SCSI UPGRADES AND EXPANSIONS

NOTE

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the installation instructions, it may interfere with radio communications. The equipment has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, which users may be required to correct at their own expense.

This document was produced using the Document Designer Series.

Specifications Subject to Change.

First Edition (December 1987) 09–01077–01

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LIST OF FIGURES

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ABOUT THIS MANUAL

This manual and companion manuals at the end of this manual describe the SCSI (Small Computer System Interface) device modules that attach to Series i and NGEN systems. This manual provides information common to all SCSI device modules. The companion manuals contain information specific to each SCSI device module. These companion manuals may be ordered separately.

MANUAL ORGANIZATION

This manual (the main manual) is organized as follows:

- Chapter 1, "Introduction," contains information about the manual set; lists where to find additional information; and provides an overview of SCSI, SCSI Upgrade and Expansion modules, and Series i and NGEN systems.

- Chapter 2, "Installation," provides configuration information and an installation overview.

- Chapter 3, "SCSI Information," presents technical information about the physical interface. The chapter includes a SCSI bus overview, connector pinouts, SCSI ID numbering, and SCSI specifications.

- Chapter 4, "Common Command Set for Hard Disk Drives," presents technical information about the firmware interface. The chapter includes an introduction to the Common Command Set and describes Convergent-specific implementations of the commands.

- A glossary of technical terms and an index are located after Chapter 4.

Companion manuals at the end of this manual are module specific and include major components, specifications, and an interconnect wirelist. If the module contains a controller (host adapter), the companion manual also includes a functional description and a software interface section.

This manual and the companion manuals contain no field service information.

WHERE TO FIND ADDITIONAL INFORMATION

The following table lists where to find information that pertains to SCSI Upgrades and Expansion.

WHERE TO FIND INFORMATION
(Page 1 of 3)

Topic	Location
Common Command Set	Chapter 4
Configuration	Chapter 2
Connectors	Module-specific companion manual

WHERE TO FIND INFORMATION
(Page 2 of 3)

Topic	Location
Controller	Companion manual for SCSI Upgrade module or Series i processor manual
Controller functional description	Companion manual for SCSI Upgrade module or Series i processor manual
Device addressing	Chapter 3
Diagnostics	Visinostics manual
Disk drive unit	Module inserts
Drivers	Companion manual for SCSI Upgrade module or Series i processor manual
Error Codes	Status Codes manual
Installation	Chapter 2; system installation manual; and hardware installation sheets
Interconnect wirelist	Module-specific companion manual
Major components	Module-specific companion manual
Motherboard	Module-specific companion manual
General Pinouts	Chapter 3
Power Codes	System installation manual
Power supply	Module-specific companion manual, Power Systems manual

WHERE TO FIND INFORMATION
(Page 3 of 3)

Topic	Location
Register Interface	Companion manual for SCSI Upgrade module or Series i processor manual
SCSI bus	Chapter 3; Companion manual for SCSI Upgrade module; Series i processor manual; American National Standards Institute specification (ANSI Committee X3T9.2, ANSI standard X3.131 approved June 23, 1986); and Common Command Set specification (Revision 4.B, June 23, 1986).
SCSI ID cable	Companion manual for SCSI Upgrade or Expansion module
SCSI ID jumpers	Chapter 3
SCSI specifications	American National Standards Institute
Software interfaces	Companion manual for SCSI Upgrade module or Series i processor manual
Specifications	Module-specific companion manual
System buses	Chapter 1
Termination	Chapter 3
X-bus	Processor manual

CONVENTIONS

This section describes conventions for numbers, signal names, and the special terms.

NUMBERS

Numbers in this manual are decimal unless suffixed as follows:

- An "h" represents hexadecimal notation, for example, 15h = 21 decimal, and 0F4h = 244 decimal.
- A "B" represents binary notation, for example, 011B = 3 decimal, and 1101B = 13 decimal.

SIGNAL NAMES

In this manual, active-low signals are suffixed with a minus sign (-). Active-high signals are suffixed with a plus sign (+). Examples of an active-high signal and an active-low signal follow:

Signal Name	Logical State	Voltage Level
RD-	0 (active)	Low
	1 (inactive)	High
RD+	0 (inactive)	Low
	1 (active)	High

TERMINOLOGY

This section defines the way the manual uses the terms controller, SCSI device, SCSI Expansion, SCSI Upgrade, HSX module, and HSD module. See the glossary for more definitions.

Controller

In this manual, the term **controller** means the host adapter. Controller always refers to the controller for the SCSI interface. Control circuitry within the SCSI device unit is transparent to the system and is not discussed in this manual.

SCSI Device

A SCSI device is any hard disk, floppy disk, tape drive, printer, scanner, etc. that supports the SCSI interface.

SCSI Expansion

A SCSI Expansion is any module that contains a SCSI device. The module expands system capabilities for memory or performance, but requires the SCSI controller in another module. Examples of SCSI Expansions include SCSI hard disk drive modules, SCSI tape drive modules, and SCSI scanner modules.

SCSI Upgrade

A SCSI Upgrade is any module that contains a SCSI controller and a SCSI device. The module upgrades system capabilities for memory or performance. An example of a SCSI Upgrade is a module containing a SCSI controller and a SCSI hard disk drive.

HSX Module

An HSX module is a SCSI hard disk expansion module.

HSD Module

An HSD module is a SCSI hard disk upgrade module.

RELATED DOCUMENTATION

The documents described below provide additional information related to the contents of this manual.

For a complete list of Convergent Technologies publications, see the Convergent Publications Catalog or the "Guide to Technical Documentation" in the Executive Manual or similar command-line interpreter manual for your operating system.

Introductory

Executive Manual

Status Code Manual

Operating Systems

CTOS Operating System Manual

Release Notices

Diagnostics

Visinostics

Hardware

NGEN Installation

Power System

Series i Hardware

Series i Installation

Specifications

Small Computer System Interface of the American National Standard for Information Systems Committee X3T9.2, ANSI Standard X3.131 approved June 23, 1986.

Common Command Set, Revision 4.B of the Common Command Set Subcommittee of X3T9.2 approved June 23, 1986.

Introductory

The Executive Manual describes the interactive command interpreter that interacts with the CTOS and CTOS/VM operating systems. The manual is both a user's guide and a reference to the available commands. It addresses command execution, file management and protection, and program invocation. The manual also provides descriptions and details about parameter fields for Executive commands.

The Status Codes Manual contains a complete list of all the status codes that can be generated by a CTOS workstation or a Shared Resource Processor (SRP), including bootstrap ROM error codes and CTOS initialization codes. The manual also describes and interprets error status codes.

Operating Systems

The CTOS Operating System Manual describes the CTOS operating system. It specifies services for managing processes, messages, memory, exchanges, tasks, video, disks, keyboard, printer, timer, communications, and files. In particular, it specifies the standard file access methods: SAM, the sequential access method; RSAM, the record sequential access method; and DAM, the direct access method.

Release Notices

The release notice contains instructions for installing the software and provides other information pertinent to the particular software release.

Diagnostics

The Visinostics manual contains detailed instructions for using NGEN/Series i diagnostic tests. Instructions for customizing the tests are also included.

Hardware

The NGEN Installation manual gives complete installation instructions for the NGEN workstation, from unpacking up to (but not including), software installation. This manual is intended for everyone, from the novice end user to the experienced technician.

