CONTROL DATA CORPORATION

CD	0
REV	A Issue
DATE	June 1987

PRODUCT SPECIFICATION
FOR
WREN™ IV SCSI
MODEL 94171

MAGNETIC PERIPHERALS, INC.
a Control Data Company

This publication may contain application, high technology, or product specification data, or any combination thereof, is considered advance technical information by the producer, and is subject to change without prior notice.

CONTROL DATA CORPORATION

SPEC	77738386
CD	0
REV	A Issue
DATE	June 1987
PAGE	1 of 202

PRODUCT SPECIFICATION
FOR
WREN™ IV SCSI
MODEL 94171

MAGNETIC PERIPHERALS, INC.
a Control Data Company

THIS SPECIFICATION OUTLINES THE PRODUCT CHARACTERISTICS AND PERFORMANCE CRITERIA OF THE 94171 WREN IV SCSI.

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

SUMMARY

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

NAME	MODEL NUMBER *	PRODUCT SPECIFICATION	INTERFACE	CAPACITY (MEGABYTES)
WREN II	94155-XX	77715909	CDC 506 (ST506 COMP.)	48, 57, 67, 77 or 86
WREN II	94156-XX	77738019	ESDI	46, 67 or 86
WREN II	94151-YY	77738208	SCSI (SASI™ Subset)	25 to 80
WREN II HH	94205-XX	77738161	CDC 506 (ST506 COMP.)	30, 41 or 51
WREN III	94166-XXX	77738212	ESDI	101, 141 or 182
WREN III	94161-YYY	77738270	SCSI **	86, 121 or 155 (512 Byte)
WREN III HH	94211-YY	77765250	SCSI **	91 (512 Byte)
WREN III HH	94216-XXX	77765276	ESDI	106
WREN IV	94171-YYY	77738386	SCSI **	298 (512 Byte)

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

YY(Y) denotes formatted drive capacity.

** These drives allow the user to format to any integer data block size between 256 and 2048 bytes. Standard format is 512 byte data block size, with capacity dependent on number of data heads.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

7.5.1 Drive Orientation

Only two WREN IV mounting orientations are permitted: disks in the horizontal plane and disks in the vertical plane. The uppermost surface must be maintained in a level position or WREN IV performance may be adversely affected. Mounting with either end down (front or rear) is not permissible. In the horizontal orientation, the spindle axis must be vertical with the disks on top. It is recommended that data written in a given orientation be read in that same orientation.

7.5.2 Cooling

Cabinet cooling must be designed by the customer so that the ambient temperature immediately surrounding the WREN IV 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 IV 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 IV, 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 IV internal defect/error management and SCSI systems error considerations (errors in communications between Initiator and WREN IV). 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 IV INTERNAL DEFECTS/ERRORS

Identified defects are recorded on the WREN IV 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 IV format operation. (See Format Unit command in Section 14.2.1.1.) The WREN IV 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 IV automatic retries and data correction by ECC features 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 IV, 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), more information on the WREN IV 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 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 IV.

Section 15.0 describes the status returned by the WREN IV 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 Magnetic Peripherals Inc. subset of the SCSI (Small Computer Systems Interface) as implemented on the WREN IV. 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 IV is classified as an Model 94171 "Intelligent" peripheral.

The Model 94171 WREN IV 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 1.5 MB/s asynchronous and (TBD) MB/s synchronous. The bus protocol supports multiple initiators, disconnect/ reconnect, additional messages plus 6 byte and 10 byte Command Descriptor Blocks. The WREN IV is always a target on the SCSI. For purposes of this specification, "WREN IV" 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 00H 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 IV 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). 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	J2-01
+12 V Return	J2-02
+ 5 V Return	J2-03
+ 5 V	J2-04

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 94171 WREN IV may be daisychained together or with other compatible SCSI devices using a common cable. Both ends of the cable must be terminated. The WREN IV 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 94171 WREN IV 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). Remove the terminator resistor packs, not the terminator power source selector jumper (Figure 10.3-3).

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:

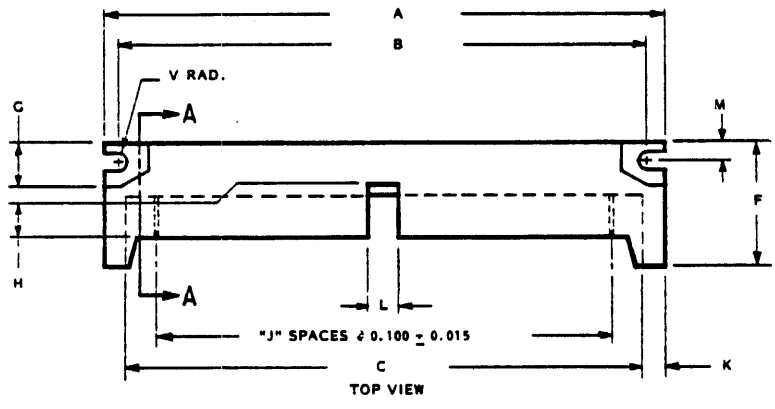
Closed end (for cable ends) *	3M-3425-7000	W/O Strain Relief, No Center Key
	3M-3425-7050	With Strain Relief, No Center Key
	Dupont-66900-950	With Strain Relief, With Center Key
Open end (In Daisychain)	3M-3425-6000	W/O Strain Relief, No Center Key
	3M-3425-6050	With Strain Relief, No Center Key
	Dupont-66900-250	With Strain Relief, With Center Key

* See Figure 10.3-2.

10.3.3 continued

The Model 94171 WREN IV 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: Berg - 65496 - 031 or equivalent.



(HH106a)

CDC P/N	A *	B *	C *	D *	E *	F *	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	NO. OF CONTACTS
51847516	2.95	2.78	2.72	.29	+.115 -.087	.66	.23	.29	24	.115	.18	.10	.100 ± .015	.15	.27	.24	.08	.100 ± .015	.025 ± .002	.04R	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

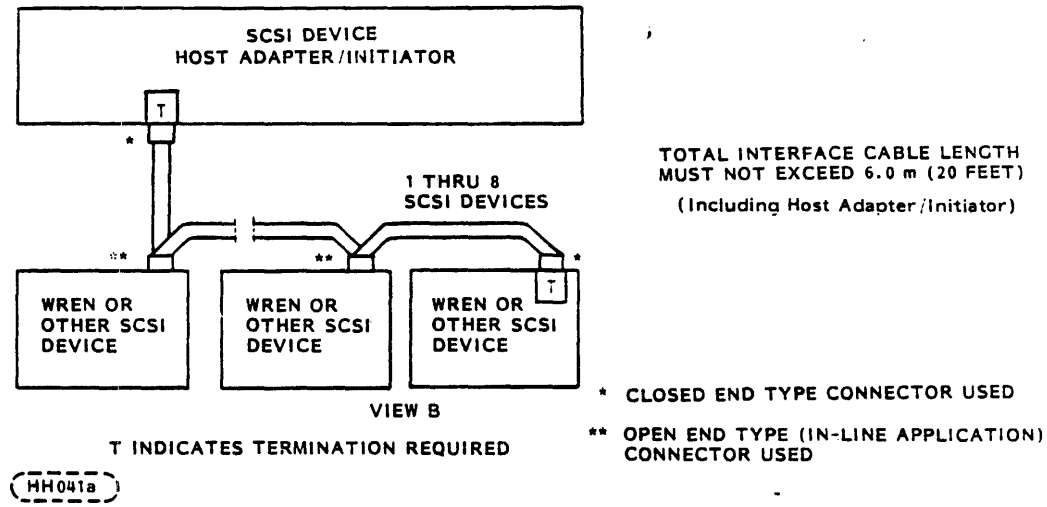


FIGURE 10.3-2. INTERFACE CABLING

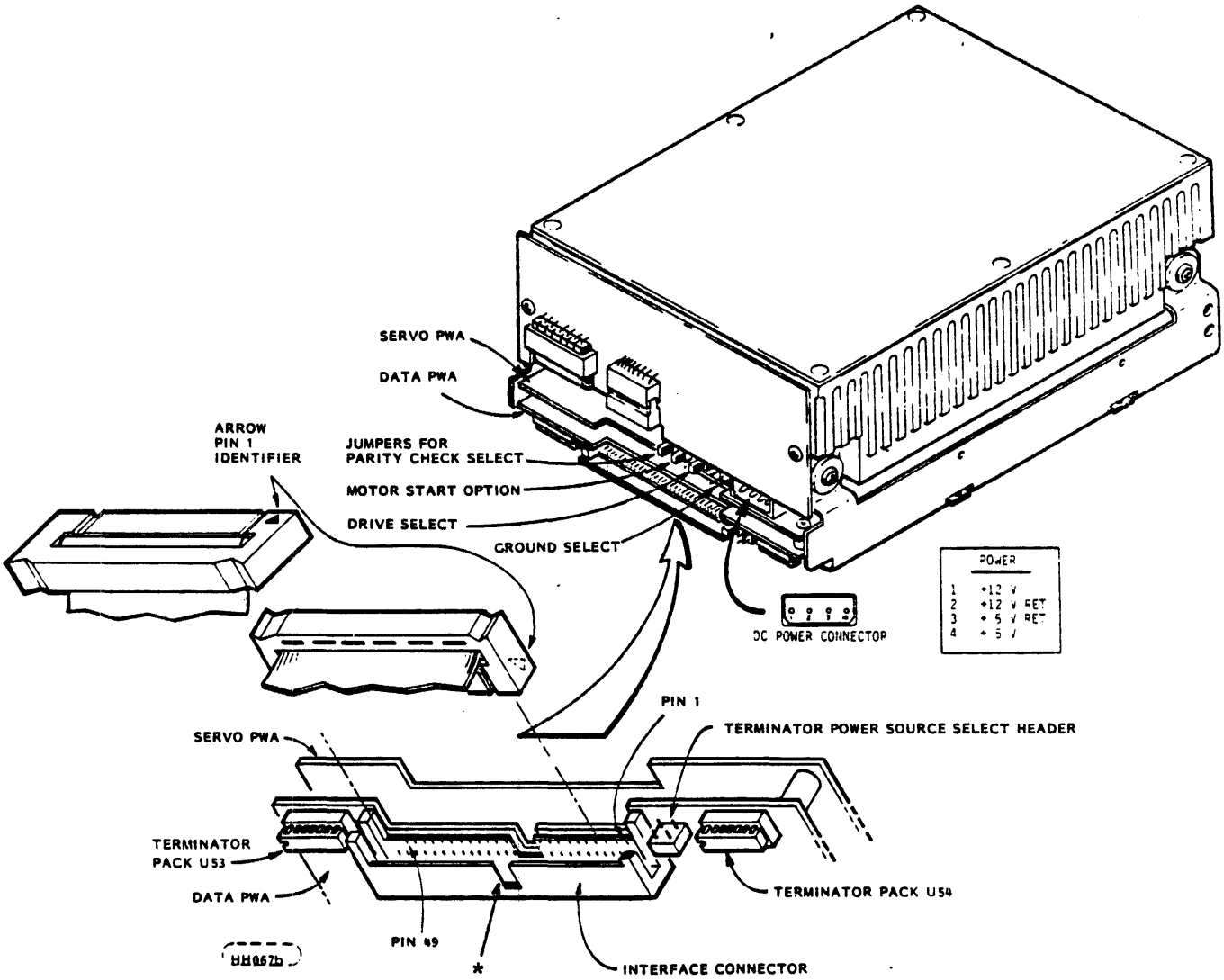
TABLE 10.3-1. SINGLE ENDED CABLE PIN ASSIGNMENTS
(NONSHIELDED CONNECTOR)

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.

