CONTROL DATA CORPORATION

PRODUCT SPECIFICATION
FOR
TM
WREN V HH DISK DRIVE
MODEL 94221 (SCSI)

**CONTROL DATA
CORPORATION**

PRODUCT SPECIFICATION
FOR
TM
WREN V HH DISK DRIVE
MODEL 94221 (SCSI)

SUMMARY

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

NAME	MODEL NUMBER *	PRODUCT SPECIFICATION	INTERFACE	CAPACITY (MEGABYTES)
WREN II	94155-XX	77715909	CDC 506 (ST506 COMP.)	57, 67, or 86 (925 Cyl)
WREN II	94155-XX	77738379	CDC 506 (ST506 COMP.)	85 or 96 (1024 Cyl)
WREN II	94155-XXX	77765324	CDC 506 (ST506 COMP.)	120, 135 (RLL)
WREN II	94156-XX	77738019	ESDI	48, 67 or 86
WREN II HH	94205-XX	77738213	CDC 506 (ST506 COMP.)	30, 41, 51, 77 (RLL)
WREN II HH	94204-YY	77738346	CDC 506 (ST506 COMP.)	65,71
WREN III	94166-XXX	77738212	ESDI	101, 141 or 182
WREN III	94161-YYY	77738270	SCSI **	86, 121 or 155 (512 Byte)
WREN III HH	94211-YY	77765250	SCSI **	91 (1024 Byte)
WREN III HH	94216-XXX	77765276	ESDI	106
WREN IV	94171-YYY	77738386	SCSI **	320 (1024 Byte)
WREN IV	94171-YYY	77765338	SCSI **	345 (1024 Byte)
WREN IV	94171-YYYD	77765361	SCSI **	345 (1024 Byte)(Dif. I/O)
WREN V	94186-442	77765300	ESDI	442 (15 Head, 1412 Cyl)
WREN V	94186-383			383 (13 Head, 1412 Cyl)
WREN V	94186-383H			383 (15 Head, 1224 Cyl)
WREN V	94181-YYY	77765336	SCSI **	702
WREN V	94181-XXXD	77765366	SCSI **	702
WREN V HH	94221-YYY	77765297	SCSI **	169, 190 (1024 Byte)
WREN VI	94191-XXX	77765353	SCSI **	766
WREN VI	94191-XXX	77765358	ESDI **	766

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

  YY(Y) denotes formatted drive capacity.

** These drives allow the user to reformat using any integer data block size between 256 and 2048 bytes (WREN III) or 4096 bytes (WREN IV, V). At the factory drives are formatted with 512 byte data block size, with capacity dependent on number of data heads. Capacity values are with limited spares for reallocation of defects.

(2260P)   -2-

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

1.0   SCOPE

This specification describes the Control Data Corporation
Model 94221 WREN™ V Half Height (HH) Disk Drive. This
high capacity, high performance, member of the 5 1/4 inch
WREN rigid disk family incorporates the Half Height WREN
III HDA (Head/Disk Assembly) with an embedded WREN IV SCSI
controller. Performance information is given in Section 5.
The Model 94221 interface is defined for functional
compatibility to the mandatory subset of the CDC SCSI
Interface Specification (which is compatible with the ANSI
SCSI standard and the Common Command Set (CCS) document,
Revision 4.B). The Model 94221 WREN is classified as an
"Intelligent" peripheral. The WREN V HH provides Level 2
conformance (highest level) with the ANSI SCSI standard.
Details of SCSI options are provided in Section 10-16.
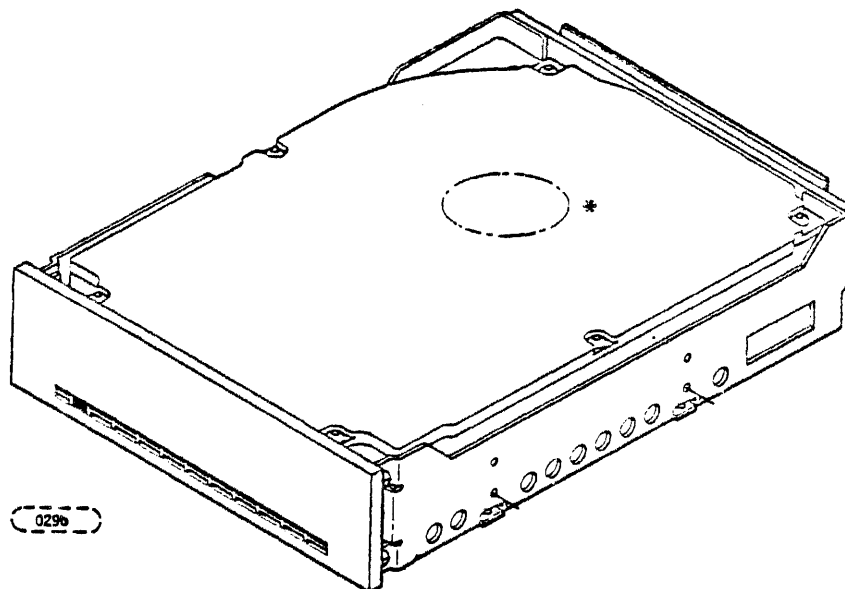
* BREATHER HOLE AREA. DO NOT OBSTRUCT.

FIGURE 1.0-1.   94221 WREN V HH

2.0   APPLICABLE DOCUMENTS

2.1   STANDARDS

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

2.1   (continued)

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

The WREN V HH is a UL Recognized component per UL478 and a CSA Certified component per CSA C22.2 No. 154-M1983. It also meets the requirements of DIN IEC 380/VDE 0806/8.81.

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

CAUTION

To avoid potential service problems, observe the following precautions:

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

2.2   DOCUMENTATION

77765298   OEM Manual (WREN V HH SCSI)
64721700   CDC Small Computer System Interface (SCSI)
ANSI Small Computer System Interface (SCSI): Document Number BSRX3.131-198X (X3T9/84-40 Rev. 1B) (X3T9.2/82-2 Rev. 17B).

3.0   GENERAL DESCRIPTION

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

The WREN V HH is designed to record and recover data on three 5-1/4 inch (130 mm) fixed disks.

3.0   continued

The Model 94221 WREN V HH supports the Small Computer System Interface (SCSI) as described in Control Data's SCSI Specification (64721700). The information contained in this product specification defines the product performance characteristics and the interface characteristics of the Model 94221 WREN V HH.

The Model 94221 WREN V HH SCSI interface supports multiple initiators, disconnect/reconnect, self configuring host software and automatic features that relieve the host from the necessity of knowing the physical characteristics of the targets (logical block addressing is used).

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

Refer to Figure 3.0-1 for an exploded view of the WREN V HH. 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.

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

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

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

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

The WREN V HH utilizes Zoned Bit Recording, an advanced recording technique that optimizes the recording media utilization. ZBR results in increased performance due to the higher transfer rates associated with the outer data tracks. Reliability is also improved by reducing the number of disks necessary to obtain the required capacity.

029a

*LED WINDOW (LED IS ON PWA)
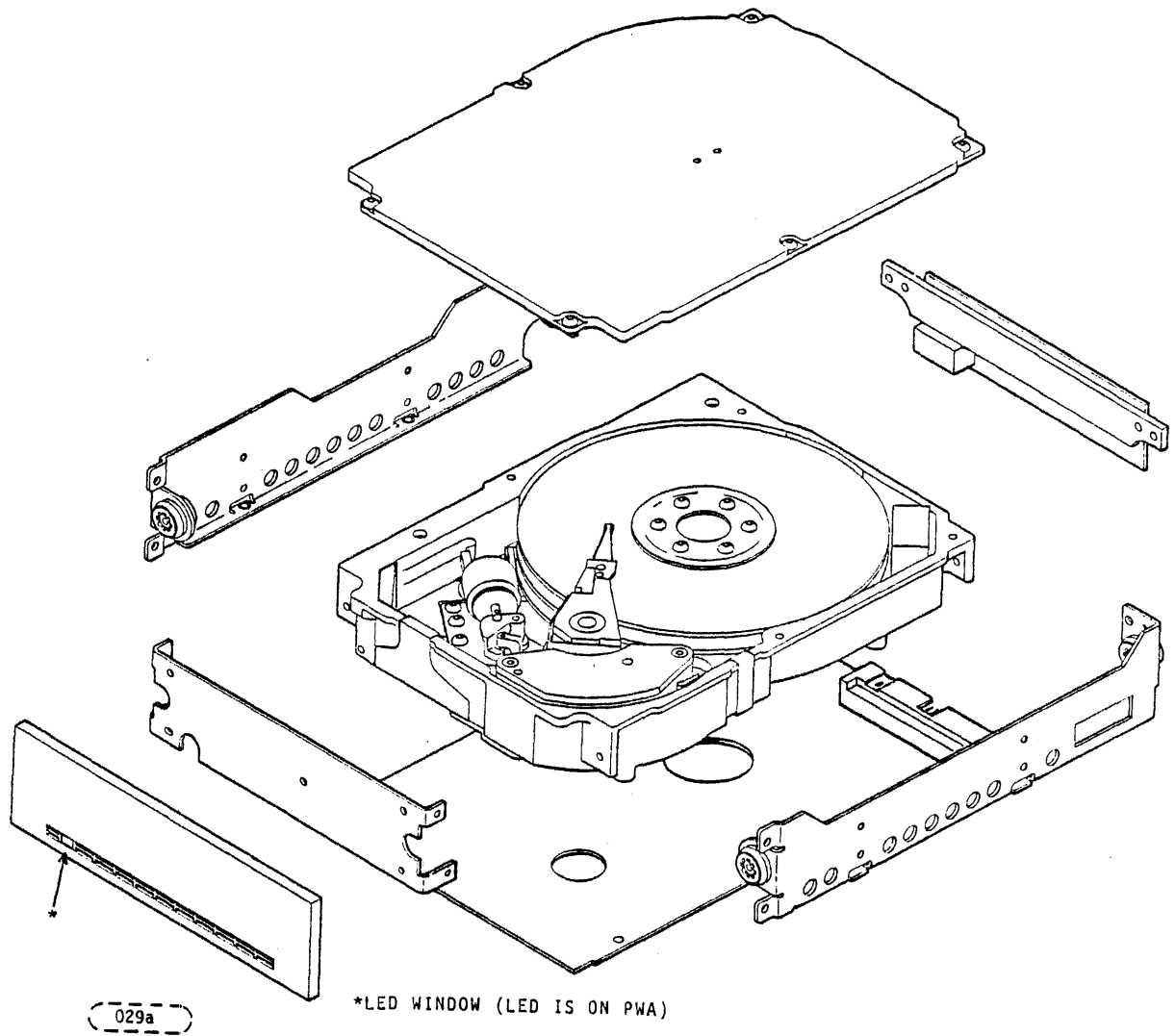
FIGURE 3.0-1. MODEL 94221 WREN V HH

4.0   FEATURES

4.1   STANDARD FEATURES

The Model 94221 WREN V HH has the following standard features:

- Integrated SCSI Controller
- Single ended SCSI drivers and receivers
- Asynchronous or synchronous SCSI bus data transfer protocol
- 32K byte data buffer
- Read Look-ahead buffer management
- Multiple capacity configurations
- Flawed sector reallocation at format time
- Reallocation of defects on command (Post Format)
- Selectable automatic reallocation
- User selectable no spare reallocation sectors, spare reallocation sectors on each track, and/or spare reallocation tracks (i.e., defective sectors reallocated to reallocation tracks)
- Error Correction (48 bit ECC polynomial)
- 1:1 sector interleave
- Data recovery circuitry contained in the WREN V HH
- Sealed head, disk and actuator chamber
- No preventive maintenance required
- No adjustments required
- LSI circuitry for high reliability
- Low audible noise for office environment
- Vertical or horizontal mounting
- Low power consumption
- Balanced low mass rotary voice coil actuator
- Automatic shipping lock
- Easy access terminators
- Integral HDA isolation mounts
- Dedicated head landing zone
- Dynamic spindle braking
- Automatic retries on seek or data read errors (can be disabled)
- Command Queing of up to One Command per initiator
- Automatic single track seek error correction capability
- Automatic adaptive temperature compensation
- Zoned Bit Recording for improved performance and reliability.

4.2   OPTIONS (FACTORY INSTALLED)

WREN V HH Unformatted Capacities

The following unformatted capacities of the fully populated (5 head) drives are available.

Model 94221-190   209 MB (5 head, 1544 track)*
Model 94221-169   184 MB (5 head, 1310 track)*

WREN V HH Formatted Capacities

The formatted capacity that is achieved depends on the spare reallocation sectors reserved and the number of bytes per sector. The following table shows some typical formatted capacities that can be achieved.

	SECTOR SIZE			
	512 Bytes/Sector		1024 Bytes/Sector	
SPARE SECTORS OR CYLINDERS RESERVED FOR REALLOCATION	190 MB Unit	169 MB Unit	190 MB Unit	169 MB Unit
NO SPARES	183 MB	162 MB	191 MB	169 MB
ONE SPARE SECTOR PER TRACK	179 MB	159 MB	183 MB	163 MB
TWO SPARE CYLINDERS/UNIT*	183 MB	162 MB	191 MB	169 MB

*Spare cylinders are on the inner tracks.

Data block size is user selectable at format time and may be modified prior to issuing a format command.

The following options are incorporated at the time of production and may be specified for delivery. See Section 17.0.

● Front panel with 3 optional LED lens colors - See Figure 3.0-1
● Single Unit shipping pack
● OEM Manual
● SCSI Interface Terminating Resistors

4.3   OPTIONAL ACCESSORIES (USER INSTALLED)

The following accessories are available. All kits may be installed in the field. See Section 18.0.

● Front Panel Kit - See Figure 3.0-1
● Single Unit shipping pack kit
● OEM Manual

5.0   PERFORMANCE CHARACTERISTICS

5.1   INTERNAL DRIVE CHARACTERISTICS (Transparent to User)

          Data Capacity Parameters (unformatted)

	190 MB	169 MB
Bytes/Track	20,880 Bytes Min	
Bytes/Surface	32,280,480 Bytes Min	27,352,796 min
Tracks/Surface, Total	1544 Tracks	1310 Tracks
Tracks/Inch	1280 TPI	1280 TPI
Bits/Inch	19,213 (Max)	19,213 (Max)
Read/Write Heads	5 Data, 1 Servo	5 Data, 1 Servo
Recording Mode	2,7 RLL	2,7 RLL
Internal Data Transfer Rate	9.0 - 15 Mbits/s (variable with zone) 1.125-1.875 Mbytes/s (variable with zone)	10.4-15 Mbits/s (variable with zone) 1.3-1.875 Mbytes/s (variable with zone)
Disk Rotational Speed	3597 $\pm$0.5% r/min	3597 $\pm$0.5% r/min
Average Seek Time	18 ms Typical	16.5 ms Typical

5.2   SCSI SEEK, READ AND WRITE PERFORMANCE CHARACTERISTICS
          (Visible to User)

          Refer also to Table 13.5-1 for additional timing details.
          (see Section 13).

          Notes are provided in Section 5.3.1 of this document.

5.2.1   Seek Command Execution Time

	Including Controller Overhead (Without Disconnect [1] [4]		Without Controller Overhead	
	190 MB	169 MB	190 MB	169 MB
Average - Maximum	21.5 ms [2]	20	20 ms [2]	18.5
Typical	19 ms [3]	17.5	18.0 ms [3]	16.5
Single Track - Maximum	7.5 ms [2]	7.5	6 ms [2]	6
Typical	5 ms [3]	5	4 ms [3]	4
Full Stroke - Maximum	41.5 ms [2]	39.5	40 ms [2]	38

5.2.2   Format Drive Command Execution Time (190 MB) [1]

Maximum   12 minutes

5.2.3   Read Data Command Execution Time [4] (190 MB Model, 512 Byte Sector Size and without disconnect). Latency time is included.

a.   From CDB reception to the WREN V HH request for the first data byte to be transferred to the Host
   1. Typical (Zero Stroke Seek)   12.5 ms [3]
   2. Typical (Average Seek)   30.5 ms [3]
   3. Maximum (Full Stroke Seek)   59.5 ms [2]

b.   Single Sector Read and Transfer of data to Host (time from receipt of last byte of the CDB to the request for a status byte transfer to Host) assuming a 1:1 interleave [7].

   1. Typical (Zero Stroke Seek)   13.5 ms [3]
   2. Typical (Average Seek)   31.5 ms [3]
   3. Maximum (Full Stroke Seek)   60.5 ms [2]

5.2.4   Write Data Command Execution Time [4].
         (512 Byte Sector Size and without disconnect) Latency time
         is included.

    a.   From CDB reception to the request for the first byte
         of write data from the Host.

         1. Typical   0.4 ms
         2. Maximum   0.6 ms

    b.   Single Sector Write [8] [7]

         (Measured from receipt of the last byte of the CDB to
         the request for a completion status transfer to the
         Host)

         1. Typical (Zero Stroke Seek)   12.5 ms [3]
         2. Typical (Average Seek)   30.5 ms [3]
         3. Maximum (Full Stroke Seek)   59.5 ms [2]

5.3   GENERALIZED PERFORMANCE CHARACTERISTICS

         See Page 5.3.1 for Notes.

         Minimum Sector Interleave   1 to 1

         Data Buffer To/From Disk Media Data
            Transfer Rate ($\leq$ 1 sector) - 512 Byte Sector
               Min [4]   1.12 MByte/s
               Avg [4]   1.65 MByte/s
               Max [4]   1.88 MByte/s

         Data Buffer To/From Disk Media
            Data Transfer Rate ($\leq$ 1 Track) - 512 Byte Sector
               Min. [4]   0.99 MByte/s - (Interleave Factor)
               Avg. [4]   1.46 MByte/s - (Interleave Factor)
               Max. [4]   1.65 MByte/s - (Interleave Factor)

         SCSI Interface Data

            Transfer Rate (Asynchronous) [5]
               -Maximum Instantaneous   2.0 MByte/s
               -Maximum Average   1.65 MByte/s

            Transfer Rate (Synchronous) [9]
               -Maximum Instantaneous   4.0 MByte/s

5.3   (continued)

Sector Sizes   512 user data blocks (default)
                                      Variable (256 to 4096)

Read/Write consecutive
  sectors on a track   YES

Flaw reallocation
  performance impact   ⎧ Minimum - 1 sector time (If flaw
  (For flaws reallocated   ⎪ on the same track as the spare)
  at format time using   ⎨
  the spare sectors per   ⎪ Typical - 17 ms
  track reallocation   ⎩ Maximum - 34 ms
  scheme.)

Flaw reallocation
  performance impact   50 ms (typical)
  (For flaws reallocated
  at format time using
  the spare tracks per
  volume reallocation
  scheme.)

Overhead time for head
  switch (512 byte sectors) Less than 2 ms

Overhead time for one
  track cylinder switch   6 ms Typical

Avg rotational latency   8.33 ms

5.3.1   Notes For Sections 5.2 and 5.3

    [1] Execution time measured from receipt of the last Byte
         of the Command Descriptor Block (CDB) to the request
         for a Status Byte Transfer to the Initiator (excluding
         connect/disconnect).
    [2] Maximum times are specified over the worst case
         conditions of temperature, voltage margins and drive
         orientation. When comparing specified seek times, care
         should be taken to distinguish between typical seek
         times and maximum seek times. The best comparison is
         obtained by system benchmark tests conducted under
         identical conditions.
    [3] Typical Seek values are measured under nominal
         conditions of temperature, voltage, and horizontal
         orientation as measured on a representative sample of
         WREN V HH drives.
    [4] Assumes no errors and assumes the sector(s) has not
         been relocated.

5.3.1   continued

[5]   Rate measured from the start of the first sector transfer with the Host.

[6]   Assumes the Initiator immediately begins sending Write Data to the WREN V HH when requested.

[7]   Command execution requires a data transfer phase (Data to/from the disk media). Assumes the initiator is instantly ready to send/receive the Data when the WREN V HH generates first request for a data byte transfer, and assumes an average data transfer rate between the WREN V HH and the Initiator of 1.25 Mbyte/s.

[8]   All performance characteristics assume that automatic adaptive temperature compensation is not in process when the command is received. A command being executed will not be interrupted for automatic adaptive temperature compensation. If automatic adaptive temperature compensation is in process, the command will be queued (max 1 per initiator) until the compensation is completed. Automatic adaptive temperature compensations are performed once every 10 minutes during Bus Free Phase, and take only 0.05% of the 10 minute period to complete. Typical time required is 250 ms. Automatic temperature compensation also occurs at other times, but should be transparent to the user (e.g., during format, at power up, after a SCSI reset, at spindle up, during read error recovery, and during Reassign Block functions).

[9]   Transfer rate is negotiable from 1.0 MByte/s to 4.0 MByte/s in 23.8 to 25 KByte/s increments.

5.4   START/STOP TIME

After DC power has been applied, the WREN V HH will become ready within 20 seconds if the Motor Start Option is disabled (i.e. the motor starts as soon as the power has been applied). During this time the drive will respond to the SCSI interface. Stop time will be less than 30 seconds from removal of DC power.

If the Motor Start Option is enabled the internal controller will accept a Motor Start, Test Unit Ready, Inquiry or Request Sense Command via the SCSI interface 3 seconds after DC power has been applied. After the Motor Start Command has been received the WREN V HH will become ready for normal operations within 20 seconds. During this time the drive will respond to the SCSI interface.

There is no power control switch on the drive.

5.5   READ LOOK-AHEAD/CACHE CONTROL

The WREN V HH Model 94221 provides a selectable Read Look-ahead buffering algorithm which can in many cases enhance system performance. This feature may be selected by issuing a Mode Select Command with the Enable/Disable Cache bit set in the Cache Control page (see para. 14.2.1.7 and 10).

The following is a simplified description of the Read Look-ahead operation:

Case A - Read command received and first LBA* not in cache

1. Fetch requested data from disk and transfer to host.

2. Fetch remaining logical blocks on current track and save in cache.

Case B - Read command received and first LBA* already in cache

1. Start transfer to (host) of all logical blocks requested which are already in cache.

2. Fetch (from disk) requested logical blocks which are not already in cache and queue for transfer to host.

3. Fetch remaining logical blocks on current track and save in cache.

In both cases the cacheing operating will abort if a new command is received, unless the command matches case B above.

*Logical Block Address

6.0   RELIABILITY SPECIFICATIONS

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

            Seek Errors   Less than 1 in 10^6 seeks

        Read Error Rates   [1]
            Unrecovered Data   Less than 1 sector in 10^{14}
                                   bits transferred

            Miscorrected Data   Less than 1 sector in 10^{21}
                                   bits transferred

        MTBF   40,000 hours

        Service Life   5 years

        Preventive Maintenance   None required

        NOTES:

        [1] Error rate specified with automatic retries and data
             correction via ECC enabled and all flaws reallocated.

6.1   ERROR RATES

        The error rates stated in this specification assume the
        following:

        a.   WREN V HH is operated per this specification using DC
             Power as defined in this specification (see Section
             7.2).
        b.   The WREN V HH has been formatted via the SCSI FORMAT
             commands.
        c.   Errors caused by media defects or host system failures
             are excluded from error rate computations. Refer to
             Paragraph 8.0, Media Characteristics.

6.1.1   Read Errors

        Before determination or measurement of read error rates:

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

6.1.2   Environmental Interference

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

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

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

6.1.3   Write Errors

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

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

6.1.4   Seek Errors

A seek error is defined as a failure of the WREN V HH to position the heads to the addressed track. There shall be no more than one recoverable seek error in 10^6 physical seek operations. A recoverable seek error (with the WREN V HH automatic retries feature disabled) is a positioning error which can be corrected by the host issuing a Rezero Unit command and then reseeking to the addressed track. Unrecoverable seek errors are classified as failures for MTBF calculations.

6.2   RELIABILITY AND SERVICE

6.2.1   Mean Time Between Failure

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

"Operating Hours" means total power on hours less any time when the WREN V HH is not functioning properly. "Equipment Failure" means any stoppage or substandard performance of the equipment because of equipment malfunction, excluding stoppages or substandard performance caused by operator error, adverse environment, power failure, host adapter (or other initiator) 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 V HH shall have a useful service life of five years before requiring factory refurbishment. Depot repair or replacement of major parts will be permitted during the lifetime (6.2.4).

6.2.4   Service Philosophy

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

6.2.5   Installation   .

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

6.2.6   Service Tools

No special tools are required for site installation or
recommended for site maintenance. Refer to paragraph 6.2.4.
The depot repair philosophy of WREN V HH precludes the
necessity for special tools. If field repair of items
external to the HDA is desired, 6 point Torx T8 and T10
drivers are required. It may be purchased through most
commercial tool catalogs.

7.0   PHYSICAL/ELECTRICAL SPECIFICATIONS

7.1   AC POWER REQUIREMENTS: None

7.2   DC POWER REQUIREMENTS

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

TABLE 7.2-1. DC POWER REQUIREMENTS

	+5 V	+12 V
Voltage	+5 V	+12 V
Regulation	±5%	±5% [2]
Noise Immunity [3]	100 mV	100 mV
Maximum Operating Current [1]	1.1 A	1.4 A
Typical Idle Current [1] [4]	1.0 A	0.9 A
Maximum Starting Current (Peak)	1.3 A	4.5 A
Delayed Motor Start (Max) [5]	1.0 A	0.7 A

[1] Measured with average reading DC ammeter. Unit is
    not supplying terminator power to external SCSI
    devices.
[2] A ±10% tolerance is permissible during power up.
    The ±5% must be maintained after the drive signi-
    fies that its power up sequence has been com-
    pleted and that the drive is able to accept
    selection by the Host Initiator.
[3] Noise is specified as periodic and random distri-
    bution of frequencies covering a band from DC to
    to 10 MHz. Values given are peak to peak
    measurements
[4] See +12 V current profile level T6 in Figure
    7.2.2-1.
[5] This condition occurs when the Motor Start Option
    is enabled and the drive has not yet received a
    Start Motor command.

Note 1:
    At powerup, the motor current regulator will limit the
    12V current to a peak value of less than 4.5 A.
Note 2:
    Minimum current loading for each supply voltage is not
    less than 30% of the maximum operating current shown in
    Table 7.2-1.
Note 3:
    The +5 V and +12 V supplies shall employ separate ground
    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. (Ref. Table 7.2-1).

(2260P)   -24-

7.2.1   Power Sequencing

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

7.2.2   12 V - Current Profile

          Figure 7.2.2-1 identifies the WREN V HH 12 V current
          profile. The current during the various times is as shown:

          T1 - Power is initially applied to the WREN V HH and the
               controller performs self check.

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

          T3 - The spindle continues to accelerate under current
               limiting.

          T4 - The spindle is up to speed.

          T5 - The arm restraint solenoid is released.

          T6 - The autovelocity adjust sequence and controller initi-
               alization is performed.

          T7 - Velocity is set and the WREN V HH is ready for reading
               and writing.

          T8 - Power is removed from the WREN V HH.

                              NOTE

          All times and currents are typical. See Table 7.2-1
          for maximum current requirements.
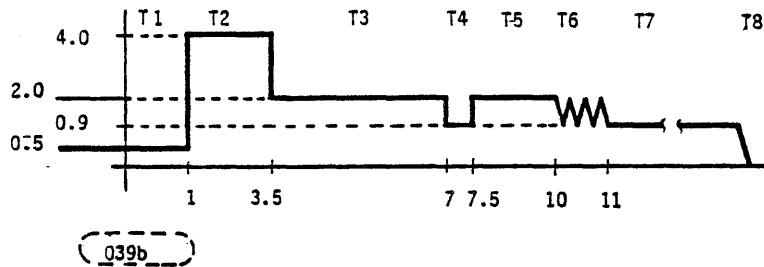
          FIGURE 7.2.2-1. TYPICAL WREN V HH +12 V CURRENT PROFILE

7.2.3   System Grounds

The WREN V HH is shipped with the DC/HDA logic ground and
chassis ground joined together. These two ground planes may
be separated by repositioning the "U" shaped grounding
washer on the motor control PWA as shown in Figure 7.2.3-1.
NOTE: To separate the grounds, loosen the screw "A" and
reorient the washer so that it does not contact the ground
run near the screw at any point (left view).

Hold the washer in place and retighten the screw.
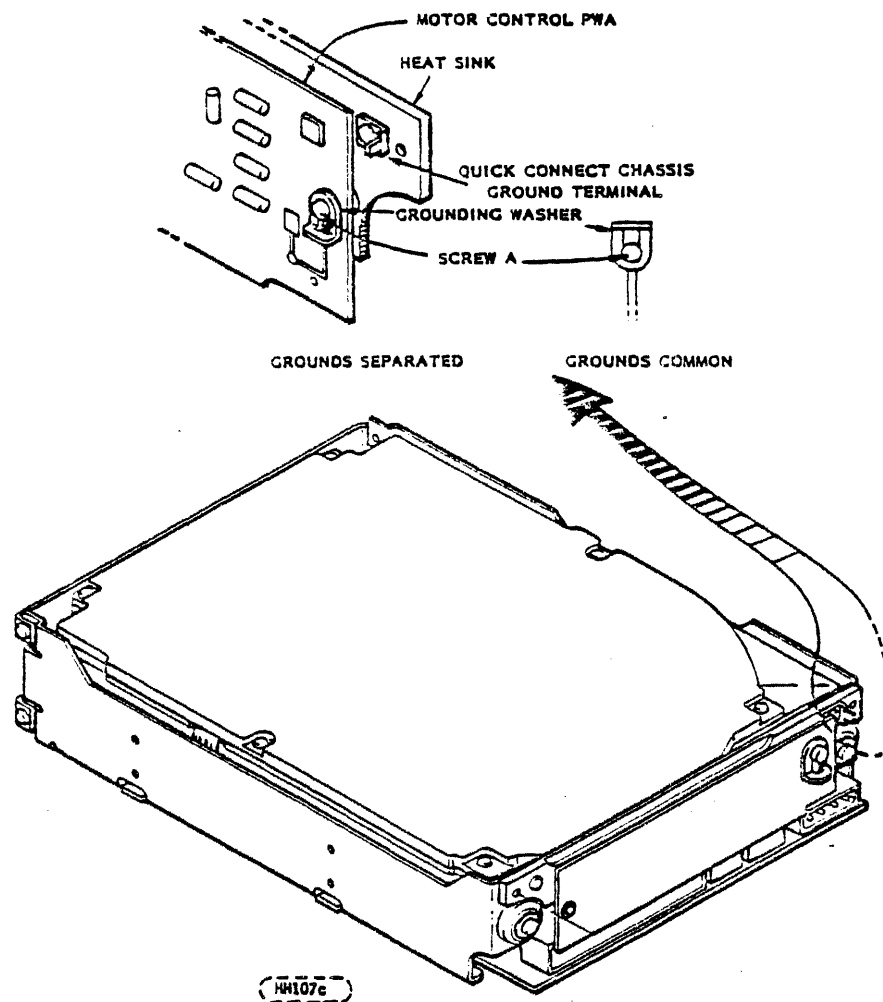
*Mating Connector Part Number is AMP 62137-2.

FIGURE 7.2.3-1. GROUNDS SEPARATION DETAIL

7.3   HEAT/POWER DISSIPATION

Each WREN V HH will dissipate no more than 22 W of DC power average. Typical power dissipation under idle operating conditions is less than 16 W.

7.4   ENVIRONMENTAL LIMITS

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

7.4.1   Temperature

a.   Operating

50°F to 122°F (10°C to 50°C) operating ambient with a maximum gradient of 18°F (10°C) per hour. Above 1000 feet (305 metres) altitude the maximum temperature is derated linearly to 112°F (44.4°C) at 10,000 feet (3048 metres). Cabinet packaging designs must provide ample air circulation around the WREN V HH to ensure environmental limits are not exceeded as a result of heat transfer from other system components. Operating ambient for specification purposes is defined as the environment immediately surrounding the WREN V HH. The temperature of the HDA is restricted to a maximum of 142°F (61.4°C) during operation as shown in Figure 7.4.1-1. System cooling consideration should avoid large thermal gradients between points A and B. (See Figure 7.4.1-1).

b.   Transit

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

c.   Storage

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

7.4.2   Relative Humidity

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

7.4.3   Effective Altitude (Sea Level Reference)

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

7.4.4   Shock and Vibration

Shock and vibration limits specified in this document are measured directly on the WREN V HH chassis. If the WREN V HH is installed in an enclosure to which the stated shock and/or vibration criteria is applied, resonances may occur internally to the enclosure resulting in WREN V HH movement in excess of the stated limits. If this situation is apparent, it may be necessary to modify the enclosure to minimize WREN V HH movement. A clearance of 0.050 inch (1.27 mm) must be provided adjacent to the top and bottom surfaces of the unit to allow sufficient sway space under shock and vibration conditions.

The limits of shock and vibration defined within this document are specified with the WREN V HH mounted by any of the four methods shown in Figure 7.4.4-1 and 7.4.4-2.

7.4.4.1   Shock

    a.   Operating - Normal

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

7.4.4.1 (continued)

      b.   Operating - Abnormal

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

      c.   Nonoperating

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

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

      d.   Packaged

          The WREN V HH as packaged by CDC for general freight shipment shall withstand* drop test from 42 inches (1070 mm) against a concrete floor or equivalent.

          *Device damage or performance degradation shall not result.
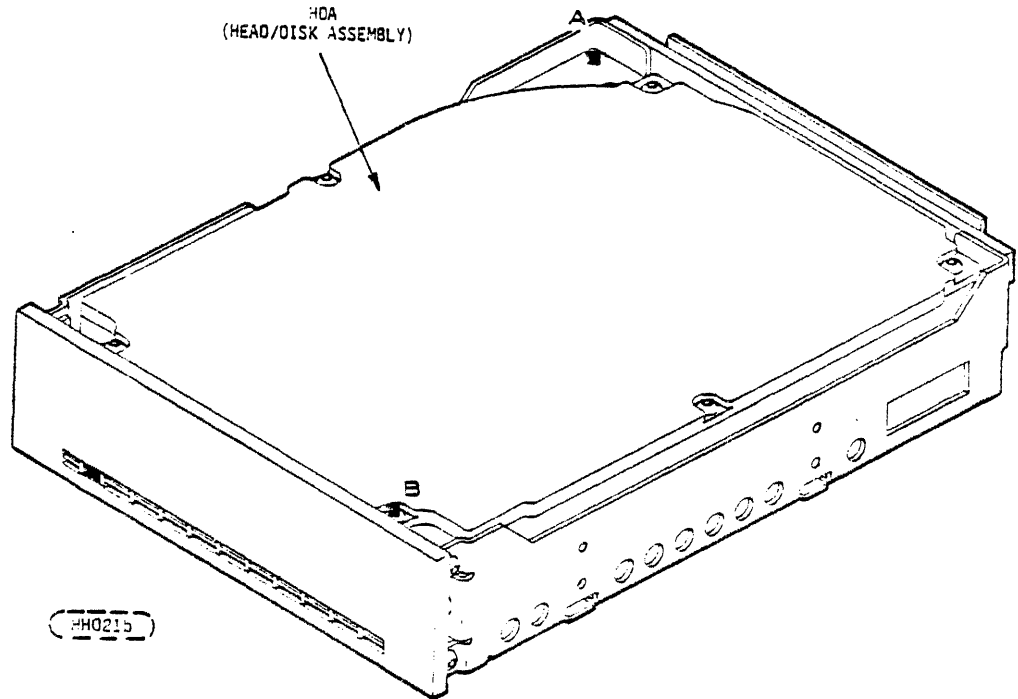
Points A and B should not exceed 142°F (61.4°C) during operation. Large thermal gradients between Points A and B should be avoided.

FIGURE 7.4.1-1. HDA TEMPERATURE MONITORING LOCATIONS
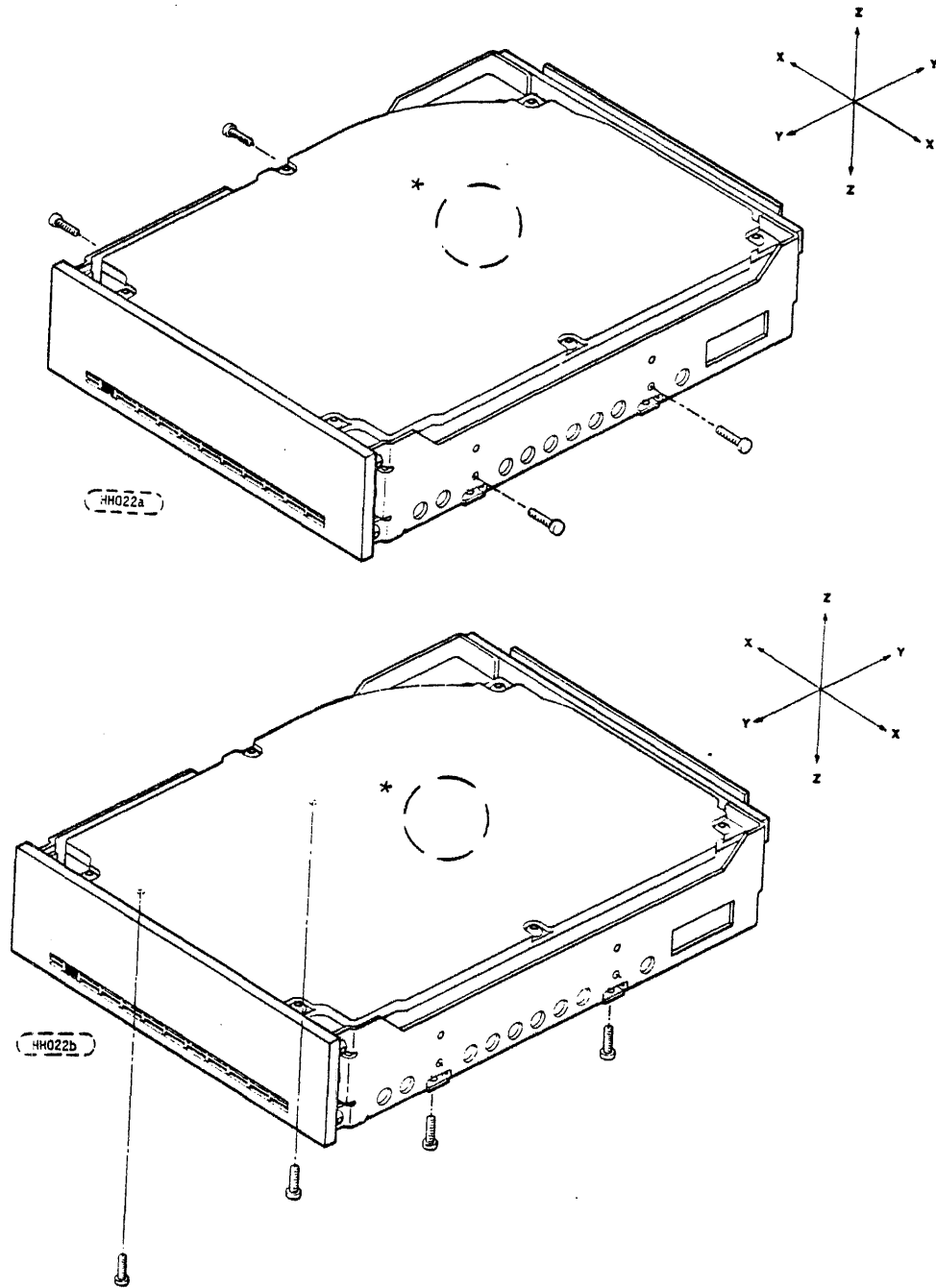
*Breather hole area. Do not obstruct air flow.

FIGURE 7.4.4-1. RECOMMENDED HORIZONTAL MOUNTING
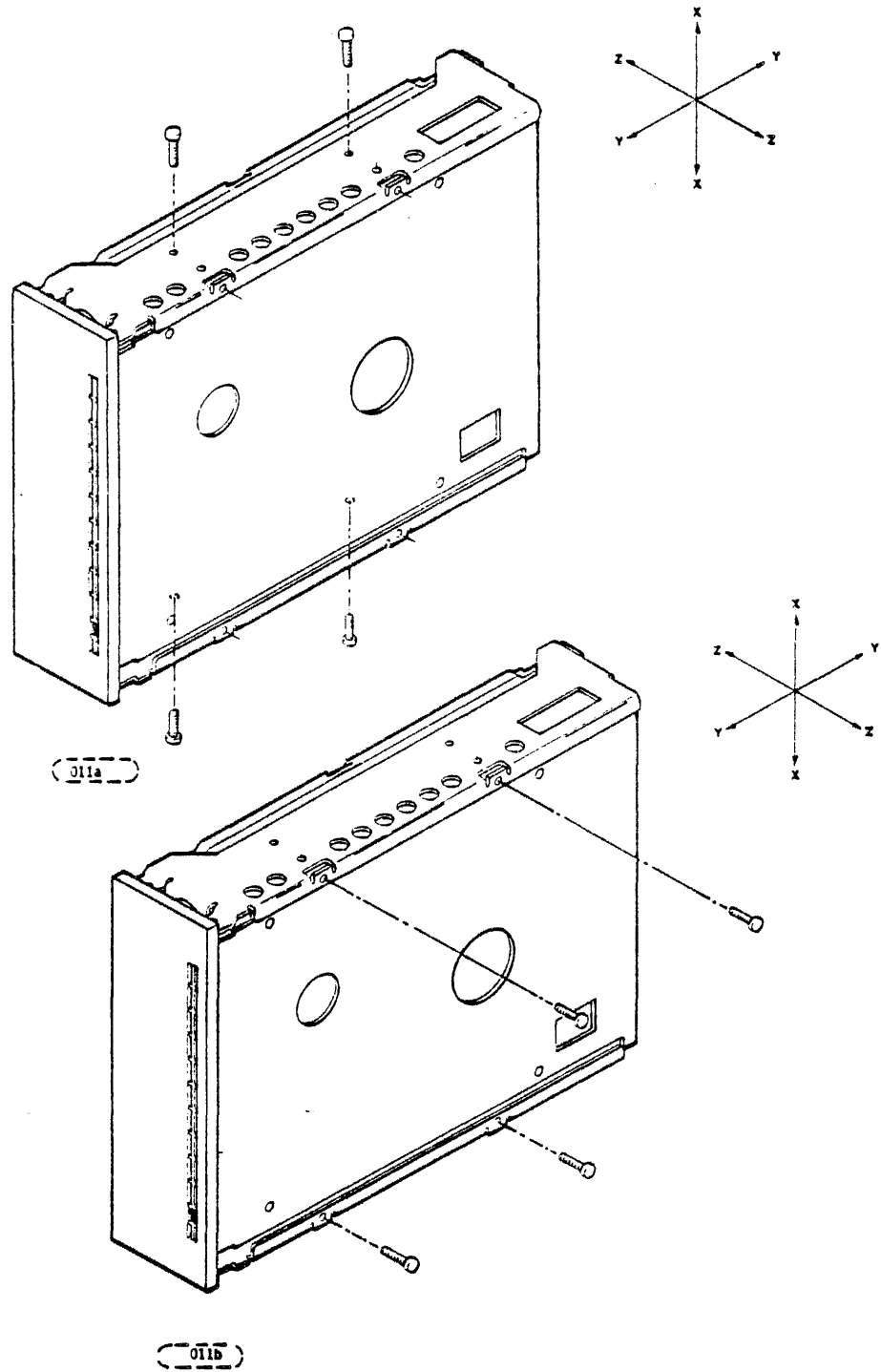
FIGURE 7.4.4-2. RECOMMENDED VERTICAL MOUNTING

(2260P)

7.4.4.2   Vibration

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

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

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

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

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

7.4.5   Air Cleanliness

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

7.5   MECHANICAL SPECIFICATIONS

The following nominal dimensions are exclusive of the decorative front panel accessory. A mounting clearance of 0.050 inches will be required on top and bottom of the drive for shock sway space. Refer to Figure 7.5-1 for detailed mounting configuration dimensions.

