PRODUCT SPECIFICATION
FOR
WREN II DISK DRIVE
MODEL 94156

CONTROL DATA CORPORATION

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FOR
WREN II DISK DRIVE
MODEL 94156

MAGNETIC PERIPHERALS, INC.
a Control Data Company

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SUMMARY

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

- WREN 1 9415-5XX

  Product Specification: 77715793
  Interface: CDC 506 (ST506 Compatible)
  Capacity: 21 to 38 MB

- WREN 1 9415-3XX

  Product Specification: 77711078
  Interface: FD1
  Capacity: 21 or 35 MB

- WREN 11 94155-XX

  Product Specification: 77715909
  Interface: CDC 506 (ST506 Compatible)
  Capacity: 48, 57, 67, 77 or 86 MB

- WREN 11 94156-XX

  Product Specification: 77738019
  Interface: ESD1
  Capacity 48, 67 or 86 MB

The XX denotes unformatted drive capacity in megabytes. Model number 94156-86, for example, would be a WREN 11 with the ESD1 Interface and 86 mb of unformatted capacity.

1.0   SCOPE

This specification describes the Control Data Corporation
Model 94156 WREN 11 Disk Drive. This 5 1/4-inch member of
the rigid disk family supports the Enhanced Small Device
Interface (ESDI) and is offered in three different
capacities.
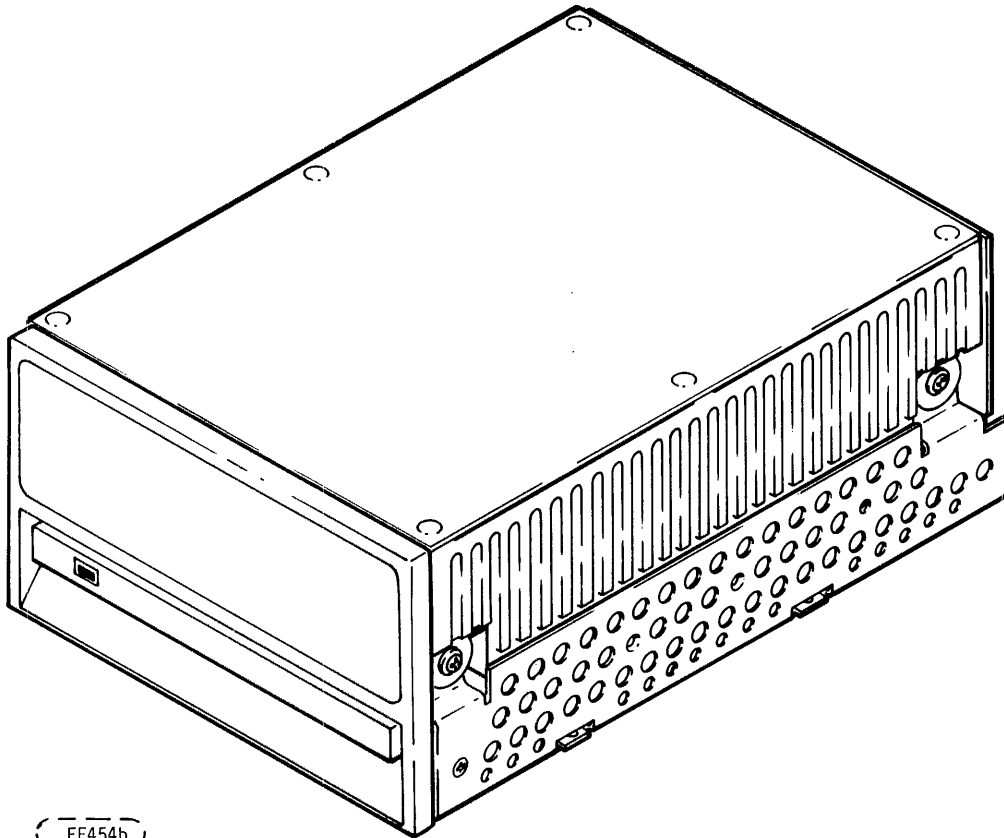
(FF454b)

FIGURE 1. 94156 WREN 11

2.0   APPLICABLE DOCUMENTS

2.1   STANDARDS

The WREN 11 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.

2.1   (continued)

The WREN 11 shall comply with CDC standards as noted in the appropriate sections of this specification.

In addition to the CDC standards, the WREN 11 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 94156 WREN 11, as delivered, is designed for system integration prior to utilization. As such, the 94156 WREN 11 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. The 94156 WREN 11 does comply with Class A of the referenced FCC regulation as delivered and has been demonstrated to satisfy Class B requirements when installed in a typical commercial system.

2.2   DOCUMENTATION

77738035   OEM Manual
77738036   Hardware Maintenance Manual
77738076   ESDI Specification

3.0   GENERAL DESCRIPTION

The WREN 11 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 11 is designed to record and recover data on five 5-1/4 inch (130mm) fixed disks; it does not contain removable media capability.

The Model 94156 WREN 11 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 94156 WREN 11.

3.0   (continued)

The Standard Model 94156 WREN 11 is configured using the Serial Mode of ESDI Operation. Customers electing to utilize the Step Mode may order the Model 94156 WREN 11 with this optional feature factory installed. (See section 13.0).

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

Refer to Figure 2 for an exploded view of the WREN 11. NEVER disassemble the WREN Head/Disk Assembly (HDA). This exploded view is for information only. Servicing items in the 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.

The WREN 11 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 11 incorporates an automatic shipping lock which prevents 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 11 decodes Track 0 location from the dedicated servo surface thereby eliminating mechanical transducer adjustments. In fact, there are no adjustments associated with the WREN family of peripherals.

The WREN 11 utilizes a High Performance Actuator Assembly consisting of a Low Mass, Balanced, Straight-Arm Design (Patent Pending) which provides excellant performance with minimal power dissipation.
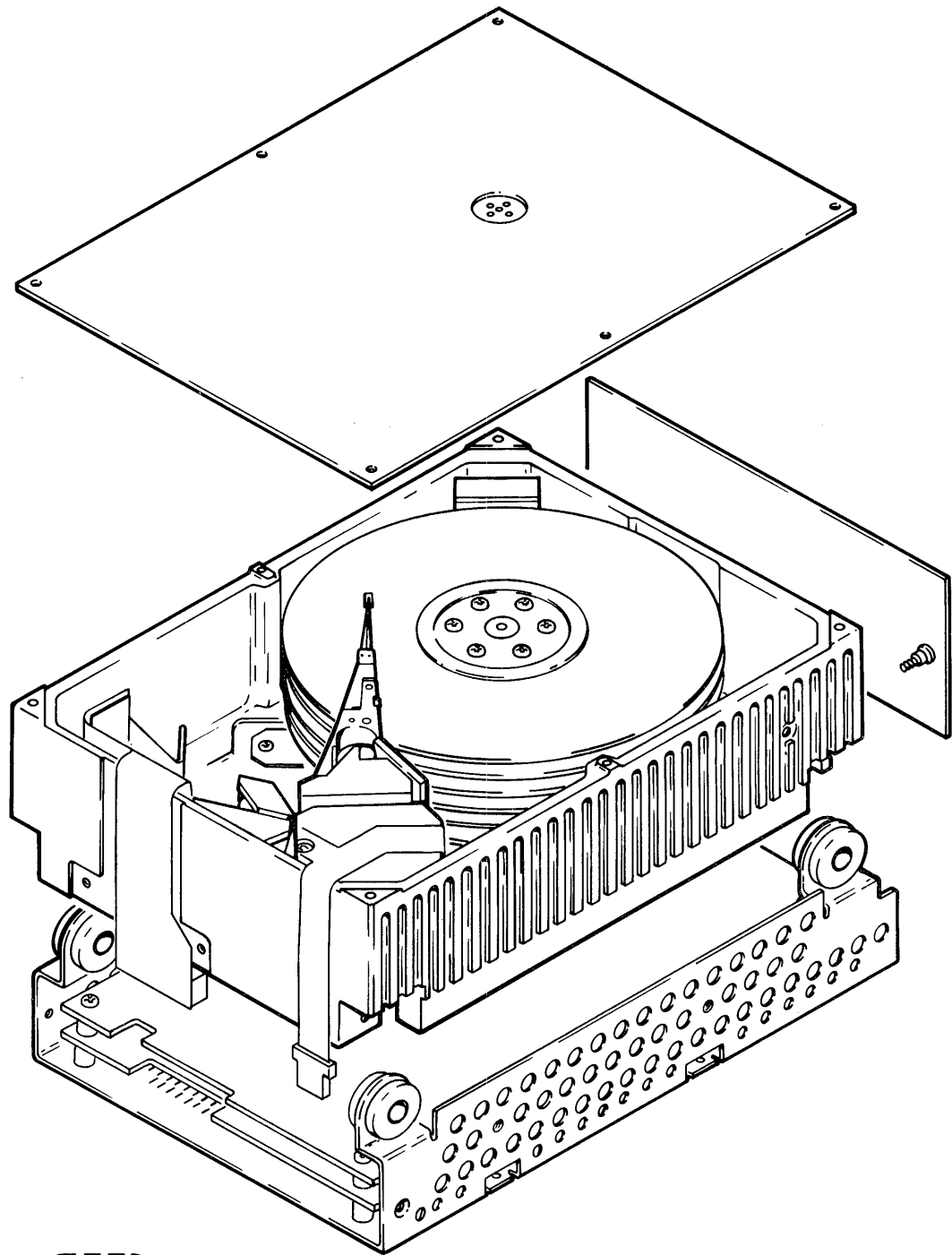
H116a

FIGURE 2. Model 94156 WREN 11

4.0   FEATURES

4.1   STANDARD FEATURES

The Model 94156 WREN II has the following standard features:

- Industry Standard Interface
- Data Recovery Circuitry contained in the drive
- Multiple Capacity Configurations
- Sealed head, disk, and actuator 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
- Terminators
- Integral shock mounts
- Dedicated head landing zone
- Dynamic Spindle Braking

4.2   OPTIONS (FACTORY INSTALLED)

The following optional capacities are available as a factory installed option.

Model 94156-86	86 MB
Model 94156-67	67 MB
Model 94156-48	48 MB

The following options are incorporated at the time of production and may be specified for delivery. (See Section 13.0.)

- Front Panel - Standard (Ref Figure 5)
- Front Panel - Thin (Ref Figure 5)
- Custom Formatting
- Power Supply (50 Hz or 60 Hz)
- Single Unit Shipping Pack
- Step and Direction Access Mode

4.3   ACCESSORIES (USER INSTALLED)

The following accessories are available to the user to facilitate his needs. All kits may be installed in the field. (Reference Section 14.0.)