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



*Not all units have this keyway on the I/O connector.

FIGURE 10.3-3. I/O CONNECTION

10.3.4 Electrical Description

All interface signals with the Model 94171 WREN IV 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 IV. See Figures 10.3-4 and 11.1-1.

10.3.4.1 Single Ended Drivers/Receivers

Single ended drivers and receivers are used by the WREN IV. Typical circuits are shown in Figure 10.3-4. Terminator circuits shown are there only when the WREN IV is last in the daisychain.

Transmitter Characteristics

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

10.3.4.2 Terminator Requirements

Internal WREN IV I/O termination consist of two resistor modules which plug into sockets on the Data PWA (see Figure 10.3-3). The WREN IV 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 IV 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.

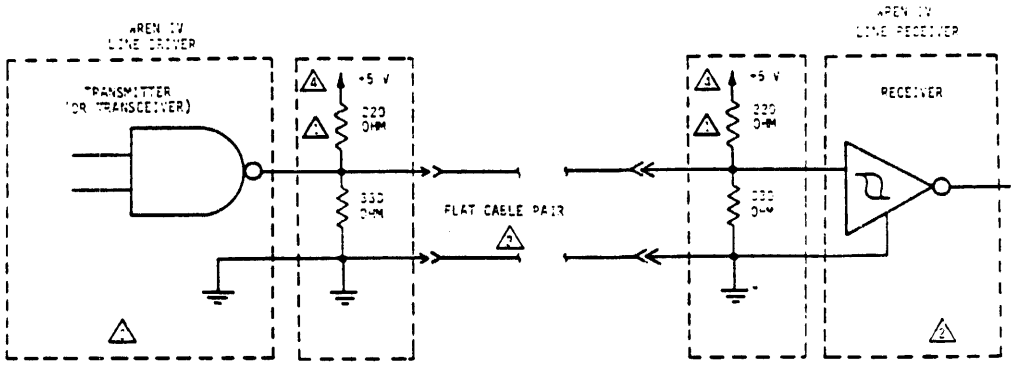
10.3.4.3 Terminator Power

The WREN IV does not supply Terminator power for the SCSI bus. The WREN IV 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 IV power connector. See Figures 10.3-3 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

*See Figure 11.1-1 for configuration details.



1. TERMINATOR CIRCUITS: PART OF REMOVABLE TERMINATOR RESISTOR PACKS, USED IN THE WREN IV WHEN IT 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)	≥2.5 V; ≤ 5.25 V	≥2.0 V; ≤5.25 V
ASSERTED	(1)	≤0.4 V; ≥0.0 V	≤0.8 V; ≥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 NOT EXCEED 20 FEET (6.0 m) FROM HOST TO END OF DAISYCHAIN.
4. SOURCE OF DRIVE TERMINATOR POWER SELECTABLE BY JUMPER PLUG.

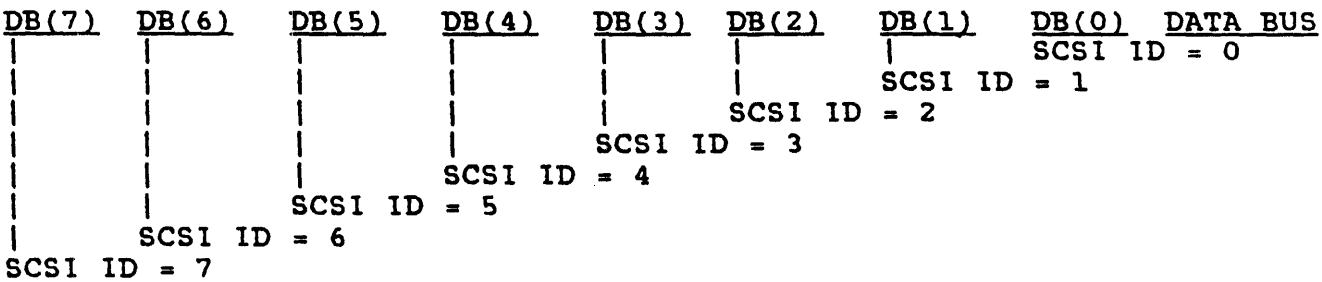
HH029c

FIGURE 10.3-4. SINGLE ENDED TRANSMITTERS AND RECEIVERS

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.



The Host Adapter/Initiator must be identified by one of the eight SCSI Device Addresses.

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 IV 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 IV 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 and 11.1-1 for the location of the drive select header. The WREN IV 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.

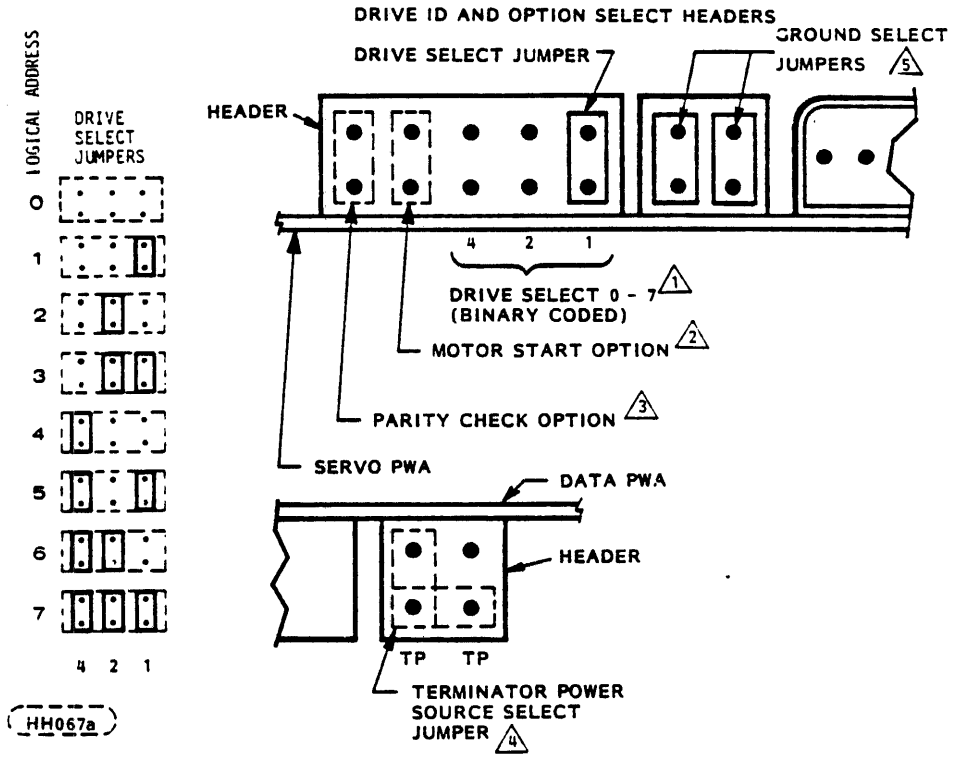


FIGURE 11.1-1. WREN IV SCSI DRIVE ID AND OPTION SELECT HEADER

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

2 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).

3 Jumper plug installed means parity checking by the WREN IV is enabled.

4 If the unit is not to be terminated, remove terminator resistor DIPs (see Figure 10.3-3). If installed, the TP jumper must be installed only in one of the two positions shown with dotted lines in Figure 11.1-1.

Jumper in vertical position means terminator power (+5 V) is from WREN IV power connector. Jumper in horizontal position means terminator power is taken from interface cable.

If the drive is not terminated, the TP jumper need not be installed.

5 See Figure 7.2.3-1.

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 IV 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 µs)

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 µs)

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 µs)

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

11.2.13 Selection Abort Time (200 µs)

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 IV 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 IV, unless otherwise stated. The WREN IV always functions as the target, never the initiator.

12.1 SCSI BUS PHASES

WREN IV responds to 8 distinct bus phases.

Bus Free phase
Arbitration phase
Selection phase
Reselection phase

Command phase
Data(In and Out)
Status (In Only)
Message (In and Out)

} These phases are collectively termed the Information Transfer phase.

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 IV will arbitrate for the bus only as a target implementing reselection. The WREN IV 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 IV 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.

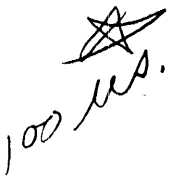
The WREN IV implements the Reselection phase if the system is capable of supporting Reselection.

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 IV 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 IV 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 IV implements only the "hard" Reset option. Upon detection of the Reset condition, the WREN IV 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).