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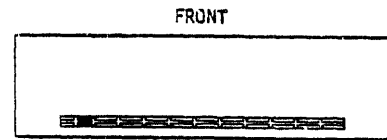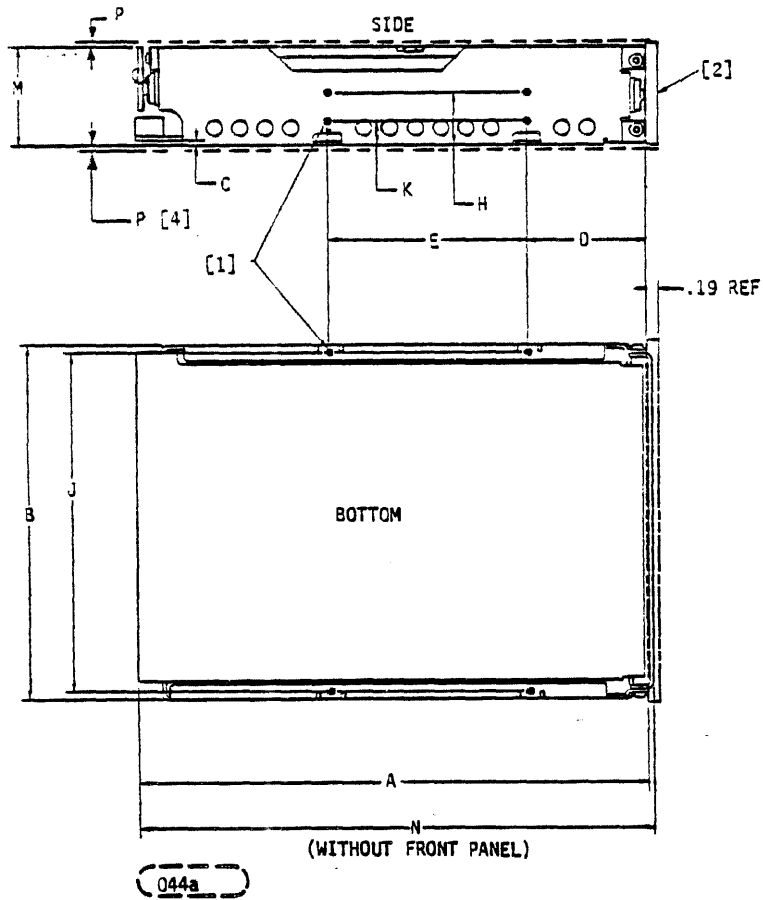
NOTES:

[1] MOUNTING HOLES (6-32 UNC-2B). FOUR ON BOTTOM, FOUR ON EACH SIDE. MAX SCREW LENGTH INTO CHASSIS 0.25 IN. (6.35 mm), EXCEPT FOUR HOLES AT H DIMENSION 0.125 IN. (3.17 mm).

[2] FRONT PANEL

3. WEIGHT IS APPROX. 3.8 LBS (1.72 kg).

[4] SWAY SPACE (0.050 INCHES)

	INCHES	MILLIMETRES
A	8.0	203.2
B	5.75 +0.00 -0.03	146.0
C	0.100	2.5
D	1.87 ±0.02	47.5
E	3.12 ±0.01	79.2
H	0.86	21.8
J	5.50 ±0.02	139.7
K	0.39	9.9
M	1.625 ±0.02	41.3
N	8.07	205.7
P	0.050	1.27

FIGURE 7.5-1. MOUNTING CONFIGURATION DIMENSIONS

7.5.1   Drive Orientation

Only two WREN V HH mounting orientations are permitted: disks in the horizontal plane and disks in the vertical plane. Horizontal mounting (Figure 7.4.4-1) with the front (non I/O cable end) raised as much as 15° above the horizontal is acceptable. Mounting with either end down (front or rear) or upside down is not permissible.

7.5.2   Cooling

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

8.0   MEDIA CHARACTERISTICS

8.1   MEDIA DESCRIPTION

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

9.0   DEFECT AND ERROR MANAGEMENT

WREN V HH, as delivered, complies with this specification. The read error rate and specified storage capacity are not dependent upon use of defect management routines by the host (initiator).

Defect and error management in the SCSI system involves WREN V HH internal defect/error management and SCSI systems error considerations (errors in communications between Initiator and WREN V HH). Tools for use in designing a defect/error management plan are briefly outlined in this section, with references to other sections where further details are given.

9.1   WREN V HH INTERNAL DEFECTS/ERRORS

Identified defects are recorded on the WREN V HH defects
list tracks (referred to as the primary or ETF defect
list). It is recommended that these known defects be
reallocated during the initial WREN V HH format operation.
(See Format Unit command in Section 14.2.1.1.) The WREN V
HH internal retries and data correction by ECC should be
enabled to recover data from additional flaws if they
occur. If data correction by ECC is required to recover
data, the host should immediately reallocate this sector by
use of the Reassign Blocks command.(See Section 14.2.1.3.)
If the WREN V HH automatic retries and data correction by
ECC feature are not used, defects are usually unrecoverable
and need to be reallocated as they are discovered. For
reallocation of bad sectors, the number of spare sectors
per track and the number of spare tracks per volume is
programmable. After formatting, defects can be
automatically reallocated by the WREN V HH, or can be
reallocated when the host sends the Reassign Blocks Command
(Section 14.2.1.3).

Once the necessary details are described about the
operation of the interface, (Sections 10 thru 14) a more
thorough discussion of the WREN V HH Error Recovery
Philosophy is presented in Section 16.0.

9.2   SCSI SYSTEMS ERROR CONSIDERATIONS

Information on the reporting of operational errors or
faults across the interface is given in Sections 12.5.2,
14.1.1, and 15.0. Section 12.5.2 of this specification and
Section 5.5 of the CDC SCSI Specification describe the
Message Protocol System. Several of the messages are used
in the SCSI systems error management system. The Request
Sense command returns information to the host about
numerous kinds of errors or faults. The Receive Diagnostic
Results reports the results of diagnostic operations
performed by the WREN V HH.

Section 15.0 describes the status returned by the WREN V HH
to the Initiator. Status reporting plays a role in the SCSI
systems error management and its use in that respect is
described in sections where the various commands are
discussed.

10.0   INTERFACE REQUIREMENTS AND OPTIONS

10.1   GENERAL DESCRIPTION

This specification describes the subset of the SCSI (Small Computer Systems Interface) commands as implemented on the WREN V HH. The interface is compatible with the mandatory subset of the CDC SCSI Interface Specification (both are compatible with the ANSI SCSI standard and the common command set (CCS) document, Revision 4.B). The WREN V HH is classified as an Model 94221 "Intelligent" peripheral.

The Model 94221 WREN V HH SCSI interface consists of a 9 bit bidirectional bus (8 data + 1 parity) plus 9 control signals supporting multiple initiators, command queing of up to one command per initiator, disconnect/reconnect, self configuring host software and automatic features that relieve the host from the necessity of knowing the physical architecture of the target (logical block addressing is used).

The physical interface consists of single ended drivers and receivers using asynchronous or synchronous communication protocols which support cable lengths of up to 6 metres and a bus interface transfer rate up to 2.0 MB/s asynchronous and 4.0 MB/s synchronous. The bus protocol supports multiple initiators, disconnect/ reconnect, additional messages plus 6 byte and 10 byte Command Descriptor Blocks. The WREN V HH is always a target on the SCSI. For purposes of this specification, "WREN V HH" may be substituted for the word "target" wherever "target" appears.

GLOSSARY

Byte - This term indicates an 8 bit (octet) byte.

Command Descriptor Block (CBD) - The structure used to communicate requests from an initiator to a target.

Connect - The function that occurs when an initiator selects a target to start an operation.

Disconnect - The function that occurs when a target releases control of the SCSI bus, allowing it to go to the Bus Free phase.

10.1   (continued)

FRU (Field Replaceable Unit) - An assembly that is believed faulty based on test results. A value of OOH indicates an unknown cause or the end of a list of known possible causes. Nonzero values have product unique meanings.

Initiator - A SCSI device (usually a host system) that requests an operation to be performed by another SCSI device.

Intermediate Status - A status code sent from a target to an initiator upon completion of each command, except the last command, in a set of linked commands.

Logical Unit - A physical or virtual device addressable through a target.

Logical Unit Number - An encoded three bit identifier for the logical unit.

LSB - Least significant byte.

LUN - Logical unit number.

mm - Millimetre.

ms - millisecond.

MSB - Most significant byte.

ns - Nanosecond.

One - A true signal value, (assertion).

Reconnect - The function that occurs when a target selects and initiator to continue an operation after a disconnect.

Reserved - The term used for bits, bytes, fields, and code values that are set aside for future standardization.

SCSI Address - The octal representation of the unique address (0-7) assigned to a SCSI device. This address would normally be assigned and set in the SCSI device during system installation.

SCSI ID - The bit significant representation of the SCSI address referring to one of the signal lines DB(7-0).

10.1   (continued)

SCSI device - A host computer adapter or a peripheral controller or an intelligent peripheral that can be attached to the SCSI bus.

Signal Assertion - The act of driving a signal to the true state.

Signal Negation - The act of driving a signal to the false state or allowing the cable terminators to bias the signal to the false state (by placing the driver in the high impedance condition).

Signal Release - The act of allowing the cable terminators to bias the signal to the false state (by placing the driver in the high impedance condition).

Status - One byte of information sent from a target to an initiator upon completion of each command.

Target - A SCSI device that performs an operation requested by an initiator.

us - Microsecond.

Vendor Unique - In this specification, this term indicates bits, fields, or code values that are vendor specific.

xxH - Numbers followed by capital H are hexadecimal values. All other numbers are decimal values.

Zero - A false signal value, (negation).

10.2   DC CABLE AND CONNECTOR

The WREN V HH receives DC power through a 4 pin right angle connector (see Table 10.2-1 for pin assignment) mounted on the servo PWA (see Figure 10.3-3 and 10.3-4). Recommended part numbers of the mating connector are listed below, but equivalent parts may be used (see Table 10.2-2.).

TABLE 10.2-1. DC INTERFACE

POWER LINE DESIGNATION	PIN NUMBER
+12 V	J1-01
+12 V Return	J1-02
+ 5 V Return	J1-03
+ 5 V	J1-04

TABLE 10.2-2. MATING CONNECTOR PARTS

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

10.3   PHYSICAL CHARACTERISTICS

This section defines the connectors, cables, signals, terminators and bus timing needed to implement SCSI.

10.3.1   Physical Description

Model 94221 WREN V HH may be daisychained together or with other compatible SCSI devices using a common cable. Both ends of the cable must be terminated. The WREN V HH implements single ended drivers and receivers, which allow a maximum cable length of six metres (primarily for connection within a cabinet). All signals are common between all SCSI devices. The Model 94221 WREN V HH may be daisychained only with SCSI devices with single ended drivers and receivers. A maximum of 8 SCSI devices (including the Host) may be daisychained together. The SCSI Devices at both ends of the daisychain are to be terminated. Intermediate SCSI devices shall not be terminated.(see Figure 10.3-2). For drives that are not to be terminated, remove the terminator resistor packs, not the terminator power source selector jumper (Figure 10.3-4).

10.3.2   CABLE REQUIREMENTS

Only nonshielded cable connectors are applicable. A 50 conductor flat cable or 25 twisted pair cable shall be used. The maximum total cable length shall be 6.0 metres. A stub length of no more than 0.1 metre is allowed off the mainline interconnection within any connected equipment. An ideal impedance match with cable terminators implies a cable characteristic impedance of 132 ohm (singled ended option). In general, cables with this high of a characteristic impedance are not available; however, impedances that are somewhat lower are satisfactory. A characteristic impedance of 100 ohm $\pm$ 10% is recommended for unshielded flat or twisted pair ribbon cable. However, most available cables have a somewhat lower characteristic impedance. To minimize discontinuities and signal reflections, cables of different impedances should not be used in the same bus. Implementations may require trade-offs in shielding effectiveness, cable length, the number of loads, transfer rates, and cost to achieve satisfactory system operation. If shielded and unshielded cables are mixed within the same SCSI bus, the effect of impedance mismatch must be carefully considered.

A minimum conductor size of 28 AWG should be used to minimize noise effects.

Suggested nonshielded flat cable part numbers are:

    Flat cable   3M-3365-50
    Twisted pair   Spectra twist in flat 455-248-50

Equivalent parts may be used.

Single ended cable pin assignments are shown in Table 10.3-1.

10.3.3   CONNECTORS REQUIREMENTS

The nonshielded cable connector shall be a 50 conductor connector consisting of two rows of 25 female contacts with adjacent contacts 100 mils apart.

Recommended Mating Flat Cable Connector Part Numbers are:

Closed end	3M-3425-7000	W/O Strain Relief, No Center Key
(for cable	3M-3425-7050	With Strain Relief, No Center Key
ends) *	Dupont-66900-290	With Strain Relief, With Center Key
Open end	3M-3425-6000	W/O Strain Relief, No Center Key
(In	3M-3425-6050	With Strain Relief, No Center Key
Daisychain)*	Dupont-66900-250	With Strain Relief, With Center Key

* See Figure 10.3-2.

10.3.3   continued

The Model 94221 WREN V HH device connector is a nonshielded 50 conductor connector consisting of two rows of 25 male pins with adjacent pins 100 mils apart. The connector is keyed (see Figure 10.3-1).

Drive Connector Part Number: DuPont 73963-001 or equivalent.
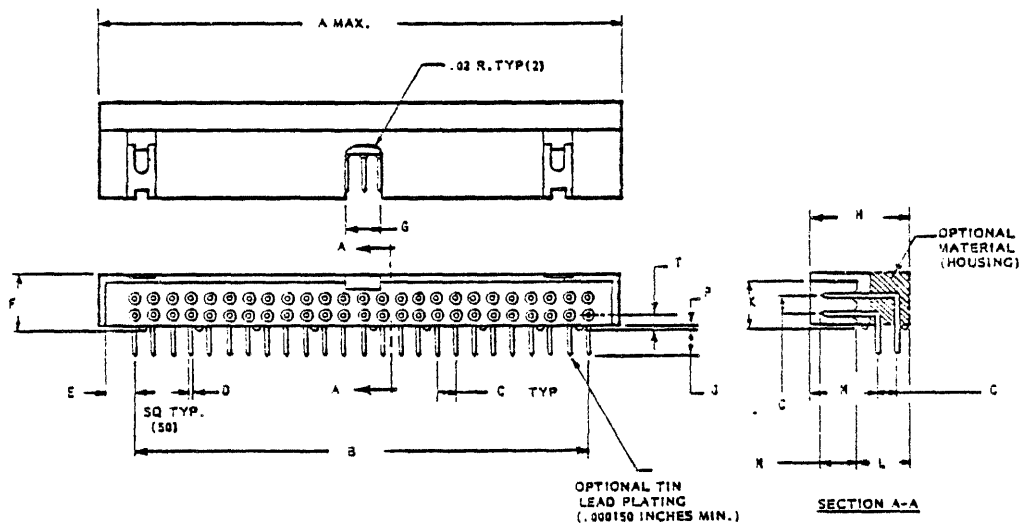
CDC P/N	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	T	NO. OF CONTACTS
51847519	2.80 MAX	2.40	0.100	0.025 SQ.	0.160	0.310 MAX.	0.20	0.54 MAX.	0.120	0.260	0.28 MAX.	0.360	0.230 ±0.008	0.015	0.02 RAD. TYP(2)	0.08	50

NOTES:
1.   Fifty Contacts on 2.54 mm (0.100 inch) spacing = 60.96 mm (2.40 inches).
2.   Tolerances ±0.127 mm (0.005 inch) noncumulative.
3.   Dimensions listed with asterisks (*) are shown for reference only.

FIGURE 10.3-1. NONSHIELDED SCSI DEVICE CONNECTOR
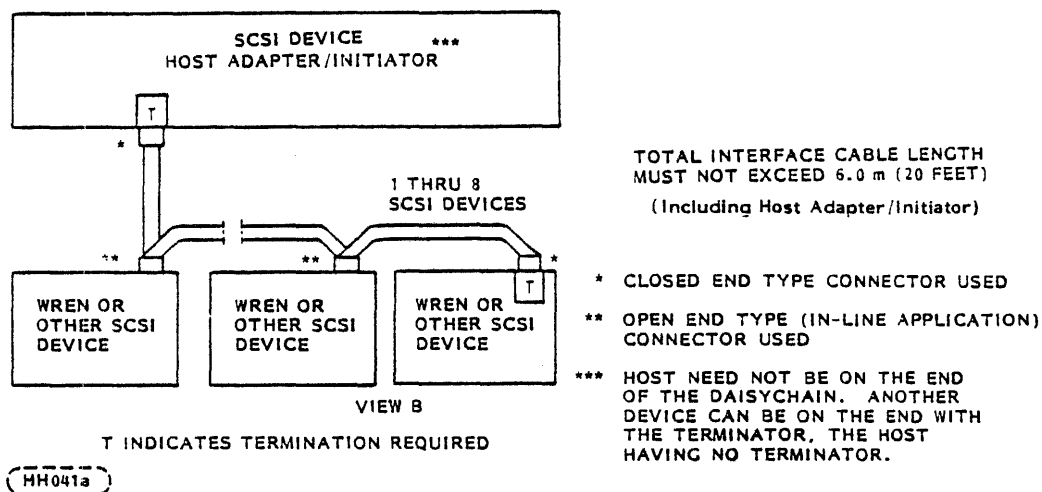
FIGURE 10.3-2. INTERFACE CABLING

TABLE 10.3-1. SINGLE ENDED CABLE PIN ASSIGNMENTS
(NONSHIELDED CONNECTOR)

SIGNAL	PIN NUMBER	SIGNAL	PIN NUMBER
-DB(0)	2	GROUND	30
-DB(1)	4	-ATN	32
-DB(2)	6	GROUND	34
-DB(3)	8	-BSY	36
-DB(4)	10	-ACK	38
-DB(5)	12	-RST	40
-DB(6)	14	-MSG	42
-DB(7)	16	-SEL	44
-DB(P)	18	-C/D	46
GROUND	20	-REQ	48
GROUND	22	-I/O	50
GROUND	24		
TERMPWR	26		
GROUND	28		

NOTES: 1. All odd pins except pin 25 are connected to ground.
Pin 25 is left open.

CAUTION

Pin 25 must not be connected to ground at the HOST
end or the drive end of the cable. If the I/O
connector should accidentally be plugged in upside
down, terminator power on Pin 26 will be shorted
to ground.

2. The minus sign next to the signals indicates asserted
state is the low voltage of the two levels used for
logic signals.

INTERFACE CABLE CONNECTOR

TERMINATOR POWER SOURCE AND
MOTOR START OPTION HEADER

UNIT ID AND PARITY CHECK
SELECT HEADER

QUICK CONNECT
TAB

POWER

1	-12 V
2	-12 V RET
3	+5 V RET
4	+5 V

DC POWER
CONNECTOR
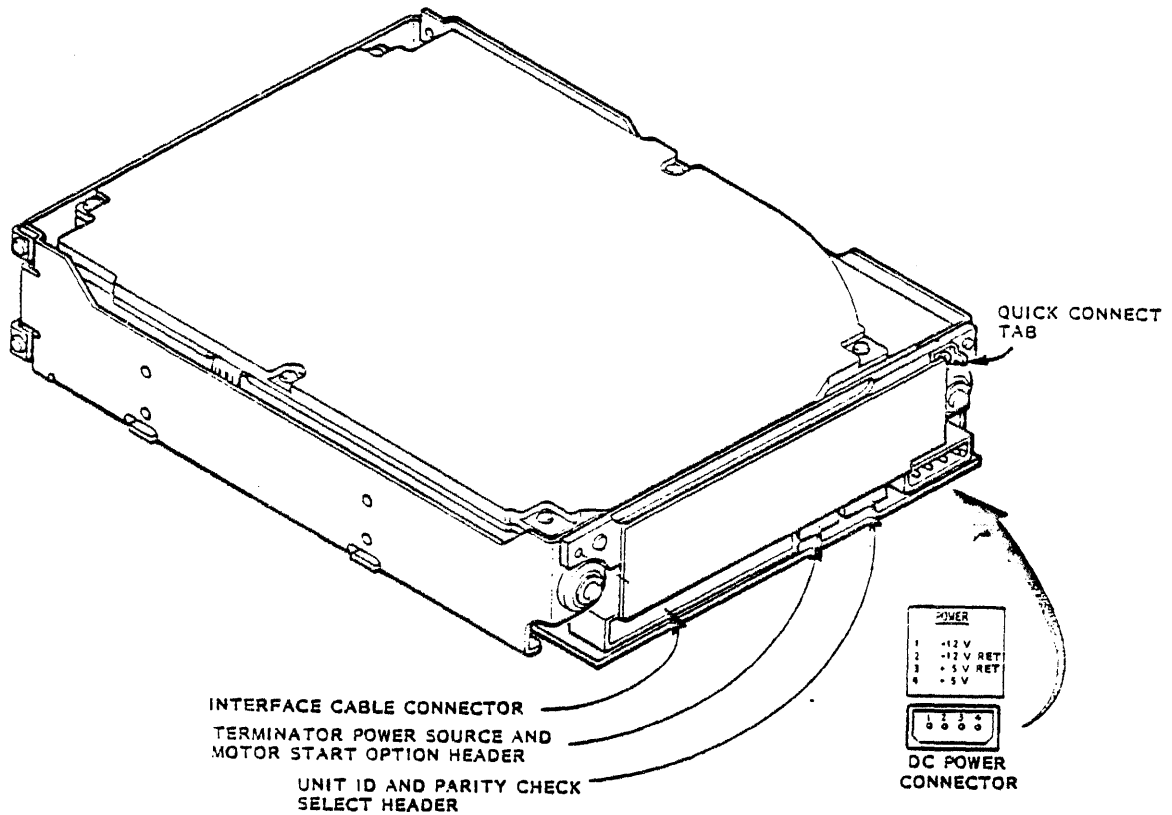
(HH071d)

See Figure 10.3-4 and 11.1-1 for more details.

FIGURE 10.3-3. I/O CONNECTION

10.3.4   Electrical Description

All interface signals with the Model 94221 WREN V HH are
single ended and must be terminated with 220 ohm to +5 V
and 330 ohm to ground at each end of the total cable. All
signals use open collector or three state drivers. Optional
termination is available internal to the WREN V HH. See
Figure 10.3-5.
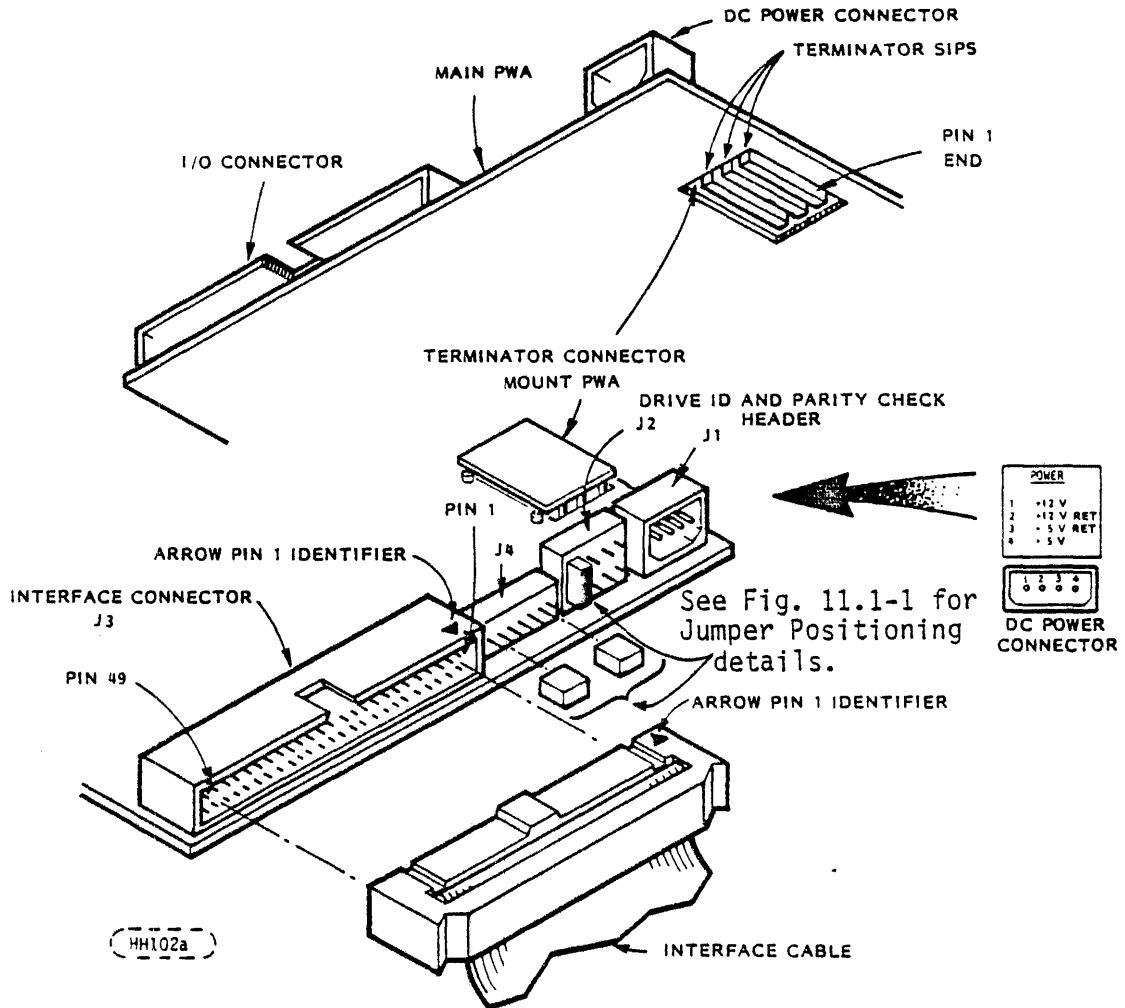
FIGURE 10.3-4. CABLE CONNECTION

10.3.4.1 Single Ended Drivers/Receivers

Single ended drivers and receivers are used by the WREN V HH. Typical circuits are shown in Figure 10.3-5. Terminator circuits shown are there only when the WREN V HH is last in the daisychain.

Transmitter Characteristics

The WREN V HH uses an ANSI SCSI compatible open collector single ended driver. This driver is capable of sinking a current of 48 mA with a low level output voltage of 0.4 volt.

Receiver Characteristics

The WREN V HH uses a ANSI SCSI single ended receiver with hysteresis gate or equivalent as a line receiver.

10.3.4.2 Terminator Requirements

Internal WREN V HH I/O termination consist of three
resistor modules which plug into sockets on the Main PWA
(see Figure 10.3-4). The WREN V HH may be ordered with or
without these termination resistors to facilitate a
particular application. All single initiator/single target
(nondaisychain) applications require that the Initiator and
WREN V HH be terminated. Daisychain applications require
that only the units at each end of the daisychain be
terminated. All other peripherals on the chain should not
be terminated. (See Figure 10.3-2). NOTE: Remove
terminator resistor packs where terminators are not
required. Removal of terminator power source selection
jumper* does not disconnect the terminator resistors from
the circuit. The 330 ohm resistor to ground still affects
the circuit operation.

10.3.4.3 Terminator Power

The WREN V HH may be configured to accept terminator power
via Pin 26 of the SCSI bus or to provide terminator power
for optional internal termination resistors via the WREN V
HH power connector. The WREN V HH can also be configured to
supply terminator power to Pin 26 of the SCSI bus via an
isolation diode. See Figures 10.3-4 and 11.1-1.

Single ended SCSI devices providing termination power
(TERMPWR) shall have the following characteristics:

      V TERM = 4.0 V to 5.25 V
      800 mA min source drive capability
      1.0 mA maximum sink capability

*See Figure 11.1-1 for configuration details.

FIGURE 10.3-5. SINGLE ENDED TRANSMITTERS AND RECEIVERS
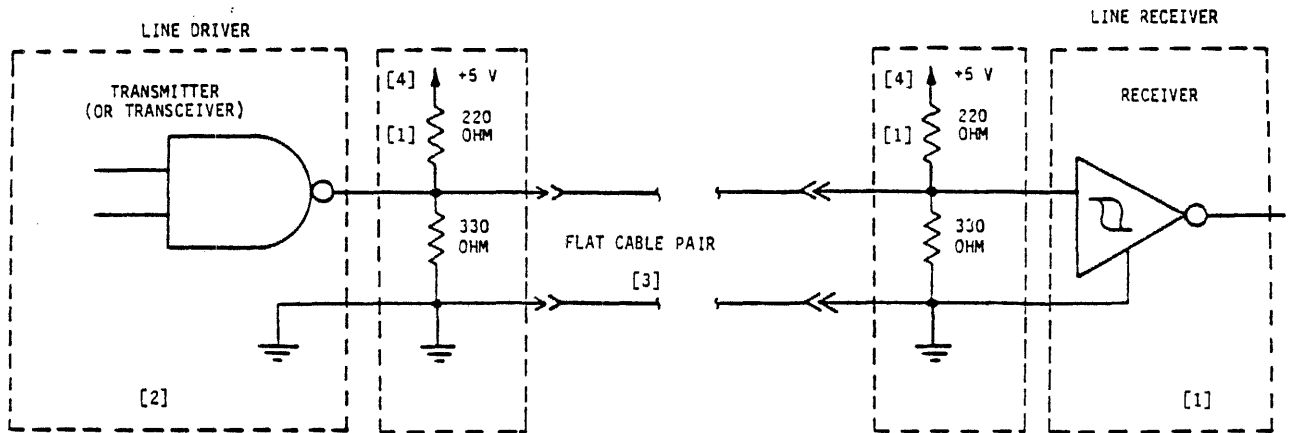
[1]   TERMINATOR CIRCUITS: PART OF REMOVABLE TERMINATOR RESISTOR PACKS, USED WHEN DRIVE
      IS LAST IN THE DAISYCHAIN.

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

LOGIC LEVEL		DRIVER OUTPUT	RECEIVER INPUT
NEGATED	(0)	$\geq$ 2.5 V; $\leq$ 5.25 V	$\geq$ 2.0 V; $\leq$ 5.25 V
ASSERTED	(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.

[2]   ANSI SCSI COMPATIBLE CIRCUITS

[3]   TOTAL INTERFACE CABLE LENGTH SHOULD OT EXCEED 20 FEET (6.0 m) FROM HOST TO END OF
      DAISYCHAIN.

[4]   SOURCE OF DRIVE TERMINATOR POWER SELECTABLE BY JUMPER PLUG.

(012a)

11.0   SCSI BUS

Communication on the SCSI Bus is allowed between only two
SCSI devices at a time. There can be a maximum of eight
SCSI devices including the host computer(s) connected to
the SCSI bus. Each SCSI device has a SCSI ID Bit assigned
as shown in Figure 11.0-1. The SCSI ID is assigned by
installing from 0 to 3 jumper plugs onto a connector in a
binary coded configuration during system configuration. See
Figure 11.1-1.

When two SCSI devices communicate on the SCSI Bus one acts
as an initiator and the other acts as a target. The
initiator (typically a host computer) originates an
operation and the target performs the operation. The WREN
IV always operates as a target.

```
DB(7)   DB(6)   DB(5)   DB(4)   DB(3)   DB(2)   DB(1)   DB(0)  DATA BUS
 |       |       |       |       |       |       |       SCSI ID = 0
 |       |       |       |       |       |       SCSI ID = 1
 |       |       |       |       |       SCSI ID = 2
 |       |       |       |       SCSI ID = 3
 |       |       |       SCSI ID = 4
 |       |       SCSI ID = 5
 |       SCSI ID = 6
SCSI ID = 7
```
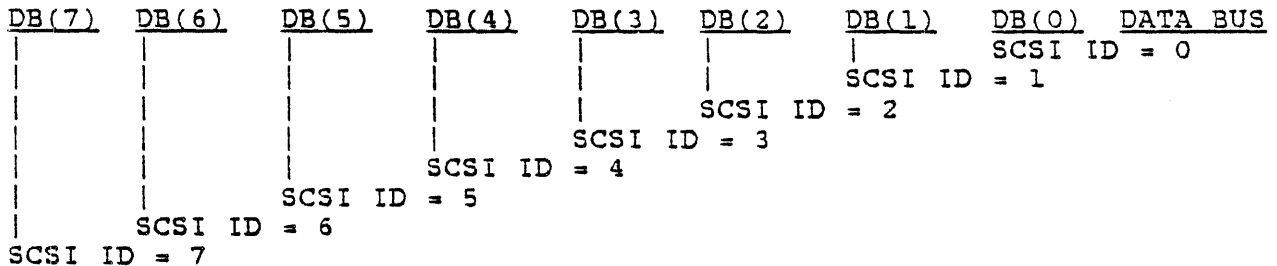
The Host Adapter/Initiator must be identified by one of the
eight SCSI Device Addresses. Make sure that none of the
devices on the interface has the same address as the Host.

FIGURE 11.0-1. SCSI ID BITS

Certain SCSI bus functions are assigned to the initiator
and certain SCSI bus functions are assigned to the target.
The initiator will select a particular target. The target
will request the transfer of Command, Data, Status or other
information on the data bus.

Information transfers on the data bus are asynchronous and
follow a defined REQ/ACK Handshake protocol. One byte of
information will be transferred with each handshake.
Synchronous data transfer option is described in Paragraph
12.5.4.

The WREN V HH supports single initiator, single target;
single initiator, multiple target; or multiple initiator,
multiple target bus configurations.

11.1   SCSI BUS SIGNALS

There are nine control and nine data signals, as listed below:

- BSY
- SEL
- C/D
- I/O

- MSG
- REQ
- ACK
- ATN

- RST
- DB(7-0, P)

These signals are described as follows:

BSY (BUSY) - An "OR-tied" signal to indicate the bus is being used.

SEL (SELECT) - A signal used by an initiator to select a target, or by a target to reselect an initiator.

C/D (CONTROL/DATA) - A signal driven by a target to indicate whether Control or Data information is on the Data Bus. Assertion (see Paragraph 11.1.1) indicates Control.

I/O (INPUT/OUTPUT) - A signal driven by a target to control the direction of data movement on the Data Bus with respect to an initiator. Assertion indicates input to the initiator. This signal is also used to distinguish between Selection and Reselection phases.

MSG (MESSAGE) - A signal driven by a target during the Message phase.

REQ (REQUEST) - A signal driven by a target to indicate a request for REQ/ACK data transfer handshake.

ACK (ACKNOWLEDGE) - A signal driven by an initiator to indicate an acknowledgment for a REQ/ACK data transfer handshake.

ATN (ATTENTION) - A signal driven by an initiator to indicate the Attention condition.

RST (RESET) - An "OR-tied" signal that indicates the Reset condition.

DB(7-0,P) (DATA BUS). Eight data bit signals, plus a parity bit signal form a Data Bus. DB(7) is the most significant bit and has the highest priority during the Arbitration phase. Bit number significance, and priority decrease downward to DB(0). A data bit is defined as one when the signal is asserted and is defined as zero when the signal is negated.

11.1   (continued)

Data parity DB(P) is odd - The use of parity is a system
option. The WREN V HH SCSI will always generate parity, but
has the capability to enable/disable parity detection.
Parity is not valid during the Arbitration phase.

Greater detail on each of the SCSI Bus signals is found in
sections following.

Drive Select

Install jumpers as shown in Figure 11.1-1 for SCSI ID
selection. Refer to Figures 10.3-3, 10.3-4 and 11.1-1 for
the location of the drive select header. The WREN V HH can
have one of eight ID bits selected by installing 0 to 3
jumpers in a binary coded configuration on the drive select
header.

11.1.1   Signal Values

Signals may assume true or false values. There are two
methods of driving these signals. In both cases, the signal
shall be actively driven true, or asserted. In the case of
OR-tied drivers, the driver does not drive the signal to
the false state, rather the bias circuitry of the bus
terminators pulls the signal false whenever it is released
by the drivers at every SCSI device. If any driver is
asserted, then the signal is true. In the case of
non-OR-tied drivers, the signal may be actively driven
false, or negated. Negated means that the signal may be
actively driven false, or may be simply released (in which
case the bias circuitry pulls it false), at the option of
the implementor.

11.1.2   OR-Tied Signals

The BSY and RST signals shall be OR-tied only. In the
ordinary operation of the bus, these signals are
simultaneously driven true by several drivers. No signals
other than BSY, RST, and DB(P) are simultaneously driven by
two or more drivers, and any signal other than BSY and RST
may employ OR-tied or non-OR-tied drivers. DB(P) shall not
be driven false during the Arbitration phase. There is no
operational problem in mixing OR-tied and non-OR-tied
drivers on signals other than BSY and RST.
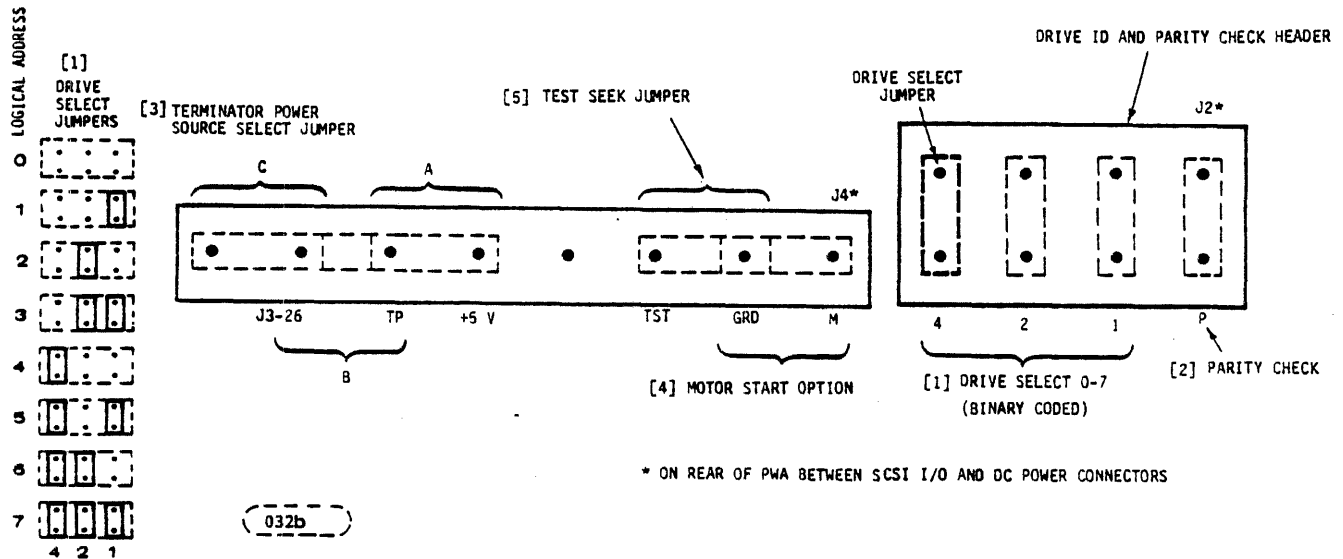
FIGURE 11.1-1. WREN V HH SCSI DRIVE ID AND OPTION SELECT HEADER

NOTES:

[1]   Drive ID is binary coded jumper position (most significant bit on left) , ie., jumper in position 4 would be Drive ID 4, no jumpers means ID 0.

[2]   Jumper plug installed means parity checking by the WREN V HH is enabled.

[3]   Jumper in position A means terminator power (+5 V) for the internal terminators is from the WREN V HH power connector. Jumper in position B means terminator power for the internal terminators is taken from the interface cable, pin 26. If the I/O cable is removed with a jumper in Position B and with the internal terminators installed, the drive will not power up. If a jumper is installed in Position C the WREN V HH will supply terminator power to pin 26 of the interface cable. [Note: If a jumper is installed in Position C a jumper must also be installed in Position A to power the internal terminators.]

If unit is not to be terminated, remove the terminator resistor packs. Removal of terminator power source select jumper does not disconnect the terminator resistors from the circuit.

[4]   Jumper plug installed enables the Motor Start Option. In this mode of operation the drive will wait for a Start Unit Command from the Host before starting the Motor. If the jumper plug is not installed the Motor will start as soon as DC power is applied to the unit (see section 14.2.1.11).

[5]   With the jumper in this position the unit will continuously perform test seeks to random cylinders. Motor starts as soon as DC power is applied.

11.1.3   Signal Sources

Table 11.1.3-1 indicates which type of SCSI device is allowed to source each signal. All SCSI device drivers that are not active sources shall be in the passive state. Note that the RST signal may be sourced by any SCSI device at any time. The WREN V HH functions as a target, never as an initiator, and is capable of performing only the reselection function.

TABLE 11.1.3-1. SIGNAL SOURCES

SIGNALS

BUS PHASE	BSY	SEL	C/D, I/O, MSG, REQ	I/O	ACK/ATN	DB(7-0,P)
BUS FREE	None	None	None	None	None	None
ARBITRATION	All	Winner	None	None	None	SCSI ID
SELECTION	I&T	Init.	None	Init.[1]	Init.	Init.
RESELECTION	I&T	Target	Target	Target	Init.	Target
COMMAND	Target	None	Target	Target	Init.	Init.
DATA IN	Target	None	Target	Target	Init.	Target
DATA OUT	Target	None	Target	Target	Init.	Init.
STATUS	Target	None	Target	Target	Init.	Target
MESSAGE IN	Target	None	Target	Target	Init.	Target
MESSAGE OUT	Target	None	Target	Target	Init.	Init.