The Power System manual describes the system power supply, which consists of the +36Vdc power supply and the dc/dc converter.

The Series i Hardware manual for the 286i and 386i contains installation instructions, a functional description, software interfaces, and I/O connector pinouts.

The Series i Installation manual gives complete installation instructions for the Series 286i or 386i workstation, from unpacking up to (but not including), software installation. This manual is intended for everyone, from the novice end user to the experienced technician.

1 INTRODUCTION

PRODUCT OVERVIEW

SCSI (Small Computer System Interface) Upgrades and Expansions are modular units that add SCSI devices to a Series i or NGEN system. A SCSI Upgrade module contains a controller (host adapter) and one or more SCSI devices. A SCSI Expansion module contains one or more SCSI devices and depends on another module for control of the SCSI bus and other host adapter functions.

Some examples of SCSI Upgrade and Expansion modules follow:

- HSD-140 is a SCSI Upgrade module that contains a SCSI controller and a 140M byte hard disk.

- HSX-020 is a SCSI Expansion module that contains an 80M byte hard disk. Since the HSX-020 has no controller (host adapter), the host system must contain either a SCSI Upgrade module or a Series i processor module.

- HSX-140 is a SCSI Expansion module that contains a 140M byte hard disk. Since the HSX-140 has no controller (host
- adapter), the host system must contain either a SCSI Upgrade module or a Series i processor module.

SCSI DEFINITION

SCSI is a standard of mechanical, electrical, and functional specifications for connecting intelligent peripheral devices to small computers. These peripheral devices can be hard or floppy disks, tape drives, printers, scanners, communication devices, etc.

The primary advantage of the SCSI standard is that the interface allows a variety of SCSI devices to be added to a system that already contains a SCSI interface with minimal hardware or software modification.

SCSI architecture uses the concept of memory blocks in the host processor for command, data, and status interchange between the host system and the SCSI device. In the middle of this exchange is the SCSI controller, which gates information between the host processor and the SCSI device.

NOTE: Check the software release notice to verify that the system has SCSI capability.

HOST SYSTEMS

The host system for SCSI devices is a Series i base processor, such as a 286i or 386i, or an NGEN processor module with a SCSI Upgrade module.

SERIES i PROCESSOR

The Series i base processor is a self-contained unit designed for office automation software. The Series i processor consists of a CPU, memory, and optional internal floppy/hard disks. The processor also contains controllers for the SCSI bus and the X-Bus. A Series i system can be expanded to include option cards, X-Bus modules, and up to seven SCSI device modules.

A Series i base processor without an optional internal hard disk can support seven SCSI Expansion modules. A Series i processor with an optional internal hard disk can support six SCSI Expansion modules. This number is determined by the limit of SCSI ID device numbers. See "SCSI Bus Limits in Chapter 2 and "SCSI ID Numbering" in Chapter 3 for more details.

NGEN SYSTEMS

NGEN systems are modular systems attached by the X-Bus that can be configured to support a variety of applications. A simple NGEN system consists of one processor module, a monitor, and a keyboard. An NGEN system can be expanded to include a variety of X-Bus modules.

With the addition of a SCSI Upgrade module to provide host adapter functions, an NGEN system can support up to six SCSI device modules. This number is determined by the limit of SCSI ID device numbers. See "SCSI Bus Limits" in Chapter 2 and "SCSI ID Numbering" in Chapter 3 for more details.

SYSTEM BUSES

System bus structure and the data path between a SCSI device and the host processor depend on system configuration. SCSI Expansion modules transmit both the X-Bus and the SCSI bus. SCSI Upgrade modules contain a SCSI bus controller and do not transmit the X-Bus.

Figure 1-1 shows three typical systems featuring HSX and HSD modules. The figure illustrates the way system configuration affects system buses. Note that the controller for the SCSI bus resides in the Series i processor module or in the SCSI Upgrade (HSD) module. Therefore, SCSI Expansion modules (HSX) must connect directly to a Series i or SCSI Upgrade module.

The configuration in the top illustration shows how data from X-Bus modules passes through HSX modules by way of the X-Bus to the host processor. Data from HSX modules goes by way of the SCSI bus to the host processor.

The middle illustration shows a configuration of HSX modules using the HSD SCSI controller instead of the Series i processor SCSI controller. In this case, the HSD controller transfers data from the SCSI bus onto the X-Bus to the host processor.

The bottom illustration shows a typical NGEN configuration, which requires an HSD module for SCSI control. The HSD controller transfers data from the SCSI bus onto the X-Bus to the host processor.

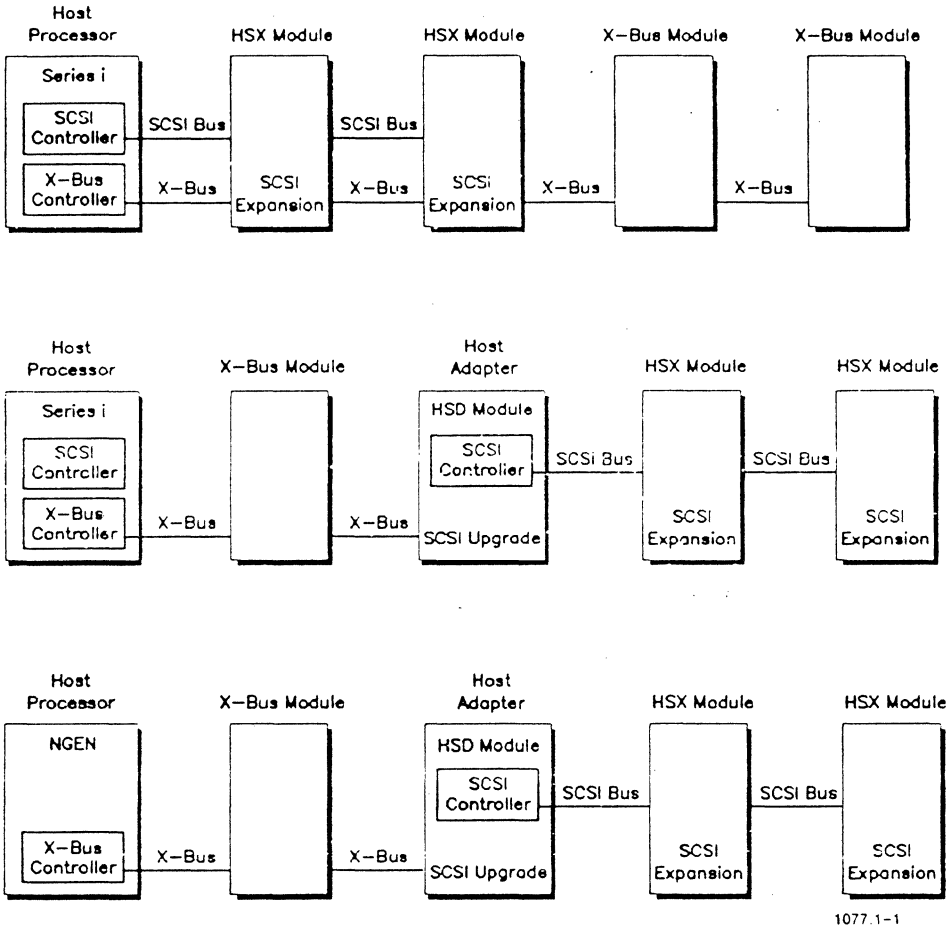

Figure 1-1. System Buses, HSX and HSD Modules

PHYSICAL DIFFERENCES BETWEEN SERIES i AND NGEN

This section describes how to determine if your system is Series i or NGEN.

