StorageWorks™ Solutions

SWXRC–04 RAID Controller OEM User and Service Guide

Order Number: EK–SMSC1–UG. A01

This guide presents OEM operation and maintenance information for the SWXRC–04 RAID controller. It presents a description of the controller and covers controller and subsystem configuration, operating, troubleshooting, and removal and replacement procedures.

Note

The information contained in this document reflects the operation of the SWXRC–04 RAID controller with the version 2.0 firmware release.

Revision A, November 3, 1994

Digital Equipment Corporation
Maynard, Massachusetts

October 1994

NOTE: This equipment generates, uses, and may emit radio frequency energy. The equipment has been type tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

Any changes or modifications made to this equipment may void the user's authority to operate the equipment.

Operation of this equipment in a residential area may cause interference, in which case the user at his own expense will be required to take whatever measures may be needed to correct the interference.

Revision History

Date	Revision	Summary of Changes
10/30/94	A	Preliminary release

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XVI

Preface

This guide presents OEM operation and maintenance information for the SWXRC–04 RAID controller. It presents a description of the controller and covers controller and subsystem configuration, operating, troubleshooting, and removal and replacement procedures.

The SWXRC–04 RAID controller is also called "the SWXRC–04 controller" or "the controller" in this manual.

Intended Audience

This guide is intended for OEM user and maintenance personnel who need assistance in operating and maintaining the SWXRC–04 RAID controller.

Structure

This guide contains the following chapters:

Chapter 1	Provides an overview of the SWXRC–04 controller.
Chapter 2	Provides a technical explanation of SWXRC–04 controller hardware and firmware.
Chapter 3	Provides information to support the installation of SWXRC–04 controller storage subsystems.
Chapter 4	Defines physical configuration rules for the SWXRC–04 controller subsystem.
Chapter 5	Provides operation and logical device configuration instructions.
Chapter 6	Provides information on upgrading the SWXRC–04 controller and storage subsystem.
Chapter 7	Discusses how to translate error information and perform initial fault analysis.
Chapter 8	Details the diagnostics, inline exercisers, and utilities for the SWXRC–04 controller.
Chapter 9	Provides procedures for the removal and replacement of FRUs.
Appendix A	Lists the SWXRC–04 controller FRUs, including part numbers and related FRUs.
Appendix B	Provides complete details for CLI commands and their usage.
Appendix C	Presents some general concepts of RAID storage subsystems.
StorageWorks Glossary	Lists acronyms and terms specific to StorageWorks systems.

Related Documentation

Table 1 lists documents containing information related to this product.

Table 1 Related Documentation

Document Title	Order Number
StorageWorks Solutions SC–4600 Controller OEM Interface Specification	EK–SC460–ES
StorageWorks HSZ40 Array Controller Utility for DEC OSF/1 System Manager's Guide	AA–QC39A–TE
StorageWorks Solutions HA-2400C Storage Enclosure OEM Engineering Specification	EK–HA240–ES
StorageWorks Solutions Building Block User's Guide	EK–SBB35–UG
StorageWorks Solutions Controller Shelf User's Guide	EK–350MA–UG
StorageWorks Solutions Configuration Guide	EK–BA350–CG
StorageWorks Solutions Shelf and SBB User's Guide	EK–BA350–UG
StorageWorks Solutions Shelf Metric Mounting Kit User's Guide	EK–35XRD–IG
StorageWorks Solutions SW300-Series RAID Enclosure Installation and User's Guide	EK–SW300–UG
StorageWorks Solutions SW500-Series Cabinet Cable Distribution Unit Installation Sheet	EK–SW5CU–IS
StorageWorks Solutions SW500-Series Cabinet Installation and User's Guide	EK–SW500–IG
StorageWorks Solutions SW800-Series Data Center Cabinet Cable Distribution Unit Installation Sheet	EK–SWCDU–IS
StorageWorks Solutions SW800-Series Data Center Cabinet Installation and User's Guide	EK–SW800–IG
The DIGITAL Guide to RAID Storage Technology	EC–B1960–45
The RAIDBOOK—A Source for RAID Technology (The RAID Advisory Board, St. Peter, MN.)	—
DECevent Translation and Reporting Utility for OpenVMS User and Reference Guide	AA–Q73KA–TE
VAXcluster Console System User's Guide	AA–GV45D–TE
VAXcluster Systems Guidelines for VAXcluster System Configurations	EK–VAXCS–CG

Documentation Conventions

The following conventions are used in this guide:

boldface type	Boldface type in examples indicates user input. Boldface type in text indicates the first instance of terms defined in either the text, the glossary, or both.
italic type	Italic type indicates emphasis, variables in command strings, and complete manual titles.
UPPERCASE	Words in uppercase text indicate a command, the name of a file, or an abbreviation for a system privilege.
Ctrl/*x*	Ctrl/*x* indicates that you hold down the Ctrl key while you press another key, indicated by *x*.
	For DILX, the caret symbol (^) is equivalent to the Ctrl key and these same instructions apply.
CDROM	This refers to both a command and a hardware device. The proper usage of CD–ROM with a hyphen is not used to avoid reader confusion.

Manufacturer's Declarations

CAUTION

This is a class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

ACHTUNG !

Dieses ist ein Gerät der Funkstörgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen die Benutzer für entsprechende Gegenmaßnahmen verantwortlich sind.

ATTENTION !

Ceci est un produit de Classe A. Dans un environment domestique, ce produit risque de créer des interférences radiélectriques, il appartiendra alors à l'utilisateur de prendre les mesures spécifiques appropriées.

Für Bundesrepublik Deutschland
For Federal Republic of Germany
Pour la République féderale d'Allemagne

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Hiermit wird bescheinigt, daß die Einrichtung in Übereinstimmung mit den Bestimmungen der DBP-Verfügung 523/1969, Amtsblatt 113/1969, und Grenzwertklasse "A" der VDE0871, funkenstört ist.
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Bei Fragen hierzu wenden Sie sich bitte an die örtlich zuständige Funkstörungsmeßstelle Ihres Fernmeldeamtes.

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Sollte ein Austausch der von Digital spezifizierten Datenkabel nötig werden, muß der Betreiber für eine einwandfreie Funkentstörung sicherstellen, daß Austauschkabel im Aufbau und Abschirmqualität dem Digital Originalkabel entsprechen.

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Die Geräte werden bereits in der Fertigung mit der Zulassungsnummer gekennzeichnet und mit einer Anmeldepostkarte versehen. Sollte Kennzeichnung und Anmeldepostkarte übergangsweise nicht mit ausgeliefert werden kontaktieren Sie bitte das nächstgelegene Digital Equipment Kundendienstbüro.

1
Overview

This chapter contains general information and a technical overview of the SWXRC–04 **controller**.

1.1 Technical Overview

The SWXRC–04 controller is a member of the **StorageWorks** SWXSC-series of **array controllers**. StorageWorks SWXSC-series controllers provide high-performance, high-availability access to Small Computer System Interface 2 (**SCSI-2**) devices from **host** computer systems via the SCSI-2 interface. The SWXRC–04 controller provides a versatile, modular, solution to array storage problems and offers a wide variety of price and performance options.

1.1.1 Standard Features

The SWXRC–04 controller offers the following capabilities as standard features:

- Scalable device capacity—Six separately-addressable SCSI device buses are supported. Up to 42 devices can be supported in a constrained single controller configuration.
- Device support—Device support is provided for rotating and solid-state disks.
- **Logical Unit** Support—Up to 8 logical units (LUNs) per controller **target ID** are supported.
- Multi-Target Support—Up to 4 target IDs per controller are supported.
- Intelligent write cache module with **write-back** capability and battery backup.
- **RAID** 0 support—Disk striping enhances performance by lowering latency and raising throughput. The SWXRC–04 controller's implementation of RAID 0 allows 2 to 14 members, with user-friendly **stripeset** configuration.
- Device **warm swapping**—The controller is seamlessly integrated with other StorageWorks components to enable device replacement while the system is operating, causing minimum impact on data integrity and system operation.
- Upgradeable controller firmware—A writeable Personal Computer Memory Card Industry Association (**PCMCIA**) flash memory card contains the controller's operating firmware and offers ease of installation and the ability to upgrade the controller firmware. The writeable firmware store also can be upgraded via a serial hardware port.
- Easy configuration of the storage subsystem—The controller and its physical storage devices are configured via a user-friendly command line interface (**CLI**). The command line interface can be accessed via a local hardware terminal port or with **virtual terminal** support from the host.

- Bad block replacement (BBR) and forced error (FE) support—The controller maintains data integrity by performing BBR activity in the controller, transparently to the host.
- Environmental Monitor Unit (**EMU**) support—The controller can be used with a hardware EMU to enable it to monitor the physical condition of the storage subsystem.
- Code patching support—A resident utility program enables the program code in the controller's RAM to be manually modified.

1.1.2 Optional Features

The SWXRC–04 controller offers the following capabilities as options:

- Intelligent **read cache** module with **write-through** capability.
- Redundant controllers and controller caches—Tightly-coupled **dual-redundant** controllers (on the same host bus) offer automatic, intelligent, failover of attached storage in the event of a controller failure. Up to 4 targets and 36 SCSI devices can be supported by the 2 controllers in a dual-redundant configuration.

  The SWXRC–04 controller supports five different dual-redundant controller configurations:

  - Two controllers configured as a single, active controller with a hot backup. The active controller services from one to four targets.
  - Both controllers configured as active controllers, with one servicing one target, the other servicing one target.
  - Both controllers configured as active controllers, with one servicing one target, the other servicing two targets.
  - Both controllers configured as active controllers, with one servicing one target, the other servicing three targets.
  - Both controllers configured as active controllers, with one servicing two targets, the other servicing two targets.

  Failover actions within the storage subsystem are firmware-controlled and transparent to the host in all dual-redundant configurations.
- Controller and cache module warm swapping—In the dual-redundant configuration, failed controller and cache modules can be replaced without interrupting the operation of the subsystem.

1.1.3 Licensed Features

Licensed features are those that are designed into the controller firmware but must be enabled with special license keys via the user CLI. A license key is preentered into the SWXRC–04 controller firmware, to enable the following licensed features:

- Intelligent **write-back cache** firmware—The write-back cache employs a hardware cache module with non-volatile storage that allows both read and write cache blocks to coexist in the cache. The ability to handle both read and write cache blocks simultaneously enables a controller with the write-back cache option to adapt to varying host I/O mixes without the typical loss in performance that fixed cache types experience. The cache implementation significantly reduces host I/O transfer latency in all configurations. Write-back caching must be enabled by the user via the CLI.

- RAID 5/3 storage firmware—The RAID (Redundant Array of Independent Disks) data structure uses the RAID 5 parity organization. When opportunities exist within a given subsystem, however, RAID 5 and RAID 3 techniques can be mixed to maximize performance and data integrity. Write aggregation, request combining, and cache flushing are implemented to enhance RAID performance. The RAID 5/3 storage firmware requires that the write-back module be installed to execute, even if write-back caching is not enabled by the user.

1.1.4 Device Support

Digital publishes OEM application notes that list the devices qualified by Digital for use with the SWXRC–04 controller. A current list of supported devices can be obtained from your Digital representative.

1.2 Controller Description

Figure 1–1 illustrates a block diagram of the SWXRC–04 controller.

The SWXRC–04 controller uses a single, fast, 16 bit, differential, SCSI bus for its connection to one or more host computers. The controller provides six, separately-addressable, single-ended, fast, 8-bit SCSI buses as its device interface. The SWXRC–04 controller is intended for attachment to SCSI ports on hosts running OSF/1™ software, and support for non-Digital hosts is also provided for the OEM environment. The SWXRC–04 supports all of the standard SCSI–2 features as well as many of the optional ones.

The SWXRC–04 controller is a single-PCB module that can be configured alone or in conjunction with another controller for increased availability. A separate read or write-back cache module can be used with each SWXRC–04 controller module. 16 megabyte (MB) and 32 MB write-back modules with battery backup are available, as are read cache modules with 16 MB or 32 MB internal storage.

The SWXRC–04 controller can be used in single-host environments where the host uses either 8 bit single-ended or 16 bit differential SCSI adapters. To connect the SWXRC–04 controller's differential interface to a host using an 8 bit single-ended interface, a StorageWorks SWXAZ–AA SCSI signal converter must be used.

The operator performs configuration of storage devices into logical units with interface firmware that is accessible via the SWXRC–04 maintenance port (an EIA–423 interface) or via a host-resident virtual terminal program.

When used in an enclosure that contains an environmental monitor unit, the SWXRC–04 controller detects fault signals from the EMU and alerts the operator in the event of potential storage subsystem damage or malfunction.

Controller hardware is designed to be installed in standard StorageWorks controller shelves and enclosures. Controller and cache modules are usually housed together in an **SWXSS–01 controller shelf** or an **SWXSC–AA storage enclosure**. These shelves can be inserted into various StorageWorks cabinets. A complete SWXRC–04 controller storage subsystem, housed in a StorageWorks data center cabinet, is shown in Figure 1–2.

Figure 1–1 SWXRC–04 Controller Block Diagram

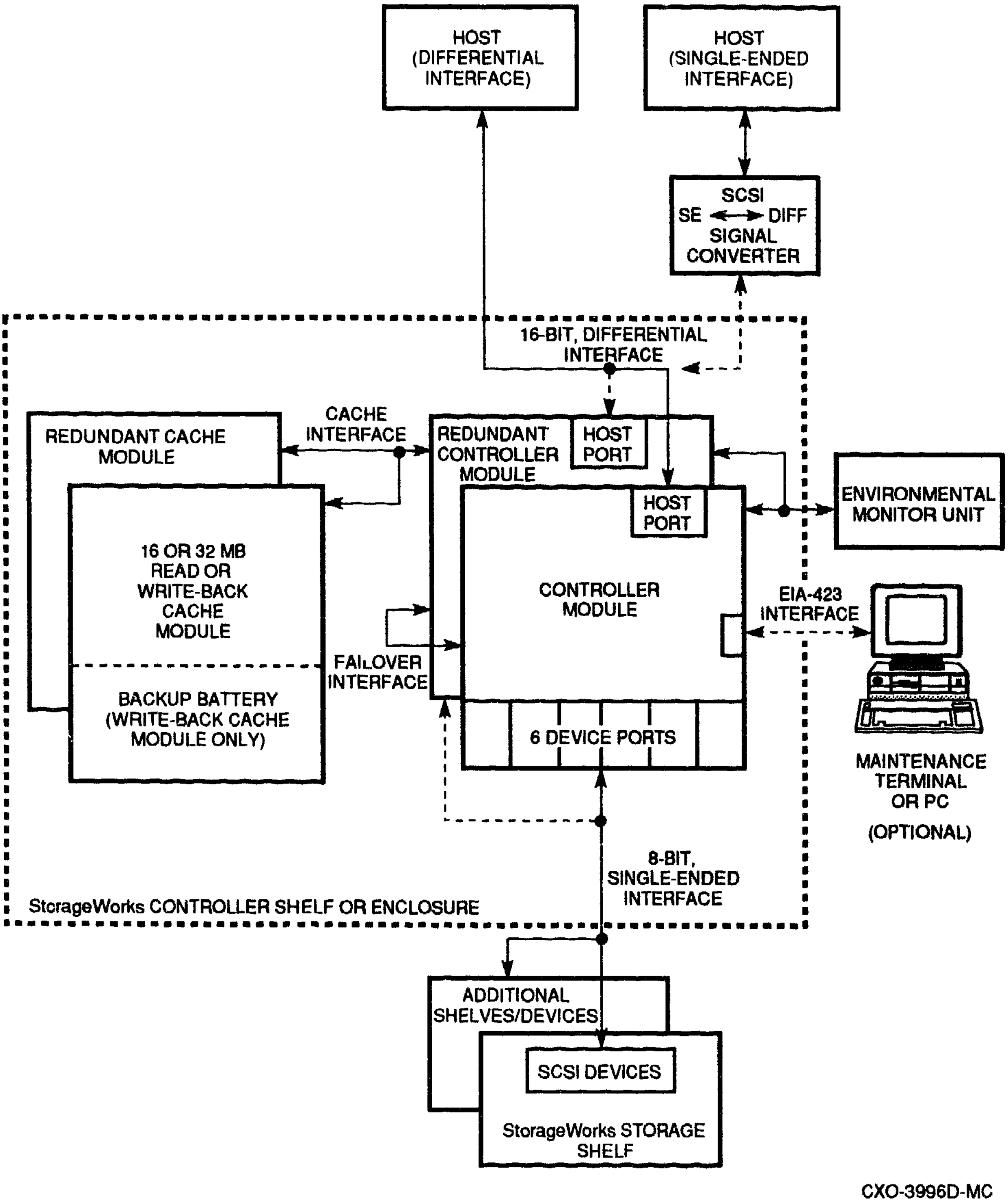
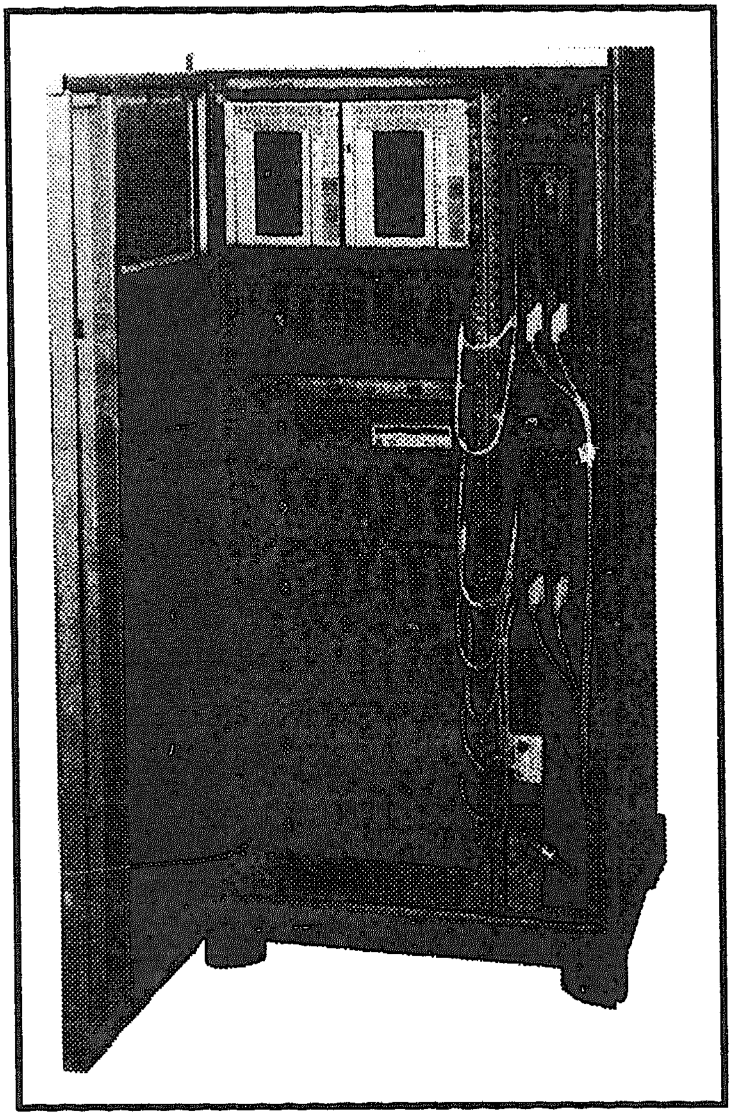


Table 1–1 summarizes the main features of the SWXRC–04 controller.

Figure 1–2 SWXSC–Dx-Series Data Center Cabinet Storage Subsystem



CXO-3658B-PH

Table 1–1 Summary of SWXRC–04 Controller Product Features

Feature	SWXRC–04 Controller
Host system bus	SCSI–2, fast, wide, differential
Host protocol	SCSI–2
Storage device bus	SCSI–2, fast, narrow, single-ended
Storage device protocol	SCSI–2
Number of SCSI device ports	6
Number of SCSI–2 devices per port (SWXSS–02 SBB shelf)	6 (or 7)†
Number of SCSI–2 devices per port (SWXSC–AA storage enclosure)	4
Maximum number of SCSI–2 devices (SWXSS–02 SBB shelves)	36 (or 42)†
Maximum number of SCSI–2 devices (SWXSC–AA storage enclosure)	24
Dual-redundant configurations	Yes
Controller warm swap	Yes
Read cache module	16 or 32 MB
Write-back cache module	16 or 32 MB
Mixed disks and tapes‡	No tape support
Tape media loaders	No tape media loader support
Device warm swap	Yes
Controller-based device exercisers	Yes
Preferred ID preservation	Yes
Spontaneous messages to maintenance terminal	Yes
RAID level support	0/3/5
Program card firmware update	Yes (by replacing or downloading the card)
Error detection code (EDC)	Validation of program card firmware
Error correction code (ECC) on cache and shared memory	Yes
Tagged command queuing	Yes
Power fail write nonvolatile journal	Yes
Data integrity and byte parity (all buses/memory)	Yes

†The dual-redundant controller configuration supports up to six devices per port. Nonredundant configurations support up to seven devices per port, but this sacrifices a convenient upgrade to high availability and redundant/backup power options.

‡On the same or different ports

1.3 Operating System Support

Refer to your firmware release notes for restrictions and updates regarding operating system support.

1.4 Controller Module Specifications

Table 1–2 lists the physical and electrical specifications for the SWXRC–04 controller and its cache module. Measurements in Table 1–2 are nominal measurements; tolerances are not listed.

Table 1–2 Controller Module Specifications

Hardware	Length	Width	Power	Current at +5 V	Current at +12 V
Controller module	12.5 inches	8.75 inches	23.27 W	4.63 A	10 mA
Read cache module, 16 MB	12.5 inches	7.75 inches	1.82 W	360 mA	2 mA
Read cache module, 32 MB	12.5 inches	7.75 inches	2.02 W	400 mA	2 mA
Write-back cache module, 16 MB (Battery charging)	12.5 inches	7.75 inches	2.28 W 8.52 W	360 mA 360 mA	40 mA 560 mA
Write-back cache module, 32 MB (Battery charging)	12.5 inches	7.75 inches	2.48 W 8.72 W	400 mA 400 mA	40 mA 560 mA

1.5 Controller Environmental Specifications

The SWXRC–04 controller is intended for installation in a Class A computer room environment.

The StorageWorks product environmental specifications are listed in Table 1–3.

Table 1–3 Environmental Specifications

Condition	Specification
	Optimum Operating Environment
Temperature	+18° to +24°C (+65° to +75°F)
Rate of change	3°C (5.4°F) per hour
Step change	3°C (5.4°F)
Relative humidity	40% to 60% (noncondensing) with a step change of 10% or less (noncondensing)
Altitude	From sea level to 2400 m (8000 ft)
Air quality	Maximum particle count .5 micron or larger, not to exceed 500,000 particles per cubic ft of air
Inlet air volume	.026 cubic m per second (50 cubic ft per minute)
	Maximum Operating Environment (Range)
Temperature	+10° to +40°C (+50° to +104°F) Derate 1.8°C for each 1000 m (1.0°F for each 1000 ft) of altitude Maximum temperature gradient 11°C/hr (20°F/hr) ±2°C/hr (4°F/hr)
Relative humidity	10% to 90% (noncondensing) Maximum wet bulb temperature: 28°C (82°F) Minimum dew point: 2°C (36°F)
	Maximum Nonoperating Environment (Range)
Temperature	–40° to +66°C (–40° to +151°F) (During transportation and associated short–term storage)
Relative humidity	
Nonoperating	8% to 95% in original shipping container (noncondensing); otherwise, 50% (noncondensing)
Altitude	From –300 m (–1000 ft) to +3600 m (+12,000 ft) MSL†

†Mean sea level

1.6 Maintenance Strategy

The maintenance philosophy of the SWXRC–04 controller subsystem involves the removal and replacement of field replaceable units (**FRUs**) when failures occur. Chapter 9 contains FRU removal and replacement procedures. See Appendix A for a list of FRUs and FRU part numbers.

Note

Do not attempt to replace or repair components within FRUs. Use the controller internal diagnostics and error logs to isolate only to the FRU level.

1.7 Maintenance Features

The SWXRC–04 controller has the following features to aid in troubleshooting and maintenance:

- **Initialization diagnostics**

  Various levels of initialization diagnostics execute on the controller. These tests ensure that the subsystem is ready to come on line after it has been reset, powered on, and so forth. You can elect to rerun many of the diagnostics even after initialization completes, to test controller operation. See Chapter 8 for more information about controller initialization.

- **Utilities**

  You can run the VTDPY utility to display current controller state and performance data, including processor utilization, host port activity and status, device state, **logical unit** state, and cache and I/O performance.

  The configuration utility (CONFIG) checks the **SCSI device** ports for any device not previously added. This utility adds and names these devices.

  The Firmware Licensing System (FLS) enables and disables RAID and write-back caching, which are licensed controller features.

  The Fault Management Utility (FMU) controls some spontaneous error displays and displays controller last failure and memory system failure information.

  See Chapter 8 for detailed information on each utility.

- **Exercisers**

  The controller can run the disk inline exerciser (**DILX**). This exerciser simulates high levels of user activity, and running it provides performance information you can use to determine the health of the controller and devices attached to it. See Chapter 8 for more information about the exercisers.

- **Terminal access**

  You can use a **virtual terminal** (host terminal) or a **maintenance terminal** to check status and set operating parameters. The terminal connection provides access to the following:

  – CLI (See Chapter 5, Appendix B)

  – Error messages (See Chapter 7)

  – Error logs (See Chapter 7)

- **Controller warm swap**

  You can safely remove and replace, or **warm swap**, one controller in a dual-redundant configuration while the power is on. When you warm swap a controller, you are changing out a controller in the most transparent method available to the SWXRC–04 controller subsystem. Warm swapping a controller has minimal system and device impact. For more information on warm swapping, see Chapter 9.

- **Operator control panel**

  The operator control panel (**OCP**) on the front of the controller has seven buttons and LEDs. The buttons and LEDs serve different functions with respect to controlling the SCSI ports and/or reporting fault and normal conditions. See Chapter 7 for a complete description of the OCP.

1.8 Precautions

This section describes necessary precautions and procedures for properly maintaining and servicing SWXRC–04 controllers. Follow the guidelines in the following sections when performing any of the hardware maintenance actions outlined in this guide.

1.8.1 Electrostatic Discharge Protection

Electrostatic discharge (**ESD**) is a common problem for any electronic device and may cause data loss, system down time, and other problems. The most common source of static electricity is the movement of people in contact with carpets and clothing. Low humidity also increases the amount of static electricity. You must discharge all static electricity prior to touching the storage subsystem.

In general, you should follow routine ESD protection procedures when handling controller modules and cache modules and when working around the cabinet and shelf that houses the modules.

Follow these guidelines to further minimize ESD problems:

- Maintain more than 40-percent humidity in the room where the equipment is installed.
- Place the subsystem cabinet away from heavy traffic paths.
- Do not place the subsystem on carpet, if possible. If carpet is necessary, choose antistatic carpet. If the carpet is already in place, place antistatic mats around the subsystem.
- Use ESD wrist straps, antistatic bags, and grounded ESD mats when handling FRUs.
- Obey the module handling and grounding guidelines listed in Section 1.8.2.

1.8.2 Module Handling Guidelines

Prior to handling the controller module or cache module, follow these grounding guidelines. See Chapter 9 for module removal and replacement instructions.

- Obtain and wear an ESD wrist strap on your wrist. Make sure the strap fits snugly.
- Attach the lead on the ESD strap to a convenient cabinet grounding point.
- After removing a module from the shelf, place the module into an approved antistatic bag or onto a grounded antistatic mat.
- Remain grounded while installing a replacement module.

1.8.3 Program Card Handling Guidelines

Follow these guidelines when handling the program card. See Chapter 9 for program card removal and replacement instructions.

CAUTION

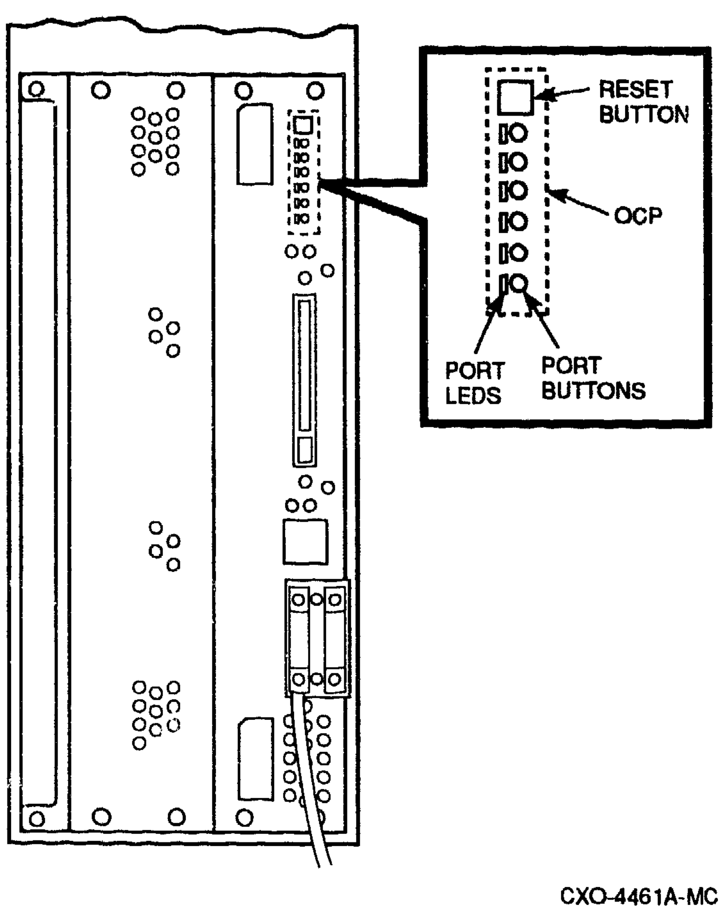
Follow program card guidelines or damage to the program card and firmware can result.

- Cover the program card with the snap-on ESD shield whenever the card is installed in the controller.

- Obtain and wear an ESD wrist strap on your wrist. Make sure the strap fits snugly.

  Attach your ESD strap to a suitable cabinet grounding point before removing, inserting, or handling the program card.
- Keep the program card in its original carrying case when not in use.
- Do not twist or bend the program card.
- Do not touch the card contacts.
- Keep the card out of direct sunlight.
- Do not immerse the card in water or chemicals.
- Always push the program card eject button, shown in Figure 1–3, to remove the card. Do not pull on the card.

Figure 1–3 Program Card Eject Button



2 Functional Description

This chapter provides a detailed functional description of the SWXRC–04 controller hardware and firmware.

2.1 Hardware

The controller provides a connection between a host computer and an array of SCSI–2 compatible storage devices. The controller hardware consists of core circuitry, common to all models of SWXSC-series controllers, as follows:

- Policy processor
- Program card
- Diagnostic registers
- Operator control panel
- Maintenance terminal port
- Dual controller port
- Nonvolatile memory (NVMEM)
- Bus exchangers
- Shared memory
- Value-added hardware
- Device ports
- Cache module

Figure 2–1 shows a block diagram of the SWXRC–04 controller hardware.

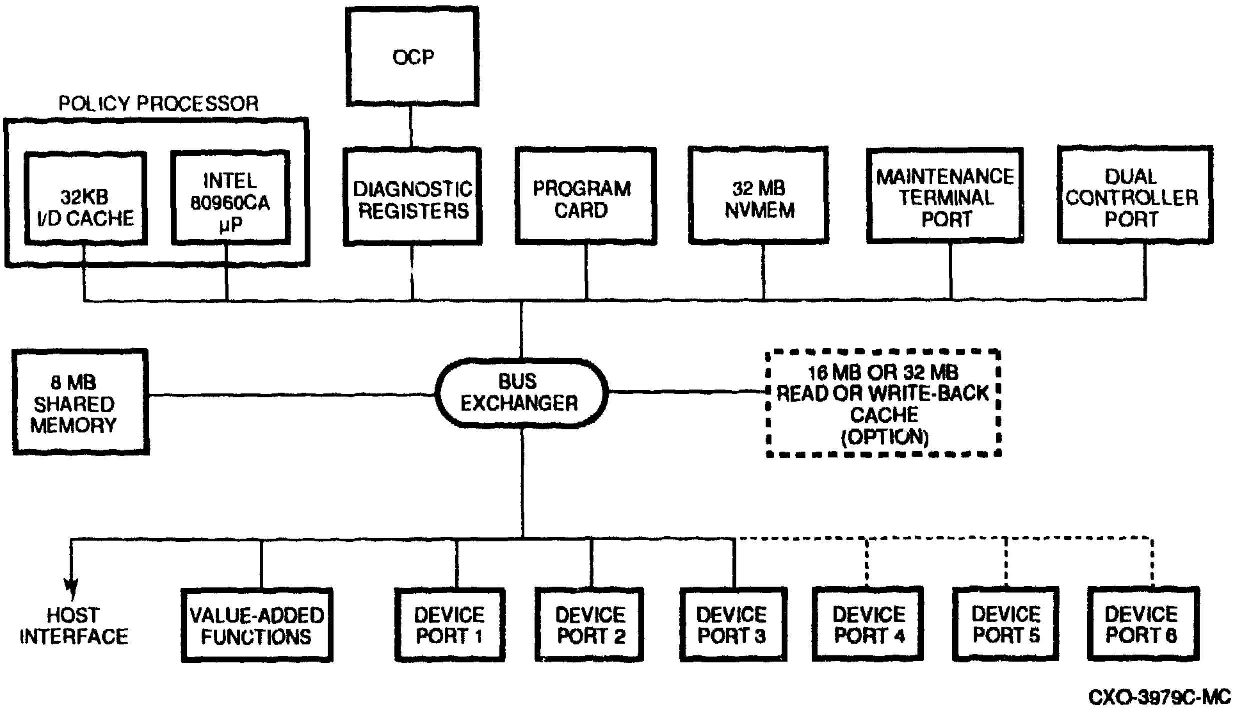
2.1.1 Policy Processor

The policy processor consists of microprocessor hardware necessary for running the controller's firmware.

2.1.1.1 Intel 80960CA

The heart of the policy processor is an Intel® 80960CA (i960) processor chip. This processor chip runs the firmware from the program card and provides a consistent 25 MIPs. The i960 controls all but low-level device and host port operations.

Figure 2–1 Controller Hardware Block Diagram



2.1.1.2 Instruction/Data Cache

Although the i960 has an internal cache, the inte- ıal cache is not large enough to offset performance degradation caused by shared memory. To compensate for this, the i960 utilizes a separate instruction/data (I/D) cache. This 32-KB static RAM (SRAM) cache helps the i960 achieve faster access to instructions and variables. A **write-through cache** design maintains data coherency in the I/D cache.

2.1.2 Program Card

The program card is a PCMCIA standard flash card device containing the firmware for operating the controller. The firmware is validated and then loaded from the program card into shared memory each time the controller initializes. The program card can be rewritten, providing a convenient method of updating the controller's firmware.

2.1.3 Diagnostic Registers

The controller has two write and two read diagnostic registers. Diagnostic and functional firmware use the write diagnostic registers to manipulate controller and device operations. Certain bits in the registers activate test modes for forcing errors in the controller. Other bits control the OCP LEDs. The policy processor reads the read diagnostic registers to determine the cause of an interrupt, when an interrupt occurs.

2.1.4 Operator Control Panel

The OCP includes the following:

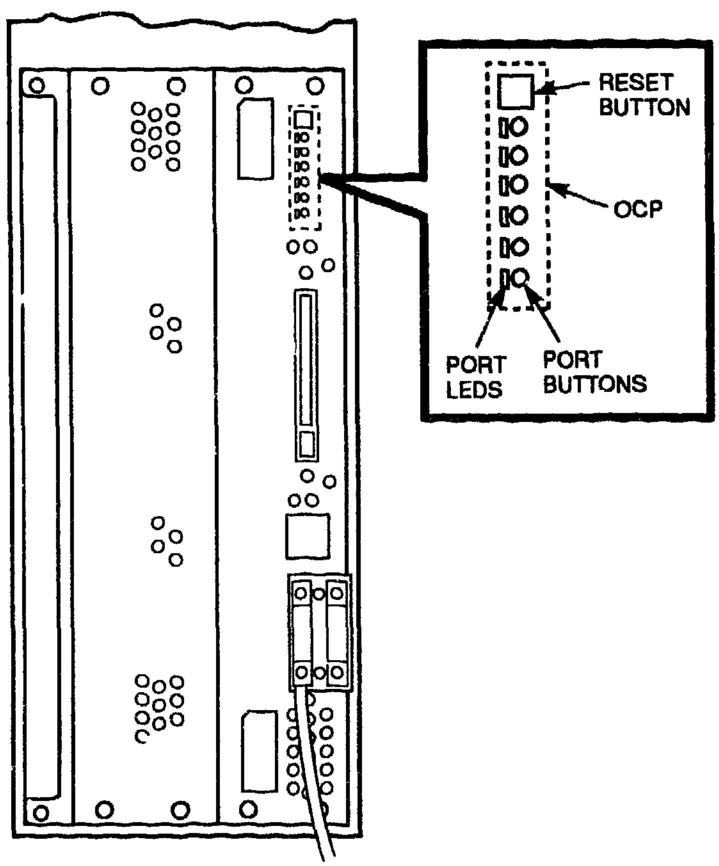
- One reset button with embedded green LED

- One button per SCSI port
- Six amber LEDs

Figure 2–2 shows the SWXRC–04 controller OCP. The buttons and LEDs serve different functions with respect to controlling the SCSI ports and/or reporting fault and normal conditions.

See Chapter 7 for further information on using the OCP.

Figure 2–2 Controller Operator Control Panel



2.1.5 Maintenance Terminal Port

Each SWXRC–04 controller has a modified modular jack (MMJ) on its front bezel that can support an EIA–423 compatible maintenance terminal. You must connect a maintenance terminal during controller installation to set initial controller parameters. During normal operation, you may use either a maintenance terminal or a virtual (host) terminal to add devices and **storagesets**, or to perform other storage configuration tasks. However, a maintenance terminal is required when a host connection is not available.

If you connect a maintenance terminal to one controller in a dual-redundant configuration and both controllers are functioning, you can communicate with both controllers.

2.1.6 Dual Controller Port

The controller has an internal serial port for communication with a second controller of the same model. The second controller needs to be mounted in the same controller shelf, with communication passing through the ports and across the shelf backplane. A dual-redundant configuration enables one controller to take over for another (failed) controller. The takeover process is called **failover**. During failover, the **surviving controller** supports the SCSI–2 devices linked to the failed controller. See Chapter 5 for more information on failover.

2.1.7 Nonvolatile Memory

The controller has 32 KB of nonvolatile memory (**NVMEM**). NVMEM is implemented using battery backed up SRAM. This memory serves two purposes:

- First, NVMEM stores parameter and configuration information such as device and **unit** number assignments entered by the user and by the controller firmware.
- Second, NVMEM stores cache module metadata, which enables the controller to check for the correct cache module.

2.1.8 Bus Exchangers

Bus exchange devices enable high-speed communication between bus devices and shared memory. One bus exchanger handles address lines while the other exchanger handles data lines. The bus exchangers are classified as four-way cross-point switches, which means the bus exchangers enable connections between one port and any other port on the switch.

2.1.9 Shared Memory

Shared memory consists of a dynamic RAM controller and arbitration engine (DRAB) gate array controller and 8 MB of associated dynamic RAM (DRAM). Shared memory uses parity-protected 9-bit error correction code (**ECC**) and error detection code (**EDC**) for improved error detection and data recovery. The shared memory also stores the controller firmware and is shared between bus devices for data structures as well as data buffers.

One portion of shared memory contains instructions for the i960, firmware variables, and data structures, including the look-up table for the i960. In the absence of the cache module, another portion of shared memory acts as a cache. Otherwise, this portion contains cache module context for cache look-ups when a cache module is in place.

2.1.10 Value-Added Functions

This circuit acts as the accelerator for RAID XOR operations as well as device compare operations. To support recovery of a lost member of a RAID5 storageset, the controller XORs parity data with the surviving **RAIDset** members' data to **reconstruct** the lost member.[3]

[3] The write-back cache module must be installed to execute the RAID functions.

2.1.11 Device Ports

The controller SCSI–2 device ports are a combination of NCR® 53C710 SCSI port processors and SCSI transceivers. The 53C710 processors perform operations in 8-bit, single-ended normal or fast mode. The 53C710 processors execute scripts read from shared memory and under control of the policy processor.

Each SCSI–2 port can have up to six or seven attached devices depending on controller configuration (dual-redundant or nonredundant, respectively). In a dual-redundant configuration, device availability improves because each controller has access to the other controller's devices.

2.1.12 Cache Module

SWXSC-series controllers can be enhanced with a companion read or a **write-back cache** module. Either option is available in 16 or 32 MB. The SWXRC–04 controller is shipped with a write-back cache module.

2.1.12.1 Common Cache Functions

The cache module increases controller I/O performance. During normal operation, a host read operation accesses data either from the fast memory of the cache module or from an I/O device.

If a host read is a cache "hit" (data already in the cache), the data is supplied to the host immediately, improving I/O performance by reducing latency. If the host read is a cache "miss" (data not in the cache), the controller accesses the appropriate device to satisfy the request. Then the controller reads the data, returns it to the host, and writes it to the cache.

Cache entry sizes are fixed at 64 KB (128 logical **blocks**) for each logical unit. Read caching is enabled by default but can be optionally disabled using the CLI> SET command on a per unit basis (see Appendix B).

The data replacement algorithm is a least recently used (**LRU**) replacement algorithm. When the cache is full and new data must be written, the LRU algorithm removes the oldest resident cached data with the least number of references and replaces it with the new data.

2.1.12.2 Read Cache Module

During a host write operation using the **read cache**, data is written to the disk *and* the cache. This is known as write-through caching, and it improves the performance of subsequent reads, because often the requested data was previously written to the cache.

The read cache consists of DRAM storage. However, the read cache is volatile. Subsystem power failures cause the loss of all data in the read cache.

2.1.12.3 Write-Back Cache Module

The write-back cache module increases subsystem performance as well as preserving data integrity under power failure situations. The SWXRC–04 controller is supplied with a write-back cache module.

In write-back caching, data is not always written to storage and cache simultaneously (write-through caching). Instead, data intended for storage may remain in the cache until the optimum time to write, or **flush**, to a device occurs. When data is suspended in this way, it is referred to as **unwritten cache data**. A power failure in conjunction with unwritten cache data has disasterous consequences because the information is lost. In RAIDset configurations, the impact of power failure is worsened by the possibility of **write hole** data loss as well.

For this reason, the write-back cache differs from the read cache by using onboard rechargeable batteries. The batteries power the memory to retain data when cache power is intentionally or accidentally interrupted. The battery circuit automatically detects loss of power and switches from shelf backplane power to battery power.

Battery Discharging

During a power failure, the write-back cache batteries discharge very slowly, providing standby power to retain cache data. Under these circumstances, Digital guarantees data retention time for fully charged batteries to be a minimum of 100 hours.