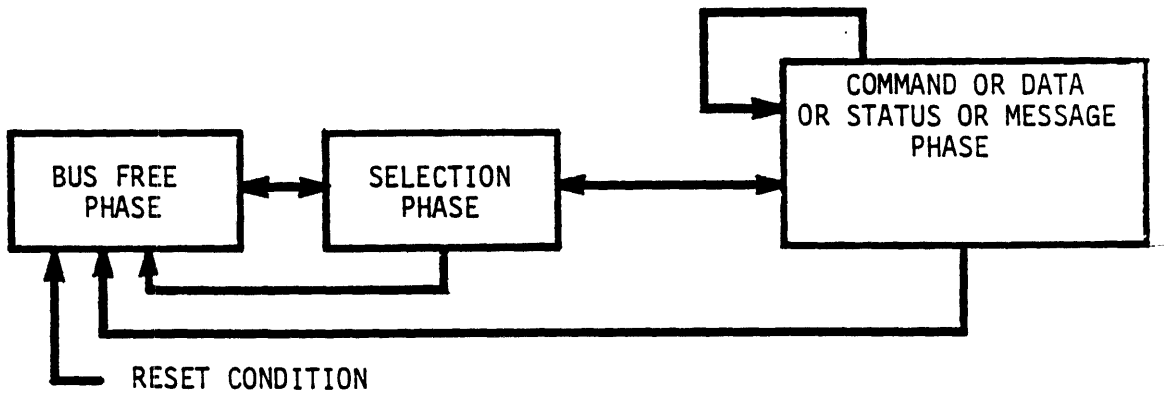


FIGURE 12.3-1. PHASE SEQUENCES WITHOUT ARBITRATION

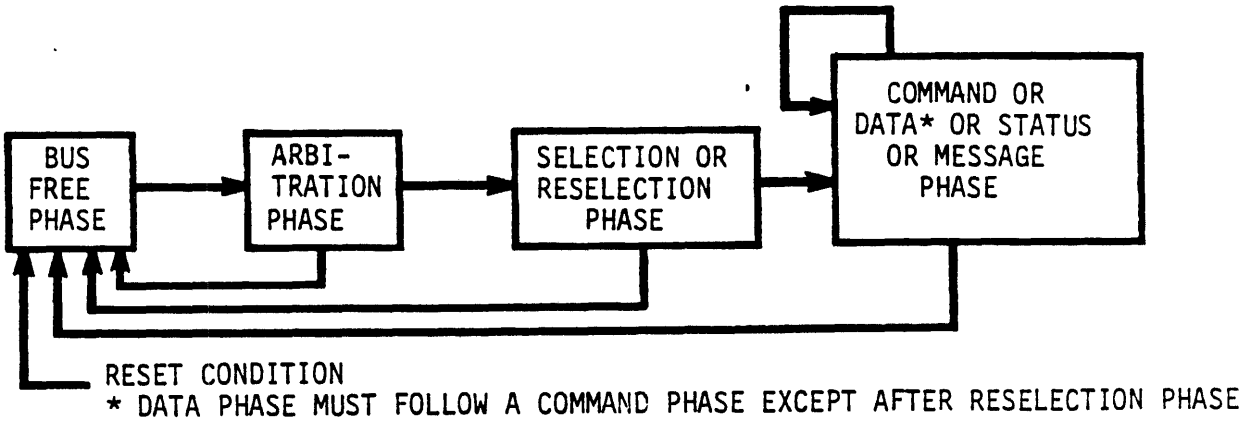


FIGURE 12.3-2. PHASE SEQUENCES WITH ARBITRATION

12.4 SCSI POINTERS

WREN IV 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.

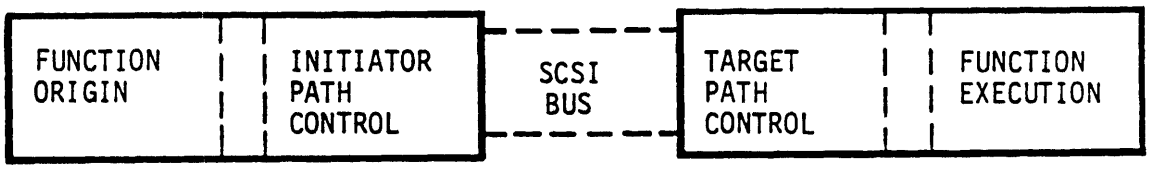


FIGURE 12.4-1. SIMPLIFIED SCSI SYSTEM

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 IV supports systems that accommodate only the Command Complete message, or systems that can accommodate additional messages. WREN IV 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 IV). 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 IV 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 IV TO INITIATOR
OUT = INITIATOR TO WREN IV

(2) WREN IV 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 IV. 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 IV.

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 IV 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 IV will not resend (retry) the original message.

12.5.2 continued

The WREN IV 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 IV 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 IV 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 IV.

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 IV 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 IV will respond with a Message Reject message after any other extended message is received.

The Extended message format to be used by WREN IV is shown in Section 12.5.4, "Sychronous 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 IV 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

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

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 IV SCSI will support only a REQ/ACK offset of 1.

The WREN IV SCSI will support only the following transfer periods.

MH - TRANSFER PERIOD VALUE		TRANSFER PERIOD (MH x 4 ns)
Decimal	Hex	
75	4BH	300 ns
88	58H	350 ns
100	64H	400 ns
113	71H	450 ns

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 IV 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 IV are structured in accordance with the requirements imposed by the WREN IV 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 IV may disconnect from the SCSI bus to allow activity by other SCSI devices while the WREN IV performs operations within itself.

Upon command completion (which may be executed either successfully or unsuccessfully), the WREN IV 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 IV. 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 IV 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 IV 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 IV 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 IV reports Check Condition status), the WREN IV 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 IV reports Check Condition status), the WREN IV 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 IV 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 IV 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 IV is capable of accepting and queing one command from each initiator for up to 7 possible initiators. When commands are queued, after the WREN IV 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 IV will allow itself to be selected and will accept the command bytes for this command. The WREN IV 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 IV 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 IV 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 IV 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 IV 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 IV is performed by sending a Command Descriptor Block (CDB) to the WREN IV. 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 IV shall terminate the command without altering the medium.

The Format description for the Command Descriptor Block as supported by the WREN IV 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 IV 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 IV 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 IV, the WREN IV will use the LUN number specified in this message. In this case, the WREN IV shall ignore the LUN specified within the command descriptor block.

The WREN IV 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 IV 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 IV 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 IV 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 IV does not support the Flag and Link bit functions. These bits must be zero for the command to be accepted. If not, WREN IV 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	0	0	0	0	0	0	FLAG 0	LINK 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 IV. 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 IV. Once this process is completed, the WREN IV assumes control of the operation.

The WREN IV obtains the command from the initiator (in this case, a Read command). The WREN IV interprets the command and executes it. For this command, the WREN IV 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 IV sends a status byte to the initiator. To end the operation, the WREN IV sends a Command Complete message to the initiator and then goes to the Bus Free state.

13.3.1 (continued)

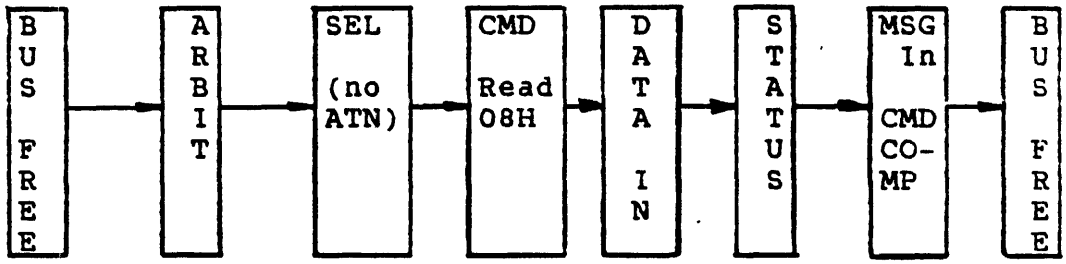


FIGURE 13.3-1. SINGLE COMMAND EXAMPLE

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 IV 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 IV must be capable of arbitrating for the SCSI bus and reselecting the initiator. See Figure 13.3-2.

After the WREN IV 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 IV 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 IV 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 IV 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 IV elects to repeat the information transfer, the WREN IV 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.