A Series i processor module has the following physical features:

- width is 14 inches
- power ON/OFF switch pushes in and out
- module plugs into AC wall outlet
- front label reads **SERIES 286 i** or **SERIES 386i**

An NGEN processor module has the following physical features:

- width is 5.75 inches
- power ON/OFF switch slides up and down
- module plugs into power brick
- front label reads **PROCESSOR**, **PROCESSOR SERIES 286**, or **PROCESSOR SERIES 386**.

2 INSTALLATION

This chapter provides configuration information and an overview of the installation process. For complete information on attaching a SCSI device module to a Series i or an NGEN system, see the installation manual for that system.

SCSI MODULE CONFIGURATION

The next two figures show typical configurations that include HSX SCSI Expansion modules and HSD SCSI Upgrade modules. Figure 2-1 is a Series i configuration and Figure 2-2 is an NGEN configuration. Note that HSD SCSI Upgrade modules are wide (5 inches) and HSX SCSI Expansion modules can be wide or narrow (3 inches).

In both figures, notice the length restrictions given in brackets under the modules. The X-Bus limit is determined by length (24 inches). The SCSI bus limit is determined by the number of SCSI devices on the bus (8 devices). For the configurations shown in Figures 2-1 and 2-2, this means six HSX modules. Some Series i configurations support seven HSX modules. The next section provides more information on SCSI bus limits.

The top illustration in Figure 2-1 shows an important factor in SCSI module configuration: when the X-Bus passes through HSX modules, those HSX modules must be included in the X-Bus limitation of 24 inches. If this same configuration had no X-Bus modules, the system could be expanded to the limits of the SCSI bus.

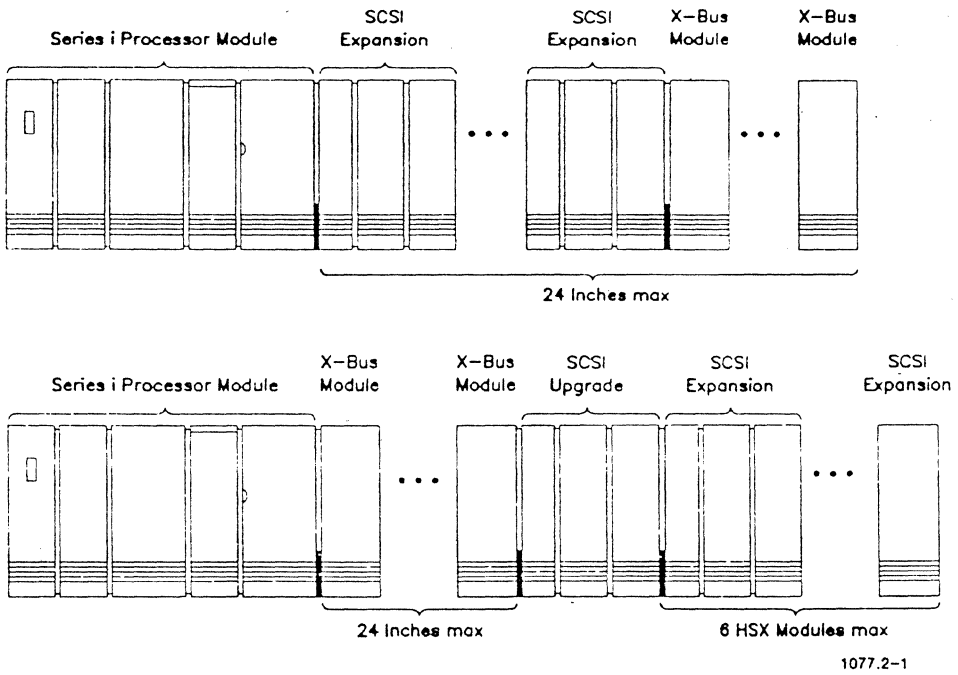

Figure 2-1. Typical Series i SCSI Configurations

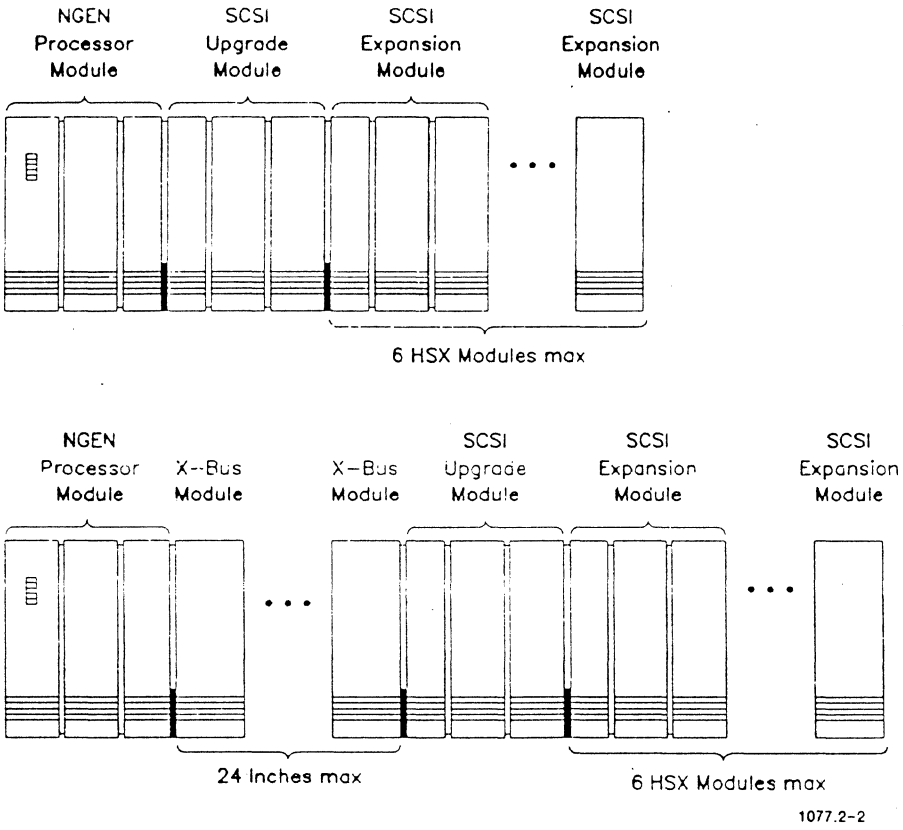

Figure 2-2. Typical NGEN SCSI Configurations

SCSI BUS LIMITS

The number of modules that can attach to the SCSI bus is either six or seven, depending on system configuration. This number is determined by the SCSI device numbering scheme, which gives one of eight unique ID numbers to each device on the bus.

One SCSI ID number is reserved for the controller and another SCSI ID number may be reserved for a hard disk within the controller module. Figure 2-3 shows two Series i configurations that illustrate the way a controller/hard disk combination influences the SCSI bus limits.

In the top illustration, the SCSI ID number assignment is as follows:

- One SCSI ID number is reserved for the controller in the Series i processor.
- One SCSI ID number is reserved for the hard disk in the Series i processor module.
- Six SCSI ID numbers are reserved for SCSI Expansion modules. Therefore, with this specific configuration, the SCSI bus can support six SCSI Expansion modules.