Studies performed by utility companies have noted that over 99 percent of all power outages last less than one minute. However, once power fails for more than 3 minutes (32 MB write-back cache) or 5 minutes (16 MB write-back cache) the controller modifies its operation upon restart, to maximize data preservation:

- Non-RAIDset, disk-based units with write-back caching enabled are accessed in write-through (read cache) mode, until the cache batteries are fully recharged. Once the batteries are recharged, write-back caching resumes.

- RAIDsets may create a write hole under power failure situations and cannot be served until after they have access to fully-charged batteries from a long power failure. An SWXRC–04-based RAIDset's LUN appears to the host as "SCSI LUN NOT READY" until fully charged batteries are available.

SWXRC–04-based RAIDsets do not fail over to the other controller in the event of a battery failure.

Battery Charging

Under normal conditions (power restored), a battery charge circuit senses the battery voltage and automatically activates a charger to achieve and maintain full battery charge. The following two ratios illustrate the relationship of power down time versus battery recharge time:

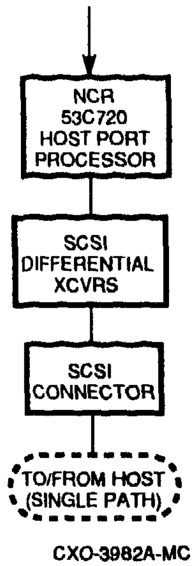
16 MB write-back cache—24:1 (power down time v. time to full charge)
32 MB write-back cache—12:1 (power down time v. time to full charge)

For example, a two hour power outage results in approximately 10 minutes of recharge time for a 32 MB write-back cache. The recharge time is a safety precaution, taken to preserve the integrity of the controller subsystem for any power outages that may occur thereafter.

Note

Digital recommends replacing the write-back cache batteries at five (5) year intervals.

Figure 2–3 SCSI–2 Host Interface Hardware Block Diagram



2.1.13 Host Interface

Figure 2–3 shows a block diagram of the SWXRC–04 to SCSI–2 host interface hardware.

The SWXRC–04 interfaces with a fast, wide, differential SCSI (**FWD SCSI**) 16-bit or fast, differential SCSI (**FD SCSI**) 8-bit host bus. The hardware consists of the NCR 53C720 chip and tranceivers.

2.2 Firmware

The controller hierarchical storage operating firmware (**HSOF**), consists of functional code, diagnostics, utilities, and exercisers.

SWXRC–04 operating firmware is stored in a writeable PCMCIA program flash card. Digital ships the card along with your controller. Thereafter, each time SWXRC–04 operating firmware is updated, new cards are manufactured. You can purchase the update cards on a per release basis or through an update service contract. You can also download new versions of the firmware directly into your program card.

Once the card is installed in the controller, the contents are validated and loaded into shared memory. Any time you reset the controller, this validating and loading process gets repeated. Because of this scheme, when the firmware executes, only part of the controller initialization diagnostics runs directly from the program card. The remaining diagnostics, all functional code, and all utilities run from controller shared memory.

Refer to your controller's firmware release notes for information on controller I/O performance using SWXRC–04 operating firmware.

The SWXRC–04 operating firmware consists of five functional areas:

- Core functions
- Host interconnect functions

- Operator interface and subsystem management
- Device services
- Value-added functions

These functions are discussed in the following sections.

2.2.1 Core Functions

SWXRC–04 operating firmware provides the following core functions, in the order they are executed following turning on the controller:

1. Tests and diagnostics
2. Executive functions

2.2.1.1 Tests and Diagnostics

Controller tests and diagnostics are integrated in a controller self-test procedure performed when the controller is powered on. The output of self-test is a simple go/nogo status of the controller subsystem. Self-test includes a test of the cache module. See Chapter 8 for additional initialization and self-test information.

2.2.1.2 Executive Functions

Firmware executive (**EXEC**) functions act as the operating system kernel for the SWXRC–04 controller. EXEC functions are common among the different controller models described in this guide. EXEC functions control firmware execution with respect to interrupts, thread control, queuing support, timers, and so forth. The EXEC functions establish the controller environment as a non-preemptive interrupt-driven process.

2.2.2 Host Interconnect Functions

The SWXRC–04 controller host interface uses the SCSI–2 protocol with SCSI passthrough software to the CLI, **tagged command queuing**, and mode select/sense support for SCSI.

2.2.3 Operator Interface and Subsystem Management Functions

The operator interface and subsystem management functions support the user interface, subsystem management, subsystem verification, and error logging/fault management. These functions are presented in the following sections.

2.2.3.1 Command Line Interpreter

The CLI is the primary user interface for the controller. The CLI contains firmware for responding to most management functions plus local program execution. Briefly, the CLI provides the following two types of commands:

- SET/SHOW commands for the controller itself. This includes setting and showing the controller ID, name, path controls, and other vital information.
- Configuration commands to add/delete devices, storagesets, and logical units.

See Appendix B for more information on the CLI and its commands.

2.2.3.2 Local Programs

There are several local exercisers and utilities available for controller subsystem management/verification, as follow:

- **DILX** is an exerciser that enables you to test and verify operation of the controller with attached SCSI–2 storage under a high or low I/O load. This utility places the load on the controller, bypassing the host port. Chapter 8 provides a full description of DILX.
- **VTDPY** enables you to display current controller state and performance data, including processor utilization, host port activity and status, device state, logical unit state, and cache and I/O performance. See Chapter 8 for detailed information on this utility.
- **Controller warm swap** (C_SWAP) enables you to safely remove and replace one controller in a dual-redundant configuration while the system is operational. When you warm swap a controller, you are changing out a controller in the most transparent method available to the controller subsystem. Warm swapping a controller has minimal system and device impact, as explained in Chapter 9.
- **Firmware licensing system** (FLS) enables a customer or field service engineer to observe and control licensed features within SWXRC–04 operating firmware. Any feature turned on without entering the corresponding key causes an appropriate host error log every hour. After entering the key, these errors stop. See Chapter 8 for more information on FLS.
- **Configuration menu** (CFMENU) enables you to quickly configure storage devices attached to the controller. CFMENU presents configuration commands normally entered at the CLI in a menu-driven format. See Chapter 8 for more information on CFMENU.
- **Code Load/Code Patch** (CLCP) Downloads new firmware code into the controller and enables changes or repairs to the controller's firmware without installing a new firmware image or program card. Downloaded firmware and patches become active once you restart the controller. See Chapter 8 for more information on CLCP.
- **Fault Management Utility** (FMU) controls some spontaneous error displays and displays controller last failure and memory system failure information. See Chapter 8 for more information on FMU.
- **Configure** (CONFIG) checks the SCSI device ports for any device not previously added. This utility adds and names these devices. See Chapter 8 for more information on the configuration utility.

2.2.3.3 Error Logging and Fault Management

Error Logging and Fault Management is an integrated function that collects system errors in a central firmware location to send the error information to the host. See Chapter 7 for more information on error logging.

2.2.4 Device Services

SCSI–2 device service firmware includes device port drivers and physical device addressing and access. Device service consists of normal functions such as read, write, and error recovery code. It also contains firmware for controlling and observing StorageWorks building blocks (**SBBs**) and shelves, with control and monitoring for SBB LEDs, power, and shelf **blowers**. Specific features include the following:

- Normal SCSI–2, 8-bit, single-ended support.
- FAST, synchronous, 8-bit, single-ended device support.
- Tagged queueing for SCSI–2 devices.
- Read and write physical device addressing and access. This is the read and write path to and from devices, and from and to the **value-added** portion of SWXRC–04 operating firmware.
- Specified device support per SWXRC–04 operating firmware release. Refer to your SWXRC–04 operating firmware release notes to identify specifically supported devices.
- Device warm swap. You can remove and replace most devices without taking the subsystem off line (see Chapter 9). See your firmware release notes for any restrictions on warm swapping devices.
- **Device shelf** and SBB observation and control. This service monitors SHELF_OK signals and alerts you of blower and power supply failures. This firmware also controls the fault LEDs on the SBBs for use in warm swap and identifying device failures or configuration mismatches.
- Device error recovery. This service performs error recovery and read and write retries directly, making every attempt to serve data to and from the host before declaring an unrecoverable error or marking a device as failed.
- Controller warm swap. This feature works under control from a local program running from the CLI. The program must **quiesce** all the SCSI buses to safely enable information).

2.2.5 Value-Added Functions

SWXRC–04 operating firmware contains value-added functions to enhance availability, performance, subsystem management and maintenance, and connectivity features of the controller subsystem. These value-added functions are presented in the following sections.

2.2.5.1 RAID

SWXRC–04 operating firmware supports levels of RAID storage methods as follows:

- SWXRC–04 operating firmware supports RAID level 0 (striping). Striping enables for parallel transfers to all **stripeset** members. This feature enhances performance in the areas of latency and throughput. Stripesets may be from 2 to 14 members. Striping firmware is tuned to balance the load across devices and not for maximum data transfer bandwidth.
- SWXRC–04 operating firmware supports RAID level 5; however, you must have the write-back cache module option to execute any RAIDset (RAID 5) functions. Both the write-back cache and RAIDsets are licensed firmware

features. RAID 5 under SWXRC–04 operating firmware includes the following features:

- Fast initialization
- 3 to 14 member RAIDsets
- Non-redundant write, read/modify/write, reconstruct/write
- Read, reconstruct read, repair
- Forced error promotion, which enables for redundancy even when a block has been marked with forced error
- Automatic removal of a member based on error history
- Automatic member **replacement** from spare disks
- **Reduced** operation of RAIDsets that are missing one member
- Reconstruct scanning, to restore a RAIDset to a consistent state

• SWXRC–04 operating firmware also supports RAID level 3, because RAIDsets created with SWXRC–04 operating firmware can achieve the high performance characteristics of RAID 3, depending on how I/O transfers are tailored:

  - Large I/O transfers (or many small transfers executed sequentially) results in high-bandwidth, RAID 3 performance.
  - Setting the RAIDset chunksize (see the INITIALIZE command in Appendix B) to a smaller value in conjunction with the large I/O tranfers also results in better RAID 3 performance.
  - You must enable RAIDset write-back caching to achieve RAID 3 performance.
  - The speed of your host interface can impact the degree of RAID 3 performance you achieve.

  Note that by varying RAIDset chunksize, you can conveniently choose between more bandwidth-oriented or more throughput-oriented performance under the same RAIDset. Furthermore, by specifying an intermediate chunksize, you realize a combination of benefits—RAID 3 technology (for very large I/O operations) and RAID 5 technology (for small I/O operations).

Refer to Appendix C and *The Digital Guide to RAID Storage Technology* for a description of RAID and how the various levels of RAID improve data integrity and error recovery.

2.2.5.2 Failover

A failover component (FOC) in SWXRC–04 operating firmware links two controllers in a dual-redundant configuration. The controllers exchange status signals and configuration information. When one controller fails, the surviving controller takes over service to the failed controller's units. FOC communication enables for easier system management, because only one terminal connection is required to access both controllers. See Chapter 5 for more information on failover.

2.2.5.3 Caching

Cache firmware within the value-added section of SWXRC–04 operating firmware addresses the following areas:

- Read caching
- Write-through caching
- Write-back caching for the battery backed up cache module. Write-back caching provides low write latency.
- Handling of up to 32 MB of cache
- RAID assistance for improved performance.
- Logical Block Number (LBN) extent locking
- Least Recently Used (LRU) replacement policy (Refer to Section 2.1.12.1 for a description of the LRU algorithm.)
- Failover of write-back cache module.
- Caching enabled on a per unit basis

The cache policies for the product are as follow:

- Transfer defined extent (TDE) based cache.
- Data caching based on transfer size. Maximum read/write size is changed on a per unit basis.
- All I/O subject to locking.

2.3 Addressing Storage Within the Subsystem

This section provides an overview about how storage is addressed in a controller subsystem. Storage is seen in two different ways, depending on your perspective:

- From the controller SCSI device interface—At the physical device level
- From the host interface—At the virtual device level

Following are descriptions of both levels of storage addressing.

2.3.1 Controller Physical Device Addressing

Figure 2–4 shows a typical physical storage device interface for a controller. Each of the controller's six device ports supports a SCSI bus connected with up to six devices. The devices typically reside in a StorageWorks SWXSS–02 SBB shelf.

The current implementation of SWXSC-series controllers supports only one controller LUN per physical device. LUN 0 is the default controller LUN address for each device.

Controller Port/Target/LUN Addressing

Controller port/target/LUN (PTL) addressing is the process by which the controller selects storage space within a specific, physical, storage device. The process takes place in three steps:

1. The port selection—The controller selects the SCSI bus port connected to a particular device.
2. The **target** selection—The controller selects the device's SCSI ID (that is, the target) on that port.
3. The LUN selection—The controller selects the desired LUN within that physical device. (In the current implementation, there is only one LUN on each device, and its LUN address is always 0.)

Note that controller PTL addressing is always tied to a physical storage device.

2.3.2 Storage Devices As Seen By the Host

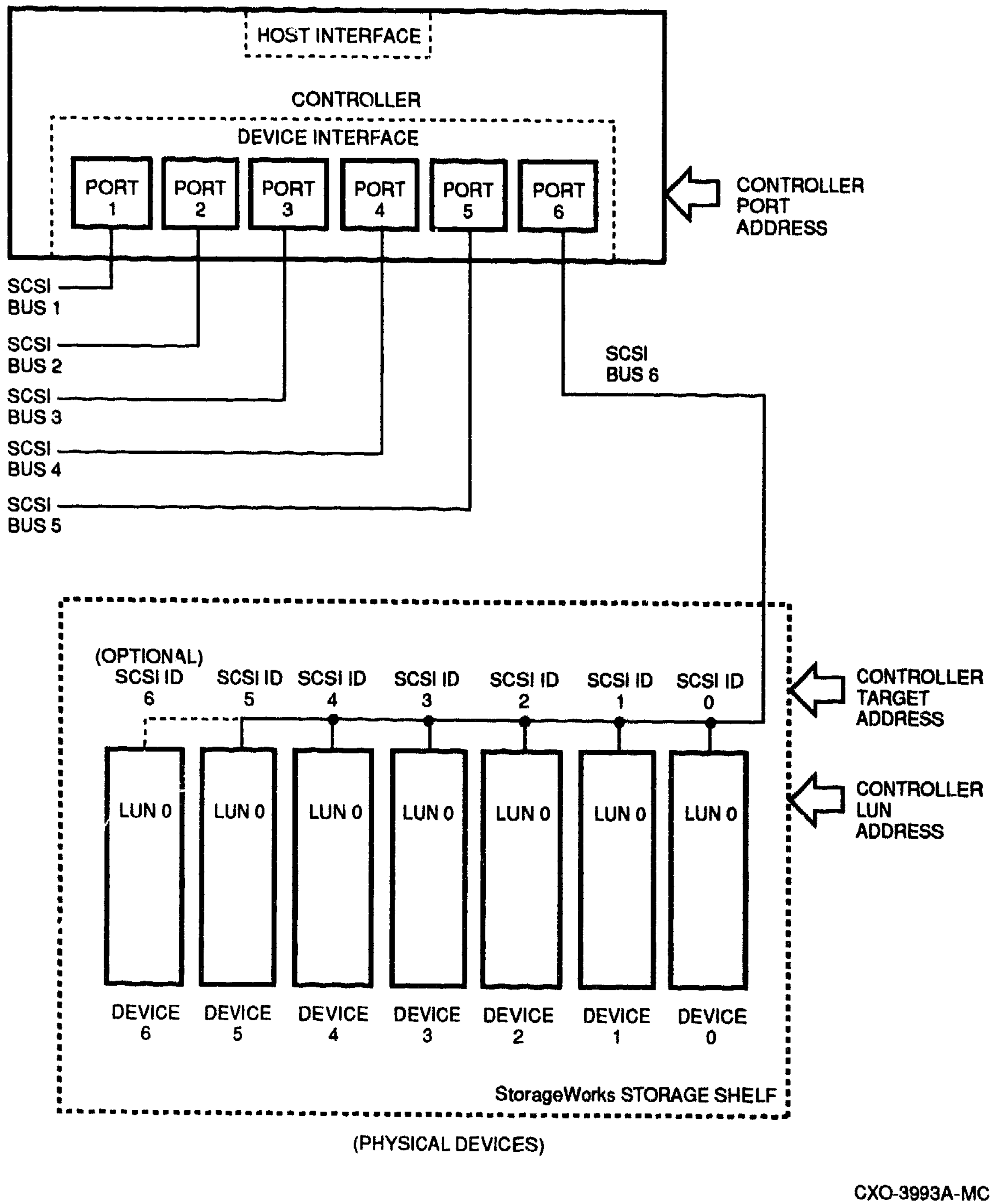
A typical host device interface consists of a number of host ports each connected to a bus containing devices. From the host's perspective, the controller is one of these devices.

To support certain high-level storage subsystem functions such as RAID, the controller presents the entire *physical* device configuration (from Figure 2–4) to the host as a group of **host logical units**. A host logical unit often consists of storage space (a storage set) distributed throughout more than one physical device. The controller presents these logical units to the host as individually-addressable, virtual devices. You configure host logical units using the CLI.

Note

Controller LUNs (devices) and host logical units *may* represent the same structure, but only if you configure the controller devices in a one-to-one unit relationship with the host. This situation could occur under normal operation.

Figure 2–4 Controller Storage Addressing

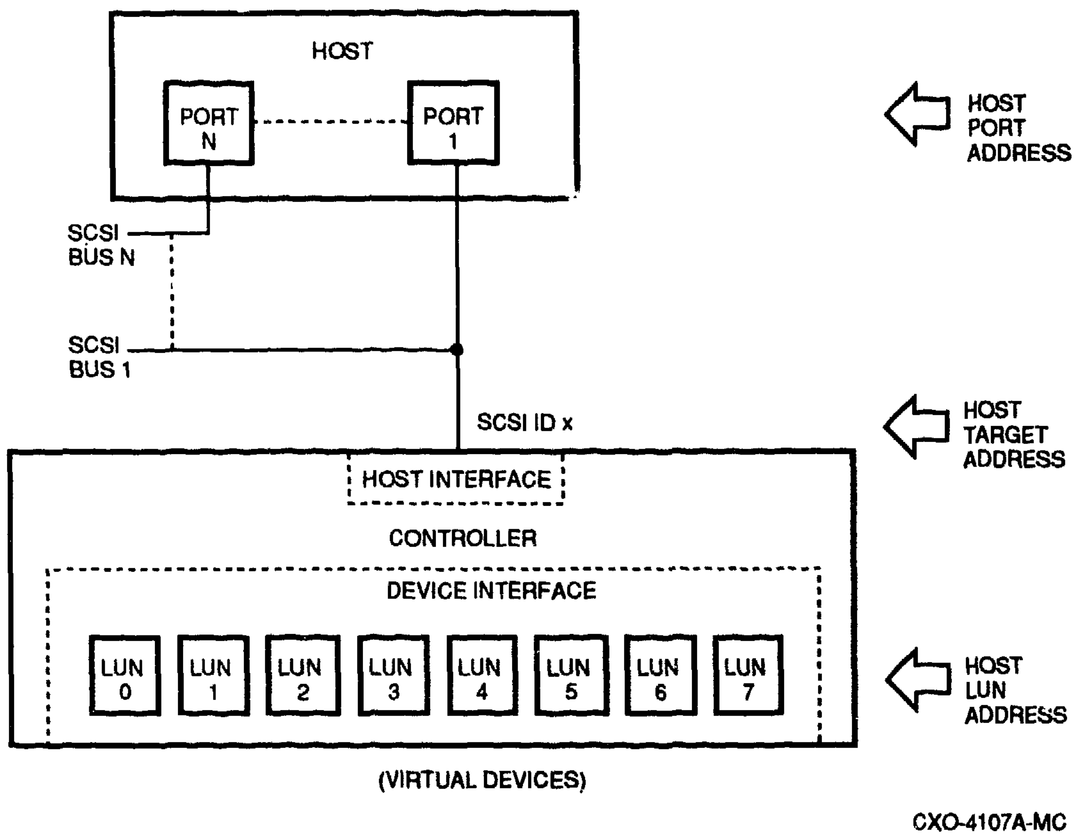


For this reason, host addressing is often tied to a virtual storage device (a storageset).

2.3.3 Host Storage Addressing

Figure 2–5 shows a typical connection between an SWXRC–04 controller and its host. In this case, the SCSI host device interface consists of device ports, each connected to a SCSI bus containing up to eight devices. The SWXRC–04 controller resides on one of the SCSI buses. The SWXRC–04 controller can be assigned from one to four SCSI IDs on the bus.

Figure 2–5 Host Storage Addressing



A SCSI host also sees host logical units through the controller. (However, in SWXRC–04 systems, there can be up to only eight units per ID. For the SWXRC–04 controller, this translates as up to 32 units, or eight per each ID.) Furthermore, the host addresses each unit by a SCSI logical unit number, *also* called a LUN.

Note

Although they share the same name, controller LUNs and SCSI host LUNs are logical addresses for two different storage structures. Controller LUNs exist on the controller's device interface, and SCSI host LUNs exist on a SCSI host's device interface.

Controller LUNs and SCSI host LUNs *may* represent the same structure, but only if the user configures (up to) eight controller devices in a one-to-one unit relationship with the host. This situation could occur under normal operation.

Host Port/Target/LUN Addressing

Host PTL addressing is the process by which a SCSI host selects a logical unit comprised of physical devices connected to an SWXRC–04 controller. The process takes place in three steps:

1. The port selection—The host selects the SCSI bus that has the SWXRC–04 controller connected to it.
2. The target selection—The host selects the controller's SCSI ID (that is, the target) on that port/bus. The SWXRC–04 controller may represent from one to four target IDs.
3. The LUN selection—The host presents the controller with the LUN of the desired host logical unit. The controller translates the LUN into the physical device addresses required to enable the host access to the virtual device.

3
Installing the Storage Subsystem

Digital offers preconfigured controller subsystems and controller subsystems configured-to-order (CTO) to your specific needs. You also can order individual storage subsystem components and assemble your own custom subsystem. This chapter presents the information necessary to perform the site installation of any of these SWXRC–04 controller storage subsystems.

3.1 Before You Begin Your Installation

Before you begin installing your SWXRC–04 controller subsystem, consider the following:

- How many people are needed for unpacking and installation?
- What type of tools are needed for unpacking and installation?
- What ESD protection is required?
- What precautions should you be aware of in handling subsystem components?
- Have you prepared your site for the installation?

The following sections discuss these considerations.

3.1.1 Personnel Needed for Installation

The number of people needed to install an SWXRC–04 controller subsystem depends on the size and weight of the subsystem cabinet.

A fully-loaded SWXSC–D*x*-series or SWXSC–C*x*-series cabinet may require two to three people to remove it from the shipping pallet because of the cabinet's weight. For details, refer to the *StorageWorks SWXSC–Dx-Series Data Center Cabinet Installation Guide*, the *StorageWorks SW500-Series Cabinet Installation and User's Guide*, or the *StorageWorks Solutions SW300-Series RAID Enclosure Installation and User's Guide*.

Most add-on options require only one person.

3.1.2 Tools Needed for Installation

The following tools could be needed during the installation of your controller subsystem. Not all of the tools listed are required for every cabinet type.

- Wrench to lower and tighten the four cabinet leveler feet.
- Allen wrench (5/32-inch) to open the front door of SWXSC–D*x*-series cabinet.
- Allen wrench (3/32-inch) to remove the front OCP bezel.
- Small straight-edge screwdriver to install host port cables.
- ESD wrist strap for handling the controller or cache modules (if applicable). The part number for the Portable Anti-Static Kit is 29–26246–00.

- A pointed object for pushing the port buttons on the operator control panel.

3.1.3 Electrostatic Discharge Protection

This section describes the necessary precautions and procedure for protecting the controller subsystem components against electrostatic discharge (ESD). ESD is a common problem for any electronic device and may cause lost data, system down time, or other problems. The most common source of static electricity is the movement of people in contact with carpets and clothing materials. Low humidity enables a large amount of electrostatic charge to build up.

Use the following strategies to minimize electrostatic discharge problems:

- Maintain more than 40 percent humidity in the room where your subsystem resides
- Place the subsystem cabinet away from heavy traffic paths.
- Do not use carpet, if possible. If carpet is necessary, choose an antistatic carpet. If a carpet already is installed, place antistatic mats around the subsystem to help decrease electrostatic discharge.

CAUTION

Use proper ESD grounding procedures or damage may result to your controller or cache modules.

Specific safety precautions must be taken when handling write-back cache modules. Therefore, only qualified service personnel may install or replace write-back cache modules.

ESD Grounding Preparation

Prior to handling (removing or replacing) a controller module or cache module, do the following:

1. Obtain and attach an ESD wrist strap to your wrist.
2. Plug or clip the other end of the ESD wrist strap to an appropriate grounding point on the storage subsystem cabinet. Grounding studs are usually located on one of the cabinet's vertical chassis rails.
3. Obtain an approved antistatic bag and/or a grounded antistatic mat.

3.1.4 Controller Components Handling Guidelines

As with any electronic equipment, some components of your controller subsystem need special handling. The following sections describe handling guidelines for modules, program cards, and cables.

3.1.4.1 Module Handling Guidelines

When handling controller or cache modules, use the following ESD grounding guidelines:

CAUTION

Use the ESD grounding procedure when handling a controller or cache module, or damage to the modules could result.

Specific safety precautions must be taken when handling write-back cache modules. Therefore, only qualified service personnel may install or replace write-back cache modules.

- Obtain and attach an ESD wrist strap to your wrist. Make sure the strap fits snugly to your wrist.
- Plug (or clip) the other end to your cabinet's grounding stud (or other chassis grounding point).
- Remove the module from its controller shelf slot and place it into an approved antistatic bag or onto a grounded antistatic mat. Remain grounded while working with the module on the antistatic mat.
- Remain grounded while installing a replacement module.
- Remove the ESD connection from the cabinet ground stud or other chassis grounding point.
- Remove the ESD wrist strap from your wrist.

3.1.4.2 Program Card Handling Guidelines

Use the following guidelines when handling the program card:

CAUTION

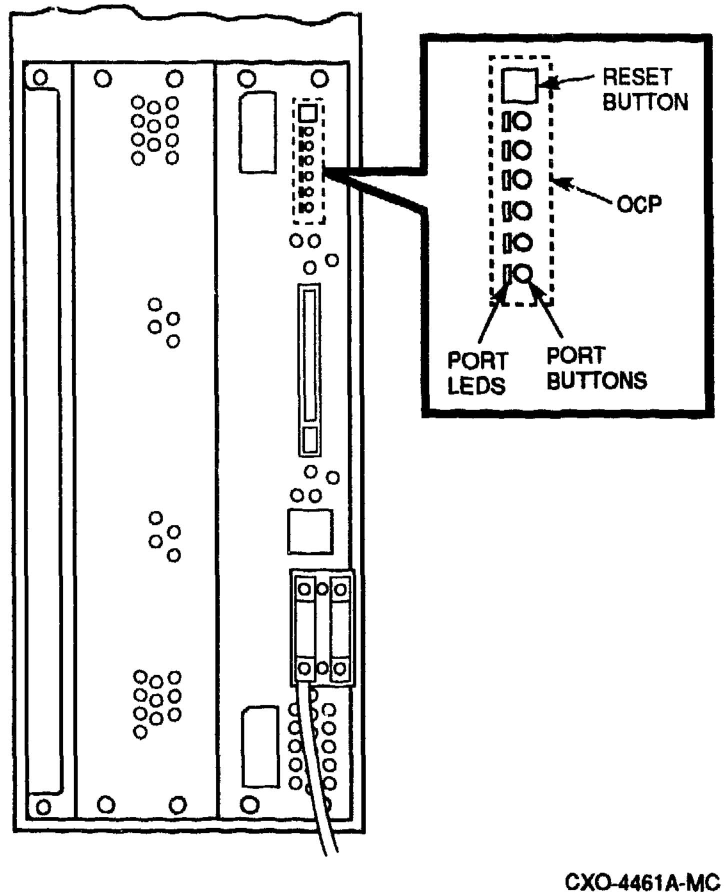
Follow these program card guidelines or damage to the program card may result.

- Keep the program card in its original carrying case unless installing it.
- Do not twist or bend the program card.
- Do not touch the contacts.
- Keep out of direct sunlight.
- DO NOT immerse the program card in water or chemicals.
- Always push the eject button to remove the card. (See Figure 3–1.)
- An ESD strap is required for installation and removal of the card.

CAUTION

The program card ESD shield must remain installed over the program card during controller operation to avoid electrostatic discharge that may cause the contents of the program card to be erased.

Figure 3–1 Location of Program Card Eject Button



3.1.4.3 SCSI Host Port Cable Handling Guidelines

SCSI host port cables can be removed or replaced with power applied. However, make sure that if you must remove the SCSI host port cables for any reason while power is applied, that you do the following:

- Halt activity on the host path to the target controller before servicing its host cables.
- If it is at the end of the SCSI host bus, leave the SCSI host port cable and the terminator connected to the trilink when you remove the trilink from the controller's front bezel.
- If it is in the middle of the SCSI host bus, leave both SCSI host port cables connected to the trilink when you remove the trilink from the controller's front bezel.

These actions are necessary to prevent breaking the SCSI bus connection. Be careful not to bend any connector pins when plugging the SCSI host port cables into the trilink.

Note

Hint: Use a very small straight blade screwdriver when disconnecting the trilink connector block (with cables and/or terminators attached) from the front bezel of the controller. The clearance between a terminator and a host port cable or two host port cables is minimal.

Refer to the *StorageWorks Solutions Configuration Guide* and the *StorageWorks Solutions Shelf and SBB User's Guide* for more information about SCSI bus cables and connectors, terminators, and trilink connector blocks.

3.1.5 Site Preparation

Site planning and preparation are necessary before installing an SWXRC–04 controller subsystem.

WARNING

To prevent damage to equipment and personnel, make sure all power sources meet the specifications required for this equipment.

Your site preparation plan should include:

- Power requirements
- Floor space requirements
- Environmental considerations (such as temperature and humidity)
- Device environment (including maximum altitude for operation and storage)
- Subsystem weight considerations (for floor supports)
- Upgrade considerations (for future subsystem expansion)

Refer to the *StorageWorks SW800-Series Data Center Cabinet Installation Guide* (three phase), the *StorageWorks SW500-Series Cabinet Installation and User's Guide* (single phase), or the *StorageWorks Solutions SW300-Series RAID Enclosure Installation and User's Guide* for details concerning site preparation requirements and unpacking information for your controller's subsystem cabinet.

Using a site preparation plan helps you fulfill the requirements to support your controller subsystem. After verifying that all requirements are met, you are ready to install your controller subsystem.

3.1.5.1 Power and Power Cord Requirements

Before installing your controller subsystem, ensure that the correct power cable for your site is attached to your StorageWorks cabinet, and that the power requirements for your country and your site have been met at the cabinet level.

For specific information about power cord plugs, refer to the StorageWorks cabinet specific installation and user's guides listed in this chapter.

3.1.5.2 Shelf Power Configuration Rules

Refer to the manual for your specific SBB shelf for specific power unit configuration rules. The term *power unit* describes both power supplies and battery backup units.

3.1.5.3 Environmental Considerations

The SWXRC–04 controller subsystem operates in a business or light industrial environment that complies with FCC Class A computing device standards. The cleanliness of the site is important for the operation of any computer system, and SWXRC–04 controllers require adherence to cleanliness standards. Temperature and humidity standards must be met to maintain proper operation of your subsystem. Refer to Section 1.5 for the environmental specifications for the SWXRC–04 controller.

3.2 Unpacking and Placing the Subsystem

When delivered, your controller subsystem is packed in a carton and attached to a shipping pallet. Upon receipt of your subsystem, perform the following tasks:

1. Check the carton and pallet for signs of shipping damage.
2. Report any damage to Digital Multivendor Customer Services or the Digital sales office in your area, and to the local carrier that delivered your equipment.
3. Unpack and remove your subsystem cabinet from the shipping pallet. Refer to the cabinet-specific installation guides for unpacking instructions.
4. Keep all packing materials and shipping labels for later use and reference.
5. Remove and read your subsystem documentation before continuing with the installation process.
6. Move the subsystem cabinet into place at your site.
7. Open the front and back doors of the cabinet.
8. **If you are installing a preconfigured or CTO subsystem,** visually inspect all subsystem components to ensure that:
    - All cables are seated properly
    - All SBBs are seated properly
    - All controller and cache modules are seated properly
    - All shelf fans are seated properly
    - All program cards are loaded properly

    If you are installing a subsystem made up of individual components you have ordered, physically configure the interior of your cabinet to contain your power distribution units, power supplies, storage device shelves, and storage SBBs. See Chapter 4 for configuration rules for your cabinet.
9. Plug the cabinet power cord into the proper wall outlet for your subsystem's power requirements.

3.3 Connecting the Maintenance Terminal

To enable you to define your subsystems's initial configuration parameters, connect a maintenance terminal to the EIA–423 terminal port on the front bezel of your controller as follows:

Note

You do not need a hardware maintenance terminal for normal operations. However, you must use a hardware maintenance terminal for initial controller parameter configuration.

---

1. Make sure the power switch on the back of the terminal is OFF (0).
2. Connect one end of the terminal cable to the back of the terminal.
3. Connect the other end of the terminal cable to the MMJ EIA–423 terminal port on the controller's front bezel.
4. Turn the terminal power switch to the ON position.
5. Set the terminal at 9600 baud, with 8 data bits, 1 stop bit, and no parity. Refer to your terminal documentation for terminal setup instructions.
6. Press the Return key if no prompt is visible on the screen. (This brings you to the controller's command line interpreter [CLI] prompt.)

Note

Your CLI prompt may be factory-set to reflect your controller model, such as SC4>. Appendix B provides details on how to change the prompt.

This guide uses the designation "CLI>" to identify the CLI prompt.

3.4 Checking the Controller's Initial Parameters

1. Switch the circuit breakers (CB1) on your controller subsystem cabinet's cable distribution units to the ON (I) position. The subsystem controllers and devices begin their normal initialization sequence.

Note

Set the configuration parameters *before* connecting your host port cables.

---

2. From your maintenance terminal, check to see which controller configuration parameters have been preset at the factory. A factory configuration printout could accompany your documentation packet. You can verify the factory preset parameters by entering the following commands at the CLI> prompt:

```
CLI> SHOW THIS_CONTROLLER
```

or

```
CLI> SHOW OTHER_CONTROLLER
CLI> SHOW DEVICES
```

If initial parameters are not set, see Chapter 5 for the specific order for setting parameters for nonredundant and dual-redundant controller configurations.

Note

Whenever you restart the controller, device activity LEDs momentarily lights while the controller discovers what devices are attached. Do not attempt to enter CLI commands that alter the device configuration (such as DELETE, SET, ADD, and so on) until after this discovery phase. This phase may take up to 2 minutes to complete.

After setting your initial parameters and defining your device configurations, print them out and keep the printout available to assist in servicing the subsystem in the future. Make a new printout each time you change your configuration parameters or add or delete units or storagesets.

Important Write-Back Cache Note

If your system contains write-back cache modules, their batteries were completely charged at the factory. It is normal for the batteries to have discharged slightly in shipment. To ensure absolute data integrity, the advanced write-back cache and RAID features of your controller require fully-charged batteries to operate. These advanced features may not be available immediately after installation, until the batteries have had an opportunity to completely recharge.

3.5 Connecting the Host Port Cables

Connect host port cables, trilink connector blocks, and terminators to your controller as follows:

Note

Do not connect the controller end of any internal host port cables to your controller unless the controller's initial parameters have been set and the host port SCSI IDs have been set.

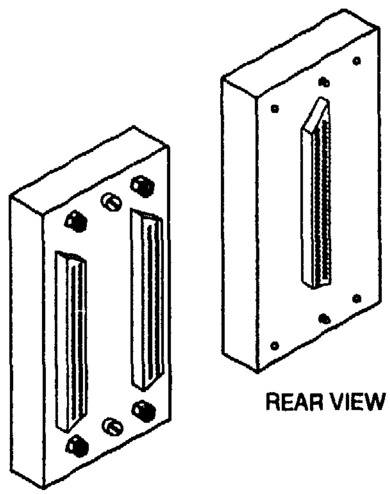
---

1. Plug the supplied trilink connector block (part number H885–AA) into the host port connector on the front bezel of your controller (if it is not already in place). Figure 3–2 shows the H885–AA trilink connector block.

   Figure 3–3 shows the connection of a SCSI host port cable and terminator to the trilink connector block on a nonredundant SWXRC–04 controller in an HA–000 shelf.

   Figure 3–4 shows the connections for a dual-redundant configuration. In this configuration, a trilink connector block must be installed on each controller. Connect the two trilink connector blocks together with a short jumper cable, as shown.

Figure 3–2 Trilink Connector Block



2. Plug the SCSI host cable onto either of the free connectors on the trilink connector blocks. For dual-redundant controllers, the host cable can be connected to either trilink connector block.
3. If the controller is to reside at the end of the host bus, the bus must be terminated at the controller. Plug the supplied terminator (option number H879–AA) onto the free connector on the trilink connector block. If the bus is to continue to other units, connect the appropriate SCSI bus cable instead.

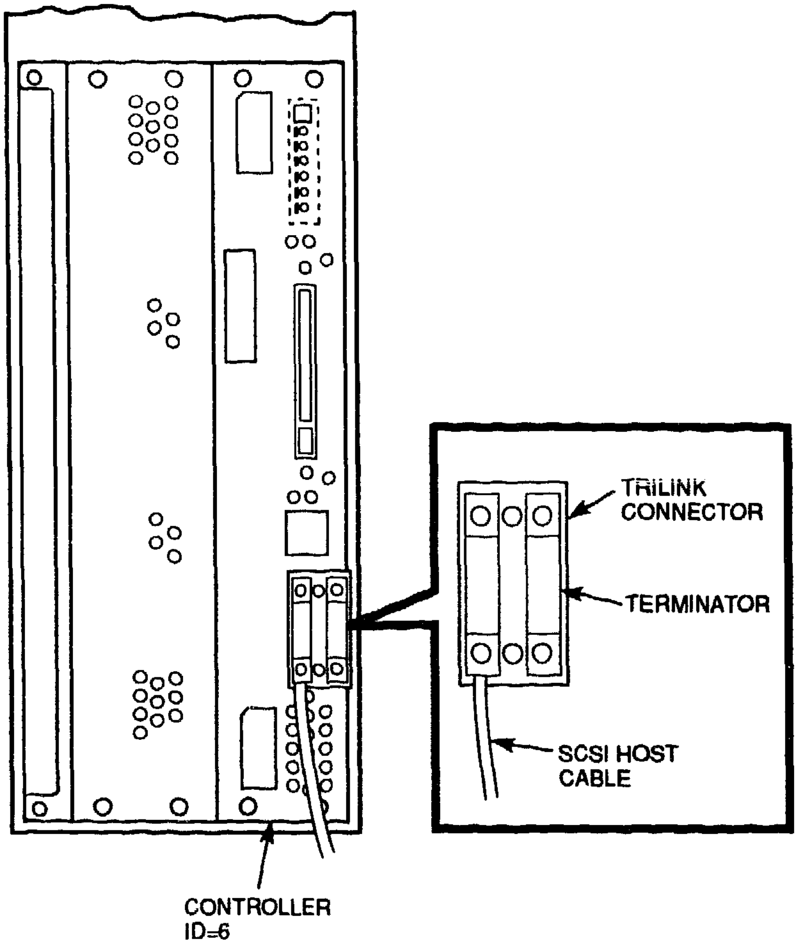
   For dual-redundant controllers, plug the terminator or bus continuation cable onto the trilink connector block that is free.
4. If the host uses a 16-bit FWD adapter, route the host port cable directly from the controller's trilink connector, through the cabinet, and to the host port adapter.
5. If the host uses an 8-bit single-ended adapter, route the host port cable from the trilink connector into an SWXAZ–AA-series SCSI bus signal converter.

   If you use a 3 1/2-inch SBB SWXAZ–AA signal converter:

   1. Plug a 3 1/2-inch SBB SWXAZ–AA signal converter into SCSI slot 0 in a SWXSS–02 SBB shelf (the SWXAZ–AA receives its power from the shelf).
   2. Plug the SCSI host port cable coming from the controller's trilink into the connector on the front of the SWXAZ–AA.
   3. Plug a SCSI–P cable into the first (upper) connector in that SWXSS–02 SBB shelf.
   4. Route the other end of the SCSI–P cable to the host.

   If you use a desktop SWXAZ–AA signal converter with a self-contained power supply:

Figure 3–3 Host Port Cable Connection—Nonredundant Configuration

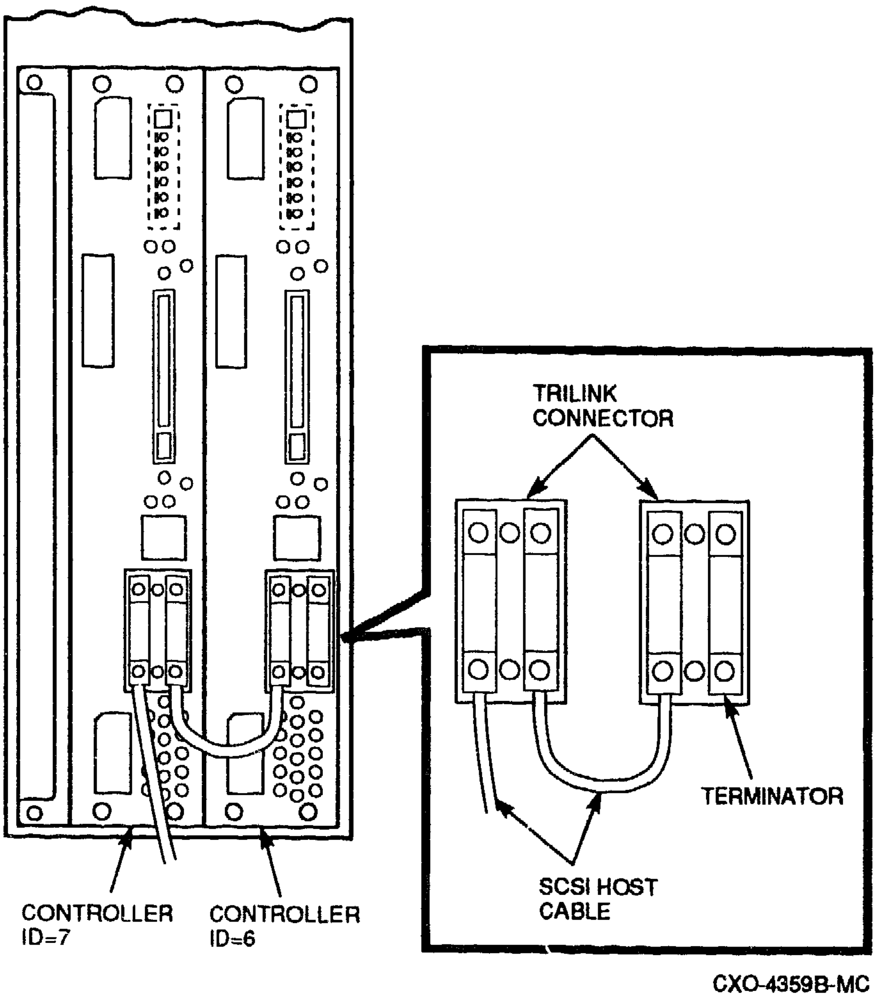


1. Plug the SCSI host port cable coming from the controller's trilink into the connector on the front of the SWXAZ–AA signal converter.
2. Route the other end of the host port cable to the host.