ALL: The signal shall be driven by all actively arbitrating SCSI devices.

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

I&T: The signal shall be driven by the initiator, target, or both, as specified in the Selection phase and Reselection phase.

Initiator: If this signal is driven, it shall be driven only by the active initiator.

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

Winner: The signal shall be driven by the one SCSI device that wins arbitration.

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

[1]   Initiator forces negation.

11.2   SCSI Bus Timing

Unless otherwise indicated, the delay time measurements for each SCSI device, defined in Paragraphs 11.2.1 through 11.2.14, shall be calculated from signal conditions existing at that SCSI device's own SCSI bus connection. Thus, these measurements (except skew delay) can be made without considering delays in the cable.

11.2.1   Arbitration Delay (2.2 us)

The minimum time a SCSI device shall wait from asserting BSY for arbitration until the Data Bus can be examined to see if arbitration has be won. There is no maximum time.

11.2.2   Assertion Period (90 ns)

The minimum time that a target shall assert REQ while using synchronous data transfers. Also, the minimum time that an initiator shall assert ACK while using synchronous data transfers.

11.2.3   Bus Clear Delay (800 ns)

The maximum time for a SCSI device to stop driving all bus signals after:

(1)   The Bus Free phase is detected (BSY and SEL both negated for a bus settle delay).

(2)   SEL is received from another SCSI device during the Arbitration phase.

(3)   The transition of RST to assertion.

NOTE: For the first condition above, the maximum time for a SCSI device to clear the bus is 1200 ns from BSY and SEL first both negated. If a SCSI device requires more than a bus settle delay to detect Bus Free phase, it shall clear the bus within a Bus Clear delay minus the excess time.

11.2.4   Bus Free Delay (800 ns)

The minimum time that a SCSI device shall wait from it's detection of the Bus Free phase (BSY and SEL both negated for a bus settle delay) until it's assertion of BSY when going to the Arbitration phase.

11.2.5   Bus Set Delay (1.8 us)

The maximum time for a SCSI device to assert BSY and it's SCSI ID bit on the Data Bus after it detects Bus Free phase (BSY and SEL both negated for a bus settle delay) for the purpose of entering the Arbitration phase.

11.2.6   Bus Settle Delay (400 ns)

The time to wait for the bus to settle after changing
certain control signals as specified in the protocol
definitions.

11.2.7   Cable Skew Delay (10 ns)

The maximum difference in propagation time allowed between
any two SCSI bus signals when measured between any two SCSI
bus signals.

11.2.8   Data Release Delay (400 ns)

The maximum time for an initiator to release the Data Bus
signals following the transition of the I/O signal from
negation to assertion.

11.2.9   Deskew Delay (45 ns)

The minimum time required for deskew of certain signals.

11.2.10   Hold Time (45 ns)

The minimum time added between the assertion of REQ or ACK
and the changing of the data lines to provide hold time in
the   initiator   or   target,   respectively,   while   using
synchronous data transfers.

11.2.11   Negation Period (90 ns)

The minimum time that a target shall negate REQ while using
synchronous data transfers. Also, the minimum time that an
initiator shall negate ACK while using synchronous data
transfers.

11.2.12   Reset Hold Time (25 us)

The minimum time for which RST is asserted. There is no
maximum time.

11.2.13   Selection Abort Time (200 us)

The maximum time that a target (or initiator) shall take
from it's most recent detection of being selected (or
reselected) until asserting a BSY response. This timeout is
required to ensure that a target (or initiator) does not
assert BSY after a Selection (or Reselection) phase has
been aborted. This is not the selection timeout period; see
Sections 12.1.3.5 and 12.1.4.2 for a complete description.

11.2.14   Selection Timeout Delay (250 ms recommended)

The minimum time an initiator (or target) should wait for a BSY response during the Selection (or Reselection) phase before starting the timeout procedure. Note this is only a recommended time period. The WREN V HH SCSI implements this 250 ms selection timeout delay.

11.2.15   Transfer Period (set during a Message phase)

The minimum time allowed between the leading edges of successive REQ pulses and of successive ACK pulses while using synchronous data transfers. (See Sections 12.1.5.2 and 12.5.4.)

12.0   LOGICAL CHARACTERISTICS

All of the operations of the SCSI bus as described in Section 12 are supported by the WREN V HH, unless otherwise stated. The WREN V HH always functions as the target, never the initiator.

12.1   SCSI BUS PHASES

WREN V HH responds to 8 distinct bus phases.

Bus Free phase
Arbitration phase
Selection phase
Reselection phase

Command phase
Data(In and Out)   These phases are collectively termed
Status (In Only)   the Information Transfer phase.
Message (In and Out)

The SCSI Bus can never be in more than one phase at a time.

12.1.1   Bus Free Phase

The Bus Free phase indicates that no SCSI device is
actively using the SCSI bus and it is available for
subsequent users.

SCSI devices shall detect the Bus Free phase after SEL and
BSY are both false for at least a bus settle delay.

SCSI devices shall release all SCSI bus signals within a
bus clear delay after BSY and SEL are continuously negated
for a bus settle delay. If a SCSI device requires more than
a bus settle delay to detect the Bus Free phase, it shall
release all SCSI bus signals within a bus clear delay minus
the excess time to detect the Bus Free phase. The total
time to clear the SCSI bus shall not exceed a bus settle
delay plus a bus clear delay.

If the initiator detects the Bus Free phase (except as a
result of a Reset condition, an Abort message, or a Bus
Device Reset message) without first receiving a Disconnect
or Command Complete message, it shall be considered to be
an error condition. If the target intentionally creates
this condition, the target shall:

1.   Clear the current command, if any, for that initiator.
2.   Set up Request Sense data with appropriate Sense Key
      and Error Code if the LUN is known.

Whenever an initiator detects an unexpected Bus Free, it
should attempt to select and issue Request Sense to
determine if the previous command was:

1.   Aborted with valid Request Sense data, or
2.   Aborted without any valid Request Sense data.

12.1.2   Arbitration Phase

The Arbitration phase allows one SCSI device to gain control of the SCSI bus so that it can assume the role of an initiator or target. The WREN V HH will arbitrate for the bus only as a target implementing reselection. The WREN V HH supports arbitration by multiple SCSI devices.

The procedure for a SCSI device to obtain control of the SCSI bus is as follows:

1.   The SCSI device shall first wait for the Bus Free phase to occur. The Bus Free phase is detected when BSY and SEL are simultaneously and continuously negated for a minimum of a bus settle delay. (Implementers note: This bus settle delay is necessary because a transmission line phenomenon known as a "Wire-OR glitch" may cause BSY to briefly appear negated, even though it is being asserted.)

2.   The SCSI device shall wait a minimum of a bus free delay after detection of the Bus Free phase (i.e. after BSY and SEL are both negated for a bus settle delay) before driving any signal.

3.   Following the bus free delay in Step (2), the SCSI device may arbitrate for the SCSI bus by asserting both BSY and it's own SCSI ID, however the SCSI device shall not arbitrate (i.e. assert BSY and it's SCSI ID) if more than a bus set delay has passed since the Bus Free phase was last observed. (Implementers Note: There is no maximum delay before asserting BSY and the SCSI ID following the bus free delay in Step (2) as long as the bus remains in the Bus Free phase. However, SCSI devices that delay longer than a bus settle delay plus a bus set delay from the time when BSY and SEL are first negated may fail to participate in arbitration when competing with faster SCSI devices.)

12.1.2   continued

4.   After waiting at least an arbitration delay (measured
       from it's assertion of BSY) the SCSI device shall
       examine the Data Bus. If a higher priority SCSI ID bit
       is true on the Data Bus [DB(7) is the highest], the
       SCSI device has lost the arbitration and the SCSI
       device must release it's signals and return to Step
       (1). If no higher priority SCSI ID bit is true on the
       Data Bus, the SCSI device has won the arbitration and
       it shall assert SEL. Any other SCSI device that is
       participating in the Arbitration phase has lost the
       arbitration and shall release BSY and it's SCSI ID bit
       within a bus clear delay after SEL becomes true. A
       SCSI device that loses arbitration may return to Step
       (1).

5.   The SCSI device that wins arbitration shall wait at
       least a bus clear delay plus a bus settle delay after
       asserting SEL before changing any signals.

NOTE: The SCSI ID bit is a single bit on the Data Bus that
corresponds to the SCSI device's unique SCSI address. All
other seven Data Bus bits shall be released by the SCSI
device. Parity is not valid during the Arbitration phase.
DB(P) may be undriven or driven to the true state, but
shall not be driven to the false state.

12.1.3   Selection Phase

The Selection phase allows an initiator to select a target
for the purpose of initiating some target function (e.g.,
Read or Write command).

NOTE: During the Selection phase the I/O signal shall be
negated so this phase can be distinguished from the
Reselection phase.

12.1.3.1 Nonarbitrating System

In systems with the Arbitration phase not implemented, the
initiator shall first detect the Bus Free phase and then
wait a minimum of a bus clear delay. Then, except in
certain single initiator environments with initiators
employing the single initiator option (see 12.1.3.4), the
initiator shall assert the desired target's SCSI ID and
it's own initiator SCSI ID on the Data Bus. After two
deskew delays, the initiator shall assert SEL.

12.1.3.2 Arbitrating Systems

In systems with the Arbitration phase implemented, the SCSI device that won the arbitration has both BSY and SEL asserted and has delayed at least a bus clear delay plus a bus settle delay before ending the Arbitration phase. The SCSI device that won the arbitration becomes an initiator by releasing I/O. Except in certain single initiator environments with initiators employing the single initiator option (see 12.1.3.4), the initiator shall set the Data Bus to a value which is the OR of it's SCSI ID bit and the target's SCSI ID bit. The initiator shall then wait at least two deskew delays and release BSY. The initiator shall then wait a least a bus settle delay before looking for a response from the target.

12.1.3.3 All Systems

In all systems, the target shall determine that it is selected when SEL and it's SCSI ID bit are true and BSY and I/O are false for at least a bus settle delay. The selected target will examine the Data Bus in order to determine the SCSI ID of the selecting initiator unless the initiator employed the single initiator option (see 12.1.3.4). The selected target shall then assert BSY within a selection abort time of it's selection; this is required for correct operation of the timeout procedure. In systems with parity implemented, the target shall not respond to a selection if bad parity is detected. Also, if more than two SCSI ID bits are on the Data Bus, the target shall not respond to selection. At least two deskew delays after the initiator detects BSY is asserted, it shall release SEL and `may change the Data Bus.

12.1.3.4 Single Initiator Option

Initiators that do not implement the Reselection phase, and do not operate in the multiple initiator environment, are allowed to set only the target's SCSI ID bit during the Selection phase. This makes it impossible for the target to determine the initiator's SCSI ID.

12.1.3.5 Selection Time Out Procedure

A Selection timeout procedure is specified for clearing the
SCSI bus. If the initiator waits a minimum of a selection
timeout delay and there has been no BSY response from the
target, the initiator shall continue asserting SEL and
shall release the Data Bus. If the initiator has not
detected BSY to be asserted after at least a selection
abort time plus two deskew delays, the initiator shall
release SEL allowing the SCSI bus to go to the Bus Free
phase. SCSI devices shall ensure when responding to
selection that the selection was still valid within a
selection abort time of their assertion of BSY. Failure to
comply with this requirement could result in an improper
selection (two targets connected to the same initiator,
wrong target connected to an initiator, or a target
connected to no initiator).

The WREN V HH supports systems that implement this
procedure.

12.1.4   Reselection Phase

Reselection is a phase that allows a target to reconnect to
an initiator for the purpose of continuing some operation
that was previously started by the initiator but was
suspended by the target (i.e., the target disconnected by
allowing a Bus Free phase to occur before the operation was
complete).

Reselection can be used only in systems that have
Arbitration phase implemented.

The WREN V HH implements the Reselection phase if the
system is capable of supporting Reselection.

12.1.4.1 Reselection Procedure

Upon completing the Arbitration phase, the winning SCSI
device has both BSY and SEL asserted and has delayed at
least a bus clear delay plus a bus settle delay. The
winning SCSI device becomes a target by asserting the I/O
signal. That device shall also set the Data Bus to a value
that is the OR of it's SCSI ID bit and the initiator's SCSI
ID bit. The target shall wait at least two deskew delays
and release BSY. The target shall then wait at least a bus
settle delay before looking for a response from the
initiator.

12.1.4.1 continued

The initiator shall determine that it is reselected when SEL, I/O, and it's SCSI ID bit are true and BSY is false for at least a bus settle delay. The reselected initiator may examine the Data Bus to determine the SCSI ID of the reselecting target.

The reselected initiator shall then assert BSY within a selection abort time of it's most recent detection of being reselected; this is required for correct operation of the timeout procedure. In systems with parity implemented, the initiator shall not respond to Reselection if bad parity is detected. The initiator shall not respond to a Reselection if more than two SCSI ID bits are on the Data Bus.

After the target detects BSY, it shall also assert BSY and wait at least two deskew delays and then release SEL. The target may then change the I/O signal and the Data Bus. After the reselected initiator detects SEL false, it shall release BSY. The target shall continue asserting BSY until the target is ready to relinquish the SCSI bus.

NOTE

When the target is asserting BSY, a transmission line phenomenon known as a "Wire-OR glitch" may cause BSY to appear false for up to a round trip propagation delay following the release of BSY by the initiator. This is the reason why the Bus Free phase is recognized only after both BSY and SEL are continuously false for a minimum of a bus settle delay. Cables longer than 25 metres should not be used even if the chosen driver, receiver, and cable provide adequate noise margins, because they increase the duration of the glitch and could cause SCSI devices to inadvertently detect the Bus Free phase.

12.1.4.2 Reselection Timeout Procedure

This Reselection timeout procedure is specified for clearing the SCSI bus during a Reselection phase. If the target waits a minimum of a selection timeout period and there has been no BSY response from the initiator, The target shall continue asserting SEL and I/O and shall release all Data Bus signals. If the target has not detected BSY to be true after at least a selection abort time plus two deskew delays, the target shall release SEL and I/O allowing the SCSI bus to go to the Bus Free phase. SCSI devices that respond to Reselection shall ensure that the Reselection was still valid within a selection abort time of their assertion of BSY. Failure to comply with this requirement could result in an improper Reselection (two initiators connected to the same target or the wrong initiator connected to a target).

If Reselection fails, the current command will be aborted. If an initiator times out while waiting to be reselected, the initiator should attempt to select and issue Request Sense to determine if the previous command is:

1.   Still in process (Busy Status will be returned),
2.   Aborted with valid Request Sense data, or
3.   Aborted without valid Request Sense data.

12.1.5   Information Transfer Phases

NOTE: The Command, Data, Status, and Message phases are grouped together as information transfer phases because they are all used to transfer data or control information via the Data Bus. The actual contents of the information is beyond the scope of this section.

The C/D, I/O, and MSG signals are used to distinguish between the different information transfer phases. (See Table 12.1.5-1). The target drives these three signals and therefore controls all changes from one phase to another. The initiator can request a Message Out phase by asserting ATN, while the target can cause the Bus Free phase by releasing MSG, C/D, I/O, and BSY.

12.1.5   continued

TABLE 12.1.5-1.   INFORMATION TRANSFER PHASES

SIGNAL					
MSG	C/D	I/O	PHASE NAME	DIRECTION OF TRANSFER	COMMENT
0	0	0	DATA OUT	Initiator to target	Data
0	0	1	DATA IN	Initiator from target	Phase
0	1	0	COMMAND	Initiator to target	
0	1	1	STATUS	Initiator from target	
1	0	0	*		
1	0	1	*		
1	1	0	MESSAGE OUT	Initiator to Target	Message
1	1	1	MESSAGE IN	Initiator from Target	Phase

Key: 0 = False,   1 = True,   * = Reserved

The information transfer phases use one or more REQ/ACK
handshakes to control the information transfer. Each
REQ/ACK handshake allows the transfer of one byte of
information. During the information transfer phases BSY
shall remain true and SEL shall remain false. Additionally,
during the information transfer phases, the target shall
continuously envelope the REQ/ACK handshake(s) with C/D,
I/O, and MSG in such a manner that these control signals
are valid for a bus settle delay before the assertion of
REQ of the first handshake and remain valid until the
negation of ACK at the end of the last handshake.

12.1.5.1 Asynchronous Information Transfer

The target shall control the direction of information
transfer by means of the I/O signal. When I/O is true,
information shall be transferred from the target to the
initiator. When I/O is false, information shall be
transferred from the initiator to the target.

If I/O is true (transfer to the initiator), the target
shall first drive DB(7-0, P) to their desired values, delay
at least one deskew delay plus a cable skew delay, then
assert REQ. DB(7-0, P) shall remain valid until ACK is true
at the target. The initiator shall read DB(7-0, P) after
REQ is true, then signal it's acceptance of the data by
asserting ACK. When ACK becomes true at the target, the
target may change or release DB(7-0, P) and shall negate
REQ. After REQ is false the initiator shall negate ACK.
After ACK is false, the target may continue the transfer by
driving DB(7-0, P) and asserting REQ, as described above.

12.1.5.1 continued

If I/O is false (transfer to the target) the target shall
request information by asserting REQ. The initiator shall
drive DB(7-0, P) to their desired values, delay at least
one deskew delay plus a cable skew delay and assert ACK.
The initiator shall continue to drive the DB(7-0,P) until
REQ is false. When ACK becomes true at the target, the
target shall read DB(7-0, P), then negate REQ. When REQ
becomes false at the initiator, the initiator may change or
release DB(7-0, P) and shall negate ACK. The target may
continue the transfer by asserting REQ, as described above.

12.1.5.2 Synchronous Data Transfer

Synchronous data transfer may be used only in the data
phase if previously agreed to by the initiator and target
through the message system (see Synchronous Data Transfer
Request message, 12.5.4). The messages determine the use of
synchronous mode by both SCSI devices and establish a
REQ/ACK offset and a transfer period.

The REQ/ACK offset specifies the maximum number of REQ
pulses that can be sent by the target in advance of the
number of ACK pulses received from the initiator,
establishing a pacing mechanism. If the number of REQ
pulses exceeds the number of ACK pulses by the REQ/ACK
offset, the target shall not assert REQ until the next ACK
pulse is received. A requirement for successful completion
of the data phase is that the number of ACK and REQ pulses
be equal.

The target shall assert the REQ signal for a minimum of an
assertion period. The target shall wait at least the
greater of a transfer period from the last transition of
REQ to true or a minimum of a negation period from the last
transition of REQ to false before asserting the REQ signal.

The initiator shall send one pulse on the ACK signal for
each REQ pulse received. The initiator shall assert the ACK
signal for a minimum of an assertion period. The initiator
shall wait at least the greater of a transfer period from
the last transition of ACK to true or for a minimum of a
negation period from the last transition of ACK to false
before asserting the ACK signal.

12.1.5.2 continued

If I/O is true (transfer to the initiator), the target shall first drive DB(7-0, P) to their desired values, wait at least one deskew delay plus one cable skew delay, then assert REQ. DB(7-0, P) shall be held valid for a minimum of one deskew delay plus one cable skew delay plus one hold time after the assertion of REQ. The target shall assert REQ for the minimum of an assertion period. The target may then negate REQ and change or release DB(7-0, P). The initiator shall read the value on DB(7-0, P) within one hold time of the transition of REQ to true. The initiator shall then respond with an ACK pulse.

If I/O is false (transfer to the target), the initiator shall transfer one byte for each REQ pulse received. After receiving a REQ pulse, the initiator shall first drive DB(7-0, P) to the desired values, delay at least one deskew delay plus one cable skew delay, then assert ACK. The initiator shall hold DB(7-0, P) valid for at least one deskew delay plus one cable skew delay plus one hold time after the assertion of ACK. The initiator shall assert ACK for a minimum of an assertion period. The initiator shall then negate ACK and may change or release DB(7-0, P). The target shall read the value of DB(7-0, P) within one hold time of the transition of ACK to true.

12.1.6   Command Phase

The Command phase allows the target to request command information from the initiator.

The target shall assert the C/D signal and negate the I/O and MSG signals during the REQ/ACK handshake(s) of this phase.

12.1.7   Data Phase

The Data phase is a term that encompasses both the Data In phase and the Data Out phase.

12.1.7.1 Data In Phase

The Data In phase allows the target to request that it send data to the initiator.

The target shall assert the I/O signal and negate the C/D and MSG signals during the REQ/ACK handshake(s) of this phase.

12.1.7.2 Data Out Phase

The Data Out phase allows the target to request that data be sent to it from the initiator.

The target shall negate the C/D, I/O, and MSG signals during the REQ/ACK handshake(s) of this phase.

12.1.8   Status Phase

The Status phase allows the target to request that it send status information to the initiator.

The target shall assert C/D and I/O and negate the MSG signal during the REQ/ACK handshake of this phase.

12.1.9   Message Phase

The Message phase is a term that references either a Message In or a Message Out phase. Multiple messages may be sent during either phase. The first byte transferred in either of these phases shall be either a single byte message or the first byte of a multiple byte message. Multiple byte messages shall be wholly contained with a single message phase.

12.1.9.1 Message IN Phase

The Message In phase allows the target to request that it send message(s) to the initiator.

The target shall assert C/D, I/O, and MSG during the REQ/ACK handshake(s) of this phase.

12.1.9.2 Message Out Phase

The Message Out phase allows the target to request that message(s) be sent from the initiator to the target. The target may invoke this phase at it's convenience in response to the Attention condition (see 12.2.1) created by the initiator.

The target shall assert C/D and MSG and negate I/O during the REQ/ACK handshake(s) of this phase. The target shall handshake byte(s) in this phase until ATN goes false, unless an error occurs (see Message Reject, 12.5.2).

12.1.9.2 continued

If the target detects one or more parity error(s) on the message byte(s) received, it may indicate it's desire to retry the message(s) by asserting REQ after detection ATN has gone false and before changing to any other phase. The initiator, upon detecting this condition, shall resend all of the previous message byte(s) sent during this phase. When resending more than one message byte, the initiator shall assert ATN before asserting ACK on the first byte and shall maintain ATN asserted until the last byte is sent as described in 12.2.1.

If the target receives all of the message byte(s) successfully (i.e., no parity errors), it shall indicate that it does not wish to retry by changing to any information transfer phase other than the Message Out phase and transfer at least one byte. The target may also indicate that it has successfully received the message byte(s) by changing to the Bus Free phase (e.g., Abort or Bus Device Reset messages).

Only the following combinations of messages will be accepted during the same Message Out transfer (and only immediately after Selection):

1.   Identify message followed by Abort message
2.   Identify message followed by Bus Device Reset message
3.   Identify message followed by No Operation message
4.   Identify message followed by Synchronous Data Xfer Request message

If a target receives illegal multiple messages, it will send a Message Reject message, go to Bus Free, and abort any command in process for that initiator.

12.1.10   Signal Restrictions Between Phases

When the SCSI bus is between two information transfer phases, the following restrictions shall apply to the SCSI bus signals:

1.   The BSY, SEL, REQ, and ACK signals shall not change.

12.1.10 continued

2. The C/D, I/O, MSG, and Data Bus signals may change.
    When switching the Data Bus direction from Out
    (initiator driving) to In (target driving), the target
    shall delay driving the Data Bus by at least a data
    release delay plus settle delay after asserting the
    I/O signal and the initiator shall release the Data
    Bus no later than a data release delay after the
    transition of the I/O signal to true. When switching
    the Data Bus direction from In (target driving) to Out
    (initiator driving), the target shall release the Data
    Bus no later than a deskew delay after negating the
    I/O signal.

3. The ATN and RST signals may change as defined under
    the descriptions for the Attention condition (12.2.1)
    and Reset condition (12.2.2).

12.2 SCSI BUS CONDITIONS

The SCSI bus has two asynchronous conditions: the Attention
condition and the Reset condition. These conditions cause
the SCSI device to perform certain actions and can alter
the phase sequence.

12.2.1 Attention Condition

The Attention condition allows an initiator to inform a
target that the initiator has a message ready. The target
will get this message at it's convenience by performing a
Message Out phase.

The initiator creates the Attention condition by asserting
ATN at any time except during the Arbitration or Bus Free
phase.

The initiator must assert the ATN signal before asserting
ACK for the last byte transferred in a bus phase for the
Attention condition to be honored before transition to a
new bus phase. An ATN asserted later may not be honored
until a later bus phase. The WREN V HH will respond with
Message Out phase as follows:

1. If ATN occurs during a Data phase, Message Out will
    occur at a convenient time. It may not occur until
    several logical blocks after ATN is first asserted.

2. If ATN occurs during a Command phase, Message Out will
    occur after transfer of all Command Descriptor Block
    bytes has been completed.

12.2.1   continued

3.   If ATN occurs during a Status phase, Message Out will occur after the status byte has been acknowledged by the initiator.

4.   If ATN occurs during a Message In phase, Message Out will occur after the last byte of the current message has been acknowledged by the initiator.

5.   If ATN occurs during a Selection or Reselection phase, Message Out will occur immediately after that Selection or Reselection phase.

The initiator shall keep ATN asserted if more than one byte is to be transferred. The initiator may negate the ATN signal at any time except it shall not negate the ATN signal while the ACK signal is asserted during a Message Out phase. Recommended practice is that the initiator negates ATN while REQ is true and ACK is false during the last REQ/ACK handshake of the Message Out phase.

12.2.2   Reset Condition

The Reset condition is used to immediately clear all SCSI devices from the bus. This condition shall take precedence over all other phases and conditions. During the Reset condition, the state of all SCSI bus signals other than RST is not defined.

The WREN V HH will never assert the Reset signal.

All SCSI devices shall release all SCSI bus signals (except RST) within a bus clear delay of the transition of RST to true. The Bus Free phase always follows the Reset condition.

The WREN V HH implements only the "hard" Reset option. Upon detection of the Reset condition, the WREN V HH shall:

1.   Clear all uncompleted commands,
2.   Release all SCSI device reservations,
3.   Return any SCSI device operating modes (Mode Select, etc) to their default conditions.

4.   Activate Unit Attention Condition for all Initiators.

12.3   SCSI BUS PHASE SEQUENCES

The order in which phases are used on the SCSI bus follows
a prescribed sequence.

In all systems, the Reset condition can abort any phase and
is always followed by the Bus Free phase. Also, any other
phase can be followed by the Bus Free phase.

12.3.1   Nonarbitrating System

For systems in which the Arbitration phase is not
implemented, the allowable sequences are shown in Figure
12.3-1. The normal progression is from the Bus Free phase
to Selection, and from Selection to one or more of the
information transfer phases (Command, Data, Status, or
Message).

12.3.2   Arbitrating Systems

For systems in which the Arbitration phase is implemented,
the allowable sequences are shown in Figure 12.3-2. The
normal progression is from the Bus Free phase to
Arbitration, from Arbitration to Selection or Reselection,
and from Selection or Reselection to one or more of the
information transfer phases (Command, Data, Status, or
Message).

12.3.3   All Systems

There are no restrictions on the sequences between
information transfer phases. A phase type may even be
followed by the same phase type (e.g., a Data phase may be
followed by another Data phase).

RESET CONDITION
* DATA PHASE MUST FOLLOW A COMMAND PHASE EXCEPT AFTER RESELECTION PHASE
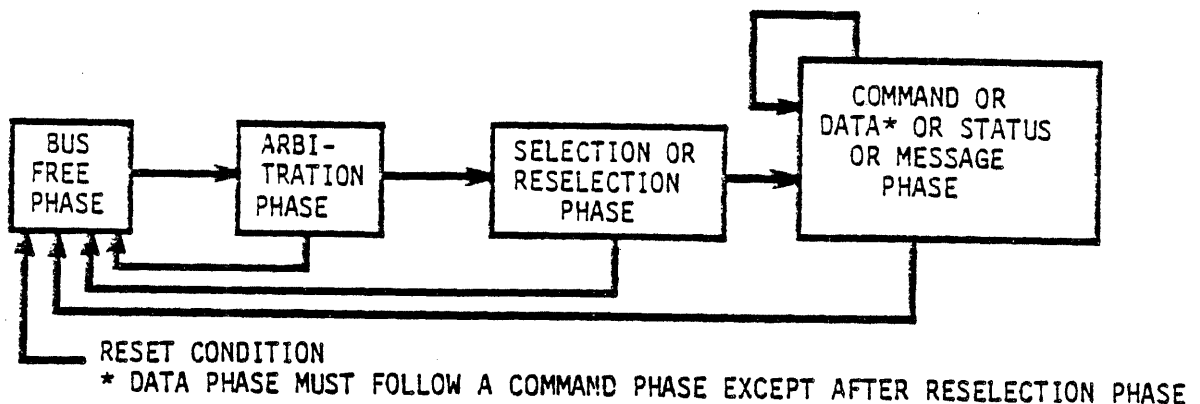
FIGURE 12.3-1.   PHASE SEQUENCES WITHOUT ARBITRATION

RESET CONDITION
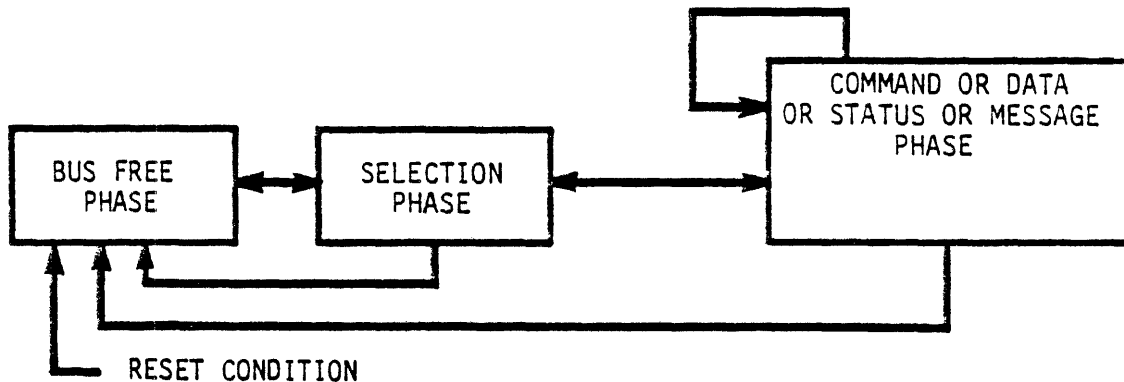
FIGURE 12.3-2. PHASE SEQUENCES WITH ARBITRATION

12.4   SCSI POINTERS

WREN V HH supports systems that use the pointer philosophy
described in the following paragraphs.

Consider the system shown in Figure 12.4-1 in which an
initiator and target communicate on the SCSI bus in order
to execute a command.

INITIATOR   TARGET
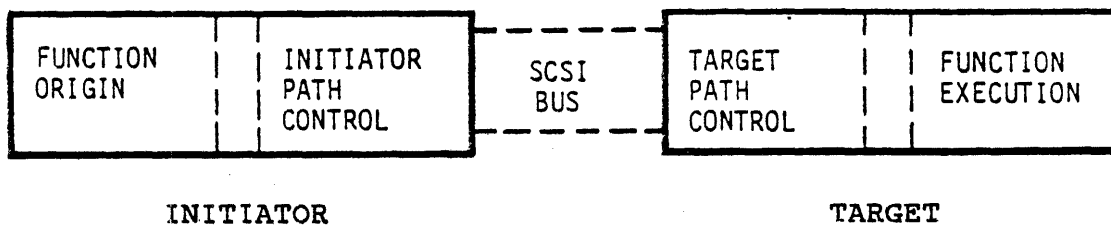
FIGURE 12.4-1. SIMPLIFIED SCSI SYSTEM

The SCSI architecture provides for two sets of three
pointers within each initiator. The pointers are part of
the initiator path control. The first set of pointers are
known as the current (or active) pointers. These pointers
represent the state of the interface and point to the next
command, data, or status byte to be transferred between the
initiator's memory and the target. There is only one set of
current pointers in each initiator. The current pointers
are used by the target currently connected to the initiator.

12.4   continued

The second set of pointers are known as the saved pointers.
There is one set of saved pointers for each command that is
currently active (whether or not it is currently
connected). The saved command pointer always points to the
start of the Command Descriptor Block (see Paragraph 13.2)
for the current command. The saved status pointer always
points to the start of the status area for the current
command. At the beginning of each command, the saved data
pointer points to the start of the data area. It remains at
this value until the target sends a Save Data Pointer
message (see Paragraph 12.5.2) to the initiator. In
response to this message, the initiator stores the value of
the current data pointer into the saved data pointer. The
target may restore the current pointers to their saved
values by sending a RESTORE POINTER Message (see Paragraph
12.5.2) to the initiator. The initiator moves the saved
value of each pointer into the corresponding current
pointer. Whenever a SCSI device disconnects from the bus,
only the saved pointer values are retained. The current
pointer values are restored from the saved values upon the
next reconnection.

12.5   MESSAGE SYSTEM SPECIFICATION

The message system allows communication between an
initiator and target for the purpose of physical path
management.

12.5.1   Message Protocol

WREN V HH supports systems that accommodate only the
Command Complete message, or systems that can accommodate
additional messages. WREN V HH is always Logical Unit (LUN)
address zero.

SCSI devices indicate their ability to accommodate more
than the Command Complete message by asserting or
responding to the ATN signal. The initiator indicates this
in the Selection phase by asserting ATN before the SCSI bus
condition of SEL true, and BSY false. If the target hasn't
received ATN by this point, it will assume the initiator
doesn't support disconnection or messages other than
Command Complete. If the ATN signal is asserted later, it
will be ignored until after the next Bus Free phase. The
target indicates it's ability to accommodate more messages
by responding to the Attention condition with the Message
Out phase after going through the Selection phase.

12.5.1   continued

For SCSI devices that support messages other than Command
Complete, the first message sent by the initiator after the
Selection phase shall be the Identify message. This allows
the establishment of the physical path for a particular
logical unit specified by the initiator. After the
Reselection phase, the target's first message shall be
Identify. This allows the physical path to be reestablished
for the target's specified logical unit number (always zero
for WREN V HH). An initiator may send the Abort message or
the Bus Device Reset message instead of the Identify
message, as the first message.

Whenever a physical path is established in an initiator
that can accommodate disconnection and reconnection, the
initiator shall ensure that the active pointers of the
physical path are equal to the save pointers for that
particular logical unit number. (An implied restore
pointers operation occurs as a result of connect or
reconnect.)

12.5.2   Messages

The single byte messages supported by the WREN V HH are
listed in Table 12.5.2-1. Their code values are given a
direction specification. Detailed descriptions follow the
table. Messages other than those listed will be answered
with a Message Reject message.

TABLE 12.5.2-1. MESSAGE CODES

CODE	DESCRIPTION	[1] DIRECTION	
00H	COMMAND COMPLETE	IN	
01H/01H	SYNC DATA TRANSFER REQUEST	IN	OUT
02H	SAVE DATA POINTER	IN	
03H	RESTORE POINTERS	IN	
04H	DISCONNECT	IN	
05H	INITIATOR DETECTED ERROR		OUT
06H	ABORT		OUT
07H	MESSAGE REJECT [2]	IN	OUT
08H	NO OPERATION		OUT
09H	MESSAGE PARITY ERROR		OUT
0CH	BUS DEVICE RESET		OUT
80H--FFH	IDENTIFY	IN	OUT

[1]   In = WREN V HH to Initiator
         Out = Initiator to WREN V HH

[2]   WREN V HH will not resend (RETRY) the original message

12.5.2   continued

Command Complete 00H - This message is sent from a target
to an initiator to indicate the execution of a command has
terminated and that valid status has been sent to the
initiator. After successfully sending this message, the
target shall go to the Bus Free phase by releasing BSY.

NOTE: The command may have been executed successfully
           or unsuccessfully as indicated in the status.

Extended Message 01H - This message is sent from either the
initiator or the target as the first byte of a multiple
byte message. (See Paragraph 12.5.3 for descriptions of
extended messages.)

Save Data Pointer 02H - This message is sent from the
currently attached target to direct the initiator to save a
copy of the presently active data pointer. (See Paragraph
12.4 for a definition of pointers.)

Restore Pointers 03H - This message is sent from the target
to direct the initiator to restore to the active state the
most recently saved pointers for the currently attached
WREN V HH. Pointers to the command, data, and status
locations for the logical unit shall be restored to the
active pointers. Command and status pointers shall be
restored to the beginning of the present command and status
areas. The data pointer shall be restored to the value at
the beginning of the data area in the absence of a Save
Data Pointer message or to the value at the point at which
the last Save Data Pointer message occurred for currently
attached WREN V HH.

Disconnect 04H - This message is sent from a target to
inform an initiator that the present physical path is going
to be broken (the target plans to disconnect by releasing
BSY), but that a later reconnect will be required in order
to complete the current operation. If the initiator detects
the Bus Free phase (other than a result of a Reset
condition) without first receiving a Disconnect or Command
Complete message, the initiator shall consider this a
catastrophic error condition. If the target intentionally
creates this condition, the target shall clear the current
command. This message shall not cause the initiator to save
the data pointer. Note: If Disconnect messages are used to
break a long data transfer into two or more shorter
transfers, then a Save Data Pointer message will be issued
before each Disconnect message. The WREN V HH will
disconnect when a substantial delay is anticipated. These
situations occur after receipt of a Command Descriptor
Block or during a data transfer.

12.5.2   continued

Initiator Detected Error 05H - This message is sent from an initiator to inform a target an error (e.g. parity error) has occurred that does not preclude the target from retrying the operation. Since present pointer integrity is not assured, a Restore Pointers message shall be sent by the target to cause the pointers to be restored to their defined prior state. An initiator should not issue this message unless it will accept the Restore Pointers message. If the target is not sure it can recover properly, Check Condition status will be created with Sense Key of Aborted Command.

Abort 06H - This message is sent from the initiator to the target to clear the present operation. If a logical unit has been identified, all pending data and status for the issuing initiator from the affected logical unit shall be aborted and target shall go to the Bus Free phase. Pending data and status for other initiators shall not be cleared. If a logical unit has not been identified, the target shall go to the Bus Free phase. No status or ending message shall be sent for the operation.

Message Reject 07H - This message is sent from either the initiator or target to indicate that the last message it received was inappropriate or has not been implemented. The WREN V HH will not resend (retry) the original message.

12.5.2   continued

The WREN V HH response to a message reject message will
depend on what the original message was.

ORIGINAL MESSAGE	RECOVERY ACTION
Command Complete	Go to Bus Free state anyway.
Synchronous Request	Assume asynchronous transfers and continue.
Save Data Pointer	If Data In Phase, don't disconnect and continue data transfer command. If Data Out Phase, continue disconnect sequence.
Restore Pointers	Terminate command immediately with Check Condition status and Hardware Error in Sense Key.
Disconnect	Don't disconnect and continue command normally.
Message Reject	Terminate command immediately with Check Condition status and Hardware Error in Sense Key.
Linked Cmd Complete	Go to Bus Free phase.
Identify	Go to Bus Free (catastrophic error), save Aborted CMD in the Sense Key.

12.5.2   continued

No Operation 08H - This message is sent from an initiator in response to a target's request for a message when the initiator does not currently have any other valid message to send.

Message Parity Error 09H - This message is sent from the initiator to the target to indicate that one or more bytes in the last message it received had a parity error. The WREN V HH will attempt to resend the original message one time. If the retry attempt also results in a parity error, the target will go to Bus Free phase.

In order to indicate it's intentions of sending this message, the initiator shall assert the ATN signal before it's release of ACK for the REQ/ACK handshake of the message that has the parity error. This provides an interlock so that the target can determine which message has the parity error.

Bus Device Reset OCH - This message is sent from an initiator to direct a target to clear all current commands. This message forces the SCSI device to an initial state with no operations pending for any initiator. Upon recognizing this message, the target shall go to the Bus Free phase.

12.5.2   continued

Identify 80H to FFH - These messages are sent by either the
initiator (after Selection phase) or the target (after
Reselection phase) to establish the physical path
connection between an initiator and target.

Bit 7 - This bit is always set to one to distinguish these
messages from the other messages.

Bit 6 - This bit is set to one only by the initiator. When
set to one, it indicates the initiator has the ability to
accommodate disconnection and reconnection. When set to
zero, the WREN V HH will not attempt to disconnect.

Bits 5-3 - Reserved

Bits 2-0 - These bits specify a logical unit number in a
target. Always "0" for WREN V HH.

When sent from a target to an initiator during
reconnection, and implied Restore Pointers message shall be
performed by the initiator before completion of this
message.

If an initiator specifies an invalid LUN in the Identify
message, the WREN V HH will accept the Identify message but
will reject the next command. See Paragraph 13.2.2.

12.5.3   Extended Messages

Extended messages except for the Synchronous Data Transfer
Request are not implemented. WREN V HH will respond with a
Message Reject message after any other extended message is
received.

The Extended message format to be used by WREN V HH is
shown in Section 12.5.4, "Synchronous Data Transfer Request
Message".

12.5.4   Synchronous Data Transfer Request Message

TABLE 12.5.4-1.   SYNCHRONOUS DATA TRANSFER REQUEST

BYTE	VALUE	DESCRIPTION
0	01H	Extended message
1	03H	Extended message length
2	01H	Synchronous Data Transfer Request code
3	mH	Transfer period (mH times 4 ns)
4	xH	REQ/ACK offset

12.5.4   continued

If data transfers between an initiator and the WREN V HH
are to be synchronous, a pair of Synchronous Data Transfer
Request messages (Table 12.5.4-1) are exchanged between an
initiator and a target whenever one of the devices
recognizes that it has not communicated with the other SCSI
device since receiving the last "hard" Reset condition or a
Bus Device Reset message. The SCSI devices may also
exchange messages to establish synchronous data transfer
when requested to do so. The message exchange establishes
the transfer period and the REQ/ACK offset. The transfer
period is the minimum time between leading edges of
successive REQ pulses and of successive ACK pulses.

The REQ/ACK offset is the maximum number of REQ pulses that
may be outstanding before a corresponding ACK pulse is
received at the target. A REQ/ACK offset value of zero
shall indicate asynchronous mode: a value of FFH shall
indicate unlimited offset.

If the initiator recognizes that negotiation is required,
it asserts ATN and sends a Synchronous Data Transfer
Request message indicating a REQ/ACK offset and minimum
transfer period. The REQ/ACK offset is chosen to prevent
initiator buffer overflows, while the minimum transfer
period is chosen to meet the data handling requirements of
the initiator. The target responds in any of the following
ways:

TARGET RESPONSE	IMPLIED AGREEMENT
1. REQ/ACK offset less than or equal to the requested value.	REQ/ACK offset equal to target value.
Minimum transfer period equal to or greater than requested period.	Minimum transfer period equal to the target value.
2. REQ/ACK offset equal to zero.	Asynchronous transfer.
3. Message Reject	Asynchronous transfer.