- Front Panel Kit - Standard (Ref Figure 5)
- Front Panel Kit - Thin (Ref Figure 5)
- Hardware Maintenance Manual
- Single Unit Shipping Pack Kit
- Power Supply Kit (50 Hz or 60 Hz)
- OEM Manual

5.0   PERFORMANCE CHARACTERISTICS

Model 94156 WREN II capacity (unformatted)
- Model 94156-86   86,913,000 Bytes (unformatted)
                        72,460,800 Bytes (formatted*)
                        5 Disks per Drive
                        9 Data Surfaces

- Model 94156-67   67,599,000 Bytes (unformatted)
                        56,358,400 Bytes (formatted*)
                        4 Disks per Drive
                        7 Data Surfaces

- Model 94156-48   48,285,000 Bytes (unformatted)
                        40,256,000 Bytes (formatted*)
                        3 Disks per Drive
                        5 Data Surfaces

Data Capacity Parameters (Unformatted)

Bytes/Track	10,440 Bytes
Bytes/Surface	9,657,000 Bytes
Tracks/Surface	925 Tracks
Tracks/Inch	960 TPI
Bits/Inch	9296 BPI

Formatted capacity/surface* 8,051,200 Bytes

Recording Mode   MFM Encoded Data

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

Data Interface   NRZ Encoded Data

Rotational Speed   3600 r/min ±0.5%

Average Latency   8.33 ms

Step Pulse Rate Maximum   4 μs between Steps
(Only applicable in STEP Mode)

Step Pulse Rate Minimum   200 μs between
(Only applicable in   Steps – Note 1
STEP Mode)

_____
*Based on 17 sectors with 512 data bytes each.
Consideration for defect management not included

5.0   (continued)

Single Track Seek Time	Maximum 7 ms-Notes 1 & 2 Typical (5 ms) - Note 3
Average Seek Time	Maximum 32 ms-Notes 1 & 2 Typical (28 ms) - Note 3
Maximum Seek Time	Maximum 70 ms-Notes 1 & 2 Typical (65 ms) - Note 3

Note 1:   See Seek Command Description 11.1.5.1 and Step Description in Section 13.1.1.6

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 time required from the receipt of a seek or position command by the WREN II 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 paragraphs 11.1.5.1 and 13.1.1.6.

5.1.2   Spindle Speed and Latency

The spindle speed is 3600 ±0.5% 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 16.74 milliseconds based on a minimum disk speed of 3582 r/min.

5.2   READ DATA TRANSFER RATE |

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

5.3   START/STOP TIME

The WREN II 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, and environmental conditions.

Error Rates
        Soft Read Errors   Less than 1 in 10^{10}
        (Recoverable)   bits transferred

        Hard Read Errors   Less than 1 in 10^{12}
        (Unrecoverable)   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.   WREN II is operated per this specification utilizing the CDC provided accessory power supply or its equivalent.
b.   A data format is employed fulfilling the requirements of the WREN II as outlined in the ESDI Specification

6.1   (continued)

c.   Errors caused by media defects or host system failures are excluded from error rate computations. Refer to paragraph 8.0, Media Defect Recognition.

6.1.1   Read Errors

Prior to the 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 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 that one error in 10^{10} 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 II within the system shall be considered acceptable if the device does not generate an unrecoverable error or cause 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 11, 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 condition where the drive fails to position the heads to the addressed track provided the correct information has been presented to the WREN 11. 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 WREN 11. 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.

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 II 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 II HDA, repairs may only be effected at a properly equipped and staffed depot service and repair facility. Although WREN II is designed primarily for depot repair service, some items may be replaced in the field as defined in the Hardware Maintenance Manual.

6.2.5   Installation

The WREN II 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 the WREN II 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 II 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 II are shown in the following table. Values indicated apply at the drive power connector.

TABLE 1. DC POWER REQUIREMENTS

	+5 VDC	+12 VDC
Voltage		
Regulation	±5%	±5% △2
Noise Immunity △3	50 mV	100 mV
Maximum Operating Current △1	0.9 A	2.4 A
Typical Operating Current △1	0.75 A	2.0 A
Maximum Starting Current (Peak)	1.3 A	4.5

△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.

△3 Noise is specified as Periodic and Random Distribution of Frequencies covering a band from DC to 10 MHz.

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 returns are tied together in the drive, but separate returns to the power supply should be used to minimize noise coupling between the supplies.

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. (Ref. Table 1).

7.2.1   Power Sequencing

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

7.2.2   12 V - Current Profile

Figure 3 identifies the 12 V current profile for the WREN II. The current during the various times is as shown:

T1 - Voltage is applied to the drive and the spindle begins to accelerate.

T2 - The spindle continues to accelerate under current limiting conditions.

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 maximum current requirements.
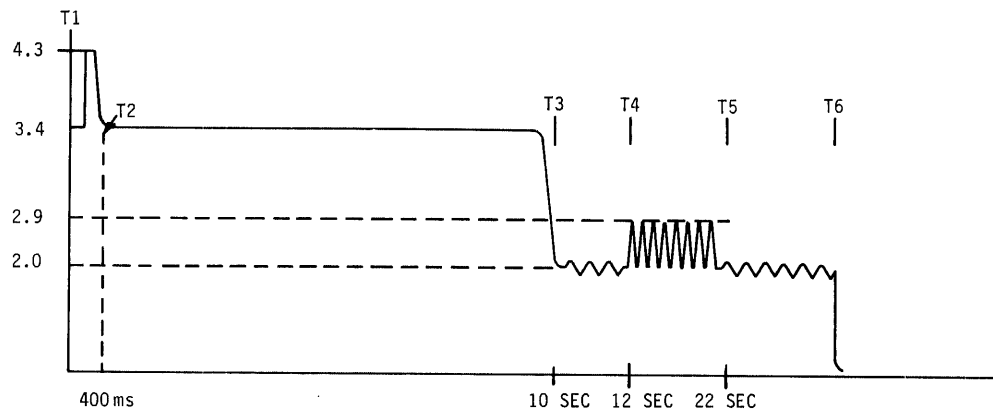
FIGURE 3. TYPICAL +12 V CURRENT PROFILE

7.3   HEAT/POWER DISSIPATION

Each WREN 11 will dissipate no more than 31.5 watts (116 BTUs per hour) of DC power average. Typical power dissipation under nominal conditions is less than 28 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). Maximum Wet Bulb 82°F (28°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 95°F (35°C) at 9840 feet (3000 meters). Cabinet packaging designs must provide ample air circulation around the WREN 11 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 11. The temperature of the base casting should not be allowed to exceed 135°F (57°C) at the hottest point. The hottest point may vary dependent upon application.

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 WREN 11.

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 +40,000 feet (-300 to +12,210 meters)

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

7.4.4   Shock and Vibration   ▌

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

The limits of shock and vibration defined within this
document are specified with the drive mounted by any of the
four methods shown in Figure 3.

4 SCREWS

4 SCREWS

H268a

2 SCREWS

2 SCREWS

H268b
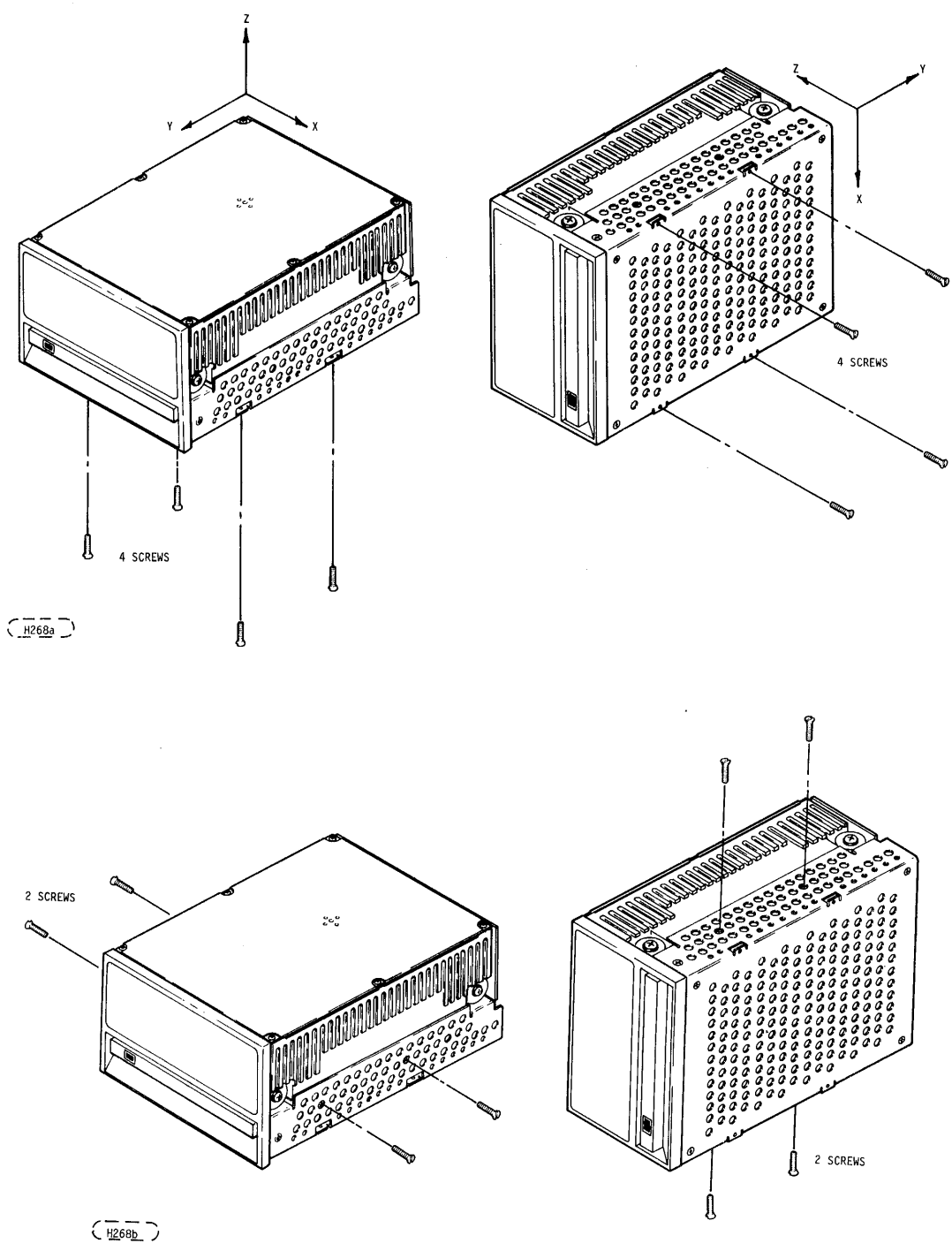
FIGURE 3. RECOMMENDED MOUNTING

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 sinewave). 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 physical damage while subjected to intermittent shock not exceeding 6 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.   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.