Refer to the *StorageWorks Solutions Shelf and SBB User's Guide* for detailed information on SWXAZ–AA-series SCSI bus signal converters. Refer to the *StorageWorks Solutions Configuration Guide* for information on the H885–AA trilink connector block.

Two important considerations for all SCSI buses are bus termination and bus length. Each bus must be terminated at each end of the bus. Maximum bus lengths must be taken into consideration when designing your subsystem configuration.

Figure 3–4 Host Port Cable Connection—Dual-Redundant Configuration



4

Physical Storage Subsystem Configuration

This chapter describes rules and restrictions as they apply to the physical configuration and connection of the following SWXRC–04 controller subsystem hardware:

- Cabinets
- Shelves
- Devices
- Controllers
- Hosts

This chapter describes physical configurations with respect to both standard and nonstandard (customized) subsystems. Further information can be found in the specific StorageWorks cabinet and shelf documentation.

4.1 Physically Configuring StorageWorks Cabinets

The following sections present information to keep in mind when loading SWXSS-series controller and storage shelves in SWXSC–D*x*-series **data center cabinets** and SWXSC–C*x*-series cabinets. The design of the SWXSC–AA-series deskside RAID enclosure is such that the single SWXSC–AA storage enclosure is internal and fixed. Configuring shelves in an SWXSC–AA cabinet essentially is not required.

Note

Note that the following sections include references to TZ8x7 tape loader devices. The SWXRC–04 controller does not support tape devices, however the cabinet in which the controller is installed may contain such devices attached to other equipment. The cabinet loading information includes tape devices for reference only.

4.1.1 SWXSC–D*x*-Series Data Center Cabinet

This section presents the rules to apply to subsystem configurations in SWXSC–D*x*-series data center cabinets. Refer to the *StorageWorks Solutions SW800 Data Center Cabinet Installation and User's Guide* for more details.

Note

In Figures 4–1 through 4–5, "S" indicates an SWXSS–02 storage shelf, and "C" indicates an SWXSS–01 controller shelf.

Figure 4–1 shows the loading sequence for storage and controller shelves in an SWXSC–D*x*-series data center cabinet.

Figure 4–1 SWXSC–Dx-Series Data Center Cabinet Loading

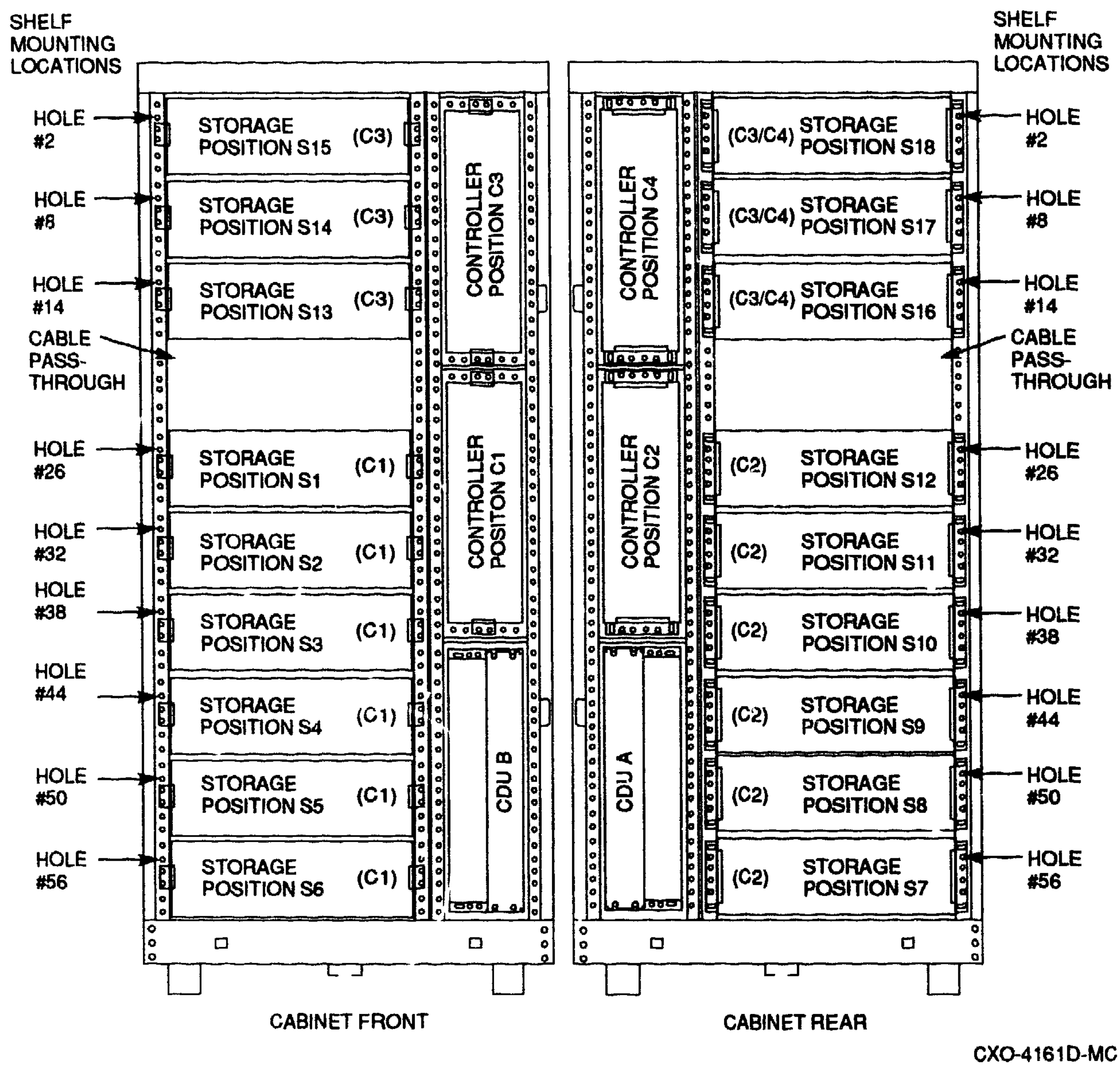


Figure 4–2 shows the loading sequence for storage and controller shelves when one or two TZ8*xx*-series tape devices are installed.

Figure 4–2 SWXSC–Dx-Series Data Center Cabinet Controller/Storage/(1–2) Tape Drive Locations

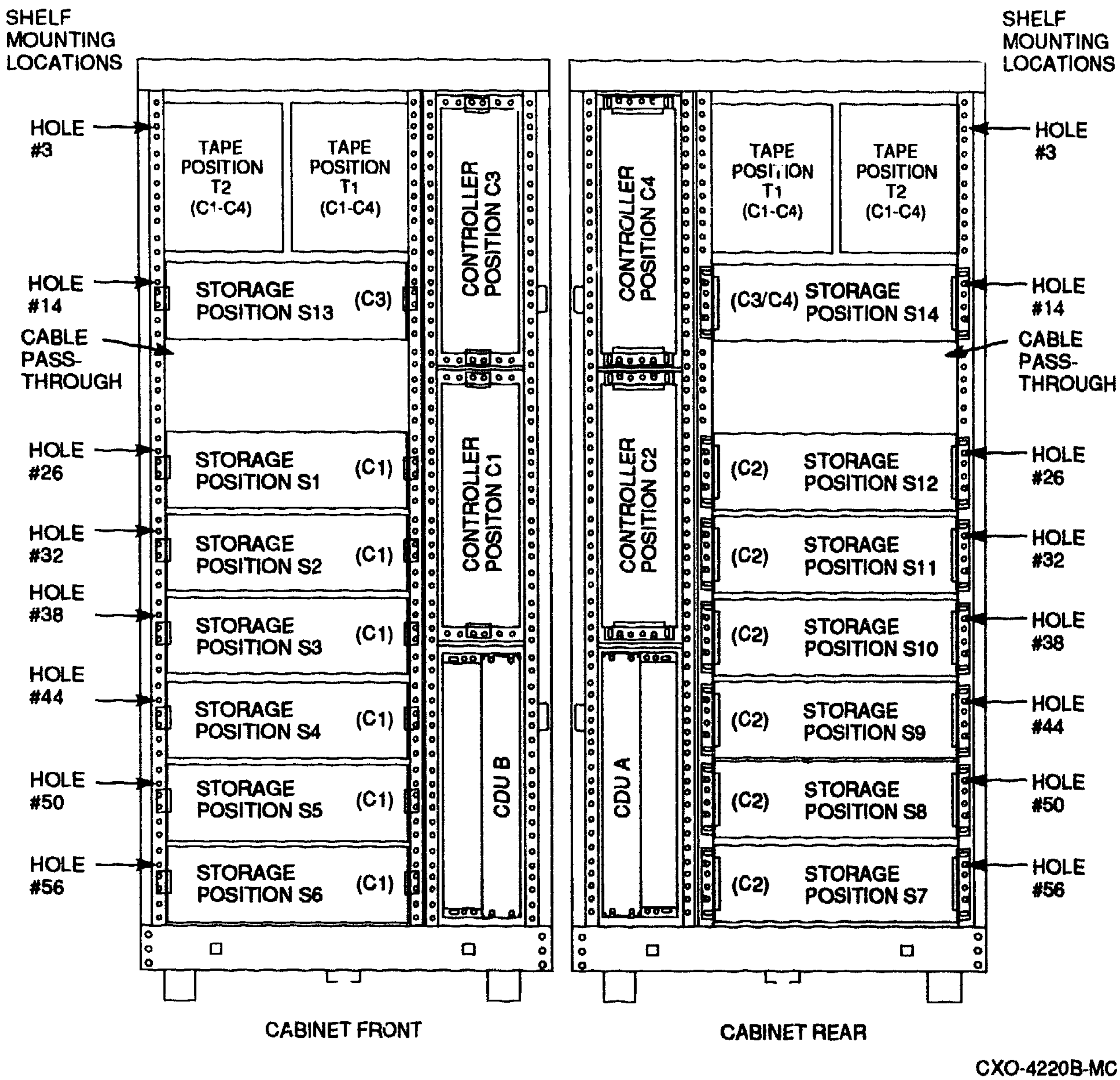
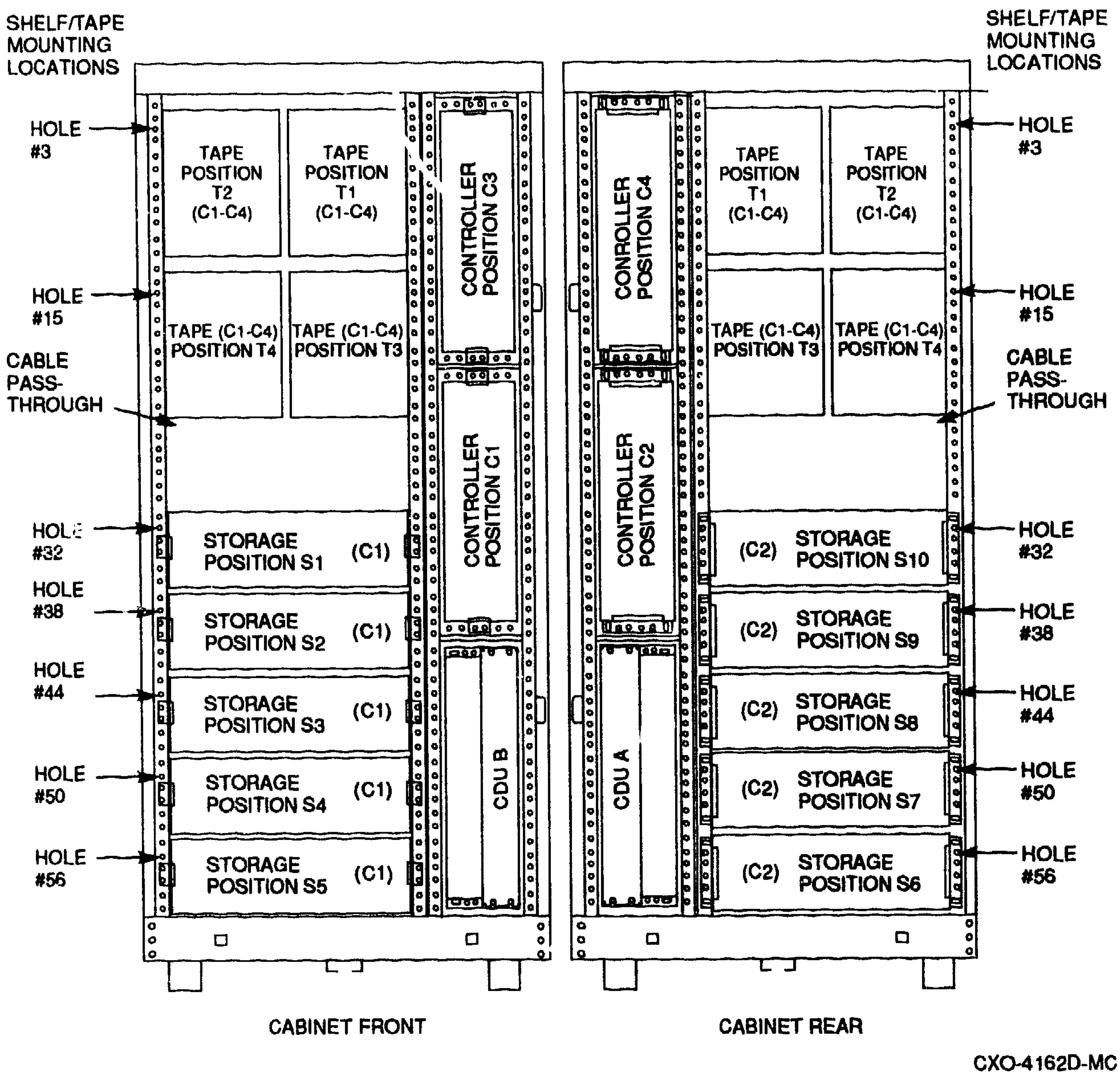


Figure 4–3 shows the loading sequence for storage and controller shelves when three or four TZ8*xx*-series tape devices are installed.

- Standard shelf configuration

  Digital suggests a standard of three (or four) SWXSS–01 shelves connected to 18 SWXSS–02 shelves in a single SWXSC–D*x*-series data center cabinet.

Figure 4–3 SWXSC–Dx-Series Data Center Cabinet Controller/Storage/(3–4) Tape Drive Locations



- Two device shelves per port (jumpered pairs)

  Two SWXSS–02 shelves can be joined on the same controller port with the following restrictions:

  – The SCSI–2 cable to the first SWXSS–02 storage shelf is 1.0 meter or less.[2]

  – The SCSI–2 cable from the first SWXSS–02 shelf to the second shelf is 0.5 meters or less. This requires two shelves to be immediately adjacent to each other.

[2] The associated SWXSS–01 controller shelf must be located near enough to satisfy this restriction.

- The first SWXSS–02 storage shelf is configured for an unterminated single SCSI cable.

- TZ8x7 half-rack tape loader

  Any TZ8x7 half-rack tape loader device must be located at the top front positions filling two or four top SWXSS–02 shelf positions (front and back). Note that each tape loader occupies the full cabinet depth.

  Up to four tape drive loader devices can be loaded in an SWXSC–Dx-series data center cabinet, displacing shelves S1 and S12–S18 (leaving 10 SWXSS–02 shelves remaining).

- Use of an upper controller shelf

  By convention, controller shelf C3 would use (only) the top three (or four) storage shelves in the front of the cabinet; the fourth controller shelf (C4) would use the top three (or four) storage shelves in the back of the cabinet.

- Number of devices

  Up to 42 devices can be attached using 7 3½-inch SBBs in each of 6 SWXSS–02 shelves attached to controllers with 6 controller ports.[3]

- Maximum number of device shelves

  Up to 18 horizontal SWXSS–02 device shelves are allowed (16 if one or two TZ8x7 tape loaders are present). An earlier cabinet configuration had a provision for 19 horizontal device shelves; however, Digital no longer recommends that configuration.

- Vertical device shelves

  Vertical shelves are not used for device shelves because some devices require horizontal alignment. If desired, vertical shelf locations may be used for most disk drives. Refer to the device-specific documentation for requirements. (Any of the vertical shelves may be used. However, Digital recommends surrendering controller positions C4, then C3, first for storage shelves. Refer to Figure 4–1.)

4.1.2 SWXSC–*Cx*-Series Cabinets

The rules presented in this section apply to subsystem configurations in SWXSC–*Cx*-series cabinets. Refer to the *StorageWorks Solutions SW500 Cabinet Installation and User's Guide* for more details.

Figure 4–4 shows the loading sequence for storage and controller shelves in an SWXSC–*Cx*-series cabinet.

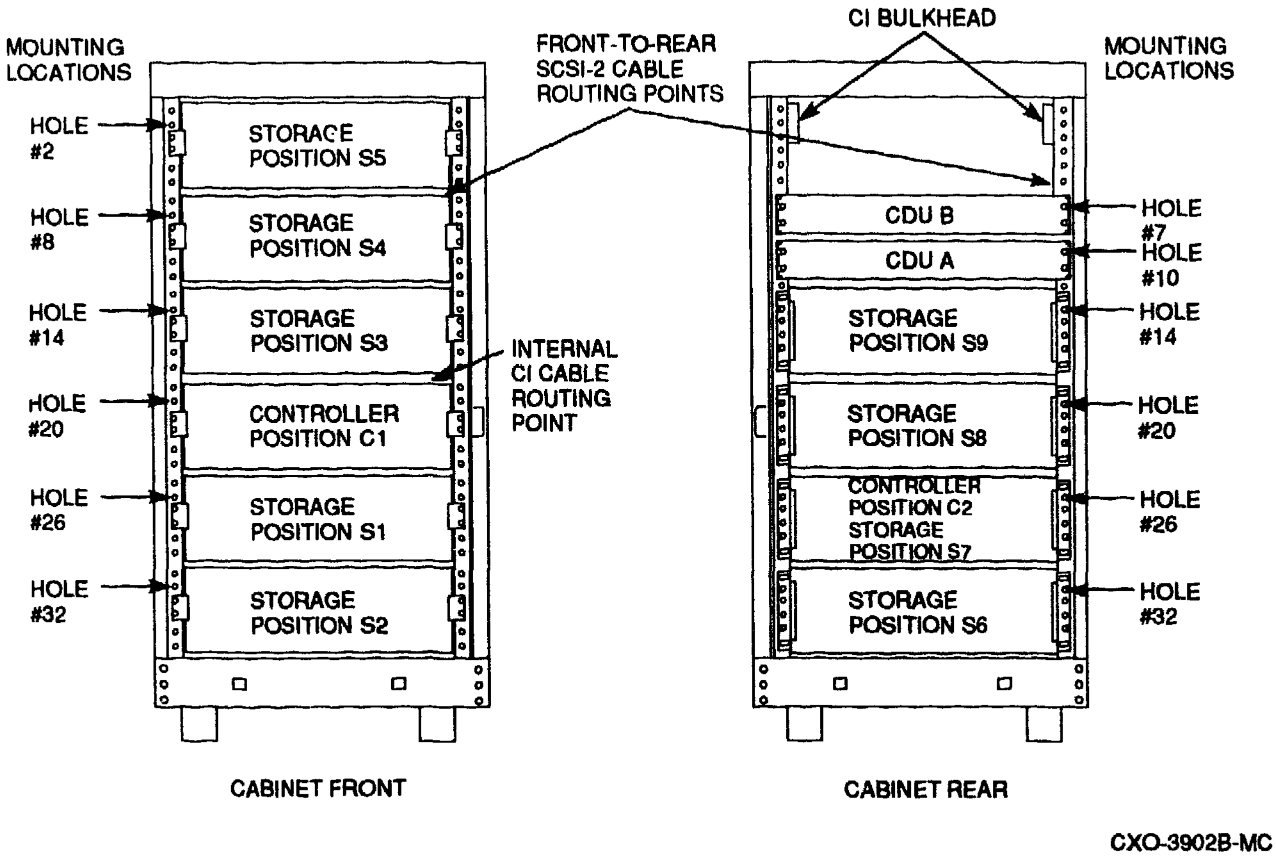
Figure 4–5 shows the loading sequence for storage and controller shelves when TZ8*xx*-series tape devices are installed.

- Standard shelf configuration

  A standard of one SWXSS–01 controller shelf connected to six SWXSS–02 storage shelves in a single SWXSC–*Cx*-series cabinet is suggested.

[3] Redundant power and dual-redundant controllers are not supported when using 42 devices. This is not a recommended configuration.

Figure 4–4 SWXSC–Cx-Series Cabinet Loading



- Two SWXSS–01 shelves can be housed with a maximum of four SWXSS–02 shelves each as two subsystems.
- Two device shelves per port (jumpered pairs)

  Two SWXSS–02 shelves can be joined on the same controller port with the following restrictions:

  – The SCSI–2 cable to the first SWXSS–02 storage shelf is 1.0 meter or less.[4]

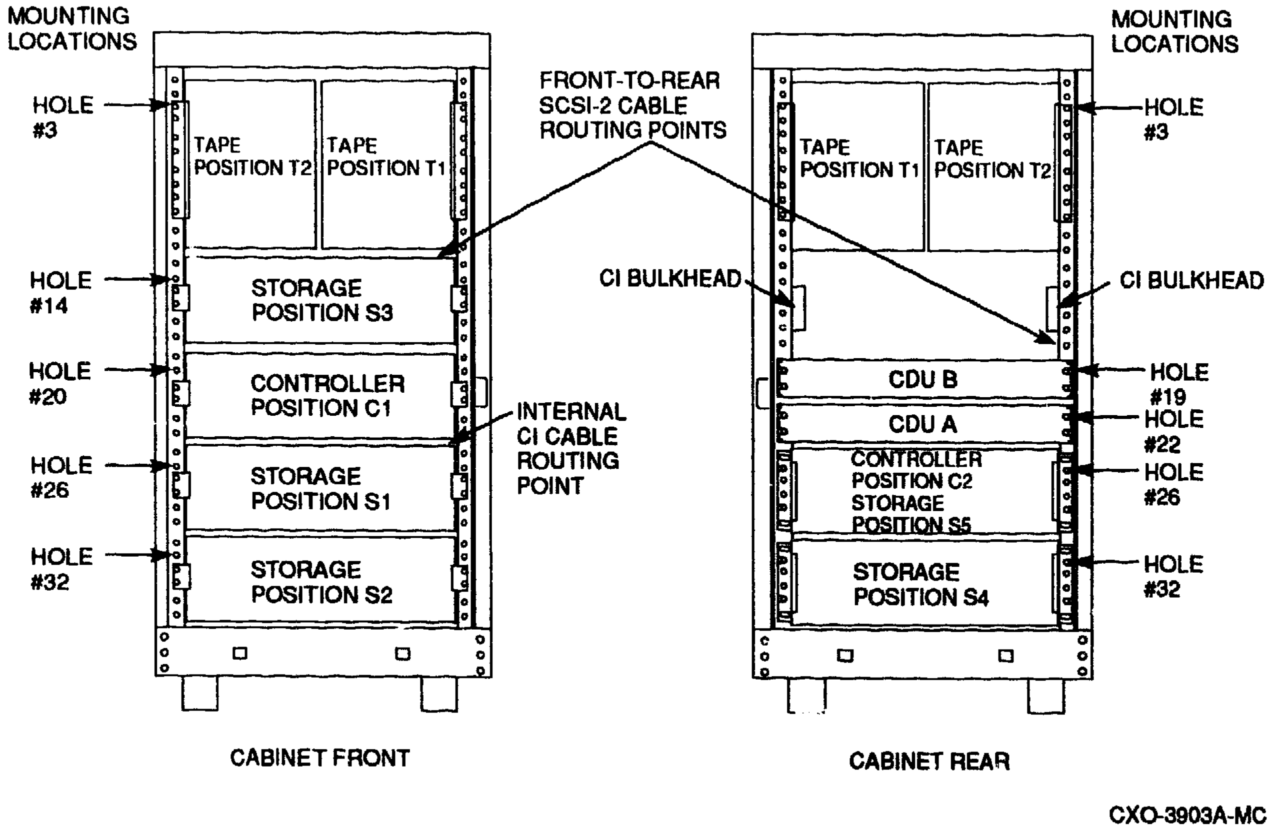
  – The SCSI–2 cable from the first SWXSS–02 shelf to the second shelf is 0.5 meters or less. This requires two shelves to be immediately adjacent to each other.

  – The first SWXSS–02 storage shelf is configured for unterminated single SCSI.

  – Controller shelf position C1 can be used with the pairs S1–S2 and S3–S4, and controller shelf position C2 can be used with the pair S8–S9, to satisfy these restrictions. A single subsystem (C1) can thus accommodate up to 16 5¼-inch SBBs.

[4] The associated SWXSS–01 controller shelf must be located near enough to satisfy this restriction.

Figure 4–5 SWXSC–Cx-Series Cabinet Controller/Storage/Tape Drive Locations



- TZ8x7 half-rack tape loader (refer to Figure 4–5):

  Any TZ8x7 half-rack tape loader must be located at the top front positions filling the two top SWXSS–02 shelf positions (front and rear). Note that each tape loader occupies the full cabinet depth. Up to two tape drive loader devices can be loaded in an SWXSC–Cx-series cabinet, displacing shelves S4, S5, and S8–S9 (moving the cable distribution units (CDUs) to shelf location S8).

- Use of a second controller shelf

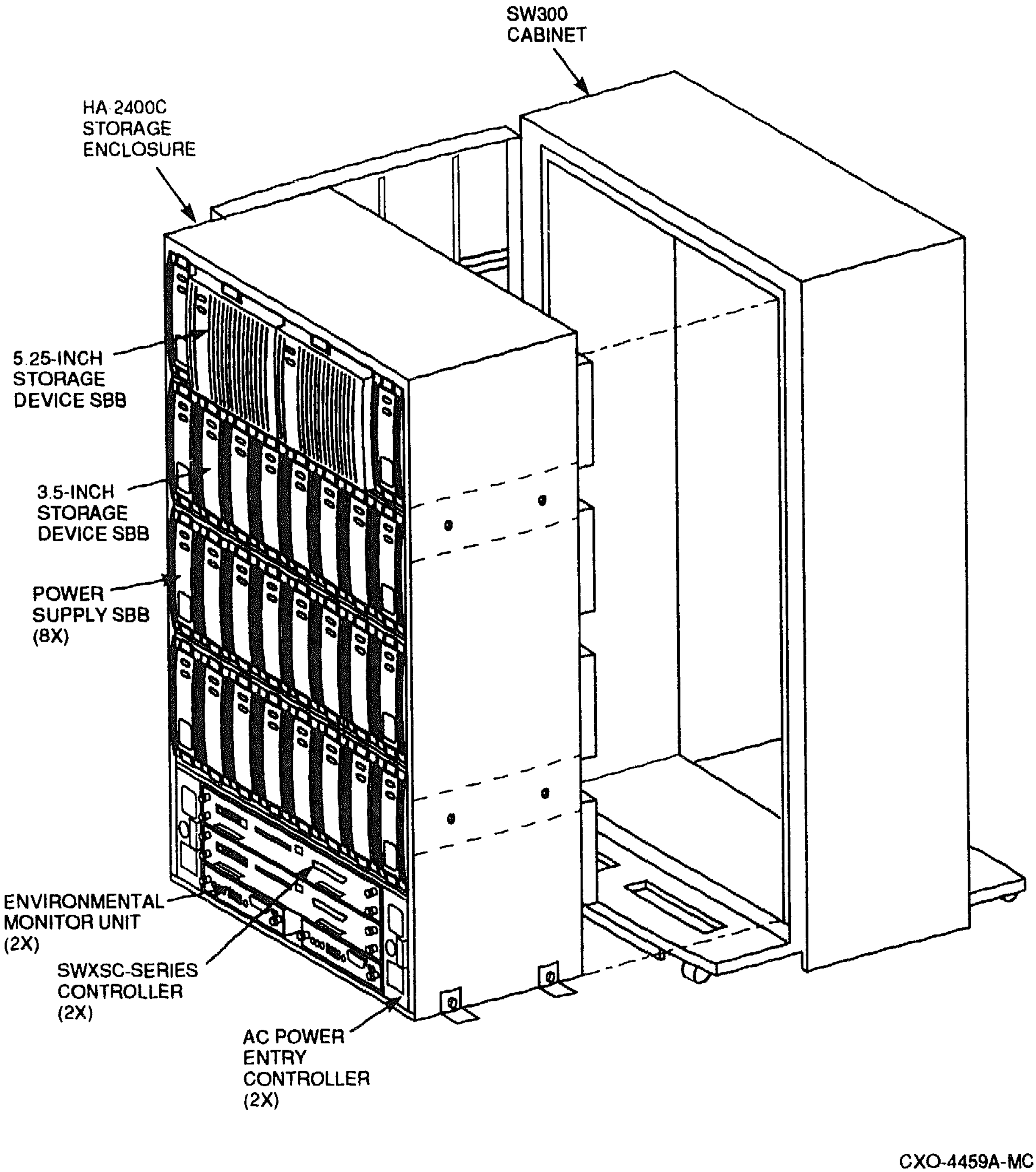
  By convention, the first controller shelf (C1) would use positions S1–S5; the second controller shelf (C2) would use positions S6, S8, and S9. This permits two subsystems, one with up to 24–28 3½-inch SBB devices (in the front), and the other with 18–21 3½-inch SBB devices (in the rear).

4.1.3 SWXSC–AA-Series RAID Enclosure

The SWXSC–AA-series RAID enclosure, as shown in Figure 4–6, is a modular, deskside, StorageWorks enclosure designed to hold one integrated set of subsystem components. The SWXSC–AA RAID enclosure comprises an SWXSC–AA storage enclosure mounted in the SWXSC–AA cabinet. The SWXSC–AA storage enclosure supports the equivalent of four SWXSS–02 SBB shelves and one SWXSS–01 controller shelf. The integrated design of the SWXSC–AA storage enclosure virtually eliminates the need for complicated physical configuring by the operator.

The SWXSC–AA-series RAID enclosure accepts only the SWXSC–AA storage enclosure, and does not accept other shelf types. See the *StorageWorks Solutions SW300-Series RAID Enclosure Installation and User's Guide* for more information on the enclosure. The SWXSC–AA-series RAID enclosure (the combination of the SWXSC–AA cabinet and the SWXSC–AA storage enclosure) is called the "SWXSC–AA cabinet" in this guide.

Figure 4–6 SWXSC–AA-Series RAID Enclosure



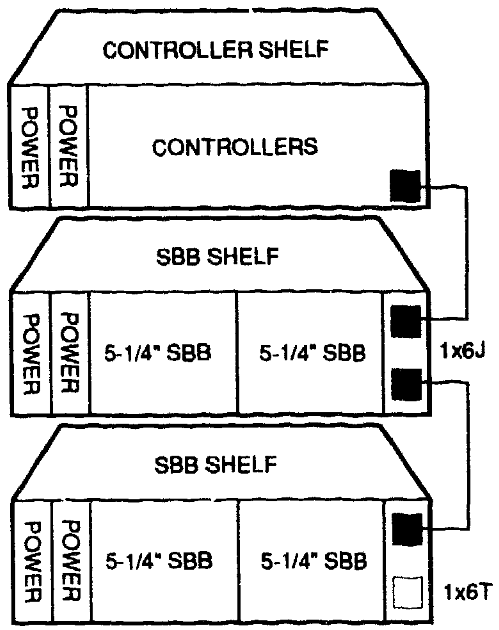
4.2 Physically Configuring StorageWorks SBB Shelves

The following configuration rules apply to the arrangement of controller and device shelves.

SWXSS-Series SBB Shelves SWXSS-series shelves may be arranged in any legal SCSI-2 configuration, subject to the following:

- No more than a single extension joining two SWXSS-02 SBB shelves is permitted. The two SWXSS-02 shelves must be physically adjacent to each other. Figure 4-7 shows an example of device shelves in a single extension configuration.

Figure 4-7 Single Extension from Device Shelf to Device Shelf



- Connecting a 1.0 meter cable from a controller shelf to a device shelf allows for device shelf jumpering. Connecting a 2.0 meter cable does *not* permit shelf jumpering. (Required cable length varies depending on cabinet type, device shelf position, and controller shelf position.)

4.3 Device SBB Configuration in the SWXSS-02 Shelf

The following sections describe recommended device configurations for 3½-inch and 5¼-inch SBBs in SWXSS-02 shelves.

4.3.1 3½-Inch SBB Configuration Restrictions

The only restriction for adding 3½-Inch SBBs to SWXSS-02 SBB shelves is to prevent SCSI ID conflicts. Devices should not be installed in slot 6 (SCSI ID 6) of an SWXSS-02 shelf when a controller serving the shelf is in controller slot 6 (the slot closest to the SCSI bus cables) of the controller shelf.

Refer to your SPD and release notes for a list of specific supported device types.

4.3.2 5¼-Inch SBB Configuration Restrictions

The following restrictions apply when adding 5¼-inch SBBs to an SWXSS–02 shelf configuration. Refer to your SPD and release notes for a list of specific supported device types.

- A maximum of two 5¼-inch SBBs are allowed per port (in a single shelf), or four 5¼-inch SBBs per port (in adjacent jumpered shelves).

  No more than four 5¼-inch SBBs are allowed on a single port (that would take three shelves, which cannot be configured within SCSI–2 cable limits).
- Intermixing 5¼-inch and 3½-inch SBBs is permitted using up to six devices per port (maximum of two shelves), with no more than three 5¼-inch SBBs.

  You can use two 5¼-inch SBBs and four 3½-inch SBBs in two SWXSS–02 shelves, or one 5¼-inch SBB and four 3½-inch SBBs in one SWXSS–02 shelf.
- When using jumpered shelves, only five jumpered-pair shelves (for a total of ten shelves) can be used within each SWXSC–D*x*-series data center cabinet. This leaves the sixth controller port unused. Alternately, four jumpered ports permit two single-shelf connections on the remaining two controller ports, which is preferable.

  This setup is permitted only in the lower front of the cabinet from the C1 controller position. Five such ports may take up to a maximum of ten front shelf locations, with no allowance for cable access to shelves or devices in the rear of the SWXSC–D*x*-series cabinet. (Refer to Figure 4–1.)

  A more balanced configuration consists of four 5¼-inch SBBs on each of four ports, and two ports each with two 5¼-inch SBBs.
- When using jumpered shelves, only two jumpered-pair shelves (for a total of four shelves) can be used with an SWXSC–C*x*-series cabinet.
- When five ports (SWXSC–D*x*) or two ports (SWXSC–C*x*) have doubled shelves for 5¼-inch SBBs (4+2), TZ8x7 tapes cannot be mounted in the cabinet because all or most (front) shelf locations are needed for the 5¼-inch SBBs.

4.3.3 Shelf Configuration Tables

Tables 4–1 through 4–2 provide the information necessary to configure and install 5¼-inch and 3½-inch SBBs in SWXSS–02 SBB shelves.

4.3.3.1 Table Conventions

Following are the conventions used in Tables 4–1 through 4–2. The designation shows the possible devices in each shelf and the possible number of devices in similarly configured shelves.

(n)mxoT

(n)mxoJ

where:
n is the number of device shelves.
m is the number of SCSI–2 connections to a device shelf.
o is the number of devices on each SCSI–2 connection.
T indicates the device shelf is terminated.
J indicates the device shelf is jumpered.

According to the formula:

$m * o =$ possible devices in each shelf.

$n * m * o =$ possible number of devices in similarly configured shelves.

4.3.3.2 3½-Inch SBB Configurations

Table 4–1 lists some recommended configurations for 3½-inch SBBs in SWXSS–02 shelves.

Table 4–1 3½-Inch SBB Configurations, 6-Port Controller

Number of Devices	Number of SWXSS–02 Shelves*	Configure as**	Available for 3½-Inch SBBs***	Ports Used
1–2	1	(1)2x3T	5-4	1–2
3–4	2	(2)2x3T	9-8	3–4
5–18	3	(3)2x3T	13-0	5–6
19–24	4	(2)2x3T	5-0	6
		(2)1x6T		
25–30	5	(1)2x3T	5-0	6
		(4)1x6T		
31–36	6	(6)1x6T	5-0	6
37–42****	6	(6)1x7T	5-0	6

Notes

2x3T: Two (split) SCSI–2 connections, separately terminated in the shelf. The devices appear as IDs 0, 2, 4, and 1, 3, 5.

1x6T: Single path SCSI–2 connection terminated in the shelf. The devices appear as IDs 0 through 5.

1x7T: Single path SCSI–2 connection terminated in the shelf. The devices appear as IDs 0 through 6.

* Consult the *StorageWorks Solutions Shelf User's Guide* for SWXSS–02 shelf information.
** Each SWXSS–02 shelf's upper SCSI–2 port connector is cabled to a controller port. The lower SCSI–2 port connector is attached to a controller port for 2x3T configurations and is unused for a 1x6T or 1x7T.
*** Available for future expansion.
**** Nonredundant controller and power (not recommended).

4.3.3.3 5¼-Inch SBB Configurations

Table 4–2 lists some recommended configurations for 5¼-inch SBBs in SWXSS–02 shelves.

Table 4–2 5¼-Inch SBB Configurations, 6-Port Controller

Number of Devices	Number of SWXSS–02 Shelves*	Configure as	Available for 5¼-inch SBBs**	Ports Used
1–2	1	(1)2x3T	1-0	1–2
3–4	2	(2)2x3T	1-0	3–4
5–6	3	(3)2x3T	1-0	5–6
7–8	4	(2)1x6T	1-0	6
		(2)2x3T		
9–10	5	(4)1x6T	1-0	6
		(1)2x3T		
11–12	6	(6)1x6T	1-0	6
13–14***	7	(6)1x6T	1-0	6
		(1)1x6J		
15–16***	8	(6)1x6T	1-0	6
		(2)1x6J		
17–18***	9†	(6)1x6T	1-0	6
		(3)1x6J		
19–20***	10†	(6)1x6T	1-0	6
		(4)1x6J		

Notes

Each SWXSS–02 shelf has its upper connector cable attached either to the adjacent SWXSS–02 shelf's lower connector (1x6J), or a controller port connector (2x3T or 1x6T).

The lower connector cable is attached either to an adjacent SWXSS–02 shelf's upper connector (1x6J, as in the first note item), controller port connector (2x3T), or is unused (1x6T).

* Consult the *StorageWorks Solutions Shelf User's Guide* for SWXSS–02 shelf information.
** Available for additional 5¼-inch device.
*** When used with the controller in the C1 position in an SWXSC–Dx-series or SWXSC–Cx-series cabinet. (Refer to Figures 4–1 and 4–5.)
† Cannot be configured in SWXSC–Cx-series cabinets.

4.3.4 Intermixing 5¼-Inch and 3½-Inch SBBs, SWXSS–02 SBB Shelf

Use these guidelines for intermixing 5¼-inch and 3½-inch SBBs:

- Treat each 5¼-inch SBB as three 3½-inch SBBs.
- Each 5¼-inch SBB must have its SCSI–2 ID set manually using the address switch on the rear of the SBB, or by setting the switch to automatic and letting the slot connector dictate the device address. (Refer to the *StorageWorks Solutions Shelf and SBB User's Guide*.)
- A 5¼-inch SBB may be located in the same shelf with up to three or four 3½-inch SBBs.

4.3.5 Atypical Configurations

By unbalancing the number of devices per controller port, configurations can be devised with a smaller shelf count. This results in lower performance and/or availability. The minimum SWXSS–02 shelf count for various numbers of 3½-inch SBBs is listed in Table 4–3 .

Table 4–3 Small Shelf Count Configurations, 6-Port Controller

Number of Devices	Number of SWXSS–02 Shelves*	Configure as	Ports Used
1–6	1	1x6T	1
7–12	2	1x6T	2
13–18	3	1x6T	3
19–24	4	1x6T	4
25–30	5	1x6T	5
31–36	6	1x6T	6
37–42**	6	1x7T	6

Notes

* Consult the *StorageWorks Solutions Shelf User's Guide* for SWXSS–02 shelf information.
** Nonredundant controller and power configurations (not recommended).

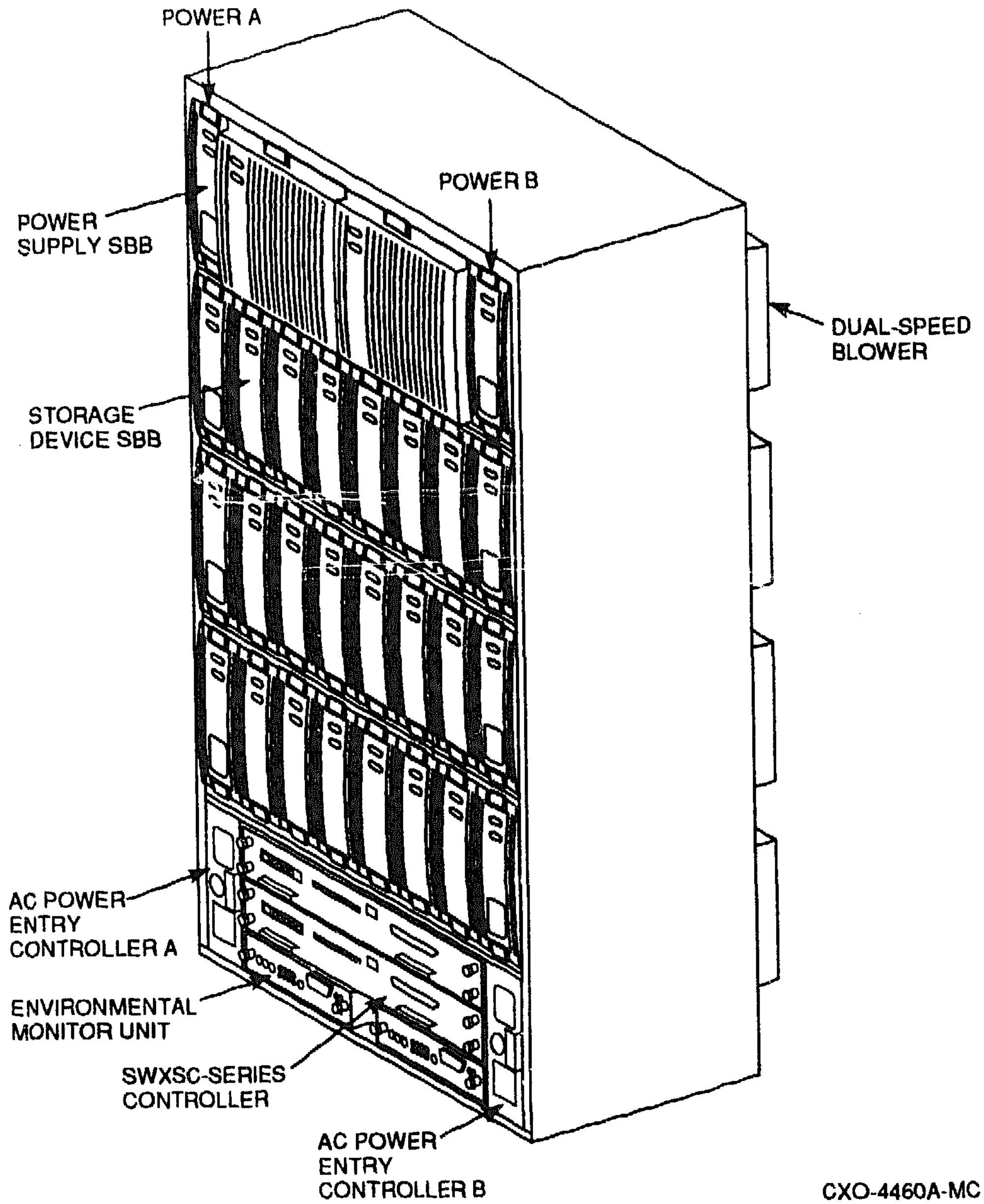
4.4 Device SBB Configuration in the SWXSC–AA Storage Enclosure

The following sections provide information on configuring and installing device SBBs in the SWXSC–AA storage enclosure.