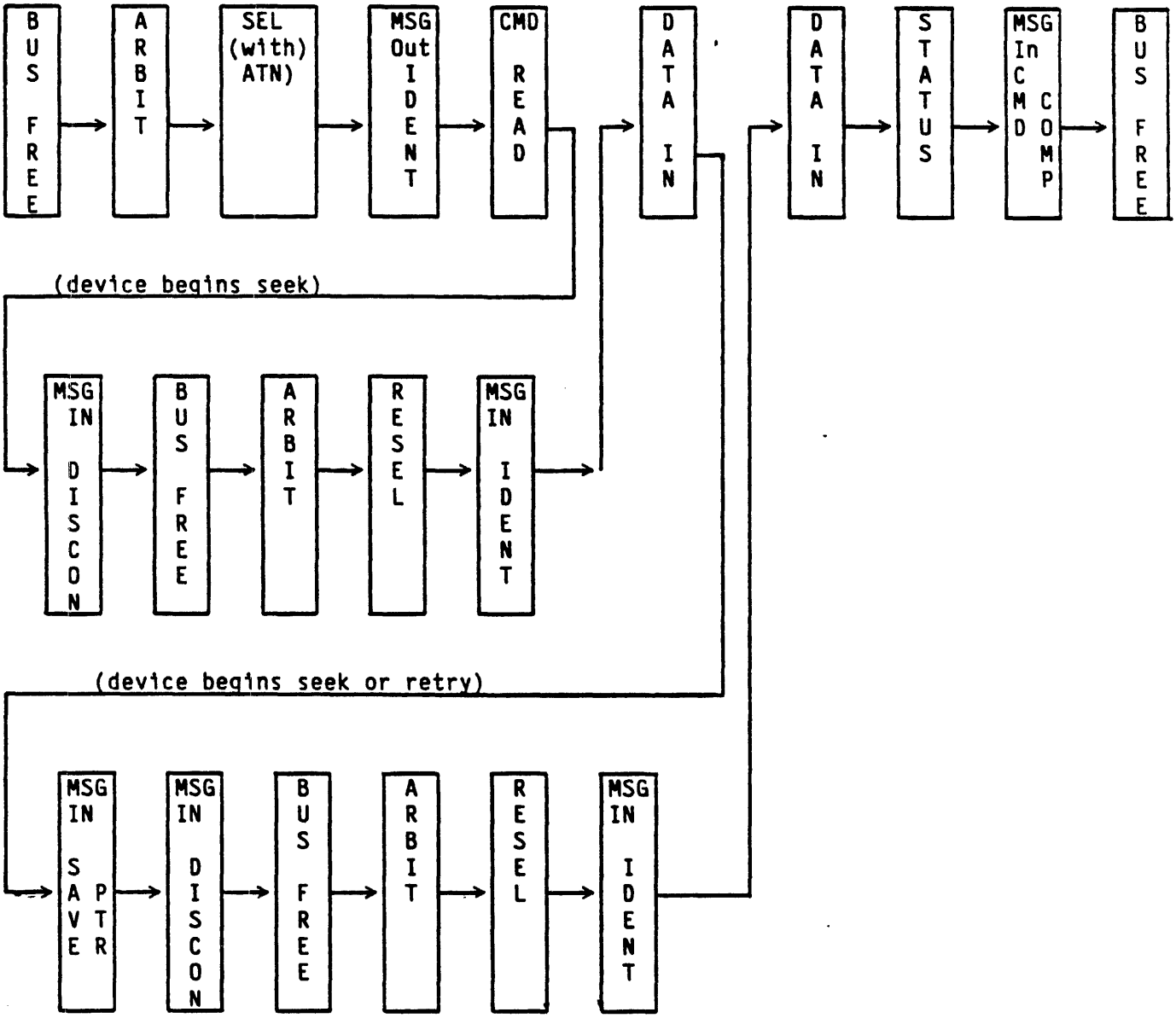


FIGURE 13.3-2. DISCONNECT EXAMPLE

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

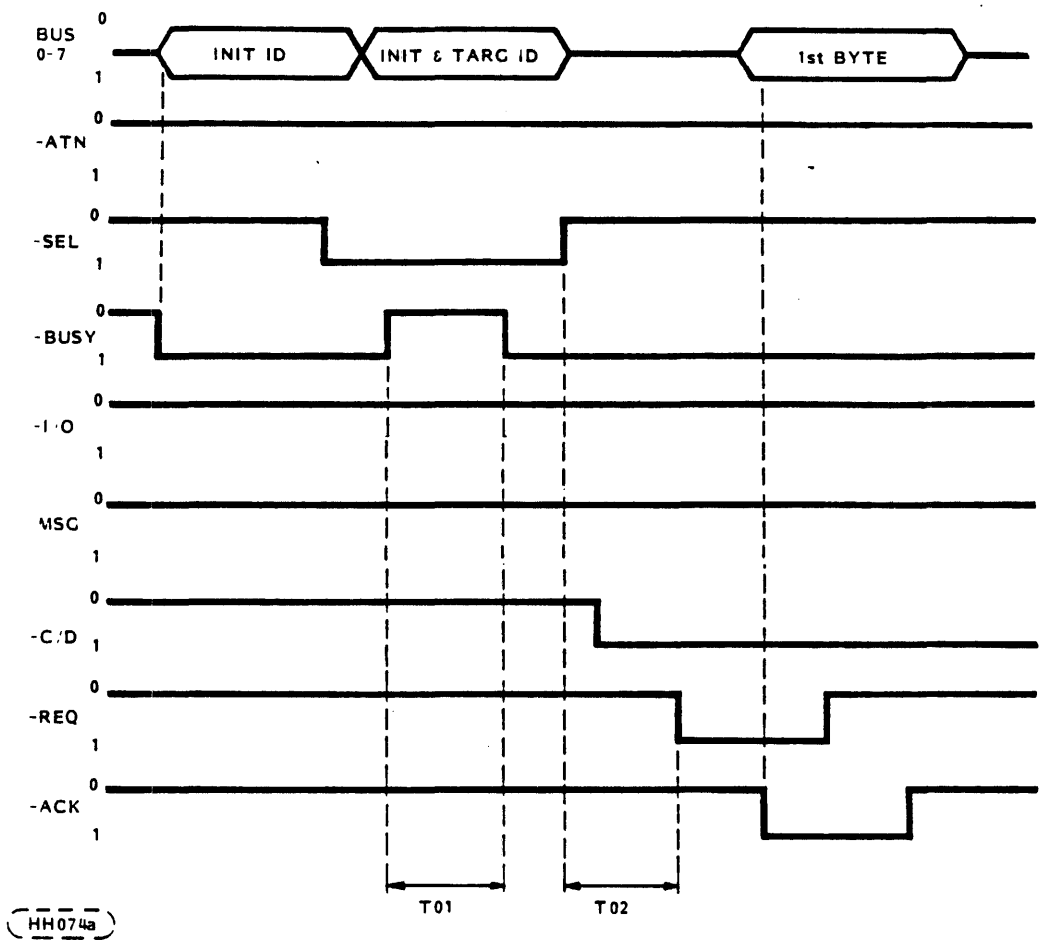


TABLE 13.4-2. ARBITRATION, SELECTION (WITH ATN), AND MESSAGE OUT

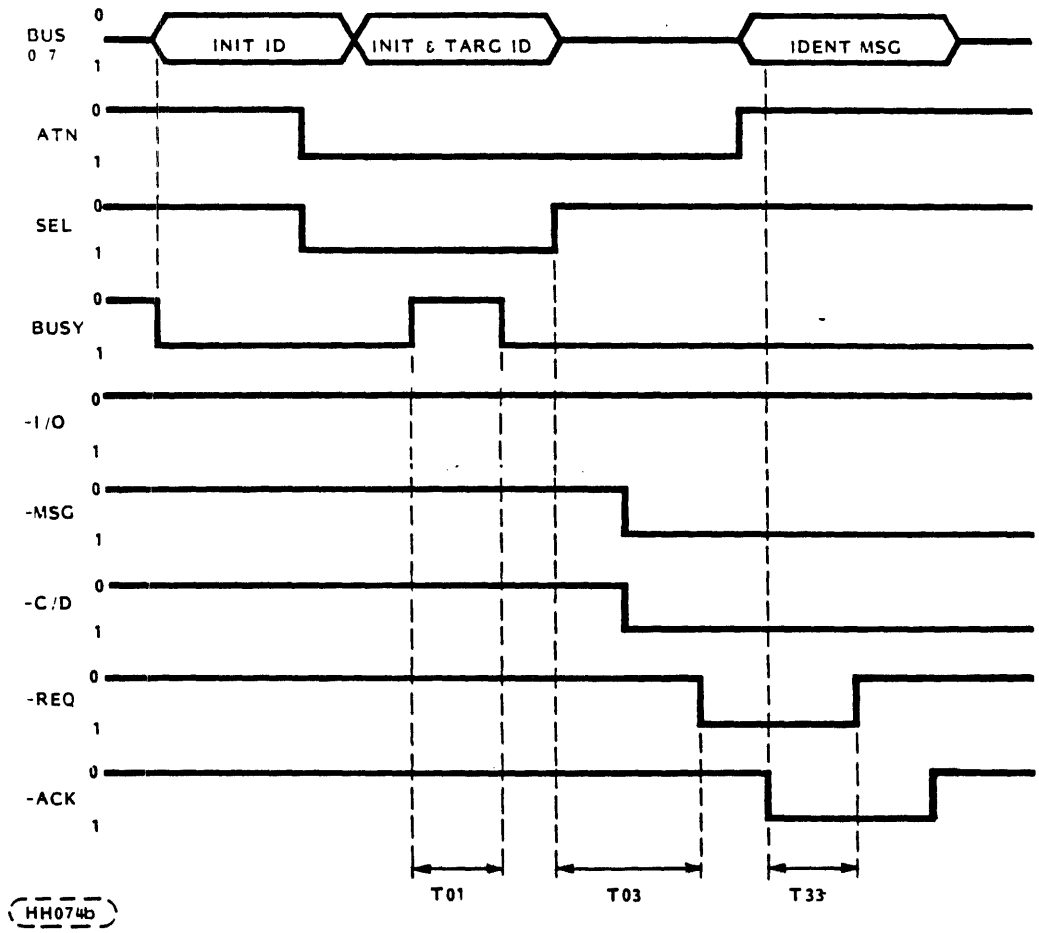


TABLE 13.4-3. IDENTIFY MSG OUT TO COMMAND PHASE

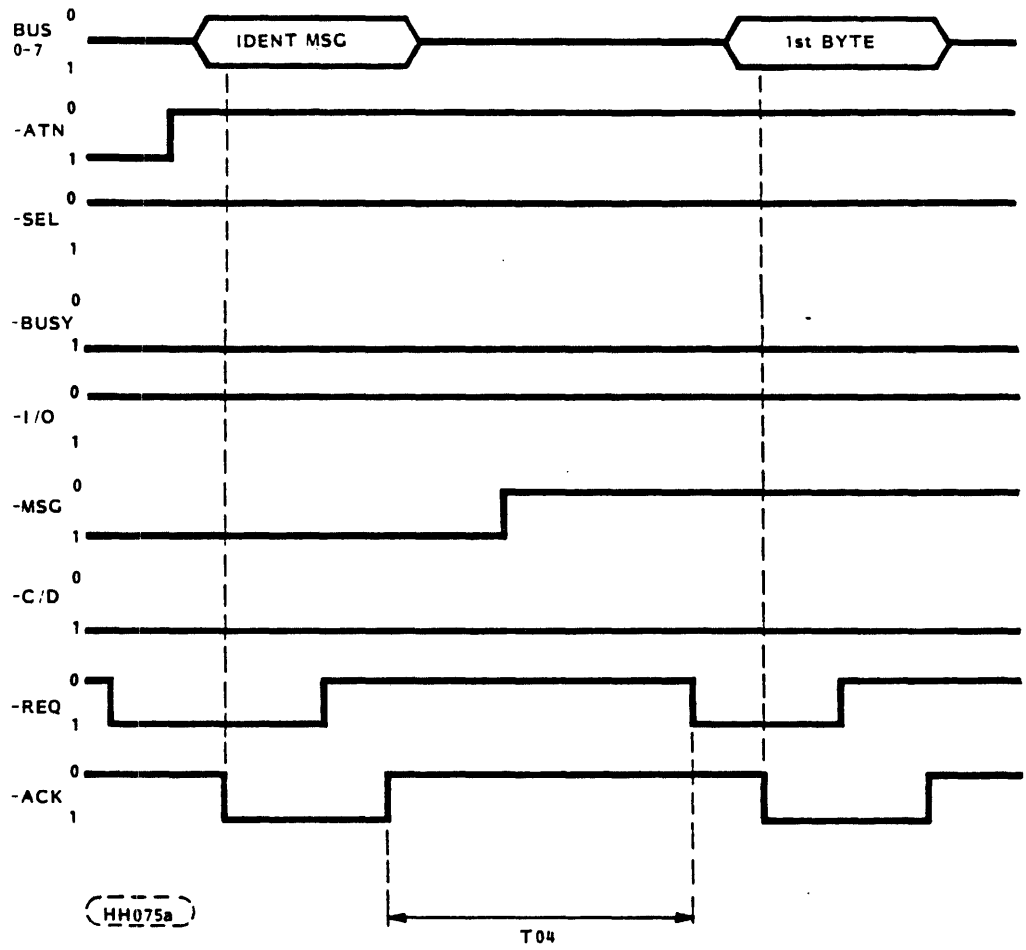