Equipment subjected to intermittent shock not exceeding 32 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. Shock is not to be repeated more than two times per second.

d.   Packaged

The WREN II 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.)

DROP HEIGHT
48 inches
(1219.2 mm)

FLOOR SURFACE

G040c
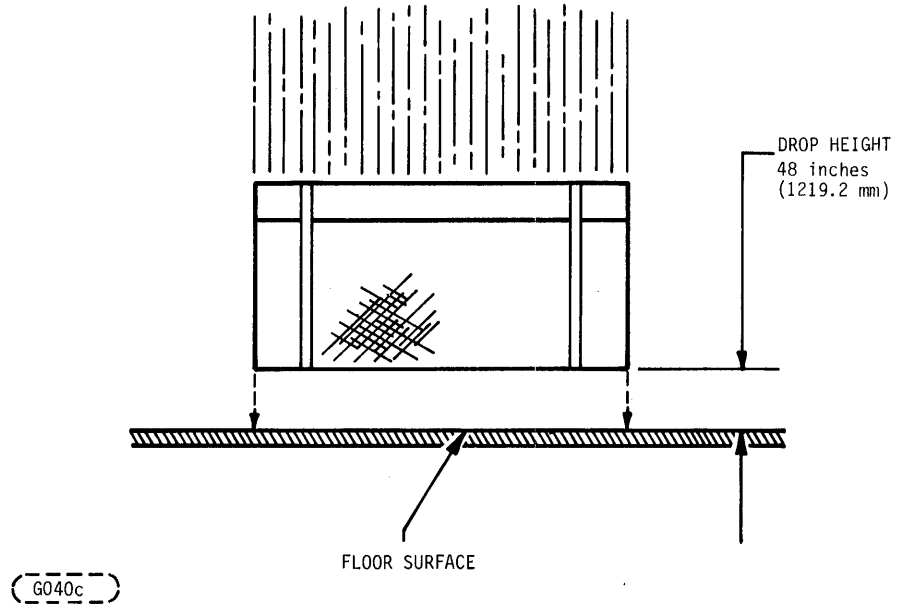
FIGURE 4. FLAT DROP TEST

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 @ 0.35 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.   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.

Equipment shall not incur physical damage or degraded performance as a result of continuous vibration not exceeding
5-10 Hz @ 0.020 inches displacement
10-500 Hz @ 1.00 G

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

7.4.5   Air Cleanliness

The WREN II 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 5 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 6.7 pounds	Approximately 3.1 kilograms
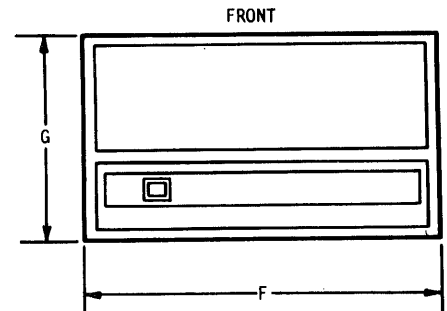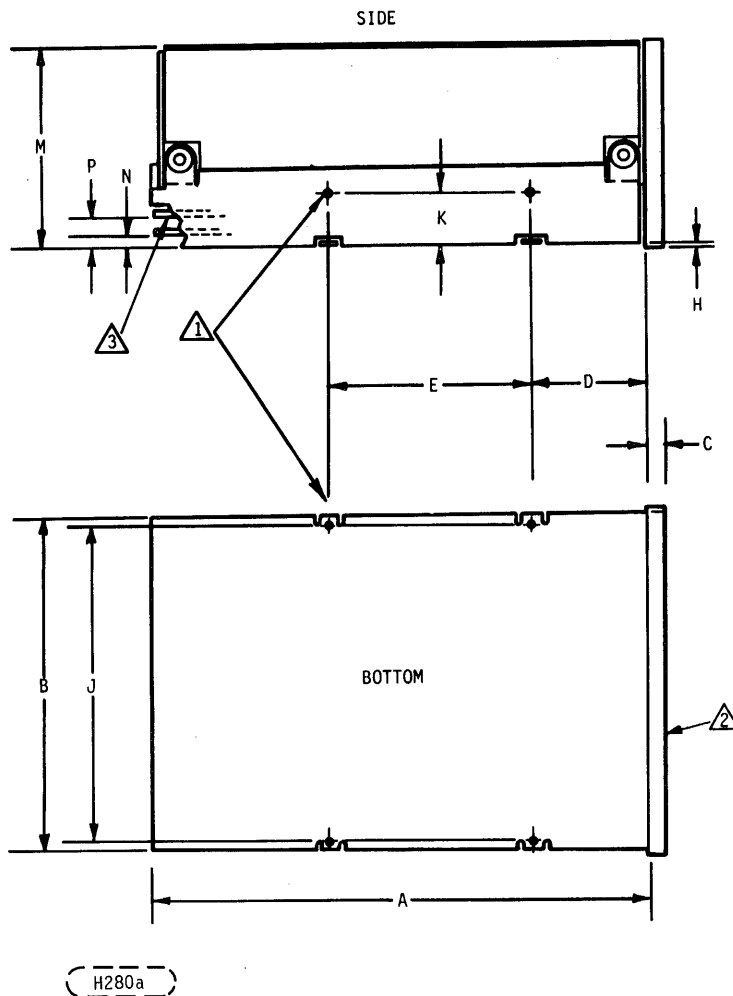
△NOTES:

1. MOUNTING HOLES, FOUR ON BOTTOM, TWO ON EACH SIDE. 6-32 UNC. MAX SCREW LENGTH INTO CHASSIS 0.31 IN. (7.87 mm)

2. FRONT PANEL ACCESSORY. TWO STYLES ARE AVAILABLE: STANDARD AND THIN.

3. DRIVE INTERFACE CONNECTIONS

	IN	CM
A	8.0 MAX	20.32
B	5.75 ± 0.00	14.6
C	0.29 ± 0.02	0.74
C*	0.19 ± 0.02	0.48
D	1.87 ± 0.02	4.75
E	3.12 ± 0.01	7.92
F	5.88 ± 0.01	14.9
G	3.38 ± 0.01	8.58
H	0.065 ± 0.02	0.165
J	5.50 ± 0.02	13.97
K	0.86 ± 0.02	2.18
M	3.25 ± 0.02	8.25
N	0.37 REF	0.94 REF
P	0.63 REF	1.60 REF

*OPTIONAL "THIN" FRONT PANEL

FIGURE 5. MOUNTING CONFIGURATION DIMENSIONS

7.5.1   Drive Orientation

Only two drive mounting orientations are permitted: disks in the horizontal plane and disks in the vertical plane. The uppermost surface must be maintained in a level position or drive performance may be adversely affected. In the vertical plane, the drive may be mounted on either side, but not on either end. The drive may not be mounted inverted (upside down) in the horizontal orientation. It is recommended for optimum performance that data written in a given orientation be read in that same orientation.

7.5.2   Cooling

The cabinet cooling must be designed by the customer so that the ambient temperature immediately surrounding the WREN II will not violate temperature conditions specified in 7.4.1. Specific consideration should be given to ensure adequate air circulation is present around the heat sinks on the circuit board at the rear of the drive.

8.0   MEDIA CHARACTERISTICS

8.1   MEDIA DESCRIPTION

The media used on the 94156 WREN II 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 a total of 925 tracks and capable of recording 9,657,000 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 peripheral. However, the code chosen should be consistent with Control Data media testing and certification methods. WREN II 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.

8.1   (continued)

Host systems utilizing the WREN II 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 II recording surfaces will meet the following requirements.

1.   925 total tracks per surface.

2.   Track 0 to be error free on each data surface.

3.   15 defects per surface maximum.

4.   Accumulative defects not to exceed 1 per megabyte, based on total available drive capacity.

9.0   DEFECT AND ERROR MANAGEMENT

The WREN II, as delivered, complies with this specification. The read error rate and specified storage capacity are not dependent upon utilization 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 ESDI specification (Sections 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 utilized, 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 II are shown in
Figure 6. View A of Figure 6 shows each drive interfaced to
its own control 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 control cable
radially connected to the host controller. The length of
each individual cable must not exceed 10 feet (3.0 meters).
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 II Disk Drive.

10.2   DAISYCHAIN CONFIGURATION

A daisychain configuration incorporates parallel
interfacing of the disk drives on a common control cable. A
maximum of seven drives may be daisychained on the control
cable in the SERIAL mode of operation (see paragraph
11.1.1). A maximum of three drives may be daisychained in
the STEP mode of operation (see paragraph 13.1.1.1). Only
the drive which is selected by the host system has its
control signals enabled through this common interface.
View B of Figure 6 illustrates a daisychain of three WREN
II Disk Drives. A terminator resistor pack is required in
the host controller for each data cable. Only the last WREN
II in the daisychain requires a terminator resistor pack
for the control cable. Terminator resistor packs for the
control cable of other drives are removed. See Figure 7 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 not be more than 10
feet (3.0 meters).

Refer to paragraph 11.1.1 for logical drive selection.

HOST CONTROLLER

DATA   CONTROL   DATA   CONTROL   DATA   CONTROL   DATA   CONTROL

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

WREN   WREN   WREN   WREN

VIEW A

HOST CONTROLLER

DATA   CONTROL   DATA   DATA

CONTROL   CONTROL

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

WREN   WREN   WREN

VIEW B

T INDICATES TERMINATOR RESISTOR PACK.

WREN DATA PORTS ARE PERMANENTLY TERMINATED.

(H142a)

FIGURE 6. INTERFACE CABLING OPTIONS

10.3   DC CABLE AND CONNECTOR

The WREN 11 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 of the mating connector are provided, but equivalent parts may be used (See Table 3).