In the bottom illustration, the SCSI ID number assignment is as follows:

- One SCSI ID number is reserved for the controller in the Series i processor.
- Seven SCSI ID numbers are reserved for SCSI Expansion modules. Therefore, with this specific configuration, the SCSI bus can support seven SCSI Expansion modules.

Since the SCSI Upgrade module contains a controller and a hard disk, up to six SCSI Expansion modules can connect to one SCSI Upgrade module.

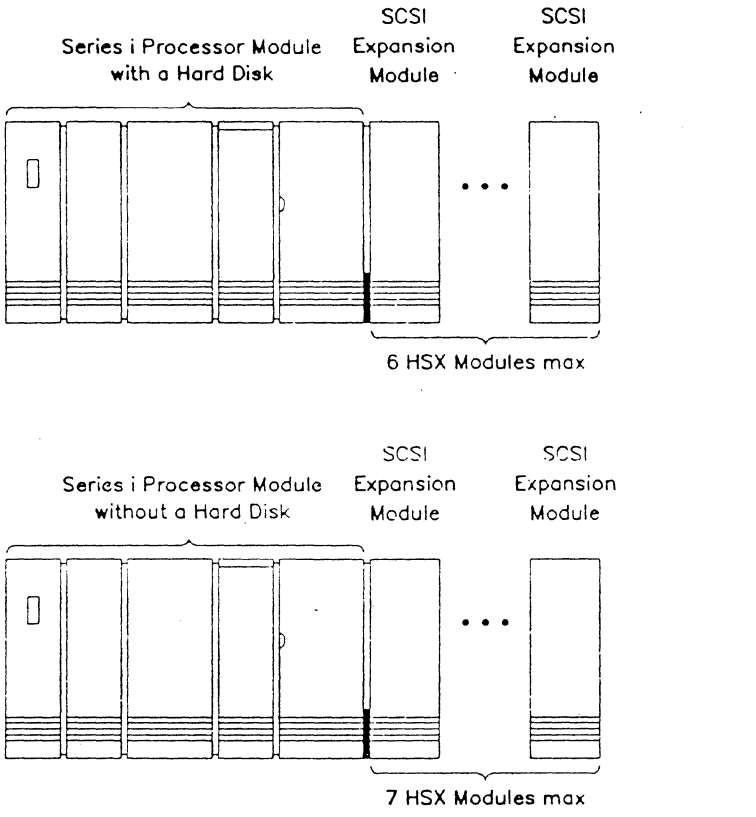

Figure 2-3. SCSI Bus Limits

HSX SCSI EXPANSION MODULE

This section lists configuration guidelines for an HSX SCSI Expansion module. Directions reference a system that is viewed from the front.

- Connect the first HSX module directly to the right side of either a Series i processor or an HSD module. See Figures 2-1 and 2-2.

- If the first HSX module connects directly to a Series i processor, attach any X-Bus modules to the right of the last HSX module. See the top illustration in Figure 2-1.

- If the first HSX module connects directly to an HSD module, attach any X-Bus modules to the left of the HSD module. See the bottom illustration in Figure 2-1.

- The number of HSX modules on the SCSI bus is limited to either six or seven, depending on system configuration. See the previous section for more information on SCSI bus limits.

- The length of the X-Bus cannot exceed 24 inches. See Figures 2-1 and 2-2 and "System Buses" in Chapter 1 for additional information.

NOTE: In some configurations, the X-Bus passes through SCSI Expansion modules. If this is the case, the width of the SCSI Expansion module is included in the 24-inch limit.

HSD SCSI UPGRADE MODULE

This section lists configuration guidelines for an HSD SCSI Upgrade module. Directions reference a system that is viewed from the front.

- In a Series i system, attach the HSD module to the right side of the last X-Bus module. HSX Expansion modules attach to the right side of the HSD module. See the bottom illustration in Figure 2-1.

- In an NGEN system with X-Bus modules, attach X-Bus modules to the right side of the processor module. Then attach the HSD module to the right side of the last X-Bus module. See the top illustration in Figure 2-2.

- In an NGEN system with no X-Bus modules, attach the SCSI Upgrade module directly to the right side of the NGEN processor module.

- The length of the X-Bus cannot exceed 24 inches. See Figures 2-1 and 2-2 and "System Buses" in Chapter 1 for additional information.

- The HSD module can support up to six SCSI Expansion modules.

INSTALLATION OVERVIEW

This section is an installation overview. See the processor module installation manual for complete installation instructions.

There are three main steps to install a SCSI device module.

1. Prepare the system for a new module.
2. Latch the new module to the system.
3. If necessary, connect another 36 Volt power brick to the system.

PREPARING THE SYSTEM FOR A NEW MODULE

The following instructions provide the necessary steps to prepare the system for a new module.

WARNING

Never install or remove modules with power applied. Failure to remove power may result in personal injury and/or damage to the equipment.

1. Turn the power off. In a Series i processor, push the power switch to the "0" or out position. In an NGEN processor, move the power switch to the "0" or down position.

2. Unplug ALL power cords from the AC wall socket.

3. If the new module attaches to the end of the system, remove the X-Bus cap from the last system module by lifting up at the bottom of the cap and pulling it off. See Figure 2-4.

4. If the new module attaches to the middle of the system, unlatch the module immediately to the right of the intended location.

   NOTE: Make sure that the latch handle of the new module is in the up position. See Figure 2-4.

5. Insert the new module.

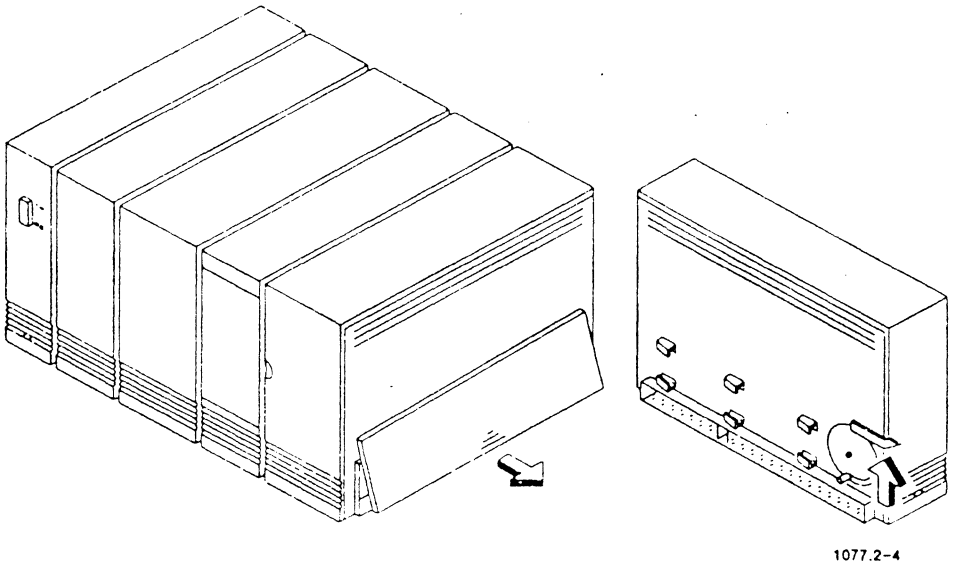

Figure 2-4. Removing the Bus Cap

LATCHING MODULES

The following instructions provide the necessary steps to latch a new module to the system.