12.5.4   continued

If the target recognizes that negotiation is required, it
sends a SYNCHRONOUS DATA TRANSFER REQUEST message to the
initiator. The REQ/ACK offset is selected to prevent buffer
and offset counter overflows, while the minimum transfer
period is chosen to meet the data handling requirements of
the target. The initiator responds in any of the following
ways if the target chooses an REQ/ACK offset equal to FFH:

INITIATOR RESPONSE	IMPLIED AGREEMENT
(1) REQ/ACK offset equal to FFH. Minimum transfer period equal to or greater than requested period.	REQ/ACK offset unlimited. Minimum transfer period equal to the initiator value.
(2) REQ/ACK offset equal to 00H.	Asynchronous transfer. The target may renegotiate for an REQ/ACK offset less than FFH and greater than 00H.
(3) MESSAGE REJECT.	Asynchronous transfer.

The initiator responds in any of the following ways if the
target selects an REQ/ACK offset less than FFH:

INITIATOR RESPONSE	IMPLIED AGREEMENT
(1) REQ/ACK offset less than or equal to the requested value. Minimum transfer period equal to or greater than requested value.	REQ/ACK offset equals initiator value. Minimum transfer period equal to the initiator value.
(2) REQ/ACK offset equal to zero.	Asynchronous transfer.
(3) MESSAGE REJECT	Asynchronous transfer.

12.5.4   continued

The implied agreement shall remain in effect until a Bus Device Reset message is received, until a "hard" Reset condition occurs, or until one of the two SCSI devices elects to modify the agreement. Renegotiation at every selection is not recommended, since a significant performance impact is likely. The default mode of data transfer is asynchronous mode. The default mode is entered at power on, after a Bus Device Reset message, or after a "hard" Reset condition. The Synchronous Data Transfer Request message exchange can only take place following a Selection phase that includes the SCSI IDs for both the initiator and the target. Violation of this rule may make data transfer impossible owing to disagreements among SCSI devices about the data transfer mode.

The WREN V HH will never send Synchronous Data Transfer Request message unless an initiator sends this message to the WREN V HH first.

The WREN V HH SCSI supports up to 15 REQ/ACK offsets.

The WREN V HH SCSI supports the following transfer periods.

m - TRANSFER PERIOD VALUE		TRANSFER PERIOD (m x 4 ns)
Decimal	Hex	
63	3F	252
73	49	292
84	54	336
94	5E	376
105	69	420
115	73	460
125	7D	500
136	88	544
146	92	584
157	9D	628
167	A7	668
178	B2	712
188	BC	752
198	C6	792
209	D1	836
219	DB	876
230	E6	920
240	F0	960
250	FA	1000

13.0   SCSI COMMANDS

          This section defines the SCSI command structure and
          describes a typical SCSI bus procedure involving a command,
          status return and message interchange. It should be noted
          that WREN V HH does not support command linking and will
          respond with a "Check Condition" status and "Illegal
          Request" sense key if a linked command is received.

          The command structure defined herein provides for a
          contiguous set of logical blocks of data to be transferred
          across the interface. The number of the logical data blocks
          to be transferred are defined in the command. Initiator
          commands to the WREN V HH are structured in accordance with
          the requirements imposed by the WREN V HH physical
          characteristics. These physical characteristics are
          reported to the initiator in response to an inquiry command.

          A single command may transfer one or more logical blocks of
          data. The WREN V HH may disconnect from the SCSI bus to
          allow activity by other SCSI devices while the WREN V HH
          performs operations within itself.

          Upon command completion (which may be executed either
          successfully or unsuccessfully), the WREN V HH returns a
          status byte to the initiator. Since most error and
          exception conditions cannot be adequately described with a
          single status byte, one status code that can be sent as the
          status byte is called Check Condition. It indicates that
          additional information is available. The initiator may
          issue a Request Sense command to request the return of the
          additional information as part of the Data In phase of the
          command.

13.1   COMMAND IMPLEMENTATION REQUIREMENTS

          The first byte of any SCSI command contains an operation
          code as defined in this document. Three bits (bits 7 - 5)
          of the second byte of each SCSI command specify the logical
          unit if it is not specified using the Identify Message (see
          Paragraph 12.5.2). Only logic unit zero is valid for the
          WREN V HH. The last byte of all SCSI commands shall contain
          a control byte as defined in Paragraph 13.2.6.

13.1.1   Reserved

Reserved bits, bytes, fields, and code values are set aside for future standardization. Their use and interpretation will be specified by future extensions to this specification. A reserved bit, field, or byte shall be set to zero, or in accordance with a future extension to this specification. A WREN V HH that receives a reserved code value shall terminate the command with a Check Condition status and the Sense Key shall be set to Illegal Request. It shall also be acceptable for the WREN V HH to interpret the bit, field, byte, or code value in accordance with a future extension to this specification.

13.1.2   Operation Code Type

Not applicable

13.1.3   Unit Attention Condition

Unit Attention condition shall begin for each initiator if Power On Sequence occurs, if an internally generated reset (caused by a power glitch) occurs, if the WREN V HH is "reset" by a Bus Device Reset message or a "hard" reset condition, or if one or more Mode Select parameters affecting this initiator were changed by another initiator. The Unit Attention condition shall persist for each initiator until that initiator clears the condition as described in the following paragraphs.

If an Inquiry command is received from an initiator with a pending Unit Attention condition (before or after the WREN V HH reports Check Condition status), the WREN V HH shall perform the Inquiry command and shall not clear the Unit Attention Condition.

If a Request Sense command is received from an initiator with a pending Unit Attention Condition (before or after the WREN V HH reports Check Condition status), the WREN V HH shall discard any pending sense data, report the Unit Attention Sense Key, and clear the Unit Attention condition for that initiator.

13.1.3   (continued)

If an initiator issues a command other than Inquiry or
Request Sense while a Unit Attention Condition exists for
that initiator, the WREN V HH shall not perform the command
and shall report Check Condition status. If a Request Sense
is issued next, the Unit Attention condition will be
reported and cleared as noted in the preceding paragraph.
If another command other than Request Sense or Inquiry is
issued instead, the WREN V HH shall perform the command and
return the appropriate status. The Unit Attention condition
for that initiator is cleared and the sense data is lost.

13.1.4   Command Queing

The WREN V HH is capable of accepting and queing one
command from each initiator for up to 7 possible
initiators. When commands are queued, after the WREN V HH
is selected it will accept the command bytes, send a
Disconnect message, go to Bus Free phase, and continue
command execution. If the command cannot be queued, the
WREN V HH will allow itself to be selected and will accept
the command bytes for this command. The WREN V HH will then
go to the status phase and send Busy Status back to the
initiator.

Command queuing can be done only for initiators that
support Arbitration and Reselection phases, send an
Identify message after Selection, and allow disconnection.
Initiators that don't support these options will be handled
as follows:

In this case or if the command queue is full, the WREN V HH
will allow itself to be selected and will accept the
command bytes for a new command. It will then go to the
Status phase and send Busy status to the initiator (see
Section 14.0). After a Command Complete message and going
to Bus Free phase, the WREN V HH will resume execution of
its current command. An initiator that received Busy status
in this manner will have to resend the command later in
order to have it executed.

A WREN V HH will not queue Reserve commands because of the
special considerations involved with queuing these
commands. See the sections describing the Reserve command
for further details.

All commands that are queued will eventually be executed in
accordance with the WREN V HH priority scheme unless a hard
Reset, a Power On Reset, or a Bus Device Reset message is
received. In these cases, all queued commands will be
cleared and no status will be sent to the initiator.

13.2   COMMAND DESCRIPTOR BLOCK (CDB)

A request by an initiator to a WREN V HH is performed by sending a Command Descriptor Block (CDB) to the WREN V HH. For several commands, the request is accompanied by a list of parameters sent during the Data Out phase. See the specific commands for detailed information.

The Command Descriptor Block always has an operation code as the first byte of the command. This is followed by a logical unit number, command parameters (if any), and a control byte.

For all commands, if there is an invalid parameter in the Command Descriptor Block, the WREN V HH shall terminate the command without altering the medium.

The Format description for the Command Descriptor Block as supported by the WREN V HH is shown in Tables 13.2-1, 13.2-2 and 13.2-3.

13.2.1   Operation Code

The operation code (Table 13.2-1) of the Command descriptor Block has a group code field and a command code field. The three bit group code field provides for eight groups of command codes. The five bit command code field provides for thirty two command codes in each group. Thus, a total of 256 possible operation codes exist. Operation codes are defined in Section 14.

For the WREN V HH the group code specifies one of the following groups:

Group 0 - Six byte commands (see Table 13.2-2).
Group 1 - Ten byte commands (see Table 13.2-3).

TABLE 13.2-1. OPERATION CODE FORMAT FOR CDB

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	Group Code			Command Code				

TABLE 13.2-2. TYPICAL COMMAND DESCRIPTOR BLOCK FOR SIX BYTE COMMANDS

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit No. 0 0 0			Logical Block Address (if req.) (MSB)				
2	Logical Block Address (if required)							
3	Logical Block Address (if required)(LSB)							
4	Transfer Length (if required)							
5	Control Byte							

TABLE 13.2-3. TYPICAL COMMAND DESCRIPTOR BLOCK FOR TEN BYTE COMMANDS

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit No. 0 0 0			Reserved			RelAdr 0	
2	Logical Block Address(if required)(MSB)							
3	Logical Block Address (if required)							
4	Logical Block Address (if required)							
5	Logical Block Address (if required)(LSB)							
6	Reserved							
7	Transfer Length (if required)(MSB)							
8	Transfer Length (if required)(LSB)							
9	Control Byte							

13.2.2   Logical Unit Number (LUN)

The logical unit number (LUN) addresses one of up to eight physical devices or virtual devices attached to a target. The only valid LUN number for WREN V HH is Zero.

The LUN in the CDB is provided for systems that do not implement the Identify Message. If an Identify message is sent to the WREN V HH, the WREN V HH will use the LUN number specified in this message. In this case, the WREN V HH shall ignore the LUN specified within the command descriptor block.

The WREN V HH will reject commands which select an invalid LUN (except Request Sense and Inquiry) by requesting and accepting the command bytes, then going to Status phase and sending Check Condition status. Note that the LUN is sent in the LUN field of a CDB (if no Identify message has been received for this selection) or by the LUN field of an Identify message.

Request Sense commands selecting an invalid LUN will receive a Sense Data block with the Illegal Request Sense Key and an Invalid LUN Error Code. Inquiry commands will return Inquiry Data with the Peripheral Device Type field set to Logical Unit Not Present (7FH). Request Sense and Inquiry commands will not send Check Condition status in response to an invalid LUN selection.

13.2.3   Logical Block Address

The logical block address on logical units shall begin with block zero and be contiguous up to the last logical block on that logical unit.

Group 0 command descriptor block contain 21 bit logical block addresses. Group 1 command descriptor blocks contain 32 bit logical block addresses.

The logical block concept implies that the initiator and target shall have previously established the number of data bytes per logical block. This may be established through the use of the Read Capacity command or the Mode Sense command or by prior arrangement.

The maximum logical block address for WREN V HH which is accessible by the Initiator is defined in Read Capacity Data in section 14.2.2.1.

13.2.4   Relative Address Bit

Not implemented. Must be zero.

13.2.5   Transfer Length

The Transfer Length specifies the amount of data to be transferred, usually the number of blocks. For several commands the transfer length indicates the requested number of bytes to be sent as defined in the command description. For these commands the transfer length field may be identified by a different name. See the following descriptions and the individual command descriptions for further information.

Commands that use one byte for Transfer Length allow up to 256 blocks of data to be transferred by one command. A Transfer Length value of 1 to 255 indicates the number of blocks that shall be transferred. A value of zero indicates 256 blocks.

Commands that use two bytes for Transfer Length allow up to 65,535 blocks of data to be transferred by one command. In this case, a Transfer Length of zero indicates that no data transfer shall take place. A value of 1 to 65,535 indicates the number of blocks that shall be transferred.

For several commands more than two bytes are allocated for Transfer Length. Refer to the specific command description for further information.

The Transfer Length of the commands that are used to send a list of parameters to a WREN V HH is called the Parameter List Length. The Parameter List Length specifies the number of bytes sent during the Data Out phase.

The Transfer Length of the commands used to return sense data (e.g. Request Sense, Inquiry, Mode Sense, etc) to an initiator is called the Allocation Length. The Allocation Length specifies the number of bytes that the initiator has allocated for returned data. The WREN V HH shall terminate the Data In phase when Allocation Length bytes have been transferred or when all available data have been transferred to the initiator, whichever is less. The Request Sense command is an exception. An Allocation Length of zero indicates four bytes are to be transferred, not zero. See Mode Sense and Mode Select commands.

13.2.6   Control Byte

Must be all zeros. WREN V HH does not support the Flag and
Link bit functions. These bits must be zero for the command
to be accepted. If not, WREN V HH will send a "Check
Condition" Status and a Sense Key of "Illegal Request". See
Table 13.2.6-1.

TABLE 13.2.6-1. CONTROL BYTE
(Table 6-4 in CDC SCSI Spec)

BIT BYTE(S)	7	6	5	4	3	2	1	0
LAST							FLAG	LINK
	0	0	0	0	0	0	0	0

13.3   COMMAND EXAMPLES

13.3.1   Single Command Example

A typical operation on the SCSI bus is likely to include
a single Read command to a peripheral device such as the
WREN V HH. This operation is described in detail starting
with a request from the initiator. This example assumes
that no malfunctions or errors occur and is illustrated
in Figure 13.3-1.

The initiator has active pointers and a set of stored
pointers representing active disconnected SCSI devices
(an initiator without disconnect capability does not
require stored pointers). The initiator sets up the
active pointers for the operation requested, arbitrates
for the SCSI bus, and selects the WREN V HH. Once this
process is completed, the WREN V HH assumes control of
the operation.

The WREN V HH obtains the command from the initiator (in
this case, a Read command). The WREN V HH interprets the
command and executes it. For this command, the WREN V HH
reads the requested data from the Disk Media and sends
this data to the initiator. After sending the read data
to the initiator, the WREN V HH sends a status byte to
the initiator. To end the operation, the WREN V HH sends
a Command Complete message to the initiator and then goes
to the Bus Free state.

13.3.1   (continued)

```
 ____      ____      ____      ____      ____      ____      ____      ____
|B  |     |A  |     |SEL|     |CMD|     |D  |     |S  |     |MSG|     |B  |
|U  |     |R  |     |   |     |   |     |A  |     |T  |     |In |     |U  |
|S  |     |B  |     |(no|     |Read     |T  |     |A  |     |   |     |S  |
|   |---> |I  |---> |ATN)| -> |08H| >   |A  | -> |T  | --> |CMD| -> |   |
|F  |     |T  |     |   |     |   |     |   |     |U  |     |CO-|     |F  |
|R  |     |   |     |   |     |   |     |I  |     |S  |     |MP |     |R  |
|E  |     |   |     |   |     |   |     |N  |     |   |     |   |     |E  |
|E  |     |   |     |   |     |   |     |   |     |   |     |   |     |E  |
 ‾‾‾‾      ‾‾‾‾      ‾‾‾‾      ‾‾‾‾      ‾‾‾‾      ‾‾‾‾      ‾‾‾‾      ‾‾‾‾
```
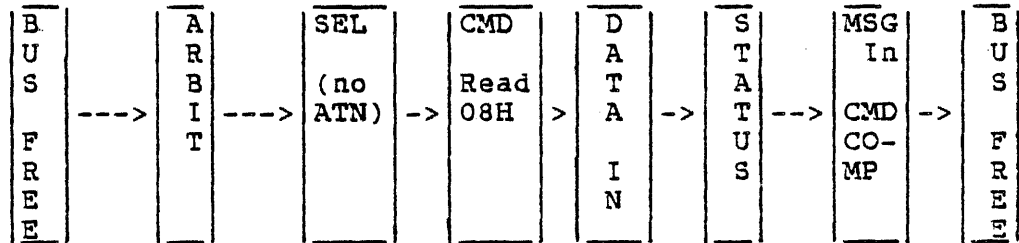
FIGURE 13.3-1. SINGLE COMMAND EXAMPLE

13.3.2   Disconnect Example

In the single command example, the length of time necessary to obtain the data may require a time consuming physical seek. In order to improve system throughput, the WREN V HH may disconnect from the initiator, freeing the SCSI bus to allow other requests to be sent to other SCSI devices. To do this, the initiator must be reselectable and capable of restoring the pointers upon reconnection. The WREN V HH must be capable of arbitrating for the SCSI bus and reselecting the initiator. See Figure 13.3-2.

After the WREN V HH has received the Read command (and has determined that there will be a delay), it disconnects by sending a Disconnect message and releasing BSY (goes to BUS Free state).

When the data is ready to be transferred, the WREN V HH reconnects to the initiator, the initiator restores the pointers to their most recently saved values (which, in this case, are the initial values) and the WREN V HH continues (as in the single command example) to finish the operation. The initiator recognizes that the operation is complete when a Command Complete message is received.

If the WREN V HH wishes to disconnect after transferring part of the data (e.g. while crossing a cylinder boundary), it may do so by sending a Save Data Pointer message and a Disconnect message to the initiator and then disconnecting. When reconnection is completed, the current data pointer is restored to its value immediately before the Save Data Pointer message.

On those occasions when an error or exception condition occurs and the WREN V HH elects to repeat the information transfer, the WREN V HH may repeat the transfer by issuing a Restore Pointers message or by disconnecting without issuing a Save Data Pointer message. When reconnection is completed, the most recently saved pointer values are restored.
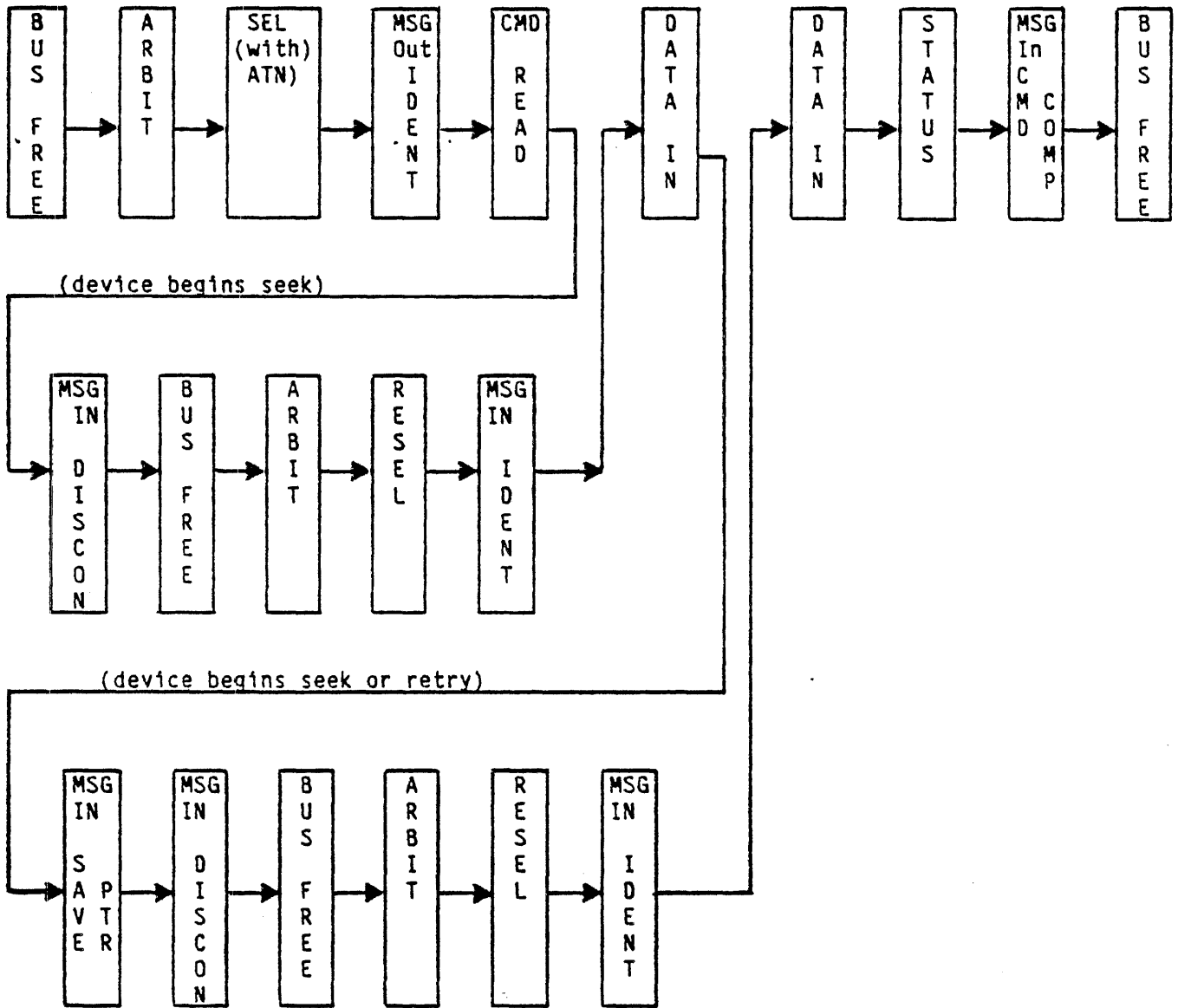
FIGURE 13.3-2. DISCONNECT EXAMPLE

13.4   TIMING EXAMPLES

Times (T00 through T35) necessary to define performance are listed in Table 13.5-1. Timing waveforms to define these times are illustrated in Tables 13.4-1 through 13.4-15.

TABLE 13.4-1. ARBITRATION, SELECTION (NO ATN), AND COMMAND PHASE
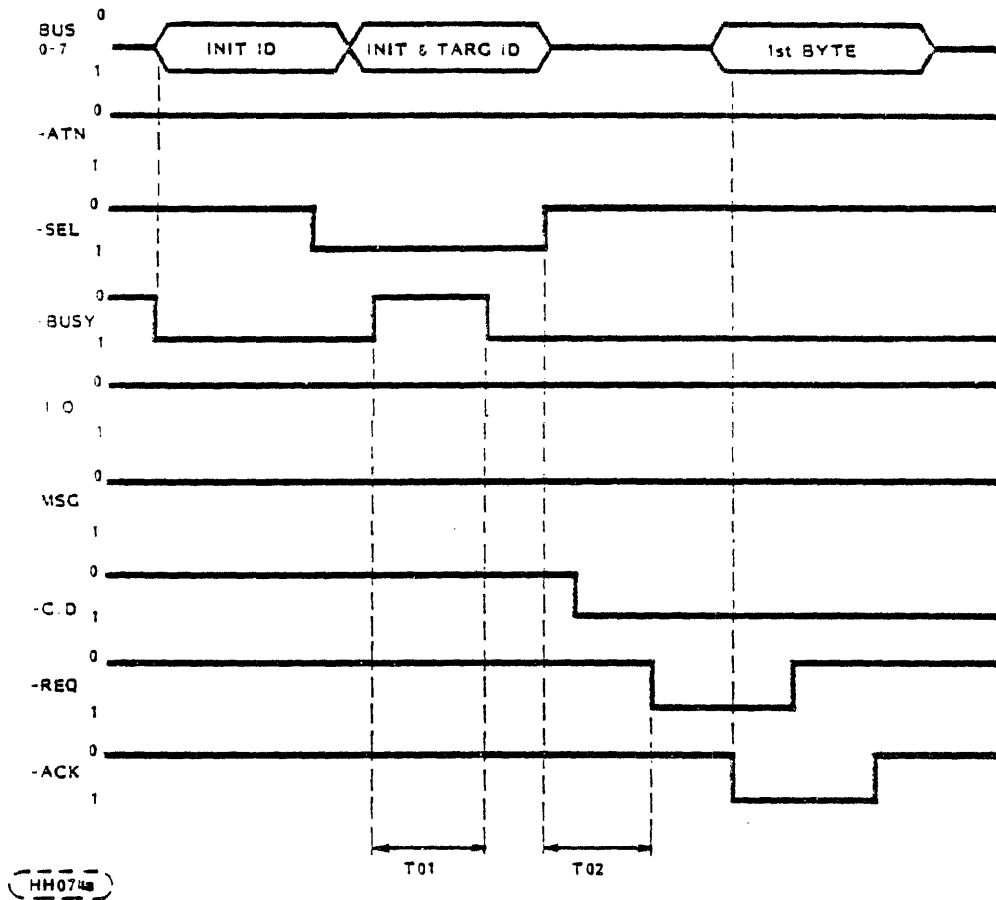
TABLE 13.4-2.   ARBITRATION, SELECTION (WITH ATN), AND MESSAGE OUT
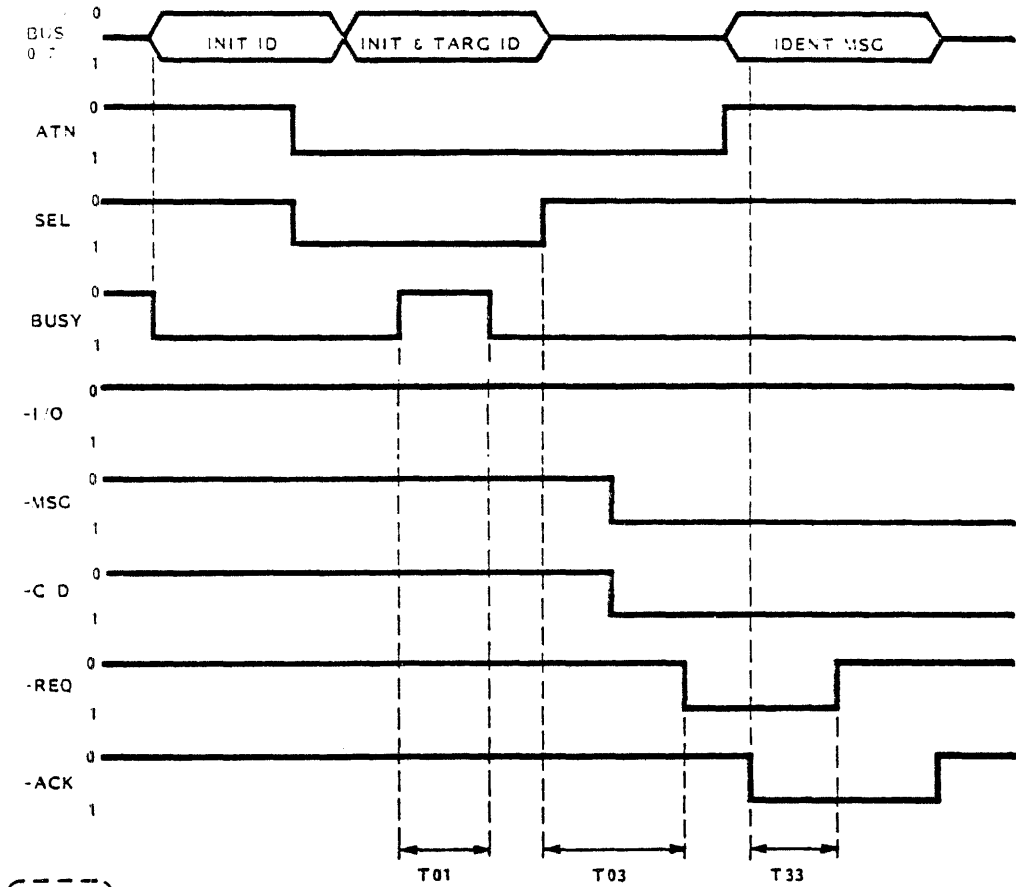
TABLE 13.4-3.   IDENTIFY MSG OUT TO COMMAND PHASE
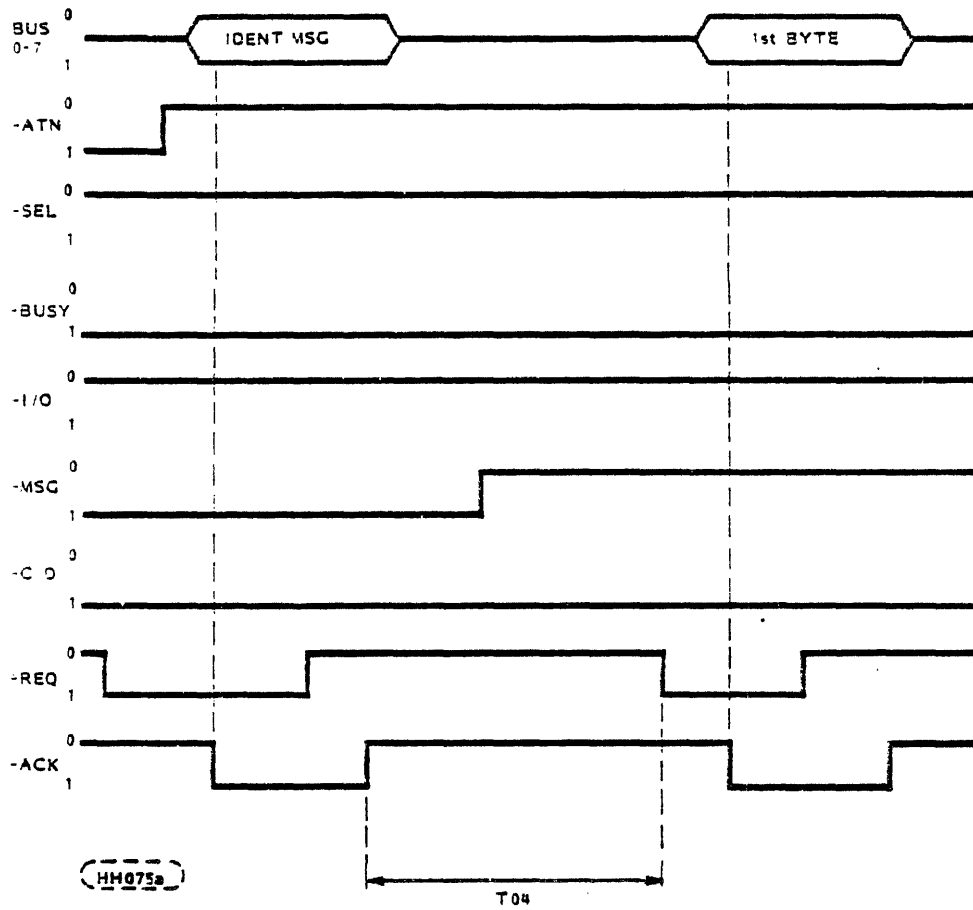
TABLE 13.4-4.   COMMAND DESCRIPTOR BLOCK TRANSFER
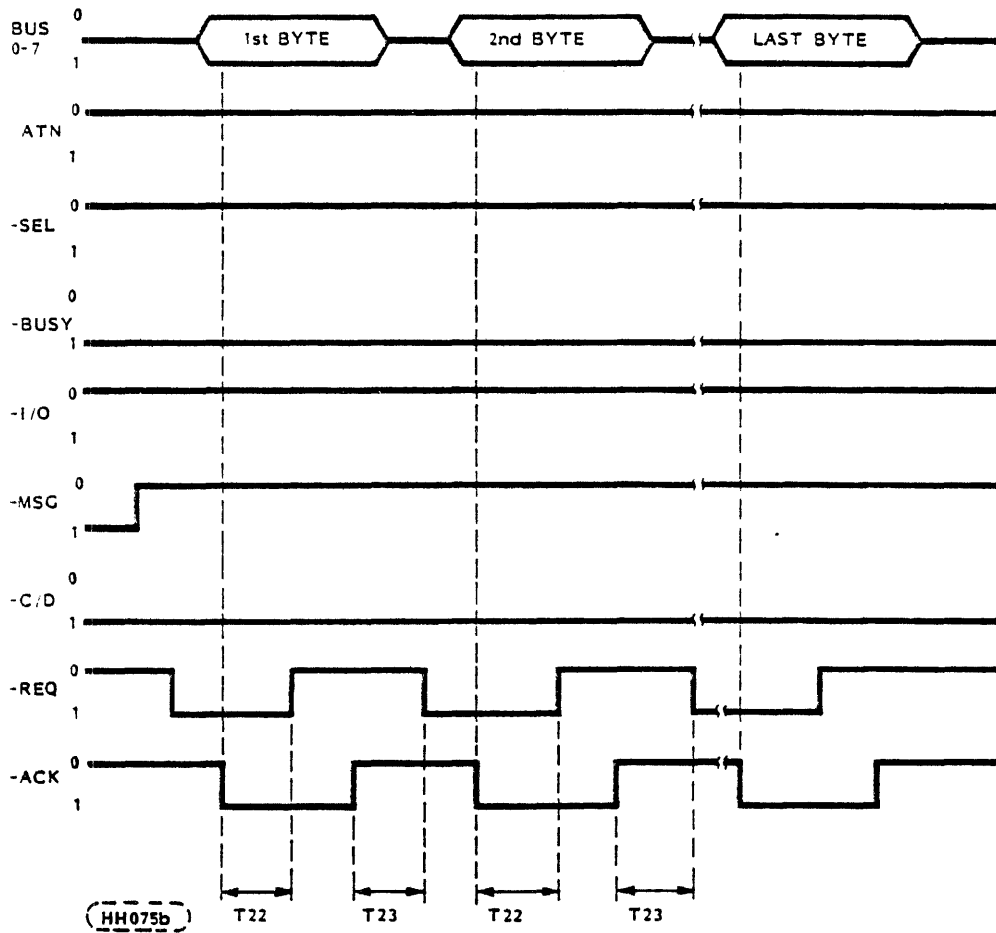
TABLE 13.4-5.   COMMAND PHASE, STATUS PHASE,
                COMMAND COMPLETE MSG AND BUS FREE
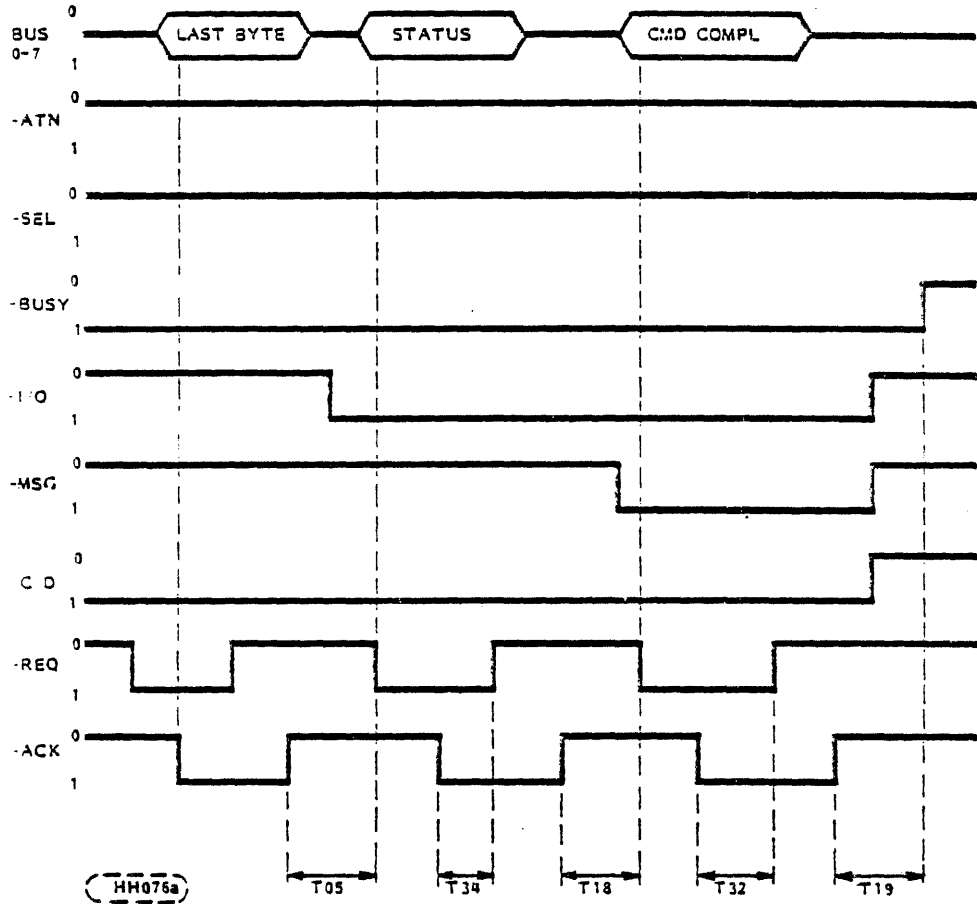
TABLE 13.4-6.   LAST COMMAND BYTE, DISCONNECT MSG,
BUS FREE, AND RESELECT
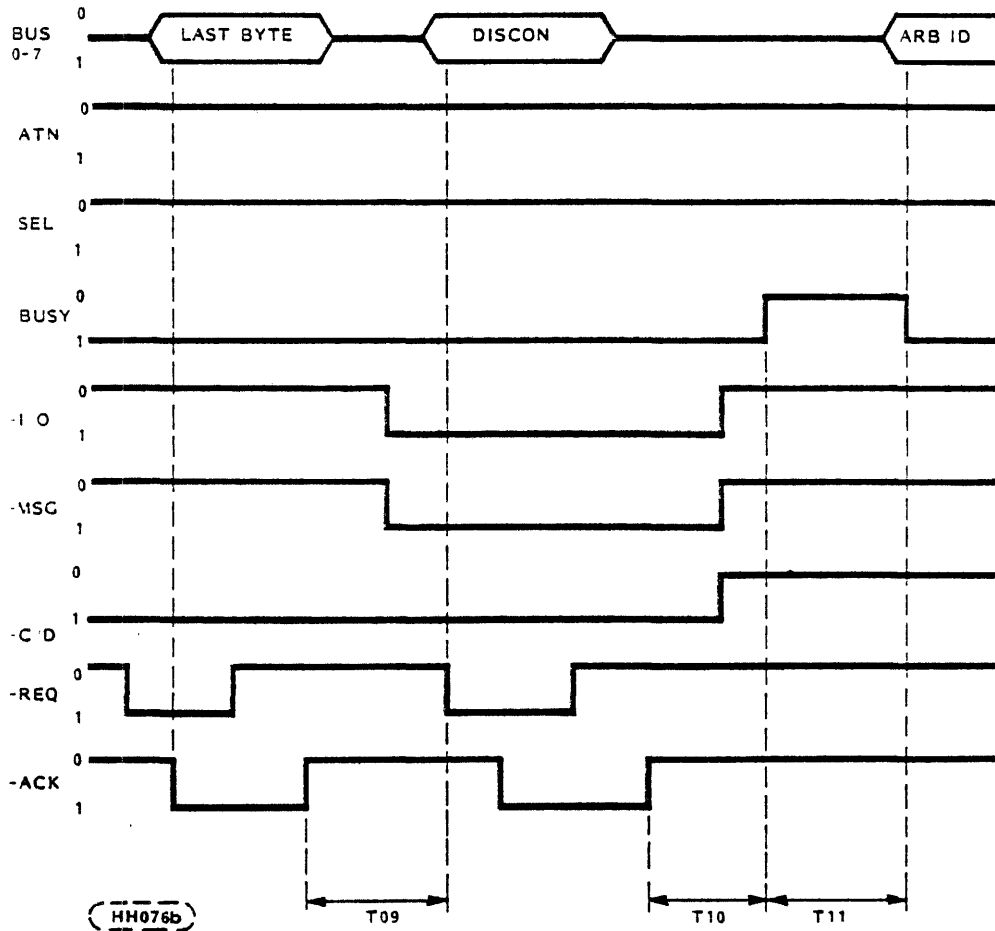
NOTE: To measure T11, there must be no other device contending for
the SCSI BUS.