The WREN 11 is shipped with the DC ground and the chassis ground joined together. These two ground planes may be separated by removing W4 from the Data PWA. (See Figure 6A and 6B.)
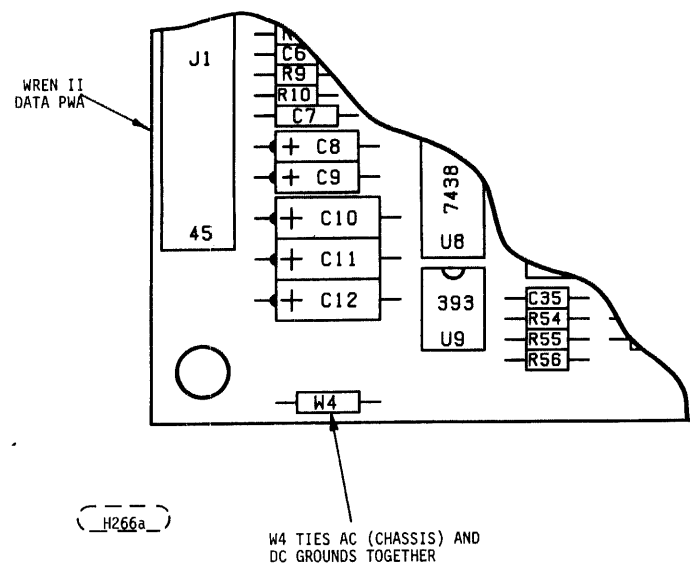
FIGURE 6A. DATA PWA SHOWING W4
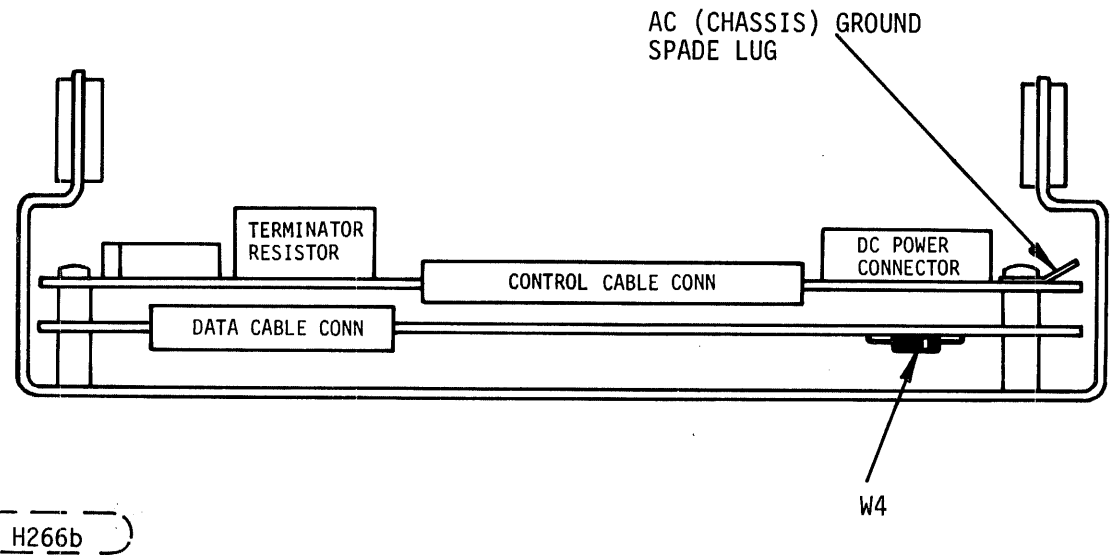
FIGURE 6B. LOCATION OF W4

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. EQUIVALENT PARTS

TYPE OF CABLE	CONNECTOR	CONTACTS (20-14 AWG)
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 (Figure 8 and 9a). The odd pins are located on the non-component side of the printed circuit board. The even pins are on the component side of the printed circuit board. A key slot is provided between pins 3 and 5. CDC recommends keying this connector to prevent the possibility of installing it upside down. However, the WREN will not be damaged if the connector is installed upside down.

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

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

Sections 11.1.1 also shows Drive Select Jumper Locations.

NOTE
UNIT SELECT ZERO IS INVALID

*STEP MODE SUPPORTS ONLY THREE VALID UNIT SELECTED DEVICES
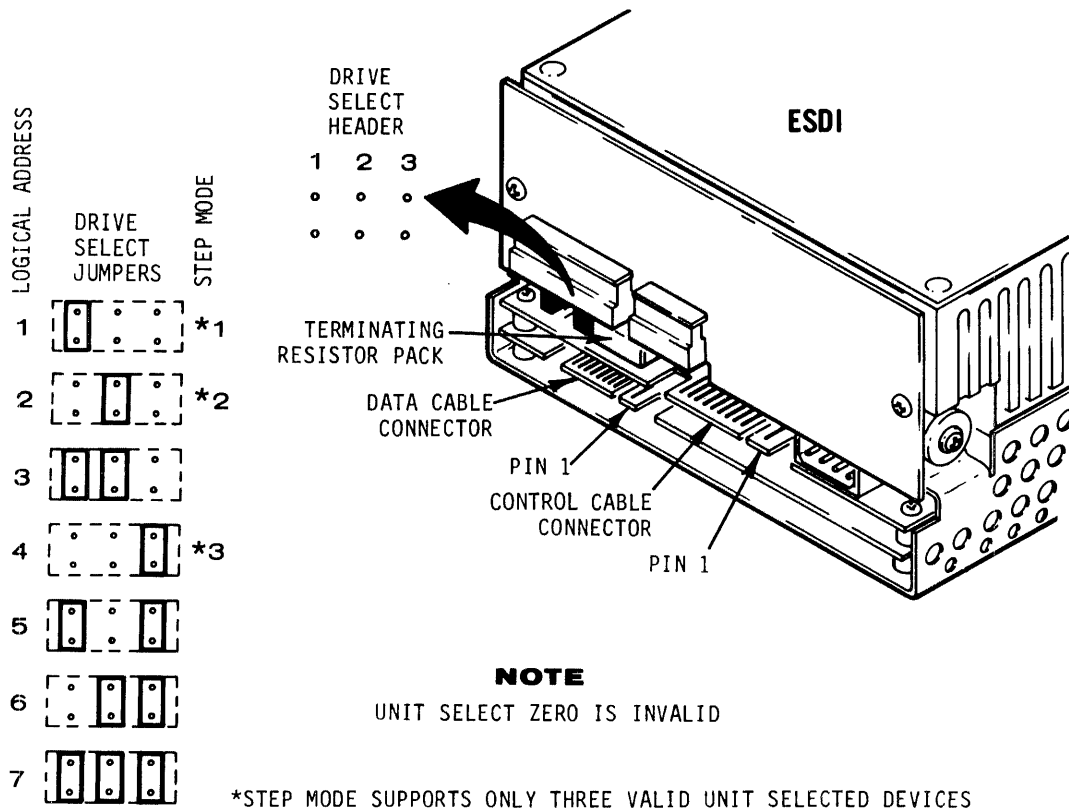
H247a

FIGURE 7. I/O CONNECTION

KEYING NOTCH
(BETWEEN PIN 3 & 5)   PIN 1

PIN 33

PIN 1

PIN 19

CONTROL CABLE

CONTROL BOARD
(COMPONENTS UP)

KEYING NOTCH
(BETWEEN PIN 3 & 5)   DATA CABLE

DATA BOARD
(COMPONENTS DOWN)

(FF274)
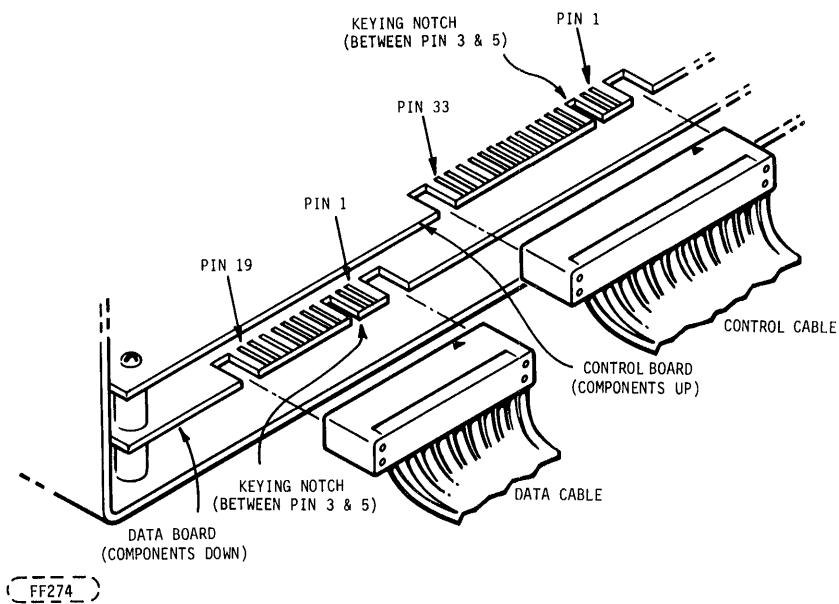
FIGURE 8. CABLE CONNECTION

NON-COMPONENT SIDE

0.065

0.030 +0.006
       -0.001

BOARD
THICKNESS
0.062 ± 0.005

19

5 3 1

PIN

0.450

0.400

KEYING SLOT

0.050

0.050

0.100

1.080 ± 0.005

(FF132c)
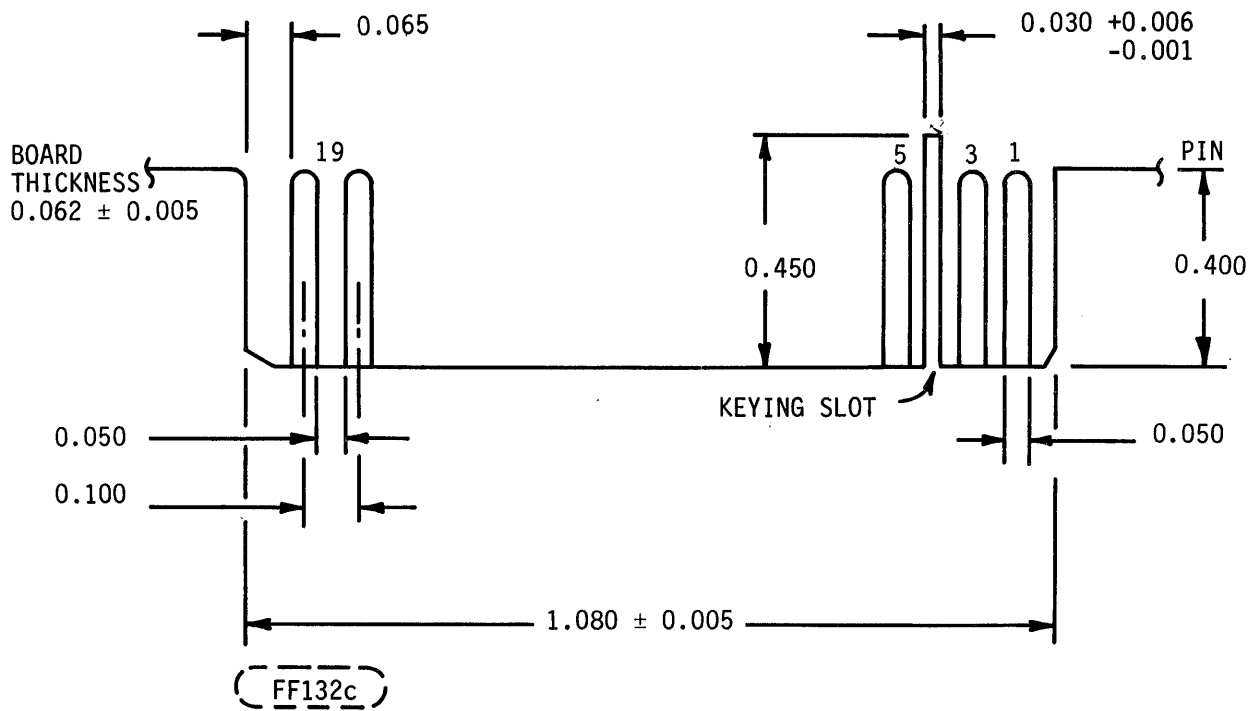
FIGURE 9a. DATA CABLE INTERFACE

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 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 pins 3 and 5. (See Figure 8 and 9b.) CDC recommends keying this connector to prevent the possibility of 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

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)

10.6   INTERFACE DRIVERS/RECEIVERS

The WREN II 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 WREN II 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 WREN II 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.