4.4.1 SWXSC–AA Storage Enclosure Description

The SWXSC–AA storage enclosure is an integrated controller and storage shelf. The enclosure is standard width, but is approximately the height of five SWXSS–02 device shelves, as shown in Figure 4–8.

Figure 4–8 SWXSC–AA Storage Enclosure



The SWXSC–AA storage enclosure contains a single backplane for controller-to-storage connections. No external SCSI device cables are needed, and very little physical configuring is required. See the *StorageWorks Solutions SW300-Series RAID Enclosure Installation and User's Guide* and *StorageWorks Solutions HA-2400C Storage Enclosure OEM Engineering Specification* for more information on the SWXSC–AA storage enclosure.

4.4.2 Configuring the Storage Enclosure

The SWXSC–AA storage enclosure (refer to Figure 4–8) can accommodate storage, controller, and support hardware within the limits described in Table 4–4.

Table 4–4 SWXSC–AA Storage Enclosure Configuration

Field Replaceable Unit	Minimum	Maximum
StorageWorks Building Block (SBB) Shelf Power Supplies	4	8
3½-Inch Storage SBBs	0 †	24
5¼-Inch Storage SBBs	0 †	8
SWXRC–04 Controllers	1	2
Controller Cache Modules	0	2
Environmental Monitor Units (EMUs)	1	2
AC Power Entry Controllers	1	2
Dual Speed Blowers	8	8

†You need, however, at least one device (of any size) to have an active subsystem.

The SWXSC–AA storage enclosure is called a "deskside RAID" configuration because its design allows for the easy creation of storagesets (stripesets and RAIDsets). Although you can configure 3½-inch and 5¼-inch SBBs in *any* combination within the SWXSC–AA storage enclosure, Digital recommends that you take advantage of the shelf layout for storagesets.

The SWXSC–AA storage enclosure includes an integrated backplane that contains six single-ended SCSI device buses. The backplane device buses eliminate the need for external device cabling to the controller device ports.

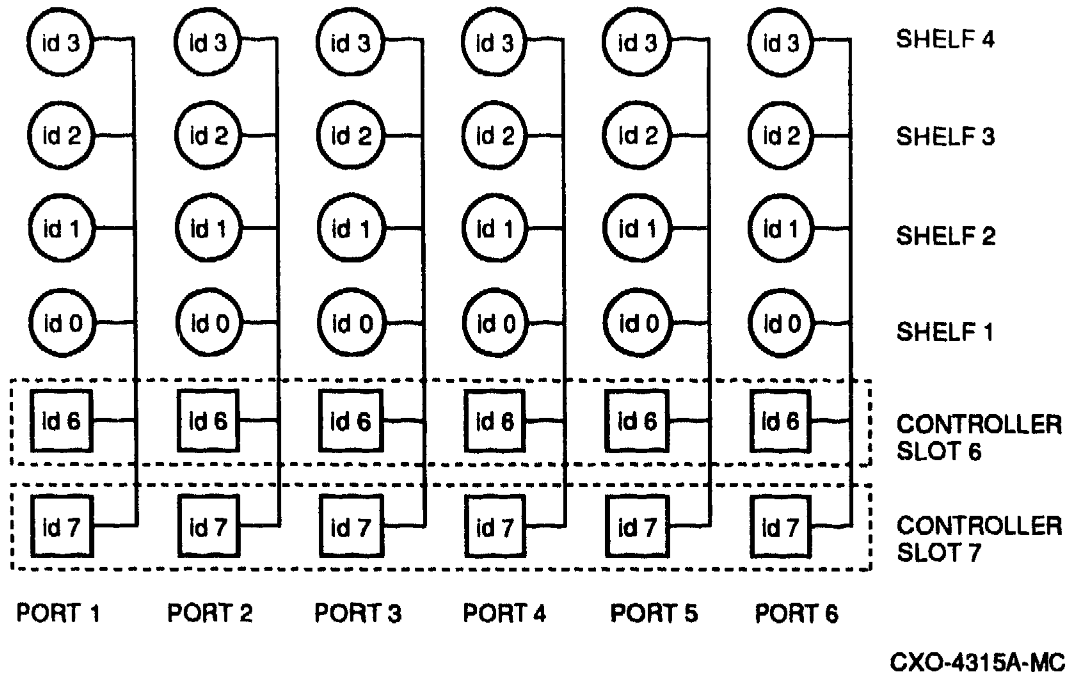
Each device bus runs vertically, attaching to up to four SCSI devices (IDs 0–3). The controller slots in the lower portion of the shelf occupy SCSI IDs 6 and 7, in much the same way as in a SWXSS–01 shelf. The SWXSC–AA storage enclosure SCSI device bus configuration appears in Figure 4–9.

Note

The vertical arrangement of the SWXSC–AA storage enclosure device buses marks a departure from the convention established with SWXSS–02 device shelves. Devices arranged horizontally in a SWXSS–02 shelf are typically on the same controller port. However, horizontally arranged devices in an SWXSC–AA storage enclosure are each on a *different* controller port.

This layout enables storagesets, which normally consist of devices on different controller ports (for best performance and availability), to be arranged as horizontal groups of devices.

Figure 4–9 SWXSC–AA Storage Enclosure SCSI Buses



4.5 Physically Configuring Controllers

This section describes the specifics of configuring StorageWorks controllers.

4.5.1 Nonredundant Controllers

The following guidelines apply to nonredundant controllers:

- A single controller must be installed in the slot furthest from a SWXSS–01 shelf's SCSI connectors. This slot is SCSI ID 7. By using SCSI ID 7, SCSI ID 6 (the other controller slot) is available as an additional ID on the SWXSS–02 device shelf.
- The maximum recommended controller subsystem configuration using SWXSS-series shelves is six devices per controller port. This allows for the addition of another controller, and additional power supplies in the storage shelves. A nonredundant controller configuration *can* support seven devices per port. However, Digital still recommends six devices per port to permit the ease of future upgrade.
- The maximum controller subsystem configuration using an SWXSC–AA storage enclosure is four devices per controller port. The maximum is determined by the design of the SWXSC–AA storage enclosure and backplane.
- The controller for a configuration using a SWXSC–AA storage enclosure must be installed in the lower portion of the shelf (refer to Figure 4–8). Controllers cannot be installed in the upper four areas, which are reserved for devices.

4.5.2 Dual-Redundant Controllers

The following guidelines apply to dual-redundant controllers:

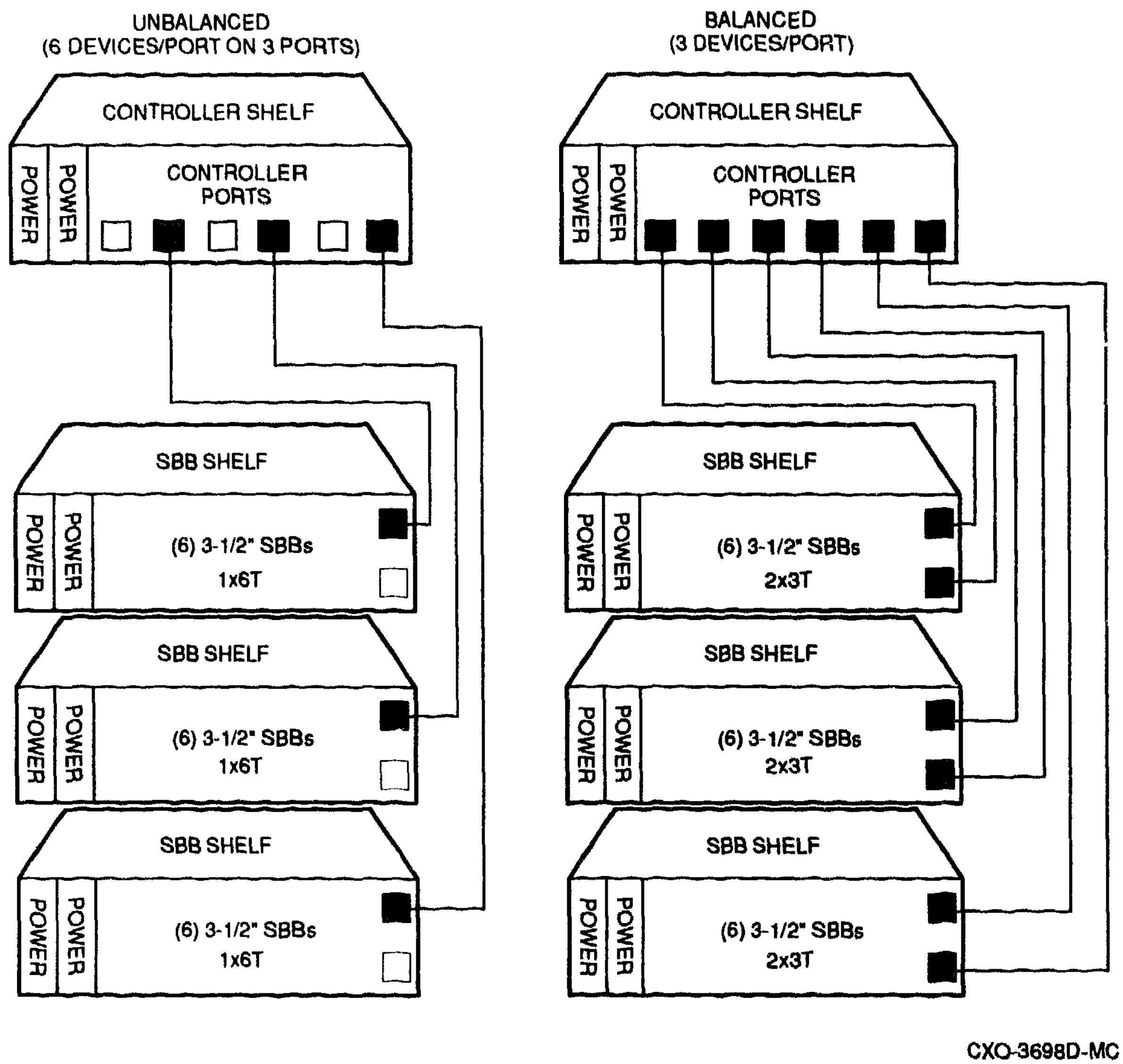
- Dual-redundant controllers are located in the same shelf, and are connected to each other through the shelf backplane. Both controllers have access to all the devices on each other's ports. This setup increases availability and provides for failover when one controller in the pair fails. (The surviving controller takes over service to all devices.)
- Dual-redundant configurations follow the same guidelines as nonredundant configurations, except there is (for SWXSS-series shelves) no option to increase to seven devices per port.
- Both controllers' cache modules must be the same type (read or write-back), have the same number of megabytes, and both firmware versions must be identical.
- Dual-redundant SWXRC–04 controllers must be on the same host SCSI bus.

4.5.3 Optimal Performance Configuration

For optimal performance, configure to the following guidelines:

- Balance the number of devices on each port of a controller. For example, for 18 3½-inch SBBs, place 3 devices on each of 6 ports. This permits parallel activity on the controller's available ports to the attached devices. Figure 4–10 is an example of how to balance devices across ports.

Figure 4–10 Balanced Devices Within Device Shelves



- Evenly distribute higher performance devices across separate ports so that higher and lower performance devices are intermixed on the same port. (For example, put multiple solid state disks on separate ports.) This intermixing of higher and lower performance devices on the same port benefits overall performance. Use the guidelines in Table 4–5.

Table 4–5 High-Performance Devices per Port

Total High-Performance Devices	High-Performance Devices per Port (3-Port Controller)	High-Performance Devices per Port (6-Port Controller)
1–3	1	1
4–6	1	2
7–9	2	3
10–12	2	4
13–15	3	5
16–18	3	6

- Limit the number of devices per controller port to three in dual-redundant configurations. In doing so, both controllers access three devices per *each other's* port, maintaining six SCSI–2 devices combined total.
- Maximize the amount of cache memory per controller with the 16 or 32 MB cache module option.

Highest Performance

To obtain the highest performance possible, use a dual-redundant configuration and balance the number of devices across the two controllers. Do this through your operating system by ordering how devices are mounted or sequenced and by setting preferred path definitions.

Following this guideline results in reducing each controller's load to approximately half of the devices normally accessed through each controller. Should one controller fail, the surviving controller automatically assumes service to the failed controller's devices.

4.5.4 Optimal Availability Configuration

For optimal availability, configure to the following guidelines:

- Use dual-redundant controllers and redundant power supplies in all shelves.
- Place storageset members on different controller ports and different device shelves.
- Use predesignated spares on separate controller ports and device shelves.

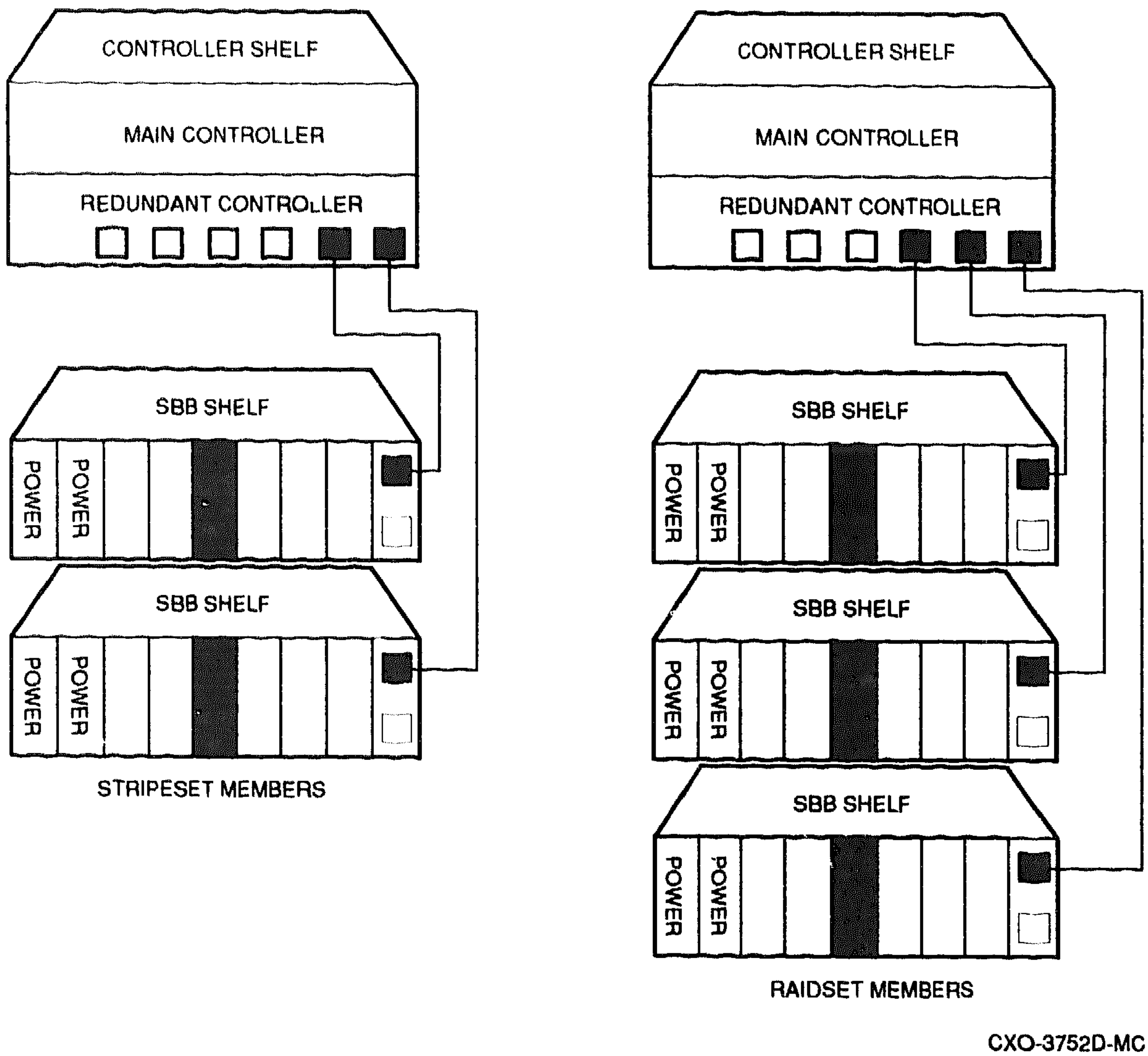
Figure 4–11 shows examples of optimal configurations for RAIDset members and designated spares on separate controller ports.

Highest Availability

For highest availability, especially with RAID implementations, follow these guidelines:

- For host-based RAID implementations, split the normal access path between controllers.
- Use redundant power supplies in all shelves.

Figure 4–11 Optimal Availability Configurations



4.6 Host Considerations

The following sections explain important considerations when configuring the SWXRC–04 controller and subsystem to the host CPU.

4.6.1 Host Cables

Following are special guidelines for configuring host cables/buses to and from the SWXRC–04 controller.

The maximum length (end-to-end) of fast and slow buses is summarized in Table 4–6:

Table 4–6 SCSI Bus Maximum Lengths

Bus Type	Transfer Rate	Meters	Feet
8-bit, single-ended	5 MB/s	6	19.7
8-bit, single-ended	10 MB/s	3	9.8
16-bit, differential	20 MB/s	25	82.0

4.6.2 Host Adapter Support

The following host adapters currently are supported:

- KZMSA (for DEC 7000™ and DEC 10000™ systems via SWXAZ–AA)
- PMAZC (for DEC 3000 systems via SWXAZ–AA)

Consult your controller SPD and release notes for current lists of supported host adapters.

5

Operating the Storage Subsystem

This chapter presents the information necessary to logically configure and operate the SWXRC–04 controller subsystem. It covers normal and failover operation, and operating system support.

Note

The "configurations" discussed in this chapter are those set by the operator, employing the CLI. Refer to Chapter 4 for *physical* configuration of the subsystem hardware.

5.1 General Sequence of Configuration and Operation

The general sequence for using the SWXRC–04 controller is as follows:

1. Establish a maintenance terminal connection with the controller and familiarize yourself with the command line interpreter and operator control panel.
2. Initialize the controller and subsystem.
3. Set the controller's initial operating parameters.
4. Set the logical configuration of the subsystem's storage devices.
5. Run an acceptance test to validate the integrity of the subsystem.

5.2 Maintenance Terminal

A maintenance terminal is used to communicate with the controller and the storage subsystem. The maintenance terminal may be a hardware device physically connected to the controller or a virtual terminal provided by the host's software.

A virtual terminal connection may be used for normal operation, but you must connect a hardware maintenance terminal for initial controller configuration.

5.2.1 Hardware Maintenance Terminal

A hardware maintenance terminal is a locally connected EIA–423 compatible terminal.

Follow this procedure to connect a maintenance terminal:

1. Make sure the power switch on the back of the terminal is in the off (0) position.
2. Connect one end of the terminal cable to the back of the terminal.
3. Connect the other end of the terminal cable to the MMJ on the controller.

4. Set your terminal at 9600 baud, 8 data bits, 1 stop bit, and no parity. Refer to your terminal documentation for terminal setup instructions.

5.3 Command Line Interpreter

The CLI is the firmware user interface to the controller. The CLI enables you to control storage and controller configurations through commands entered into the maintenance terminal. The following sections explain how to use the CLI, and how it defines and modifies configurations. A detailed description of CLI commands is provided in Appendix B.

5.3.1 Accessing the CLI

You can access the CLI through a hardware maintenance terminal (see Section 5.2).

To access the CLI through a maintenance terminal (all controllers), connect the terminal and press the Return key. You must use a maintenance terminal to set the controller's SCSI ID and inital configuration.

Thereafter, you may use a virtual (host) terminal to modify the configuration. The method of establishing the virtual terminal connection varies depending on your operating system and interface.

To use the host-based, HSZterm application, see the *StorageWorks HSZ40 Utility for DEC OSF/1 System Manager's Guide.*

Note

Your CLI prompt could be factory-set to reflect your controller model, such as SC4>. Appendix B provides details on how to change the prompt.

This guide uses the designation "CLI>" to identify the CLI prompt.

5.3.2 Exiting the CLI

If you are using a maintenance terminal, you cannot exit the CLI. Entering the EXIT command merely restarts the CLI and redisplays the controller type and any last fail error information.

5.3.3 Command Sets

The CLI consists of the following command sets:

- Failover commands support dual-redundant controller configurations.
- Controller commands
  - Set and show the basic controller parameters.
  - Set the controller ID (SCSI target ID).
  - Set the resident terminal characteristics.
  - Restart the controller.
  - Run resident diagnostics and utilities (see Chapter 8).

- Device commands specify and show the location of *physical* SCSI–2 devices attached to the controller. Locations of devices are specified using their SCSI PTL designation.

  Only devices that have been defined by the ADD command are seen or used by the controller. Devices that have been placed in a shelf, but have not been added, are *not* automatically used by the controller. Use either the CONFIG or CFMENU utility to quickly add such devices (see Chapter 8).
- Storageset commands add, modify, rename, and show storagesets (stripesets and RAIDsets). These commands also apply (to some extent) to the **spareset** and **failedset**.
- Logical unit commands add, modify, and show logical units built from devices and storagesets.
- Exerciser commands invoke a disk exerciser that tests device data transfer capabilities. The exerciser (DILX) is fully described in Chapter 8.

Note

Remember these two guidelines when using the CLI:

- Not all configuration parameters need to be specified on one line. They can be entered by using multiple SET commands.
- Only enough of each command need be entered to make the command unique (usually three characters). For example, SHO is equivalent to SHOW.

5.4 Operator Control Panel

You can use the OCP to reset the controller, control the SCSI–2 buses attached to the controller, and interpret error conditions that result in LED error codes. The OCP and its use are described in Chapter 7.

5.5 Initialization

The following sections discuss the operating conditions related to initialization of the controller and subsystem.

5.5.1 Controller Initialization

The controller initializes after any of the following conditions:

- Power is turned on.
- The firmware resets the controller.
- The operator presses the green reset (//) button.
- The host clears the controller.

Note

Keep the program card in its slot during controller subsystem operation. If you remove the program card, the controller resets.

See Chapter 8 for a description of the initialization of both the controller and its cache module. (The process is described in Chapter 8 because some of the initialization diagnostics are available as a controller self-test function for the operator.)

Important Write-Back Cache Note

If your system contains write-back cache modules, their batteries were completely charged at the factory. It is normal for the batteries to have discharged slightly in shipment. To ensure absolute data integrity, the advanced write-back cache and RAID features of your controller require fully-charged batteries to operate. These advanced features may not be available immediately after installation, until the batteries have had an opportunity to completely recharge.

5.5.2 Dual-Redundant Controller Initialization

The controllers in a dual-redundant configuration run the same initialization sequence that is described in Chapter 8, except that they exchange signals during their individual initialization sequences. The first signal occurs after one controller starts initializing. The signal informs the other controller that an initialization is occurring. This way, the other controller does not assume that the initializing controller has malfunctioned and does not attempt to disable it.

5.5.3 Subsystem Initialization

Full StorageWorks subsystem initialization occurs when the subsystem is switched on for the first time. In the event of a reset due to one of the following conditions, a subset of the initialization sequence is run:

- A partial or complete power failure
- Equipment failure
- An error condition

A complete StorageWorks subsystem initialization includes the following:

1. When the subsystem is turned on, all shelves in the subsystem are reset. Then, entities in the shelves (including storage devices, controllers, and cache modules) run their initialization and self-test sequences.
2. During initialization, the controller interrogates the entities with which it has connections, including other controllers in the subsystem.
3. When the initialization sequence on all entities is completed, the controller begins data transfer and other operations with the host.

Note

Whenever you restart the controller, device activity LEDs momentarily lights while the controller discovers what devices are attached. Do not attempt to enter CLI commands that alter the device configuration (such as DELETE, SET, ADD, and so on) until after this discovery phase. This phase may take up to 2 minutes to complete.

5.5.4 Initial Configuration (Nonredundant Controller)

After installation of a nonredundant controller, use the CLI to define its parameters in the following order from a maintenance terminal:

1. Enter the following command to set a valid controller ID:

   ```
   CLI> SET THIS_CONTROLLER ID=n
   ```

   where *n* is the SCSI target ID(s) (0–7).

   Note

   Always restart the controller after setting the ID.

2. Restart the controller either by pressing the green reset (//) button, or by entering the following command:

   ```
   CLI> RESTART THIS_CONTROLLER
   ```

3. Enter the following command to verify the preceding parameters were set:

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   ```

4. Connect the host port cable to the front of the controller (see Chapter 9).

5.5.5 Initial Configuration (Dual-Redundant Controllers)

In a dual-redundant configuration, one terminal can set both controller configurations. After installation of both controllers, use the CLI to define the controllers' parameters in the following order from a maintenance terminal connected to one controller:

1. Enter the following command to set a valid controller ID:

   ```
   CLI> SET THIS_CONTROLLER ID=n
   ```

   where *n* is the superset of unique SCSI target IDs (range 0–7, up to four total–SET THIS_CONTROLLER ID=*w,x,y,z*) assigned to *both* controllers. Then enter the following command:

   ```
   CLI> SET THIS_CONTROLLER PREFERRED_ID=n
   ```

   where *n* represents the unique SCSI target IDs from the superset (up to four total–SET THIS_CONTROLLER PREFERRED_ID=*w,x,y,z*) assigned to only *this* controller. The remaining IDs from the superset are automatically assigned to the companion controller.

   CAUTION

   The SET FAILOVER command establishes controller-to-controller communication and copies configuration information. Always enter this command on one controller only. COPY=*configuration-source* specifies where the *good* configuration data are located. *Never* blindly specify SET FAILOVER. Know where your good configuration information resides before entering the command.

2. Enter the following command to copy parameters to the other controller (the one *not* connected to):

   ```
   CLI> SET FAILOVER COPY=THIS_CONTROLLER
   ```

   Note

   Always restart the controllers after setting the ID.

3. Restart both controllers either by pressing the green reset (//) buttons, or by entering the following commands:

   ```
   CLI> RESTART OTHER_CONTROLLER
   CLI> RESTART THIS_CONTROLLER
   ```

4. Enter the following commands to verify the preceding parameters were set.

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   CLI> SHOW OTHER_CONTROLLER FULL
   ```

5. Connect the host port cables to the front of the controllers (see Chapter 9). Do *not* connect the two controllers in a dual-redundant pair to separate or different SCSI buses.

5.5.6 Logically Configuring Storage Devices

To automatically configure devices on the controller, use either the CONFIG or CFMENU utility described in Chapter 8.

For manual configuration, the following steps add devices, storagesets, and logical units. Use the CLI to complete these steps so that the host recognizes the storage device. (These steps may be run from a virtual terminal.)

Important Write-Back Cache Note

If your system contains write-back cache modules, their batteries were completely charged at the factory. It is normal for the batteries to have discharged slightly in shipment. To ensure absolute data integrity, the advanced write-back cache and RAID features of your controller require fully-charged batteries to operate. These advanced features may not be available immediately after installation, until the batteries have had time to completely recharge.

1. Add the physical devices by using the following command:

   CLI> ADD *device-type device-name scsi-location*

   For example:

   ```
   CLI> ADD DISK DISK100 1 0 0
   ```

   where:

   device-type is the type of device to be added. This is DISK.

   device-name is the name to refer to that device. The name is referenced when creating units or storagesets.

   SCSI-location is the PTL for the device. When entering the PTL, at least one space must separate the port, target, and LUN.

2. Add the storagesets for the devices. Storagesets include stripesets and RAIDsets.

   See Appendix B for examples of adding storagesets. (If you do not want storagesets in your configuration, skip this step.)

   CAUTION

   The INITIALIZE command destroys all data on a **container**. See Appendix B for specific information on this command.

3. Enter the following command to initialize the containers (devices, storagesets, or both) prior to adding logical units to the configuration.

   ```
   CLI> INITIALIZE container-name
   ```

   where *container-name* is a device or storageset that becomes part of a unit.

   When initializing a single-device container:

   - If NOTRANSPORTABLE (the default) was specified when the device was added, a small amount of disk space was made inaccessible to the host and used for **metadata**. The metadata is initialized.
   - If TRANSPORTABLE was specified, any metadata on the device is destroyed. See Appendix B for details on metadata and when INITIALIZE is required.

4. Add the units that use either the devices or the storagesets built from the devices by entering the following command:

   ```
   CLI> ADD UNIT logical-unit-number container-name
   ```

   where:

   logical-unit-number is the unit number the host uses to access the device.

   container-name identifies the device or the storageset.

5.6 Acceptance Testing

After you install, set parameters for, and configure your controller, follow the guidelines in this section to acceptance test your subsystem.

1. Turn your system on. This resets all shelves and starts the spin-up cycle on devices within the shelves. This includes the initialization (diagnostics) on the controller(s) and device self-tests.
2. Run DILX using the default answers to the test questions (see Chapter 8). This tests all disk devices in your subsystem.

5.7 Failover Operation

There are two general categories of failover operation:

- Host-assisted failover operation—A process in which the host must be involved to direct the transfer of storage subsystem control from one controller to the other.
- Transparent failover operation—A process in which the transfer of storage subsystem control occurs in a manner transparent to the host.

Currently, SWXRC–04 controllers support only the transparent failover operation.

5.7.1 Transparent Failover

Two SWXRC–04 controller modules installed in a StorageWorks controller shelf and connected to the same host SCSI bus operate as a redundant pair with transparent failover. Figure 5–1 shows two controllers connected in this manner. Each controller may be configured to have multiple SCSI target IDs, in one of five different configurations:

- Two controllers configured as a single, active, controller with a hot standby
- Each controller configured as an active controller, one servicing one target, the other servicing a different target
- Each controller configured as an active controller, one servicing one target, the other servicing two other targets
- Each controller configured as an active controller, one servicing one target, the other servicing three other targets
- Each controller configured as an active controller, one servicing two targets, the other servicing two other targets

In normal operation, each controller services only the targets it has been assigned. In a failover situation, the surviving controller services all of the targets from both controllers. Each target in any of these configurations supports up to eight LUNs.

5.7.2 Transparent Controller Failover Resulting from a Fault

Once redundant controllers establish a communications link in a normally operating SWXRC–04 controller storage subsystem, they maintain the link with periodic status checks. If one controller fails, the other controller senses the situation and begins the failover operation.

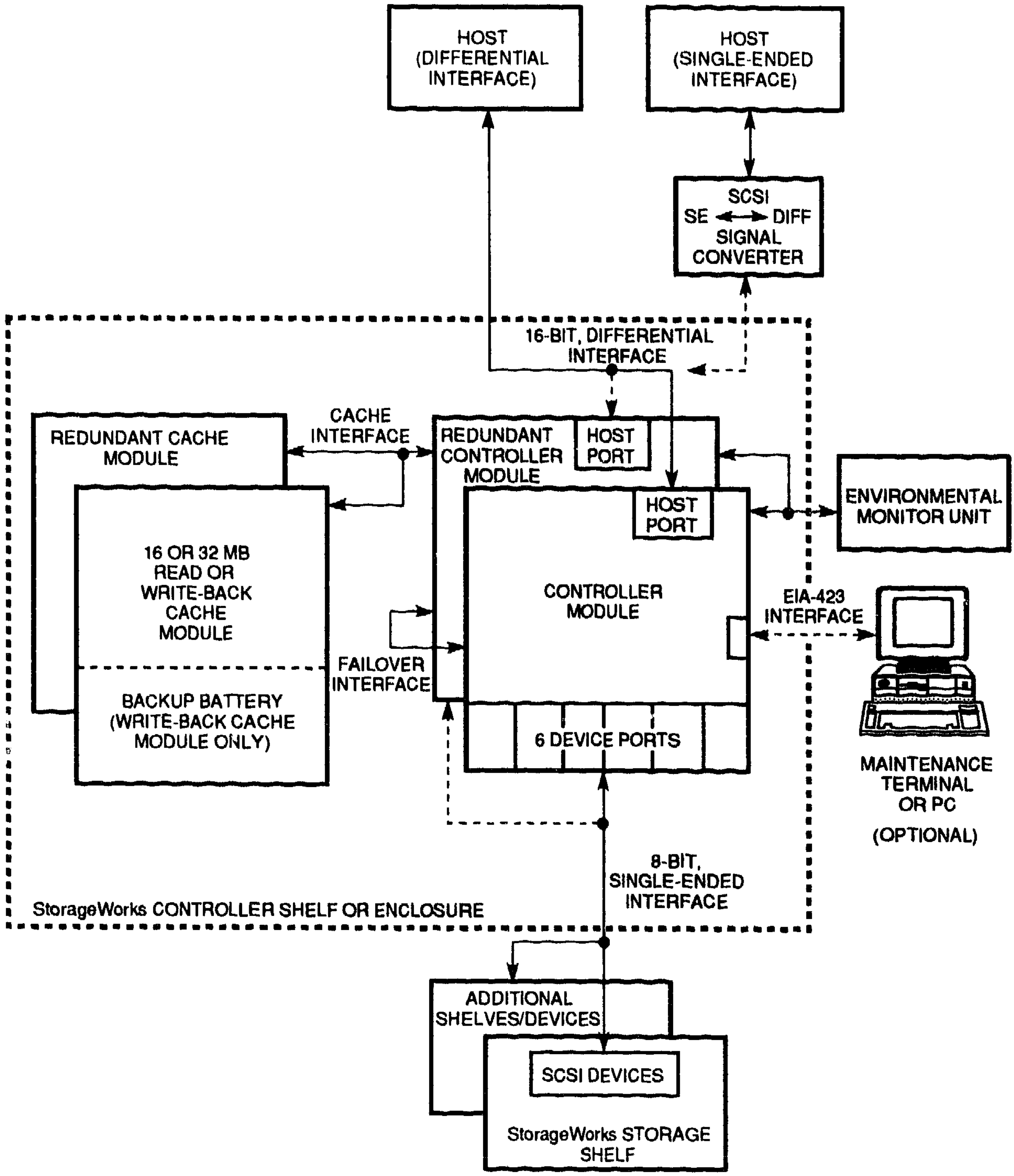
The sensing controller's first action is to assert the KILL signal, locking the failing controller out of any further subsystem control. Once a controller asserts this signal, it cannot be disabled by the companion controller. In the event that both SWXRC–04 controllers assert the KILL signal (as each senses a bad UART connection, for example), the first controller to assert the signal gains control of the subsystem.

In normal operation, each controller keeps a record of the subsystem configuration of the other controller. When a failure occurs, the surviving controller can then take over control of its companion's cache module and storage devices.

Note

RAIDsets do not fail over for SWXRC–04 dual-redundant controller configurations individually: all RAIDsets failover together as the surviving controller takes over the relevant SCSI target IDs and associated LUNs.

Figure 5–1 Dual-Redundant Controller Configuration



Note that the failover operation takes place at the controller level, in a manner completely transparent to the host. As long as the redundant controllers reside on the same SCSI bus, the host is not required to be actively involved. The transparent failover process is implemented in the SWXRC–04 controller as a simulated power fail situation.

The failover action appears to the host as a power failure, in which there is a complete subsystem reinitialization, and one controller begins servicing all of the targets of both of the original controllers. The simulated power fail situation consumes a large amount of time with respect to normal host activity, and any outstanding host requests to the failed controller normally time out. When the host reinitiates such requests, the surviving controller services them. The time out of the host's requests is the only indication to the host that a fault of some kind has occurred.

The surviving controller continues to monitor the status of the failed controller until it is restarted or replaced by the user. Once the failed controller is replaced and its replacement reestablishes communication with the surviving controller, the failback operation begins, returning subsystem control to the replacement controller for its SCSI targets.

5.7.3 Transparent Controller Failover Resulting from Operator Action

You can initiate a failover operation by running the C_SWAP local program from the CLI interface, for the purposes of swapping a controller or cache module. The C_SWAP program forces the controller on which it is executed to assume control over the entire storage subsystem.

5.7.4 Failover Commands

To support failover, information is shared between the two controllers, such as:

- Physical device PTL configurations
- Storageset names
- Logical unit definitions

Prior to failover, resources are always bound to a particular controller, because the controller is a SCSI target of the host, and LUNs must communicate through the target ID. This is true whether or not a unit is currently interacting with the host.

In a failover configuration, all commands are shared between the two controllers except the following:

SET THIS_CONTROLLER
SET OTHER_CONTROLLER
SHOW THIS_CONTROLLER
SHOW OTHER_CONTROLLER
RESTART THIS_CONTROLLER
RESTART OTHER_CONTROLLER
SHUTDOWN THIS_CONTROLLER
SHUTDOWN OTHER_CONTROLLER

In these cases, the command is directed to the correct controller:

- THIS_CONTROLLER refers to the controller to which the terminal is connected.
- OTHER_CONTROLLER refers to the other controller in the dual-redundant pair.

5.7.5 Setting Failover

To place two controllers into failover configuration, enter the following command:

```
CLI> SET FAILOVER COPY=configuration-source
```

where *configuration-source* is either THIS_CONTROLLER or OTHER_CONTROLLER, depending on where the "good" copy of device configuration information resides.

CAUTION

Digital recommends that the controllers be set for failover before any device configuration commands are entered. Then, as devices, storagesets, and units are added to one controller's configuration, they are automatically added to the other controller's configuration.

Given two controllers, it is possible to fully configure one controller, and then enter the SET FAILOVER command, but if the wrong *configuration-source* is specified, all device configuration information are lost (overwritten). *Never* blindly specify SET FAILOVER. Know where your good configuration information resides before entering the command. (A considerable amount of work and effort could easily be lost by overwriting good information.)

Note

Due to the amount of information that must be passed between the two controllers, the SET FAILOVER command may take up to one minute to complete.

When setting dual-redundant controllers for failover, make sure the target controller (the controller you are copying configuration to) has no cache errors or unwritten cache data. Delete any remaining, configured units on the target controller to verify there are no cache errors before entering the SET FAILOVER command. Deleting units from the target controller does not create problems because, after setting failover, the system does not access those units anyway. (The target controller only accesses the copied units.)

Observe the following considerations when setting dual-redundant SWXRC–04 controllers for failover:

- Subsystem performance is far better if you balance the assignment of target IDs across your dual-redundant pair. See Section 5.7.9 for information on preferred ID assignment.
- The controller to which you are copying configuration information automatically restarts after entering the SET FAILOVER command.
- You must connect both controllers to the same host SCSI bus. If you connect the controllers in a dual-redundant pair to different host buses, and one controller fails, the attempted failover process causes adverse effects on your subsystem(s).

5.7.6 Exiting Failover

You should rarely force a dual-redundant controller pair out of the failover configuration. However, the circumstances in which you may safely do this are described below.

5.7.6.1 Before Failover Occurs

If you have two normally operating dual-redundant controllers set for failover, and you want to remove one controller for use somewhere else, shut down one controller (see Chapter 9). Shutting down one controller forces failover to occur, which preserves access to your entire configuration through the surviving controller.

5.7.6.2 After Failover Occurs

After one controller in your dual-redundant pair fails or is shut down, the surviving controller services your entire configuration. To take the controllers out of the failover configuration, enter the following command:

```
CLI> set nofailover
```

You must consider the following before entering the SET NOFAILOVER command or removing one controller:

- You do not need to SET NOFAILOVER, unless you must make configuration changes before you can replace the failed controller.
- If the surviving controller and its cache module are functioning normally, you can SET NOFAILOVER without special preparation.
- If the surviving controller is running with a low write-back cache battery (enter SHOW *controller* to check the battery), replace/recharge the battery before entering SET NOFAILOVER and before removing the failed controller's cache module.
- Do not take a dual-redundant controller pair out of failover (SET NOFAILOVER) with unwritten cache data present in the write-back cache module. Doing so destroys data. Use the SHOW THIS_CONTROLLER command to confirm that cache data has been written.

Entering SET NOFAILOVER removes the controller from the failover configuration (as well as the other controller, if it is reachable). You may then make the configuration changes under the surviving controller.

5.7.7 Failing Over

A failed or unresponsive controller in a dual-redundant configuration is disabled by its companion controller. The functioning controller sends a signal to the other controller to induce failover. The functioning controller assumes control of the storage devices that were on line to the disabled controller. Maintenance may now take place on the failed controller.

Failover should normally complete in 30 seconds or less (15 seconds or less for three-port controllers). If there is no outstanding drive I/O activity at the time of controller failure, failover should require substantially less than 30 seconds. If drive I/O is in progress at the time of failure, the surviving controller must reset any SCSI buses with outstanding I/O. These bus resets may require up to 5 seconds per port to complete.

When you need to revive a disabled controller, you must enter the following command from a terminal connected to the functioning controller:

```
CLI> RESTART OTHER_CONTROLLER
```

Then, press the reset (//) button to initialize the controller.

You can test failover by removing the program card from one of the controllers. The other controller assumes service to the dormant controller's devices until you reinsert the program card and reinitialize/restart the controller.

5.7.8 Failover Setup Mismatch

During failover mismatch, one controller functions while the second controller does not recognize any devices. Although it is rare, a failover mismatch may occur during the following scenarios:

- If the controllers initialize at *exactly* the same time, one controller could be set for failover while the other is not.
- If one controller is running (operating normally) while the second controller is initialized, mismatch could occur. For example, this may happen after one controller underwent maintenance.

To correct a failover mismatch, stop all processes on the devices for both controllers. Then enter the following commands to determine which controller has the desired, good configuration information:

```
CLI> SHOW UNITS
CLI> SHOW STORAGESETS
CLI> SHOW DEVICES
```

After deciding on one of the two configurations, use the SET FAILOVER command to copy the good information from one controller to the other.

5.7.9 Preferred Paths

Preferred paths are set on SWXRC–04 controllers through the controller's target ID on the host SCSI bus. A LUN under a controller is linked to a particular target ID as part of the addressing process, so the LUN cannot be accessed through any "other" controller unless the new controller assumes a new target ID (such as during failover).

To set preferred paths for dual-redundant SWXRC–04 controllers, do the following:

1. Define the superset of *all* SCSI IDs (up to four) representing both controllers by entering the SET THIS_CONTROLLER ID=(*w,x,y,z*) command.
2. Set the preferred IDs for one controller. For example, set up the controller your terminal session is connected to by entering the SET THIS_CONTROLLER PREFERRED_ID=(*w,x,y,z*) command.

The preferred IDs for one controller can total up to four, and must come from the same superset of IDs defined when using the ID= parameter. Preferred IDs from the superset which are not attached to one controller via the PREFERRED_ID= parameter is automatically attached to the companion controller. (Note that this enables for the creation of a "hot spare" controller, the one with no IDs in a 4–0 pair.)

Be aware that subsystem performance is better if you balance target IDs across your dual-redundant pair. Furthermore, if the hot spare in a 4–0 combination fails, you Should the active, 4-ID controller fail under these circumstances, its companion does not assume service to any devices (because it had already "secretly" failed).

5.8 Moving Devices Between Controllers

The moving of devices from one controller to another is supported under the following conditions:

- **Nontransportable devices**

  Under normal operation, the controller makes a small portion of a disk inaccessible to the host and uses this area to store metadata. Metadata improves error detection and media defect management. Devices utilizing metadata are called **nontransportable**. Initializing a device that is set as nontransportable places/resets metadata on the device.

  When bringing other SWXRC–04 controller (nontransportable) devices to an SWXRC–04 controller subsystem, simply add the device to your configuration using the ADD command. Do not initialize the device or the forced error information on the device is destroyed/reset.

  When adding devices, the controller firmware verifies that metadata is present. If in doubt, try to add the device so that the controller checks for metadata. If an error stating that there is no metadata occurs, initialize the device before adding it.

  A nontransportable device is interchangeable with another SWXRC–04 controller subsystem.

- **Transportable devices**

  A **transportable** feature is provided for transfer of devices between non-SWXRC–04 controller systems and SWXRC–04 controller arrays. Transportable devices do not have metadata on them, and initializing a device after setting it as transportable destroys metadata (if any) on the device.

  Before moving devices from an SWXRC–04 controller subsystem to a non-SWXRC–04 controller system, delete the unit associated with the device and set the device as transportable. Then, initialize the device to remove any metadata.

  When bringing non-SWXRC–04 controller devices to an SWXRC–04 controller subsystem, initialize the device after setting it transportable, then copy the data on the device to another, nontransportable, unit. Then, reinitialize the device after setting it nontransportable (thereby putting metadata on the device). You *must* initialize these devices because they may contain intact metadata blocks, which can "fool" the controller into attempting to run with the device.

  CAUTION

  Do not keep any device set as transportable on an SWXRC–04 controller subsystem. Doing so sacrifices forced error support on all units attached to the device. This is mandatory for HBVS and improving data integrity on the entire array.

  A transportable device is interchangeable with any SCSI interface that does not utilize the device metadata (for example, a VAX workstation, an SZ200, or a PC). Transportable devices may not have write-back caching enabled, may not be members of a shadowset or storageset, and do not support forced error. A controller error (see Chapter 7) occurs if the operating system attempts to write forced error information to a transportable device.

Note

Be careful not to confuse the terms "transportable" and "nontransportable" with the qualifiers TRANSPORTABLE and NOTRANSPORTABLE. See the ADD or SET *unit-number* commands in Appendix B for more information on these qualifiers.

Transportable/nontransportable device support is summarized in Table 5–1.

Table 5–1 Transportable and Nontransportable Devices

Media Format	VAX or AXP Workstation	SWXRC–04 Controller
Transportable	Yes	Yes
Nontransportable	No	Yes

5.9 Moving Devices Under the Same Controller

CAUTION

Do not use a controller failure situation as an opportunity to move devices or otherwise reconfigure your subsystem. Doing so prevents the controller from communicating with its units once the fault is corrected.

You can physically relocate some or all of a storageset's member devices according to the following procedure. (This procedure also applies to reduced RAIDsets, but you must remember to add the RAIDset as REDUCED when you re-add it.)

CAUTION

If you lose track of the storageset members at any point during this procedure, attempt to restore the storageset by guessing where its members are installed. There is currently no way to retrace your steps using the controller or SWXRC–04 operating firmware.

1. Make note of all devices comprising the storageset. Digital recommends marking them after using the CLI> LOCATE command to find all storageset members.
2. Delete the unit associated with the storageset.
3. Delete the storageset.
4. Delete the device(s) to be moved.
5. Move the device(s) to the new port/target/LUN (PTL) location.
6. Add the device(s) using the new PTL location.

7. Re-add the storageset. Make sure you create it from the exact, original set of devices.

CAUTION

Do *not* initialize the storageset. Doing so destroys its data.

8. Re-add the unit.

The following example shows the unit "D100" made of stripeset "STRIPE0." "STRIPE0" has member disks at PTLs 200 and 210. The member at PTL 210 can be relocated to PTL 300 as follows:

```
CLI> DELETE D100
CLI> DELETE STRIPE0
CLI> DELETE DISK210
```

(Move the disk to PTL 300.)