TABLE 13.4-7.   ARBITRATION, RESELECTION AND MESSAGE IN
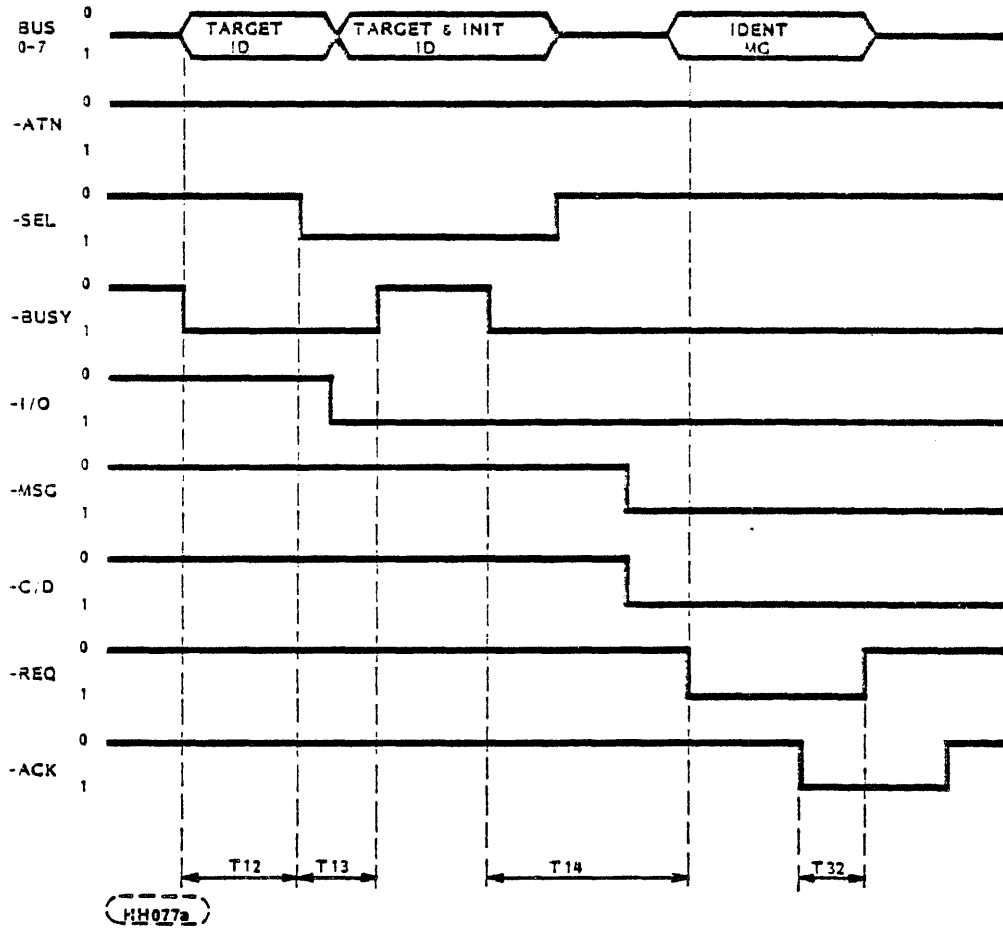
TABLE 13.4-8.   RESELECT IDENTIFY MSG, STATUS PHASE, COMMAND COMPLETE MSG AND BUS FREE

HH0077b
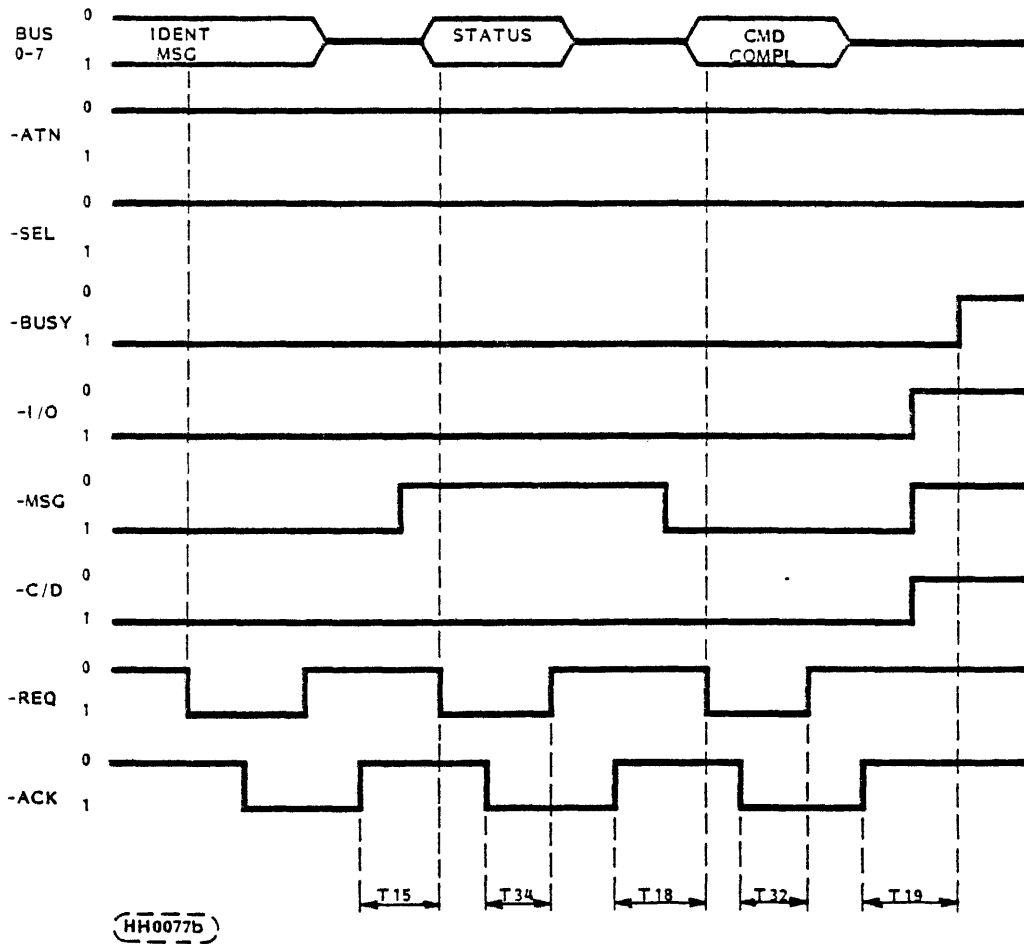
TABLE 13.4-9.   LAST COMMAND BYTE TO DATA IN PHASE
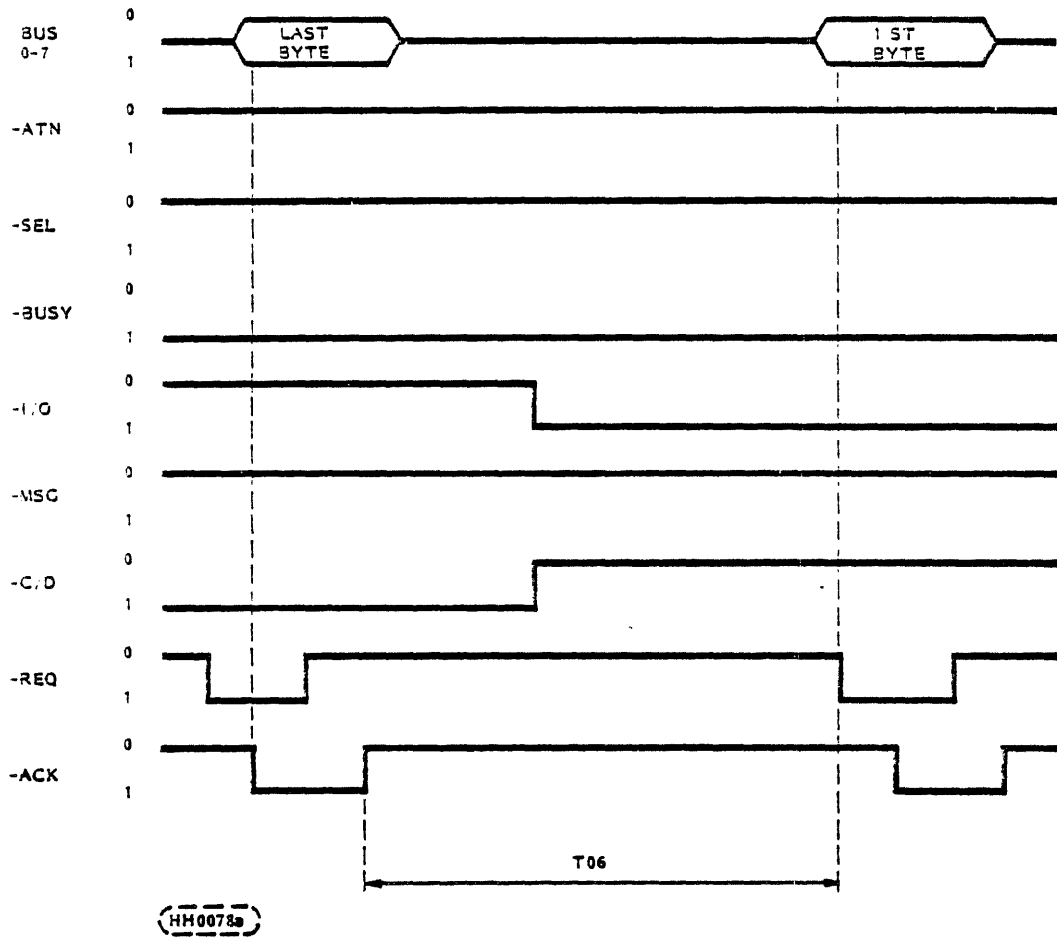
TABLE 13.4-10.   LAST COMMAND BYTE TO DATA OUT PHASE
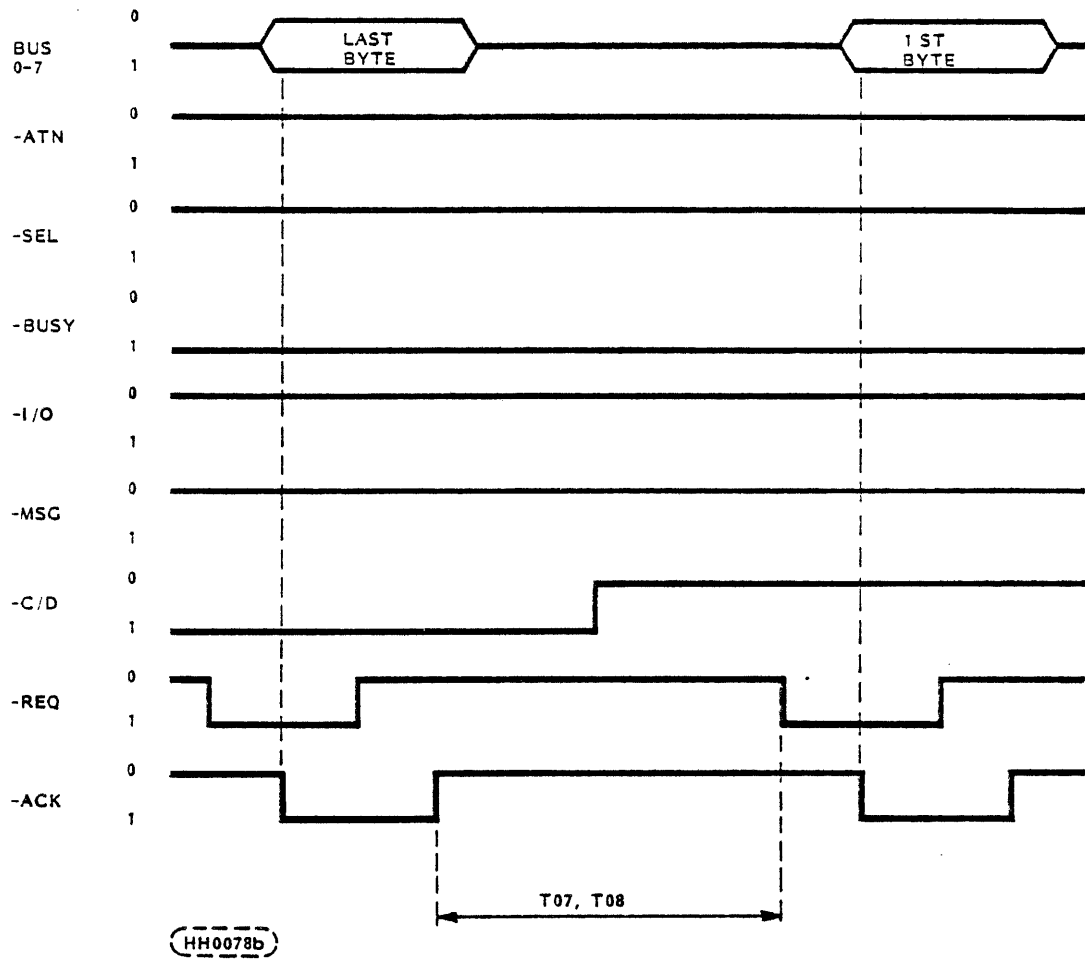
TABLE 13.4-11.   RESELECT IDENTIFY MSG TO DATA IN PHASE

BUS 0-7

IDENT MSG   1 ST BYTE

-ATN

-SEL

-BUSY

-I/O

-MSG

-C.D

-REQ

-ACK

HH0079a

T 16
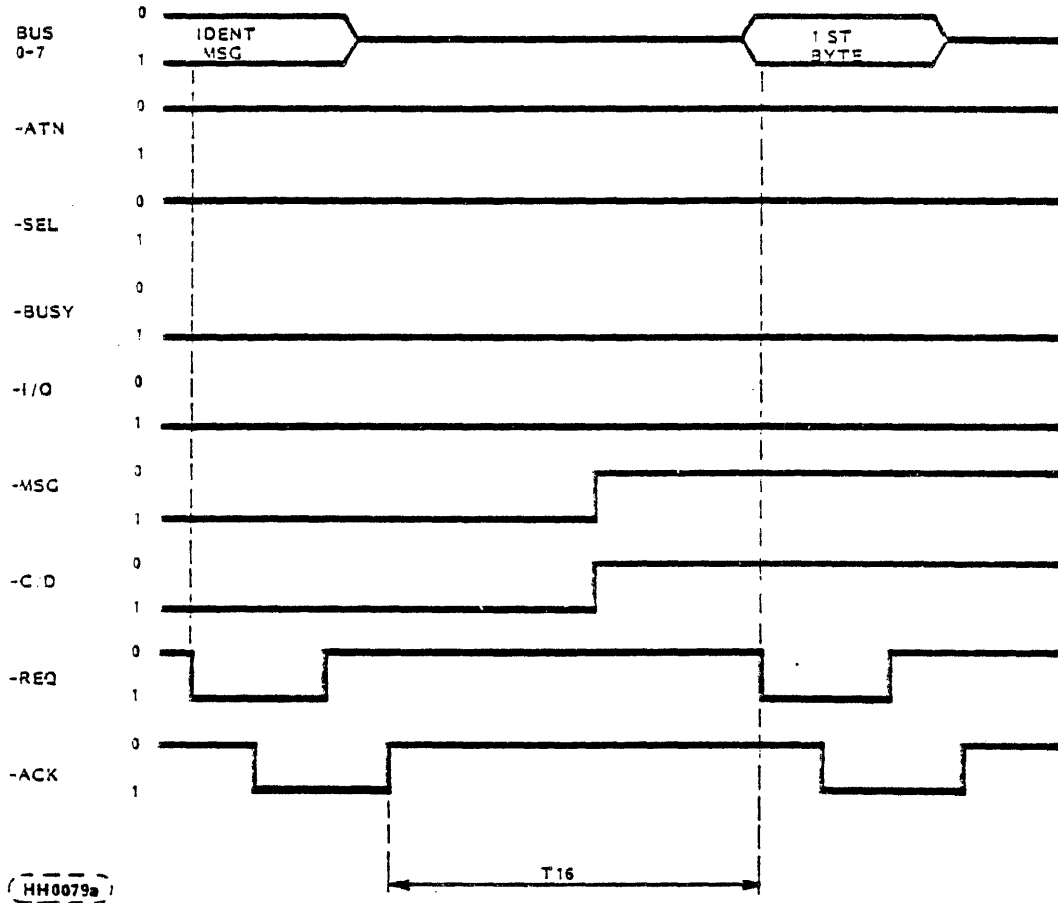
TABLE 13.4-12.   DATA IN BLOCK TRANSFER
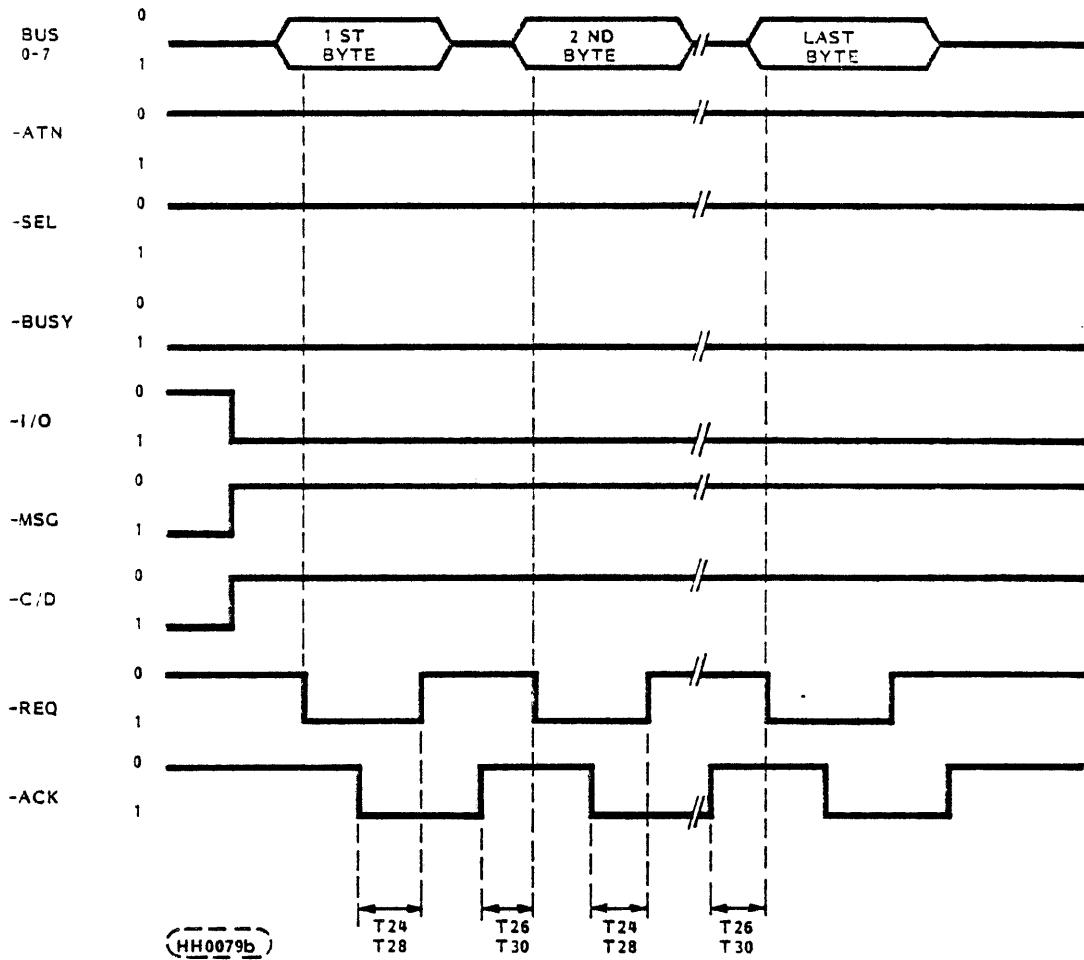
TABLE 13.4-13.   DATA OUT BLOCK TRANSFER
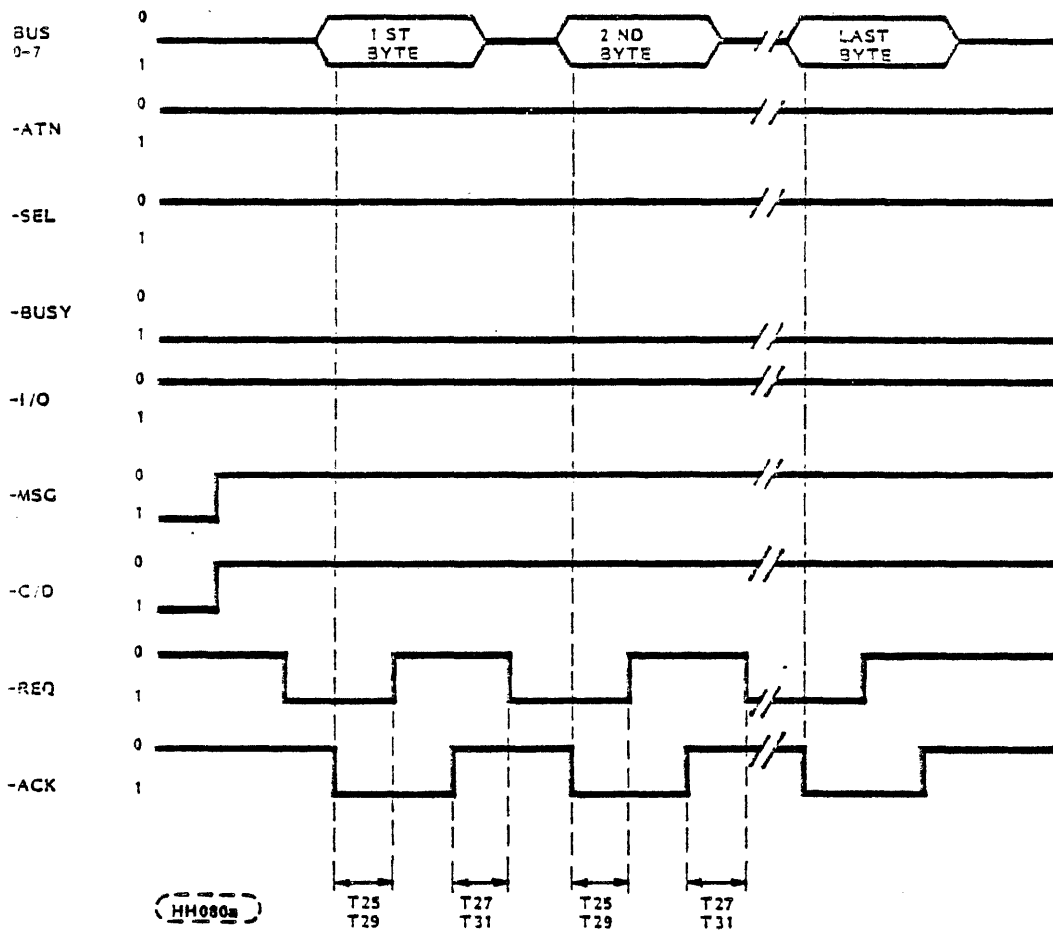
TABLE 13.4-14.   LAST DATA BYTE, SAVE POINTER MSG,
AND DISCONNECT MSG
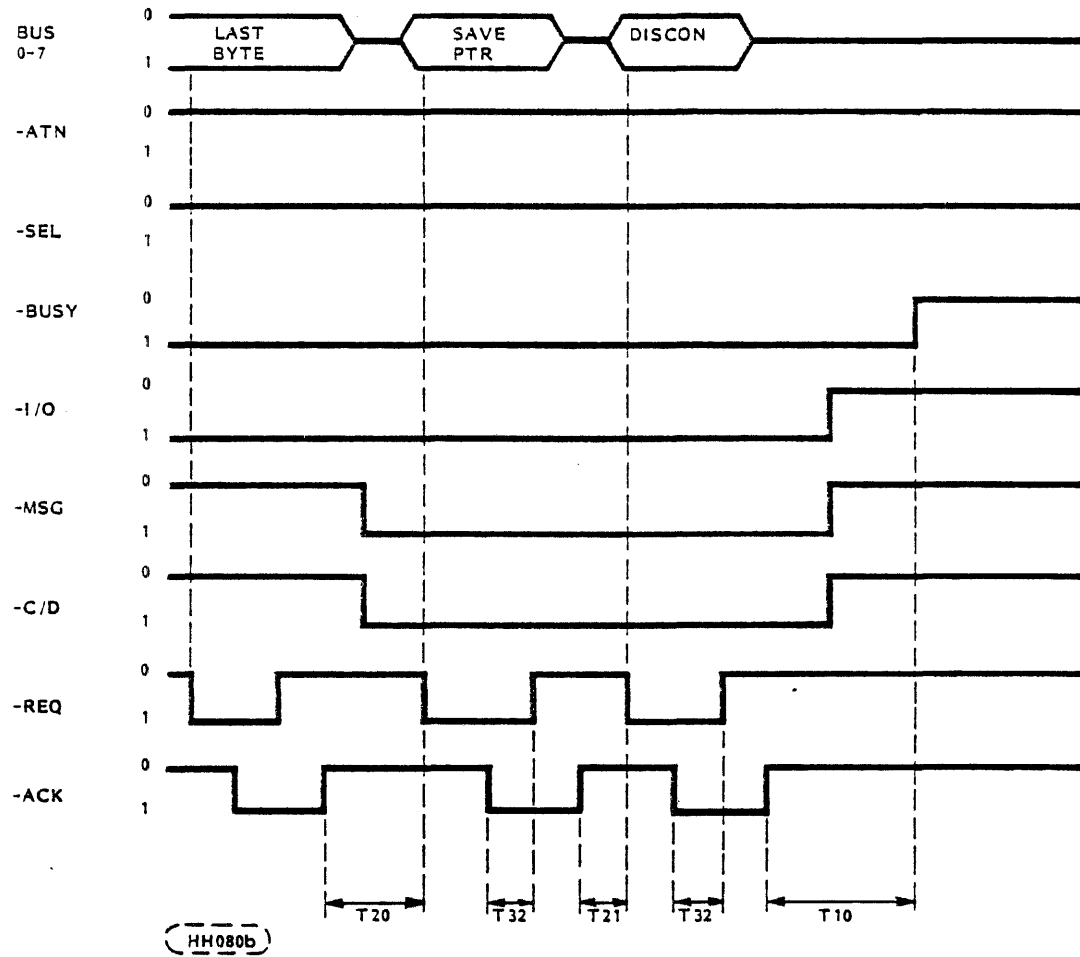
TABLE 13.4-15.   DATA IN PHASE, STATUS PHASE,
                  COMMAND COMPLETE MSG, AND BUS FREE
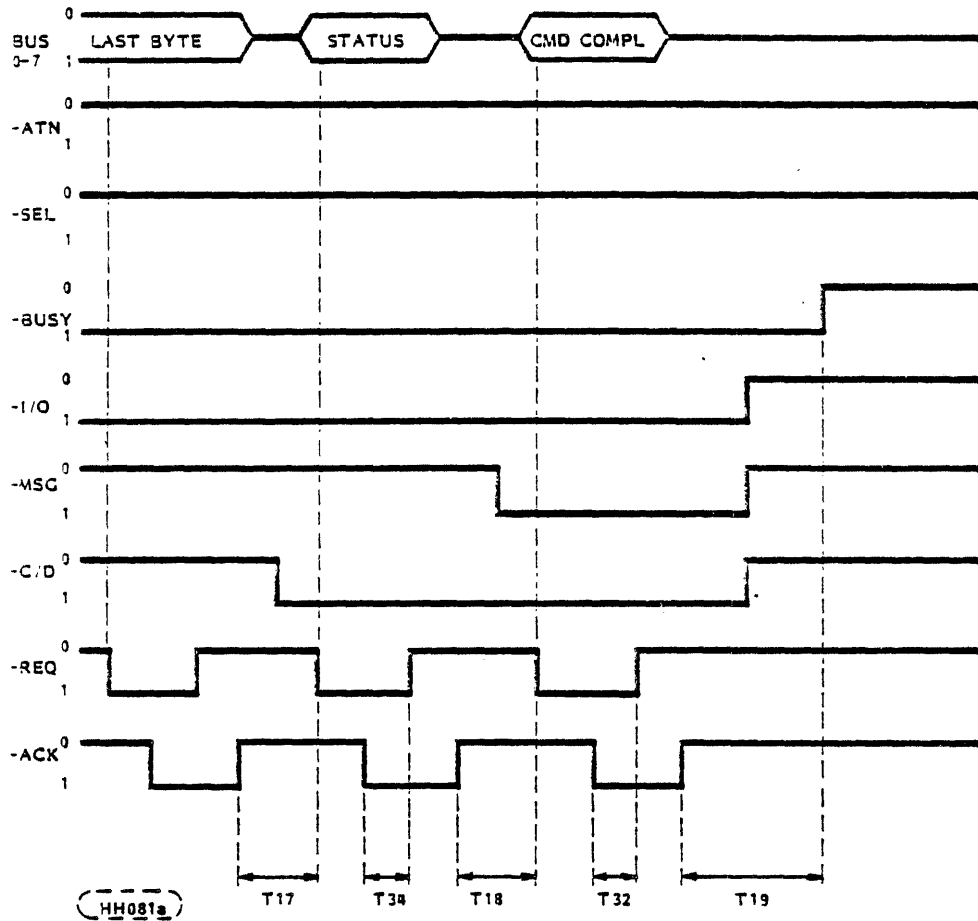
13.5   WREN V HH SCSI TIMING

TABLE 13.5-1. WREN V HH SCSI TIMING

DESCRIPTION	WAVEFORM SYMBOL	WAVEFORM TABLE	TYPICAL	MAX
Target Select Time (no Arbitration)	T00	N/A	<1 µs	<250 µs
Target Select Time (with Arbitration)	T01	13.4-1	<1 µs	<250 µs
		13.4-2		
Target Select to Command	T02	13.4-1	<1 µs	
Target Select to MSG Out	T03	13.4-2	<1 µs	
Identify MSG To Command	T04	13.4-3	<1 µs	
Command to Status	T05	13.4-5	Command Dependent	
Command to Data (para. In)	T06	13.4-9	Command Dependent	
Command to Data (para. Out)	T07	13.4-10	Command Dependent	
Command to Data (Write to Data Buffer)	T08	13.4-10	<400 µs	<600 µs
Command to Disconnect MSG	T09	13.4-6	Command Dependent	
Disconnect MSG to Bus Free	T10	13.4-6,	<1 µs	
		13.4-14		
Disconnect to Arbitration (for Reselect) This measures disconnected CMD overhead.	T11	13.4-6	Command Dependent	
Target win Arbitration (for Reselect)	T12	13.4-7	<5 µs	
Arbitration to Reselect	T13	13.4-7	<4 µs	
Reselect to Identify MSG In	T14	13.4-7	<2 µs	
Reselect Identify MSG to Status	T15	13.4-8	<100 µs	
Reselect Identify MSG to Data (media)	T16	13.4-11	Command Dependent	
Data to Status	T17	13.4-15	Command Dependent	
Status to Command Complete MSG	T18	13.4-5,8,15	<1 µs	
Command Complete MSG to Bus Free	T19	13.4-5,8,15	<1 µs	
Data to Save Data Pointer MSG	T20	13.4-14	<175 µs	
Save Data Pointer MSG to Disconnect MSG	T21	13.4-14	<2 µs	
Command Byte Transfer	T22	13.4-4	<0.06 µs	0.1 µs
Next Command Byte Access	T23	13.4-4	<0.7 µs	1.0 µs

Asynchronous Data Transfer Characteristics:

Data In Byte Transfer (parameter)	T24	13.4-12	<0.06 µs	0.1 µs
Data Out Byte Transfer (parameter)	T25	13.4-13	<0.06 µs	0.1 µs
Next Data In Byte Access (parameter)	T26	13.4-12	<0.7 µs	1.0 µs

TABLE 13.5-1. WREN V HH SCSI TIMING (continued)

DESCRIPTION	WAVEFORM SYMBOL	WAVEFORM TABLE	TYPICAL	MAX
Asynchronous Data Transfer Characteristics: (continued)				
Next Data Out Byte Access (Parameter)	T27	13.4-13	<0.7 μs	1.0 μs
Data In Byte Transfer (media) [2]	T28	13.4-12	<0.06 μs	0.1 μs
Data Out Byte Transfer (media) [2]	T29	13.4-13	<0.06 μs	0.1 μs
Next Data In Byte access (media) [2]	T30	13.4-12	<0.7 μs	1.0 μs
Next Data Out Byte access (media) [2]	T31	13.4-13	<0.7 μs	1.0 μs
MSG IN Byte Transfer	T32	13.4-5,7 13.4-8,14,15	<0.06 μs	0.1 μs
MSG OUT Byte Transfer	T33	13.4-2	<0.06 μs	0.1 μs
STATUS Byte Transfer	T34	13.4-5,8 13.4-15	<0.06 μs	0.1 μs
Synchronous Data Transfer Characteristics:				
Request Signal Transfer Period [2]	-	-	-	1.0 μs

[1]   Maximum SCSI asynchronous interface transfer rate is 2.0 MB/second. Therefore, the, minimum time between two leading edges of Request is 500 ns.

[2]   Synchronous Transfer Period is determined by negotiations between an Initiator and a Drive. The Drive is capable of setting periods between 252 ns and 1000 ns in 40 to 44 ns increments. See also section 12.1.5.2.

14.0   COMMAND DESCRIPTIONS

Two types of commands are supported by the WREN V HH: commands for all devices; and commands for direct access devices. In each of these categories the WREN V HH supports only Group 0 and Group 1 commands.

14.1   COMMAND DESCRIPTIONS FOR ALL DEVICE TYPES

14.1.1   Group 0 Commands for All Device Types

The WREN V HH implements the following Group 0 commands which are applicable for all device types. See Table 14.1.1-1.

TABLE 14.1.1-1.   GROUP 0 COMMANDS FOR ALL DEVICE TYPES

COMMAND OP CODE*	COMMAND NAME	APPLICABLE SECTION
00H	Test Unit Ready	14.1.1.1
03H	Request Sense	14.1.1.2
12H	Inquiry	14.1.1.3
1CH	Receive Diag. Results	14.1.1.5
1DH	Send Diagnostic	14.1.1.6

*Byte 0 of Command Descriptor Block.

14.1.1.1 Test Unit Ready (00H)

TABLE 14.1.1-2.   TEST UNIT READY COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	LOGICAL UNIT NO. 0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Test Unit Ready command provides a means to verify the logical unit is ready. This is not a request for a self test. If the logical unit would accept an appropriate medium access command without returning check condition status, the WREN V HH will return a Good status. For WREN V HH, the flag and link bits must be zero, and the only valid Logical Unit Number is zero. See Table 14.1.1-2 for proper format.

14.1.1.2   Request Sense Command (03H)

TABLE 14.1.1-3.   REQUEST SENSE COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	1
1	LOGICAL UNIT NO. 0 0 0			0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	ALLOCATION LENGTH IN BYTES							
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Request Sense command (TABLE 14.1.1-3) requests that the WREN V HH transfer sense data to the initiator in the format shown in Table 14.1.1-4. The sense data shall be valid for a Check Condition status returned on the prior command. This sense data shall be preserved by the WREN V HH for the initiator until retrieval is requested by the initiator sending the Request Sense command or until the receipt of any other command for the same logical unit from the initiator that issued the command resulting in the Check Condition status. Sense data shall be cleared upon receipt of any subsequent command to the logical unit from the initiator receiving the Check Condition status.

If a WREN V HH sends a Check Condition status as a response to a Request Sense command being in error, it shall do so only if the error was a fatal error. For example:

1.   The WREN V HH receives a nonzero reserved bit in the command descriptor block.

2.   An unrecovered parity error occurs on the Data Bus.

3.   A WREN V HH malfunction prevents return of sense data.

14.1.1.2   continued

If any nonfatal error occurs during execution of Request
Sense, the WREN V HH shall return sense data with Good
status. Following a fatal error on a Request Sense
command, sense data may be invalid.

The Allocation Length in byte four of the format shown
specifies the number of bytes the initiator has allocated
for returned sense data. The Allocation Length should
always be at least 18 bytes for WREN V HH devices for the
initiator to receive all of the WREN V HH sense data. Any
other value indicates the maximum number of bytes that
shall be transferred. The WREN V HH shall terminate the
Data In phase when allocation length bytes have been
transferred or when all available sense data have been
transferred to the initiator, which ever is less. If the
Allocation Length is zero, the WREN V HH will return 4
bytes of sense data in Extended Sense Data Format. The
WREN V HH always returns sense data in the Extended Sense
Data Format. The Flag and Link bits in the Request Sense
command must always be zero for WREN V HH.

Extended Sense Data Format

WREN V HH is capable of sending 18 bytes of extended
sense data, and will send 18 bytes if the Allocation
Length of the Request Sense Command is equal to or
greater than 18 bytes (otherwise, the number of bytes
specified by the Allocation Length will be sent). The
Extended Sense Data Format is summarized in Table
14.1.1-4. Numbers in parentheses in the sense data are
references to notes following the table. A "1" or a "0"
means the data bit will always be logic 1 or logic 0,
respectively, when sent by a WREN V HH.

TABLE 14.1.1-4. WREN V HH EXTENDED SENSE DATA SUMMARY

BYTE \ BIT	7	6	5	4	3	2	1	0
0	VALIDITY BIT [1]	1 ERROR CLASS [3]	1	1	0	0	0 [3]	0
1	0	0	0	0	0	0	0	0
1				SEGMENT NUMBER [4]				
2	0 FILEMARK [5]	0 EOM [6]	0 ILI [7]	0		SENSE KEY [8]		
3 4 5 6	INFORMATION BYTE (MSB) [9] : : INFORMATION BYTE (LSB) [9]							
7	ADDITIONAL SENSE LENGTH - Decimal 10 (Max) [10]							
8 9 10 11	Bytes 8 - 11 are Reserved for use by Copy or Search commands. Will be all zeros.							
12	ERROR CODE [11]							
13	RESERVED (All Zeros)							
14	FRU CODE [12]							
15	FPV [13]	C/D [14]	0	0	BPV [16]	BIT POINTER [17]		
16 17	FIELD POINTER (MSB) [15] FIELD POINTER (LSB) [15]							
18-n	PRODUCT UNIQUE SENSE DATA [18]							

TABLE 14.1.1-4.   WREN V HH EXTENDED SENSE DATA SUMMARY (continued)

NOTES:

[1]   Validity Bit - "1" if the Information Bytes (Bytes 3-6) are valid, "0" if not valid.

[2]   Error Class - "111" [7] indicates Extended Sense is being used here.

[3]   "0000" specifies the Extended Sense Data Format. Byte 12 has error codes for Extended Sense.

[4]   Segment Number - Always Zeros

[5]   Filemark - Always "0" for WREN V HH.

[6]   EOM - End of medium indicator. Always "0" for WREN V HH.

[7]   ILI - Incorrect Length Indicator. The requested (previous command) block of data did not match the logical block length of the data on the medium.

[8]   Sense Key - Indicates nine (for WREN V HH) general error categories. These are listed in Table 14.1.1-5. the code given in byte 12 provides additional clarification of errors. See also note [15] below for related information.

[9]   If the validity bit is a 1, the Information Bytes will contain the unsigned Logical Block Address associated with the Sense Key. Unless otherwise specified, the Information Bytes will contain the address of the current logical block. For example, if the Sense Key is Medium Error, it will be the Logical Block Address of the failure block.

[10] Additional Length - Specifies additional sense bytes are to follow. This is limited to a maximum of 10 (decimal) additional bytes. If the Allocation length of the Command Descriptor Block is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

[11] Error Code - Provides additional clarification of errors whenever Sense Key is valid. Error code definitions are in Table 14.1.1-6.

TABLE 14.1.1-4.   WREN V HH EXTENDED SENSE DATA SUMMARY (continued)

NOTES: (continued)

[12] FRU (Field Replaceable Unit) Code - Defined for Field Maintenance personnel only.

[13] FPV (Field Pointer Valid) bit - When set to one, indicates that the C/D bit and bytes 16 and 17 are valid. When zero, ignore these fields.

[14] C/D Bit - Command/Data bit, when set to one, indicates that the value reported in the field pointer bytes is the CDB's byte number for which an Illegal Request Sense Key was issued. When set to zero, it indicates that the value reported in the field pointer bytes is the byte number in the data phase for which an Illegal Request Sense Key was issued. See also [15].

[15] Field Pointer (MSB) Refer to Table 14.1.1-5 for details
      Field Pointer (LSB) on the Illegal Request Sense Key description. The Illegal Request extended sense report uses the 16 bit Field Pointer to point to the first byte in a Command Descriptor Block or associated data block where an illegal parameter was detected, causing the Illegal Request Sense Key.

[16] BPV - Bit Pointer Valid Bit, when set to one, indicates that the Bit Pointer field is valid.

[17] Bit Pointer Field - Indicates which bit of the byte indicated by the Field Pointer caused the Illegal Request Sense Key. A value of 7 indicates the leftmost bit and zero indicates the rightmost bit.

[18] Not presently used by the WREN V HH.

14.1.1.2 continued

Table 14.1.1-5 lists the Sense Keys in the extended sense data format that are used by the WREN V HH.

14.1.1.2 continued

TABLE 14.1.1-5.   APPLICABLE WREN V HH SENSE KEYS

SENSE KEY	DESCRIPTION
OH	No Sense - Indicates there is no specific Sense Key information to be reported for the WREN V HH. This would be the case for a successful command.
1H	Recovered Error - Indicates the last command completed successfully with some recovery action performed by the WREN V HH. NOTE: For some Mode settings, the last command may have terminated before completing.
2H	Not Ready - Indicates the logical unit addressed cannot be accessed. Operator intervention may be required to correct this condition.
3H	Medium Error - Indicates the command terminated with a nonrecovered error condition, probably caused by a flaw in the medium or an error in the recorded data.
4H	Hardware Error - Indicates the WREN V HH detected a nonrecoverable hardware failure while performing the command or during a self test. This includes SCSI interface parity error, controller failure, device failure, etc.
5H	Illegal Request - Indicates an illegal parameter in the command descriptor block or in the additional parameters supplied as data for some commands (Format Unit, Mode Select, etc). If the WREN V HH detects an invalid parameter in the Command Descriptor Block, it shall terminate the command without altering the medium. If the WREN V HH detects an invalid parameter in the additional parameters supplied as data, the WREN V HH may have already altered the medium.
6H	Unit Attention - Indicates the WREN V HH may have been reset. See Paragraph 13.1.3 for more detailed information about the Unit Attention Condition.
BH	Aborted Command - Indicates the WREN V HH aborted the command. The initiator may be able to recover by trying the command again.
DH	Volume Overflow - Indicates a buffered peripheral device has reached the end of medium and data remains in the buffer that has not been written to the medium.
EH	Miscompare - Indicates that the source data did not match the data read from the medium.

14.1.1.2 continued

TABLE 14.1.1-6. DIRECT ACCESS DEVICES, ADDITIONAL SENSE ERROR CODES

ERROR CODE	DESCRIPTION	MOST PROBABLE RELATED SENSE KEYS. OTHER SENSE KEYS MAY APPLY TO ADDITIONAL SENSE CODES.
00	No additional information	No Sense
01	No Index/Address Mark Found signal	Hardware error
02	No Seek Complete	Hardware error
03	Write Fault	Hardware Error or Recovered Error
04	Drive not ready	Not Ready or Recovered Error
08	Logical Unit communication failure	Hardware error or Recovered Error
09	Track Following error	Hardware error or Recovered Error
10	ID CRC or ECC error	Hardware Error or Medium error or Recovered Error
11	Unrecovered Read error	Medium error or Recovered error
12	No Address Mark (byte sync byte) found in ID field	Medium error or Recovered error
13	No Address Mark (byte sync byte) found in Data Field	Medium error or Recovered error
14	No record found	Medium error or Recovered error
15	Seek Positioning error	Hardware error or Medium error or Recovered error
17	Recovered Read data with target's Read retries (not with ECC)	Recovered error
18	Recovered Read data with target's ECC correction (not with retries)	Recovered error
19	Defect List error	Medium error
1A	Parameter overrun	Illegal request
1B	Synchronous transfer error	Hardware error
1C	Primary Defect List not found	Medium error
1D	Compare error	Miscompare

14.1.1.2 continued

TABLE 14.1.1-6.   DIRECT ACCESS DEVICES, ADDITIONAL SENSE ERROR CODES
(continued)

ERROR CODE	DESCRIPTION	MOST PROBABLE RELATED SENSE KEYS. OTHER SENSE KEYS MAY APPLY TO ADDITIONAL SENSE CODES.
20	Invalid Command Operation Code	Illegal Request
21	Illegal Logical Block Address. Address greater than the LBA returned by the Read Capacity data with PMI bit not set in CDB.	Illegal Request
22	Illegal function for device type	Illegal Request
24	Illegal use of bit of byte in CDB	Illegal Request
25	Invalid LUN	Illegal Request
26	Invalid field in parameter list	Illegal Request
29	Power On or Reset or Bus Device Reset	Unit Attention
2A	Mode Select Parameters changed by another initiator	Unit Attention
2B	Firmware has been downloaded	Unit Attention
31	Medium Format corrupted	Medium error
32	No Spare Defect Locations Available	Medium error
40	RAM failure	Hardware error
41	Data Path diagnostic failure	Hardware error
42	Power On diagnostic failure	Hardware error
43	Message Reject Error	Aborted Command
44	Internal controller error	Hardware error or Not Ready Recovered error
45	Selection/Reselection failure	Aborted Command
47	SCSI interface bus parity error	Hardware error
48	Initiator detected error	Aborted Command
49	Inappropriate/illegal message	Aborted Command
80 thru FF	Product Unique Error Codes	

14.1.1.3 Inquiry Command (12H)

TABLE 14.1.1-7.   INQUIRY COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	1	0
1	LOGICAL UNIT NO.			0	0	0	0	0
	0	0	0					
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	
4	ALLOCATION LENGTH IN BYTES							
5	0	0	0	0	0	0	FLAG 0	LINK 0

In Inquiry command (Table 14.1.1-7) requests that information regarding parameters of the WREN V HH be sent to the initiator.