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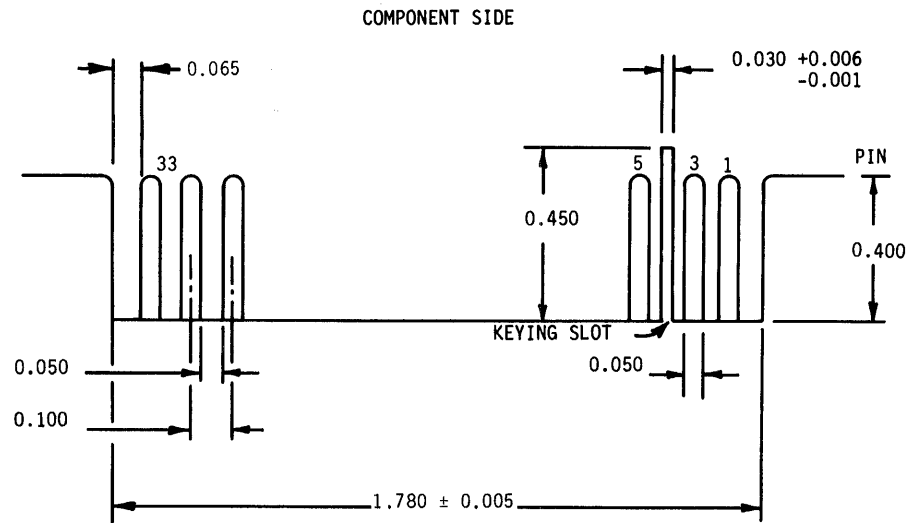
NOTE: TOLERANCE ±0.010 in. EXCEPT WHERE OTHERWISE NOTED.

H146b

FIGURE 9b. CONTROL CABLE INTERFACE

LINE DRIVER

LINE RECEIVER
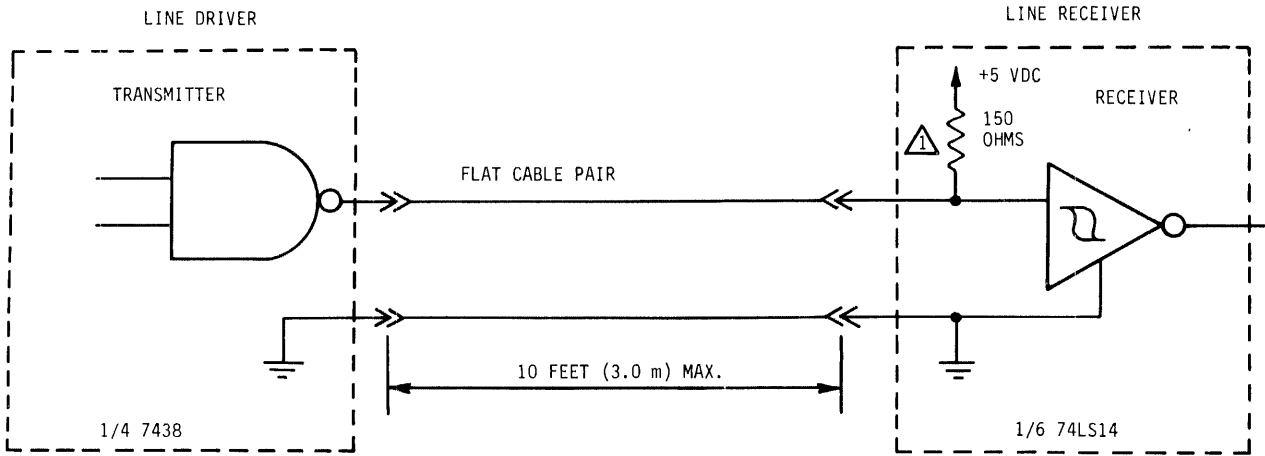
PART OF REMOVABLE RESISTOR PACK. (SEE FIGURE 9)

INTERFACE SIGNALS 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 V; $\leq$5.25 V	$\geq$2.0 V; $\leq$5.25 V
LOW (TRUE OR ACTIVATED) (1)	$\leq$0.4 V; $\geq$0.0 V	$\leq$0.8 V; $\geq$0.0 V

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

H118b

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 Control cable resistor module is removable.

10.6.2   Balanced Differential Drivers/Receivers

10.6.2.1 Transmitter Characteristics

The WREN 11 uses 26LS31 type balanced differential drivers. A 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 WREN 11 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.

⚠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

⚠3 NOMINAL "+" LINE

LOGIC 0   LOGIC 1
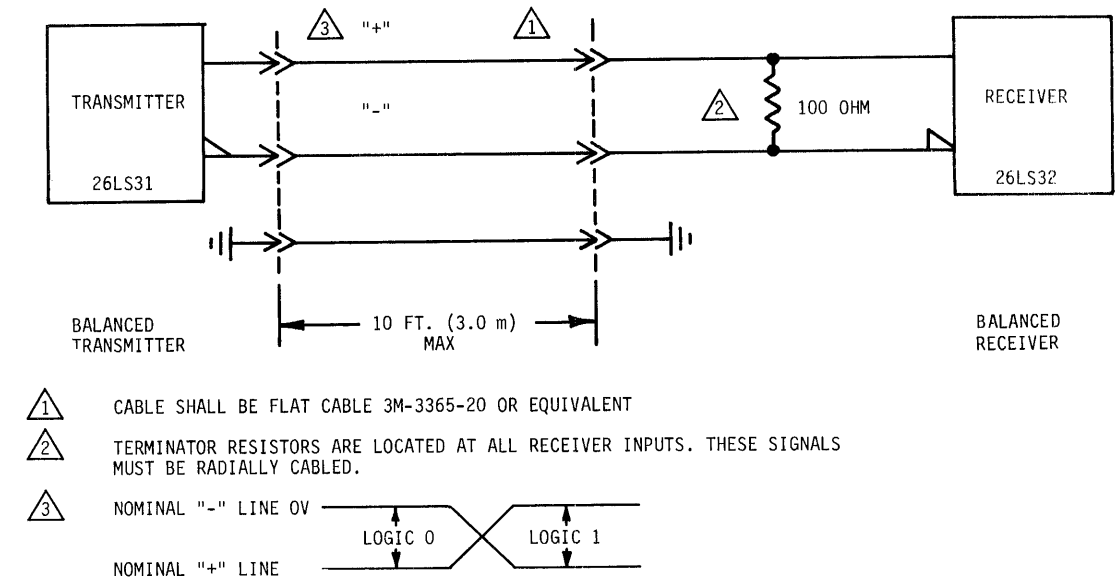
(H118a)

FIGURE 11. BALANCED DIFFERENTIAL DRIVERS/RECEIVERS

11.0   SERIAL MODE INTERFACE SIGNAL DESCRIPTION

This Section (11) specifies standard WREN II ESDI parameters for the SERIAL mode of operation. Section 5.0 of the ESDI Specification (77738076) contains a detailed description of the SERIAL mode and must be referenced to define the ESDI interface operation.

Figures 9 and 10 of the ESDI Specification lists the signals between the drive and the controller for the SERIAL mode of operation. These same signals are used by the Standard Model 94156 WREN II.

11.1   CONTROL INPUT LINES

11.1.1   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 the jumper on the baseboard assembly as shown in Figures 7 and 12 of this specification.

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 true or false) within 500 ns after the drive is selected. Refer to Fig. 13.

3.   The drive will be selected (and the DRIVE SELECTED Signal true) within 1 µs after the DRIVE SELECT lines contain that unit's select address. The drive will be deselected (and the DRIVE SELECTED signal false) within 1 µs after the DRIVE SELECT lines contain another unit's select address.

4.   The DRIVE SELECT lines must remain active for 1 us after a write operation.

5.   When the DRIVE SELECT lines are deactivated, a head change will occur per Section 11.1.2 requiring a delay before a read or write operation can be initiated. Refer to Figure 13.

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11.1.1   (continued)

Install jumpers as shown below for logical unit address.
Refer to Figure 7 for location of unit select header. The
logical address is selected by installing jumper/jumpers in
the Drive Select header as shown in Figure 7 and also in
Figure 12 below.

NOTE

UNIT SELECT ZERO IS INVALID

*STEP MODE SUPPORTS ONLY THREE VALID UNIT SELECTED DEVICES
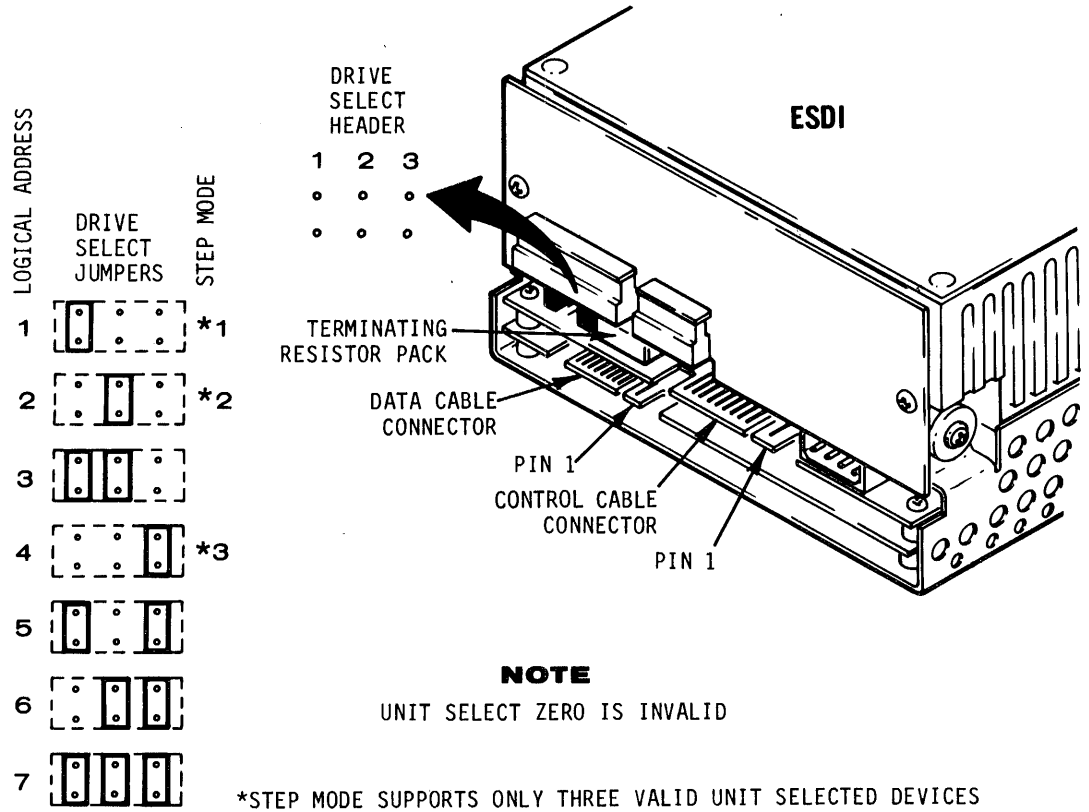
FIGURE 12. WREN II ESDI LOGICAL ADDRESS SELECT JUMPERS

With the jumper installed in position 1 of the logical
address header as shown, the logical address would be 1.

