4E in Gap 3. If sequential sectoring is not required the minimum length of Hex 4E bytes required could be 6 bytes ($0.02) X (282)$.

The 15 bytes shown in Figure 19 is compatible with existing controllers and more than adequate for the drive for 256 byte data fields.

12.1.7 Gap 4

Gap 4 is the speed tolerance gap for the entire track. This gap is required to insure that the entire track can be formatted during an Index Pulse to Index Pulse Track Format operation. The Gap 4 of Figure 17 is compatible with existing controllers for the shown track format of 32 sectors per track.

Any format must allow for a minimum of 10,416 bytes times 1.01% or 106 bytes. During a format function with a minimum Gap 4 and a 5.0 MHz write frequency and nominal disk rotational speed, the actual size of the Pre-Index gap written will be approximately 106 bytes. If the format allows for only 106 bytes of Pre-Index gap, the actual gap size after a format may vary from 0 to 312 bytes depending on the disk rotational speed ($\pm 1\%$) and write frequency tolerance ($\pm 0.01\%$) at the time of formatting.

13.0 ACCESSORIES

13.1 FRONT PANEL KIT

The front panel kit for the WREN I consists of a plastic front panel with a Drive Selected indicator.

The indicator designates the drive is selected when luminated.

13.1 Continued

A flashing indicator displays the presence of a non-recoverable fault. A Fault indication is displayed irrespective of Drive Select status.

13.2 WREN I POWER SUPPLY

The WREN I power supply is an accessory which will provide the necessary DC power to support one 9415-5 WREN I drive. The characteristics of the supply are shown below:

Voltage	+5 V	+12 V
Regulation	+3%	+5%
Ripple	50 mV	100 mV
Maximum Operating Current	1.5 A	2.5 A
Operating Current (Peak)	1.5 A	4.0 A

13.3 HARDWARE MAINTENANCE MANUAL VOLUME 2

The Volume 2 Manual will provide the user with a general overview and description of the 9415-5 WREN I operation and design basics.

13.4 TOP MOUNT PWA ADAPTER

The top mount PWA Adapter is an accessory which allows a user to mount an additional PWA (i.e., Controller, etc.) above the WREN I.

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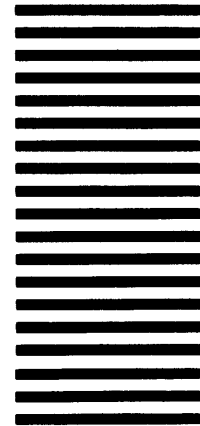
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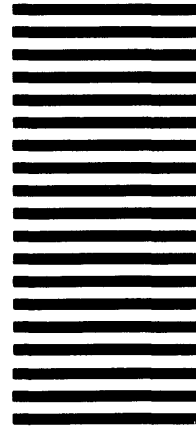
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