TABLE 13.4-4. COMMAND DESCRIPTOR BLOCK TRANSFER

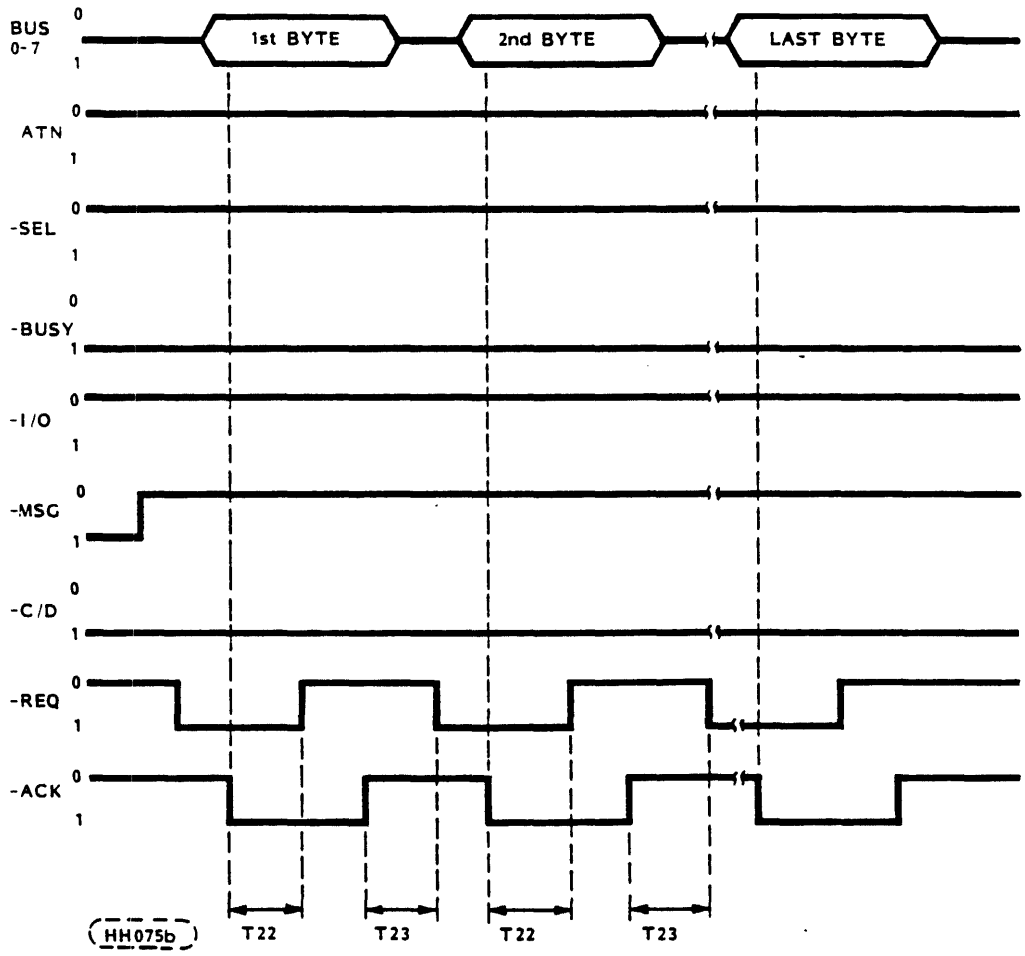


TABLE 13.4-5. COMMAND PHASE, STATUS PHASE, COMMAND COMPLETE' MSG AND BUS FREE

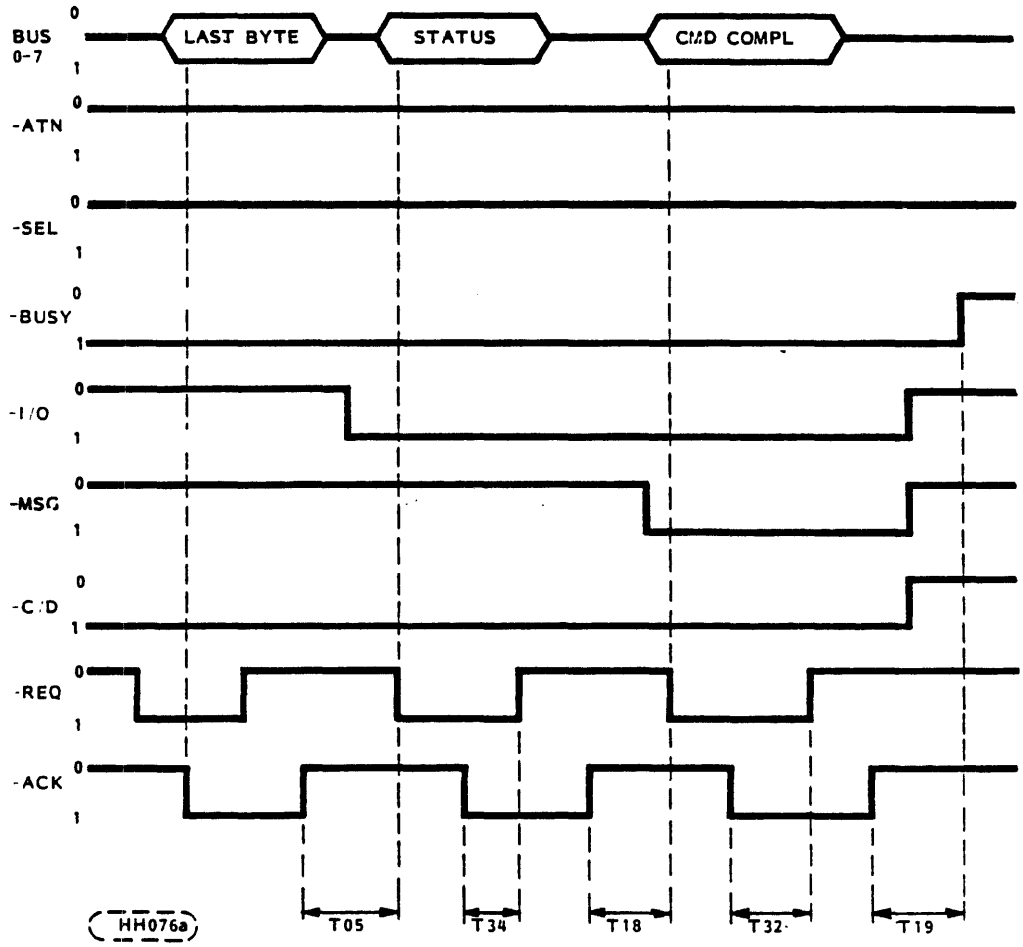
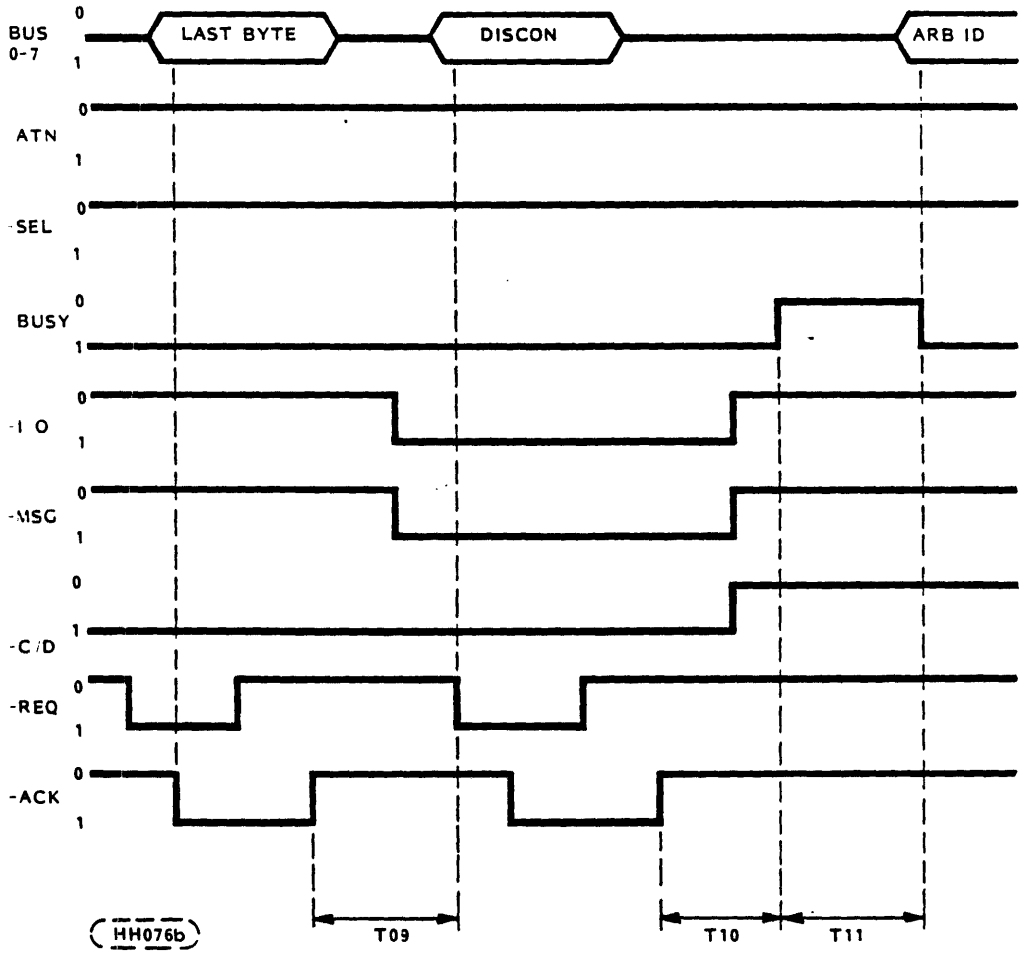


TABLE 13.4-6. LAST COMMAND BYTE, DISCONNECT MSG, BUS FREE, AND RESELECT



NOTE: To measure T11, there must be no other device contending for the SCSI BUS.