*   The step mode option is discussed in greater detail in
    section 13.6 of this document.
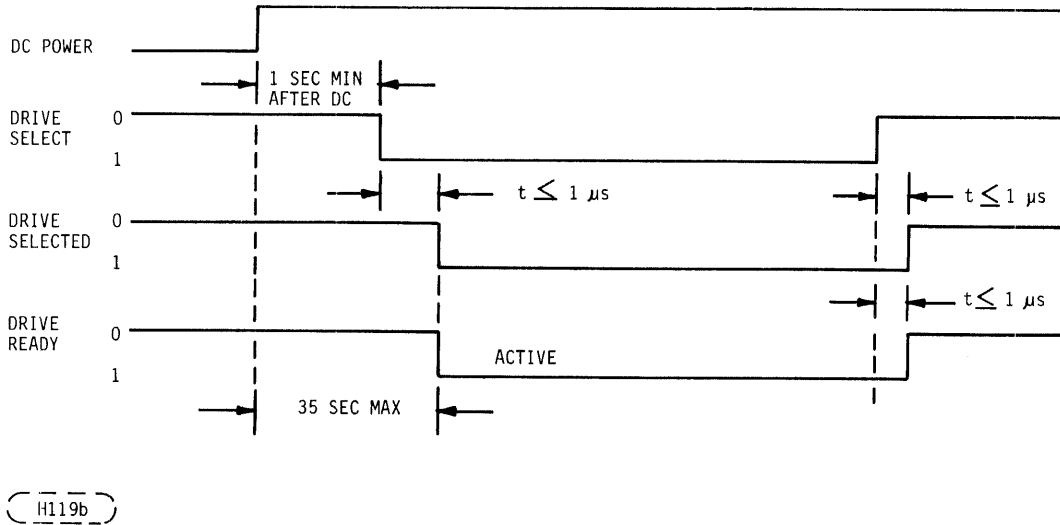
FIGURE 13. POWER TURN ON AND DRIVE SELECTION

11.1.2   Head Select 2^0, 2^1, 2^2, and 2^3

Refer to ESDI Specification Section 5.1.2.

These lines are used to select the proper media and head for data transfer per Table 4.

Head selection may be changed at any time following activation of DRIVE SELECT, but must occur a minimum of 5 us prior to a write operation. WRITE GATE must be deactivated a minimum of 1 μs prior to a head change. READ DATA will be valid within 5 μs from a head selection (change) if the drive is selected, READ GATE is true, the DRIVE READY line is true, and the COMMAND COMPLETE line is true.

Neither the DRIVE READY line or the COMMAND COMPLETE line will change as a result of a head selection (change).

11.1.2   (continued)

TABLE 4. HEAD-SELECT ENCODING

DISK NOMENCLATURE	HEAD SELECT 2^3 2^2 2^1 2^0	TOP OF SPINDLE	HEAD NUMBER BY MODEL CAPACITY IN MEGA BYTES 86	67	48
TOP OR 5th DISK	1 0 0 0		8	*	*
	0 1 1 1		7	*	*
4th DISK	0 1 1 0		6	6	*
	0 1 0 1		5	5	*
3rd DISK	0 1 0 0		4	4	4
	0 0 1 1		3	3	3
2nd DISK	0 0 1 0		2	2	2
	0 0 0 1		1	1	1
BOTTOM OR 1st DISK	0 0 0 0 SERVO		0 S	0 S	0 S

BASE DECK

* INVALID HEAD

HEAD SELECTS OTHER THAN THOSE SHOWN ARE INVALID

(H060a)

11.1.3   Write Gate

Refer to ESDI Specification Section 5.1.3.

Note that a False to True transition of WRITE GATE does not initiate writing a special PLO Sync Field by the WREN II. The WREN II will write the same PLO Sync Field supplied by the controller at this time.

11.1.4   Read Gate

Refer to ESDI Specification Section 5.1.4.

11.1.5   Command Data

Refer to ESDI Specification Section 5.1.5.

11.1.5.1 Command Data Bits 15 thru 12 Decode Definition

Refer to ESDI Specification Section 5.1.5.1.

The 94156 WREN II 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 true.

11.1.5.1 (continued)

SERIAL MODE COMMAND SET IMPLEMENTED	WREN II
● SEEK	YES
● RECALIBRATE	YES
● REQUEST STATUS	
-STANDARD	YES
-VENDOR UNIQUE	YES
● REQUEST CONFIGURATION	YES
● SELECT HEAD GROUP	NO
● CONTROL	
-RESET ATTENTION AND STANDARD STATUS 0-11	YES
-STOP MOTOR	NO
-START MOTOR	YES
● DATA STROBE OFFSET - 3 LEVELS/ ONE PHYSICAL OFFSET	YES
● TRACK OFFSET - 3 LEVELS/ONE PHYSICAL OFFSET	YES
● INITIATE DIAGNOSTICS	YES
● SET BYTES PER SECTOR	YES

The following ESDI commands are recognized by the Model 94156 WREN II. 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 activated when the drive has completed the SEEK operation and is ready to accept the next command word.

11.1.5.1 (continued)

RECALIBRATE (0001):

The maximum time to complete the Recalibrate function is 500 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 activated when the Recalibrate function is completed.

REQUEST STATUS (0010):

1. REQUEST STANDARD STATUS (command modifier equals 0000)

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

    The COMMAND COMPLETE line will be activated after the controller has read the drive's standard status word.

    The controller should always first request the Standard Status in response to the activation 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 11.2.3.2 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 only valid if bit 2 of the Standard Status is a one.

    This status is only intended to be utilized 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 prior to 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 utilized by the field maintenance personnel.

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11.1.5.1 (continued)

<u>REQUEST CONFIGURATION (0011):</u>

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 5.

See Section 11.2.3.1 for the responses to the "Request Configuration" commands.

<div align="center">TABLE 5.</div>

COMMAND MODIFIER BITS				FUNCTION
11	10	9	8	
0	0	0	0	GENERAL CONFIGURATION OF DRIVE AND FORMAT
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

*NOT INCLUDING INTERSECTOR SPEED TOLERANCE

<u>CONTROL (0101):</u>

Refer to ESDI Specification Section 5.1.5.1.

The WREN II 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.

11.1.5.1 (continued)

    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 activated.

    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 active (see Sections 11.2.3.1 and 12). This command is not required to turn on the spindle motor if the "Motor Control Option Implemented" configuration bit is inactive, and will be treated as an Invalid Command.

        The interface COMMAND COMPLETE line will be activated when the Control Command has been executed.

DATA STROBE OFFSET (0110):

The drive will accept all of the Data Strobe Offset Commands but will only offset from nominal by a single amount.

TRACK OFFSET (0111):

The drive will accept all of the Track Offset Commands but will only offset from nominal by a single amount. 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 activated when the COMMAND COMPLETE signal is activated to signify that status is available.

If no error state exists in the drive, the COMMAND COMPLETE signal will be activated and the ATTENTION signal will not be activated.

11.1.5.1 (continued)

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 41 (decimal).

11.1.6   Transfer Request

Refer to ESDI Specification Section 5.1.6.

11.1.7   Address Mark Enable

Refer to ESDI Specification Section 5.1.7 and Section 11.1.3 of this document.

11.2   CONTROL OUTPUT LINES

11.2.1   Drive Selected

Refer to ESDI Specification Section 5.2.1. and Section 11.1.1 of this specification.

11.2.2   Ready

Refer to ESDI Specification Section 5.2.2.

Writing is also inhibited if a Write Fault condition exists or if the Interface ATTENTION line is true.

11.2.3   Config/Status Data

11.2.3.1 Configuration Response Bits

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

a.   If the Command Modifier bits (11-8) were 0000, the general configuration status information shown below is returned.

CONFIGURATION BIT	FUNCTION	WREN II VALUE	
15	TAPE 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%	1	
10	TRANSFER RATE > 10 MHz	0	
9	TRANSFER RATE > 5 MHz ≤ 10 MHz	0	
8	TRANSFER RATE ≤ 5 MHz	1	△2
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	RLL ENCODED (NOT MFM)	0	△5
2	CONTROLLER SOFT SECTORED (ADR MARK)	△4	
1	DRIVE HARD SECTORED (SECTOR PULSES)	△4	
0	CONTROLLER HARD SECTORED (BYTE CLK)	△4	

△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 DEACTIVATED WHEN A HEAD CHANGE IS PERFORMED BY THE DRIVE.

△4   THE APPROPRIATE BIT WILL BE ACTIVATED TO INDICATE THAT THE SIGNAL WHICH IS CURRENTLY BEING TRANSMITTED ON THE SECTOR/ BYTE CLOCK/ADDRESS MARK FOUND SIGNAL LINES IN THE INTERFACE (SEE SECTION 12.0).

△5   INTERNAL RECORDING MECHANISM IS MFM. DRIVE REQUIRES ZEROS FOR THE PLO SYNC FIELD.

△6   SWITCH SELECTABLE (SEE SECTION 12).

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11.2.3.1 (continued)

b.   Number of Cylinders, FIXED - (command modifier = 0001) Equals the maximum number of drive cylinders.

c.   Number of Cylinders, REMOVABLE - (command modifier = 0010). Equals 0 to signify no removable media.

d.   Number of Heads - (command modifier = 0011)
Bits 15-8 equal 0 to signify no removable media is present.