```
CLI> ADD DISK DISK300 3 0 0
CLI> ADD STRIPESET STRIPE0 DISK200 DISK300
CLI> ADD UNIT D100 STRIPE0
```

6 Upgrading the Storage Subsystem

This chapter presents instructions for upgrading the SWXRC–04 controller components and storage subsystem configuration.

6.1 Upgrading Subsystem Components

The following is a list of components that you can upgrade in your SWXRC–04 controller subsystem:

- Program card—Upgrade your firmware by replacing the program card with a program card containing the new firmware version.
- SWXRC–04 controller subsystem—Upgrade by adding a second controller and cache module to form a dual-redundant controller configuration.
- Cache module—Upgrade from a 16 MB read cache module to a 16 or 32 MB write-back cache module. Or upgrade to a 32-MB read cache module. For subsystems with no cache, upgrade to any read or write-back cache module size.

CAUTION

In a dual-redundant configuration with cache modules, both cache modules must have the same number of megabytes and be the same cache type (both read or both write-back). The controller firmware version must be the same for both controllers for proper operation of the subsystem. When the firmware version and/or cache module sizes are mismatched, the controllers detect the mismatch and do not allow access to any devices.

- Power supply—Add redundant power by adding a second power supply to your controller or storage shelves. (Refer to the *StorageWorks Solutions Configuration Guide* for power supply details.)
- SWXSS–01 controller shelf—Add up to four controller shelves to your SWXSC–D*x*-series data center cabinet, or up to two controller shelves to your SWXSC–C*x*-series cabinet.
- More storage devices—Add additional disk drives, tape drives, or other supported devices to unused slots in your storage shelves.

6.2 Installing the Program Card

This section describes how to insert or remove the program card. Figure 6–1 shows the location of the program card and its associated eject button. An ESD shield is usually installed over the program card.

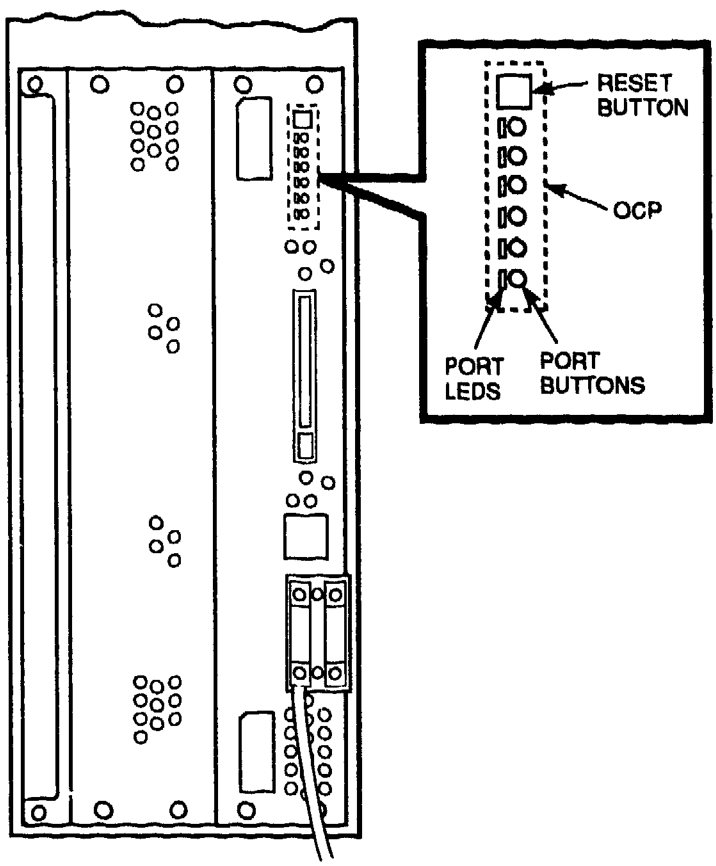
Insert the program cards prior to applying power to your subsystem cabinet by doing the following:

- Attach an ESD grounding strap to your wrist at one end, and to a cabinet grounding stud at the other end.
- Remove the program card ESD shield by pulling the two plastic push pins on each side of the shield.
- Push the card into the program slot on the controller's front bezel. The eject button extends as the card is inserted.
- Snap the program card ESD shield in place over the program card by pressing the plastic push pins in on each side of the shield.
- Remove the ESD grounding strap.

CAUTION

The program card must remain inserted at all times during controller operation with the ESD shield in place. If you remove the program card during operation, the controller does not function.

Figure 6–1 Program Card and Eject Button



Use the following procedures to replace your program cards in the event that you wish to load new firmware:

6.2.1 Program Card Upgrade—Nonredundant Configuration

An HS operating firmware upgrade causes a brief (30 to 45 second) interruption in service to attached drives. The operating system should automatically recover from this outage within a few seconds after the new firmware becomes operational and restores service.

Use the following procedure to upgrade the firmware (replace the program card) in a nonredundant controller:

1. Locate the controller to be shut down.
2. Attach an ESD grounding strap to your wrist at one end, and to a cabinet grounding stud at the other end.
3. Remove the ESD shield over the program card by pulling the two plastic push pins on each side of the shield.
4. Press the program card eject button to eject the program card from the controller.

5. Remove the program card.
6. Press and hold the OCP reset (//) button, while inserting the new program card, pressing the card in until the eject button extends outward almost even with the program card, then release the reset (//) button. The controller restarts.

   If the controller initializes correctly, the green reset LED begins to flash at 1 Hz. If an error occurs during initialization, the OCP displays a code.
7. Replace the ESD shield over the program card by pushing the two plastic push pins on each side of the shield.
8. Remove the ESD grounding strap.

6.2.2 Program Card Upgrade—Dual-Redundant Configuration

In dual-redundant configurations, the firmware in both controllers must be upgraded simultaneously. This in not an inherent restriction of the firmware design, but occurs with Version 2.0 firmware because of a change in intercontroller synchronization protocol.

Use the following procedure to upgrade the firmware (replace the program cards) of a dual-redundant controller configuration:

1. Attach an ESD grounding strap to your wrist at one end, and to a cabinet grounding stud at the other end.
2. Remove the ESD shields over both program cards by pulling the two plastic push pins on each side of the two shields.
3. Press the program card eject buttons on both controllers simultaneously and remove both program cards.
4. Press and hold the OCP reset (//) buttons on both controllers while inserting new program cards. Be sure the eject buttons extend outward almost even with the edge of the cards.
5. Release the reset (//) buttons. Both controllers restart.

   The two controllers reinitialize concurrently and synchronize with each other. The timing of this procedure is not critical, except that the program cards should be removed and inserted at approximately the same time (within an interval of a few seconds).
6. Replace the ESD shields over the program cards by pushing the two plastic push pins on each side of the two shields.
7. Remove the ESD grounding strap.

6.3 Installing a Redundant Controller and Cache Module

The following sections present the information necessary to enable you to create a dual-redundant controller configuration from a nonredundant one.

6.3.1 The Warm Swap Utility

The controller warm swap utility, C_SWAP, was designed to enable the replacement of controller and/or cache modules in dual-redundant controller configurations with power applied to the controller shelf. C_SWAP also is used for adding new controller and cache modules to a preexisting nonredundant controller configuration to form a dual-redundant configuration.

Chapter 9 describes how to use the controller warm swap utility. The utility leads you through the process of creating a dual-redundant controller configuration.

When a controller you plan to warm swap is still functioning (green LED blinking), you must shut down that controller using the CLI> SHUTDOWN command prior to running C_SWAP.

6.3.2 Special Considerations for Redundant Controller and Cache Modules

The second controller and its companion cache module occupy the SCSI ID 6 shelf positions. The second controller does not function correctly if there are attached devices in slot 6 of any storage shelf for any port. (Check that each port has no more than six SCSI–2 devices at ID numbers 0 through 5.)

CAUTION

In a dual-redundant configuration with cache modules, both cache modules must have the same number of megabytes and both must be the same cache type (both read or both write-back). The controller firmware version must be the same for both controllers for proper operation of the subsystem. When the firmware version and/or cache module sizes are mismatched, the controllers detect the mismatch and do not allow access to any devices.

If for some reason your first SWXRC–04 array controller occupies the SCSI ID 6 slot, you cannot effectively add the second controller to the SCSI ID 7 slot with the power on because of mechanical interference from the trilink connector block attached to the companion controller in slot 6. In this case you must power down the first controller and remove it so that the second controller can be physically inserted.

When the new controller and cache modules are installed, set your initial configuration parameters for the new controller using the procedure in Chapter 4. Do not install your host port cables until the initial parameters are set.

Refer to Appendix A for controller module ordering information.

6.4 Upgrading Your Cache Module

You may want to upgrade your current read cache to a write-back cache module or to a read cache module with more memory. This section describes how to determine what kind of cache module you currently have in your subsystem. This helps you to determine which option numbers to order for your upgrade.

How to Determine Your Cache Module Type

You can upgrade your cache module by increasing its memory size, or by changing from a read to a write-back cache. To determine your cache module type (version type and number of megabytes), enter the SHOW THIS_CONTROLLER command at the CLI> prompt. The firmware outputs information describing your cache configuration.

Refer to Appendix A for cache module ordering information.

7
Error Analysis and Fault Isolation

This chapter describes the errors, faults, and significant events that may occur during SWXRC–04 controller initialization and normal operation. A translation of the events and, in most cases, information on how to respond to a specific event, are also given.

The error and event descriptions isolate failures to the field replaceable unit (FRU). However, in most cases, additional information for diagnosis beyond the FRU is given. This information helps increase your knowledge of controller functions and assists with your report to repair personnel.

CAUTION

Do not attempt to replace or repair components within FRUs or equipment damage may result. Use the controller fault indications and error logs to isolate FRU-level failures.

7.1 Special Considerations

Some or all of the situations presented in the following sections may apply when your controller detects a fault.

7.1.1 Nonredundant Configurations

When a controller (or its cache module, or both) fails in a nonredundant configuration, a short period of system down time is needed to remove the faulty unit and install a replacement. The devices attached to that controller are off line for the duration of the remove and replace cycle.

7.1.2 Dual-Redundant Configurations

When a controller fails in a dual-redundant configuration, fault isolation and corrective actions are similar to a nonredundant configuration. However, failover takes place, so the surviving controller takes over service to the failed controller's ports and devices.

7.1.3 Cache Module Failures

If a cache module fails, its controller still functions using on-board cache; however, Digital recommends that you replace the cache module as soon as possible.

7.1.4 Write-Back Cache Battery Failures

When a write-back cache module's batteries fail or go low, the following conditions occur:

- Non-RAIDset, disk-based units with write-back caching enabled are accessed in write-through (read cache) mode, until the cache batteries are replaced or fully recharged. Once good batteries are in place, write-back caching automatically resumes.
- RAIDsets and nonredundant configuration RAIDsets do not fail over when the write-back cache module's batteries fail or go low.

7.2 Types of Error Reporting

The controller can notify you of an error through one or more of the following means:

- The OCP
- Device LEDs
- Environmental Monitor Unit (EMU)
- Error messages at a host virtual terminal, or
  error messages at a maintenance terminal (if attached)

7.3 Troubleshooting Basics

When an error occurs, use the following steps as top-level guidelines for fault isolation:

1. Make a note of all visual indicators (OCP, device LEDs, EMU, or error messages) available to you.
2. For surviving controllers in dual-redundant pairs, try entering the RESTART OTHER_CONTROLLER command. The surviving controller may be keeping its companion from operating.
3. Errors can be intermittent; reset the controller to see if the error clears. (Record which devices have lit/flashing fault LEDs before resetting, as a reset may temporarily clear the LED even though the fault remains.)
4. See if the error indication changes after resetting the controller. If the error remains the same, look up information for that error. If the indication changes, look up information for the newer error.
5. Always consider reseating the controller and/or cache module when troubleshooting. Poor connections between module and backplane can cause a variety of errors.

   See Sections 7.4 through 7.7 for detailed information about errors and repair actions.

CAUTION

Do not use a controller failure situation as an opportunity to move devices or otherwise reconfigure your subsystem. Doing so prevents the controller from communicating with its units once the fault is corrected.

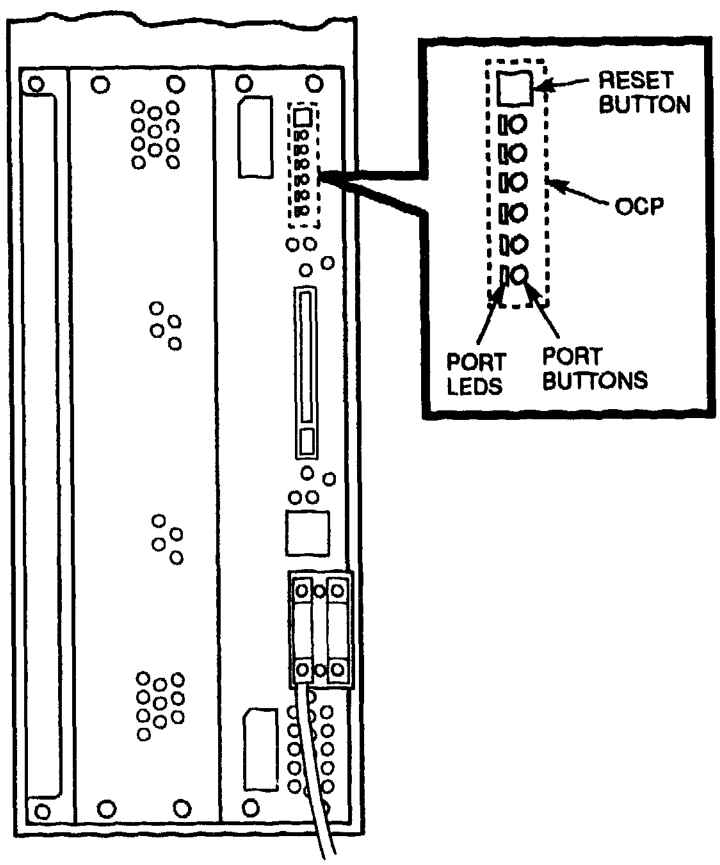
7.4 Operator Control Panel

The OCP includes the following:

- One reset button with an embedded green LED
- One button per SCSI port
- Six amber LEDs

Figure 7–1 shows the OCP from the SWXRC–04 controller. The buttons and LEDs serve different functions with respect to controlling the SCSI ports and/or reporting fault and normal conditions. Button and LED functions are discussed in the following sections.

Figure 7–1 Operator Control Panel



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7.4.1 Normal Operation

The green LED (//) reflects the state of the controller and the host interface. Once controller initialization completes and its firmware is functioning, the green button flashes continuously at 1 Hz. Pressing the green button during this normal operation resets the controller.

Under normal operation, the amber LEDs indicate the state of the respective SCSI–2 buses attached to the controller. When the devices on the buses are functioning correctly, the amber LEDs are not lit or flashing.

Pressing one of the port buttons at this time lights its corresponding amber LED and momentarily quiesces its SCSI–2 port. You must quiesce a port to remove or warm swap a device on the SCSI–2 bus for that port. See Chapter 9 for a detailed description of removing and replacing devices.

7.4.2 OCP Fault Notification

The OCP LEDs display information when the SWXRC–04 controller encounters a problem with a device configuration, a device, or the controller itself.

Should a configuration mismatch or a device fault occur, the amber LED for the affected device's bus lights continuously.

For controller problems, LED codes determined by internal diagnostics and operating firmware indicates either controller or operating firmware program card faults. In either case, the single (green) reset (//) LED lights continuously when an error is detected. The remaining (amber) LEDs display the error codes in two different ways:

- The error code is lit continuously for faults detected by internal diagnostic and initialization routines. See Figure 7–2 for the meaning of these codes, and the suggested manintenance actions that correspond to them.
- The error code flashes at 3 Hz representing faults that occur during normal controller operation. See Figure 7–3 for the meaning of these codes, and the suggested manintenance actions that correspond to them.

Note

Any flashing OCP codes present while initialization or self-test diagnostic error information is posted to the display momentarily stop flashing (becoming solidly lit). Normal flashing resumes once the display completes. Do not attempt to look up OCP codes while this information is printing at the terminal.

Figure 7–2 Solid OCP Codes

Reset	1	2	3	4	5	6		Description of Error	Action
■	■	■	■	■	■	■	3F	DAEMON hard error.	Replace controller module.
■	■	■	■	■	■	□	3E	Repeated firmware bugcheck.	Replace controller module.
■	■	■	■	■	□	■	3D	NVMEM version mismatch.	Replace program card with later version.
■	■	■	■	■	□	□	3C	NVMEM write error.	Replace controller module.
■	■	■	■	□	■	■	3B	NVMEM read error.	Replace controller module.
■	■	■	■	□	■	□	3A	NMI error within firmware bugcheck.	RESET (//) the controller.
■	■	■	■	□	□	■	39	Inconsistent NVMEM structures repaired.[1]	RESET (//) the controller.
■	■	■	■	□	□	□	38	Bugcheck with no restart.	RESET (//) the controller.
■	■	■	□	■	■	■	37	Firmware induced restart following bugcheck failed to occur.	Replace controller module.
■	■	■	□	■	■	□	36	Hardware induced restart following bugcheck failed to occur.	Replace controller module.
■	■	■	□	■	□	■	35	Bugcheck within bugcheck controller.	RESET (//) the controller.
■	□	□	□	□	□	□	00	No program card seen.[2]	Replace controller module.

□ Off ■ Lit continuously

DAEMON = Diagnostic and Execution Monitor
NVMEM = Nonvolatile Memory
NMI = Nonmaskable Interrupt

[1] A power failure or controller reset during an NVMEM update causes this error. If the error occurs on one controller in a dual-redundant configuration, a configuration mismatch will probably occur upon restart.
[2] Try the card in another module. If the problem moves with the card, replace the card. If the problem does not move with the card, replace the controller module.

Figure 7–3 Flashing OCP Codes

Reset	1	2	3	4	5	6		Description of Error	Action
■	□	□	□	□	□	◩	01	Program card EDC error.	Replace program card.
■	□	□	□	◩	□	□	04	Timer zero in the timer chip will run when disabled.	Replace controller module.
■	□	□	□	◩	□	◩	05	Timer zero in the timer chip decrements incorrectly.	Replace controller module.
■	□	□	□	◩	◩	□	06	Timer zero in the timer chip did not interrupt the processor when requested.	Replace controller module.
■	□	□	□	◩	◩	◩	07	Timer one in the timer chip decrements incorrectly.	Replace controller module.
■	□	□	◩	□	□	□	08	Timer one in the timer chip did not interrupt the processor when requested.	Replace controller module.
■	□	□	◩	□	□	◩	09	Timer two in the timer chip decrements incorrectly.	Replace controller module.
■	□	□	◩	□	◩	□	0A	Timer two in the timer chip did not interrupt the processor when requested.	Replace controller module.
■	□	□	◩	□	◩	◩	0B	Memory failure in the I/D cache.	Replace controller module.
■	□	□	◩	◩	□	□	0C	No hit or miss to the I/D cache when expected.	Replace controller module.
■	□	□	◩	◩	□	◩	0D	One or more bits in the diagnostic registers did not match the expected reset value.	Replace controller module.
■	□	□	◩	◩	◩	□	0E	Memory error in the nonvolatile journal SRAM.	Replace controller module.
■	□	□	◩	◩	◩	◩	0F	Wrong image seen on program card.	Replace program card.
■	□	◩	□	□	□	□	10	At least one register in the controller DRAB does not read as written.	Replace controller module.
■	□	◩	□	□	□	◩	11	Main memory is fragmented into too many sections for the number of entries in the good memory list.	Replace controller module.
■	□	◩	□	□	◩	□	12	The controller DRAB chip does not arbitrate correctly.	Replace controller module.

□ Off ■ Lit continuously ◩ Flashing

I/D = Instruction/Data (cache on the controller module)
DRAB = Dynamic RAM Controller and Arbitration Engine (operates controller shared memory)
ECC = Error Correction Code
EDC = Error Detection Code
SRAM = Static RAM
NXM = Nonexistent Memory

Cont'd on next page

Figure 7–3 (Cont.) Flashing OCP Codes

Reset	1	2	3	4	5	6		Description of Error	Action
■	□	◪	□	□	◪	◪	13	The controller DRAB chip failed to detect forced parity, or detected parity when not forced.	Replace controller module.
■	□	◪	□	◪	□	□	14	The controller DRAB chip failed to verify the EDC correctly.	Replace controller module.
■	□	◪	□	◪	□	◪	15	The controller DRAB chip failed to report forced ECC.	Replace controller module.
■	□	◪	□	◪	◪	□	16	The controller DRAB chip failed some operation in the reporting, validating, and testing of the multibit ECC memory error.	Replace controller module.
■	□	◪	□	◪	◪	◪	17	The controller DRAB chip failed some operation in the reporting, validating, and testing of the multiple single-bit ECC memory error.	Replace controller module.
■	□	◪	◪	□	□	□	18	The controller main memory did not write correctly in one or more sized memory transfers.	Replace controller module.
■	□	◪	◪	□	□	◪	19	The controller did not cause an I-to-N bus timeout when accessing a "reset" host port chip.	Replace controller module.
■	□	◪	◪	□	◪	□	1A	The controller DRAB chip did not report an I-to-N bus timeout when accessing a "reset" host port chip.	Replace controller module.
■	□	◪	◪	□	◪	◪	1B	The controller DRAB did not interrupt the controller processor when expected.	Replace controller module.
■	□	◪	◪	◪	□	□	1C	The controller DRAB did not report an NXM error when nonexistent memory was accessed.	Replace controller module.
■	□	◪	◪	◪	□	◪	1D	The controller DRAB did not report an address parity error when one was forced.	Replace controller module.
■	□	◪	◪	◪	◪	□	1E	There was an unexpected nonmaskable interrupt from the controller DRAB during the DRAB memory test.	Replace controller module.
■	□	◪	◪	◪	◪	◪	1F	Diagnostic register indicates there is no cache module, but an interrupt exists from the nonexistent cache module.	Replace controller shelf backplane.
■	◪	□	□	□	□	□	20	The required amount of memory available for the code image to be loaded from the program card is insufficient.	Replace controller module.

□ Off ■ Lit continuously ◪ Flashing

I/D = Instruction/Data (cache on the controller module)
DRAB = Dynamic RAM Controller and Arbitration Engine (operates controller shared memory)
ECC = Error Correction Code
EDC = Error Detection Code
SRAM = Static RAM
NXM = Nonexistent Memory

Cont'd on next page

Figure 7-3 (Cont.) Flashing OCP Codes

Reset	1	2	3	4	5	6		Description of Error	Action
■	◪	□	□	□	□	◪	21	The required amount of memory available in the pool area is insufficient for the controller to run.	Replace controller module.
■	◪	□	□	□	◪	◪	23	The required amount of memory available in the buffer area is insufficient for the controller to run.	Replace controller module.
■	◪	□	□	◪	□	□	24	The code image was not the same as the image on the card after the contents were copied to memory.	Replace ontroller module.
■	◪	□	□	◪	□	◪	25	Diagnostic register indicates that the cache module exists, but access to that cache module caused an error.	Replace controller shelf backplane.
■	◪	□	□	◪	◪	□	26	Diagnostic register indicates that the cache module does not exist, but access to that cache module did not cause an error	Replace controller shelf backplane.
■	◪	◪	□	□	□	□	30	The journal SRAM battery is bad.	Replace controller module.
■	◪	◪	◪	□	◪	□	3A	There was an unexpected interrupt from a read cache or the present and lock bits are not working correctly.	Replace controller module.
■	◪	◪	◪	□	◪	◪	3B	There is an interrupt pending to the controller's policy processor when there should be none.	Replace controller module.
■	◪	◪	◪	◪	□	□	3C	There was an unexpected fault during initialization.	Replace controller module.
■	◪	◪	◪	◪	□	◪	3D	There was an unexpected maskable interrupt received during initialization.	Replace controller module.
■	◪	◪	◪	◪	◪	□	3E	There was an unexpected nonmaskable interrupt received during initialization.	Replace controller module.
■	◪	◪	◪	◪	◪	◪	3F	An illegal process was activated during initialization.	Replace controller module.

□ Off ■ Lit continuously ◪ Flashing

I/D = Instruction/Data (cache on the controller module)
DRAB = Dynamic RAM Controller and Arbitration Engine (operates controller shared memory)
ECC = Error Correction Code
EDC = Error Detection Code
SRAM = Static RAM
NXM = Nonexistent Memory

7.5 Storage Building Block Indicators

Storage device and power supply SBBs have LEDs to indicate power and status. You can use these LEDs in conjunction with the OCP indicators to isolate certain faults, as discussed in the following sections.

7.5.1 Storage Device SBB Status

Each storage device SBB has two LED indicators that display the device's status. These LEDs have three states: on, off, and flashing.

- Upper LED—The upper (green) LED is the device activity LED and is on or flashing when the device is active. The device SBB controls the upper LED directly.

CAUTION

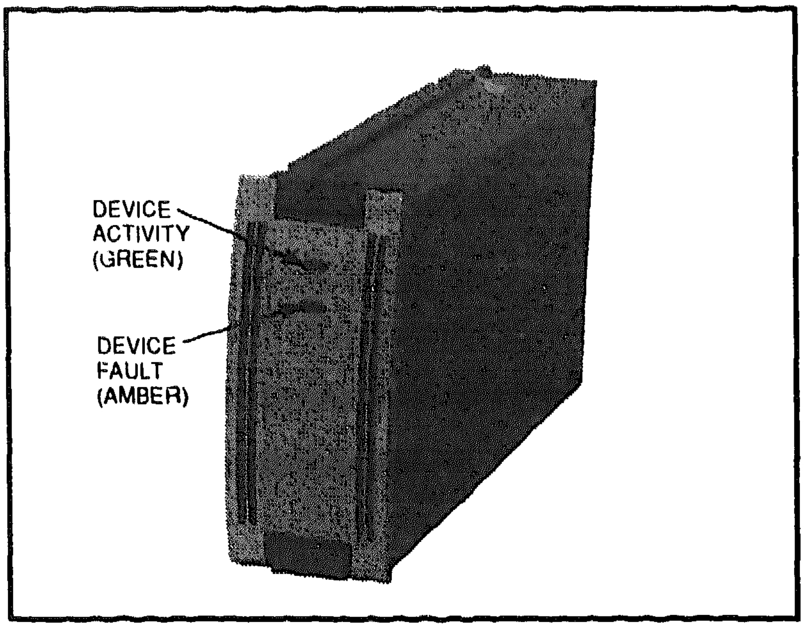
Do not remove a storage SBB when the upper LED is on or flashing. This can cause the loss or corruption of data.

- Lower LED—The lower (amber) LED is the device fault LED. It indicates a device error condition when it is either on or flashing. The controller monitors the device's status and controls the fault LED using the StorageWorks high-availability storage subsystem fault bus.

  When this LED indicates a fault, the amber, controller OCP LED for the device's port is lit continuously. You should record which devices have lit/flashing fault LEDs before resetting the controller, as a reset may temporarily clear the LED even though the fault remains.

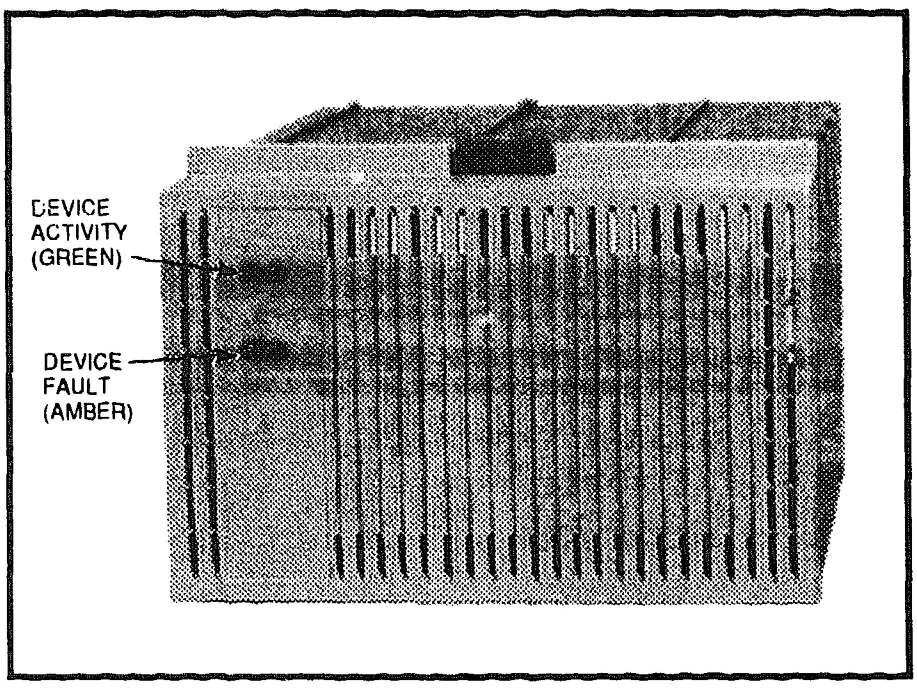
Figures 7–4 and 7–5 show the locations of the LEDs on both the 3.5- and 5.25-inch SBBs. Table 7–1 shows the states of the device SBB LEDs, along with the device/shelf conditions they represent.

Figure 7–4 3½-Inch Storage SBB LEDs



CXO-3671A-PH

Figure 7–5 5¼-Inch Storage SBB LEDs



CXO-4308A-PH

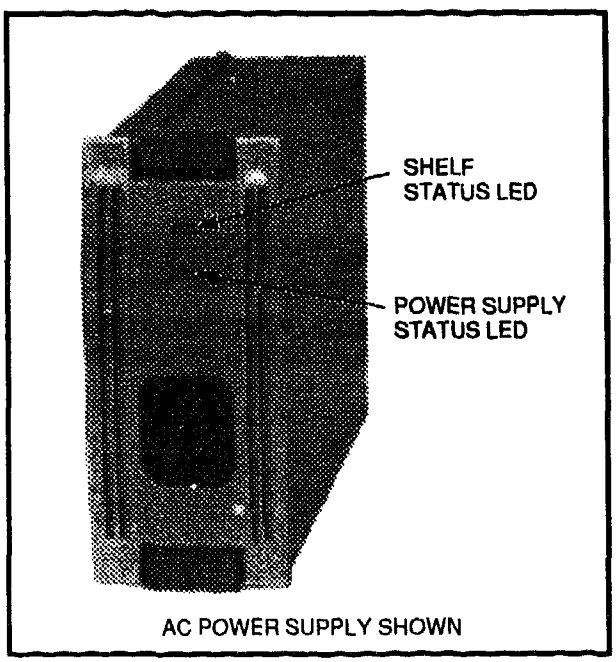
Table 7–1 Storage SBB Status LEDs

LED	Status	Indication
Device activity Device fault	On Off	SBB is operating normally.
Device activity Device fault	Flashing Off	SBB is operating normally.
Device activity Device fault	Off Off	SBB is operating normally. The SBB is inactive, and there is no fault.
Device activity Device fault	On On	Fault status. SBB is probably not responding to control signals. Digital recommends that you replace the SBB.
Device activity Device fault	Off On	Fault status. SBB is inactive and spun down. Digital recommends that you replace the SBB.
Device activity Device fault	On Flashing	Fault status. SBB is active and is spinning down because of the fault.

7.5.2 Power Supply SBB and Shelf Status

The status of both the shelf blowers and power supplies is displayed on the power supply LEDs, as shown in Figure 7–6. The upper LED displays the shelf status and the lower LED displays the power supply SBB's status.

Figure 7–6 Power Supply LEDs



7.5.2.1 Single Power Supply LED Status

In a shelf with only one power supply, Table 7–2 shows the states of the power supply LEDs, along with their corresponding power supply/shelf status.

Table 7–2 Single Power Supply Status LEDs

Status LED	State	Indication
Shelf (upper) PS (lower)	On On	System is operating normally.
Shelf (upper) PS (lower)	Off On	Blower or power supply fault. There is a shelf fault; there is no power supply fault. Replace blower as described in Chapter 9.
Shelf (upper) PS (lower)	Off Off	Fault status. Shelf or power supply fault. Replace power supply as described in Chapter 9.

7.5.2.2 Dual Power Supply LED Status

In a shelf with two power supplies, Table 7–3 shows the states of the LEDs on both power supplies, along with their corresponding power supply/shelf status.

Table 7–3 Dual Power Supply Status LEDs

Status LED	PS1†	PS2‡	Indication
Shelf (upper) PS (lower)	On On	On On	Normal status. System is operating normally.
Shelf (upper) PS (lower)	Off On	Off On	Fault status. There is a shelf fault; there is no power supply fault. Replace blower as described in Chapter 9.
Shelf (upper) PS (lower)	Off On	Off Off	Fault status. PS1 is operational. Replace PS2 as described in Chapter 9.
Shelf (upper) PS (lower)	Off Off	Off On	Fault status. PS2 is operational. Replace PS1 as described in Chapter 9.
Shelf (upper) PS (lower)	Off Off	Off Off	Fault status. Possible PS1 and PS2 fault or input power problem.

† Shelf power supply installed in slot 7.

‡ Redundant power supply installed in slot 6.

7.6 Environmental Monitor Unit

The EMU is used only in the SWXSC–AA cabinet and provides increased protection against catastrophic subsystem faults. The EMU works with the controller to warn you of various existing or impending subsystem failures. The controller responds to such conditions by displaying console error messages, and by controlling warning LEDs on the EMU and the devices themselves.

The EMU performs the following specific functions (SWXSC–AA cabinets only):

- Monitors and controls the shelf blowers
- Monitors the on/off condition of each power supply
- Senses shelf/cabinet temperature
- Monitors power supply voltages

See the *StorageWorks Solutions SW300-Series RAID Enclosure Installation and User's Guide* and the *StorageWorks Solutions HA–2400C Storage Enclosure OEM Engineering Specification* for more information on the EMU.

7.6.1 EMU Fault Detection

Once the SWXSC–AA cabinet is powered on, it operates normally until a fault condition is detected by the EMU. If the EMU detects a fault condition, it performs any or all of the following:

- Turn on the appropriate LED on the EMU panel
- Turn on the fault (amber) LED on the front upper right corner of the SWXSC–AA cabinet
- Activate an audible alarm
- Increase the speed of the blowers

As shown in Figure 7–7, the EMU front panel LEDs display the information when the subsystem is turned on or encounters a problem. Table 7–4 lists the EMU control panel buttons and LEDs, their functions, and error descriptions.

7.6.2 Controller Fault Detection

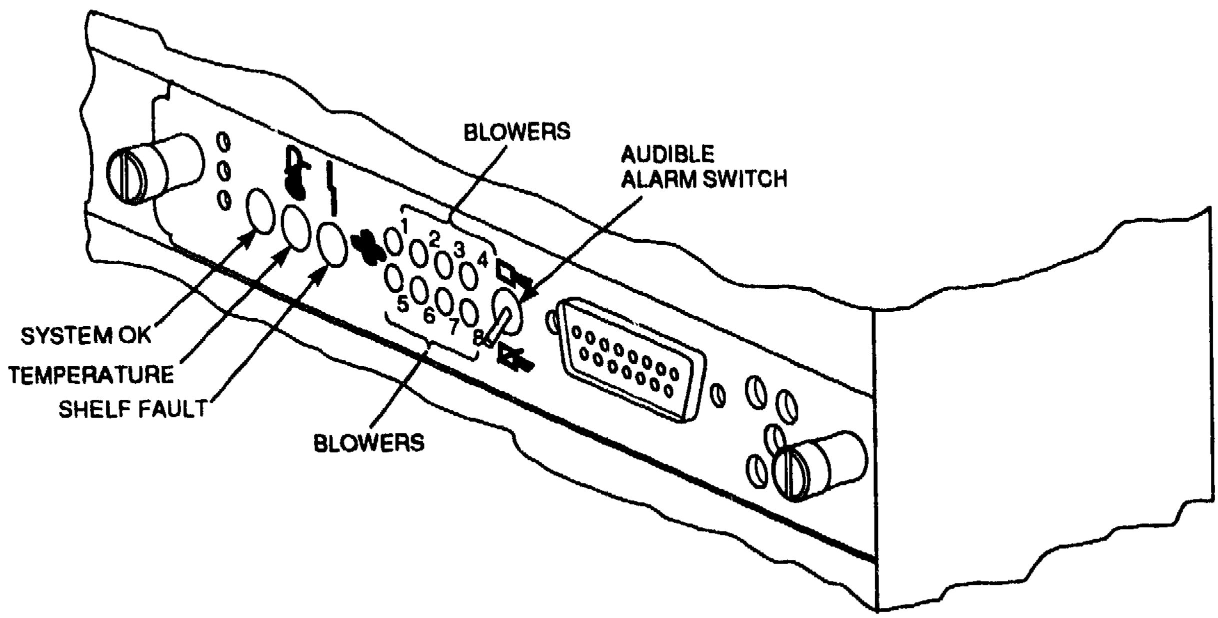
If the controller detects a storage device failure or a fault in the other controller in a dual-redundant configuration, it uses a controller fault drive signal to illuminate the fault (amber) LED on the EMU. When a special "controller alive" signal from either controller indicates to the EMU that a controller is not functioning, the EMU:

- turns on its fault (amber) LED
- turns off its System OK (green) LED
- activates an audible alarm

The SWXRC–04 controller generates an error message on the maintenance terminal (see Section 7.8.3) when it detects one of the following fault conditions:

- A power supply SBB has failed
- a blower has failed or is either not installed or not connected

Figure 7–7 EMU Control Panel LEDs and Switches



- The operating temperature is too high

Table 7–4 EMU Control Panel LEDs/Switches and Error Descriptions

When the ...	Is	The subsystem ..
System OK (green) LED Shelf Fault (amber) LED Blower 1 through 8 (amber) LEDs Temperature (amber) LED Audible Alarm	ON OFF OFF OFF OFF	Is in the normal operating state.
Audible Alarm	ON	Has a failed FRU. Check the EMU control panel LEDs to determine which FRU has failed.
System OK (green) LED	OFF	Has a failed FRU and one or more of the following error conditions exist: • The temperature is above the maximum safe operating level. • The +12 V dc power supply output is out of regulation • The +5 V dc power supply output is out of regulation • Fewer than four power supply SBBs are operational • One controller may be defective. Check for any error messages on the terminal (if one is attached).
Blower *x* LED	ON	Has an individual blower *x* failure.
Blower 1, 2, 3, *and* 4 (amber) LEDs	ON	Has one of these four blowers either not installed or not connected.
Blower 5, 6, 7, *and* 8 (amber) LEDs	ON	Has one of these four blowers either not installed or not connected.
Temperature (amber) LED	ON	Operating temperature is too high. The blowers operate at high speed to reduce the temperature.
Shelf Fault (amber) LED	ON	Has one or more of the following faults: • A power supply SBB has failed. (Verify if any individual power supply SBB LEDs are off to confirm.) • A storage device SBB or one of the controllers has failed. Refer to Section 7.4 for additional information on status LEDs on the controller OCP. • Fewer than four power supply SBBs are operational.

7.7 Error and Status Messages

The SWXRC–04 controller outputs error and status messages in response to both system- and operator-initiated events. Spontaneous error and status messages occur at any time, and are driven by system events. Interactive errors are associated with some action that the operator is performing.

7.8 Spontaneous Error and Status Messages

Spontaneous error and status messages are part of a CLI error report (CER) system, which causes the error message text to appear on a maintenance terminal along with the CLI prompt, as shown in the following example:

```
%CER -- 13-JUL-1994 13:28:45 -- SWAP signal cleared - all SWAP interrupts reenabled
CLI>
%CER -- 13-JUL-1994 13:29:11 -- Other controller restarted
CLI>
```

Spontaneous CER messages appear only under the following conditions:

- A hardware maintenance terminal is connected for receiving messages. Spontaneous messages do not appear on virtual terminals.
- The subsystem has finished initializing.
- You are not currently running a utility program on the maintenance terminal.
- A maintenance terminal is not actively displaying input from another source, such as event logging or last failure logging.
- No CLI commands are in progress on a maintenance terminal.

If any one of the previous conditions is not met, the spontaneous CER message display does not occur. In this case, the SWXRC–04 operating firmware stores messages for you. You need only connect a virtual or maintenance terminal (if one is not already connected) and press the Return key from the CLI prompt to review the 15 most recently received error messages.

Often, message review continues to occur each time Return is pressed. To clear the terminal of the errors, enter the CLEAR_ERRORS CLI command. (You may want to make a note of the errors before clearing them because they cannot be recalled afterwards.)

Note

Because the severity of errors varies, the controller may not initialize or operate, or both, even though an error message appears.

For example, if all of the SCSI ports, or the host port and local terminal port fail diagnostics, the controller cannot operate. However, if the cache module fails during normal operation, the controller continues to operate.

The following sections list spontaneous error and status messages you may encounter. The CER messages are presented in the following error categories:

- Configuration and CLI
- Diagnostic and intialization
- EMU

- Failover
- NVPM
- Read cache
- Shelf
- Write-back cache

Consult your firmware release notes for updates to the list of error messages.

7.8.1 Spontaneous Configuration and CLI Messages

This section lists messages that appear when configuration inconsistencies occur.

Configuration information deleted due to internal inconsistencies

> **Explanation:** This message displays if a test of nonvolatile memory shows corruption. The configuration information for the controller is deleted when this message is displayed.

Controllers misconfigured. Type SHOW THIS_CONTROLLER

> **Explanation:** If this message appears, examine the SHOW THIS_CONTROLLER display to determine the source of the misconfiguration.

Device and/or storageset names changed to avoid conflicts

> **Explanation:** Digital adds new CLI keywords at each new SWXRC–04 operating firmware release that can conflict with existing device and/or storageset names. When this happens, SWXRC–04 operating firmware changes your device and/or storageset names and sends this message. The functional operation of your configuration is not changed when this message appears.

Licensing different between the two controllers

> **Explanation:** The licensing features are set differently on two controllers of a dual-redundant pair.

Restart of the other controller required

> **Explanation:** When changing some parameters, you must reinitialize the companion controller in a dual-redundant pair to have the parameter take effect.

Restart of this controller required

> **Explanation:** A changed parameter requires reinitialization of this controller to take effect.

Serial number initialized due to format error

> **Explanation:** An invalid serial number was entered for the second controller of a dual-redundant pair.

Taken out of failover due to serial number format error

> **Explanation:** An invalid serial number format was entered for the second controller of a dual-redundant pair.

Restart of the controller required to apply new patch

Explanation: You used the Code Patch utility to enter a firmware patch, but the patch is not applied until you restart the controller.

7.8.2 Spontaneous Diagnostic and Initialization Messages

This section contains error messages that may be displayed if a fault occurs during initialization or self-test diagnostics. See Chapter 8 for more information on diagnostics.

Half CACHE FAILED Diagnostics

Explanation: Up to 50% of the cache memory has failed diagnostic tests.

HOST port FAILED Diagnostics

Explanation: The host port of the controller has failed diagnostics.

Local Terminal Port FAILED Diagnostics

Explanation: The maintenance (EIA–423) terminal port has failed diagnostics.

SCSI port *n* FAILED Diagnostics

Explanation: A SCSI–2 port has failed diagnostics. This message can appear even if you do not have a host connection. The variable *n* indicates which port failed.

Whole CACHE FAILED Diagnostics

Explanation: The cache module has failed diagnostics tests.

Write-Back CACHE BATTERY FAILED Diagnostics, cache treated as READ CACHE

Explanation: The write-back cache battery has failed the diagnostic tests described in Chapter 8. Any unwritten cache data on the cache is flushed. Non-RAIDset units are accessed in read cache mode. RAIDsets are unavailable unless they have access to good batteries on a dual-redundant companion cache. Replace the cache battery.

7.8.3 Spontaneous EMU Messages

This section contains error messages that may be displayed if an EMU-detected fault occurs (SWXSC–AA shelves only). Refer to Section 7.6 for more information on the EMU.

Power Supply failure detected

Explanation: One of the power supply SBBs in the SWXSC–AA shelf has failed.

Fan failure detected

Explanation: A blower in the SWXSC–AA shelf has failed.

WARNING: High temperature detected

Explanation: The SWXSC–AA shelf temperature is above the recommended operating temperature of 35°C (95°F). The blowers run at high speed. If the shelf temperature rises over 50°C (122°F), the subsystem shuts down.

Power Supply failure cleared

Explanation: A power supply SBB fault is corrected.

Fan failure cleared

Explanation: A blower fault is corrected.

Temperature within optimum limit

Explanation: The SWXSC–AA shelf temperature has returned to below 35°C (95°F). If the blowers were on high speed, they now returns to normal speed.

7.8.4 Spontaneous Failover Messages

The messages in this section are generated during failover between dual-redundant controllers.

Both HS*xxx* controllers are using SCSI address 6

Explanation: There is a hardware problem with the SWXSS–01 shelf. This problem probably involves the shelf backplane.

Both HS*xxx* controllers are using SCSI address 7

Explanation: There is a hardware problem with the SWXSS–01 shelf. This problem probably involves the shelf backplane.

Other controller not responding - RESET signal asserted

Explanation: One controller in a dual-redundant configuration is locked up, not responding, or the kill line to it is asserted.

Other controller restarted

Explanation: The other controller in a dual-redundant pair has successfully restarted after failing or undergoing a bugcheck.

Received LAST GASP message from other controller

Explanation: One controller in a dual-redundant configuration is attempting an automatic restart after failing or undergoing a bugcheck.

SCSI Device and HS*xxx* controller both configured at SCSI address 6

Explanation: This message appears when a device is accidentally configured as SCSI ID 6, and two controllers (SCSI IDs 6 and 7) are in a dual-redundant configuration.

7.8.5 Spontaneous NVPM Messages

The messages listed in this section are displayed because of a problem or fault associated with the nonvolatile parameter memory (NVPM).

Note

Some NVPM messages read "NVPM *component-name* component initialized to default settings." For some of these initialization cases, corrective action clears the error message only until the next time the controller is reset, because the error could be caused by a fault in NVPM itself. If the error persists, replace the controller module.

NVPM Failover Information component initialized to default settings.

Explanation: The identity of the other controller in a dual-redundant pair has been lost. Enter the SET FAILOVER COPY=OTHER_CONTROLLER command to correct this problem.

NVPM Revision level updated from *n* to *N*.

Explanation: The format of the NVPM has changed as a result of installing a newer program card (containing updated firmware). However, all subsystem configuration information has been retained.

NVPM User Interface Parameters component initialized to default settings.

Explanation: Terminal setting information has been lost.

To correct this problem, enter the SHOW THIS_CONTROLLER and SHOW OTHER_CONTROLLER commands to determine the current terminal settings. Compare the terminal settings with the CONFIGURATION.INFO output information, and use the SET THIS_CONTROLLER and SET OTHER_CONTROLLER commands to restore terminal settings.

The following NVPM Configuration Information component elements were initialized to default settings: [*n* ...

Explanation: The settings given by *n* have been initialized in connection with another NVPM error. To clear this error, perform the following procedure:

1. Enter the following commands:

```
CLI> SHOW DEVICES
CLI> SHOW UNITS
CLI> SHOW STORAGESETS
```

2. Compare the information displayed with a printout of the CONFIGURATION.INFO file or with a copy of the most current configuration.
3. Reconfigure the necessary devices, units, or storagesets. (See the CLI commands described in Appendix B.)

The following Firmware Licensing Service component elements were initialized to default settings: [*n* ...

Explanation: Licensing information for licensed features has been lost. To correct this problem, reenter your license keys through FLS.

NVPM FMU Parameters component initialized to default settings.

Explanation: FMU settings have been lost. Default FMU options are in place until you run FMU to change them.

NVPM Product Information component initialized to default settings.

Explanation: The controller product identification setting has been reset. If the controller "name" is not what it used to be (for example, "SWXRC–04") the controller module should be replaced immediately.

CAUTION: Replace the controller immediately if any of the following NVPM messages occur. Do not continue to use the controller.

All NVPM components initialized to their default settings.

Controller Characteristics component reformat failed during NVPM Revision Level 1 to 2 reformat.

Host Access Disabled.

NVPM Controller Characteristics component initialized to default settings.

NVPM Recursive Bugcheck Information component initialized to default settings.

NVPM System Information Page component initialized to default settings.

NVPM Volume Serial Number component initialized to default settings.

The following NVPM Manufacturing Failure Information component elements were initialized to default settings: *[...list of component elements*

Unknown NVPM Revision Level.

Unknown reformat stage encountered during NVPM Revision Level 1 to 2 reformat.

7.8.6 Spontaneous Read Cache Messages

This section contains error messages that may be displayed if a read cache related fault occurs.

Cache module failed diagnostic testing

Explanation: The cache has failed the diagnostic tests described in Chapter 8. Replace the read cache module.

Cache module failed diagnostic testing - half not accessible

Explanation: Up to 50% of the cache memory has failed the diagnostic tests described in Chapter 8. Replace the read cache module.

7.8.7 Spontaneous Shelf Messages

This section lists messages that appear when a shelf problem occurs.

Shelf *xx* fixed

Explanation: Shelf number *xx* has been correctly repaired.

Shelf *xx* has a bad power supply or fan

Explanation: Troubleshoot the system to isolate and replace the failed component.

SWAP signal cleared - all SWAP interrupts re-enabled

Explanation: This message indicates that the swap signal is now cleared.

Unable to clear SWAP signal on shelf *xx* - all SWAP interrupts disabled

Explanation: The subsystem is unable to clear the swap signal for a swapped device, where *xx* is the shelf number. This could indicate an unsupported SBB or no power to the device shelf.

7.8.8 Spontaneous Write-Back Cache Messages

This section contains error messages that may be displayed if a write-back cache related fault occurs.

This controller has an invalid cache module

Explanation: The wrong cache module is present. This means the serial number stored in controller NVMEM and in the cache do not match, and unwritten cache data exists. (This message can also occur for a new, uninitialized module.) Correct the problem in one of two ways:

- Replace this cache with the correct one for this controller.
- Enter the CLI command CLEAR_ERRORS INVALID_CACHE, which enables you to use the random module.

Cache module has metadata incompatible with this firmware

Explanation: The subsystem was not properly run down before changing firmware versions. There may be unwritten cache data that cannot be recovered because the cache metadata format has changed along with the firmware. Correct the problem in one of two ways:

- Restore the previous firmware version, and properly run down the subsystem.
- Enter the CLI command CLEAR_ERRORS INVALID_CACHE, which enables you to use the cache module (although you lose the unwritten cache data).

This controller has a missing cache module

Explanation: The cache module is missing or is not seated properly. (Controller NVMEM indicates that a cache module is expected because there may be unwritten cache data.) You can either find/reseat the module or enter the CLI command CLEAR_ERRORS INVALID_CACHE, which enables you to run (in write-through mode) without a cache but without accessing RAIDsets.

Cache module failed diagnostic testing

Explanation: The cache has failed the diagnostic tests described in Chapter 8. Any unwritten cache data in the cache module is lost. Replace the write-back cache module.

Cache module failed diagnostic testing - half not accessible

Explanation: Up to 50 percent of the cache memory has failed the diagnostic tests described in Chapter 8. Unwritten cache data in the cache module is lost. Replace the write-back cache module.

Cache battery failed diagnostic testing

Explanation: The write-back cache battery has failed the diagnostic tests described in Chapter 8. Any unwritten cache data on the cache is flushed. Non-RAIDset units are accessed in read cache mode. RAIDsets are unavailable unless they have access to good batteries on a dual-redundant companion cache. Replace the cache battery.

Cache battery charge is low

Explanation: The write-back cache battery is partially discharged. Any unwritten cache data on the cache is flushed. Non-RAIDset units are accessed in read cache mode. RAIDsets are unavailable unless they have access to good batteries on a dual-redundant companion cache. Replace the cache battery.

Cache modules are misconfigured

Explanation: This message is generated in dual-redundant configurations under the following circumstances:

- The companion controller's cache module is not a write-back cache.
- The companion controller's write-back cache is not the same size as this controller's write-back cache.

Cache failover of unwritten cache data is not performed if this message occurs. Correct the problem by replacing/adding cache to make sure both are compatible.

7.8.9 Last Failure Logging Messages

If you used the Fault Management Utility (FMU) to enable spontaneous last failure logging (LFL) displays, you may see maintenance terminal messages that begin with "%LFL." With LFL display enabled, the controller spontaneously displays information relevant to the sudden termination of executing firmware.

In cases when an automatic hardware reset occurs (such as power failure, pressing the reset (//) button, and so on) the last failure log display is inhibited because automatic reset does not allow sufficient time to complete the display.

See Chapter 8 for more information on the FMU and last failure logging.

7.8.10 Event Logging Messages

If you used FMU to enable spontaneous event logging (EVL) display, you may see maintenance terminal messages that begin with "%EVL." With EVL display enabled, the controller spontaneously displays EIP information during your maintenance terminal session.

Event log displays are inhibited during the execution of both CLI commands and utilities invoked from a maintenance terminal. Events that are reported while a maintenance terminal is in use do not appear when the terminal again becomes available. (The %EVL display is lost.)

See Chapter 8 for more information on the FMU and event logging.

7.9 Interactive Error and Status Messages

The previous sections detailed spontaneous , system-initated error and status messages you may encounter. For a list of messages you may see during while interacting with the controller via the CLI, see Appendix B.

8 Diagnostics, Exercisers, and Utilities

This chapter discusses the following firmware programs available to assist in the operation and diagnosis of the SWXRC–04 controller subsystem:

- Initialization and self-test routines
- Disk exerciser (DILX)
- System performance utility (VTDPY)
- Configuration utility (CONFIG)
- Menu-driven Configuration utility (CFMENU)
- Code Load/Code Patch utility (CLCP)
- Firmware Licensing System (FLS)
- Fault Management Utility (FMU)
- Crash Utility
- Volume Serial Number Utility (CHVSN)

Note

Some examples in this chapter include references to tape, tape loader, and CDROM devices. The SWXRC–04 controller does not, at the time of printing of this document, support such devices. Inclusion of examples referencing tape, tape loader, and CDROM devices does not imply SWXRC–04 controller support.

8.1 Initialization

The SWXRC–04 controller executes a number of diagnostic programs as part of its initialization sequences. The controller initializes after any of the following conditions:

- Power is turned on.
- The firmware resets the controller.
- The operator presses the green reset (//) button.
- The host clears the controller.

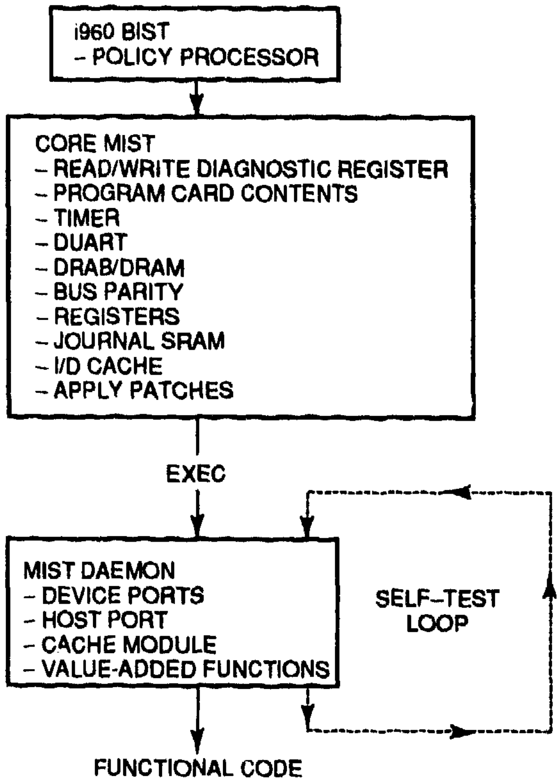
Whenever the controller initializes, it steps through a three-phase series of tests designed to detect any hardware or firmware faults. The three test areas are as follow:

1. Built-in self-test
2. Core module integrity self-test

3. Module integrity self-test DAEMON

Initialization time varies depending on your model of controller and what size and type of cache module, if any, you are running. However, initialization always completes in under 1 minute. Figure 8–1 shows the initialization process.

Figure 8–1 Controller Initialization



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8.1.1 Built-In Self-Test

The controller begins initialization by executing its policy processor's internal built-in self-test (**BIST**). BIST always executes upon initialization, because it is an integral part of the i960 microcode. BIST runs entirely from the i960 chip and a small portion of the firmware program card.

Successful completion of BIST means the i960 chip is functioning properly. If BIST fails, the controller shows no activity, and all port indicators on the OCP are off. (The green reset LED is solidly lit.) BIST fails if an incorrect program card is present.

8.1.2 Core Module Integrity Self-Test

After BIST completes successfully, initialization routines and diagnostics expand to testing of the controller module itself. The tests are part of the program card firmware and are known as core module integrity self-test (**MIST**).

Just before beginning core MIST, the controller reads the initial boot record (**IBR**) to determine the address of hardware setup parameters and process control information. After reading the IBR, the firmware within the program card is initialized to the IBR parameters. Program card firmware then executes core MIST as follows:

1. MIST checks the initial state of the read/write diagnostic register.
2. The test validates program card contents by reading each memory location and computing an error detection code (EDC). The test then compares the computed EDC with a predetermined EDC. The program card contents are valid if both EDCs match.
3. Core MIST then tests and/or checks module hardware attached to the buses:
   - Timer operation
   - DUART operation
   - DRAB/DRAM (shared memory) operation
     - The test writes to and reads all legal addresses. Then, boundaries are checked by attempting to access nonexistent addresses. To pass this test, the first two megabytes of memory must test good. If bad segments are found, the bad segments may divide total memory into no more than 16 good, continuous sections.
     - The test selects a device, then checks whether or not the bus has selected that device.
     - The test verifies that each allowable memory transfer size works and that illegal transfer sizes do not.
   - Bus parity
   - Registers (The test checks registers for frozen bits.)
   - Journal SRAM (The test writes to and reads all journal SRAM addresses.)
   - I/D cache
4. After core MIST successfully tests the program card and bus hardware, the initialization routine loads the firmware into the first two megabytes of controller shared memory. The initialization routine then uses the EDC method to compare the memory contents with the program card to verify a successful download.
5. The initialization routine applies any memory-resident code patches for this firmware version, and updates the free memory list accordingly.
6. The i960 is initialized to the new parameters (the ones read from the IBR). At this time, control of initialization passes to the firmware executive (EXEC). EXEC runs from controller shared memory.

   If, at any time, a fault occurs during core MIST, the OCP displays a code (refer to Chapter 7). In addition, register contents are displayed at the terminal. The register contents should be reported to DIGITAL Multivendor Customer Services personnel to help with module troubleshooting and repair.

The following is an example of MIST diagnostic error output:

```
MIST Diag-err Error Code  0000000F
MIST Diag-err Parameter 1 01234567
MIST Diag-err Parameter 2 89ABCDEF
MIST Diag-err Parameter 3 00000001

MIST Diag-err Master/Cache DRAB register contents:
MIST Diag-err   DSR  2D170CBC, 2C17003D
MIST Diag-err   CSR  00000000, 00000000
MIST Diag-err   DCSR 00000000, 00003402
MIST Diag-err   DER  00001C00, 00001C76
MIST Diag-err   EAR  00800000, 00000000
MIST Diag-err   EDR  00800000, FFFFFFFF
MIST Diag-err   ERR  0000002F, 00000000
MIST Diag-err   RSR  09805432, 09805432
MIST Diag-err   CHC  00000000, 00000000
MIST Diag-err   CMC  00078006, 00000000

MIST Diag-err Read diagnostic register 0  E7FFFFFC
MIST Diag-err Read diagnostic register 1  FFFFFEF0
MIST Diag-err Write diagnostic register 0 C3FFF80F
MIST Diag-err Write diagnostic register 1 0002FF04

MIST Diag-err Halting.
```

8.1.3 Module Integrity Self-Test DAEMON

Once initialization control is passed to EXEC, EXEC calls the diagnostic and execution monitor (DAEMON). DAEMON tests the device port hardware, host port hardware, cache module, and value-added functions.

- To test the device ports, DAEMON checks each NCR 53C710 SCSI processor chip. Initialization continues unless *all* SCSI device ports fail testing. In other words, it is possible for the controller to run with only one functioning device port.
- DAEMON tests the host port hardware for the controller. The NCR 53C720 host processor chip is tested. Initialization continues even if the host port tests fail, however, DAEMON stops initialization if the dual universal asynchronous receiver transmitter (DUART) test (from core MIST) *and* the host port tests fail.
- DAEMON tests the cache module as follows:

  Note

  The controller still functions if the cache module fails its testing. In this case, the controller uses its on-board shared memory for caching operations.

  - Write-back cache

    DAEMON works in close conjunction with the cache manager, a program that runs in the background of controller firmware. DAEMON first asks the cache manager if unwritten cache data exists on the write-back cache.

    If unwritten cache data does not exist, DAEMON tests the DRAB (memory controller) on the cache module, followed by testing the write-back cache batteries. After DAEMON completes, and functional code takes control of the firmware, the cache manager tests the memory on the cache. At least the first megabyte of the memory must test good, or the cache is declared bad.

If unwritten cache data exists, DAEMON tests only the batteries, and postpones other tests. Later, in operational code, the cache manager flushes the unwritten cache data after testing the DRAB and memory.

If cache is locked by the other controller (dual-redundant configurations), then all cache DAEMON diagnostics are postponed. During functional code, when the cache manager determines that the cache is unlocked, the cache manager tests the DRAB, batteries, and memory.

- Read cache

  DAEMON tests the DRAB (memory controller) on the read cache module. After DAEMON completes, and operational code takes control of the firmware, the cache manager tests the memory on the cache. At least the first megabyte of the memory must test good, or the cache is declared bad.

- The tests run by DAEMON and the cache manager are summarized in Table 8–1.

Table 8–1 Cache Module Testing

Test	DAEMON	Cache Manager
DRAB	• All memory is initialized. • Full address test.	• No memory is initialized. • Address test on diagnostic pages only.
Memory	• Never invoked.	• Always invokes all memory tests. • Read only, or read/write.
Battery	• If battery is charged, full battery test. • Otherwise, battery interrupt is checked.	• If battery is charged, full battery test except non-DRAB DRAM refresh circuitry is not tested. • Otherwise, battery interrupt is checked.

DAEMON handles all interrupts and errors received during cache module testing. If DAEMON receives any interrupt, it stops initialization. DAEMON and/or the cache manager display any errors as a code on the OCP (refer to Chapter 7).

- To make sure of proper RAID functions, DAEMON tests the XOR operations of the value-added hardware and the associated buffer memory. Initialization stops if this test fails.

After successful test completion, DAEMON releases control. At this time, initialization is finished, and functional controller firmware takes over.

Self-Test Self-test is a special function of DAEMON, where you set DAEMON to run in a continuous loop. Self-test enables you to diagnose intermittent hardware failures because the loop continues until an error is detected. The DAEMON battery tests, however, only run once per self-test. They do not repeat or loop.

In addition, self-test checks the controller hardware without affecting devices on any ports. DIGITAL recommends you run self-test from the maintenance terminal because the host port disconnects once the controller begins self-test.

For self-test to properly execute, you must have a valid configuration and enable the host paths.

To run self-test, enter one of the following commands (which command you need depends on your configuration, which controller the terminal is connected to, and which controller you wish to test.)

```
CLI> SELFTEST THIS_CONTROLLER
CLI> SELFTEST OTHER_CONTROLLER
```

See Appendix B for more information on the command and its qualifiers.

When you run self-test, all outstanding I/O operations complete. The controller also attempts to flush the cache. However, even if self-test fails to flush the cache, the program continues to execute.

Self-test halts if it detects a fault. Otherwise, the self-test loop continues until you press the reset (//) button or cycle the controller power off and on, after which the controller reinitializes.

8.2 Disk Inline Exerciser

DILX is a diagnostic tool used to exercise the data transfer capabilities of selected disks connected to an SWXRC–04 controller. DILX exercises disks in a way that simulates a high level of user activity. Using DILX, you can read and write to all customer-available data areas. Thus, DILX can be used to determine the health of a controller and the disks connected to it and to acquire performance statistics. You can run DILX from a maintenance terminal.

DILX allows for auto-configuring of drives. This allows for quick configuring and testing of all units at once. Please be aware that *customer data is lost* by running this test. DIGITAL recommends only using the Auto-Configure option during initial installations.

DILX tests logical units that may consist of storagesets of multiple physical devices. Error reports identify the logical units, not the physical devices. Therefore, if errors occur while running against a unit, its storageset should be reconfigured as individual devices, and then DILX run again, against the individual devices.

There are no limitations on the number of units DILX may test at one time. However, DIGITAL recommends only using DILX when no host activity is present. If you must run DILX during a live host connection, you should limit your testing to no more than half of any controller's units at one time. This conserves controller resources and minimizes performance degradation on the live units you are not testing.

8.2.1 Invoking DILX

To invoke DILX from a maintenance terminal, enter the following command at the CLI> prompt:

```
CLI> run dilx
```

8.2.2 Interrupting DILX Execution

Use the following guidelines to interrupt DILX execution.

Note

The symbol "^" is is used to indicate the Ctrl key in this guide and in the controller's firmware messages. You must press and hold the Ctrl key and type the character key given.

- Ctrl/G or Ctrl/T causes DILX to produce a performance summary. DILX continues normal execution without affecting the runtime parameters.
- Ctrl/C causes DILX to produce a performance summary, stop testing, and ask the "reuse parameters" question.
- Ctrl/Y causes DILX to abort. The "reuse parameters" question is not asked.

8.2.3 DILX Tests

There are two DILX tests, as follow:

- The Basic Function test
- The User-Defined test

8.2.3.1 Basic Function Test—DILX

The Basic Function test for DILX executes in two or three phases. The three phases are as follow:

- **Initial Write Pass**—Is the only optional phase and is always executed first (if selected). The initial write pass writes the selected data patterns to the entire specified data space or until the DILX execution time limit has been reached. Once the initial write pass has completed, it is not re-executed no matter how long the DILX execution time is set. The other phases are re-executed on a 10-minute cycle.
- **Random I/O**—Simulates typical I/O activity with random transfers from one byte to the maximum size I/O possible with the memory constraints DILX runs under. Note that the length of all I/Os is in bytes and is evenly divisible by the sector size (512 bytes).

  Read and write (if enabled) commands are issued using random logical block numbers (LBNs). In the read/write mode, DILX issues the reads and writes in the ratio specified previously under read/write ratio. When read-only mode is chosen, only read commands are issued.

  If compares are enabled, compares are performed on read commands using DILX internal checks. The percentage of compares to perform can be specified. This phase is executed 80 percent of the time. It is the first phase executed after the initial write pass has completed. It is re-executed at 10-minute intervals with each cycle lasting approximately 8 minutes.

  Intervals are broken down into different cycles. The interval is repeated until the user-selected time interval expires.

  ```
  <------------------------------10 min-------------------------------->
  <----------------8 min Random I/O--------------><--2 min Data Inten--->
  ```

- **Data Intensive**—Designed to test disk throughput by selecting a starting LBN and repeating transfers to the next sequential LBN that has not been accessed by the previous I/O. The transfer size of each I/O equals the maximum sized I/O that is possible with the memory constraints DILX must run under. This phase continues performing spiraling I/O to sequential tracks. Read and write commands are issued in read/write mode. This phase is executed 20 percent of the time after the initial write pass has completed. This phase always executes after the random I/O phase. It is re-executed at 10-minute intervals with each cycle approximately 2 minutes.

8.2.3.2 User-Defined Test—DILX

CAUTION

The User-Defined test should be run *only* by very knowledgeable personnel. Otherwise, customer data can be destroyed.

When this test is selected, DILX prompts you for input to define a specific test. In the DILX User-Defined test, a total of 20 or fewer I/O commands can be defined. Once all of the commands are issued, DILX issues the commands again in the same sequence. This is repeated until the selected time limit is reached. As you build the test, DILX collects the following information from you for each command:

- The I/O command name (write, read, or quit). "Quit" is not a data command; instead it indicates to DILX that you have finished defining the test.
- The starting logical block number (LBN).
- The size of the I/O in 512 byte blocks.

8.2.4 DILX Test Definition Questions

The following text is displayed when running DILX. The text includes questions that are listed in the approximate order that they are displayed on your terminal. These questions prompt you to define the runtime parameters for DILX.

Note

Defaults for each question are given inside [ ]. If you press the Return key as a response to a question, the default is used as the response.

After DILX has been started, the following message and prompt is displayed:

```
It is recommended that DILX only be run when there is no host activity
present on the SWXRC-04 controller. Do you want to continue (y/n) [n] ?
```

The following message describing the Auto-Configure option is displayed:

```
The Auto-Configure option automatically selects, for testing,
all of the disk units configured. It performs a very thorough
test  with *WRITES* enabled. The user is only able to select the
run time and performance summary options. The user is not able
to specify specific units to test. The Auto-Configure option is only
recommended for initial installations. It is the first question asked.
```

```
Do you wish to perform an Auto-Configure (y/n) [n] ?
```

Explanation: Enter "Y" if you wish to invoke the Auto-Configure option.

After the Auto-Configure option is selected, DILX displays the following caution statement:

```
 **CAUTION**
All data on the Auto-Configured disks is destroyed. You *MUST* be sure
of yourself.
```

```
Are you sure you want to continue (y/n) [n] ?
```

Explanation: This question is self explanatory.

`Use All Defaults and Run in Read Only Mode (y/n) [y]?`

Explanation: Enter "Y" to use the defaults for DILX, run in read-only mode, and most of the other DILX questions are not asked. Enter "N" and the defaults are not used. You must then answer each question as it is displayed. The following defaults are assumed for all units selected for testing:

- Execution time limit = 10 minutes.
- Performance summary interval = 10 minutes.
- Displaying sense data for hard or soft errors is disabled.
- The hard error limit = 65535. Testing stops if the limit is reached.
- The I/O queue depth = 4. A maximum of 4 I/Os is outstanding at any time.
- The Selected Test = the Basic Function test.
- Read-only mode.
- All user available LBNs are available for testing.
- Data compares are disabled.

`Enter the execution time limit in minutes (1:65535) [10]?`

Explanation: Enter the desired time you want DILX to run. The default run time is 10 minutes.

`Enter the summary interval in minutes (1:65535) [10]?`

Explanation: Enter a value to set the interval for which a performance summary is displayed. The default is 10 minutes.

`Include performance statistics in performance summary (y/n) [n]?`

Explanation: Enter "Y" to see a performance summary that includes the performance statistics that include the total count of read and write I/O requests and the kilobytes transferred for each command type. Enter "N" and no performance statistics are displayed.

`Display hard/soft errors (y/n) [n]?`

Explanation: Enter "Y" to enable displays of sense data and deferred errors. Enter "N" to disable error reporting. The default is disabled error reporting.

`When the hard error limit is reached, the unit is dropped from testing.Enter hard error limit (1:65535) [65535] ?`

Explanation: Enter a value to specify the hard error limit for all units to test. This question is used to obtain the hard error limit for *all* units under test. If the hard error limit is reached, DILX discontinues testing the unit that reaches the hard error limit. If other units are currently being tested by DILX, testing continues for those units.

`When the soft error limit is reached, soft errors are no longer displayed but testing continues for the unit. Enter soft error limit (1:65535) [32] ?`

Explanation: Enter a value to specify the soft error limit for *all* units under test. When the soft error limit is reached, soft errors are no longer displayed, but testing continues for the unit.

`Enter IO queue depth (1:12) [4]?`

Explanation: Enter the maximum number of outstanding I/Os for each unit selected for testing. The default is 4.

`Enter unit number to be tested?`

Explanation: Enter the unit number for the unit to be tested.

Note

When DILX asks for the unit number, it requires the number designator for the disk, where D117 would be specified as unit number 117.

`Unit x are write enabled. Do you still wish to add this unit (y/n) [n]?`

Explanation: This is a reminder of the consequences of testing a unit while it is write enabled. This is the last chance to back out of testing the displayed unit. Enter "Y" to write enable the unit. Enter "N" to back out of testing that unit.

`Select another unit (y/n) [n]?`

Explanation: Enter "Y" to select another unit for testing. Enter "N" to begin testing the units already selected. The system displays the following test selections:

```
***Available tests are:
1.   Basic Function
2.   User Defined Test

Use the Basic Function 99.9% of the time.  The User Defined
test is for special problems only.
```

`Enter test number (1:2) [1]?`

Explanation: Enter "1" for the Basic Function test or "2" for the User-Defined test. After selecting a test, the system then displays the following messages:

```
In the User-Defined test, you may define up to 20 commands.  They are
executed in the order entered.  The commands are repeated until the
execution time limit expires.

** CAUTION **
If you define write commands, user data is destroyed.
```

`Enter command number x (read, write, quit) [ ]?`

Explanation: This question only applies to the User-Defined test. It allows you to define command *x* as a read or write command. Enter quit to finish defining the test.

After making your command selection(s), the following message is displayed by DILX:

```
* IMPORTANT *  If you answer yes to the next question, user data
WILL BE destroyed.
```

`Write enable disk unit (y/n) [n] ?`

Explanation: Enter "Y" to write enable the unit. Write commands are enabled for the currently selected test. Data within your selected LBN range is destroyed. *Be sure of your actions before answering this question.* This question applies to all DILX tests. Enter "N" to enable read only mode, where read and access commands are the only commands enabled.

`Perform initial write (y/n) [n] ?`

Explanation: Enter "Y" to write to the entire user-selected LBN range with the user-selected data patterns. Enter "N" for no initial write pass.

If you respond with "Y", the system performs writes starting at the lowest user-selected LBN and issues spiral I/Os with the largest byte count possible. This continues until the specified LBN range has been completely written. Upon completion of the initial write pass, normal functions of the Random I/O phase start. The advantage of selecting the initial write pass is that compare host data commands can then be issued and the data previously written to the media can be verified for accuracy. It makes sure that all LBNs within the selected range are accessed by DILX.

The disadvantage of using the initial write pass is that it may take a long time to complete because a large LBN range was specified. You can bypass this by selecting a smaller LBN range, but this creates another disadvantage in that the entire disk space is not tested. The initial write pass only applies to the Basic Function test.

`The write percentage is set automatically. Enter read percentage for random IO and data intensive phase (0:100) [67] ?`

Explanation: This question is displayed if read/write mode is selected. It enables you to select the read/write ratio to use in the Random I/O and Data Intensive phases. The default read/write ratio is similar to the I/O ratio generated by a typical OpenVMS system.

`Enter data pattern number 0=all, 19=user_defined, (0:19) [0]?`

Explanation: The DILX data patterns are used in write commands. This question is displayed when writes are enabled for the Basic Function or User-Defined tests. There are 18 unique data patterns to select from. These patterns were carefully selected as worst case or most likely to produce errors for disks connected to the controller. (See Section 8.2.8 for a list of data patterns.) The default uses all 18 patterns in a random method. This question also enables you to create a unique data pattern of your own choice.

`Enter the 8-digit hexadecimal user defined data pattern [ ] ?`

Explanation: This question is only displayed if you choose to use a User-Defined data pattern for write commands. The data pattern is represented in a longword and can be specified with eight hexadecimal digits.

`Enter start block number (0:highest_lbn_on_the_disk) [0] ?`

Explanation: Enter the starting block number of the area on the disk you wish DILX to test. Zero is the default.

```
Enter end block number
   (starting_lbn:highest_lbn_on_the_disk)\[highest_lbn_on_the_disk]
   ?
```

Explanation: Enter the highest block number of the area on the disk you wish DILX to test. The highest block number (of that type of disk) is the default.

```
Perform data compare (y/n) [n] ?
```

Explanation: Enter "Y" to enable data compares. Enter "N" and no data compare operations are done.

This question is only asked if you select the initial write option. Data compares are only performed on reads. This option can be used to test data integrity.

```
Enter compare percentage (1:100) [5] ?
```

Explanation: This question is displayed only if you choose to perform data compares. This question enables you to change the percentage of read and write commands that have a data compare operation performed. Enter a value indicating the compare percentage. The default is 5.

```
Enter command number x (read, write, quit) [] ?
```

Explanation: This question only applies to the User-Defined test. It enables you to define command *x* as a read, write, access, or erase command. Enter quit to finish defining the test.

```
Enter starting LBN for this command (0:highest_lbn_on_the_disk) [] ?
```

Explanation: This question only applies to the User-Defined test. It enables you to set the starting LBN for the command currently being defined. Enter the starting LBN for this command.

```
Enter the IO size in 512 byte blocks for this command (1:size_in_blocks) []
   ?
```

Explanation: This question only applies to the User-Defined test. It enables you to set the I/O size in 512-byte blocks for the command currently being defined. Enter values indicating the I/O size for this command.

```
Reuse parameters (stop, continue, restart, change_unit) [stop]?
```

Explanation: This question is displayed after the DILX execution time limit expires, after the hard error limit is reached for every unit under test, or after you enter Ctrl/C. These options are as follow:

- **Stop**—DILX terminates normally.
- **Continue**—DILX resumes execution without resetting the remaining DILX execution time or any performance statistics. If the DILX execution time limit has expired, or all units have reached their hard error limit, DILX terminates.
- **Restart**—DILX resets all performance statistics and restarts execution so that the test performs exactly as the one that just completed. However, there is one exception. If the previous test was the Basic Function test with the initial write pass and the initial write pass completed, the initial write pass is not performed when the test is restarted.

- **Change_unit**—DILX allows you to drop or add units to testing. For each unit dropped, another unit must be added until all units in the configuration have been tested. The unit chosen is tested with the same parameters that were used for the unit that was dropped from testing. When you have completed dropping and adding units, all performance statistics are initialized and DILX execution resumes with the same parameters as the last run.

`Drop unit #x (y/n) [n] ?`

Explanation: This question is displayed if you choose to change a unit as an answer to the "reuse parameters" (previous) question. Enter the unit number that you wish to drop from testing.

`The new unit is write enabled. Do you wish to continue (y/n) [n] ?`

Explanation: This question is displayed if you choose to change a unit as an answer to the "reuse parameters" question. It is only asked if the unit being dropped was write enabled. This question gives you the chance to terminate DILX testing if you do not want data destroyed on the new unit. Enter "N" to terminate DILX.

8.2.5 DILX Output Messages

The following message is displayed when DILX is started:

`Disk Inline Exerciser - version 2.0`

This message identifies the internal program as DILX and gives the DILX software version number.

Change Unit is not a legal option if Auto-Configure was chosen.

Explanation: This message is displayed if the user selected the Auto-Configure option and selected the "change unit response" to the "reuse parameters" question. You cannot drop a unit and add a unit if all units were selected for testing.

DILX - Normal Termination.

Explanation: This message is displayed when DILX terminates under normal conditions.

Insufficient resources.

Explanation: Following this line is a second line that gives more information about the problem, which could be one of the following messages:

- Unable to allocate memory.

  DILX was unable to allocate the memory it needed to perform DILX tests. You should run DILX again but choose a lower queue depth and/or choose fewer units to test.

- Cannot perform tests.

  DILX was unable to allocate all of the resources needed to perform DILX tests. You should run DILX again but choose a lower queue depth and/or choose fewer units to test.

- Unable to change operation mode to maintenance.

  DILX tried to change the operation mode from normal to maintenance using the SYSAP$CHANGE_STATE( ) routine but was not successful due to insufficient resources. This problem should not occur. If it does occur, submit a CLD (error report), then reset the controller.

Disk unit *x* does not exist.

Explanation: An attempt was made to allocate a unit for testing that does not exist on the controller.

Unit *x* successfully allocated for testing.

Explanation: All processes that DILX performs to allocate a unit for testing, have been completed. The unit is ready for DILX testing.

Unable to allocate unit.

Explanation: This message should be preceded by a reason why the unit could not be allocated for DILX testing.

DILX detected error, code *x*.

Explanation: The "normal" way DILX recognizes an error on a unit is through the reception of SCSI sense data. This loosely corresponds to an MSCP error log. However, the following are some errors that DILX detects using internal checks without SCSI sense data:

- Illegal Data Pattern Number found in data pattern header. Unit *x*

  This is code 1. DILX read data from the disk and found that the data were not in a pattern that DILX previously wrote to the disk.

- No write buffers correspond to data pattern Unit *x*.

  This is code 2. DILX read a legal data pattern from the disk at a place where DILX wrote to the disk, but DILX does not have any write buffers that correspond to the data pattern. Thus, the data have been corrupted.

- Read data do not match what DILX thought was written to the media. Unit *x*.

  This is code 3. DILX writes data to the disk and then reads it and compares it against what was written to the disk. This indicates a compare failure. More information is displayed to indicate where in the data buffer the compare failed and what the data were and should have been.

DILX terminated. A termination, a print summary or a reuse parameters request was received but DILX is currently not testing any units.

Explanation: You entered a Ctrl/Y (termination request), a Ctrl/G (print summary request) or a Ctrl/C (reuse parameters request) before DILX had started to test units. DILX cannot satisfy the second two requests so DILX treats all of these requests as a termination request.

DILX does not change the state of a unit if it is not NORMAL.

Explanation: DILX cannot allocate the unit for testing because it is already in Maintenance mode. (Maintenance mode can only be invoked by the firmware. If another DILX session is in use, the unit is considered in Maintenance mode.)

Unable to bring unit online.

Explanation: This message is self explanatory.

Soft error reporting disabled. Unit *x*.

Explanation: This message indicates that the soft error limit has been reached and therefore no more soft errors are displayed for this unit.

Hard error limit reached, unit *x* dropped from testing.

Explanation: This message indicates that the hard error limit has been reached and the unit is dropped from testing.

Soft error reporting disabled for controller errors.

Explanation: This message indicates that the soft error limit has been reached for controller errors. Thus, controller soft error reporting is disabled.

Hard error limit reached for controller errors. All units dropped from testing.

Explanation: This message is self explanatory.

Unit is already allocated for testing.

Explanation: This message is self explanatory.

No drives selected.

Explanation: DILX parameter collection was exited without choosing any units to test.

Maximum number of units are now configured.

Explanation: This message is self explanatory. (Testing starts after this message is displayed.)

Unit is write protected.

Explanation: The user wants to test a unit with write and/or erase commands enabled but the unit is write protected.

The unit status and/or the unit device type has changed unexpectedly. Unit x dropped from testing.

Explanation: The unit status may change if the unit experienced hard errors or if the unit is disconnected. Either way, DILX cannot continue testing the unit.

Last Failure Information follows. This error was NOT produced by running DILX. It represents the reason why the controller crashed on the previous controller run.

Explanation: This message may be displayed while allocating a unit for testing. It does not indicate any reason why the unit is or is not successfully allocated, but rather represents the reason why the controller went down in the previous run. The information that follows this message is the contents of an EIP.

Disk unit numbers on this controller include:

Explanation: After this message is displayed, a list of disk unit numbers on the controller is displayed.

IO to unit *x* has timed out. DILX aborting.

Explanation: One of the DILX I/Os to this unit did not complete within the command timeout interval and, when examined, was found not progressing. This indicates a failing controller.

DILX terminated prematurely by user request.

Explanation: A Ctrl/Y was entered. DILX interprets this as a request to terminate. This message is displayed and DILX terminates.

Unit is owned by another sysap.

Explanation: DILX could not allocate the unit specified because the unit is currently allocated by another system application. Terminate the other system application or reset the controller.

This unit is reserved.

Explanation: The unit could not be allocated for testing because a host has reserved the unit.

This unit is marked inoperative.

Explanation: The unit could not be allocated for testing because the controller internal tables have the unit marked as inoperative.

The unit does not have any media present.

Explanation: The unit could not be allocated for testing because no media is present.

The RUNSTOP_SWITCH is set to RUN_DISABLED.

Explanation: The unit could not be allocated for testing because the RUNSTOP_SWITCH is set to RUN_DISABLED. This is enabled and disabled through the Command Line Interpreter (CLI).

Unable to continue, run time expired.

Explanation: A continue response was given to the "reuse parameters" question. This is not a valid response if the run time has expired. Reinvoke DILX.

When DILX starts to exercise the disk units, the following message is displayed with the current time of day:

```
DILX testing started at: xx:xx:xx
    Test will run for x minutes
    Type ^T(if running DILX through a VCS) or ^G(in all other cases)
      to get a current performance summary
    Type ^C to terminate the DILX test prematurely
    Type ^Y to terminate DILX prematurely
```

8.2.6 DILX Sense Data Display

To interpret the sense data fields correctly, refer to SCSI–2 specifications. Example 8–1 is an example of a DILX sense data display.

Example 8–1 DILX Sense Data Display

```
Sense data in hex for unit x

      Sense Key                   x
      Sense ASC                   x
      Sense ASQ                   x
      Instance                    x
```

8.2.7 DILX Deferred Error Display

Example 8–2 is an example of a DILX deferred error display.

Example 8–2 DILX Deferred Error Display

```
Deferred error detected, hard error counted against each unit.