1. Push the modules together, beginning at the rear and working towards the front. See Figure 2-5.

2. Lock the modules together by gently pushing down on the latch until it is flush with the front of the enclosure. See Figure 2-6.

Caution: Do not force the latch handle. If the latch handle does not move, verify that there are no bent X-Bus or SCSI bus pins, then try again.

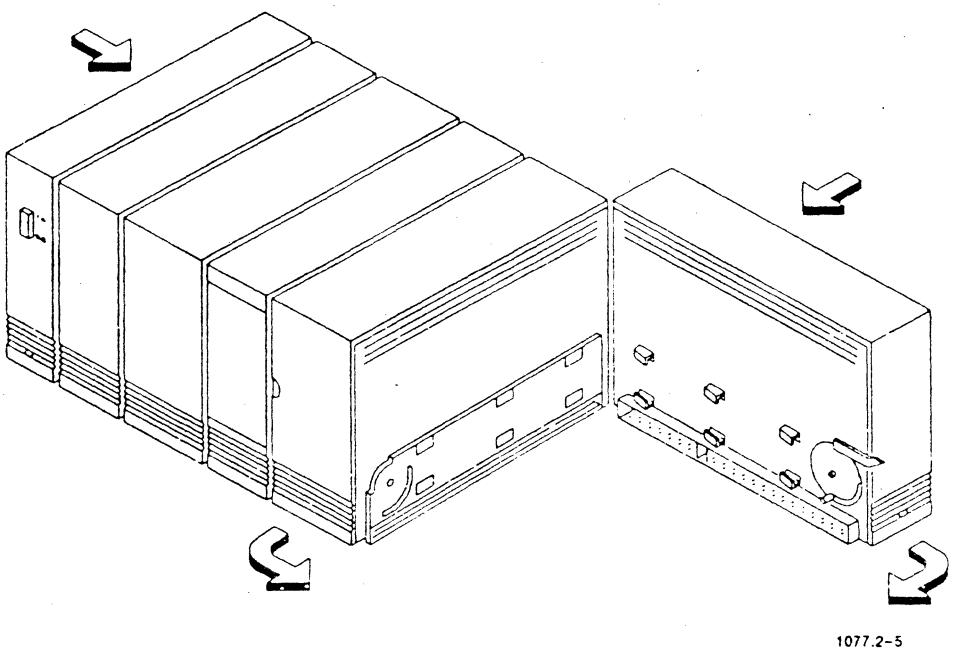

Figure 2-5. Pushing Modules Together

3. Push the modules together at the bottom to ensure complete electrical contact.

4. If this is the last module in the system, cover the exposed bus connectors with a cap.

To attach more modules to the system, follow the above procedure, attaching each module to the right side of the previous one.

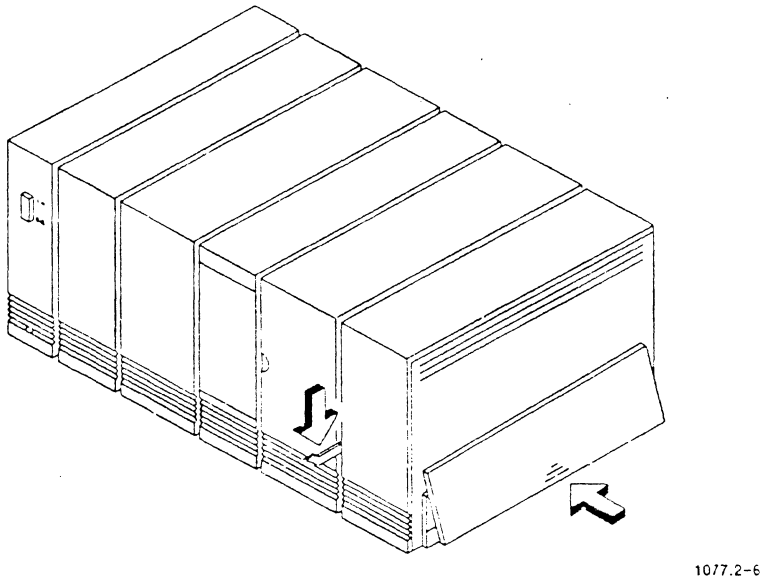

Figure 2-6. Latching Modules Together

CONNECTING POWER BRICKS

The following instructions provide the necessary steps to connect a power brick (36 Vdc power supply) to the new module. To determine if the new system configuration requires another brick, see the system installation manual for an explanation of power codes.

1. Turn the power off. In a Series i processor, push the power switch to the "0" or out position. In an NGEN processor, move the power switch to the "0" or down position.

2. Make sure that the system and all power bricks are disconnected from the AC wall outlet.

3. Plug one end of the flat power cable into the output jack of the power brick. The cable connector is keyed and clicks into place.

   Figure 2-7 shows how to attach a power brick to the first SCSI Expansion module in a Series i system.

4. Plug the other end of the flat power cable into the connector at the rear of the module. The cable connector is keyed and clicks into place.

5. Plug the power brick into the AC wall outlet. The female connector on the power cord connects to the brick, and the male connector on the power cord connects to the AC wall outlet.

6. Turn on system power. In a Series i processor, push the power switch to the "1" or in position. In an NGEN processor, move the power switch to the "1" or up position.

NOTE: To stack power bricks, use a short extension cable to connect two bricks. Make sure that no more than two bricks connect to one AC wall outlet.