TABLE 13.4-7. ARBITRATION, RESELECTION AND MESSAGE IN

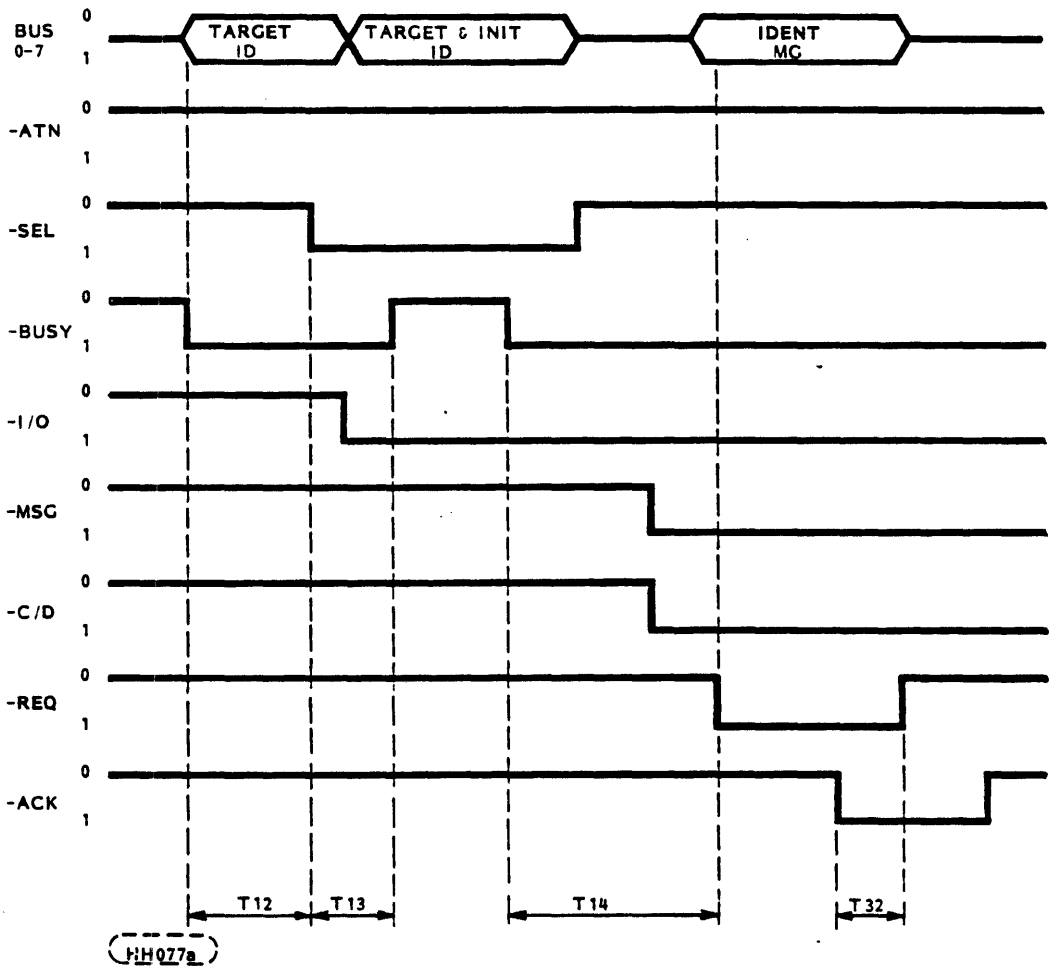


TABLE 13.4-8. RESELECT IDENTIFY MSG, STATUS PHASE, COMMAND COMPLETE MSG' AND BUS FREE

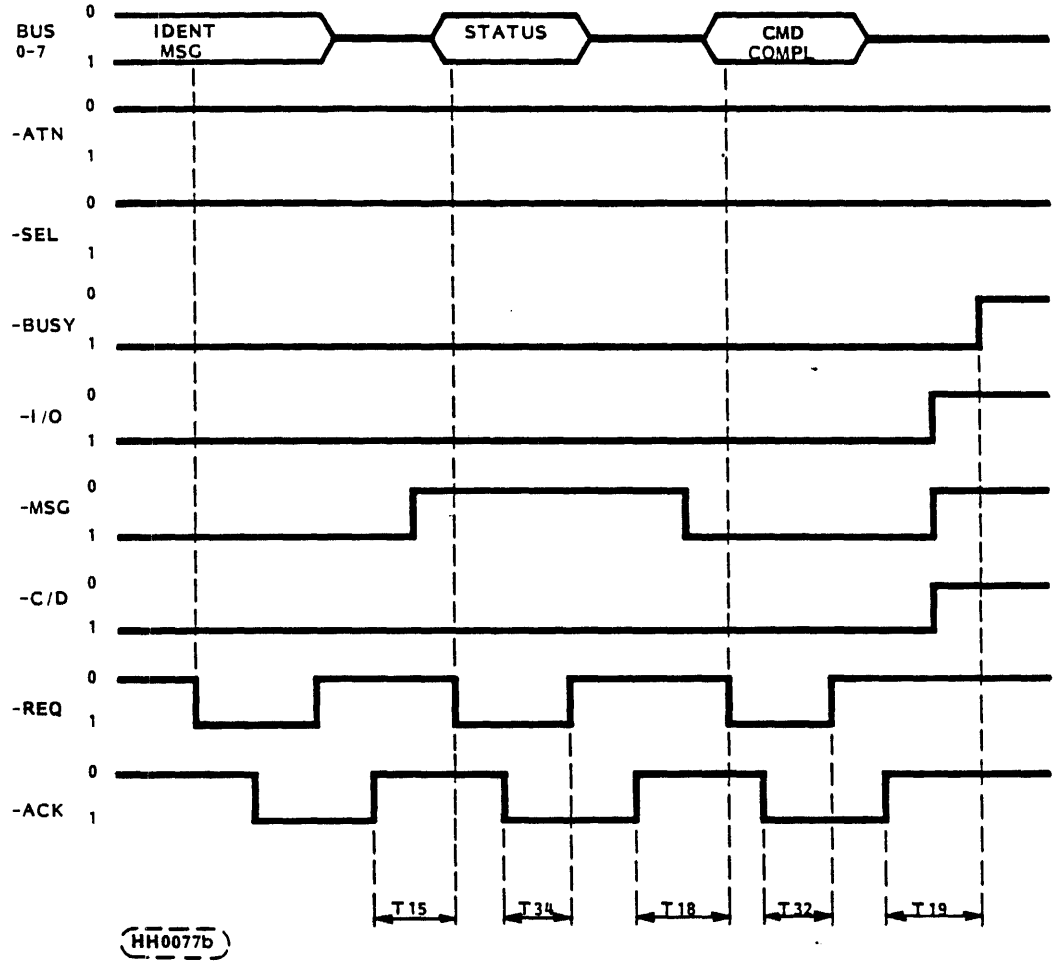


TABLE 13.4-9. LAST COMMAND BYTE TO DATA IN PHASE

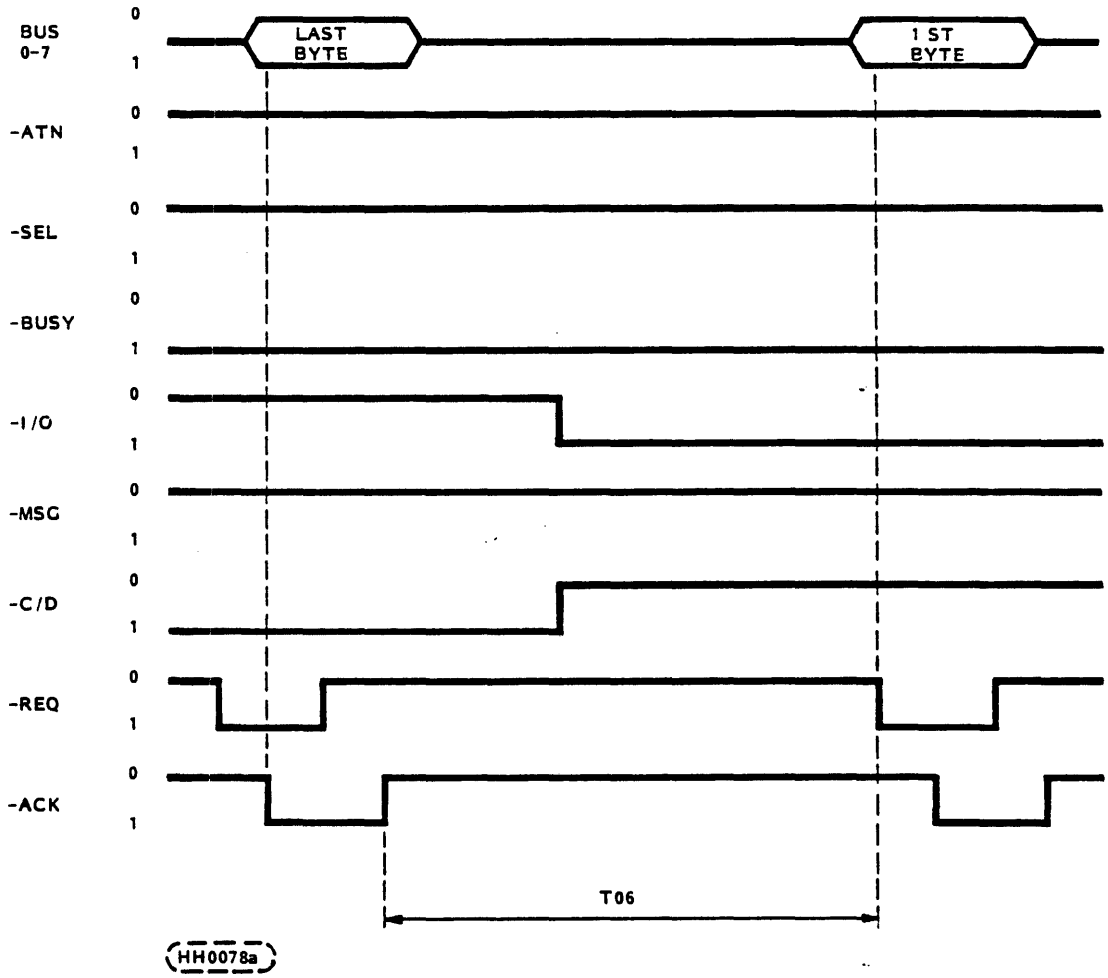


TABLE 13.4-10. LAST COMMAND BYTE TO DATA OUT PHASE