Bits 7-0 (in decimal) equals either 5, 7 or 9 and is determined by the number of R/W heads installed (i.e., model number).

e.   Minimum Unformatted Bytes per Track (command modifier = 0100). Equals 10,440 (decimal).

f.   Unformatted Bytes per Sector (command modifier = 0101). The Value will be the Integer value of 10,440 divided by the number of Sectors per Track (see following g).

g.   Sectors per Track (command modifier = 0110). The default value, which is determined by switch settings at the time of installation (see Section 12.0), will be either 16, 17, 32, or 34. See also "Set Bytes per Sector" command which results in a value of Integer 10,440 divided by desired Number of Bytes per Sector.

h.   Minimum Bytes in ISG Field (command modifier = 0111)
Bits 15-8: Equal 12 (decimal)
Bits 7-0: Equal 16 (decimal)

i.   Minimum Bytes per PLO Sync Field (command modifier = 1000).
Bits 15-8: Equal 0
Bits 3-0: Equal 11 (decimal)

j.   Maximum number of vendor unique status words available (command modifier 1001).

11.2.3.1 (continued)

k.   WREN II Unique (command modifiers 1010, 1011, 1100)These codes are reserved for use by the WREN II and must not be requested by the controller.

l.   Reserved (command modifiers 1101, 1110, and 1111). These codes are reserved and if requested, no configuration data will be sent, but the Interface ATTENTION line will be activated and an Invalid Command Standard Status bit will be activated.

11.2.3.2 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 94156 WREN II will support the following standard status bits as referenced in the ESDI Specification Section 5.2.3.2.

SERIAL MODE-STANDARD STATUS BITS SUPPORTED   WREN II

Bit(s)	Function	
15, 11, 10	RESERVED AND WILL BE ZERO	YES
14	REMOVABLE MEDIA NOT PRESENT	YES (=1)
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

11.2.3.2 (continued)

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	NO (=0)

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 1 for the WREN II drive.
      The WREN Drive only contains fixed media.

c.   Write Protected, Removable Media (Bit 13)
      This bit will always be zero for the WREN II drives.

d.   Write Protected, Fixed Media (Bit 12)
      This bit will always be zero for the WREN II drives.

e.   Spindle Motor Stopped (Bit 9)
      This bit is activated when the spindle motor is stopped. (See also Section 12.)

11.2.3.2 (continued)

f.   Power On Reset Conditions Exist (Bit 8)
        This bit is activated 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 13 if the
        "Spindle Motor Control Option Implemented" is
        selected.)

g.   Command Data Parity Fault (Bit 7)
        This bit will be activated 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
        prior to defining the drive as inoperable.

h.   Interface Fault (Bit 6)
        This bit will be activated when an interface protocol
        violation is detected by the drive. This bit will be
        activated when either the Command Word or
        Configuration/Status word 1/0 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 false.

11.2.3.2 (continued)

    i.   Invalid or Unimplemented Command Fault (Bit 5)
This bit is activated 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 ESD1 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 activated when the drive detects a problem with its actuator electronics or mechanism(s). This bit is activated when the Drive is unable to maintain the Read/Write heads within the recording zone of the media.

If the Seek Fault bit is activated the controller should attempt to Reset the Standard Status, send a RTZ command and reissue the SEEK command a minimum of three times prior to 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.

11.2.3.2 (continued)

k.   Write Gate With Track Offset Fault (Bit 3)
      This bit is activated when the drive actuator is
      offset from the normal On Cylinder location and the
      controller activates the WRITE GATE signal. Writing
      to the drive media will be inhibited. If this bit
      (bit 3) is activated 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 activated to indicate that additional
      Vendor Unique Status is available in the Vendor
      Unique Status word(s).

m.   Write Fault (Bit 1)
      This bit is activated to indicate that a Write Fault
      condition has occurred in the drive and that further
      writing will be inhibited until the fault is cleared.

NOTE

The interface Attention signal will be
activated 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
      Active or no write current with Write Gate
      Active and Drive Selected.

2.   Write Gate active 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 activated.

11.2.3.2 (continued)

> The controller should attempt to reset the Write Fault at
> least three times prior to defining a drive as inoperable.
>
> n.   Removable Media Changed (Bit 0)
>   This bit will always be zero for the WREN II drives.

11.2.4   Transfer Ack

Refer to ESDI Specification Section 5.2.4.

11.2.5   Attention

Refer to ESDI Specification Section 5.2.5.

11.2.6   Index

This signal occurs once per revolution or 16.67 ms nominal.
The logic 1 pulse width is 8 times the reference clock
period or 1.596 μs, $\pm$1.0%.

Refer to ESDI Specification Section 5.2.6 and Table 7 of
this document.

11.2.7   Sector/Byte Clock/Address Mark Found

The WREN II supports all three format modes, selection is
determined by switch settings. Refer to Section 12.0 for
configuration information.

Refer to ESDI Specification Section 5.2.7 and Table 7 of
this document. If applicable, the Sector Pulse logic one
pulse width is 8 times the reference clock period or 1.596
μs $\pm$1.0%.

11.2.8   Command Complete

Refer to ESDI Specification Section 5.2.8.

Command Complete will be activated (following a
deactivation) in the following cases:

11.2.8   (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 actuator is 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.

11.3   DATA TRANSFER LINES

Refer to ESDI Specification Section 5.3

The nominal data transfer rate is 5.0 MHz which will result in a Read/Write Clock period (T) of 200 ns in Figure 21 of the ESDI Specification.

11.4   READ, WRITE, AND FORMAT PARAMETERS

Refer to ESDI Specification Section 5.4 except 5.4.3.5, 5.4.3.6, 5.4.4.5, and 5.4.4.6 which are not applicable. Refer to Table 6 in this document. The intersector gap is 16 bytes long and is oriented to begin four bytes before a sector (Index) pulse.

The PLO Sync Field length is 11 bytes minimum. See also Configuration Data Specifications in Section 11.2.3.1 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) or a Soft Sectored Format (Figure 24 of the ESDI Specification).

11.5   DEFECTS LIST

The WREN 11 provides media defect information in accordance with the ESD1 Specification. Refer to ESD1 Specification Section 5.5 for details.

12.0   DRIVE CONFIGURATION SWITCHES

The WREN 11 is configured by turning on/off the switches in SW1 on Servo PWB. SW1 is located behind the front panel as shown in Figure 14 and the functions defined in Table 6.
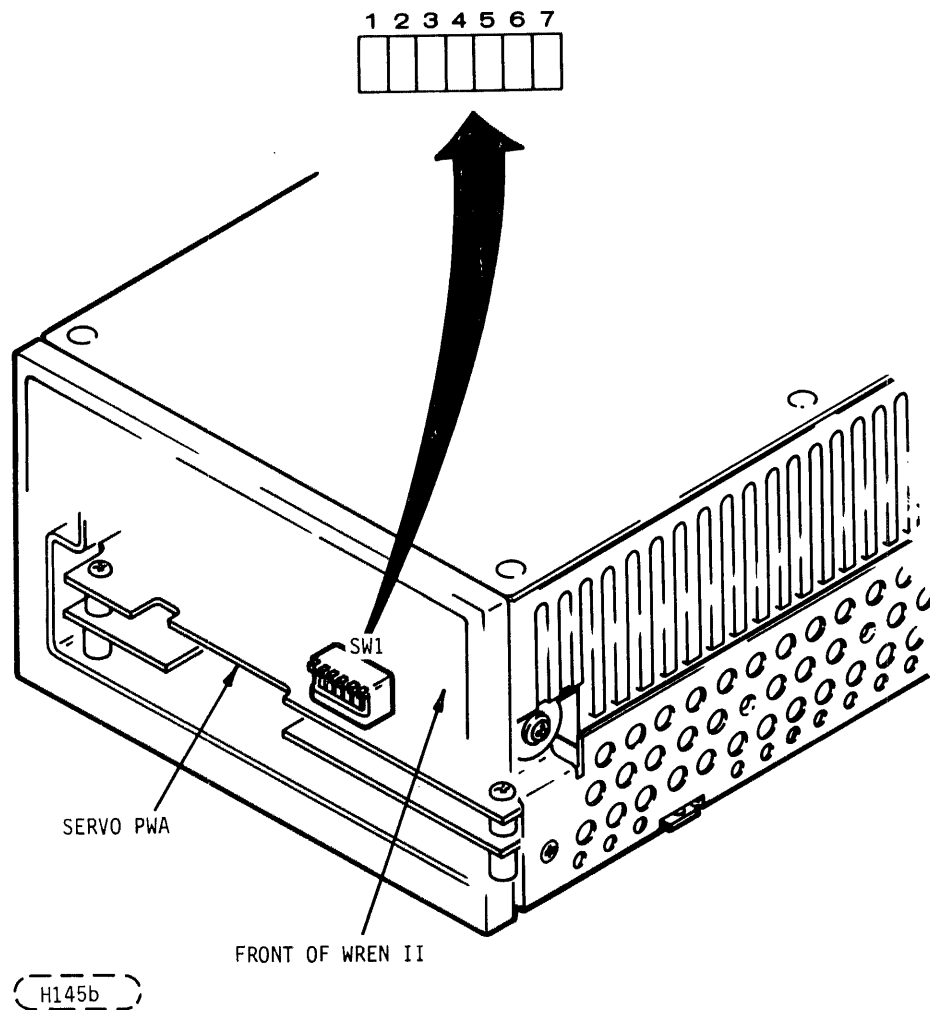

FIGURE 14. CONFIGURATION SWITCH LOCATIONS

12.0   (continued)

TABLE 6. CONFIGURATION SWITCH SETTINGS

SWITCH #	ON	OFF
SW1-1	Factory Test	Normal
SW1-2	Motor Control* Implemented	Motor Control Not Implemented
SW1-7	Serial Mode	Step Mode

	SWITCH #	
SECTORS/TRACK	SW1-3	SW1-4
17	ON	ON
16	OFF	ON
34	ON	OFF
32	OFF	OFF

	SWITCH #	
FORMAT MODE	SW1-5	SW1-6
Address Mark	ON	ON
Byte Clock	OFF	ON
Sector Pulse	OFF	OFF
Sector Pulse	ON	OFF

*When the SW1-2 switch is on, 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 activate Standard Status Bits (Section 11.2.3.2) 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 also the Start Motor Command in order to start the spindle motor.

NOTE

This procedure is required anytime that the "Power On Reset Condition Exists" status bit is received by the controller if the "Motor Control Implemented" switch is on.