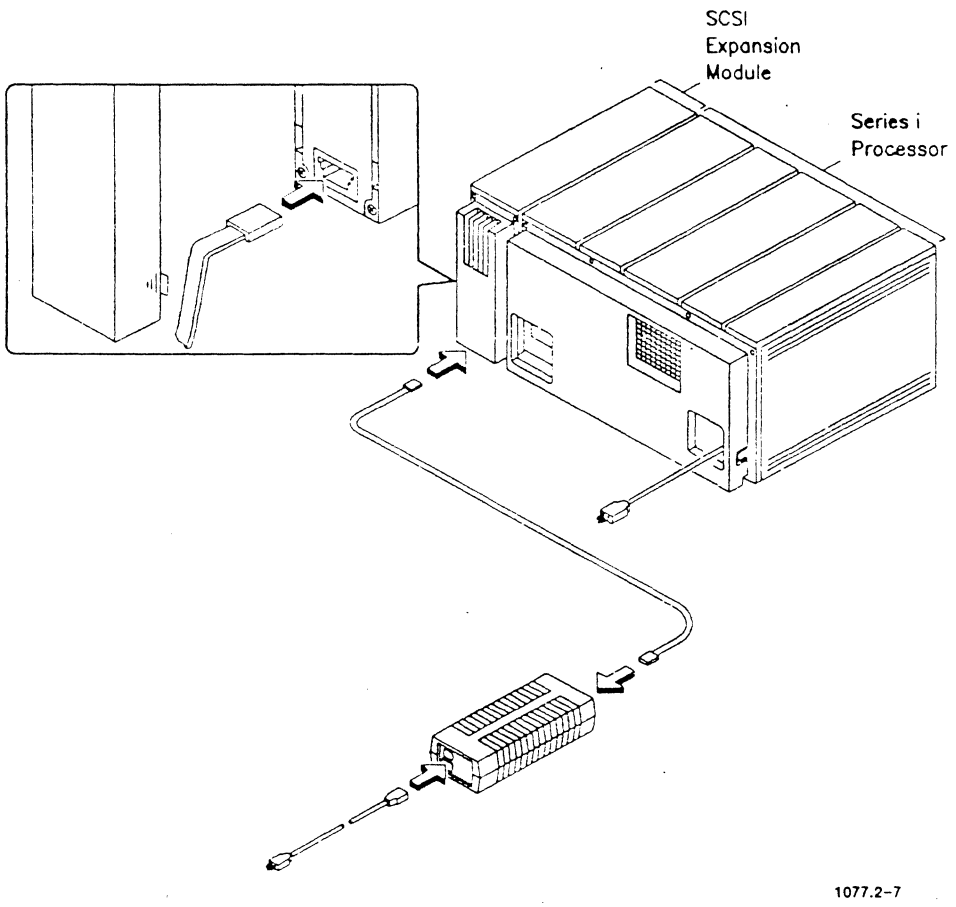

Figure 2-7. Connecting Power to a Series i System

3 SCSI MODULE PHYSICAL INTERFACE

INTRODUCTION

The SCSI interface is a combination of two entities: the physical interface and the firmware interface. The physical interface consists of the SCSI bus, connector pinouts, and other hardware implementations of the SCSI standard. The firmware interface consists of the command set used by devices on the SCSI bus.

This chapter describes the physical interface used by all SCSI Upgrade and Expansion devices. The next chapter describes the firmware interface used by one type of SCSI device, the hard disk drive.

ANSI SCSI SPECIFICATION

SCSI devices contained in SCSI Upgrade and Expansion modules conform to the Small Computer System Interface of the American National Standard for Information Systems committee X3T9.2. Except for the refinements described in the next chapter, all SCSI devices meet, as a minimum level, the ANSI standard X3.131 approved June 23, 1986.

SCSI BUS DESCRIPTION

SCSI bus communication takes place between only two SCSI devices at a time. One device acts as an initiator, and one acts as a target. The initiator starts an operation, requesting the transfer of command, status, or data information on the bus. The target performs the operation.

SCSI Upgrades and Expansions use a single-initiator/multiple-target model. The SCSI controller (host adapter) acts as the initiator and the SCSI devices (disk drives, tape drives, scanners, etc.) act as the targets.

Data transfers on the bus are synchronous or asynchronous and follow a request/acknowledge handshake protocol. Each handshake transfers one 8-bit byte of information.

The SCSI bus has seventeen signals: nine are control signals and eight are data signals. Table 3-1 describes the SCSI bus signals functions. For pinouts and signal names, see "Connector Pinouts" at the end of this chapter.

Table 3-1
SCSI BUS SIGNALS
(Page 1 of 2)

Signal	Description
BUSY	An OR-tied signal that indicates when the bus is being used.
SELECT	An OR-tied signal used by the initiator to select a target or by the target to reselect an initiator.
COMMAND/DATA	A signal from the target that indicates whether control or data information is on the bus.
INPUT/OUTPUT	A signal from the target that controls the direction of data movement on the bus. Signal assertion indicates input to the controller.
MESSAGE	A signal from the target that puts the bus into a message phase.

Table 3-1
SCSI BUS SIGNALS
(Page 2 of 2)

Signal	Description
REQUEST	A signal from the target that indicates a request for a REQ/ACK data transfer handshake.
ACKNOWLEDGE	A signal from the initiator that indicates acknowledgment for a REQ/ACK data transfer handshake.
ATTENTION	A signal from the initiator that indicates it has a message ready.
RESET	An OR-tied signal from the target or initiator that indicates a reset condition.
DB7-DB0	Data bit signals. DB7 is the most-significant bit and has the highest priority during bus arbitration.

SCSI ID NUMBERING

Each device on the SCSI bus has one of eight unique SCSI ID numbers. These numbers allow the controller to address the device and prioritize device requests. Typically, a SCSI device has SCSI ID jumpers that set this number. SCSI Upgrade and Expansion modules, however, perform automatic and sequential SCSI ID numbering without jumper setting changes.

Automatic numbering begins inside the modules when the system is turned on. The SCSI controller transmits SCSI ID number 1 to the first SCSI Expansion module on the bus. The SCSI Expansion module relays the number to its device via the SCSI ID cable, in effect, setting the device ID jumpers to 1. Module circuitry then increments the number by one and sends SCSI ID number 2 to the next SCSI Expansion module. The process repeats until all devices on the SCSI bus have an ID number from 0 to 7.

SCSI ID numbers are transmitted by SCSI Expansion bus signals SCSI_ID0-, SCSI_ID2-, and SCSI_ID3-.

SCSI ID NUMBER ASSIGNMENTS

SCSI ID number assignments follow these rules:

- The controller is always SCSI ID 7.
- Any SCSI device within the controller module is always SCSI ID 0.
- The first SCSI Expansion module on the bus contains a device that is numbered SCSI ID 1.
- After SCSI ID 1, module device numbers are sequential, except in a Series i system with no SCSI device in the processor module. In this case, SCSI ID 6 is followed by SCSI ID 0.

TERMINATION

SCSI Upgrades and Expansions require no additional termination. SCSI bus signals are terminated internally.

CONNECTOR PINOUTS

Each side of a SCSI Upgrade or Expansion module has two connectors: one for the X-Bus and one for the SCSI Expansion bus. Table 3-2 lists pinouts for the X-Bus connectors and Table 3-3 lists pinouts for the SCSI Expansion Bus connectors.

Table 3-2
X-BUS CONNECTOR PINOUTS (120 PINS)
(Page 1 of 2)

Pin	Signal	Pin	Signal
1	+5V	2	+5V
3	GND	4	GND
5	XPWREN-	6	XDACK3-
7	XDRQ3-	8	XDACK2-
9	XDRQ2-	10	XDACK1-
11	GND	12	XDRQ1-
13	XDRQ4-	14	XADRF-
15	XADRE-	16	XADRD-
17	GND	18	XADRC-
19	XADRB-	20	XADRA-
21	XADR17-	22	XADR16-
23	GND	24	XADR15-
25	XADR14-	26	XADR13-
27	XADR12-	28	XADR11-
29	GND	30	XADR10-
31	XADR9-	32	XADR8-
33	XADR7-	34	XADR6-
35	GND	36	XADR5-
37	XADR4-	38	XADR3-
39	XADR2-	40	XADR1-
41	GND	42	XADR0-
43	Reserved	44	XPOUT+
45	Reserved	46	X33KHZSYNC+
47	GND	48	XINTR5-
49	XINTR3-	50	XINTR4-
51	XINTR2-	52	XINTR1-
53	GND	54	XINTR0-
55	XMODE3-	56	Reserved
57	XMEMRD-	58	XMEMWR-
59	GND	60	XDMAEN-

Table 3-2

X-BUS CONNECTOR PINOUTS (120 PINS)

(Page 2 of 2)