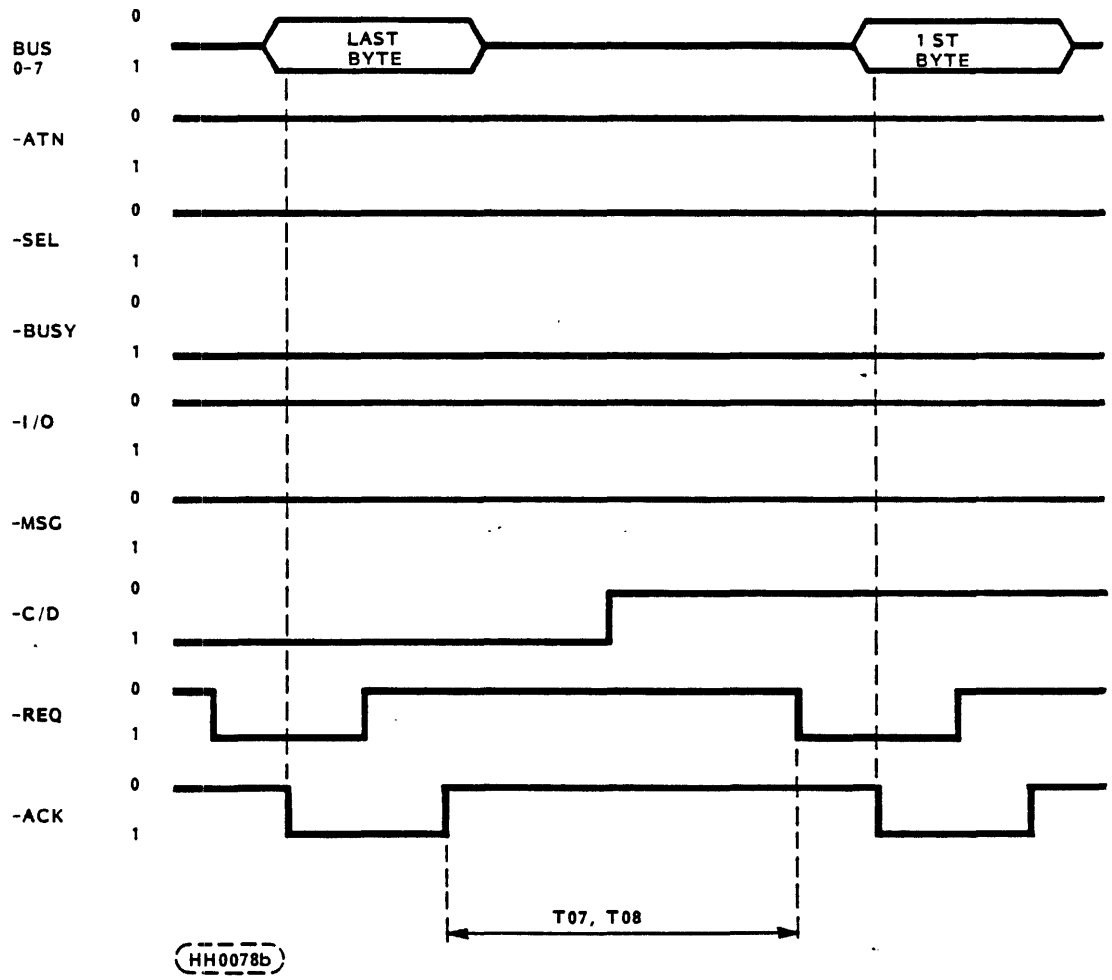


TABLE 13.4-11. RESELECT IDENTIFY MSG TO DATA IN PHASE

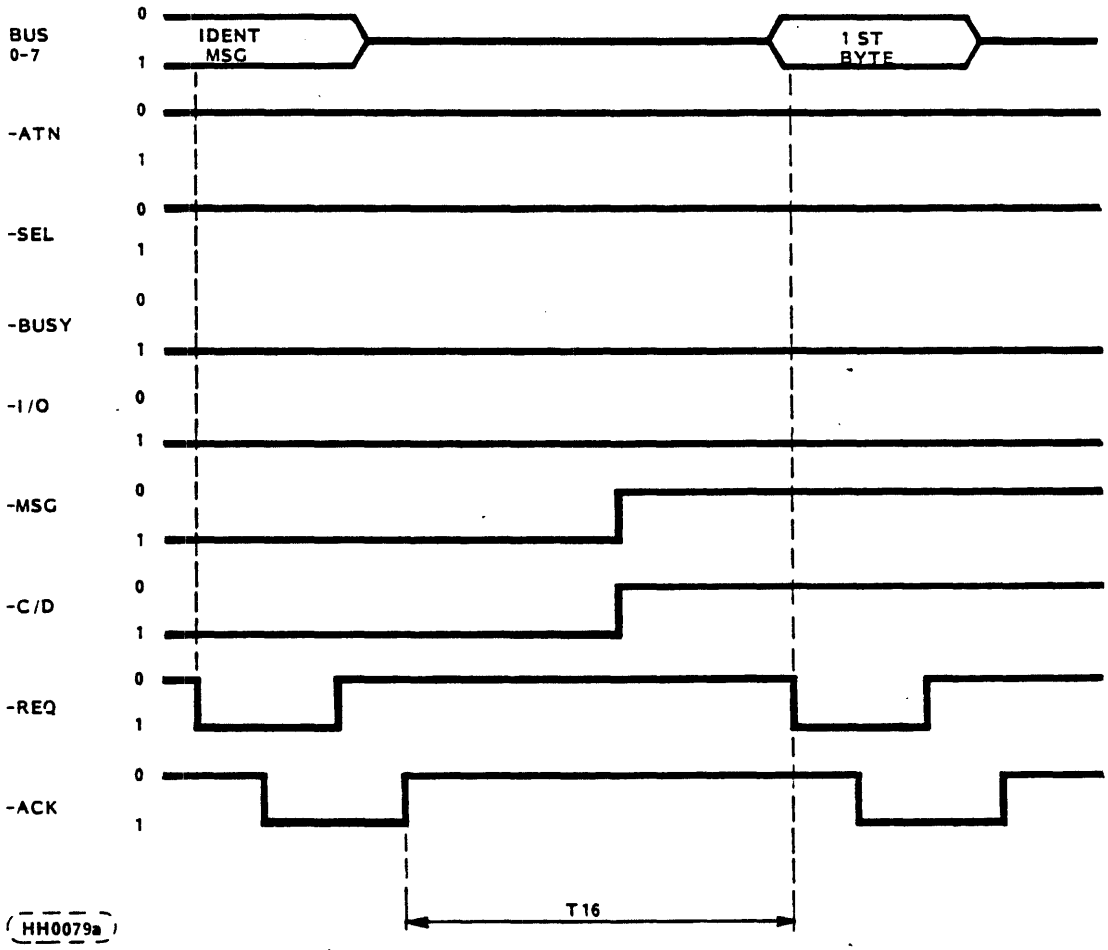


TABLE 13.4-12. DATA IN BLOCK TRANSFER

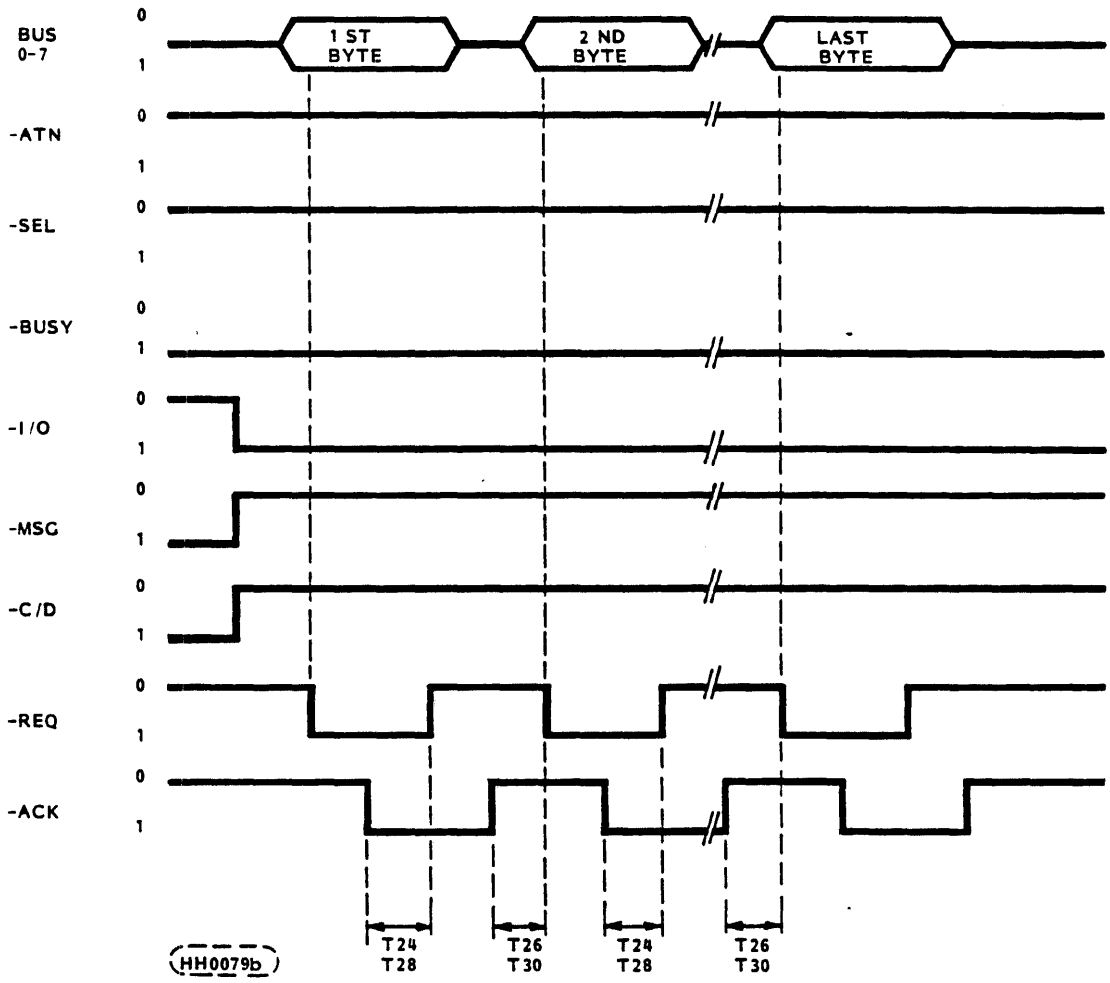


TABLE 13.4-13. DATA OUT BLOCK TRANSFER

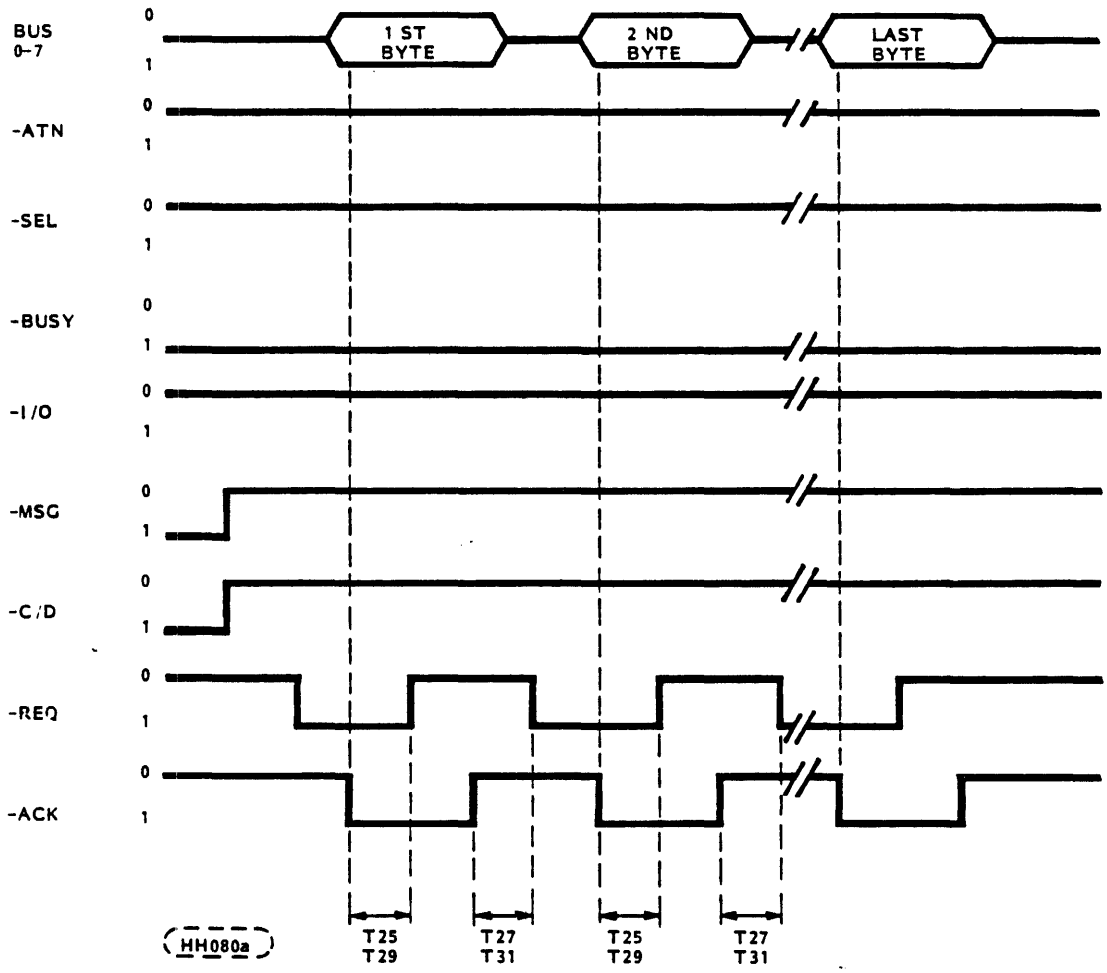


TABLE 13.4-14. LAST DATA BYTE, SAVE POINTER MSG, AND DISCONNECT MSG'