12.0   (continued)

TABLE 7. KEY DRIVE PARAMETERS

PARAMETER	WREN II
DATA CAPACITY (UNFORMATTED)	
-Bytes per Track	10,440
-Tracks per Surface - Fixed	925
-Maximum Number of Data	
Heads - Fixed	9, 7 or 5
Rotational Speed	3600 r/min $\pm$0.5%
Rotational Period (T_{RX})	16.67 ms ($\pm$0.5%)
Data Transfer Rate (Reference/Read Clock Frequency)	5 MHz ($\pm$1.0%)
Data Bit Clock Period (R_{RC}) (Reference/Read Clocks)	200 ns ($\pm$1.0%)
Read Propagation Delay	3 bit times
Write Propagation Delay	4 bit times

13.0   OPTIONS

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

13.1   FRONT PANEL

The front panel is available in two styles differing only
by thickness of the panel (Ref. Figure 5). Each panel has a
single red rectangular LED indicator which designates the
drive is selected when illuminated. A flashing indication
displays the presence of a non-recoverable fault. A fault
indication is displayed irrespective of DRIVE SELECT status.

13.2   CUSTOM FORMATTING

The 94156 WREN II is formatted during production. CDC
maintains custom formatting capability which can
incorporate many of the unique formats utilized in the
Winchester marketplace. A majority of special format
requirements can be implemented as specified.

13.3   POWER SUPPLY

The WREN II power supply is an option which will provide
the necessary DC power to support one WREN II drive. Two
models are available, one for 60 Hz/120 VAC applications
and one for 50 Hz/230 VAC. The DC characteristics of the
supplies are shown below:

	+5 V	+12 V
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	4.5 A

13.4   AC/DC GROUND SEPARATION

The 94156 WREN II may be provided with the AC ground
(chassis) isolated from the DC logic ground. This option
may be beneficial in reducing ground induced noise in some
system applications.

13.5   SINGLE UNIT SHIPPING PACK

The 94156 WREN II is normally shipped in bulk packaging to
ensure 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.

13.6   OPTIONAL FEATURES

The Model 94156 WREN II is designed to support either the
Serial or Step Mode of ESDI operation. The standard ESDI
WREN II is produced to conform to the Serial Mode with
functional parameters outlined in Section 11.0 of this
specification. The ESDI Step Mode of operation is available
on the 94156 WREN II as an option. This feature is
installed and tested during manufacturing at the request of
the customer.

13.6.1   STEP MODE INTERFACE SIGNAL DESCRIPTIONS

This section describes the functional characteristics of
the Step Mode of operation of the ESDI WREN II. Section 6.0
of the ESDI specification outlines a detailed description
of the Step Mode and should be referenced for additional
information.

The Step Mode Option provides the following signals on ESDI
WREN II. The associated signals of the Serial Mode are not
available in units produced with the Step Mode option.

13.6.2   Control Input Lines

13.6.2.1 Drive Select

Refer to ESDI Specification Section 6.1.1 and Section 11.1.1 of this document. Figure 12 identifies the appropriate unit select configuration. Please note that the step mode supports only three devices.

NOTE

UNIT SELECT ZERO IS INVALID

*STEP MODE SUPPORTS ONLY THREE VALID UNIT SELECTED DEVICES
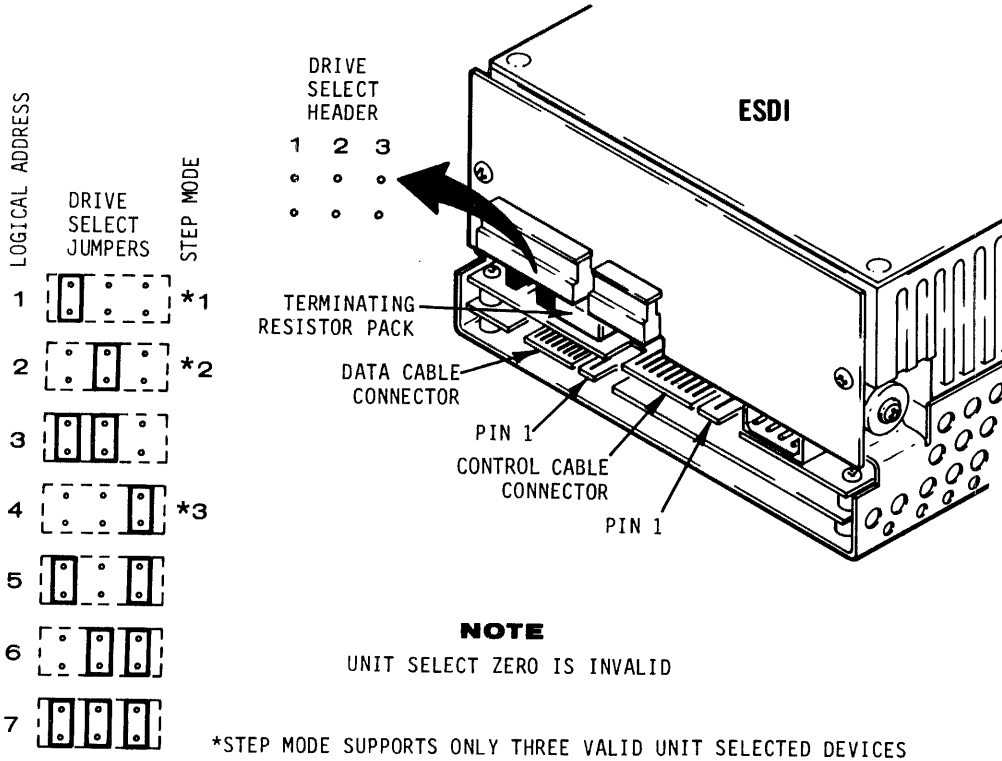
Note: Logical address 0 is invalid.

FIGURE 15. WREN II ESDI DRIVE SELECT JUMPERS

13.6.2.2 Head Select 2^0, 2^1, 2^2, 2^3

Refer to ESDI Specification Section 6.1.2 and Section 11.1.2 of this document.

NOTE

The change cartridge function is not used.

13.6.2.3 Write Gate

Refer to ESDI Specification Section 6.1.3

Note that a False to True transition of WRITE GATE does not initiate writing a special PLO Sync Field by the WREN II. The WREN 11 will write the PLO Sync Field being supplied by the controller.

13.6.2.4 Read Gate

Refer to ESDI Specification Section 6.1.4

13.6.2.5 Direction In

Refer to ESDI Specification Section 6.1.5

13.6.2.6 Step

Refer to ESDI Specification Section 6.1.6

NOTE

The drive will accept step pulse rates between 4.0 μs and 200 μs. To meet the drive seek performance characteristics, however, the maximum time between Step Pulses is 35 μs. Longer Step times degrade the drive's seek performance.

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

The seek performance characteristics as defined in Section 5 assumes a maximum time between STEP pulses of 35 μs which is measured from the receipt of the first STEP pulse.

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. 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.

13.6.2.6 (continued)

After the last Step pulse has been sent to the drive, the Drive Select line may be deactivated and a different 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 the last track in the data zone (Track 0 or maximum track). 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 connection with the interface TRACK 0 indication may be used to perform the recalibrate function. The recommended 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.

13.6.2.6 (continued)

A recalibration may also be accomplished by sending a string of Step Pulses at maximum rate (in reverse direction) which exceeds the maximum cylinder count and then waiting for Seek Complete. The drive will reposition the heads to Track 0.

13.6.2.7 Address Mark Enable

Refer to ESDI Specification Section 6.1.7.

13.6.3   Control Output Lines

13.6.3.1 Drive Selected

Refer to ESDI Specification Section 6.2.1.

13.6.3.2 Ready

Refer to ESDI Specification Section 6.2.2. The writing is also inhibited if the WRITE FAULT line is true.

13.6.3.3 Seek Complete

Refer to ESDI Specification Section 6.2.3.

13.6.3.4 TRACK 0

Refer to ESDI Specification Section 6.2.4.

13.6.3.5 Write Fault

Refer to ESDI Specification Section 6.2.5.

The following conditions cause a write fault:
a.   WRITE GATE is true and either:
    1.   no write current; or
    2.   no write data; or
    3.   READY is false; or
    4.   SEEK COMPLETE is false; or
    5.   an invalid head or multiple heads are selected; or
    6.   the drive is not on-cylinder; or
    7.   READ GATE is true.
b.   WRITE GATE is false and write current is present.

13.6.3.6   Index

Refer to ESDI Specification Section 6.2.6 and Section 11.2.6 of this document.

13.6.3.7   Sector/Byte Clock/Address Mark Found

Refer to ESDI Specification Section 6.2.7 and Section 11.2.7 of this document.

13.6.3.8   Seek Complete (Radial)

See ESDI Specification Section 6.2.8.

13.6.3.9   Write Protected

This signal is not implemented by the WREN II. This line will be an open circuit at the drive.

13.6.3.10 Cartridge Changed

This signal is not implemented by the WREN II. This line will be an open circuit at the drive.

13.6.4   Data Transfer Lines

Refer to ESDI Specification Section 6.3

The nominal Data Transfer rate is 5.0 MHz (T of Figure 39 of ESDI Specification equals 200 ns).

13.6.5   Read, Write, and Format Parameters

Refer to ESDI Specification Section 6.4 except 6.4.3.5, 6.4.3.6, and 6.4.4.4 which are not applicable.

Refer to Table 7 of this document.

The Intersector Gap is 16 bytes long and is oriented to begin four bytes before a Sector (Index) pulse.

The PLO Sync Field length is 11 bytes minimum. The WREN 11 does not require format speed tolerance gaps. (Refer to Figures 40 or 42 of the ESDI specification.)

13.6.6   Defect List

Refer to ESDI Specification Section 6.5.

14.0   ACCESSORIES

All accessories are designed for implementation by the customer.

14.1   FRONT PANEL KIT

Same as 13.1 but includes all mounting hardware to support field installation. Kits are provided in two styles differing only by panel thickness (Ref. Figure 5).

14.2   HARDWARE MAINTENANCE MANUAL

This manual provides detailed maintenance information to facilitate repair of items external to the HDA (Head/Disk Assembly).

14.3   SINGLE UNIT SHIPPING PACK KIT

Same as 13.5 except kit provides the necessary packing materials required to package and ship one WREN II device to be supplied by the user.

14.4   POWER SUPPLY KIT (50 Hz or 60 Hz)

Same as 13.3 except the requested power supply is packaged and sold separately as an accessory.

14.5   OEM MANUAL

This manual provides basic information for the care, handling and installation of the WREN II. It is recommended for individuals who are not familiar with the product or Winchester Disk Drives in general.

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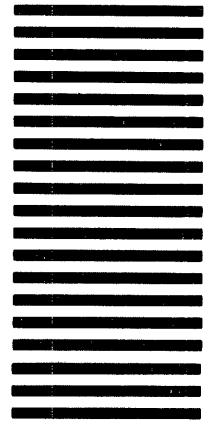
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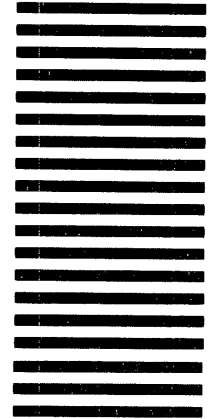
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