Pin	Signal	Pin	Signal
61	XMODE2-	62	XDATF-
63	XDATE-	64	XDATD-
65	GND	66	XDATC-
67	XDATB-	68	XDATA-
69	XDAT9-	70	XDAT8-
71	GND	72	XDAT7-
73	XDAT6-	74	XDAT5-
75	XDAT4-	76	XDAT3-
77	GND	78	XDAT2-
79	XDAT1-	80	XDAT0-
81	XSPKR-	82	XACK-
83	GND	84	XLOCK-
85	XBHE+	86	XRESET-
87	Reserved	88	Reserved
89	GND	90	Reserved
91	XIOWR-	92	XIORD-
93	XPCLK-	94	GND
95	XDCLK-	96	GND
97	GND	98	GND
99	+5 V	100	+5 V
101	Reserved	102	Reserved
103	Reserved	104	Reserved
105	Reserved	106	Reserved
107	Reserved	108	Reserved
109	+36VRTN	110	+36V
111	+36VRTN	112	+36V
113	+36VRTN	114	+36V
115	+36VRTN	116	+36V
117	+36VRTN	118	+36V
119	+36VRTN	120	+36V

Table 3-3

SCSI EXPANSION BUS CONNECTOR PINOUTS

Pin	Signal Name	Pin	Signal Name
1	RESERVED	23	SCSIATTN-
2	SCSI_ID0-	24	RESERVED
3	BSD0	25	SCSIBSY-
4	GND	26	GND
5	BSD1	27	SCSIACK-
6	RESERVED	28	RESERVED
7	BSD2	29	SCSIRST-
8	GND	30	GND
9	BSD3	31	MSG-
10	SCSI_ID2-	32	RESERVED
11	BSD4	33	SCSISEL-
12	GND	34	GND
13	BSD5	35	C_D
14	SCSI_ID3-	36	RESERVED
15	BSD6	37	REQ-
16	GND	38	GND
17	BSD7	39	I_O
18	RESERVED	40	GND
19	RESERVED	41	RESERVED
20	GND	42	GND
21	RESERVED	43	GND
22	SCSI_DEVICE-	44	GND

4 SCSI FIRMWARE INTERFACE

INTRODUCTION

The SCSI interface is a combination of two entities: the physical interface and the firmware interface. The physical interface consists of the SCSI bus, connector pinouts, and other hardware implementations of the SCSI standard. The firmware interface consists of the command set used by devices on the SCSI bus.

The previous chapter describes the physical interface used by all SCSI Upgrade and Expansion devices. This chapter details the firmware interface used by one type of SCSI device, the hard disk drive.

The chapter describes three levels of SCSI commands; each level is an enhancement or closer definintion of the previous level. The levels are based on SCSI command architecture, which provides for three command types: optional, mandatory, and vendor specific. The levels are

1. The SCSI Command Set as specifed in the SCSI standard. This level applies to all SCSI devices.

2. The Common Command Set (CCS) as specified by a SCSI subcommittee. This level applies to SCSI hard disk drives. The CCS subcommittee changed some SCSI command types from optional to mandatory and further defined command structure.

3. HSX/HSD enhancements to the Common Command Set. This level applies to SCSI hard disk drives in HSX and HSD modules. Convergent Technologies changed some CCS command types from optional to mandatory and further defined command structure.

SCSI COMMAND SET OVERVIEW

SCSI Upgrade and Expansion devices use the command set specified in the SCSI standard. The commands provide the interface with a contiguous set of logical blocks of data with a defined length. A single command transfers one or more logical blocks.

The first byte of a SCSI command contains a group code field and a command code field. The 3-bit group code field contains information such as the command length and whether the command is vendor unique. The 5-bit command code field contains the hex operation code for the command. Since field lengths allow 8 group codes and 32 command codes, a total of 256 operations can be specified by the first command byte.

The succeeding bytes of a SCSI command contain information such as logical unit number, logical block address, transfer length, and a control byte.

COMMON COMMAND SET FOR HARD DISK DRIVES

The Common Command Set is a refinement of the SCSI command set described above and was developed to provide an industry standard for hard disk drives. Developers of the Common Command Set enhanced and further defined command structures and changed a number of command types from optional to mandatory.

SCSI Upgrade and Expansion hard disk drives (HSX/HSD) use the Common Command Set, Revision 4.B (June 23, 1986) of the Common Command Set Subcommittee of X3T9.2.

HSX/HSD ENHANCEMENTS TO THE COMMON COMMAND SET

Convergent Technologies has further refined the Common Command Set in order to improve HSX/HSD disk drive functions. This section describes these Common Command Set refinements and supersedes both the SCSI specification and the Common Command Set specification.

MESSAGES (SCSI 5.5.2)

Table 4-1 supersedes Message Code Table 5-2 in both the SCSI specification and the Common Command Set specification.

Table 4-1
MESSAGE CODES

Code	Type	Description	Direction
00h	M	Command Complete	In
01h	O	Extended Message	In Out
02h	M*	Save Data Pointer	In
03h	M	Restore Pointers	In
04h	M*	Disconnect	In
05h	M*	Initiator Detected Error	Out
06h	M	Abort	Out
07h	M	Message Reject	In Out
08h	M	No Operation	Out
09h	M*	Message Parity Error	Out
0Ah	O	Linked Command Complete	In
0Bh	O	Linked Cmd Complete (w/Flag)	In
0Ch	M	Bus Device Reset	Out
0Dh-Fh	R	(Reserved Codes)	
80h-FFh	M	Identify	In Out

M = Mandatory
O = Optional
R = Reserved
* = Change from Common Command Set

GROUP 0 COMMANDS

Table 4-2 supersedes the Group 0 Commands Table in the SCSI specification, Section 8.1, and in the Common Command Set specification.

REZERO UNIT Command

HSX/HSD hard disk drives support the REZERO UNIT command (code 01h) found in the SCSI specification, Section 8.1.1.

REASSIGN BLOCKS Command

HSX/HSD hard disk drives support the REASSIGN BLOCKS command (code 07h) found in the SCSI specification, Section 8.1.3. The disk drives have a spare block capacity of at least one block per formatted megabyte. There is no limit on the number of blocks that can be reassigned on a given track or cylinder.

SEEK Command

HSX/HSD hard disk drives support the SEEK command (code 0Bh) found in the SCSI specification, Section 8.1.6.

Table 4–2
GROUP 0 COMMANDS FOR HSX/HSD HARD DISK DRIVES

Operation Code	Type	Command Name	SCSI Section
00h	M	TEST UNIT READY	7.1.1
01h	M*	REZERO UNIT	8.1.1
02h	V		
03h	M	REQUEST SENSE	7.1.2
04h	M	FORMAT UNIT	8.1.2
05h-06h	V		
07h	M*	REASSIGN BLOCKS	8.1.3
08h	M	READ	8.1.4
09h	V		
0Ah	M	WRITE	8.1.5
0Bh	M*	SEEK	8.1.6
0Ch-11h	V		
12h	M	INQUIRY	7.1.3
13h-14h	V		
15h	M*	MODE SELECT	8.1.7
16h	M	RESERVE	8.1.8
17h	M	RELEASE	8.1.9
18h	O	COPY	7.1.4
19h	V		
1Ah	M*	MODE SENSE	8.1.10
1Bh	O	START/STOP UNIT	8.1.11
1Ch	O	RECEIVE DIAGNOSTIC RESULTS	7.1.5
1Dh	M	SEND DIAGNOSTIC	7.1.6
1Eh	O	PREVENT/ALLOW MEDIUM REMOVAL	8.1.12
1Fh	R		

M = Mandatory
O = Optional
R = Reserved
V = Available for vendor-specific commands
* = Change from Common Command Set

MODE SELECT/MODE SENSE Commands

HSX/HSD hard disk drives support the MODE SELECT (code 15h) and MODE SENSE (code 1Ah) commands found in the SCSI specification, Sections 8.1.7 and 8.1.10 and in the Common Command Set specification. The disks have a spare block capacity of at least one block per formatted megabyte. There are no limits on the number of blocks that can be reassigned on a given track or cylinder.