The Allocation Length specifies the number of bytes the initiator has allocated for returned Inquiry data. An Allocation Length of zero indicates that no Inquiry data shall be transferred. This condition shall not be considered as an error. Any other value indicates the maximum number of bytes that shall be transferred. The WREN V HH shall terminate the Data In phase when Allocation Length bytes have been transferred or when all available Inquiry data have been transferred to the initiator, whichever is less. The Initiator should have an allocation length of 36 minimum in order to receive all of the WREN V HH drive's Inquiry Data.

A Check Condition status shall be reported only when the WREN V HH cannot return the requested Inquiry data. Inquiry Data may be returned even though the WREN V HH is not ready for other commands (i.e. prior to receiving a Start Unit command if the WREN V HH is configured to require a Start Unit command to start the spindle motor).

14.1.1.3 (continued)

If an Inquiry command is received from an initiator with a pending Unit Attention Condition (before the WREN V HH reports Check Condition status), the WREN V HH shall perform the Inquiry command and shall not clear the Unit Attention Condition.

In Inquiry data (Table 14.1.1-8) contains a five byte header, followed by the vendor unique parameters, if any.

The Inquiry command is implemented with the following WREN V HH drive specific parameters:

Flag and Link bits must be zero. The initiator should allocate 36 bytes of inquiry data. The Inquiry command format is shown in Table 14.1.1-7. Inquiry data returned by the WREN V HH to the initiator is summarized in Table 14.1.1-8 and 14.1.1-9.

TABLE 14.1.1-8. INQUIRY DATA SUMMARY

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	DEVICE TYPE (00H or 7FH LUN-NOT PRESENT)							
1	RMB 0	DEVICE TYPE QUALIFIER (00H)						
2	ISO VERSION (0H)	ECMA VERSION (0H)			ANSI VERSION (1H)			
3	0	0	0	0	RESPONSE DATA FORMAT (1H)			
4	ADDITIONAL LENGTH (n) (1FH)							

Device Type: 00H indicates a Direct Access Device (i.e., Magnetic Disk)
            7FH indicates the Requested LUN is not present.
RMB: 0H indicates the medium is not removable.
Device Type Qualifier: 00H indicates this field is not supported.
ISO Version: 0H indicates the WREN V HH does not claim compliance to the ISO version.
ECMA Version: 0H indicates the WREN V HH does not claim compliance to the ECMA version.
ANSI Version: 1H indicates compliance to the first release of the ANSI SCSI Standard (i.e. ANSI X3.131-1986)
Response Data Format: 1H indicates the format of the additional inquiry data (bytes 5-35) is compatible to the Common Command Set (CCS) definition.
Allocation Length: 1FH (31) specifies the length of additional inquiry data. If the allocation length in the CDB is too small to transfer all of the Inquiry Data, this additional length shall not be adjusted to reflect the truncation.

TABLE 14.1.1-8.   INQUIRY DATA SUMMARY (continued)

COMMON COMMAND SET PARAMETERS

5	CDC RESERVED (12H)
6	CDC RESERVED (00H)
7	CDC RESERVED (00H)
8	VENDOR IDENTIFICATION: ASCII 'C' (43H) [1]
9	VENDOR IDENTIFICATION: ASCII 'D" (44H)
10	VENDOR IDENTIFICATION: ASCII 'C" (43H)
11	VENDOR IDENTIFICATION: ASCII "BLANK" (20H)
12	VENDOR IDENTIFICATION: ASCII "BLANK" (20H)
13	VENDOR IDENTIFICATION: ASCII "BLANK" (20H)
14	VENDOR IDENTIFICATION: ASCII "BLANK" (20H)
15	VENDOR IDENTIFICATION: ASCII "BLANK" (20H
16	PRODUCT IDENTIFICATION: ASCII '9' (39H)
17	PRODUCT IDENTIFICATION: ASCII '4' (34H)
18	PRODUCT IDENTIFICATION: ASCII '2' (31H)
19	PRODUCT IDENTIFICATION: ASCII '2' (36H)
20	PRODUCT IDENTIFICATION: ASCII '1' (31H)
21	PRODUCT IDENTIFICATION: ASCII '-' (2DH)
22	PRODUCT IDENTIFICATION: ASCII [2]
23	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
24	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
25	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
26	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
27	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
28	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
29	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
30	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
31	PRODUCT IDENTIFICATION: ASCII "BLANK" (20H)
32	REVISION LEVEL: ASCII DRIVE REVISION NO.
33	REVISION LEVEL: ASCII DRIVE REVISION NO.
34	REVISION LEVEL: ASCII DRIVE REVISION NO.
35	REVISION LEVEL: ASCII DRIVE REVISION NO.

[1] SCSI Data fields shall have the most significant byte returned first with no leading spaces as shown.

[2] The dash number representing the drive configuration is given in Table 14.1.1-9.

TABLE 14.1.1-9.   INQUIRY DATA BYTE 22, DRIVE MODEL DASH NUMBER

BYTE #22   DRIVE CONFIGURATION

5   5 Headed Drive

3   3 Headed Drive

Blank (20H)   Number of Heads not yet known.
                         The drive spindle motor not yet
                         up to speed and ready.

14.1.1.4 Copy Command (18H)

Not Implemented. If received the WREN V HH will send a "Check Condition" status and a Sense Key of "Illegal Request".

14.1.1.5 Receive Diagnostic Results Command (1CH)

TABLE 14.1.1-10.   RECEIVE DIAGNOSTIC RESULTS COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	1	1	0	0
1	LOGICAL UNIT NO. 0 0 0			0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	ALLOCATION LENGTH IN BYTES (MSB)							
4	ALLOCATION LENGTH IN BYTES (LSB)							
5	0	0	0	0	0	0	FLAG 0	LINK 0

14.1.1.5 continued

The Receive Diagnostic Results command requests analysis data be sent to the initiator after completion of a Send Diagnostic command.

The Allocation Length shall specify the number of bytes the initiator has allocated for returned diagnostic data. An Allocation Length of zero indicates that no diagnostic data shall be transferred. Any other value indicates the maximum number of bytes that shall be transferred. The WREN V HH terminates the Data In phase when Allocation Length bytes have been transferred or when all available diagnostic data have been transferred to the initiator, whichever is less.

For the WREN V HH the allocation length should be at least 8 bytes to receive all of the WREN V HH Diagnostic Data.

The CDB should be as shown in Figure 14.1.1-10. The Flag and Link bits in the CDB must be zero.

WREN V HH is capable of sending 8 Diagnostic Data Bytes per Table 14.1.1-11. All FRU and error code definitions are unique to this product and intended for CDC Factory/Field Maintenance personnel.

14.1.1.5 continued

TABLE 14.1.1-11.   CDC DIAGNOSTIC DATA BYTES

CODE	BYTE	DESCRIPTION
00H	0	Additional Length (MSB)
06H	1	Additional Length (LSB)
01H	2	FRU Code (most probable)
00H	3	FRU Code
00H	4	FRU Code
00H	5	FRU Code (least probable)
00H	6	Error Code (MSB)
V.U.*	7	Error Code (LSB)

Additional
Length: This two byte value indicates the number of
                  additional bytes included in the diagnostic data
                  list. For example, if no product unique bytes were
                  available, this value would be 0006H. A value of
                  0000H means that there are no additional bytes.

14.1.1.5 continued

TABLE 14.1.1-11.   CDC DIAGNOSTIC DATA BYTES (continued)
(Table 7-24 in CDC SCSI Spec)

FRU Code: A Field Replaceable Unit code is a byte that
identifies an assembly that may have failed. The
codes will be listed in probability order, with
the most probable assembly listed first and the
least probable listed last. A code of 00H
indicates there is no FRU information and a code
of 01H indicates the entire unit should be
replaced. Other values have product unique
meanings.

Error Code: This two byte value provides information
designating which part of a diagnostic operation
has failed. The byte 7 error code is vendor unique
and defined as follows.

  * Vendor Unique

     Diagnostic Fault Codes

01H	Formatter Diagnostic Error
02H	Microprocessor RAM Diagnostic Error
04H	No Drive Ready
08H	No Sector or Index Detected
09H	Fatal Hardware Error While Doing Drive Diagnostics
0CH	No Drive Command Complete
10H	Unable to Set Drive Sector Size
14H	Unable to Clear Drive Attention
18H	Unable to Start Spindle Motor
20H	Unable to Recal Drive
30H	Unable to Send Write Current Data to Drive
34H	Unable to Issue Drive Seek Command
40H	Unable to Read User Table From Drive
41H	Ran Out of Sectors While Doing Drive Diagnostics
42H	Unable to Read Reallocation Table
43H	Unable to Read ETF Log
44H	Drive was unable to read the firmware stored on the disk.
45H	Firmware read from disk or sent by host has an invalid checksum.
60H	Thermal Calibration Failure
70H	Microprocessor Internal Timer Error
80H	Buffer Controller Diagnostic Error
81H	Buffer RAM Diagnostic Error
C1H	Data Miscompare While Doing Drive Diagnostics

14.1.1.6 Send Diagnostic Command (1DH)

TABLE 14.1.1-12.   CDB REQUIREMENTS FOR SEND DIAGNOSTIC COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	1	1	0	1
1	LOGICAL UNIT NO.					SELF-TEST	DEV-OFL	UNIT OFL
	0	0	0	0	0	1	0	0
2	0	0	0	0	0	0	0	0
3	PARAMETER LIST LENGTH (MSB)							
	0	0	0	0	0	0	0	0
4	PARAMETER LIST LENGTH (LSB)							
	0	0	0	0	0	0	0	0
5							FLAG	LINK
	0	0	0	0	0	0	0	0

This command requests the WREN V HH to perform diagnostic tests on itself. It is implemented with the WREN V HH interpretations listed in Table 14.1.1-12.

Parameter List Length specifies the length in bytes of the parameter list that shall be transferred during the Data Out phase. A Parameter List Length of zero indicates that no data out shall be transferred. This condition shall not be considered as an error. The parameter list is vendor unique and reserved for future standardization by CDC. The WREN V HH will accept only a parameter list length of zero.

A logical Unit Off Line (UnitOfL) bit of zero disables write operations on user medium or operations that affect user visible medium positioning. The bit is not interpreted by the WREN V HH.

The SCSI Device Off Line (DOfL) bit of 1 enables diagnostic operations that may adversely affect operations to other Logic Units on the same target. This bit is not interpreted by the WREN V HH.

14.1.1.6 continued

The Logical Unit Off Line and SCSI Device Off Line bits are
generally set by operating system software, while the
parameter list is prepared by diagnostic application
software. Thus, by preventing operations that are not
enabled by these bits, the WREN V HH assists the operating
system in protecting it's resources.

A Self Test bit of one directs the WREN V HH to complete
it's default self test. If the self test is requested, the
Parameter List Length shall be set to zero and no data
shall be transferred. If the self test successfully passes,
the command shall be terminated with a Good Condition
status; otherwise, the command shall be terminated with a
check condition status and, if extended sense is
implemented, the Sense Key shall be set to Hardware Error.
For the WREN V HH, the self test bit must be set to a 1.

WREN V HH performs only it's default self test. This will
include seeking to a reserved nonuser-accessible cylinder
and writing, reading and verifying data for each data
surface.

For systems which support disconnection, WREN V HH will
disconnect while executing this command.

14.1.2   GROUP 1 COMMANDS FOR ALL DEVICE TYPES

WREN V HH implements the following commands which are
applicable for all device types.

OP CODE	COMMAND NAME	SECTION
3BH	Write Data Buffer	14.1.2.3
3CH	Read Data Buffer	14.1.2.4

14.1.2.1 Compare Command (39H)

Not Implemented

14.1.2.2 Copy and Verify Command (3AH)

Not Implemented

14.1.2.3 Write Data Buffer Command (3BH)

TABLE 14.1.1-13.   WRITE DATA BUFFER COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	1	1	0	1	1
1	LOGIC UNIT NO. 0	0	0	0	0	MODE		
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	BYTE TRANSFER LENGTH (MSB)							
8	BYTE TRANSFER LENGTH (LSB)							
9	0	0	0	0	0	0	FLAG 0	LINK 0

The Write Data Buffer command may be used in conjunction with the Read Buffer command as a diagnostic function for testing the WREN V HH drive's data buffer memory and the SCSI bus integrity. When used in a diagnostic mode the medium shall not be accessed during the execution of this command. An additional mode is provided for downloading and saving executable micro-code.

The function of this command and the meaning of the fields within the Command Descriptor Block depend on the mode field. The mode field is defined as follows:

DB2	DB1	DB0	MODE DEFINITION
0	0	0	Write Combined Header and Data
1	0	1	Download micro-code and save.

14.1.2.3.1 Combined Header and Data Mode (000b)

In this mode, data to be written to the Drives data buffer is preceded by a four byte header.

The Byte Transfer Length includes a four byte header and the Write Data Buffer data. In WREN V HH, up to 32,772 bytes may be transferred, consisting of four bytes of header and up to 32,768 bytes of data. Writing will be initiated at "Byte Number 0" of the WREN V HH data buffer. A transfer length of zero indicates that no data transfer shall take place. This condition shall not create the Check Condition status. If the transfer length is greater than the Available Length reported by the Read Data Buffer header, the WREN V HH shall create the Check Condition status with the Sense Key of Illegal Request. In this case no data shall be transferred from the initiator.

It shall not be considered an error to request a transfer length less than the Available Length.

The write data following the Write Data Buffer CDB consists of a 4 byte write data buffer header (which always precedes the data) plus the data to be written to the data buffer as follows:

TABLE 14.1.1-14a. WRITE DATA BUFFER HEADER

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4 - n	DATA TO BE WRITTEN INTO WREN V HH BUFFER							

14.1.2.3.2 Download and Save Micro-Code Mode (101b)

In this mode, vendor-unique executable micro-code (which is not preceded by a 4 byte header) and/or control information shall be transferred to the control memory space of the target and, if the download is completed successfully, shall also be saved on the disk media. The downloaded code shall then be effective after each power cycle and reset until it is supplanted in another download microcode and save operation. When the download microcode and save command has been completed successfully the target shall generate a "Unit Attention Condition" for all initiators except the one that issued the download microcode and save command. The Attention Condition shall be set to "Microcode has been downloaded" (error code 2Bh).

<u>Buffer ID (CDB byte 2)</u>: Not checked or interpreted by the drive.

<u>Buffer Offset (CDB bytes 3, 4, and 5)</u>: Not checked or interpreted by the drive.

<u>Transfer Length (CDB bytes 6, 7 and 8)</u>: The transfer length in bytes of the downloadable code. This value must be the exact length of the download data. A value of zero signifies no data transfer and shall not create an error. A value of one signifies one byte of download data, etc.

<u>Control Byte (CDB byte 9)</u>: Must-Be-Zero.

14.1.2.4   Read Data Buffer Command (3CH)

TABLE 14.1.1-14b.   READ DATA BUFFER CDB PARAMETERS

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	1	1	1	0	0
1	LOGICAL UNIT NO. 0 0 0			0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	ALLOCATION LENGTH (MSB) [1]							
8	ALLOCATION LENGTH (LSB) [1]							
9	0	0	0	0	0	0	FLAG 0	LINK 0

[1] Should be 32,772 decimal to read the drive's entire buffer
    plus the 4 byte read data buffer header (Figure 14.1.1-15).

The Read Data Buffer command is used in conjunction with
the Write Data Buffer command as a diagnostic function for
testing the WREN V HH drive's data buffer memory and the
SCSI bus integrity. The medium shall not be accessed during
the execution of this command.

The Read Data Buffer command is implemented with the WREN V
HH parameters listed in Table 14.1.1-14b.

14.1.2.4 continued

The Allocation Length specifies the number of bytes the
initiator has allocated for returned Read Data Buffer data.
An Allocation Length of zero indicates that no Read Data
Buffer data shall be transferred. This condition shall not
create the Check Condition status. Any other value
indicates the maximum number of bytes to be transferred.
This data is to be used by the initiator for comparison
with the data pattern sent during the Write Data Buffer
command. Up to 32,772 bytes may be requested consisting of
four bytes of header and up to 32,768 bytes of data.

If the Allocation Length is greater than the Available
Length (from Read Data Buffer Header), only the Available
Length shall be transferred to the initiator. It shall not
be considered an error to request an Allocation Length less
than the Available Length.

The WREN V HH shall terminate the Data In phase when
Allocation Length bytes have been transferred or when all
available Read Data Buffer data have been transferred to
the initiator, whichever is less.

The Read Data Buffer contains a four byte header, followed
by the Read Data Buffer data.

TABLE 14.1.1-15. READ DATA BUFFER HEADER

BIT BYTES	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	AVAILABLE LENGTH (MSB) [2]							
3	AVAILABLE LENGTH (LSB) [2]							
4-n	BUFFER DATA BYTES							

[2] 32,768 Bytes

To avoid corruption of data, it is recommended that the
initiator issue the Reserve Unit command before the Write
Data Buffer command and issue Release Unit command after
the Read Data Buffer command.

14.1.2.4 continued

The Available Length of data bytes returned by the WREN V
HH may be up to 32,768 bytes (32,772 bytes minus 4 byte
header) If the Allocation Length of the CDB is too small to
transfer all of the Available Length, the Available Length
shall not be adjusted to reflect the truncation.

Reading will be initiated from "Byte Number 0" of the WREN
V HH data buffer. The drive will not attempt to detect
whether buffer data has been changed between Write and Read
Data Buffer commands.

14.1.3   Groups 2 through 5 Commands for All Device Types

Not implemented. A "Check Condition" status will be sent if
received.

14.1.4   Group 6 Commands for All Device Types

Reserved for CDC usage. Customers should not attempt to use
these functions. If these functions are used, the users
stored data may be destroyed.

14.1.5   Group 7 Commands for All Device Types

Same as Group 6 Commands.

14.2   COMMAND DESCRIPTIONS FOR DIRECT ACCESS DEVICES

The WREN V HH supports Group 0, and Group 1 commands for Direct Access Devices. Refer to sections listed below for more details on these commands.

14.2.1   Group 0 Commands for Direct Access Devices

The Group 0 Commands implemented by WREN V HH are listed in Table 14.2.1-1.

TABLE 14.2.1-1. GROUP 0 COMMANDS IMPLEMENTED

OPERATION CODE (HEX)	COMMAND NAME	SECTION
00	TEST UNIT READY	14.1.1.1
01	REZERO UNIT	14.2.1.1
03	REQUEST SENSE	14.1.1.2
04	FORMAT UNIT	14.2.1.2
07	REASSIGN BLOCKS	14.2.1.3
08	READ	14.2.1.4
0A	WRITE	14.2.1.5
0B	SEEK	14.2.1.6
12	INQUIRY	14.1.1.3
15	MODE SELECT	14.2.1.7
16	RESERVE	14.2.1.8
17	RELEASE	14.2.1.9
1A	MODE SENSE	14.2.1.10
1B	START UNIT	14.2.1.11
1C	RECEIVE DIAGNOSTIC RESULTS	14.1.1.5
1D	SEND DIAGNOSTIC	14.1.1.6

14.2.1.1 Rezero Unit Command (01H)

TABLE 14.2.1-2.   REZERO UNIT COMMAND CDB SPECIFICATION
(Table 8.2 in CDC SCSI Spec)

BIT BYTES	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	LOGICAL UNIT NO. 0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Rezero Unit command (Table 14.2.1-2) requests that the WREN V HH set it's logical block address to zero and return the disk drive read/write heads to the track (or cylinder) containing Logical Block Zero. This command is implemented for a LUN of zero and Flag and Link bits of zero. This command is intended for systems which disable retries and the initiator performs error recovery. It is longer than a seek to Logical Block Address zero and should be utilized if seek errors are encountered.

For systems that support disconnection, WREN V HH will disconnect when this command is received.

14.2.1.2 Format Unit Command (04H)

TABLE 14.2.1-3.   FORMAT UNIT COMMAND CDB SPECIFICATION

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0	0
1	LOGICAL UNIT NO. 0 0 0			FMT DATA [1]	CMP- LIST [1]	DEFECT LIST FORMAT [1]		
2	0	0	0	0	0	0	0	0
3	INTERLEAVE (MSB)							
4	INTERLEAVE (LSB) (a value of 0000H defaults to an interleave of 1)							
5	0	0	0	0	0	0	0	0

[1] See Table 14.2.1-4 for details of values used here and their meanings.

The Format Unit command (Table 14.2.1-3) ensures that the medium is formatted so all of the user addressable data blocks can be accessed. There is no guarantee that the medium has or has not been altered. In addition, the medium may be certified and control structures may be created for the management of the medium and defects.

The Format Unit command shall be rejected with Reservation Conflict status (see Section 14.2.1.8.2) if the specified logical unit is reserved. Extent reservation is not supported by WREN V HH.

This command is implemented in WREN V HH for a LUN of zero, mandatory features and a subset of the available optional features of the Common Command Set (CCS) specification and CDC SCSI specification as defined in the following paragraphs.

WREN V HH allows an initiator to specify (or not specify) sectors which are to be reallocated during the format process. The format parameters to be specified in the Format Unit command are defined in Table 14.2.1-3.

14.2.1.2   continued

A Format Data (FmtData) bit of one indicates that format
data is supplied during the Data Out phase. The defect
list included with this data specifies the defects that
shall be entered into the defect map. The format of the
defect list is determined by Defect List Format field. A
FmtData bit of zero indicates the Data Out phase shall
not occur (no defect data shall be supplied by the
initiator).

A Complete List (CmpLst) bit of one indicates the data
supplied is to be the complete list of Growth defects.
Any previous Growth or Certification defect data shall be
erased. The WREN V HH may add to this list as it formats
the medium. The result is to purge any previous Growth or
Certification defect list and to build a new defect list.
A CmpLst bit of zero indicates the data supplied is in
addition to existing Growth defect list.

The use of the P and C defect lists is controlled by byte
1 of the defect list header (see Table 14.2.1-5).

The Defect List Format field specifies additional
information related to the defect list. (See Table
14.2.1-4 for further information.)

The Interleave field requests that logical blocks be
related in a specific fashion to the physical blocks to
facilitate speed matching. An interleave value of zero
requests that the target use it's default interleave. An
interleave value of one requests that consecutive logical
blocks be placed in consecutive physical order. Values of
two or greater indicate that one or more (respectively)
physical blocks separate consecutive logical blocks. The
WREN V HH will accept only an interleave of 0 or 1 (an
interleave of 0 defaults to an interleave of 1). The WREN
V HH has implemented an optional "read look ahead"
function which reads all of the data from the starting
block address to the end of the last track read into it's
buffer regardless of the block count specified in the
read command. This data (from the last block read to the
end of the track) is subsequently available for the next
sequential read command without reaccess of the disk
media thereby increasing performance and negating the
need for an interleave during format. (See Read Command,
Section 14.2.1.4.)

14.2.1.2   continued

        These definitions of flaw categories are supplied to help
        in   understanding   the   alternatives   listed   in   Table
        14.2.1-4.

        P =   Primary Defect Type: P type flawed sectors are
              identified at the time of shipment in a list of
              defects (permanent flaws) supplied by CDC and stored
              on the disk in an area that is not directly
              accessible by the user. (This list may be referred
              to as an ETF List). This defect list will not be
              modified or changed by WREN V HH (or initiator)
              after shipment.

        C =   Certification Defect Type: C type flawed sectors are
              sectors which fail a format verify during the format
              function.

        D =   Data   Defect   Type: D   type   sectors   are   sectors
              identified in a list supplied to the target by the
              initiator during a Data Out phase of the current
              Format Unit command. The D List follows a four byte
              defect list header and is referred to as Defect
              Descriptor Bytes.

        G =   Growth Defect Type: G type flawed sectors contain
              medium flaws and have been reallocated as a result
              of   receiving   a   Reassign   Blocks   command,   or
              certification defects (C type) reallocated during a
              previous Format Unit command, or Data Defects (D
              type) reallocated during a previous Format Unit
              command or defects that have been automatically
              reallocated by the drive. This (G) list is recorded
              on the WREN V HH media and may be referenced for the
              current (and subsequent) Format Unit commands. This
              (G) list does not include the Primary (P) list of
              defects.

14.2.1.2 continued

TABLE 14.2.1-4. FORMAT UNIT PARAMETER DEFINITION (FORMAT VARIATIONS)

CDB-Byte 1 Bits [1]			COMMENTS
4 FMT DATA	3 CMP LIST	2 1 0 DEFECT LIST FORMAT	
0	X	X X X	Default Format: No Data Out phase occurs. WREN V HH will reallocate all sectors in the P list plus any sector which fails the Format Verify phase (C type flaws). Any previous G list will be erased:
1	0	0 X X	Format with G and no D: A four byte Defect List Header must be sent by the initiator. No Defect Descriptors (D list) are sent by the initiator. WREN V HH will reallocate all sectors in the drives current G list. See also Note [2].
1	1	0 X X	Format without G or D: A four byte Defect List Header must be sent by the initiator. No D list may be sent by the initiator. WREN V HH will erase any previous G list. See also Note [2].
1	1	1 0 0	Format with D and without G. The initiator must send a four byte Defect List Header followed by a D list of defects that the WREN V HH will reallocate. The D list must be in the bytes from Index format (see Table 14.2.1-6A). The WREN V HH will erase any previous G list. See also Note [2].
1	1	1 0 1	Format with D and without G: The initiator must send a four byte Defect List Header followed by a D List of defects that WREN V HH will reallocate. The D list must be in the Physical Sector format (see Table 14.2.1-6b). WREN V HH will erase any previous G list. See also Note [2].

[1]   Refer to Table 14.2.1-3.

[2]   Byte one of the Defect List Header determines whether the P and C defects are reallocated. See Table 14.2.1-5.

14.2.1.2 continued

The defect list shown in Table 14.2.1-5 contains a four byte header followed by one or more defect descriptors. The Defect List Length in each table specifies the total length in bytes of the defect descriptors that follow. In Table 14.2.1-5 the Defect List Length is equal to eight times the number of defect descriptors.

TABLE 14.2.1-5.   DEFECT LIST HEADER (4 Bytes)

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	FOV [1]	DPRY [2]	DCRT [3]	STPF [4]	0	RESERVED 0	0	0
2	DEFECT LIST LENGTH (MSB) [5]							
3	DEFECT LIST LENGTH (LSB) [5]							

DEFECT DESCRIPTORS

0-n	DEFECT DESCRIPTOR BYTES (Refer to Table 14.2.1-6a or Table 14.2.1-6b for Format)

TABLE 14.2.1-6a. DEFECT DESCRIPTOR BYTES - BYTES FROM INDEX FORMAT

0	Cylinder Number of Defect (MSB)
1	Cylinder Number of Defect
2	Cylinder Number of Defect (LSB)
3	Head Number of Defect
4	Defect Bytes from Index (MSB)
5	Defect Bytes from Index
6	Defect Bytes from Index
7	Defect Bytes from Index (LSB)

NOTES: Definitions follow Table 14.2.1-6b.

14.2.1.2   continued

> For defects to be specified in the Bytes from Index
> format, the defect list format field must be 100
> (binary), see Tables 14.2.1-3 and 14.2.1-4.
>
> Each Defect Descriptor for the Bytes from Index format
> specifies the beginning of an eight bit (1 byte) defect
> location on the medium. Each defect descriptor is
> comprised of the cylinder number of the defect, the head
> number of the defect and the number of bytes from Index
> to the defect location. (Defect bytes from Index)
>
> The Defect Descriptors shall be in ascending order. For
> determining ascending order, the Cylinder Number of
> Defect is considered the most significant part of the
> address and the Defect Bytes from Index is considered the
> least significant part of the address.
>
> A value for Defect Bytes from Index of FFFFFFFFH (i.e.,
> reassign the entire track) is illegal for a WREN V HH.

TABLE 14.2.1-6b.   DEFECT DESCRIPTOR BYTES - PHYSICAL SECTOR FORMAT

0	Cylinder Number of Defect (MSB)
1	Cylinder Number of Defect
2	Cylinder Number of Defect (LSB)
3	Head Number of Defect
4	Defect Sector Number (MSB)
5	Defect Sector Number
6	Defect Sector Number
7	Defect Sector Number (LSB)

Information in this Table is repeated for each defect.

> For defects to be specified in the Physical Sector
> format, the Defect List format field must be 101
> (binary). See Tables 14.2.1-3 and 14.2.1-4.
>
> Each Defect Descriptor for the Physical Sector format
> specifies a sector size defect location comprised of the
> cylinder number of the defect, the head number of the
> defect and the defect sector number.

14.2.1.2 continued

The Defect Descriptors shall be in ascending order. For determining ascending order, the Cylinder Number of the defect is considered the most significant part of the address and the Defect Sector Number is considered the least significant part of the address.

A Defect Sector Number of FFFFFFFF (i.e., reassign the entire track) is illegal for the WREN V HH.

Notes for Table 14.2.1-5. Defect List Header Bit Interpretations (continued)

NOTES:

FUNCTION	WREN IV DEFECT LIST HEADER BIT INTERPRETATIONS
[1] FOV	If one, WREN V HH interprets the DPRY, DCRT and STFP bits. If zero, WREN V HH will check the DPRY, DCRT and STFP bits for zeros.
[2] DPRY	If one, flaws in the WREN V HH P list will not be reallocated during formatting. This means existing reallocations of the P list will be cancelled and no new reallocations made during formatting. The P list is retained. If zero, flaws in the WREN V HH P list will be reallocated during formatting. A Check Condition shall be sent in the status if the P list cannot be found by the WREN V HH.
[3] DCRT	If one, WREN V HH will not perform a verify function during formatting (thus no C list for this format will be created or reallocated). If zero, WREN V HH will perform a verify function during formatting and will reallocate any sector which fails the verify (i.e.; a C list will be created and these flaws reallocated).
[4] STPF	If one, formatting will be terminated if an error is encountered while accessing either the P or G defect list. If zero, formatting will not be terminated if an error is encountered while accessing either the P or G defect list.
[5] DEFECT LIST LENGTH	The length of any following D list (Defect Descriptors) must equal to 8 times the number of sectors to be reallocated per Table 14.2.1-6a or Table 14.2.1-6b.

14.2.1.2 continued

NOTE: The initiator may not use any previously defined "C", "G", or
       "D" lists if the sector size (block length) has been changed.

       For systems which support disconnection, WREN V HH will
       disconnect while executing the Format Unit command.

14.2.1.3 Reassign Blocks Command (07H)

TABLE 14.2.1-7.   REASSIGN BLOCKS COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	1	1
1	LOGICAL UNIT NO.							
	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5							FLAG	LINK
	0	0	0	0	0	0	0	0

The Reassign Blocks command (Table 14.2.1-7) requests the
target to reassign the defective logical blocks to an area
on the logical unit reserved for this purpose. For a WREN V
HH drive's the Logical Unit number must be zero and the
Flag and Link bits must be zero.

After sending the Reassign Blocks command, the initiator
transfers a defect list which contains the logical block
addresses to be reassigned. The WREN V HH shall reassign
the physical medium used for each logical block address in
the list. The data contained in the logical blocks
specified in the defect list will not be preserved, but the
data in all other logical blocks on the medium shall be
preserved. It is recommended that the initiator recover the
data from the logical block(s) to be reassigned before
issuing this command. After completion of this command, the
initiator can write the recovered data to the same Logical
Block Address(es).

14.2.1.3   continued

The effect of specifying a logical block to be reassigned that has previously been reassigned is to reassign the block again. Thus, over the life of the medium, a logical block can be assigned to multiple physical addresses (until no more spare locations remain on the medium).

This command should be used by an initiator to immediately reallocate any block (sector) which requires the WREN V HH to recover data by data correction via ECC if the automatic reallocation feature of the WREN V HH is not enabled, see Mode Select command (Section 14.2.1.7).

For systems which support disconnection, WREN V HH will disconnect while executing this command.

The Reassign Blocks defect list (Table 14.2.1-8) contains a four byte header followed by one or more Defect Descriptors. The length of each Defect Descriptor is four bytes.

TABLE 14.2.1-8.   REASSIGN BLOCKS DEFECT LIST

DEFECT LIST HEADER

BYTE \ BIT	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	DEFECT LIST LENGTH (MSB)							
3	DEFECT LIST LENGTH (LSB)							

DEFECT DESCRIPTOR(S)

0	DEFECT LOGICAL BLOCK ADDRESS (MSB)
1	DEFECT LOGICAL BLOCK ADDRESS
2	DEFECT LOGICAL BLOCK ADDRESS
3	DEFECT LOGICAL BLOCK ADDRESS (LSB)

The Defect List Length specifies the total length in bytes of the Defect Descriptors that follow. The Defect List Length is equal to four times the number of Defect Descriptors.

14.2.1.3   continued

The Defect Descriptor specifies a four byte Defect Logical Block Address that contains the defect. The Defect Descriptors shall be in ascending order.

If the logical unit has insufficient capacity to reassign all of the defective logical blocks, the command shall terminate with a Check Condition status and the Sense Key shall be set to Medium Error. The logical block address of the first logical block not reassigned shall be returned in the information bytes of the sense data.

14.2.1.4   Read Command (08H)

TABLE 14.2.1-9.   READ COMMAND

BIT BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	0
1	LOGICAL UNIT NO. 0 0 0			LOGICAL BLOCK ADDRESS (MSB)				
2	LOGICAL BLOCK ADDRESS							
3	LOGICAL BLOCK ADDRESS (LSB)							
4	TRANSFER LENGTH							
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Read Command (Table 14.2.1-9) requests that the WREN V HH transfer data to the initiator.

The Logical Block Address specifies that logical block at which the read operation shall begin.

In the CDB the LUN must be zero and the Flag and Link bits must be zero.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates that 256 logical blocks shall be transferred. Any other value indicates the number of logical blocks that shall be transferred.

The data value most recently written in the addressed logical block shall be returned.

14.2.1.4   continued

Read data transfers with the initiator will not begin
until at least one full sector of data is available in
the WREN V HH data buffer. For multiple sector reads, the
transfer of data will continue until the number of blocks
specified in byte 4 of the CDB has been read and
transferred or until an unrecoverable error is detected.

Data transfer could stop if the option to stop on
recovered error is selected.

For systems which support disconnection. WREN V HH will
disconnect when a valid Read command is received by the
WREN V HH. WREN V HH will reconnect depending on the
value of the Buffer Full Ratio Set in Page 2 of the Mode
Select Data (see Section 14.2.1.7). After data transfer
has been initiated with an initiator, the WREN V HH will
not disconnect unless an internal error recovery
procedure is required or the data transfer to an
initiator will be interrupted for more than 1 millisecond.

The initiator must accept all data presented to the
initiator after sending this command until the WREN V HH
sends Completion Status during a Status phase. (Note the
WREN V HH may disconnect and reconnect while executing
this command and the initiator may prematurely terminate
this command by creating the Reset condition or by
sending an Abort or Bus Device Reset message).

Sense Data will be valid after this command is executed
and Completion Status is sent. If the Address Valid bit
in the Sense Data is true (1), the Sense Data Logical
Block Address (Information bytes) will point to the last
Logical Block accessed by the WREN V HH. If the Address
Valid bit in the Sense Data is false (0), the Sense Data
Logical Block Address bytes are not valid.

The WREN V HH contains a track buffer and implements an
optional "read look" ahead function whereby all data from
the starting Logical Block Address to the end of the
physical track is read into the buffer regardless of the
transfer length in the CDB specified. This data is
available for subsequent sequential disk reads without
having to access the disk medium for increased
performance.

This command shall be terminated with a Reservation
Conflict status if any reservation access conflict (see
Section 14.2.1.8) exists and no data shall be read.

14.2.1.4 continued

If any of the following conditions occur, this command shall
be terminated with a Check Condition status, and if extended
sense is implemented, the Sense Key shall be set as
indicated in the following table. This table does not
provide an exhaustive enumeration of all conditions that may
cause the Check Condition status.

CONDITION	SENSE KEY
Invalid Logical Block Address	Illegal Request (see note)
Target reset since last command from this initiator	Unit Attention
Unrecoverable read error	Medium Error
Recovered read error	Recovered Error
Overrun or other error that might be resolved by repeating the command	Aborted Command

NOTE: The extended sense Information Bytes shall be set
         to the Logical Block Address of the first invalid
         address.

14.2.1.5 Write Command (OAH)

TABLE 14.2.1-10.   WRITE COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	0
1	LOGICAL UNIT NO. 0 0 0			LOGICAL BLOCK ADDRESS (MSB)				
2	LOGICAL BLOCK ADDRESS							
3	LOGICAL BLOCK ADDRESS (LSB)							
4	TRANSFER LENGTH							
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Write command (Table 14.2.1-10) requests that the WREN
V HH write, to the medium, the data transferred by the
initiator.

The Logical Block Address specifies the logical block at
which the write operation shall begin.

14.2.1.5 continued

The Transfer Length specifies the number of contiguous logical blocks of data to transferred. A Transfer Length of zero indicates that 256 logical blocks shall be transferred. Any other value indicates the number of logical blocks that shall be transferred.

In the CDB the LUN must be zero and the Flag and Link bits must be zero.

For a valid Write command WREN V HH initiates requests for write data before disconnecting and before initiating any required seek function specified for this command.

For systems which support disconnection, WREN V HH will disconnect when any internal error recovery procedure is required, or the data transfer with the initiator will be interrupted for more than 1 millisecond, or if the WREN IV's internal data buffer is full. After a disconnect the WREN V HH will reconnect depending on the value of the Buffer Empty Ratio in Page 2 of Mode Select Data (see Section 14.2.1.7).

The initiator must send requested write data to the drive until the drive sends Completion status during a Status phase or until the initiator Resets/Aborts the command. (Note: the drive may disconnect and reconnect while executing this command).

Sense Data will be valid after this command is executed and Completion status is sent. (refer to the Read Command description in Section 14.2.1.4).

This command shall be terminated with a Reservation Conflict status if any reservation access conflict (see Section 14.2.1.8) exists and no data shall be written.

If any of the following conditions occur, this command shall be terminated with a Check Condition status, and if extended sense is implemented, the Sense Key shall be set as indicated in the following table. This table does not provide an exhaustive enumeration of all conditions that may cause the Check Condition status.

14.2.1.5 continued

CONDITION	SENSE KEY
Invalid Logical Block Address	Illegal Request (see note)
Target reset since last command from this initiator	Unit Attention
Overrun or other error that might be resolved by repeating the command	Aborted Command

NOTE: The extended sense Information Bytes shall be set to the Logical Block Address of the first invalid address. In this case, no data shall be written on the logical unit.

14.2.1.6 Seek Command (OBH)

TABLE 14.2.1-11.   SEEK COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	1
1	LOGICAL UNIT NO. 0 0 0			LOGICAL BLOCK ADDRESS (MSB)				
2	LOGICAL BLOCK ADDRESS							
3	LOGICAL BLOCK ADDRESS (LSB)							
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Seek command (Table 14.2.1-11) requests that the WREN IV HH seek to the specified logical block address.

For WREN V HH, the Logical Unit number is zero and the Flag and Link bits are zero.

The use of this command is infrequent since all commands involving data transfer to/from the WREN V HH media contain implied seek addresses.

14.2.1.6 continued

> For systems which support disconnection, the WREN V HH will
> disconnect when a valid Seek command is received.
>
> The maximum Logical Block Address that may be specified for
> a Seek command is defined in Read Capacity Data, Section
> 14.2.2.1.

14.2.1.7 Mode Select Command (15H)

TABLE 14.2.1-12.   MODE SELECT COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	0	1
1	LOGICAL UNIT NO. 0 0 0			PF	0	0	0	SMP 0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	PARAMETER LIST LENGTH							
5	0	0	0	0	0	0	FLAG 0	LINK 0

> The Mode Select command (Table 14.2.1-12) provides a means
> for the initiator to specify medium, logical unit, or
> peripheral device parameters to the WREN V HH. For a WREN V
> HH, the Logical Unit number must be zero and the Flag and
> Link bits must be zero.
>
> The Page Format (PF) bit, when set to one, indicates the
> data sent by the initiator after the mode select Header and
> Block Descriptors (if any) complies with the Page Format.
> The PF bit, when set to zero, indicates the data sent after
> the Mode Select Header and the Block Descriptors (if any)
> are vendor unique. The WREN V HH will always interpret the
> PF bit to a one.

14.2.1.7   continued

The Save Mode Parameters (SMP) bit, when set to one, requests that the WREN V HH save the savable pages. Pages 3 and 4 may be stored only during Format commands, so they cannot be saved via a Mode Select command. The WREN V HH must update the Current mode values with parameters included with this command, save the Current values of the savable parameters, and report Good status only after the save operation is completed. The Saved parameters shall not be changed if an error is detected during the Mode Select command. When the SMP bit is set to zero, the Saved parameter values will not be changed.

The Parameter List Length specifies the length in bytes of the Mode Select parameter list that shall be transferred during the Data Out phase. A Parameter List Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. See Table 14.2.1-15 to determine the List Length.

A list length other than those shown in Table 14.2.1-15 (except zero) is considered an error by the WREN V HH.

The Mode Select parameter list (Table 14.2.1-13) contains a four byte header, followed by zero or one block descriptor, followed by the pages of Mode Select Parameters.

Acceptable values for the Mode Select parameter list for the WREN V HH drive are shown in Table 14.2.1-13.

14.2.1.7 continued

TABLE 14.2.1-13. MODE SELECT PARAMETER LIST

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	RESERVED							
	O	O	O	O	O	O	O	O
1	MEDIUM TYPE							
	O	O	O	O	O	O	O	O
2	RESERVED							
	O	O	O	O	O	O	O	O
3	BLOCK DESCRIPTOR LENGTH EITHER 0 OR 8 (DECIMAL)							

BLOCK DESCRIPTOR

BYTE	7	6	5	4	3	2	1	0
0	DENSITY CODE							
	O	O	O	O	O	O	O	O
1	NUMBER OF BLOCKS (MSB)							
	O	O	O	O	O	O	O	O
2	NUMBER OF BLOCKS							
	O	O	O	O	O	O	O	O
3	NUMBER OF BLOCKS (LSB)							
	O	O	O	O	O	O	O	O [1]
4	O	O	O	O	O	O	O	O
5	BLOCK LENGTH (MSB)							
6	BLOCK LENGTH [2]							
7	BLOCK LENGTH (LSB)							

PARAMETER INFORMATION   [3]

8 - n	MODE SELECT PAGE HEADERS AND THEIR PARAMETERS (TABLE 14.2.1-15)

NOTES: [1] All zeros to signify only one block size for the entire LUN.
        [2] Set to desired sector size before a Format. (Valid values are 256 to 4096.)
        [3] See Mode Sense Command.