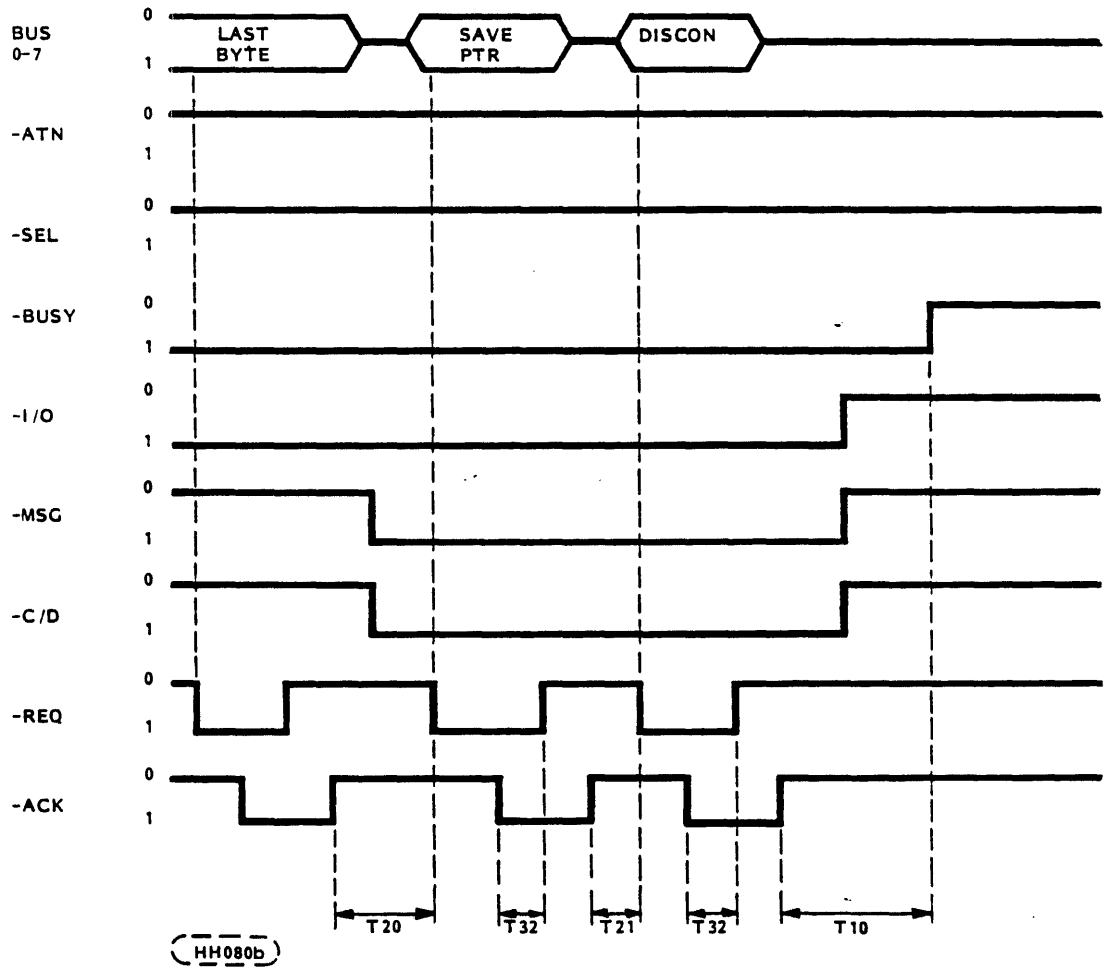
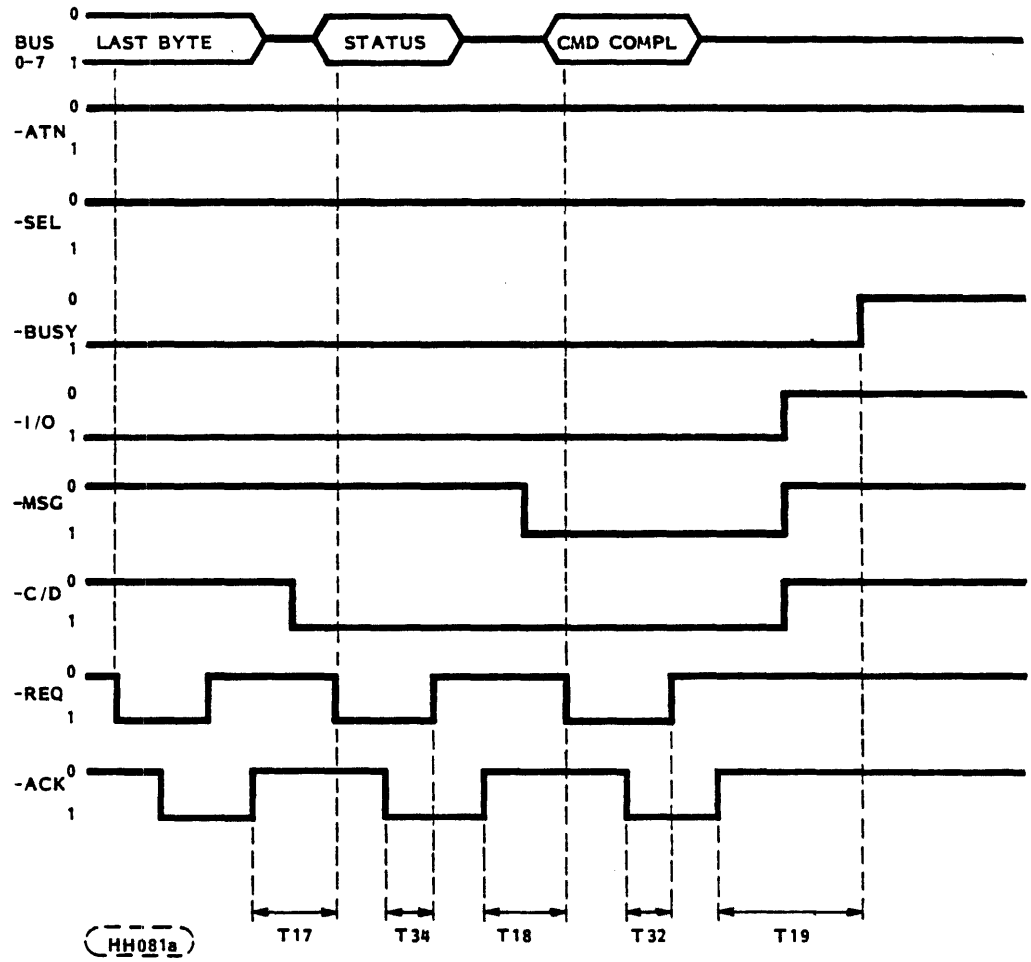


TABLE 13.4-15. DATA IN PHASE, STATUS PHASE, COMMAND COMPLETE MSG, AND BUS FREE



13.5 WREN IV SCSI TIMING

TABLE 13.5-1. WREN IV SCSI TIMING

DESCRIPTION	WAVEFORM SYMBOL	WAVEFORM TABLE	TYPICAL	MAX
Target Select Time (no Arbitration)	T00	N/A	<1.0 µs	<250 µs
Target Select Time (with Arbitration)	T01	13.4-1 13.4-2	<1.0 µs	<250 µs
Target Select to Command	T02	13.4-1	<150 µs	
Target Select to MSG Out	T03	13.4-2	<125 µs	
Identify MSG To Command	T04	13.4-3	<150 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	<500 µs	<700 µs
Command to Disconnect MSG	T09	13.4-6	Command Dependent	
Disconnect MSG to Bus Free	T10	13.4-6, 13.4-14	<100 µs	
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	<6 µs	
Arbitration to Reselect	T13	13.4-7	<5 µs	
Reselect to Identify MSG In	T14	13.4-7	<150 µs	
Reselect Identify MSG to Status	T15	13.4-8	<150 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	<150 µs	
Command Complete MSG to Bus Free	T19	13.4-5,8,15	<100 µs	
Data to Save Data Pointer MSG	T20	13.4-14	<175 µs	
Save Data Pointer MSG to Disconnect MSG	T21	13.4-14	<175 µs	
Command Byte Transfer	T22	13.4-4	<0.06 µs	0.1 µs
Next Command Byte Access	T23	13.4-4	<0.8 µs	100 µs⚠1
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	<0.8 µs	1.5 µs

⚠1 T23 will be <1 µs, except for byte 7 of a 10 byte CDB. A 6 byte CDB will require <5 µs for five T23 occurrences. A 10 byte CDB will require <110 µs for 9 occurrences.

TABLE 13.5-1. WREN IV 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	<0.8 µs	1.5 µs
Data In Byte Transfer (media) (2)	T28	13.4-12	<60 ns	100 ns
Data Out Byte Transfer (media) (2)	T29	13.4-13	<60 ns	100 ns
Next Data In Byte access (media) (2)	T30	13.4-12	<600 ns	1.2 ns
Next Data Out Byte access (media) (2)	T31	13.4-13	<600 ns	1.2 ns
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

(2) Maximum SCSI asynchronous interface transfer rate is 1.67 MB/second. Therefore, the, minimum time between two leading edges of Request is 600 ns.