All blocks supported by the disks have the same block length, which defaults to 512 bytes.

Page Defaults. MODE SENSE and MODE SELECT commands provide a way for the initiator to specify device parameters to the HSX/HSD hard disk drive. The command references a block of information called a "page." The page contains a number of parameters grouped by functionality. This section lists the defaults for Pages 1-4.

Page 1, Read/Write Error Recovery Parameters

The following fields are changeable and saveable and have the defaults specified below:

FIELD	DEFAULT
TB	don't care
EEC	0
PER	don't care
DTE	0
DCR	0
Retry Count	2<X<255

Depending on the drive manufacturer, the following fields may be used. If they are used, they are changeable and saveable and have the defaults specified below:

FIELD	DEFAULT
ARRE	0
AWRE	0
RC	0

Page 2, Disconnect/Reconnect Control Parameter Read

All fields in this page are optional and may be used by some HSX/HSD disk drives.

Page 3, Device Format Parameters

All fields in this page are optional and may be used by some HSX/HSD hard disk drives. The following fields have defaults:

FIELD	DEFAULT
Sectors per Track	Actual value used by drive but never 0.
Data Bytes per Physical Sector	512

Page 4, Drive Geometry Parameters

All fields in this page are optional and may be used by some HSX/HSD disk drives. The following fields have defaults:

FIELD	DEFAULT
Number of Cylinders	Actual value used by drive but never 0.
Number of Heads	Actual value used by drive but never 0.

GROUP 1 COMMANDS (SCSI 8.2)

Table 4-3 supersedes the Group 1 Commands Table found in the SCSI specification, Section 8.2 and in the Common Command Set specification.

Table 4-3
GROUP 1 COMMANDS FOR HSX/HSD HARD DISK DRIVES

Operation Code	Type	Command Name	SCSI Section
20h-24h	V		
25h	M	READ CAPACITY	8.2.1
26h-27h	V		
28h	M	READ EXTENDED	8.2.2
29h	V		
2Ah	M	WRITE EXTENDED	8.2.3
2Bh	O	SEEK EXTENDED	8.2.4
2Ch-2Dh	V		
2Eh	O	WRITE AND VERIFY	8.2.5
2Fh	M*	VERIFY	8.2.6
30h	O	SEARCH DATA HIGH	8.2.7.1
31h	O	SEARCH DATA EQUAL	8.2.7.2
32h	O	SEARCH DATA LOW	8.2.7.3
33h	O	SET LIMITS	8.2.8
34h-38h	R		
39h	O	COMPARE	7.2.1
3Ah	O	COPY AND VERIFY	7.2.2
3Bh-3Fh	R		

M = Mandatory
O = Optional
R = Reserved
V = Available for vendor-specific commands
* = Change from Common Command Set

VERIFY Command (SCSI 8.2.6)

HSX/HSD disk drives support the VERIFY command found in the SCSI specification, Section 8.2.6. The relative address (RelAdr) bit and the Byte Check (BytChk) bits are optional.

GLOSSARY

brick. The 36 Volt power supply that provides power to a processor module, X-Bus module, SCSI Upgrade module, or SCSI Expansion module.

bus. A common conductor or group of conductors for one or more signals. A bus can also distribute power and ground.

bus cap. A plastic cover for the X-Bus and SCSI Expansion bus connectors.

byte. A group of eight adjacent bits that operate as a unit.

Common Command Set. A SCSI command set refinement that was developed to provide an industry standard for hard disk drives.

connect. A function that occurs when a SCSI intiator selects a SCSI target to start an operation. See disconnect.

controller. A device used to regulate a specific function or feature.

Central Processing Unit (CPU). The part of a computer system that contains main storage, the arithmetic unit, and special register groups. The CPU is the master control, computational, and decision-making unit of a computer.

CPU. See Central Processing Unit.

DMA. See Direct Memory Access.

Direct Memory Access. A process that transfers data between a peripheral device and memory, bypassing the CPU.

disconnect. A function that occurs when a SCSI target releases control of the SCSI bus.

expansion. A system module that expands system capabilities but does not contain a controller.

handshake. A process that exchanges control signals between two devices.

host adapter. A controller that acts as the interface between a SCSI peripheral device and a host processor.

HSD Module. A SCSI hard disk upgrade module.

HSX Module. A SCSI hard disk expansion module.

ID Number. See SCSI ID Number.

initiator. A SCSI device that requests an operation to be performed by another SCSI device.

interface. A shared boundary between systems or between parts of a system. The boundary can be electrical, mechanical, functional, or contractual.

motherboard. The main PC board, which contains connectors to module components and to system buses.

NGEN system. Modular computer system that can be configured to support a variety of applications. Parts of an NGEN system can include a processor module, monitor, keyboard, X-Bus modules, and SCSI modules.

OR-tied signal. A common control line that can be activated by one or more drivers.

page. In the Common Command Set, a block of information that contains device parameters.

power brick. See brick.

power code. The number assigned to each module (or system unit) that determines power supply system configuration. Each power brick supports a module or group of modules as long as the sum of the power codes does not exceed ten.

processor module (NGEN). The central NGEN component that contains the CPU, memory, I/O, video/keyboard support, and power supply circuitry. Each NGEN system must have one (and only one) processor module.

processor (Series i). The base processor or main component of a Series i system. Contains the CPU, memory, I/O circuitry, power supply, and optional internal floppy/hard disks. Each Series i system must have one (and only one) base processor.

protocol. The set of conventions that governs the format and timing of message exchanges.

RAM. Random-access memory.

ROM. Read-only memory.

SCSI. See **Small Computer System Interface**

SCSI controller. A device that acts as the interface between a SCSI peripheral device and a host processor. Synomous with host adapter.

SCSI device. Any controller, hard disk, floppy disk, tape drive, printer, scanner, etc. that supports the SCSI interface.

SCSI Expansion. An expansion module that contains a SCSI device but no SCSI controller. Examples of SCSI Expansions include SCSI hard disk drive modules, SCSI tape drive modules, and SCSI scanner modules.

SCSI ID number. The octal representation of the unique address (0-7) assigned to each SCSI device.

SCSI Upgrade. A module that contains a SCSI controller and a SCSI device. An example of a SCSI Upgrade is a module containing a SCSI controller and a SCSI hard disk drive.

Series i system. A computer system that consists of the Series i base processor and attached X-Bus modules, SCSI Upgrade modules, and SCSI Expansion modules. See also **processor.**

Small Computer System Interface. An industry standard of mechanical, electrical, and functional specifications for connecting intelligent peripheral devices to small computers.

target. A SCSI device that performs an operation requested by an initiator.

upgrades. System modules that improve/enhance system performance and contain a controller.

X-Bus. Standard asynchronous system bus that provides total configurability and interconnection of system modules. The X-Bus supports two independent address spaces: memory and I/O. The X-Bus structure is build upon the master/slave concept, allowing modules of different speeds to interface.

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