     Sense Key                   x
     Sense ASC                   x
     Sense ASQ                   x
     Instance                    x
```

8.2.8 DILX Data Patterns

Table 8–2 defines the data patterns used with the DILX Basic Function or User-Defined tests. There are 18 unique data patterns. These data patterns were selected as worst case, or the ones most likely to produce errors on disks connected to the controller.

Table 8–2 DILX Data Patterns

Pattern Number	Pattern in hex
1	0000
2	8B8B
3	3333
4	3091
5, shifting 1s	0001, 0003, 0007, 000F, 001F, 003F, 007F, 00FF, 01FF, 03FF, 07FF, 0FFF, 1FFF, 3FFF, 7FFF
6, shifting 0s	FIE, FFFC, FFFC, FFFC, FFE0, FFE0, FFE0, FFE0, FE00, FC00, F800, F000, F000, C000, 8000, 0000
7, alternating 1s, 0s	0000, 0000, 0000, FFFF, FFFF, FFFF, 0000, 0000, FFFF, FFFF, 0000, FFFF, 0000, FFFF, 0000, FFFF
8	B6D9
9	5555, 5555, 5555, AAAA, AAAA, AAAA, 5555, 5555, AAAA, AAAA, 5555, AAAA, 5555, AAAA, 5555, AAAA, 5555
10	DB6C
11	2D2D, 2D2D, 2D2D, D2D2, D2D2, D2D2, 2D2D, 2D2D, D2D2, D2D2, 2D2D, D2D2, 2D2D, D2D2, 2D2D, D2D2
12	6DB6
13, ripple 1	0001, 0002, 0004, 0008, 0010, 0020, 0040, 0080, 0100, 0200, 0400, 0800, 1000, 2000, 4000, 8000
14, ripple 0	FIE, FFFD, FFFB, FFF7, FFEF, FFDF, FFBF, FF7F, FEFF, FDFF, FBFF, F7FF, EFFF, BFFF, DFFF, 7FFF
15	DB6D, B6DB, 6DB6, DB6D, B6DB, 6DB6, DB6D, B6DB, 6DB6, DB6D, B6DB, 6DB6, DB6D
16	3333, 3333, 3333, 1999, 9999, 9999, B6D9, B6D9, B6D9, B6D9, FFFF, FFFF, 0000, 0000, DB6C, DB6C
17	9999, 1999, 699C, E99C, 9921, 9921, 1921, 699C, 699C, 0747, 0747, 0747, 699C, E99C, 9999, 9999

Table 8–2 (Cont.) DILX Data Patterns

Pattern Number	Pattern in hex
18	FFFF
Default—Use all of the above patterns in a random method	

8.2.9 Interpreting the DILX Performance Summaries

A DILX performance display is produced under the following conditions:

- When a specified performance summary interval elapses
- When DILX terminates for any conditions except an abort
- When Ctrl/G or Ctrl/T is entered

The performance display has different formats depending on whether or not performance statistics are requested in the user-specified parameters and if errors are detected.

The following is an example of a DILX performance display where performance statistics were not selected and where no errors were detected:

```
   DILX Summary at 18-JUN-1993 06:18:41
   Test minutes remaining: 0, expired: 6

Unit 1     Total IO Requests 482
  No errors detected
Unit 2     Total IO Requests 490
  No errors detected
```

The following is an example of a DILX performance display where performance statistics were selected and no errors were detected:

```
   DILX Summary at 18-JUN-1993 06:18:41
   Test minutes remaining: 0, expired: 6

Unit 1     Total IO Requests 482
  Read Count   292   Write Count 168
  KB xfer    Read 7223   Write 4981   Total 12204
  No errors detected
```

The following is an example of a DILX performance display where performance statistics were not selected and where errors were detected on a unit under test:

```
     DILX Summary at 18-JUN-1993 06:18:41
     Test minutes remaining: 0, expired: 6

❶ Unit 10     Total IO Requests 153259
           No errors detected
❷ Unit 40     Total IO Requests 2161368
           Err in Hex: IC:031A4002  PTL:04/00/00  Key:04  ASC/Q:B0/00  HC:0  SC:1
           Total Errs   Hard Cnt 0   Soft Cnt 1
❸ Unit 55     Total IO Requests 2017193
           Err in Hex: IC:03094002  PTL:05/05/00  Key:01  ASC/Q:18/89  HC:0  SC:1
           Err in Hex: IC:03094002  PTL:05/05/00  Key:01  ASC/Q:18/86  HC:0  SC:1
❹          Total Errs   Hard Cnt 0   Soft Cnt 2
```

where:

❶ Represents the unit number and the total I/O requests to this unit.

❷ Represents the unit number and total I/O requests to this unit.

This also includes the following items associated with this error, and the total number of hard and soft errors for this unit:

- The SWXRC–04 Instance code (in hex)
- The port/target/LUN (PTL)
- The SCSI Sense Key
- The SCSI ASC and ASQ (ASC/Q) codes
- The total hard and soft count for this error

❸ Represents information about the first two unique errors for this unit.

This also includes the following items associated with this error, and the total number of hard and soft errors for this unit:

- The SWXRC–04 Instance code (in hex)
- The port/target/LUN (PTL)
- The SCSI Sense (Key)
- The SCSI ASC and ASQ (ASC/Q) codes
- The total hard and soft count for this error

A line of this format may be displayed up to three times in a performance summary. There would be a line for each unique error reported to DILX for up to three errors for each unit.

❹ Represents the total hard and soft errors experienced for this unit.

The following is an example of a DILX performance display where performance statistics were not selected and where a controller error was detected:

```
   DILX Summary at 18-JUN-1993 06:18:41
   Test minutes remaining: 0, expired: 6

Cnt err in HEX  IC:07080064  Key:06  ASC/Q:A0/05  HC:1  SC:0
  Total Cntrl Errs   Hard Cnt 1   Soft Cnt 0

Unit 1     Total IO Requests 482
  No errors detected
Unit 2     Total IO Requests 490
  No errors detected
```

For the previous examples, the following definitions apply.

- IC—The SWXRC–04 Instance code.
- ASC/Q—The SCSI ASC and ASCQ code associated with this error.
- HC—The hard count of this error.
- SC—The soft count of this error.
- PTL—The location of the unit (port/target/LUN).

The performance displays contain error information for up to three unique errors. Hard errors always have precedence over soft errors. A soft error represented in one display may be replaced with information on a hard error in subsequent performance displays.

8.2.10 DILX Abort Codes

Table 8–3 lists the DILX abort codes and definitions.

Table 8–3 DILX Abort Codes and Definitions

Value	Definition
1	An IO has timed out.
2	dcb_p->htb_used_count reflects an available HTB to test IOs but none could be found.
3	FAO returned either FAO_BAD_FORMAT or FAO_OVERFLOW.
4	TS$SEND_TERMINAL_DATA returned either an ABORTED or INVALID_BYTE_COUNT.
5	TS$READ_TERMINAL_DATA returned either an ABORTED or INVALID_BYTE_COUNT.
6	A timer is in an unexpected expired state that prevents it from being started.
7	The semaphore was set after a oneshot IO was issued but nothing was found in the received HTB que.
8	A termination, a print summary, or a reuse parameters request was received when DILX was not testing any units.
9	User requested an abort via ^Y.

8.2.11 DILX Error Codes

Table 8–4 list the DILX error codes and definitions for DILX-detected errors.

Table 8–4 DILX Error Codes and Definitions

Value	Definition
1	Illegal Data Pattern Number found in data pattern header.
2	No write buffers correspond to data pattern.
3	Read data do not match write buffer.

8.3 VTDPY Utility

The VTDPY utility gathers and displays system state and performance information for the SWXRC–04 family of modular storage controllers. The information displayed includes processor utilization, host port activity and status, device state, logical unit state, and cache and I/O performance.

The VTDPY utility requires a video terminal that supports ANSI control sequences, such as a VT220, VT320, or VT420 terminal. A graphics display that provides emulation of an ANSI compatible video terminal also can be used. VTDPY can be run only on terminals connected to the SWXRC–04 controller maintenance terminal port.

The following sections show how to use the VTDPY utility.

8.3.1 How to Run VTDPY

Only one VTDPY session can be run on each controller at one time. Prior to running VTDPY, be sure the terminal is set in NOWRAP mode. Otherwise, the top line of the display scrolls off of the screen.

To initiate VTDPY from a maintenance terminal at the CLI> prompt, enter the following command:

```
CLI> RUN VTDPY
```

8.3.2 Using the VTDPY Control Keys

Use the following control key sequences to work the VTDPY display:

Table 8–5 VTDPY Control Keys

Control Key Sequence	Function
Ctrl/C	Prompts for commands.
Ctrl/G	Updates the screen (same as Ctrl/Z).
Ctrl/O	Pauses or resumes screen updates.
Ctrl/R	Refreshes current screen display, without updating information. (same as Ctrl/W).
Ctrl/W	Refreshes current screen display (same as Ctrl/R).
Ctrl/Y	Terminates VTDPY and resets screen characteristics.
Ctrl/Z	Updates the screen with current information (same as Ctrl/G).

8.3.3 Using the VTDPY Command Line

VTDPY contains a command line interpreter that is invoked by entering Ctrl/C any time after the program has begun execution. The command line interpreter is used to modify the characteristics of the VTDPY display. Commands also exist to duplicate the function of the control keys listed in Section 8.3.2.

Table 8–6 VTDPY Commands

Command String	Function
DISPLAY CACHE	Use 132 column unit caching statistics display.

Table 8–6 (Cont.) VTDPY Commands

Command String	Function
DISPLAY DEFAULT	Use default 132 column system performance display.
DISPLAY DEVICE	Use 132 column device performance display.
DISPLAY STATUS	Use 80 column controller status display.
EXIT	Terminates program (same as QUIT).
INTERVAL <seconds>	Changes update interval.
HELP	Displays help message text.
REFRESH	Refreshes the current display, without updating the information.
QUIT	Terminates program (same as EXIT).
UPDATE	Updates screen display with current information.

The keywords in the command strings can be abbreviated to the minimum number of characters that are necessary to uniquely identify the keyword. Typing a question mark (?) after a keyword causes the parser to provide a list of keywords or values that can follow the supplied keyword. The command line interpreter is not case sensitive.

Upon successful execution of a command other than HELP, the command line interpreter is exited and the display is resumed. Typing a carriage return without a command also exits the command line interpreter and resumes the display. If an error occurs in the command, the user prompts for command expansion help, or the HELP command is entered, the command line interpreter prompts for an additional command instead of returning to the display.

8.3.4 How to Interpret the VTDPY Display Fields

This section describes the major fields in the VTDPY displays. Examples of the VTDPY screens are shown followed by an explanation of each field of the screens.

```
SWXRC S/N: CX12345678 SW: V20Z HW: 00-00 VTDPY Monitor
                                         61.4% Idle      927 KB/S      300 Rq/S                             Up:     0  1:32.46
Pr   Name  Stk/Max Typ Sta  CPU% SCSI Target  2                 Unit  ASWC  KB/S  Rd% Wr% Cm% HT% Unit  ASWC  KB/S  Rd% Wr% Cm% HT%
 0    NULL   0/  0      Rn  61.4                                D0000 o^ b    112  62  37   0   0
 2   RECON  10/  1 FNC  Bl   0.0                                D0001 o^ b    118  61  38   0   0
 3    SHIS  40/  7 FNC  Rn  32.3 Xfer Rate                      D0002 o^ b    122  67  32   0   0
 8   VTDPY  10/  3 DUP  Rn   0.2  Id   Mhz                      D0003 o^ b    128  65  34   0   0
18  SCSIVT  10/  1 FNC  Bl   0.0  0 = Asynch                    D0004 o^ b     93  69  30   0   0
19   DS_HB  10/  1 FNC  Bl   0.0  1 = Asynch             Target D0005 o^ b    112  67  32   0   0
24      VA  10/  1 FNC  Bl   0.0  2 = This             01234567 D0006 o^ b    156  66  33   0   0
25    DS_1  40/  6 FNC  Bl   5.5  3 = Asynch           P1D D D  H D0007 o^ b   83  71  28   0   0
26    DS_0  20/  1 FNC  Bl   0.4  4 = Asynch           o2 D D DDH
27 CLIMAIN  16/  7 FNC  Bl   0.0  5 = Asynch           r3D D D  H
28   NVFOC  10/  1 FNC  Bl   0.0  6 =  3.57            t4 D D  DH
29  REMOTE  10/  1 FNC  Bl   0.0  7 = Asynch            5D D D  H
30     FOC  20/  2 FNC  Bl   0.0                         6 D D DDH
31   DUART  10/  1 FNC  Bl   0.0
```

Figure 8–2 VTDPY Default Display

Figure 8–3 VTDPY Device Performance Display

```
SWXRC S/N: CX12345678 SW: V20Z HW: 00-00 VTDPY Monitor                                                 03-FEB-1994 16:53:06
                                         0.0% Idle   2389 KB/S      348 Rq/S                              Up:     0 0:25.26
  Target                                PTL ASWF Rq/S RdKB/S WrKB/S Que Tq CR BR TR  PTL ASWF Rq/S RdKB/S WrKB/S Que Tq CR BR TR
 01234567                              D100 A^      0      0      0   0  0  0  0  0 D430 A^      0      0      0   0  0  0  0  0
P1DDFDDDhH                             D200 A^     57      0    396  16 11  0  0  0 D530 A^      0      0      0   0  0  0  0  0
o2DDDDDDhH                             D300 A^      0      0      0   0  0  0  0  0 D630 A^      0      0      0   0  0  0  0  0
r3DDDDDDhH                             D400 A^      0      0      0   0  0  0  0  0 D140 A^      0      0      0   0  0  0  0  0
t4DDDDDDhH                             D500 A^      0      0      0   0  0  0  0  0 D240 A^     60      0    415  16 11  0  0  0
 5DDDDDDhH                             D600 A^      0      0      0   0  0  0  0  0 D340 A^      0      0      0   0  0  0  0  0
 6DDDDDDhH                             D110 A^      0      0      0   0  0  0  0  0 D440 A^      0      0      0   0  0  0  0  0
                                       D210 A^     50      0    340  17 11  0  0  0 D540 A^      0      0      0   0  0  0  0  0
                                       D310 A^      0      0      0   0  0  0  0  0 D640 A^      0      0      0   0  0  0  0  0
                                       D410 A^      0      0      0   0  0  0  0  0 D150 A^      0      0      0   0  0  0  0  0
                                       D510 A^      0      0      0   0  0  0  0  0 D250 A^     45      0    292  16 11  0  0  0
                                       D610 A^      0      0      0   0  0  0  0  0 D350 A^      0      0      0   0  0  0  0  0
Port Rq/S RdKB/S WrKB/S  CR  BR  TR    F120  v F    0      0      0   0  0  0  0  0 D450 A^      0      0      0   0  0  0  0  0
  1     0      0      0   0   0   0    D220 A^     51      0    333  16 11  0  0  0 D550 A^      0      0      0   0  0  0  0  0
  2   348      1   2387   0   0   0    D320 A^      0      0      0   0  0  0  0  0 D650 A^      0      0      0   0  0  0  0  0
  3     0      0      0   0   0   0    D420 A^      0      0      0   0  0  0  0  0
  4     0      0      0   0   0   0    D520 A^      0      0      0   0  0  0  0  0
  5     0      0      0   0   0   0    D620 A^      0      0      0   0  0  0  0  0
  6     0      0      0   0   0   0    D130 A^      0      0      0   0  0  0  0  0
                                       D230 A^     83      0    608  16 11  0  0  0
                                       D330 A^      0      0      0   0  0  0  0  0
```

```
SWXRC S/N: CX12345678 SW: V202 HW: 00-00 VTDPY Monitor                                                    03-FEB-1994 16:53:26
                                    80.1% Idle     2719 KB/S       23 Rq/S                                Up:     0  0:25.45
Unit  ASWC  KB/S  Rd% Wr% Cm% HT% PH% MS% Purge BlChd BlHit Unit  ASWC  KB/S  Rd% Wr% Cm% HT% PH% MS% Purge BlChd BlHit
D0410 a^ r     0    0   0   0   0   0   0     0     0     0 D0444 a^ r     0    0   0   0   0   0   0     0     0     0
D0411 a^ r     0    0   0   0   0   0   0     0     0     0 D0445 a^ r     0    0   0   0   0   0   0     0     0     0
D0413 a^ r     0    0   0   0   0   0   0     0     0     0 D0450 a^ r     0    0   0   0   0   0   0     0     0     0
D0414 a^ r     0    0   0   0   0   0   0     0     0     0 D0451 a^ r     0    0   0   0   0   0   0     0     0     0
D0415 a^ r     0    0   0   0   0   0   0     0     0     0 D0452 a^ r     0    0   0   0   0   0   0     0     0     0
D0420 o^ r   483    0 100   0   0   0 100     0   132     0 D0453 a^ r     0    0   0   0   0   0   0     0     0     0
D0421 o^ r   483    0 100   0   0   0 100     0   132     0 D0454 a^ r     0    0   0   0   0   0   0     0     0     0
D0422 o^ r   476    0 100   0   0   0 100     0   132     0 D0455 a^ r     0    0   0   0   0   0   0     0     0     0
D0423 o^ r   315    0  99   0   1   0  99     0   159     1 D0460 a^ r     0    0   0   0   0   0   0     0     0     0
D0424 o^ r   483    0 100   0   0   0 100     0   132     0 D0461 a^ r     0    0   0   0   0   0   0     0     0     0
D0425 o^ r   476    0 100   0   0   0 100     0   132     0 D0462 a^ r     0    0   0   0   0   0   0     0     0     0
D0430 a^ r     0    0   0   0   0   0   0     0     0     0 D0463 a^ r     0    0   0   0   0   0   0     0     0     0
D0431 a^ r     0    0   0   0   0   0   0     0     0     0 D0464 a^ r     0    0   0   0   0   0   0     0     0     0
D0432 a^ r     0    0   0   0   0   0   0     0     0     0 D0465 a^ r     0    0   0   0   0   0   0     0     0     0
D0433 a^ r     0    0   0   0   0   0   0     0     0     0
D0434 a^ r     0    0   0   0   0   0   0     0     0     0
D0435 a^ r     0    0   0   0   0   0   0     0     0     0
D0440 a^ r     0    0   0   0   0   0   0     0     0     0
D0441 a^ r     0    0   0   0   0   0   0     0     0     0
D0442 a^ r     0    0   0   0   0   0   0     0     0     0
D0443 a^ r     0    0   0   0   0   0   0     0     0     0
```

Figure 8–4 VTDPY Unit Cache Performance Display

Figure 8–5 VTDPY Brief SCSI Status Display

```
                 60.9% Idle      861 KB/S      293 Rq/S        Up:    0  1:33.50
Pr    Name   Stk/Max Typ Sta  CPU%    Target   Unit  ASWC  KB/S  Unit  ASWC  KB/S
 0    NULL    0/  0        Rn  60.9   01234567  D0000 o^ b    98
 2   RECON   10/  1 FNC   Bl   0.0 P1D D D  H   D0001 o^ b   100
 3    SHIS   40/  7 FNC   Rn  32.7 o2 D D DDH   D0002 o^ b   115
 8   VTDPY   10/  3 DUP   Rn   0.1 r3D D D  H   D0003 o^ b    86
18  SCSIVT   10/  1 FNC   Bl   0.0 t4 D D  DH   D0004 o^ b    96
19   DS_HB   10/  1 FNC   Bl   0.0  5D D D  H   D0005 o^ b   141
24      VA   10/  1 FNC   Bl   0.0  6 D D DDH   D0006 o^ b   125
25    DS_1   40/  6 FNC   Bl   5.8              D0007 o^ b    97
26    DS_0   20/  1 FNC   Bl   0.1 Xfer Rate
27 CLIMAIN   16/  7 FNC   Bl   0.0  Id   Mhz
28   NVFOC   10/  1 FNC   Bl   0.0  0 = Asynch
29  REMOTE   10/  1 FNC   Bl   0.0  1 = Asynch
30     FOC   20/  2 FNC   Bl   0.0  2 = This
31   DUART   10/  1 FNC   Bl   0.0  3 = Asynch
                                    4 = Asynch
                                    5 = Asynch
                                    6 =  3.57
                                    7 = Asynch
```

Display Header

```
SWX[illegible]-04 ❶ S/N: CX00000002 ❷ SW: V20Z ❸ HW:  A-02 ❹
```

Description

This subdisplay provides title information for the display. For 132 column displays, this subdisplay is displayed across one line.

❶ Controller model

❷ Controller serial number

❸ Controller firmware version

❹ Controller hardware version

Date and Time

```
29-JAN-1994 13:46:34 ❶
  Up:     1  3:45.19 ❷
```

Description

This subdisplay provides time information.

❶ System date and time. Only displayed if the operator has set these parameters in the controller.

❷ Time in days, hours, minutes, and seconds since the last controller boot.

Controller Performance Summary

```
47.2% Idle ❶ 1225 KB/S ❷106 Rq/S ❸
```

Description

This subdisplay provides total system performance information.

❶ Policy processor idle rate.

❷ Cumulative data transfer rate in kilobytes per second. When logical units are being displayed, this is the transfer rate between the host and the controller. When physical devices are being displayed, this is the transfer rate between the controller and the devices.

❸ Cumulative unit or device request rate per second. When logical units are being displayed, this is the request rate between the host and the controller. When physical devices are being displayed, this is the request rate between the controller and the devices.

Controller Threads Display

```
Pr❶ Name❷   Stk/Max❸ Typ❹ Sta❺ CPU%❻
 0     NULL    0/  0        Rn   47.2
 3      HPT   40/  7   FNC  Rn   40.3
 8    VTDPY   10/  3   DUP  Rn    0.1
18   FMTHRD   10/  2   FNC  Bl    0.0
19    DS_HB   10/  2   FNC  Bl    0.0
20      DUP   10/  2   FNC  Bl    1.3
21      SCS   10/  2   FNC  Bl    0.0
24       VA   10/  3   FNC  Bl    1.2
25     DS_1   40/  6   FNC  Rn    8.9
26     DS_0   20/  4   FNC  Bl    0.0
28  CLIMAIN   16/  6   FNC  Bl    0.0
30      FOC   16/  4   FNC  Bl    0.0
31    DUART   10/  2   FNC  Bl    0.0
```

Description

This display shows the status and characteristics of the active threads in the controller. Threads that are not active, such as DUP Local Program threads are not displayed until they become active. If the number of active threads exceeds the available space, not all of them are displayed.

❶ The **Pr** column lists the thread priority. The higher the number, the higher the priority.

❷ The **Name** column contains the thread name. For DUP Local Program threads, this is the name used to invoke the program.

❸ The **Stk** column lists the allocated stack size in 512 byte pages. The **Max** column lists the number of stack pages actually used.

❹ The **Typ** column lists the thread type. The following thread types may appear:

- **FNC**—Functional thread. Those threads that are started when the controller boots and never exit.
- **DUP**—DUP local program threads. These threads are only active when run either from a DUP connection or through the command line interpreter's **RUN** command.
- **NULL**—The NULL thread does not have a thread type because it is a special type of thread that only executes when no other thread is executable.

❺ The **Sta** column lists the current thread state. The following thread states may appear:

- **Bl**—The thread is blocked waiting for timer expiration, resources, or a synchronization event.
- **Io**—A DUP local program is blocked waiting for terminal I/O completion.
- **Rn**—The thread is currently executable.

⓫ The **CPU%** column lists the percentage of execution time credited to each thread since the last screen update. The values may not add up to exactly 100 percent due to both rounding errors and the fact that there may not be enough room to display all of the threads. An unexpected amount of time may be credited to some threads because the controller's firmware architecture allows code from one thread to execute in the context of another thread without a context switch.

Table 8–7 describes the processes that may appear in the active thread display.

Note

It is possible that different versions of the controller firmware may have different threads or different names for the threads.

Table 8–7 Thread Description

Thread Name	Description
CLI	A local program that provides an interface to the controller's command line interpreter thread.
CLIMAIN	The command line interpreter (CLI) thread.
CONFIG	A local program that locates and adds devices to an SWXRC–04 array controller configuration.
DILX	A local program that exercises disk devices.
DIRECT	A local program that returns a listing of available local programs.
DS_0	A Device error recovery management thread.
DS_1	The thread that handles successful completion of physical device requests.
DS_HB	The thread that manages the device and controller error indicator lights and port reset buttons.
DUART	The console terminal interface thread.
DUP	The DUP protocol server thread.
FMTHREAD	The thread that performs error log formatting and fault reporting for the controller.
FOC	The thread that manages communication between the controllers in a dual controller configuration.
NULL	The process that is scheduled when no other process can be run.
NVFOC	The thread that initiates state change requests for the other controller in a dual controller configuration.
REMOTE	The thread that manages state changes initiated by the other controller in a dual controller configuration.
RMGR	The thread that manages the data buffer pool.
RECON	The thread that rebuilds the parity blocks on RAID 5 storagesets when needed.
SCSIVT	A thread that provides a virtual terminal connection to the CLI over the host SCSI bus.
SHIS	The host SCSI protocol interface thread for SCSI controllers.

Table 8–7 (Cont.) Thread Description

Thread Name	Description
VA	The thread that provides host protocol independent logical unit services.
VTDPY	A local program thread that provides a dynamic display of controller configuration and performance information.

SCSI Host Port Characteristics

```
Xfer Rate
T❶W❷I❸Mhz❹
1 W 7 10.00
2 W Async❺
```

Description

This subdisplay shows the current host port SCSI target identification, any initiator which has negotiated synchronous transfers, and the negotiated transfer method currently in use between the controller and the initiators. This subdisplay is available only for SWXRC–04 controllers.

❶ SCSI host port target ID.

❷ Transfer width. **W** indicates 16 bit or wide transfers are being used. A space indicates 8 bit transfers are being used.

❸ The initiator with which synchronous communication has been negotiated.

❹ A numeric value indicates the synchronous data rate which has been negotiated with the initiator at the specified SCSI ID. The value is listed in megahertz (Mhz). In this example, the negotiated synchronous transfer rate is approximately 3.57 Mhz. To convert this number to the nanosecond period, invert and multiply by 1000. The period for this is approximately 280 nanoseconds.

❺ **Async** indicates communication between this target and all initiators is being done in asynchronous mode. This is the default communication mode and is used unless the initiator successfully negotiates for synchronous communications. If there is no communication with a given target ID, the communication mode is listed as asynchronous.

Device SCSI Status

```
  Target
  01234567 1
Pl DDDDFhH 2
o2TTT T hH
r3DDD   hH
t4DDDDDDhH
 5DDDD  hH
 6      hH 3
```

Description

This display shows what devices the controller has been able to identify on the device buses.

Note

The controller does not look for devices that are not configured into the nonvolatile memory using the CLI ADD command.

1. The column headings indicate the SCSI target numbers for the devices. SCSI targets are in the range 0 through 7. Target 7 is always used by a controller. In a dual controller configuration, target 6 is used by the second controller.
2. The device grid contains a letter signifying the device type in each port/target location where a device has been found:
   - **C** indicates a CDROM device.
   - **D** indicates a disk device.
   - **F** indicates a device type not listed above.
   - **H** indicates bus position of this controller.
   - **h** indicates bus position of the other controller.
   - **L** indicates a media loader.
   - **T** indicates a tape device.
   - A period (.) indicates the device type is unknown.
   - A space indicates there is no device configured at this location.
3. This subdisplay contains a row for each SCSI device port supported by the controller. The subdisplay for a controller that has six SCSI device ports is shown.

Unit Status (abbreviated)

```
Unit❶ ASWC❷ KB/S❸ Rd%❹ Wr%❺ Cm%❻ HT%❼
D0110  a^ r     0    0    0    0    0
D0120  a^ r     0    0    0    0    0
D0130  o^ r   236  100    0    0  100
T0220  av       0    0    0    0    0
T0230  o^     123    0  100    0    0
```

Description

This subdisplay shows the status of the logical units that are known to the controller firmware. It also indicates performance information for the units. Up to 42 units can be displayed in this subdisplay.

❶ The **Unit** column contains a letter indicating the type of unit followed by the unit number of the logical unit. The list is sorted by unit number. There may be duplication of unit numbers between devices of different types. If this happens, the order of these devices is arbitrary. The following device type letters may appear:

- **D** indicates a disk device.
- **T** indicates a tape device.
- **L** indicates a media loader.
- **C** indicates a CDROM device.
- **F** indicates a device type not listed above.
- **U** indicates the device type is unknown.

❷ The **ASWC** columns indicate respectively the availability, spindle state, write protect state, and cache state of the logical unit.

The availability state is indicated using the following letters:

- **a**—Available. Available to be mounted by a host system.
- **d**—Offline, Disabled by DIGITAL Multivendor Customer Services. The unit has been disabled for service.
- **e**—Online, Exclusive Access. Unit has been mounted for exclusive access by a user.
- **f**—Offline, Media Format Error. The unit cannot be brought available due to a media format inconsistency.
- **i**—Offline, Inoperative. The unit is inoperative and cannot be brought available by the controller.
- **m**—Offline, Maintenance. The unit has been placed in maintenance mode for diagnostic or other purposes.
- **o**—Online. Mounted by at least one of the host systems.
- **r**—Offline, Rundown. The CLI SET NORUN command has been issued for this unit.
- **v**—Offline, No Volume Mounted. The device does not contain media.
- **x**—Online to other controller. Not available for use by this controller.

- A space in this column indicates the availability is unknown.

The spindle state is indicated using the following characters:

- ^—For disks, this symbol indicates the device is at speed. For tapes, it indicates the tape is loaded.
- >—For disks, this symbol indicates the device is spinning up. For tapes, it indicates the tape is loading.
- <—For disks, this symbol indicates the device is spinning down. For tapes, it indicates the tape is unloading.
- v—For disks, this symbol indicates the device is stopped. For tapes, it indicates the tape is unloaded.
- For other types of devices, this column is left blank.

For disks and tapes, a **w** in the write protect column indicates the unit is write protected. This column is left blank for other device types.

The data caching state is indicated using the following letters:

- **b**—Both Read caching and Write Back caching are enabled.
- **r**—Read caching is enabled.
- **w**—Write Back caching is enabled.
- A space in this column indicates caching is disabled.

❸ **KB/S**—This column indicates the average amount of kilobytes of data transferred to and from the unit in the previous screen update interval. This data is available only for disk and tape units.

❹ **Rd%**—This column indicates what percentage of data transferred between the host and the unit were read from the unit. This data is contained only in the **DEFAULT** display for disk and tape device types.

❺ **Wr%**—This column indicates what percentage of data transferred between the host and the unit were written to the unit. This data is contained only in the **DEFAULT** display for disk and tape device types.

❻ **Cm%**—This column indicates what percentage of data transferred between the host and the unit were compared. A compare operation can be accompanied by either a read or a write operation, so this column is not cumulative with read percentage and write percentage columns. This data is contained only in the **DEFAULT** display for disk and tape device types.

❼ **HT%**—This column indicates the cache hit percentage for data transferred between the host and the unit.

Unit Status (full)

Unit❶	ASWC❷	KB/S❸	Rd%❹	Wr%❺	Cm%❻	HT%❼	PH%❽	MS%❾	Purge❿	BlChd⓫	BlHit⓬
D0003	o^ r	382	0	100	0	0	0	0	0	6880	0
D0250	o^ r	382	100	0	0	0	0	100	0	6880	0
D0251	o^ r	284	100	0	0	0	0	100	0	5120	0
D0262	a^ r	0	0	0	0	0	0	0	0	0	0
D0280	o^ r	497	44	55	0	0	0	100	0	9011	0
D0351	a^ r	0	0	0	0	0	0	0	0	0	0
D0911	a^ r	0	0	0	0	0	0	0	0	0	0
D1000	a^ r	0	0	0	0	0	0	0	0	0	0

Description

This subdisplay shows the status of the logical units that are known to the controller firmware. It also shows I/O performance information and caching statistics for the units. Up to 42 units can be displayed in this subdisplay.

❶ The **Unit** column contains a letter indicating the type of unit followed by the unit number of the logical unit. The list is sorted by unit number. There may be duplication of unit numbers between devices of different types. If this happens, the order of these devices is arbitrary. The following device type letters may appear:

- **D** indicates a disk device.
- **T** indicates a tape device.
- **L** indicates a media loader.
- **C** indicates a CDROM device.
- **F** indicates a device type not listed above.
- **U** indicates the device type is unknown.

❷ The **ASWC** columns indicate the availability, spindle state, write protect state, and cache state respectively of the logical unit.

The availability state is indicated using the following letters:

- **a**—Available. Available to be mounted by a host system.
- **d**—Offline, Disabled by DIGITAL Multivendor Customer Services. The unit has been disabled for service.
- **e**—Online, Exclusive Access. Unit has been mounted for exclusive access by a user.
- **f**—Offline, Media Format Error. The unit cannot be brought available due to a media format inconsistency.
- **i**—Offline, Inoperative. The unit is inoperative and cannot be brought available by the controller.
- **m**—Offline, Maintenance. The unit has been placed in maintenance mode for diagnostic or other purposes.
- **o**—Online. Mounted by at least one of the host systems.
- **r**—Offline, Rundown. The CLI SET NORUN command has been issued for this unit.

- **v**—Offline, No Volume Mounted. The device does not contain media.
- **x**—Online to other controller. Not available for use by this controller.
- A space in this column indicates the availability is unknown.

The spindle state is indicated using the following characters:

- **^**—For disks, this symbol indicates the device is at speed. For tapes, it indicates the tape is loaded.
- **>**—For disks, this symbol indicates the device is spinning up. For tapes, it indicates the tape is loading.
- **<**—For disks, this symbol indicates the device is spinning down. For tapes, it indicates the tape is unloading.
- **v**—For disks, this symbol indicates the device is stopped. For tapes, it indicates the tape is unloaded.
- For other types of devices, this column is left blank.

For disks and tapes, a **w** in the write protect column indicates the unit is write protected. This column is left blank for other device types.

The data caching state is indicated using the following letters:

- **b**—Both Read caching and Write Back caching are enabled.
- **r**—Read caching is enabled.
- **w**—Write Back caching is enabled.
- A space in this column indicates caching is disabled.

❸ **KB/S**—This column indicates the average amount of kilobytes of data transferred to and from the unit in the previous screen update interval. This data is only available for disk and tape units.

❹ **Rd%**—This column indicates what percentage of data transferred between the host and the unit were read from the unit. This data is only contained in the **DEFAULT** display for disk and tape device types.

❺ **Wr%**—This column indicates what percentage of data transferred between the host and the unit were written to the unit. This data is only contained in the **DEFAULT** display for disk and tape device types.

❻ **Cm%**—This column indicates what percentage of data transferred between the host and the unit were compared. A compare operation may be accompanied by either a read or a write operation, so this column is not cumulative with read percentage and write percentage columns. This data is only contained in the **DEFAULT** display for disk and tape device types.

❼ **HT%**—This column indicates the cache hit percentage for data transferred between the host and the unit.

❽ **PH%**—This column indicates the partial cache hit percentage for data transferred between the host and the unit.

❾ **MS%**—This column indicates the cache miss percentage for data transferred between the host and the unit.

❿ **Purge**—This column shows the number of blocks purged from the write back cache in the last update interval.

- **BlChd**—This column shows the number of blocks added to the cache in the last update interval.
- **BlHit**—This column shows the number of cached data blocks "hit" in the last update interval.

Device Status

PTL❶	ASWF❷	Rq/S❸	RdKB/S❹	WrKB/S❺	Que❻	Tg❼	CR❽	BR❾	TR❿
D100	A^	0	0	0	11	0	0	0	0
D120	A^	0	0	0	0	0	0	0	0
D140	A^	0	0	0	0	0	0	0	0
D210	A^	11	93	0	1	1	0	0	0
D230	A^	0	0	0	0	0	0	0	0
D300	A^	11	93	0	2	1	0	0	0
D310	A^	0	0	0	0	0	0	0	0
D320	A^	36	247	0	12	10	0	0	0
D400	A^	11	93	0	2	1	0	0	0
D410	A^	0	0	0	0	0	0	0	0
D420	A^	36	247	0	10	8	0	0	0
D430	A^	0	0	0	0	0	0	0	0
D440	A^	0	0	0	0	0	0	0	0
D450	A^	0	0	0	0	0	0	0	0
D500	A^	11	93	0	1	1	0	0	0
D510	A^	0	0	0	0	0	0	0	0
D520	A^	0	0	0	0	0	0	0	0
D530	A^	47	0	375	6	5	0	0	0

Description

This subdisplay shows the status of the physical storage devices that are known to the controller firmware. It also shows I/O performance information and bus statistics for these devices. Up to 42 devices can be displayed in this subdisplay.

❶ The **PTL** column contains a letter indicating the type of device followed by the SCSI Port, Target, and LUN of the device. The list is sorted by port, target, and LUN. The following device type letters may appear:

- **D** indicates a disk device.
- **T** indicates a tape device.
- **L** indicates a media loader.
- **C** indicates a CDROM device.
- **F** indicates a device type not listed above.
- **U** indicates the device type is unknown.

❷ The **ASWF** columns indicate the allocation, spindle state, write protect state, and fault state respectively of the device.

The availability state is indicated using the following letters:

- A—Allocated to this controller.
- a—Allocated to the other controller.
- U—Unallocated, but owned by this controller.
- u—Unallocated, but owned by the other controller.
- A space in this column indicates the allocation is unknown.

The spindle state is indicated using the following characters:

- ^—For disks, this symbol indicates the device is at speed. For tapes, it indicates the tape is loaded.
- >—For disks, this symbol indicates the device is spinning up. For tapes, it indicates the tape is loading.
- <—For disks, this symbol indicates the device is spinning down. For tapes, it indicates the tape is unloading.
- v—For disks, this symbol indicates the device is stopped. For tapes, it indicates the tape is unloaded.
- For other types of devices, this column is left blank.

For disks and tapes, a **W** in the write protect column indicates the device is hardware write protected. This column is left blank for other device types.

A **F** in the fault column indicates an unrecoverable device fault. If this field is set, the device fault indicator also is illuminated.

❸ **Rq/S**—This column shows the average I/O request rate for the device during the last update interval. These requests are up to 8 kilobytes long and are either generated by host requests or cache flush activity.

❹ **RdKB/S**—This column shows the average data transfer rate from the device in kilobytes during the previous screen update interval.

❺ **WrKB/S**—This column shows the average data transfer rate to the device in kilobytes during the previous screen update interval.

❻ **Que**—This column shows the maximum number of transfer requests waiting to be transferred to the device during the last screen update interval.

❼ **Tg**—This column shows the maximum number of transfer requests queued to the device during the last screen update interval. If a device does not support tagged queuing, the maximum value is 1.

❽ **CR**—This column indicates the number of SCSI command resets that occurred since VTDPY was started.

❾ **BR**—This column indicates the number of SCSI bus resets that occurred since VTDPY was started.

❿ **TR**—This column indicates the number of SCSI target resets that occurred since VTDPY was started.

Device SCSI Port Performance

Port❶	Rq/S❷	RdKB/S❸	WrKB/S❹	CR❺	BR❻	TR❼
1	0	0	0	0	0	0
2	11	93	0	0	0	0
3	48	341	0	0	0	0
4	48	340	0	0	0	0
5	58	93	375	0	0	0
6	0	0	0	0	0	0

Description

This subdisplay shows the accumulated I/O performance values and bus statistics for the SCSI device ports. The subdisplay for a controller that has six SCSI device ports in shown.

❶ The **Port** column indicates the number of the SCSI device port.

❷ **Rq/S**—This column shows the average I/O request rate for the port during the last update interval. These requests are up to 8 kilobytes long and are either generated by host requests or cache flush activity.

❸ **RdKB/S**—This column shows the average data transfer rate from all devices on the SCSI bus in kilobytes during the previous screen update interval.

❹ **WrKB/S**—This column shows the average data transfer rate to all devices on the SCSI bus in kilobytes during the previous screen update interval.

❺ **CR**—This column indicates the number of SCSI command resets that occurred since VTDPY was started.

❻ **BR**—This column indicates the number of SCSI bus resets that occurred since VTDPY was started.

❼ **TR**—This column indicates the number of SCSI target resets that occurred since VTDPY was started.

Help Example

```
VTDPY> HELP

Available VTDPY commands:

^C - Prompt for commands
^G or ^Z - Update screen
^O - Pause/Resume screen updates
^Y - Terminate program
^R or ^W - Refresh screen
DISPLAY CACHE - Use 132 column unit caching statistics display
DISPLAY DEFAULT - Use default 132 column system performance display
DISPLAY DEVICE - Use 132 column device performance display
DISPLAY STATUS - Use 80 column controller status display
EXIT - Terminate program (same as QUIT)
INTERVAL <seconds> - Change update interval
HELP - Display this help message
REFRESH - Refresh the current display
QUIT - Terminate program (same as EXIT)
UPDATE - Update screen display

VTDPY>
```

Description

This is the sample output from executing the HELP command.

8.4 CONFIG Utility

The CONFIG utility locates and adds devices to the controller. You should run the CONFIG utility whenever new devices are added to the controller.

8.4.1 CONFIG Conventions

The CONFIG searches all PTL device combinations to determine what devices exist on the subsystem. It adds all new devices that are found. The CONFIG utility does not initialize these devices, and it does not add units or storagesets.

If a device somewhere in the cluster already has the PTL that the CONFIG utility plans to assign, the program assigns an alpha character after the numbers. For example, if another device is already called DISK100, the program assigns the name DISK100A to the new device. (The program compares DISK100A to other PTLs in the cluster, and if DISK100A has already been used, the program increments to DISK100B and so forth.) This avoids the assignment of duplicate PTLs in the same cluster.

8.4.2 Running the CONFIG Utility

You can run the CONFIG utility on either a virtual terminal or on a maintenance terminal.

Before running the CONFIG utility, you may use the SHOW DEVICES command to verify the list of devices that are currently configured on the controller, as shown in the following example.