14.2.1.7 continued

The medium type field shall be OOH to define the default type direct access device.

The Block Descriptor Length specifies the length in byte of the Block Descriptor. It is equal to the number of bytes in the Block Descriptor (either O or 8) and does not include the page headers and mode parameters. A Block Descriptor Length of zero indicates that no block descriptor shall be included in the parameter list.

Each Block Descriptor specifies the medium characteristics for all or part of a logical unit. Each Block Descriptor contains a Density Code, a Number of Blocks and a Block Length.

The Density Code shall be OOH to define the default density of medium.

The Number of Blocks field specifies the number of logical blocks on the medium that corresponds to the Density Code and Block Length in the Block Descriptor. For a WREN V HH drive's there is only one Block Descriptor, thus the Number of Blocks must be zero signifying that all logical blocks of the logical unit shall have the medium characteristics specified by the Block Descriptor.

The Block Length specifies the length in bytes of each logical block described by the Block Descriptor.

The rest of the Mode Select parameters are organized into pages that group the parameters by function. The parameter definitions are the same as those described in the Mode Sense command (paragraph 14.2.1.10) and will not be repeated here.

TABLE 14.2.1-14.   MODE SELECT PAGE DESCRIPTOR HEADER

BIT BYTE	7	6	5	4	3	2	1	0
0	0	0	PAGE CODE					
1	PAGE LENGTH							
2-n	MODE PARAMETERS							

Each page of mode parameters begins with a two byte Page Descriptor Header. The Page Code identifies which page of mode parameters is being transferred. The Page Length indicates the number of additional bytes of mode parameters contained in this page. The number of additional bytes sent must always match the Page Length value.

14.2.1.7 continued

The WREN V HH only verifies Mode Select Data that is defined as changeable by the drive. The WREN V HH supports the following Page Codes:

Page Code	Description
01H	Error Recovery parameters
02H	Disconnect/Reconnect Control parameters
03H	Format parameters
04H	Rigid Disk Drive Geometry parameters
38H	Cache Control Parameters

The initiator shall issue a Mode Sense command requesting the WREN V HH to return all pages with changeable values (see PCF field description for Mode Sense command) before issuing any Mode Select commands. This allows the initiator to correctly determine which pages are supported, the proper length for those pages, and which parameters in those pages may be changed for that Logical Unit Number.

Table 14.2.1-15 summarizes the number of bytes and changeability status of the Mode Select parameter list for the WREN IV. The detail information can be obtained by issuing the Mode Sense command requesting changeable values as previously discussed.

TABLE 14.2.1-15.   TABLE TO DETERMINE PARAMETER LIST LENGTH

FUNCTION	NUMBER OF BYTES (Decimal) [1]	CHANGEABLE BY AN INITIATOR
Mode Select Header	4	NO
Block Descriptor	8 or 0	SOME
Error Recovery Page Header	2	NO
Error Recovery Page Parameters	6	SOME
Disconnect/Reconnect Page Header	2	NO
Disconnect/Reconnect Parameters	10	SOME
Format Page Header	2	NO
Format Page Parameters	22	SOME
Rigid Disk Drive Geometry Header	2	NO
Rigid Disk Drive Geometry Parameters	18	NO
Cache Control Header	2	NO
Cache Control Parameters	14	SOME

[1] Derive Parameter List Length in Table 14.2.1-12 from these numbers.

14.2.1.8 Reserve Command (16H)

TABLE 14.2.1-16.   RESERVE COMMAND CDB SETUP

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	1	0
1	LOGICAL UNIT NO.			3rd PRTY	3rd PRTY DEV. ID			EXTENT
	0	0	0	0 or 1 [1]	[1]			0
2	RESERVATION IDENTIFICATION							
	0	0	0	0	0	0	0	0
3	EXTENT LIST LENGTH (MSB)							
	0	0	0	0	0	0	0	0
4	EXTENT LIST LENGTH (LSB)							
	0	0	0	0	0	0	0	0
5							FLAG	LINK
	0	0	0	0	0	0	0	0

[1] If bit 4 is zero, bits 3, 2, and 1 are zeros. If bit 4 is one, bits 3, 2, and 1 identify the SCSI device ID for which the drive is to be reserved.

The Reserve command (Table 14.2.1-16) is used to reserve logical units. If the third party reservation option is implemented, the logical unit may be reserved for another specified SCSI device. The Reserve and Release commands provide the basic mechanism for contention resolution in multiple initiator systems.

This command is implemented by WREN V HH for an Entire Unit Reserve with Third Party Reserve supported and with the WREN V HH specific parameters shown in Table 14.2.1-16.

14.2.1.8.1 Logical Unit Reservation

If the Extent bit is zero, this command shall request the entire logical unit (WREN V HH drive) be reserved for exclusive use of the initiator until the reservation is superseded by another valid Reserve command from the initiator that made the reservation, released by a Release command from the same initiator, by a Bus Device Reset message from any initiator, or by a "hard" Reset condition. A logical unit reservation shall not be granted if any extent or logical unit is reserved by another initiator or if any extent with a read shared reservation type is reserved by this initiator. It shall be permissible for an initiator to reserve a logical unit that is currently reserved by that initiator. If the Extent bit is zero, the Reservation Identification and the Extent List Length shall be ignored. If the Extent bit is a one, the WREN V HH will generate Check Condition status and set the sense key to illegal request.

If, after honoring the reservation, any other initiator subsequently attempts to perform a command other than a Release command, which shall be ignored, or an Inquiry command, which shall be executed, or a Request Sense command, which shall be executed, the command shall be rejected with Reservation Conflict status.

14.2.1.8.2 Extent Reservation

WREN V HH does not support Extent reservations. This bit must always be zero. Since the Reservation Identification byte and the Extent List Length are valid only for extent reservations, WREN V HH will ignore these fields.

14.2.1.8.3 Third Party Reservation

WREN V HH supports the third party reservation option. The third party reservation option for the Reserve command allows an initiator to reserve a logical unit for another SCSI device. This option is intended for use in multiple initiator systems which use the Copy command. WREN V HH shall also implement the third party release option (see Section 14.2.1.9.3).

If the third party (3rdPty) bit is zero, then the third party reservation option is not requested. If the 3rdPty bit is one the Reserve command shall reserve the specified logical unit for the SCSI device specified in the third party device ID field. The WREN V HH shall preserve the reservation until it is superseded by another valid Reserve command from the initiator which made the reservation or until it is released by the same initiator, by a Bus Device Reset message from any initiator, or a "hard" Reset condition. The WREN V HH shall ignore any attempt to release the reservation made by any other initiator.

14.2.1.8.4 Superseding Reservations

An initiator which holds a current reservation may modify that reservation by issuing another Reserve command to the same logical unit. The superseding Reserve command shall release the previous reservation state when the new reservation request is granted. The previous reservation shall not be modified if the new reservation request cannot be granted.

Implementors Note: Superseding reservations are principally intended to allow the SCSI device ID to be changed on a reservation using third party reservation option. This capability is necessary for certain situations when using the Copy command.

14.2.1.9   Release Command (17H)

TABLE 14.2.1-17.   RELEASE COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	1	1
1	LOGICAL UNIT NO. 0 0 0			3rd[1] PRTY 0 or 1	THIRD PRTY DEV. ID. [1]			EXTENT 0
2	RESERVATION IDENTIFICATION 0 0 0 0 0 0 0 0							
3	EXTENT LIST LENGTH (MSB) 0 0 0 0 0 0 0 0							
4	EXTENT LIST LENGTH (LSB) 0 0 0 0 0 0 0 0							
5	0	0	0	0	0	0	FLAG 0	LINK 0

[1] Same as Note 1 for Reserve Command, Section 14.2.1.8.

The Release command (Table 14.2.1-17) is used to release
previously reserved logical units. It is not an error for
an initiator to attempt to release a reservation that is
not currently active. In this case, the target returns
Good status without altering any other reservation.

The command is implemented by WREN V HH for an Entire
Unit Release and Third Party Release supported with the
WREN V HH specific parameters listed in Table 14.2.1-17.

In the CDB the LUN must be zero, and the Extent, Flag and
Link bits must be zero.

14.2.1.9.1 Logical Unit Release

If the extent bit is zero, the Release command shall
cause the WREN V HH to terminate all reservations from
the initiator to the WREN V HH.

14.2.1.9.2 Extent Release

The WREN V HH does not support extent reservations. This
bit must always be zero. Since the Reservation Identifi-
cation byte is valid only for extent reservations, WREN V
HH will ignore this byte.

14.2.1.9.3 Third Party Release

WREN V HH supports the third party release option. The third party release option for the Release command allows an initiator to release a logical unit which was previously reserved using the third party reservation option (see Section 14.2.1.8.3). This option is intended for use in multiple initiator systems which use the Copy command.

If the third party (3rdPty) bit is zero, the third party release option is not requested. If the 3rdPty bit is one, the WREN V HH shall release the specified logical unit, but only if the reservation was made using the third party reservation option by the initiator that is requesting the release, and for the same SCSI device specified in the third party ID field.

14.2.1.10 Mode Sense Command (1AH)

TABLE 14.2.1-18. MODE SENSE COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	1	0
1	LOGICAL UNIT NO. 0 0 0			0	0	0	0	0
2	PCF (See Table 14.2.1-19)		PAGE CODE (See Table 14.2.1-20)					
3	0	0	0	0	0	0	0	0
4	ALLOCATION LENGTH (See Table 14.2.1-20)							
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Mode Sense command provides a means for a WREN V HH to report it's medium, logical unit, or peripheral device parameters to the initiator. It is a command complementary to the Mode Select command for support of medium that may contain multiple block lengths or densities.

This command is implemented in WREN V HH with the following drive specific parameters:

14.2.1.10   continued

CDB Specification

The LUN must be zero, and the Flag and Link bits must be zero. See Table 14.2.1-18.

The content of Mode Parameter bytes is determined by the value of the PCF (Page Control Field) bits specified in CDB byte 2, bits 6 & 7. The WREN V HH shall return the same Page Length for each supported page regardless of the value of PCF. The PCF field is defined in Table 14.2.1-19.

TABLE 14.2.1-19.   PAGE CONTROL FIELD BITS AFFECT ON MODE
PARAMETERS RETURNED

PCF BIT		
7	6	
0	0	Return Current values. The Current values are the values currently being used by the WREN V HH to control it's operation. After a Power On Reset, a hard Reset, or a Bus Device Reset message the Current values will be equal to the Saved values (if Saved values can be retrieved) or the Default values (if Saved values cannot be retrieved). The Current value of a parameter is updated whenever a Mode Select command which changes that parameter ends with Good status being returned.
0	1	Return Changeable values. The changeable values of any page is a mask that indicates which parameters may be changed via a Mode Select command and which parameters may not. Each returned parameter byte shall contain ones where a field or bit may be changed and zeros where a field or bit may not be changed.
1	0	Return Default values. The Default values are the values to which the WREN V HH will set the Current values after a reset condition unless valid Saved values are available.
1	1	Return Saved values. The saved values are the values the WREN V HH stores in nonvolatile memory. The Saved values of any changeable parameter can be set via a Mode Select command. For nonchangeable parameters, the Default value will be used.

The Block descriptor will contain it's normal values regardless of the value of the PCF. Unsupported fields or bits within a page will be returned as zeros for all PCF values.

14.2.1.10 continued

The Page Code allows the initiator to select one or all
of the pages of Mode parameters supported by the target.
Page Codes which are supported by WREN V HH are
summarized here (see Table 14.2.1-20):

Page Code	Description
00H	Product Unique. Not used. If received, the WREN V HH will only return the four byte header and 8 byte block descriptor.
01H	Error Recovery parameters.
02H	Disconnect/Reconnect Control parameters.
03H	Format parameters.
04H	Rigid Disk Drive Geometry parameters.
05H - 37H	Not used.
038H	Cache Control Parameters
39H-3EH	Not used.
3FH	Return all supported pages.

The Allocation Length specifies the number of bytes that
the initiator has allocated for returned Mode Sense data.
An Allocation Length of zero indicates that no Mode Sense
data shall be transferred. This condition shall not be
considered as an error. Any other value indicates the
maximum number of bytes that shall be transferred. The
WREN V HH shall terminate the Data In phase when
allocation length bytes have been transferred or when all
available Mode Sense data has been transferred to the
initiator, whichever is less.

The Mode Sense data (Table 14.2.1-21) will always include
a four byte header, followed by one eight byte block
descriptor, followed by the requested page or pages of
Mode Sense parameters.

WREN V HH supports the following page codes. The
Allocation Length should be at least the value in Table
14.2.1-20 for the initiator to receive all of the
possible available information for this page code.

14.2.1.10 continued

TABLE 14.2.1-20. MODE SENSE CDB SETUP

CDB PAGE CODE	LENGTH (DECIMAL)	MODE SENSE "DATA" RETURNED
(CDB Byte 2,Bits 5-0)		
00H	12	4 bytes of Mode Sense Header and 8 bytes of Block Descriptor Data
01H	20	4 bytes of Mode Sense Header 8 bytes of Block Descriptor Data 2 bytes of Error Recovery Header 6 bytes of Error Recovery Parameters [1]
02H	24	4 bytes of Mode Sense Header 8 bytes of Block Descriptor Data 2 bytes of Disconnect/Reconnect Control Header 10 bytes of Disconnect/Reconnect Control Parameters [1]
03H	36	4 bytes of Mode Sense Header 8 bytes of Block Descriptor Data 2 bytes of Format Control Header 22 bytes of Format Parameters [1]
04H	32	4 bytes of Mode Sense Header 8 bytes of Block Descriptor Data 2 bytes of Rigid Disk Drive Geometry Header [1] 18 bytes of Rigid Disk Drive Geometry Parameters
38H	28	4 bytes of Mode Sense Header 8 bytes of Block Descriptor Data 2 bytes of Cache Control Parameter Page Header 14 bytes of Cache Control Parameter Data [1]
3FH	92	4 bytes of Mode Sense Header 8 bytes of Block Descriptor Data 80 bytes of Headers and parameter data for 01H, 02H 03H 04H and 38H Page Codes. [1]

1 See PCF description for Mode Sense CDB (Table 14.2.1-18).

WREN V HH returned values of Mode Sense Header and Block Descriptor Data are defined in Table 14.2.1-21.

14.2.1.10   continued

TABLE 14.2.1-21. MODE SENSE DATA

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	SENSE DATA LENGTH "LENGTH" ENTRY OF TABLE 14.2.1-20 MINUS ONE [1]							
1	MEDIUM TYPE							
	0	0	0	0	0	0	0	0 [2]
2	WP 0[3]	RESERVED						
		0	0	0	0	0	0	0
3	BLOCK DESCRIPTOR LENGTH (8 decimal)							
	0	0	0	0	1	0	0	0 [4]

BLOCK DESCRIPTOR DATA

	7	6	5	4	3	2	1	0
0	DENSITY CODE							
	0	0	0	0	0	0	0	0 [5]
1	NUMBER OF BLOCKS (MSB)							
	0	0	0	0	0	0	0	0 [6]
2	NUMBER OF BLOCKS							
	0	0	0	0	0	0	0	0 [6]
3	NUMBER OF BLOCKS (LSB)							
	0	0	0	0	0	0	0	0 [6]
4	RESERVED							
	0	0	0	0	0	0	0	0
5	BLOCK LENGTH (MSB) [7]							
6	BLOCK LENGTH [7]							
7	BLOCK LENGTH (LSB) [7]							

PARAMETER INFORMATION

0-n	MODE SENSE PAGE HEADERS AND THEIR PARAMETERS (See Table 14.2.1-22)

See following page for notes.

14.2.1.10   continued

Notes for Table 14.2.1-21 Mode Sense Data (continued)

[1] The Sense Data Length specifies the length in bytes of the following Mode Sense data that is available to be transferred during the Data In phase. The Sense Data Length does not include itself.

[2] WREN V HH supports only 00H (default medium) in the Medium Type field.

[3] A Write Protect (WP) bit of zero indicates the medium is write enabled. A WP bit of one indicates the medium is write protected. The WREN V HH will always return a zero in this bit.

[4] The Block Descriptor Length specifies the length in bytes of the Block Descriptor. It is equal to the number of bytes in the Block Descriptor (8) and does not include the page headers and mode parameters, if any. WREN V HH will send one Block Descriptor.

     Each Block Descriptor specifies the medium characteristics for all or part of a logical unit. Each Block Descriptor contains a Density Code, a Number of Blocks, and a Block Length.

[5] WREN V HH supports only 00H (default density) in the Density Code field.

[6] The Number of Blocks field specifies the number of logical blocks of the medium that meets the Density Code and Block Length in the Block Descriptor. A Number of Blocks of zero indicates that all of the remaining logical blocks of the logical unit have the medium characteristics specified by the Block Descriptor. The WREN V HH will always return zeros in the Number of Blocks field.

[7] The Block Length, as defined after a format function, specifies the length in bytes of each logical block described by the Block Descriptor. Default is 512 if no Mode Select command is received before the Format command. Valid values are 256 through 4096.

14.2.1.10   continued

Mode Sense Page Descriptor Header

TABLE 14.2.1-22.   MODE SENSE PAGE DESCRIPTOR HEADER

BIT BYTE(S)	7	6	5	4	3	2	1	0	
0	PS 0 or 1	0	PAGE CODE						[1]
1	PAGE LENGTH								[1]
2-n	MODE PARAMETERS								[1]

[1]

PAGE CODE	PAGE DESCRIPTION	REFERENCE TABLE
01	Error Recovery	14.2.1-23
02	Disconnect/Reconnect Control	14.2.1-24
03	Format Parameters	14.2.1-25
04	Rigid Disk Drive Geometry	14.2.1-26
38	Cache Control Parameters	14.2.1-27

Each page of mode parameters (for the Mode Sense command) begins with a two byte Page Descriptor Header. The Page Code identifies which page of mode parameters is being transferred. The Page Length indicates the number of additional bytes of mode parameters being sent by the WREN V HH. Multiple pages of mode parameters may be transferred in one Mode Sense Data In phase (using Page Code 3FH).

The Parameters Savable (PS) bit, when set to one, indicates if the page contains savable parameters. When the PS bit is set to zero, none of the parameters within the page are savable. Since the parameters within pages 3 and 4 will always be saved during Format commands (but not via a Mode Select command with the SMP bit set to 1), these pages will return a one for the PS bit.

Error Recovery Page

WREN V HH Error Recovery Page implementation is defined in Table 14.2.1-23. This table summarizes: the function, the default value, and changeability status for each byte/bit.

14.2.1.10   continued

TABLE 14.2.1-23.   ERROR RECOVERY PAGE

PAGE DESCRIPTOR HEADER

BIT BYTE(S)	7	6	5	4	3	2	1	0	
0	PS 1[1]	0	0	0	0	0	0	1	PAGE CODE (1 Decimal)
1	0	0	0	0	0	1	1	0	PAGE LENGTH (BYTES) - 6 Decimal

ERROR RECOVERY PARAMETERS

2	AWRE	ARRE	TB	RC	EEC	PER	DTE	DCR	
DEFAULT	0	0	0	0	0	0	0	0	[3]
CHANGE-ABLE [2]	1	1	1	1	1	1	1	1	
3					RETRY COUNT				
DEFAULT	0	0	0	1	1	0	1	1	27 Decimal
CHANGE-ABLE [2]	1	1	1	1	1	1	1	1	[4]
4					CORRECTION SPAN (bits)- 11 Decimal				
DEFAULT	0	0	0	0	1	0	1	1	[5]
CHANGE-ABLE [2]	0	0	0	0	0	0	0	0	
5					HEAD OFFSET COUNT				
DEFAULT	0	0	0	0	0	0	0	0	[6]
CHANGE-ABLE [2]	0	0	0	0	0	0	0	0	
6					DATA STROBE OFFSET COUNT				
DEFAULT	0	0	0	0	0	0	0	0	[7]
CHANGE-ABLE [2]	0	0	0	0	0	0	0	0	
7					RECOVERY TIME LIMIT				
DEFAULT	1	1	1	1	1	1	1	1	[8]
CHANGE-ABLE [2]	0	0	0	0	0	0	0	0	

See following pages for notes.

14.2.1.10   continued

Notes for Table 14.2.1-23. Error Recovery Page

[1] The returned PS (Parameter Savable) bit of 1 indicates that page 01H parameter data is savable.

[2] A value of zero means this bit function is not directly changeable by an initiator, a value of 1 means the bit function is directly changeable by an initiator. (See Mode Select Command)

[3] The Automatic Write Reallocation of defective data blocks Enabled (AWRE) bit, when set to one, allows the WREN V HH to automatically relocate bad blocks detected during write operations. This function doesn't apply to the Format Unit command. When set to zero, the WREN V HH shall not perform automatic reallocation but shall create Check Condition status with Sense Key of Medium Error instead.

The Automatic Read Reallocation of defective data blocks Enabled (ARRE) bit, when set to one, allows the WREN V HH to automatically relocate bad blocks detected during read operations. When set to zero, the WREN V HH shall not perform automatic reallocation but shall create Check Condition status with Sense Key of Medium Error instead.

The Transfer Block (TB) bit, when set to one, indicates the failing data block shall be transferred to the initiator. When set to zero, the failing data block shall not be transferred.

The Read Continuous (RC) bit, when set to one, requests the WREN V HH to transfer the requested data length without adding delays (for retries or ECC correction) which may be required to ensure data integrity. The WREN V HH may send erroneous data in order to maintain the continuous flow of data. This bit shall override the DTE bit if it is set. When set to zero, recovery actions during data transfer are allowed.

The Enable Early Correction (EEC) bit, when set to one, allows the WREN V HH to apply ECC correction as soon as possible, before the retry count is exhausted. Seek error retries are not affected by this bit. When this bit is set, the DCR bit must be zero. When the EEC bit is set to zero, the WREN V HH shall exhaust the retry count before applying ECC correction.

14.2.1.10   continued

Notes for Table 14.2.1-23.   Error Recovery Page (continued)

[3]   continued

The Post Error (PER) bit, when set to one, indicates the WREN V HH will report Check Condition status and appropriate Sense Key for any recovered errors encountered. Reporting of unrecoverable errors will have priority over reporting of recoverable errors. When set to zero, any errors recovered within the limits established by the other Error Recovery Flags will not be reported. Any unrecoverable errors will be reported.

The Disable Transfer on Error (DTE) bit is valid only when the PER bit is set to one. When the DTE bit is set to one, it indicates the WREN V HH will terminate data transfer even for recoverable errors. The setting of the TB bit determines whether the block in error will be transferred. When DTE is set to zero, data transfer will continue if recoverable errors are encountered. If the PER bit is one and the DTE bit is zero, recoverable errors will be reported after all data has been transferred.

The Disable Correction (DCR) bit, when set to one, indicates ECC correction shall not be applied to the data even if correction is possible. When set to zero, ECC correction shall be applied if correction is possible.

[4]   The Retry Count is the maximum number of times the WREN V HH will attempt it's read recovery algorithms. The Retry Count is changeable between 0 and 27 inclusive. A Retry Count of zero will inhibit retries from being performed. If the EEC bit is set then the number of retries specified by the Retry Count, up to a maximum of nine retries, will be performed before ECC is applied.

[5]   The Correction Span is the size of the largest read data error, in bits, on which ECC correction will be attempted. Errors longer than this span (11 decimal) are reported as unrecoverable.

14.2.1.10   continued

Notes for Table 14.2.1-23.   Error Recovery Page (continued)

[6]   The WREN V HH Head Offset Count is a default of zero
      and not changeable to signify that this feature is not
      programmable by the initiator. Head offsets will be
      performed as part of the WREN V HH drives retry
      algorithms.

[7]   The WREN V HH Data Strobe Offset Count is a default of
      zero and not changeable to signify that this feature
      is not programmable by the initiator. Data Strobe
      Offsets will be performed as part of the WREN V HH
      drive's retry algorithms.

[8]   A Hex FF indicates that the Recovery Time Limit is
      unlimited.

Disconnect/Reconnect Control Page

The WREN V HH Disconnect/Reconnect Page implementation is
defined in Table 14.2.1-24. This table summarizes the
function and defines the default value and changeable
status.

TABLE 14.2.1-24. DISCONNECT/RECONNECT CONTROL PAGE

PAGE DESCRIPTOR HEADER

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	PS 1 [1]	0	PAGE CODE 0	0	0	0	1	0
1	PAGE LENGTH (10 Decimal) 0	0	0	0	1	0	1	0

DISCONNECT/RECONNECT CONTROL PARAMETERS

BYTE(S)	7	6	5	4	3	2	1	0
2	BUFFER FULL RATIO							
DEFAULT	0	0	0	0	0	1	0	0
CHANGEABLE[2]	1	1	1	1	1	1	1	1
3	BUFFER EMPTY RATIO							
DEFAULT	0	0	0	0	0	1	0	0
CHANGEABLE[2]	1	1	1	1	1	1	1	1
4	BUS INACTIVITY LIMIT (MSB)							
DEFAULT	0	0	0	0	0	0	0	0
CHANGEABLE[2]	0	0	0	0	0	0	0	0
5	BUS INACTIVITY LIMIT (LSB) (10 Decimal)							
DEFAULT	0	0	0	0	1	0	1	0 [3]
CHANGEABLE[2]	0	0	0	0	0	0	0	0
6,7	DISCONNECT TIME UNIT							
DEFAULT			0 0 0 0 H					
CHANGEABLE[2]			0 0 0 0 H					
8,9	CONNECT TIME LIMIT							
DEFAULT			0 0 0 0 H					
CHANGEABLE[2]			0 0 0 0 H					
10,11	RESERVED							
DEFAULT 2			0 0 0 0 H					
CHANGEABLE[2]			0 0 0 0 H					

[1]   The PS (Parameter Savable) bit of 1 indicates that the page 02H parameter data is savable.

[2]   A changeable value of zero means this function is not directly changeable by an initiator. A value of 1 means the bit function is directly changeable by an initiator. (See Mode Select command.)

[3]   1 millisecond

14.2.1.10   continued

Both the ratio parameters are the numerator of a fractional multiplier that has 256 as it's denominator.

The Buffer Full Ratio indicates, on Read commands, how full the WREN V HH drive's buffer shall be before reconnecting. The WREN V HH will round up to the nearest whole logical block. This value is changeable by an initiator.

The Buffer Empty Ratio indicates, on Write commands, how empty the WREN V HH drive's buffer shall be before reconnecting to fetch more data. The WREN V HH, rounds up to the nearest whole logical block. This value is changeable by an initiator.

The Bus Inactivity Limit field (bytes 4 & 5) indicates the time, in 100 microsecond increments, the WREN V HH is allowed to assert the Busy signal without handshakes until it shall disconnect. The WREN V HH may round down to it's nearest capable value. The value of ten indicates the WREN V HH is allowed to maintain the Busy signal for one millisecond without handshakes. This value is not changeable by the initiator.

The Disconnect Time Limit field (bytes 6 and 7) indicates the minimum time, in 100 microsecond increments, the WREN V HH shall remain disconnected until it shall attempt to reconnect. A value of zero indicates the WREN V HH is allowed to reconnect immediately. For WREN V HH, this is always zero and the changeable code is always zero.

The Connect Time Limit field (bytes 8 and 9) indicates the maximum time in 100 microsecond increments that the target should remain connected until it attempts to disconnect. The target may round to it's nearest capable value. A setting of zero indicates that the WREN V HH is allowed to remain connected indefinitely until it attempts disconnection.

Format Parameters Page

The WREN V HH Format Parameters Page implementation is defined in Table 14.2.1-25. This table summarizes the function and defines the default or changeability status for each bit.

14.2.1.10 continued

TABLE 14.2.1-25. FORMAT PARAMETER PAGE

PAGE DESCRIPTOR HEADER

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	PS[1]			PAGE	CODE	(3 Decimal)		
	1	0	0	0	0	0	1	1
1				PAGE LENGTH	(22 Decimal)			
	0	0	0	1	0	1	1	0

FORMAT PARAMETERS [1]

2,3	TRACKS PER ZONE (MSB)
DEFAULT	0 0 0 1 (HEX) [2]
CHANGEABLE	0 0 0 0 (HEX)
4,5	ALTERNATE SECTORS PER ZONE
DEFAULT	0 0 0 1 (HEX) [3]
CHANGEABLE	F F F F (HEX)
6,7	ALTERNATE TRACKS PER ZONE
DEFAULT	0 0 0 0 (HEX) [4]
CHANGEABLE	0 0 0 0 (HEX)
8,9	ALTERNATE TRACKS PER VOLUME
DEFAULT	0 0 X X (HEX) [5]
CHANGEABLE	F F F F (HEX)
10,11	SECTORS PER TRACK
DEFAULT	0 0 X X (HEX) [6]
CHANGEABLE	0 0 0 0 (HEX)
12,13	DATA BYTES PER PHYSICAL SECTOR
DEFAULT	0 2 0 0 (HEX) [7]
CHANGEABLE	0 0 0 0 (HEX)
14,15	INTERLEAVE
DEFAULT	0 0 0 1 (HEX) [8]
CHANGEABLE	0 0 0 0 (HEX)
16,17	TRACK SKEW FACTOR
DEFAULT	0 0 X X (HEX) [9]
CHANGEABLE	0 0 0 0 (HEX)
18,19	CYLINDER SKEW FACTOR
DEFAULT	0 0 X X (HEX) [10]
CHANGEABLE	0 0 0 0 (HEX)

20	DRIVE TYPE FIELD							
DEFAULT	1	0	0	0	0	0	0	0 [11]
	SSEC	HSEC	RMB	SURF	INS		RESERVED	
CHANGEABLE	0	0	0	0	1	0	0	0

21,22,23 DEFAULT	RESERVED 000000 (HEX)
CHANGEABLE	000000 (HEX)

14.2.1.10 continued

Notes for Table 14.2.1-25. Format Parameter Page (continued)

[1]   This page of parameters may be sent only immediately before sending a Format Unit command to the WREN V HH. The Current parameters for this page will be updated immediately but any changes between these Current parameters and the existing media format will not be in effect until after the Format Unit command is completed.

[2]   The Tracks per Zone field indicates the number of tracks the WREN V HH will allocate to each defect management zone. Spare sectors or tracks will be placed at the end of each defect management zone. A value of zero indicates the entire unit will be taken as one defect management zone. The WREN V HH value of one indicates spare sectors may be placed at the end of a track.

[3]   The Alternate Sectors per Zone field indicates the number of spare sectors to be reserved at the end of each defect management zone. A value of zero indicates that no sectors are to be reserved in each zone for defect management. This is to accommodate hosts that want to manage the defects themselves. The WREN V HH defaults to one spare sector per zone (track) but may be changed by the initiator to any value between 0 and 3.

[4]   The Alternate Tracks per Zone field indicates the number of spare tracks to be reserved at the end of each defect management zone. A value of zero indicates that no spare tracks are to be reserved in each zone for defect management by the WREN V HH.

[5]   The Alternate Tracks per Volume field indicates the number of spare tracks to be reserved at the end of the logical unit. The WREN V HH will use these locations for replacing sectors. A value of zero indicates that no spare tracks are to be reserved at the end of the unit for defect management. The WREN V HH defaults to two times the number of read/write heads in the drive. The initiator may change this value for any number between 0 and 256. This number must be a multiple of the number of Data Read/Write heads installed.

14.2.1.10 continued

Notes for Table 14.2.1-25. Format Parameter Page (continued)

[6]   The Sectors per Track field indicates the number of physical sectors the WREN V HH shall allocate per disk track. A value of zero indicates the number of sectors per track may be variable or the WREN V HH is to determine the best value. The WREN V HH will report the average number of physical sectors per track since the number of sectors per track varies between the outer and inner tracks. This field will not be verified on a Mode Select command.

[7]   The Bytes per Physical Sector field indicates the number of data bytes the WREN V HH shall allocate per physical sector. This value will equal the block length reported in the block descriptor. The bytes per physical sector is not directly changeable by the initiator and will not be verified on a Mode Select command.

[8]   The Interleave field is the interleave value sent to the WREN V HH during the last Format Unit command. This field is valid only for Mode Sense commands. The WREN V HH shall ignore this field during Mode Select commands. WREN V HH interleave will always be 1:1.

[9]   The Track Skew Factor field indicates that number of physical sectors between the last logical block on one track and the first logical block on the next sequential track of the same cylinder. A value of zero indicates no skew. The Default Value is (TBD) for 512 byte sectors. This value is not changeable by an initiator.

[10]   The Cylinder Skew Factor field indicates the number of physical sectors between the last logical block of one cylinder and the first logical block of the next cylinder. A value of zero indicates no skew. The Default Value is (TBD) for 512 byte sectors. Cylinder skew will be utilized by a WREN V HH but is not changeable by an initiator.

14.2.1.10 continued

Notes for Table 14.2.1-25. Format Parameter Page (continued)

[11]   The Drive Type field bits are defined as follows:

The Soft Sectoring (SSEC) bit (bit 7) is set to one indicating the WREN V HH shall use soft sector formatting.

The Inhibit Save (INS) bit (bit 3), when set to one, indicates the WREN V HH shall inhibit the saving of any parameters other than those contained in pages 3 or 4 during the next Format command. The preexisting values of any savable parameters will be maintained. When INS is set to zero, any savable parameters shall be updated to their Current values and saved during the next Format command. The default value is zero, but the changeable bit is one, indicating it may be changed.

The following bits are not implemented by WREN V HH and are always zero and changeable bits are likewise zero.

The Hard Sectoring (HSEC) bit, when set to one, indicates that the target shall use hard sector formatting. The SSEC and HSEC bits cannot both be set to one in Mode Select commands.

The Removable Media (RMB) bit, when set to one, indicates that the logical unit contains removable media. This same bit is also returned in the Inquiry parameters (see Section 14.1.1.3).

The Surface Map (SURF) bit, when set to one, indicates that the target shall allocate successive logical blocks to all sectors on a surface before allocating logical blocks to the next surface. When SURF is set to zero, the target shall allocate successive logical blocks to all sectors within a cylinder before allocating logical blocks to the next cylinder.

14.2.1.10 continued

Rigid Disk Drive Geometry Parameters

The WREN V HH Rigid Disk Drive Geometry Parameters Page implementation is defined in Table 14.2.1-26. This table summarizes the function and defines the default value. An initiator may not change the default values, thus the changeable status is always zero for all bytes/bits in this page.

TABLE 14.2.1-26. RIGID DISK DRIVE GEOMETRY PARAMETERS

PAGE DESCRIPTOR HEADER

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	PS[1] 1	0	0	0	PAGE CODE (4 Decimal) 0	1	0	0
1	0	0	0	1	PAGE LENGTH (18 Decimal) 0	0	1	0

RIGID DISK DRIVE GEOMETRY PARAMETERS

BIT BYTE(S)	7	6	5	4	3	2	1	0	
2	NUMBER OF CYLINDERS (MSB)								
	0	0	0	0	0	0	0	0	[2]
3	NUMBER OF CYLINDERS								
	0	0	0	0	0	1	1	0	[2]
4	NUMBER OF CYLINDERS (LSB)								
	0	0	0	0	1	0	1	0	[2]
5	NUMBER OF HEADS [3]								
6,7,8	STARTING CYLINDER - WRITE PRECOMP								
	0	0	0	0	0	0	0	0	[4]
9,10,11	STARTING CYLINDER-REDUCED WRITE CURRENT								
	0	0	0	0	0	0	0	0	[4]
12,13	DRIVE STEP RATE								
	0	0	0	0	0	0	0	0	[4]
14,15,16	LOADING ZONE CYLINDER								
	0	0	0	0	0	0	0	0	[4]
17,18,19	RESERVED								
	0	0	0	0	0	0	0	0	[4]

[1]   The reserved PS bit of 1 indicates that page 04 parameter data is savable and will be saved when a Format Function is performed.

[2]   1546 user accessible cylinders maximum with no spare cylinders (tracks) set aside for flaw reallocation (190 MB Model).

[3]   Either 3 or 5 depending on model number.

[4]   Not applicable.

The following page of parameters may be sent via a Mode Select command only immediately before sending a Format Unit command to the WREN V HH and must equal the values reported by the Mode Sense command.

14.2.1.10   continued

The Number of Cylinders field indicates the maximum number of user available cylinders for the WREN V HH. The WREN V HH will use some of the additional cylinders available for storing WREN V HH parameters, defect lists, or diagnostic purposes.

The number of Heads field indicates the maximum number of data (read/write) heads on the WREN V HH drive.

TABLE 14.2.1-27. CACHE CONTROL PARAMETERS

BIT BYTE(S)	7	6	5	4	3	2	1	0	
0	PS 1[1]	0	Page Code (38 decimal)						
			1	1	1	0	0	0	
1	PAGE LENGTH (bytes) - (14 decimal)								
	0	0	0	0	1	1	1	0	
CACHE CONTROL PARAMETERS									
2 DEFAULT	RSVD 0	WIE 0	RSVD 0	CE 0	CACHE TABLE SIZE [3]				
					0	0	0	1	
CHANGE- ABLE[2]	0	0	0	1	0	0	0	0	
3 DEFAULT	PREFETCH THRESHOLD [4]								
	1	1	1	1	1	1	1	1	
CHANGE- ABLE	0	0	0	0	0	0	0	0	
4 DEFAULT	MAXIMUM PREFETCH [5]								
	0	0	1	1	0	1	0	0	
CHANGE- ABLE	0	0	0	0	0	0	0	0	
5 DEFAULT	MAXIMUM PREFETCH MULTIPLIER [5]								
	0	0	0	0	0	0	0	0	
CHANGE- ABLE	0	0	0	0	0	0	0	0	
6 DEFAULT	MINIMUM PREFETCH [6]								
	0	0	0	0	0	0	0	0	
CHANGE- ABLE	0	0	0	0	0	0	0	0	
7 DEFAULT	MINIMUM PREFETCH MULTIPLIER [6]								
	0	0	0	0	0	0	0	0	
CHANGE- ABLE	0	0	0	0	0	0	0	0	
8-15	RESERVED								
	0	0	0	0	0	0	0	0	

14.2.1.10 continued

Notes for Table 14.2.1-27 Cache Control Parameters

[1]   The PS (Parameter Savable) bit of 1 indicates that
         the page 38 parameter data is savable.

[2]   A changeable value of zero means this function is
         not directly changeable by an initiator. A value
         of 1 means the bit function is directly changeable
         by an initiator. (See Mode Select command.)

[3]   Cache Enable bit 4 of one indicates that the WREN
         drive will use a read look ahead algorithem on all
         data reads. On subsequent reads, if the data is
         already residing in the WREN data buffer, the data
         transfer commences with no latency times. If bit 4
         is zero it indicates read look ahead will not be
         used.

         Write Index Enable bit 6 controls the creation of
         Cache data on Write commands. If bit 6 is a one
         the Write data will be treated as Cache Read data
         on the next command. If bit 6 is zero the next
         command treats the cache area as empty of data.

         Cache table size bits 3 thru 0 indicate the number
         of cache segments to maintain in buffer ram.

[4]   Prefetch Threshold byte 3 indicates the maximum
         value of the transfer length byte of the Read
         command for which a prefetch will be performed.

[5]   The product of the Maximum Prefetch Multiplier,
         byte 5, and the Read command transfer length is
         added to the value of the Maximum Prefetch, byte
         4, to indicate the maximum number of blocks to
         prefetch when a Read command is issued and the
         blocks are not already cached.

[6]   The product of the Minimum Prefetch Multiplier,
         byte 7, and Read command transfer length is added
         to the value of the Minimum Prefetch, byte 6, to
         indicate the minimum number of blocks to prefetch
         when a Read command is issued and the blocks are
         not already cached.

14.2.1.11 Start Unit Command (1BH)

TABLE 14.2.1-28. START UNIT COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	1	1
1	LOGICAL UNIT NO. 0	0	0	0	0	0	0	IMMED
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	START 1
5	0	0	0	0	0	0	FLAG 0	LINK 0

The Start Unit command requests that the target enable the
logical unit for further operations.

An Immed bit of zero indicates that status shall be
returned after the operation is completed. If the Immed
bit is a one status will be returned as soon as the
operation is initiated.

The Start bit must be a one. This requests that the
logical unit be made ready for use. If the Start bit is
zero (requesting that the unit be stopped), the command
will be rejected as an illegal request.

14.2.1.11 continued

This command is applicable only if the Motor Start Option
jumper is installed. See Figures 10.3-2 and 11.1-1. If
this jumper is installed, the drive will only respond to
the Start Unit, Inquiry and Request Sense commands. If
the jumper is not installed the WREN V HH will respond to
communications on the interface while the drive is coming
up to speed.

For systems which support disconnection, WREN V HH will
disconnect when a Start Unit procedure is commanded, and
will reconnect when the unit is up to speed and Ready.

14.2.1.12 Prevent/Allow Medium Removal Command (1EH)

Not implemented by WREN IV. If received, WREN V HH will
terminate with Check Condition status and set an Illegal
Request Sense Key.

14.2.2 GROUP 1 COMMAND FOR DIRECT ACCESS DEVICES

The Group 1 commands implemented by the WREN V HH are
listed in Table 14.2.1-29.

TABLE 14.2.1-29. GROUP 1 COMMANDS FOR DIRECT ACCESS DEVICES

OPERATION CODE (HEX)	COMMAND NAME	SECTION
25	READ CAPACITY	14.2.2.1
28	READ EXTENDED	14.2.2.2
2A	WRITE EXTENDED	14.2.2.3
2B	SEEK EXTENDED	14.2.2.4
2F	VERIFY	14.2.2.6
37	READ DEFECT DATA	14.2.2.9
3B	WRITE DATA BUFFER	14.1.2.3
3C	READ DATA BUFFER	14.1.2.4

14.2.2.1 Read Capacity Command (25H)

TABLE 14.2.2-1.   READ CAPACITY COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	0	0	1	0	1
1	LOGICAL UNIT NO.							
	0	0	0	0	0	0	0	0
2	LOGICAL BLOCK ADDRESS (MSB)							
3	LOGICAL BLOCK ADDRESS							
4	LOGICAL BLOCK ADDRESS							
5	LOGICAL BLOCK ADDRESS (LSB)							
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	PMI
9	0	0	0	0	0	0	FLAG 0	LINK 0

The Read Capacity command (Table 14.2.2-1) provides a means for the initiator to request information regarding the capacity of the WREN V HH.

A Partial Medium Indicator (PMI) bit of zero indicates the information returned in the Read Capacity data shall be the Logical Block Address and Block Length (in bytes) of the last logical block of the logical unit. The Logical Block Address in the Command Descriptor Block shall be set to zero for this option.

A PMI bit of one indicates the information returned shall be the Logical Block Address and Block Length (in bytes) of the last Logical Block Address after which a substantial delay (defined as approximately 1 millisecond for the WREN V HH) in data transfer will be encountered. This Logical Block Address shall be greater than or equal to the Logical Block Address specified in the Command Descriptor Block. This reported Logical Block Address will be a cylinder boundary.

14.2.2.1 continued

The returned 8 bytes of Read Capacity Data are listed in Table 14.2.2-2.

TABLE 14.2.2-2. READ CAPACITY DATA

BYTE	DESCRIPTION
0	LOGICAL BLOCK ADDRESS (MSB)
1	LOGICAL BLOCK ADDRESS
2	LOGICAL BLOCK ADDRESS
3	LOGICAL BLOCK ADDRESS (LSB)
4	BLOCK LENGTH (MSB)
5	BLOCK LENGTH
6	BLOCK LENGTH
7	BLOCK LENGTH (LSB)

14.2.2.2 Read Extended Command (28H)

TABLE 14.2.2-3. READ EXTENDED COMMAND

BIT / BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0	0
1	LOGICAL UNIT NO. 0	0	0	0	0	0	0	REL ADR 0
2	LOGICAL BLOCK ADDRESS (MSB)							
3	LOGICAL BLOCK ADDRESS							
4	LOGICAL BLOCK ADDRESS							
5	LOGICAL BLOCK ADDRESS (LSB)							
6	0	0	0	0	0	0	0	0
7	TRANSFER LENGTH (MSB)							
8	TRANSFER LENGTH (LSB)							
9	0	0	0	0	0	0	FLAG 0	LINK 0

The Read Command requests that the target transfer data to the initiator.

14.2.2.2 continued

    The Logical Block Address specifies the logical block at which the read operation shall begin.

    The Transfer Length specifies the number of contiguous logical blocks of data that shall be transferred. A Transfer Length of zero indicates that no logical blocks shall be transferred (an Implied Seek is still performed). This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be transferred.

    The data value most recently written in the addressed logical block shall be returned.

    This command is implemented with the WREN V HH specific parameters listed in Table 14.2.2-3.

    In the CDB the LUN must be zero and the Flag and Link bits must be zero. Relative Addressing is not implemented and the relative address (REL ADR) bit must zero.

    This command operates the same as the Read command (see Section 14.2.1.4) except that in the CDB for this command a four byte Logical Block Address and a two byte Transfer Length may be specified.

    This command shall be terminated with a Reservation Conflict status if any reservation access conflict (see Section 14.2.1.8) exists, and no data shall be read.

14.2.2.2   continued

If any of the following conditions occur, this command
shall return a Check Condition status and the Sense Key
shall be set as indicated in enumeration of all
conditions which may cause the Check Condition status.

CONDITION	SENSE KEY
Invalid Logical Block Address	Illegal Request (see note)
Target reset since last command from this initiator	Unit Attention
Unrecovered read error	Medium Error
Recoverable read error	Recovered Error
Overrun or other error that might be resolved by repeating the command	Aborted Command

NOTE: The extended sense information bytes shall be set
to the Logical Block Address of the first invalid address.

14.2.2.3   Write Extended Command (2AH)

TABLE 14.2.2-4. WRITE EXTENDED COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	1	0
1	LOGICAL UNIT NO.						REL ADR	
	0	0	0	0	0	0	0	0
2	LOGICAL BLOCK ADDRESS (MSB)							
3	LOGICAL BLOCK ADDRESS							
4	LOGICAL BLOCK ADDRESS							
5	LOGICAL BLOCK ADDRESS (LSB)							
6	0	0	0	0	0	0	0	0
7	TRANSFER LENGTH (MSB)							
8	TRANSFER LENGTH (LSB)							
9	0	0	0	0	0	0	FLAG	LINK
							0	0

14.2.2.3   continued

The Write command requests that the WREN V HH write to
the medium the data transferred by the initiator.

The Logical Block Address specifies the logical block at
which the write operation shall begin.

The Transfer Length specifies the number of contiguous
logical blocks of data that shall be transferred. A
Transfer Length of zero indicates no logical blocks shall
be transferred (an Implied Seek is still performed). This
condition shall not be considered an error and no data
shall be written. Any other value indicate the number of
logical blocks that shall be transferred.

This command is implemented with the WREN V HH specific
parameters listed in Table 14.2.2-4.

In the CDB, the LUN must be zero and the Flag and Link
bits must be zero. The Relative Address (REL ADR) bit
must be zero.

This command operates the same as the Write command
(Section 14.2.1.5) except that in the CDB for this
command a four byte Logical Block Address and a two byte
Transfer Length may be specified.

This command shall be terminated with a Reservation
Conflict status if any reservation access conflict (see
Section 14.1.8) exists, and no data shall be written.

If any of the following conditions occur, this command
shall be terminated with a Check Condition status and the
Sense Key shall be set as indicated in the following
table. This table does not provide an exhaustive
enumeration of all conditions which may cause the Check
Condition status.

CONDITION	SENSE KEY
Invalid Logical Block Address	Illegal Request (see note)
Target reset since the last command from this initiator	Unit Attention
Overrun or other error that might be resolved by repeating the command	Aborted Command

NOTE: The extended sense information bytes shall be set
to the Logical Block Address of the first invalid
address. In this case, no data shall be written on the
logical unit.

14.2.2.4   Seek Extended Command (2BH)

TABLE 14.2.2-5a. SEEK EXTENDED COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	1	1
1	LOGICAL UNIT NO. 0	0	0	0	0	0	0	0
2	LOGICAL BLOCK ADDRESS (MSB)							
3	LOGICAL BLOCK ADDRESS							
4	LOGICAL BLOCK ADDRESS							
5	LOGICAL BLOCK ADDRESS (LSB)							
6	0	0	0	0	0	0	0	0
7	0	0	0		0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	FLAG 0	LINK 0

The Seek Extended command requests that the WREN V HH seek to
the specified Logical Block Address.

This command is implemented with the WREN V HH specific
parameters listed in Table 14.2.2-5

In the CDB, the LUN must be zero and the Flag and Link bits
must be zero. This command operates the same as the Seek
command (Section 14.2.1.6) except that a four byte Logical
Block Address is specified.

14.2.2.5   Write and Verify Command (2EH)

TABLE 14.2.2-5b. SEEK EXTENDED COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	0	1	1	1	0
1	LOGICAL UNIT NO. 0	0	0	0	0	0	BYT CHECK	0
2	LOGICAL BLOCK ADDRESS (MSB)							
3	LOGICAL BLOCK ADDRESS							
4	LOGICAL BLOCK ADDRESS							
5	LOGICAL BLOCK ADDRESS (LSB)							
6	0	0	0	0	0	0	0	0
7	TRANSFER LENGTH (MSB)							
8	TRANSFER LENGTH (LSB)							
9	0	0	0	0	0	0	FLAG 0	LINK 0

The WRITE AND VERIFY command requests that the target write the data transferred from the initiator to the medium and then verify that the data is correctly written.

A byte check (BYtChk) bit of zero causes the verification to be simply a medium verification (ECC). A BytChk bit of one causes a byte-by-byte compare of data written on the peripheral device and the data transferred from the initiator. If the compare is unsuccessful, the command shall be terminated with a CHECK CONDITION status and the sense key shall be set to MISCOMPARE.

The logical block address specifies the logical block at which the write operation shall begin.

The transfer length specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered as an error and no data shall be written. Any other value indicates the number of logical blocks that shall be transferred.

In the CDB, the LUN must be zero and the flag and Link bits must be zero.

For Systems which support disconnection, the WREN V HH will disconnect during the execution of this command.

14.2.2.6   Verify Command (2FH)

TABLE 14.2.2-6. VERIFY COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	0	1	1	1	1
1	LOGICAL UNIT NO. 0	0	0	0	0	0	BYT CHK	0
2	LOGICAL BLOCK ADDRESS (MSB)							
3	LOGICAL BLOCK ADDRESS							
4	LOGICAL BLOCK ADDRESS							
5	LOGICAL BLOCK ADDRESS (LSB)							
6	0	0	0	0	0	0	0	0
7	TRANSFER LENGTH (MSB)							
8	TRANSFER LENGTH (LSB)							
9	0	0	0	0	0	0	FLAG 0	LINK 0

14.2.2.6   continued

The Verify command requests that the target verify the data written on the medium.

A Byte Check (ByteChk) bit of zero causes the verification to be simply a medium verification (CRC, ECC, etc). A ByteChk bit of one causes a byte by byte compare of data on the medium and the data transferred from the initiator. If the compare is unsuccessful, the command shall be terminated with a Check Condition status and the Sense Key shall be set to Miscompare.

The Logical Block Address specifies the logical block at which the verify operation shall begin.

The Verification Length specifies the number of contiguous logical blocks of data that shall be verified. A Verification Length of zero indicates that no logical blocks shall be verified (an Implied Seek is still performed). This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be verified.

This command is implemented with the WREN V HH specific parameters listed in Table 14.2.2-6.

The drive will disconnect while this command is being executed if the initiator supports disconnect/reconnect.

14.2.2.7   Search Data Commands (30H, 31H, or 32H)

Not implemented. If received, will be treated as an Illegal Request.

14.2.2.8   Set Limits Command (33H)

Not implemented. If received, will be treated as an Illegal Request.

14.2.2.9   Read Defect Data Command (37H)

TABLE 14.2.2-7a.   READ DEFECT DATA COMMAND

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	0	0	1	1	0	1	1	1
1	LOGICAL UNIT NO. 0	0	0	0	0	0	0	0
2	0	0	0	P	G [1]	DEFECT LIST FORMAT 1 or 1	0 0	0[2] 1
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	ALLOCATION LENGTH (MSB)							
8	ALLOCATION LENGTH (LSB)							
9	0	0	0	0	0	0	FLAG 0	LINK 0

[1], [2] . See following page for notes.

14.2.2.9   continued

Notes for Table 14.2.2-7a. Read Defect Data Command

[1]   The WREN V HH interprets the P and G bits (bits 4
        and 3 of byte 2 of the CDB) as follows:

BIT P   BIT G
  0   0   (1)   Return Defect List header only
  0   1   (2)   Return the growth "G" list only.
  1   0   (3)   Return the manufacturers original ETF
                       list only.
  1   1   (4)   Return all lists.

(1) If the P, G bits were 0,0 and the Defect List
    length will reflect the length of the 1,1 list and
    no Defect Descriptor Bytes will be sent to the
    initiator.

(2) This list will reflect the grown or "G" list as
    defined in Section 14.2.1.2.

(3) This list reflects the manufacturers original ETF
    list. These defects may or may not have been
    reallocated, depending on the last Format command
    received (the last format may or may not have
    requested the P list flaws be reallocated during
    the format function).

(4) The returned list will contain all of the drive's
    defect lists (i.e. P, G, C & D) regardless of
    whether these lists have been reallocated by the
    drive.

[2]   The Defect List format field indicates the defect
        data format preferred by the initiator. The
        meaning is the same as the Defect List Format
        field in the Format command (indicated in Table
        14.2.1-3)

        The Defect List format bits (bits 2, 1, 0 in the
        CDB) should be; 1 0 0, respectively, to signify
        a defect list in the Bytes from Index format, or,
        1 0 1, respectively to signify a defect list in
        the Physical Sector format. If neither of these
        two, the WREN V HH will respond with the defect
        list in the drives default format (physical
        sector) and create the check condition status with
        Recovered Error Sense Key at the end of the Read
        Defect Data data transfer.

14.2.2.9 continued

The Read Defect Data command requests that the target transfers the medium defect data to the initiator.

This command is implemented with the WREN V HH specific parameters listed in Table 14.2.2-7a.

Allocation Length specifies the number of bytes the initiator has allocated for the returned defect data. An Allocation Length of zero indicates that no Read Defect Data shall be transferred. Any other value indicates the maximum number of bytes to be transferred. The WREN V HH shall terminate the Data In phase when the Allocation Length bytes have been transferred or when all available defect data has been transferred to the initiator, whichever is less.

In the CDB the LUN must be zero and the Flag and Link bits must be zero.

This command is intended to be used only with the Format Unit command (Section 14.2.1.2). The initiator should not interpret or act upon this list except to resend this list as defect data in a Format Unit command.

The Defect Data returned is listed in Table 14.2.2-7b.

The first 4 bytes returned are the Defect List Header. The P bit, G bit, and Defect List Format fields indicate the defect format actually returned by the WREN V HH. The definitions are the same as for byte 2 of the Read Defect Data Command Descriptor Block (Table 14.2.2-7a).

The Defect List Length specifies the total length in bytes of all the defect descriptors available from the WREN V HH. If the Allocation Length of the CDB is too small to transfer all of the defect descriptors, the Defect List Length is not adjusted to reflect the truncation. The Defect Descriptors do not have to be in ascending order.

14.2.2.9 continued

TABLE 14.2.2-7b. DEFECT LIST HEADER DESCRIPTION

BIT BYTE(S)	7	6	5	4	3	2	1	0
0	RESERVED							
	0	0	0	0	0	0	0	0
1	RESERVED			P	G	DEFECT LIST FORMAT		
	0	0	0	----------		1	0	0 [2]
				[1]		or 1	0	1
2	DEFECT LIST LENGTH (MSB)				(VALUE IS 8 TIMES THE NUMBER			
3	DEFECT LIST LENGTH (LSB)				OF DEFECTIVE SECTORS)			[3]
4-n	DEFECT DESCRIPTOR BYTES [3]							
	DRIVE RETURNS DEFECTIVE SECTOR ADDRESS							

[1]   Either 00, 01, 10, or 11 as previously defined in [1] of
        Table 14.2.2-7a.

[2]   100 defines a list in the Bytes from Index format.
        101 defines a list in the Physical Sector format.

[3]   If the P, G bits were 0,0 the Defect List length will
        reflect the length of the 1,1 list and no Defect
        Descriptor Bytes will be sent to the initiator.

15.0   STATUS

A status byte shall be sent from the WREN V HH to the
initiator during the Status phase at the termination of
each command as specified in Table 15.0-1 and 15.0-2 unless
the command is cleared by an Abort message, by a Bus Device
Reset message, by a "hard" Reset condition, or by a
catastrophic reset condition.

TABLE 15.0-1. STATUS BYTE FORMAT

BIT BYTE	7	6	5	4	3	2	1	0
0	0	0	0	X	X	0	X	0

"X" will be 1 or 0 depending on command completion status.

The drive will return one of the completion status bytes
codes listed in Table 15.0-2.

TABLE 15.0-2. COMMAND COMPLETION STATUS

7	6	5	4	3	2	1	0	STATUS REPRESENTED
0	0	0	0	0	0	0	0	Good
0	0	0	0	0	0	1	0	Check Condition
0	0	0	0	1	0	0	0	Busy
0	0	0	1	1	0	0	0	Reservation Conflict

A description of the status byte codes is given below:

Good - Indicates the WREN V HH has successfully completed
execution of the command.

Check Condition - Any error, exception, or abnormal
condition that causes sense data to be set, shall cause a
Check Condition status. The Request Sense command should be
issued in response to a Check Condition status, to
determine the nature of the condition.

Busy - The WREN V HH is busy. This status shall be sent
whenever a WREN V HH is unable to accept a command from an
initiator. The normal initiator recovery action is to issue
the command again at a later time.

15.0   continued

Reservation Conflict - This status shall be returned whenever a SCSI device attempts to access a logical unit that is reserved for that type of access to another SCSI device.

16.0   ERROR RECOVERY PHILOSOPHY

The error recovery procedures for the WREN V HH vary in accordance with parameter values and the states of "flags" stored in error recovery parameter storage locations in WREN V HH control memory. The WREN V HH control firmware error recovery routines reference these parameters for decision making when an error recovery procedure is performed. These error recovery parameters are changeable by commands from the initiator. The parameters are flagged as being changeable and this information is given to the initiator when requested by a Mode Sense command. The error recovery parameters can be changed by a Mode Select command from the initiator. Table 16.0-1 lists the error recovery parameters. More details, on how these functions operate, are given in Sections 14.2.1.7 and 14.2.1.10.

TABLE 16.0-1. ERROR RECOVERY PARAMETERS

CHANGEABILITY
INDICATOR**

PARAMETER NAME		VALUE	DESCRIPTION OF PARAMETER
AWRE	1	1 or 0*	Automatic Write Reallocation Enable
ARRE	1	1 or 0*	Automatic Read Reallocation Enable
TB	1	1 or 0*	Transfer (failed data) Block
RC	1	1 or 0*	Read Continuous (no recovery actions)
EEC	1	1 or 0*	Enable ECC correction to occur early
PER	1	1 or 0*	Post Error (report to initiator)
DTE	1	1 or 0*	Disable data Transfer on Recovered Error
DCR	1	1 or 0*	Disable ECC application
Retry cnt Correction	1	0 - 27	Maximum times for read retry algorithm
Span	0	11	Largest error span for ECC use (bits)

*Default value is 0 which means disable.
**1 means is changeable, 0 means not changeable.

16.0   continued

In general, when a read error occurs, the WREN V HH will attempt to recover using retries, application of ECC and/or early application of ECC (if these are enabled). If the error still exists, the WREN V HH will report Check Condition in the status returned to the initiator. The initiator will likely command Request Sense and the WREN V HH will reply with a Data In phase with 18 bytes of Extended Sense Data which will contain information about the error. Sense Key codes used and their meanings are listed in Table 14.1.1-5. Error codes used and the errors they report are listed in Table 14.1.1-6. If the error is recovered, it will be reported only if the PER bit is set (Table 16.0-1). Error recovery procedures for several of the error conditions are defined in Sections 16.1 through 16.5.

16.1   SEEK ERRORS (09 or 15 HEX ERROR CODE)

If a seek error occurs, up to three retries will be attempted by positioning the heads to track zero and reissuing the seek. If all retries fail error code 09 or 15 will be reported in the Extended Sense Data.

16.2   DATA FIELD WRITE FAULT (03 HEX ERROR CODE)

If a write fault is detected while writing the data field the operation will be immediately suspended. If the internal write fault can be cleared, the drive will automatically perform a rewrite of the sector (up to 3 attempts will be made to clear the write fault and rewrite the sector).

If the write fault condition cannot be cleared the "Write Fault" error (03 Hex) will be reported in extended Sense Data.

16.3   SYNC BYTE ERROR (12 Hex Error Code)

If the sync byte cannot be recovered during a read, up to 27 retries will be attempted using the offset sequence shown in Figure 16.3-1.

No Servo Offset	Retry 3 times
Servo Offset Plus	Retry 3 times
Servo Offset Minus	Retry 3 times
No Servo Offset	Retry 3 times
Servo Offset Plus	Retry 3 times
Servo Offset Minus	Retry 3 times
No Servo Offset	Retry 3 times
Servo Offset Plus	Retry 3 times
Servo Offset Minus	Retry 3 times

FIGURE 16.3-1.   POSSIBLE DATA STROBE AND SERVO OFFSET
                 COMBINATIONS USED BY THE SCSI WREN DURING
                 READ RETRIES

16.4   DATA FIELD ECC ERROR (11 Hex or 18 Hex Error Code)

If EEC bit is one (Table 14.2.1-23), ECC correction is applied as soon as possible. If EEC bit is zero data field ECC error correction is not applied until all retry attempts (per Figure 16.3-1) are exhausted and if specified by DCR bit and retry count (Table 14.2.1-23). If the ECC error persists and is within the correction span being used (11 bits) the data is corrected and sent to the initiator if that capability is enabled by DTE bit (Table 14.2.1-23). Data correction by ECC will not occur unless two ECC syndrome matches occur. For unrecoverable ECC errors an error code of 11 Hex is reported.

16.5   ALTERNATE SECTOR PROCESSING

Any media defect detected during formatting or listed internally in the factory recorded defect table will already have been assigned an alternate sector in an area not directly accessible by the initiator. If conditions are appropriate, the initiator may want to call for a complete reformatting of the WREN V HH. The options available when that is done are discussed in Section 14.2.1.2.

If Automatic Read Reallocation (ARRE) is disabled, the initiator should request that media errors (that occur after formatting) be reassigned using a Reassign Blocks command.

If Automatic Read Reallocation (ARRE) is enabled, read errors that require more than 1 retry to recover or read errors that require ECC correction to recover will be automatically reallocated by the drive. The initiator should not use the Reassign Blocks command to reallocate these flaws. The initiator should still use the Reassign Blocks command to reallocate unrecoverable sectors.

If Automatic Write Reallocate (AWRE) is disabled, the drive will report a No Record Found status if a header cannot be recovered. The initiator should request that bad sector(s) be reallocated using the Reassign Blocks command and then rewrite the record.

If Automatic Write Reallocation (AWRE) is enabled, the drive will automatically reallocate the sector and rewrite the data field if a header cannot be recovered. The initiator should not use the Reassign Blocks command or rewrite the sectors if AWRE is a 1 and it receives a Record Not Found status.

17.0   OPTIONS

All options are incorporated or packaged at the manufacturing facility. Ground isolation capability is provided on every Motor Control PWA shipped. The user may exercise his option to isolate grounds at his convenience. See Paragraph 17.2.

17.1   FRONT PANEL

The front panel is available in black plastic. Each panel has a single red, green, or amber rectangular LED lens. The LED (on the PWA) when glowing, indicates the drive is selected.

17.2   AC/DC GROUND SEPARATION

The 94221 WREN V HH is provided with the DC/HDA logic ground and chassis tied together. An option is provided permitting the user to isolate the ground planes by repositioning the "U" shaped grounding washer. This option may be beneficial in reducing ground induced noise in some system applications. (See Figures 7.2.3-1 and Paragraph 7.2.3.)

17.3   SINGLE UNIT SHIPPING PACK

The 94221 WREN V HH is normally shipped in bulk packaging to provide maximum protection against transit damage. Units shipped individually require additional protection as provided by the single unit shipping pack. Users planning single unit distribution should specify this option.

17.4   DRIVE TERMINATION

This option may be incorporated during manufacture at the request of the customer. Termination consists of a 220/330 ohm resistor module which is installed on the Main PWA via a socket (see Figure 10.3-4). The user may install or remove it as desired.

18.0   ACCESSORIES

All accessories are designed for implementation by the customer.

18.1   FRONT PANEL KIT

Same as 17.1 but includes all mounting hardware to support field installation. Kits are provided in two styles differing only by panel thickness.

18.2   OEM MANUAL

This manual provides basic information on the care and handling of Winchester Disk Peripherals in general. Specific instructions for installing the WREN V HH are included to assist individuals not familiar with the product. It also includes basic information describing repair procedures for items external to the Head/Disk/ Actuator Assembly (HDA).

APPENDIX A

SCSI PROTOCOL ERROR HANDLING FLOW CHARTS

GLOSSARY OF FLOWCHART ABBREVIATIONS

ATTN	Attention signal on SCSI bus
BDR	Bus Device Reset message
BF	Bus Free phase
CMD	Command
DISCON	Disconnect message
ERR CD	Error Code in Request Sense byte 12
HDWE ERR	Hardware Error Sense Key
ID	Identify message
IDE	Initiator Detected Error message
LUN	Logical Unit Number
MPE	Message Parity Error message
MR	Message Reject message
MSG	Message
NOOP	No Operation message
PAR ERR	Parity Error was detected during Message Out phase
RES	Any Reserved or unimplemented message code (extended or nonextended)
RP	Reset Pointers message
SDP	Save Data Pointer message
STR	Synchronous Data Transfer Request message
U.A.	Unit Attention condition

3127-1   0221D
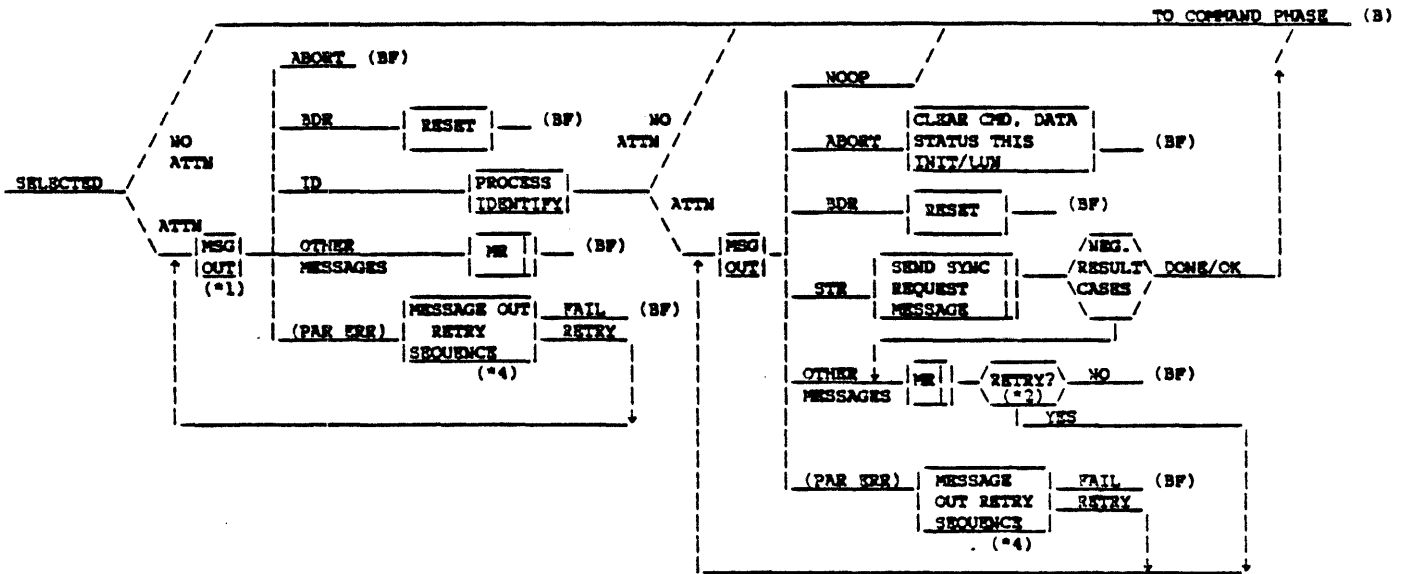
FLOWCHART 1.   SELECTION MESSAGES

Notes:

1. MSG OUT may accept the next complete message (1 or 5 bytes) or
    may accept and buffer all message bytes available while ATN is
    asserted.

2. Retry is optional in these cases. If messages are buffered;
    discard.

3. The MSG OUT retry sequence will insure that any buffered
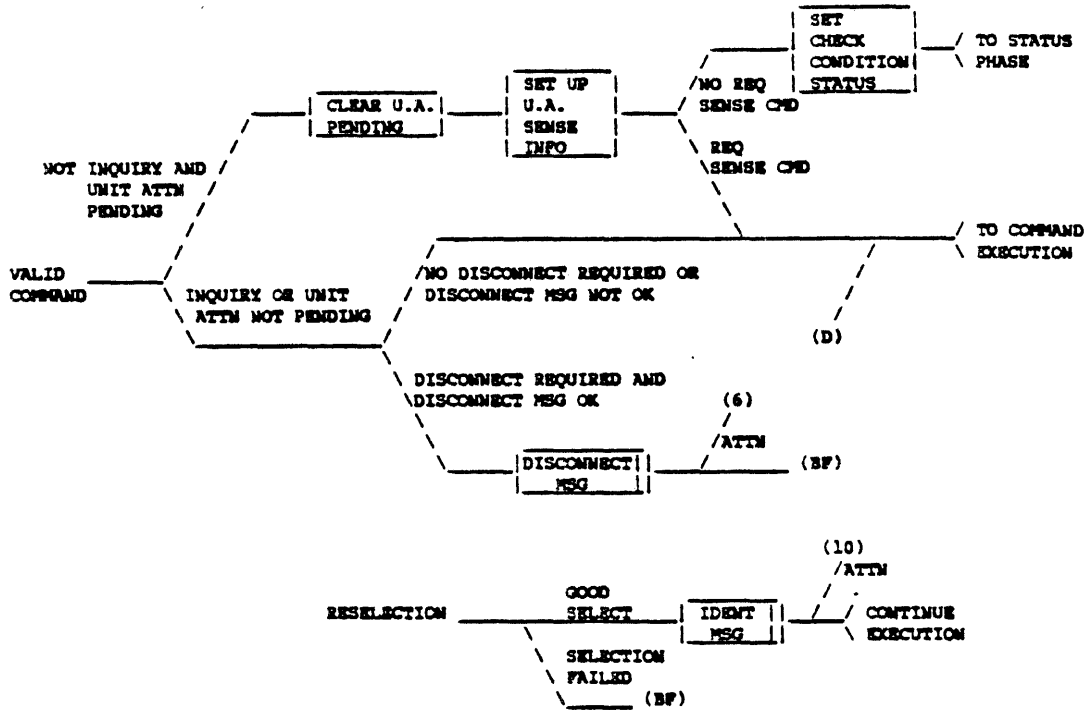   messages are discarded and that ATN is false.
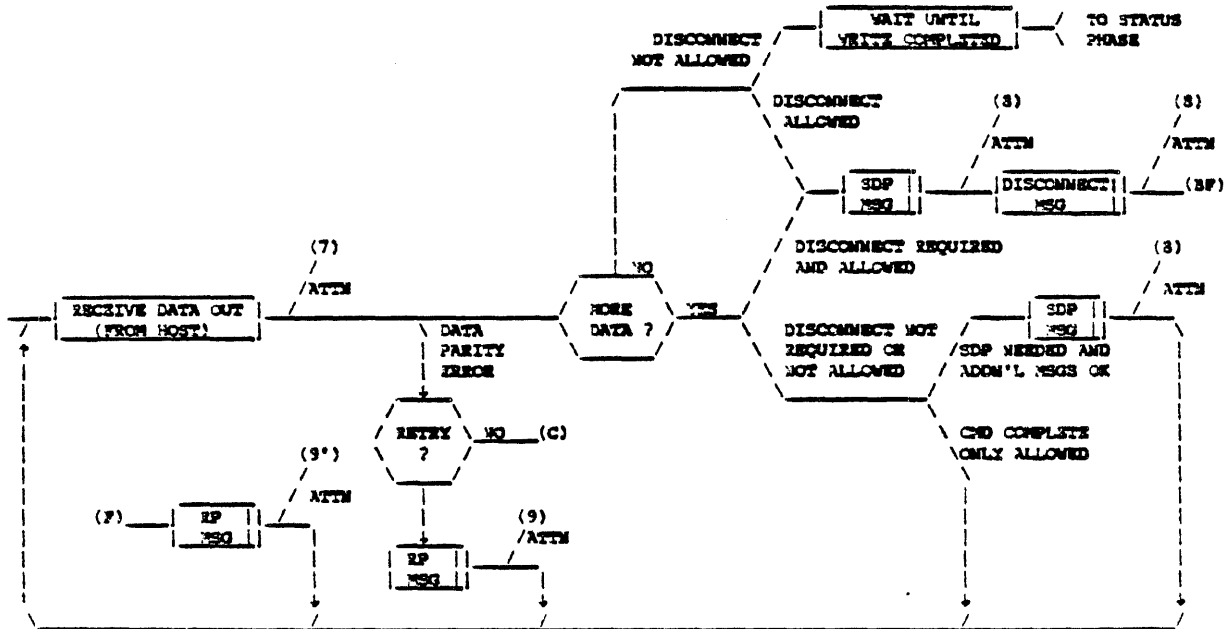
4. ⌷   Indicates a transmission to the Host.

NOTE: FOR ALL ATTN'S
  (PAR ERR) → RETRY ONCE - (BF)
  ABORT   → ABORT - (BF)
  SDR   → RESET - (BF)
  NOOP   → CONTINUE

GET 1st BYTE OF COMMAND	
/10 BYTE /COMMAND	GET 9 MORE BYTES
6 BYTE COMMAND	GET 5 MORE BYTES

DISCON MESSAGE   (3) /ATTN / (BF)

/DIFF HOST AND / DISCON OK (QUEUE CMD)

CMD IN PROCESS

SAME HOST OR DISCON NOT OK

(2) ATTN/

INVALID LUN ?   NO / (N)→\   SET BUSY STATUS   / TO STATUS \ PHASE

YES

NO CMD IN PROCESS

/ TO VALID \ COMMAND PROCESS / VALID COMMAND

\PARITY \ERROR   PARITY ERROR

\ INVALID COMMAND

SET ILLEGAL REQUEST SENSE KEY

(1) /ATTN

HOST ACCEPTS MSGS & 1st RETRY   RP MSG   / (B)

\ CMD CMPLT ONLY OR
(C)   \ RETRY FAILED   SET HOME ERR   SET CHECK COND STATUS   /TO STATUS \PHASE

(Cx)   SET SENSE KEY = CMD ABORT   SET ERR CD

(1)	(2)	(3)
IDE -> MR - (Cx)	IDE -> RP - (B)	IDE -> MR - (Cx)
STR -> MR - (Cx)	STR -> MR - (Cx)	STR -> MR - (Cx)
MR -> (C)	MR -> MR - (Cx)	MR -> MR
MPE -> RETRY ONCE - (BF)	MPE -> MR - (Cx)	MPE -> RETRY ONCE - (BF)
ID -> MR - (Cx)	ID -> MR - (Cx)	ID -> MR - (Cx)
RES -> MR - (Cx)	RES -> MR - (Cx)	RES -> MR - (Cx)

FLOWCHART 2.   COMMAND PHASE

FLOWCHART 3.   VALID COMMAND PROCESS

```
(6)                                    (10)
IDE -> MR - (Cx)                       IDE -> MR - (Cx)
STR -> MR - (Cx)                       STR -> MR - (Cx)
MR  -> (D) (DO NOT DISCONNECT)         MR  -> MR - (BF)
MPE -> RETRY ONCE - (BF)               MPE -> RETRY ONCE - (BF)
ID  -> MR - (Cx)                       ID  -> MR - (Cx)
RES -> MR - (Cx)                       RES -> MR - (Cx)
```

<table>
<thead>
<tr><th>(7)</th><th>(9 & 9')</th><th>(8)</th></tr>
</thead>
<tbody>
<tr><td>IDE -> (F)</td><td>IDE -> MR - (C_X)</td><td>IDE -> MR - (C_X)</td></tr>
<tr><td>STR -> MR - (C_X)</td><td>STR -> MR - (C_X)</td><td>STR -> MR - (C_X)</td></tr>
<tr><td>MR -> MR - (C_X)</td><td>MR -> (C_X) or (C_X')</td><td>MR -> CONTINUE</td></tr>
<tr><td>MPE -> MR - (C_X)</td><td>MPE -> RETRY ONCE - (BF)</td><td>MPE -> RETRY ONCE - (BF)</td></tr>
<tr><td>ID -> MR - (C_X)</td><td>ID -> MR - (C_X)</td><td>ID -> MR - (C_X)</td></tr>
<tr><td>RES -> MR - (C_X)</td><td>RES -> MR - (C_X)</td><td>RES -> MR - (C_X)</td></tr>
</tbody>
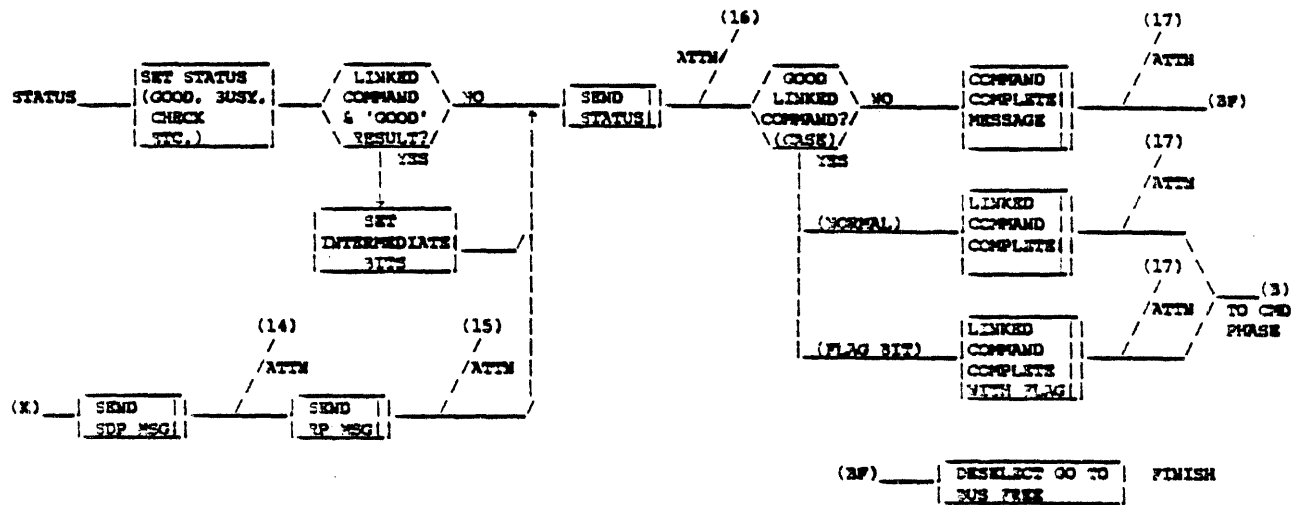</table>

FLOWCHART 4.   DATA OUT PHASE
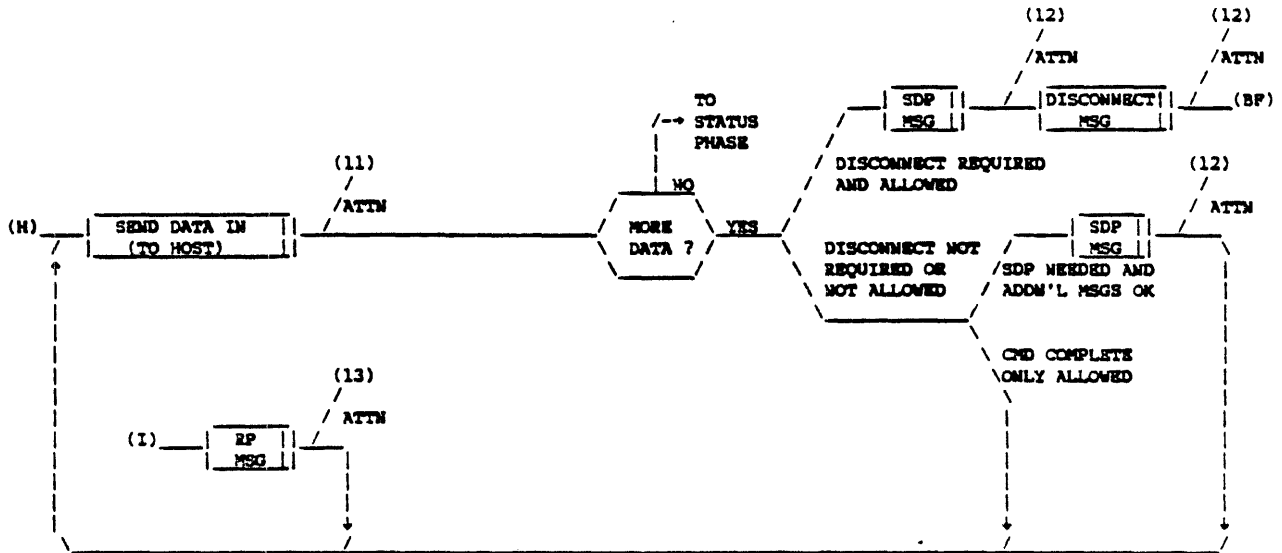
(11)
IDE -> (I)
STR -> MR - (C_X)
MR -> MR - (C_X)
MPE -> MR - (C_X)
ID -> MR - (C_X)
RES -> MR - (C_X)

(13)
IDE -> MR - (C_X)
STR -> MR - (C_X)
MR -> (C_X)
MPE -> RETRY ONCE - (BF)
ID -> MR - (C_X)
RES -> MR - (C_X)

(12)
IDE -> MR - (C_X)
STR -> MR - (C_X)
MR -> (H)
MPE -> RETRY ONCE - (BF)
ID -> MR - (C_X)
RES -> MR - (C_X)

FLOWCHART 5.   DATA IN PHASE

FLOWCHART 6.   STATUS PHASE

(14)	(15)	(16)	(17)
IDE->MR-CONTINUE	IDE->MR-CONTINUE	IDE->(K) IF FIRST TRY	IDE->MR-(BF)
STR->MR-CONTINUE	STR->MR-CONTINUE	STR->MR-CONTINUE	STR->MR-(BF)
MR ->CONTINUE	MR ->CONTINUE	MR ->CONTINUE	MR ->(BF)
MPE->RETRY ONCE-(BF)	MPE->RETRY ONCE-(BF)	MPE->MR-CONTINUE	MPE->RETRY ONCE-(BF)
ID ->MR-CONTINUE	ID ->MR-CONTINUE	ID ->MR-CONTINUE	ID ->MR-(BF)
RES->MR-CONTINUE	RES->MR-CONTINUE	RES->MR-CONTINUE	RES->MR-(BF)

TECHNICAL INQUIRY

FROM:

Date _____

Name _____

Address _____

City _____

State _____ Zip Code _____

Area Code _____ Phone _____

PLEASE SUPPLY:

Document Title _____ Number _____ Revision _____

COMMENTS:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

STAPLE

FOLD FOLD

NO POSTAGE
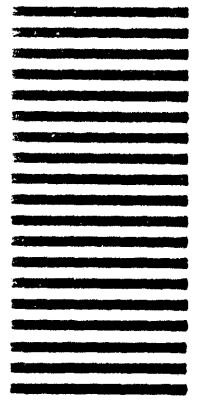NECESSARY
IF MAILED
IN THE
UNITED STATES

| BUSINESS REPLY MAIL |
| FIRST CLASS   PERMIT NO 1332   OKLAHOMA CITY OKLA |

POSTAGE WILL BE PAID BY ADDRESSEE

CONTROL DATA CORP.

P.O. BOX 12313

OKLAHOMA CITY, OKLAHOMA 73157

Attention *Rigid Disk Applications Engineering, OKM 272*

FOLD FOLD

CUT ALONG LINE