```
CLI> show devices
No devices
CLI> run config

Config Local Program Invoked

Config is building its tables and determining what devices exist
on the subsystem. Please be patient.

add disk DISK100   1 0 0
add disk DISK120   1 2 0
add disk DISK140   1 4 0
add disk DISK210   2 1 0
add disk DISK230   2 3 0
add disk DISK500   5 0 0
add disk DISK520   5 2 0

Config - Normal Termination
CLI>
```

```
CLI> show devices
Name          Type          Port Targ  LUN                    Used by
---------------------------------------------------------------------------

DISK100       disk             1    0    0
DISK120       disk             1    2    0
DISK140       disk             1    4    0
DISK210       disk             2    1    0
DISK230       disk             2    3    0
DISK500       disk             5    0    0
DISK520       disk             5    2    0
CLI>
```

After you run the CONFIG utility, you may have to initialize your containers using the INITIALIZE command as described in Appendix B.

8.5 Configuration Menu Utility

The configuration menu (CFMENU) enables you to quickly configure storage devices attached to the controller. CFMENU presents configuration commands normally entered at the CLI in a menu-driven format.

The CFMENU utility requires a video terminal that supports ANSI control sequences, such as a VT220, VT320, or VT420 terminal. A graphics display that provides emulation of an ANSI compatible video terminal also can be used. CFMENU can be run only on terminals connected the the controller maintenance terminal port. Prior to running CFMENU, be sure the terminal is set in NOWRAP mode. Otherwise, the display may not correctly appear on the screen.

You should have a good understanding of the various CLI commands described in Appendix B before running CFMENU, because CFMENU asks you to choose options for devices, storagesets, and units based on the command qualifiers of the CLI.

This section presents an overview of one configuration, from start to finish. Only one example is described because of the many combinations of choices that can be made during any configuring situation.

8.5.1 Restrictions

The following restrictions apply to CFMENU:

- For dual-redundant configurations, do not run CFMENU on both controllers at the same time.
- There is currently no support for modifying switches (options) on existing devices, storagesets, or units. You must delete and re-add to modify options.
- Use CFMENU only for configuring storagesets. Specifically, do not use CFMENU to set WRITEBACK_CACHE or NOWRITEBACK_CACHE. Set these parameters through the CLI instead. Enabling caching through CFMENU may result in cache policies inconsistent with what CFMENU displays.

8.5.2 Main Menu

Run CFMENU during a terminal session by invoking it from the CLI prompt:

```
CLI> run cfmenu
```

The main menu appears as shown in Figure 8–6. Any attached devices that have not been added to your configuration appear, with their PTLs, in the column to the right of the menu options.

When prompted with "y/n/q", enter y for Yes, n for No, and q for Quit.

Figure 8–6 CFMENU Main Menu

```
------------------------------------------ CFMENU  Configuration Menu Utility ------------------------------------------
MAIN MENU:                      |Unconfig'd|   Config'd  Device       Product         Stor.set Stor.set Chnk  Trn  In- Re-       W W
1. Add/delete devices           | Dev.PTLs |    PTLs     Name          ID              Name    Type     Size  sp. it'd duc  Unit P B
2. Add/delete stripesets        |----------|   ------ --------- ---------------   -------- ------- ------ --- ---- --- ----- - -
3. Add/delete RAIDsets          | 110 (dsk)|
4. Add/delete passthrough       | 150 (cdr)|
5. Initialize devices           | 200 (dsk)|
   and/or storagesets           | 220 (dsk)|
6. Add/delete units             | 240 (cdr)|
7. Setup terminal               | 310 (dsk)|
8. Exit CFMENU                  | 330 (dsk)|
                                | 350 (dsk)|
                                | 400 (dsk)|
                                | 420 (dsk)|
                                | 440 (dsk)|
                                | 510 (dsk)|
  D=Scroll down  U=Scroll up    | 530 (dsk)|
-----------------------------------------------------------------------------------------------------------------------



Enter menu choice (1,8) [8] ?
```

8.5.3 Adding Devices

From the main menu, enter option 1 (press 1 Return). The device menu appears as shown in Figure 8–7. The same list of unconfigured devices remains to the right of the options. When the list is too long to be shown on one screen, you can enter D or U to scroll the information down/up.

Figure 8–7 CFMENU Device Menu (Before Adding Devices)

```
------------------------------------------ CFMENU  Configuration Menu Utility ------------------------------------------
DEVICE MENU:                    |Unconfig'd|   Config'd  Device       Product         Stor.set Stor.set Chnk  Trn  In- Re-       W W
1. Add a device from list       | Dev.PTLs |    PTLs     Name          ID              Name    Type     Size  sp. it'd duc  Unit P B
   of PTLs not configured       |----------|   ------ --------- ---------------   -------- ------- ------ --- ---- --- ----- - -
   (marked with ^)              |^110 (dsk)|
2. Delete an unbounded device   |^150 (cdr)|
   (marked with *)              |^200 (dsk)|
3. Add all devices from list    |^220 (dsk)|
   of PTLs not configured       |^240 (cdr)|
   (marked with ^)              |^310 (dsk)|
4. Delete all unbounded         |^330 (dsk)|
   devices (marked with *)      |^350 (dsk)|
5. Return to main menu          |^400 (dsk)|
                                |^420 (dsk)|
                                |^440 (dsk)|
                                |^510 (dsk)|
  D=Scroll down  U=Scroll up    |^530 (dsk)|
-----------------------------------------------------------------------------------------------------------------------



Enter menu choice (1,5) [5] ?
```

In Figure 8–7, none of the devices have been added to the configuration yet. If you enter option 1, CFMENU asks you whether or not to add each device on the list. If you enter option 3, CFMENU adds *all* the unknown devices, in the same way as the CONFIG utility (refer to Section 8.4).

After entering option 1 and adding some devices, the screen resembles Figure 8–8.

Figure 8–8 CFMENU Device Menu

```
-------------------------------------------- CFMENU  Configuration Menu Utility ------------------------------------------
DEVICE MENU:                  |Unconfig'd|   Config'd Device      Product      Stor.set Stor.set Chnk Trn  In- Re-       W W
1. Add a device from list     | Dev.PTLs |     PTLs    Name          ID          Name     Type    Size sp. it'd duc  Unit P B
   of PTLs not configured     |----------|     ---- -------- -------------   -------- -------- ----- --- ---- --- ----- - -
   (marked with ^)            |^310 (dsk)|disks:  110 *  DISK110 RZ25    (C) DEC                        N   N
2. Delete an unbounded device |^350 (dsk)|        200 *  DISK200 RZ35    (C) DEC                        N   N
   (marked with *)            |^400 (dsk)|        220 *  DISK220 RZ25    (C) DEC                        N   N
3. Add all devices from list  |^510 (dsk)|        330 *  DISK330 RZ26    (C) DEC                        N   N
   of PTLs not configured     |^600 (dsk)|        420 *  DISK420 RZ25    (C) DEC                        N   Y
   (marked with ^)            |          |        440 *  DISK440 RZ26    (C) DEC                        N   Y
4. Delete all unbounded       |          |        530 *  DISK530 RZ26    (C) DEC                        N   N
   devices (marked with *)    |          |        550 *  DISK550 RZ25    (C) DEC                        N   N
5. Return to main menu        |          |        620 *  DISK620 RZ25    (C) DEC                        N   N
                              |          |        640 *  DISK640 RZ26    (C) DEC                        N   Y
                              |          |cdrms:  150 * CDROM150 RRD44   (C) DEC
                              |          |        240 * CDROM240 RRD44   (C) DEC
                              |          |loadr:  540 *   LDR540 TL820   (C) DEC
--------------------------------------------------------------------------------------------------------------------------


Enter menu choice (1,5) [5] ?
```

CFMENU has added information to the following fields:

- **Config'd PTLs**—Configured PTLs. The program lists the PTL of each device added to your configuration.
- **Device Name**—CFMENU automatically assigns a name to each device. The name contains both the device type and PTL. You cannot override the automatic CFMENU naming convention.
- **Product ID**—Information identifying the device model appears here.
- **Trnsp**—Transportable. This field identifies whether or not the device is transportable.
- **Init'd**—Initialized. This field identifies whether or not the device is initialized.

After adding devices, return to the main menu.

8.5.4 Adding Stripesets

Enter option 2 from the main menu to work with stripesets. From the stripeset menu (see Figure 8–9), enter option 1 to add a stripeset. CFMENU asks you how many and which devices from the configured PTLs list you wish to include in the stripeset (2–14 devices allowable). In Figure 8–9, a stripeset was created from disks at PTLs 110 and 220.

Figure 8–9 CFMENU Stripeset Menu

```
---------------------------------------- CFMENU  Configuration Menu Utility ----------------------------------------
STRIPESET MENU:            |Unconfig'd|        Config'd Device        Product      Stor.set Stor.set Chnk  Trn  In- Re-       W W
1. Create a stripeset      | Dev.PTLs |        PTLs     Name          ID           Name     Type     Size  sp.  it'd duc  Unit P B
   (eligible devices marked |----------|       ------ --------- -------------- -------- -------- ------ ---  ---- ---  ---- - -
   by ^)                   | 310 (dsk)|disks:  200 ^  DISK200 RZ35    (C) DEC                               N    N
2. Delete an unbounded     | 350 (dsk)|        330 ^  DISK330 RZ26    (C) DEC                               N    N
   stripeset (marked by *) | 400 (dsk)|        420 ^  DISK420 RZ25    (C) DEC                               N    Y
3. Delete all unbounded    | 510 (dsk)|        440 ^  DISK440 RZ26    (C) DEC                               N    Y
   stripesets (marked by *)| 600 (dsk)|        530 ^  DISK530 RZ26    (C) DEC                               N    N
4. Return to main menu     |          |        550 ^  DISK550 RZ25    (C) DEC                               N    N
                           |          |        620 ^  DISK620 RZ25    (C) DEC                               N    N
                           |          |        640 ^  DISK640 RZ26    (C) DEC                               N    Y
                           |          |cdrms:  150    CDROM150 RRD44  (C) DEC
                           |          |        240    CDROM240 RRD44  (C) DEC
                           |          |loadr:  540     LDR540 TL820   (C) DEC
                           |          |strps:  110    DISK110 RZ25    (C) DEC *  S1       STRP     unk        N
                           |          |        220    DISK220 RZ25    (C) DEC    "        "        "          "
--------------------------------------------------------------------------------------------------------------------


Enter menu choice (1,4) [4] ?
```

CFMENU updates the following fields after adding a stripeset:

- **Stor.set Name**—Storageset name. CFMENU automatically assigns the name "Sx" to a stripeset. You cannot alter this automatic CFMENU naming convention.
- **Stor.set Type**—Storageset type. This field reads "STRP" for storagesets that are stripesets.
- **Chnk Size**—Chunk size. This field reads "unk" (unknown) until you initialize the stripeset.

After adding stripesets, return to the main menu.

8.5.5 Adding RAIDsets

Enter option 3 from the main menu to work with RAIDsets. From the RAIDset menu (see Figure 8–10), enter option 1 to add a RAIDset. CFMENU asks you how many and which devices from the configured PTLs list you wish to include in the RAIDset (3–14 devices allowable). In Figure 8–10, a RAIDset was created from disks at PTLs 330, 440, and 530.

Figure 8–10 CFMENU RAIDset Menu

```
---------------------------------------------- CFMENU  Configuration Menu Utility ----------------------------------------------
RAIDSET MENU:                 |Unconfig'd|  Config'd Device       Product       Stor.set Stor.set Chnk  Trn  In- Re-       W W
1. Create a RAIDset (eligible | Dev.PTLs |    PTLs    Name          ID           Name     Type    Size  sp. it'd duc  Unit P B
   devices marked by ^)       |----------|   ------ --------- --------------  -------- ------ ------ --- ---- --- ----- - -
2. Delete an unbounded        | 310 (dsk)|disks: 200 ^  DISK200 RZ35    (C) DEC                              N    N
   RAIDset (marked by *)      | 350 (dsk)|       420 ^  DISK420 RZ25    (C) DEC                              N    Y
3. Delete all unbounded       | 400 (dsk)|       550 ^  DISK550 RZ25    (C) DEC                              N    N
   RAIDsets (marked by *)     | 510 (dsk)|       620 ^  DISK620 RZ25    (C) DEC                              N    N
4. Add/delete device in       | 600 (dsk)|       640 ^  DISK640 RZ26    (C) DEC                              N    Y
   spareset or failedset      |          |cdrms: 150   CDROM150 RRD44  (C) DEC
5. Replace member of a        |          |       240   CDROM240 RRD44  (C) DEC
   reduced RAIDset            |          |loadr: 540     LDR540 TL820  (C) DEC
6. Return to main menu        |          |strps: 110    DISK110 RZ25    (C) DEC      S1      STRP   unk          N
                              |          |       220    DISK220 RZ25    (C) DEC      "        "      "           "
                              |          |raid5: 330    DISK330 RZ26    (C) DEC *    R1      RAID   unk          N   N
                              |          |       440    DISK440 RZ26    (C) DEC      "        "      "           "   "
                              |          |       530    DISK530 RZ26    (C) DEC      "        "      "           "   "
--------------------------------------------------------------------------------------------------------------------------------


Enter menu choice (1,6) [6] ?
```

CFMENU updates the following fields after adding a RAIDset:

- **Stor.set Name**—Storageset name. CFMENU automatically assigns the name "Rx" to a RAIDset. You cannot alter this automatic CFMENU naming convention.
- **Stor.set Type**—Storageset type. This field reads "RAID" for storagesets that are RAIDsets.
- **Chnk Size**—Chunk size. This field reads "unk" (unknown) until you initialize the RAIDset.
- **Reduc**—Reduced. This field indicates whether or not a RAIDset is running reduced (missing one member).

8.5.6 Adding to Sparesets

Enter option 4 from the RAIDset menu tc work with the sparesets and failedsets associated with RAIDsets. From the spareset/failedset menu (see Figure 8–11), you can, for example, enter option 1 to add a device to the spareset. CFMENU asks you which devices from the configured PTLs list that you wish to include in the spareset. In Figure 8–11, one device, PTL 420, was added to the spareset.

Figure 8–11 CFMENU Spareset/Failedset Menu

```
------------------------------------------- CFMENU  Configuration Menu Utility ----------------------------------------
SPARESET/FAILEDSET MENU:      |Unconfig'd|    Config'd Device      Product      Stor.set Stor.set Chnk Trn  In- Re-       W W
1. Add a device to the        | Dev.PTLs |      PTLs   Name          ID           Name    Type    Size sp. it'd duc  Unit P B
   spareset (eligible         |----------|      ----- -------- ------------  -------- ------- ------ --- ---- --- ----- - -
   devices marked by ^)       | 310 (dsk)|disks:  200 ^  DISK200 RZ35    (C) DEC                               N   N
2. Remove a device from the   | 350 (dsk)|        550 ^  DISK550 RZ25    (C) DEC                               N   N
   spareset                   | 400 (dsk)|        620 ^  DISK620 RZ25    (C) DEC                               N   N
3. Move a device from a       | 510 (dsk)|        640 ^  DISK640 RZ26    (C) DEC                               N   Y
   RAIDset to the failedset   | 600 (dsk)|cdrms:  150   CDROM150 RRD44   (C) DEC
   (eligible devices marked   |          |        240   CDROM240 RRD44   (C) DEC
   by *)                      |          |loadr:  540     LDR540 TL820   (C) DEC
4. Remove a device from the   |          |strps:  110    DISK110 RZ25    (C) DEC    S1      STRP    unk          N
   failedset                  |          |        220    DISK220 RZ25    (C) DEC    "        "       "           "
5. Return to RAIDset menu     |          |raid5:  330    DISK330 RZ26    (C) DEC    R1      RAID    unk          N   N
                              |          |        440    DISK440 RZ26    (C) DEC    "        "       "           "   "
                              |          |        530    DISK530 RZ26    (C) DEC    "        "       "           "   "
                              |          |spare:  420    DISK420 RZ25    (C) DEC
--------------------------------------------------------------------------------------------------------------------------


Enter menu choice (1,5) [5] ?
```

After adding sparesets, return to the main menu via the RAIDset menu.

8.5.7 Initializing Containers

Enter option 5 from the main menu to initialize containers (devices or storagesets). From the initialization menu (see Figure 8–12), enter option 1. CFMENU asks you if you want to initialize each eligible container.

In addition, CFMENU asks you to decide on other operating qualifiers, depending on whether the container is a device, stripeset, or RAIDset. See the descriptions of the ADD or SET commands in Appendix B if you need help understanding the qualifiers.

In Figure 8–12, the RAIDset created earlier (R1) is initialized. Notice that R1 now has a chunksize of 32. The disk at PTL 640 has been initialized throughout this example, because CFMENU detected its condition when it was added to the configuration.

Figure 8–12 CFMENU Initialization Menu

```
-------------------------------------------- CFMENU  Configuration Menu Utility ------------------------------------------
INITIALIZATION MENU:         |Unconfig'd|      Config'd Device        Product       Stor.set Stor.set Chnk Trn  In- Re-       W W
1. Initialize a device or    | Dev.PTLs |        PTLs    Name          ID            Name     Type   Size sp. it'd duc Unit P B
   storageset (eligible      |----------|       ----- -------- -------------    -------- -------- ----- --- ---- --- ---- - -
   entities marked with ^)   | 310 (dsk) |disks:  200 ^  DISK200 RZ35     (C) DEC                            N   N
2. Return to main menu       | 350 (dsk) |        550 ^  DISK550 RZ25     (C) DEC                            N   N
                             | 400 (dsk) |        620 ^  DISK620 RZ25     (C) DEC                            N   N
                             | 510 (dsk) |        640 ^  DISK640 RZ26     (C) DEC                            N   Y
                             | 600 (dsk) |cdrms:  150   CDROM150 RRD44   (C) DEC
                             |           |        240   CDROM240 RRD44   (C) DEC
                             |           |strps:  110    DISK110 RZ25     (C) DEC ^   S1      STRP    unk         N
   WARNING!  Initialization of |         |        220    DISK220 RZ25     (C) DEC     "        "       "          "
   any device or storageset  |           |raid5:  330    DISK330 RZ26     (C) DEC ^   R1      RAID    32          Y   N
   will destroy all of its   |           |        440    DISK440 RZ26     (C) DEC     "        "       "          "   "
   current data.             |           |        530    DISK530 RZ26     (C) DEC     "        "       "          "   "
                             |           |spare:  420    DISK420 RZ25     (C) DEC
                             |           |pass:   540     LDR540 TL820   (C) DEC *   P1      PASS
-----------------------------------------------------------------------------------------------------------------------------



Enter menu choice (1,2) [2] ?
```

After initializing containers, return to the main menu.

8.5.8 Adding Units

Enter option 6 from the main menu to work with units. From the unit menu (see Figure 8–13), enter option 1 to add a unit. CFMENU asks you which initialized containers you wish to create units from.

CFMENU also asks you to assign a unit number. (The program automatically assigns a "D" or "T" to the unit number when listing the unit, as shown in Figure 8–13.) In addition, CFMENU asks you to decide on other unit qualifiers. See the description of the ADD *unit* or SET *unit* commands in Appendix B if you need help understanding the qualifiers.

In Figure 8–13, two units were created from RAIDset R1 and the disk at PTL 640.

Figure 8–13 CFMENU Unit Menu

```
------------------------------------ CFMENU  Configuration Menu Utility --------------------------------
UNIT MENU:                    |Unconfig'd|   Config'd Device       Product      Stor.set Stor.set Chnk Trn  In- Re-       W W
1. Create a unit (eligible    | Dev.PTLs |     PTLs   Name           ID          Name     Type    Size sp. it'd duc  Unit P B
   entities marked by ^)      |----------|     ----- -------- -------------   -------- ------- ------ --- ---- --- ---- - -
2. Delete a unit (eligible    | 310 (dsk)|disks: 200   DISK200 RZ35    (C) DEC                           N    N
   units marked by *)         | 350 (dsk)|       550   DISK550 RZ25    (C) DEC                           N    N
3. Return to main menu        | 400 (dsk)|       620   DISK620 RZ25    (C) DEC                           N    N
                              | 510 (dsk)|       640   DISK640 RZ26    (C) DEC                           N    Y     * D464 N Y
                              | 600 (dsk)|cdrms: 150 ^ CDROM150 RRD44 (C) DEC
                              |          |       240 ^ CDROM240 RRD44 (C) DEC
                              |          |strps: 110   DISK110 RZ25    (C) DEC     S1      STRP    unk         N
                              |          |       220   DISK220 RZ25    (C) DEC     "        "       "          "
                              |          |raid5: 330   DISK330 RZ26    (C) DEC     R1      RAID    32          Y   N * D465 N Y
                              |          |       440   DISK440 RZ26    (C) DEC     "        "       "          "   "     "  " "
                              |          |       530   DISK530 RZ26    (C) DEC     "        "       "          "   "     "  " "
                              |          |spare: 420   DISK420 RZ25    (C) DEC
                              |          |pass:  540    LDR540 TL820  (C) DEC *   P1      PASS
--------------------------------------------------------------------------------------------------------------------------


Enter menu choice (1,3) [3] ?
```

CFMENU updates the following fields after adding a unit:

- **Reduc**—Reduced. This field indicates whether or not a RAIDset is running reduced (missing one member).
- **Unit**—The unit number you assign appears here, preceded by the letter "D" or "T."
- **WP**—Write protect. This value indicates whether or not the unit is write protected.
- **WB**—Write-back. This value indicates whether or not the unit is set for write-back caching.

8.5.9 Terminal Setup

You can enter option 7 from the main menu to set the number of rows CFMENU displays. This feature is available primarily for terminals with the capability of displaying more than 24 rows.

8.5.10 Messages

This section lists the messages, other than the standard CLI messages, that CFMENU displays. However, most messages you see are those sent by the CLI, and are described in Appendix B.

CFMENU cannot complete request without exceeding array boundary.

> **Explanation:** CFMENU detected an unexpected condition which would exceed an array boundary and possibly require controller reinitialization, so it aborted your request.

...CFMENU is updating its configuration tables. Please be patient...

> **Explanation:** CFMENU is polling the SCSI ports to see what physical devices are in place, as well as checking the configuration information.

Not enough eligible devices to complete the storageset.

> **Explanation:** You chose to create a stripeset or a RAIDset and specified how many members to use, but there are not enough eligible devices to make up a storageset of this size. Eligible devices are disks that have the NOTRANSPORTABLE switch set, and that are not already used in any higher-level configuration such as a unit, storageset, spareset, or failedset.

Not enough members specified for a non-reduced RAIDset

> **Explanation:** You chose to create a RAIDset and specified that it is not a previously reduced RAIDset. However, when choosing how many members to add to the RAIDset, you specified a number that is only legal for a reduced RAIDset and is too low for a non-reduced RAIDset.

...Polling for unconfigured devices...

> **Explanation:** CFMENU is polling the SCSI ports to see what physical devices are in place.

Port *port#* is blocked. No devices are configured on port *port#*

> **Explanation:** In order to check each device bus to discover what devices are present, firmware must also see if any port is currently blocked. A port can be blocked for various reasons, such as when its bus is quiesced. When a port is blocked, CFMENU does not access devices on that bus.

RAID5 license is not enabled; cannot create RAID5 set.

> **Explanation:** You may not configure any RAIDsets unless the RAID5 license has been enabled by running the FLS utility.

Received user request to terminate CFMENU...

> **Explanation:** You pressed Ctrl/C or Ctrl/Y to abort CFMENU.

There are no devices available to use as a replacement.

Explanation: You chose to replace a member of a reduced RAIDset, but there are no disks eligible to use for the replacement member. Eligible disks must have the NOTRANSPORTABLE switch set and may not be part of any higher-level configuration such as units, storagesets, or the spareset or failedset.

There are no *devices/stripesets/RAIDsets/passthroughs* eligible for deletion.

Explanation: You chose to delete a device, stripeset, RAIDset, or passthrough; but there are none that are eligible for deletion. A stripeset, RAIDset, or passthrough may not be deleted if it is configured as a unit. A device may not be deleted if it is configured as a unit or if it is used in a storageset, spareset, or failedset.

There are no devices eligible to be added to the configuration.

Explanation: You chose to add a device, but there are no devices available to add. The only devices that are eligible to be added are devices that CFMENU has detected as being physically present on a SCSI port and that are not already configured as devices on the controller.

There are no devices eligible to be added to the spareset.

Explanation: You chose to add a device to the spareset, but no devices are eligible. The only devices that may be added to the spareset are disks that have the NOTRANSPORTABLE switch set, and that are not already used in any higher-level configuration such as a unit, storageset, spareset, or failedset.

There are no devices in the failedset.

Explanation: You chose to delete devices from the failedset but the failedset currently is empty.

There are no devices in the spareset.

Explanation: You chose to delete devices from the spareset but the spareset currently is empty.

There are no entities eligible for initialization.

Explanation: You chose to initialize a device or storageset, but there are currently no devices or storagesets that are eligible to be initialized. Optical memory devices, stripesets, and RAIDsets may be initialized, but only if they are not already configured as a unit. Disks may be initialized only if they are not already configured as a unit or as part of a storageset, spareset, or failedset.

There are no entities eligible to be added as units.

Explanation: You chose to add a unit, but there are no devices or storagesets that are eligible to become units. Disks, stripesets, and RAIDsets must first be initialized before they can be added as units. Disks may not be made into units if they are currently in the spareset or the failedset.

There are no reduced RAIDset units with NOPOLICY set.

Explanation: You chose to replace a member of a reduced RAIDset. CFMENU is unable to find any RAIDsets that are eligible for a manual replacement. In order to be eligible, the RAIDset must be configured as a unit, it must be in a reduced state, and it must have the NOPOLICY switch set.

There are no units to delete.

Explanation: You chose to delete a unit, but there are no units configured on the controller.

Unable to allocate memory, CFMENU terminating.

Explanation: There is not enough memory available for CFMENU to run.

User has not picked enough eligible devices to complete the storageset.

Explanation: You chose to create a stripeset or a RAIDset and specified how many members to use, but when CFMENU prompted for devices, you did not select enough to complete the storageset.

Waiting for completion of CLI command...

Explanation: Some CLI commands take a long time to complete, such as initializing a large RAIDset. CFMENU prints out this message periodically to inform you that it is still waiting for the last CLI command to finish.

8.5.11 Exiting CFMENU

Enter the last option from the main menu to stop CFMENU and return to the CLI. (You may also enter Ctrl/C or Ctrl/Y to abort CFMENU.)

8.6 CLCP Utility

The Code Load/Code Patch utility enables the user to perform two memory modification functions in the controller:

- Code loading—The user can upgrade the firmware in the controller's PCMCIA card via the EIA–423 port.
- Code patching—The user can alter memory locations in the controller's RAM, while the controller is active.

8.6.1 Invoking the CLCP Utility

The CLCP utility is invoked using the RUN command, via the CLI interface as follows:

```
CLI> RUN CLCP
 Select an option from the following list:
 Code Load & Code Patch local program Main Menu
 0: Exit
 1: Code LOAD
 2: Code PATCH
  Enter option number (0..2) [0] ?
```

The user selects the desired option, and the appropriate module of the utility executes, prompting for further inputs.

CAUTION

The write protect switch on the program card is shipped from the factory in the write protect position. Before loading or patching the program card, slide the write protect switch on the bottom right-hand end (when the label is facing up) of the card (this can be done with the card still inserted in its slot) to the *left*. This action shuts off the write protection and enables you to write the new information. When the card has been rewritten, remember to slide the switch back to the *right* (the write protect position).

8.6.2 Code Loading

The code load program is invoked from an external processor (typically a PC) connected to the EIA–423 maintenance terminal port. The processor must be configured to run the KERMIT terminal protocol at 19,200 baud, with 8 data bits, no parity, and one stop bit. When running the code load option of the CLCP utility from a personal computer, all screen savers should be disabled. Screen savers are terminate-and-stay-ready (TSR) programs can interfere with the code load process.

To perform a code load operation, a file containing the new firmware image must be stored in the external processor. The file must be in binary image format. The binary firmware image file can be obtained from your Digital representative. See your Digital representative for further details on the distribution of firmware updates.

The user invokes the CLCP program from the CLI, via the external processor. The CLCP program then waits to be downloaded from the external processor, via the serial interface and the KERMIT file transfer protocol. The code load process takes approximately 27 minutes to successfully complete.

Once loaded into the SWXRC–04 controller's memory, the new image is written into the controller's PCMCIA card. The code load program then automatically initializes the controller to place the new controller firmware into effect.

Using the Code Load Utility

Note

If you run the Code Load option of the CLCP utility from a personal computer, disable all screen savers while the code load program is in process.

Operate the code load utility as follows:

1. Load the binary firmware image file into the external processor, using file or network transfer utilities appropriate to the operating environment of the external processor.
2. Invoke the CLCP program and the select the code load option, as follows:

```
CLI> RUN CLCP

 Select an option from the following list:

 Code Load & Code Patch local program Main Menu

 0: Exit
 1: Code LOAD
 2: Code PATCH
  Enter option number (0..2) [0] ? 1
--------------------------------------------------------------------

 This is the Code Load local program.  This program loads a new
 firmware image on the controller program card.  Perform the file
 transfer from a computer that runs the KERMIT file transfer
 protocol.  Connect this computer via a serial communication line
 to the MMJ maintenance port on the front of the controller
 module.

 Type ^Y or ^C (then RETURN) at any time to abort Code Load.

 Perform the following steps before continuing:
     * Access the new image file over the serial line from the host computer.
     * Configure KERMIT with the following parameters:
          Terminal speed 19200 baud, eight bit, no parity, 1 stop bit

 It takes approximately 27 minutes to load the new image.

 WARNING: Proceeding with Code Load overwrites the current
          content of your program card with a new image.
          Enter Y (then RETURN) to continue [N]: ? y

Start KERMIT now..
```

3. Using the KERMIT file transfer protocol from the external processor, download the binary firmware image file to the SWXRC–04 controller. This details of this action are specific to the operating environment of the external processor.

4. The code load program acknowledges the downloaded file, and writes the new firmware image to the PCMCIA program card memory.

```
KERMIT file transferred successfully.

Program card is being re-programmed with new file.
 *** Do not interrupt this step ***
 Manufacturer code read from memory card= 8989
 Device Code read from memory card= bdbd

DEBUG: file mms$src:clcp_main.c, line 2633, addr 200ae440
    pfp          rip
 201e1cd0 200ae440
 201e1c80 200afb88
 201e1bf0 2010be98
.
Check diag reg 00000000, 0000FEFE
Check card     00000000, 0000FEFE
Validate code  00000000, 0000FEFE
Timer tests    00000000, 0000FEFE
Duart tests    00000000, 0000FEFE
Pend int tests 00000000, 0000FEFE
Flashing LEDs  00000000, 0000FEFE
Drab tests     00000000, 0000FEFE
Jsram tests    00000000, 0000FEFE
ID cache tests 00000000, 0000FEFE
Loading image  00000000, 0000FEFE
Apply patches  00000000, 0000FEFE
Building GML   00000000, 0000FEFE
Booting Exec.. 00000000, 0000FEFE

CLI>
```

8.6.3 Aborting the Code Load Operation

You can abort a code load in progress by entering N at the confirmation step or by entering ^Y or ^C (and RETURN) at anytime in the code load process. Following are examples of both types of code load interruption:

- Interruption at the confirmation step:

```
CLI> RUN CLCP

 Select an option from the following list:

 Code Load & Code Patch Local Program Main Menu

 0: Exit
 1: Code LOAD
 2: Code PATCH
  Enter option number (0..2) [0] ? 1
----------------------------------------------------------------------

 This is the Code Load local program.  This program loads a new
 firmware image on the controller program card.  Perform the file
 transfer from a computer that runs the KERMIT file transfer
 protocol.  Connect this computer via a serial communication line
 to the MMJ maintenance port on the front of the controller
 module.

 Type ^Y or ^C (then RETURN) at any time to abort Code Load.

 Perform the following steps before continuing:
     * Access the new image file over the serial line from the host computer.
     * Configure KERMIT with the following parameters:
          Terminal speed 19200 baud, eight bit, no parity, 1 stop bit

 It takes approximately 27 minutes to load the new image.
```

```
WARNING: Proceeding with Code Load overwrites the current
         content of your program card with a new image.
         Enter Y (then RETURN) to continue [N]: ? n

Received user request to terminate Code Load...
```

- **Interruption using an user abort command:**

```
CLI>RUN CLCP

 Select an option from the following list:

 Code Load & Code Patch local program Main Menu

 0: Exit
 1: Code LOAD
 2: Code PATCH
  Enter option number (0..2) [0] ? 1
------------------------------------------------------------------

 This is the Code Load local program.  This program loads a new
 firmware image on the controller program card.  Perform the file
 transfer from a computer that runs the KERMIT file transfer
 protocol.  Connect this computer via a serial communication line
 to the MMJ maintenance port on the front of the controller
 module.

 Type ^Y or ^C (then RETURN) at any time to abort Code Load.

 Perform the following steps before continuing:
     * Access the new image file over the serial line from the host computer.
     * Configure KERMIT with the following parameters:
          Terminal speed 19200 baud, eight bit, no parity, 1 stop bit

 It takes approximately 27 minutes to load the new image.

 WARNING: Proceeding with Code Load overwrites the current
          con.ent of your program card with a new image.
          Enter Y (then RETURN) to continue [N]: ? y

Start KERMIT now..^C

Received user request to terminate Code Load...
```

8.6.4 Code Patching

The code patch module of the CLCP program can be run from either a maintenance terminal or a virtual host terminal. The user enters the appropriate patch information directly into the program, and the program places it into the controller's RAM memory. The patch becomes active after the first controller initialization.

The code patching utility allows more than one patch to be entered for a given firmware version. Each patch is associated with only one firmware version, and the code patch utility verifies the patch against the currently-installed firmware version. Some patches require the installation of previous patches, called dependent patches, before they can be installed. To identify it, each patch has a unique patch number. Operate the CLCP utility as follows:

1. Obtain the appropriate patch data for your controller's firmware version from your Digital representative.
2. Invoke the CLCP program, as follows:

```
CLI> run clcp

 You have selected the Code Patch local program.  This program is
 used to manage firmware code patches.  Select an option from the
 following list:

 Type ^Y or ^C (then RETURN) at any time to abort Code Patch.

 Code Patch Main Menu

       0: Exit
       1: Enter a Patch
       2: Delete Patches
       3: List Patches

  Enter option number (0..3) [0] ?
```

3. Select the desired code patch option, by entering an option number and pressing RETURN.

The following sections describe each of the code patch options in detail.

Note

The patch data in these examples is provided only for the purposes of illustrating the code patch operation. Obtain actual code patch data for your controller's firmware from your Digital representative.

8.6.4.1 Special Code Patch Considerations

Consider the following when using the code patch utility:

- The controller reserves enough SRAM for approximately ten (10) patches. However, this number varies according to the size of the patches you enter.
- Patches are hierarchical. In other words, patch number one (1) must be entered before you enter patch number two (2), and so on. Furthermore, there are no "0" patches. Patches are always numbered sequentially beginning with "1."
- Because of the hierarchical patch structure, removing any patch also removes all higher numbered patches. For example, deleting patch number two (2) also removes patches three (3), four (4), and so on.
- Controllers in dual-redundant configurations must have the same patches applied, and patches must be entered into each controller separately.

8.6.4.2 Exit Option

Select this option to terminate the code patch program. Pressing Ctrl/Y at any time during the Code Patch program performs the same function.

8.6.4.3 Enter a Patch Option

This option enables you to enter a firmware program patch directly into the controller's RAM. You are prompted to enter the firmware version number to which the patch applies, the patch length, the patch type, the patch number, the count, the RAM address, the new contents of that address, and a patch verification number.

The code patch utility verifies that the patch you are entering is appropriate for the firmware version in the controller, and that there are no required dependent patches. It allows you to enter only one patch at a time. The utility prompts with error messages if you attempt to perform an illegal patch entry. Following is an example of the use of the patch entry option:

```
CLI> run clcp

 You have selected the Code Patch local program.  This program is
 used to manage firmware code patches.  Select an option from the
 following list:

 Type ^Y or ^C (then RETURN) at any time to abort Code Patch.

 Code Patch Main Menu

       0: Exit
       1: Enter a Patch
       2: Delete Patches
       3: List Patches

  Enter option number (0..3) [0] ? 1

 This is the Enter a Code Patch option.  The program
 prompts you  for the patch information, one line at time.  Be careful
 to enter the information exactly as it appears on the patch release.
 Patches may be installed for any version of firmware; however,
 patches entered for firmware versions other than X27J  are not
 applied until the matching version of firmware is installed.

 To enter any patch, you must first install all patches with lower patch
 numbers than the patch you are entering, beginning with patch number 1,
 for a specific firmware version.
 If you incorrectly enter the patch information, you are given the option
 to review the patch one line at a time.

 Type ^Y or ^C (then RETURN) at any time to abort Code Patch.

 Do you wish to continue (y/n) [y] ? Y

 Version:       ? X27J
 Length:        ? 10
 Patch Type:    ? 0
 Patch Number:  ? 1

 Count:         ?  1
 Address:       ? 00000099
 Value[  0]     ? 00000000

 Count:         ? 0

 Verification.  ? fdd6e08f

 The patch you just entered, is not applied until the controller
 is restarted.

 Code Patch Main Menu

       0: Exit
       1: Enter a Patch
       2: Delete Patches
       3: List Patches

  Enter option number (0..3) [0] ?

CLCP - Normal Termination
Restart of the controller required to apply new patch
CLI>
```

8.6.4.4 Delete Patches Option

The Delete Patches option enables you to remove previously-installed patches from controller RAM. The program displays the currently-installed patches and patches to be deleted.

The code patch utility verifies that the patch requested for deletion exists, and that it is not a dependent patch for a higher-numbered installed patch. It allows you to delete only one patch at a time. The utility prompts with error messages if you attempt to perform an illegal patch deletion.

Following is an example of the use of the patch deletion option.

```
CLI> run clcp

 You have selected the Code Patch local program.  This program is
 used to manage firmware code patches.  Select an option from the
 following list:

 Type ^Y or ^C (then RETURN) at any time to abort Code Patch.

 Code Patch Main Menu

       0: Exit
       1: Enter a Patch
       2: Delete Patches
       3: List Patches

  Enter option number (0..3) [0] ? 2

 This is the Delete Patches option.  The program prompts you for
 the firmware version and patch number you wish to delete.  If
 you select a patch for deletion that is required for another patch,
 all dependant patches are also selected for deletion.  The program
 lists your deletion selections and asks if you wish to continue.

 Type ^Y or ^C (then RETURN) at any time to abort Code Patch.

 The following patches are currently stored in the patch area:

   Firmware Version - Patch number(s)
        ________       _________
        X27J     -      1

 Currently, 97% of the patch area is free.

 Firmware Version of patch to delete ? X27J
 Patch Number to delete ? 1

 The following patches have been selected for deletion:

  Firmware Version - Patch #
        ________       _________
        X27J     -      1

 Do you wish to continue (y/n) [y] ?  Y

 The patch you have just deleted is currently applied, but will
 not be applied when the controller is restarted

 Code Patch Main Menu

       0: Exit
       1: Enter a Patch
       2: Delete Patches
       3: List Patches

  Enter option number (0..3) [0] ?
```

8.6.4.5 List Patches Option

The List Patches option enables you to display a listing of controller firmware versions, and the currently-installed patches that apply to them.

Following is an example of the use of the patch listing option:

```
CLI> run clcp

 You have selected the Code Patch local program.  This program is
 used to manage firmware code patches.  Select an option from the
 following list:

 Type ^Y or ^C (then RETURN) at any time to abort Code Patch.

 Code Patch Main Menu

      0: Exit
      1: Enter a Patch
      2: Delete Patches
      3: List Patches

  Enter option number (0..3) [0] ? 3

 The following patches are currently stored in the patch area:

   Firmware Version - Patch number(s)
      ___________     __________
      V027        -       1
      X27J        -       1

 Currently, 94% of the patch area is free.

 Code Patch Main Menu

      0: Exit
      1: Enter a Patch
      2: Delete Patches
      3: List Patches

  Enter option number (0..3) [0] ?
```

Note

The SHOW *controller* command also provides patch information in the form of a "dash number" following the firmware version. In the following example, firmware version 2.0 has had patches applied up to patch number three (3):

```
CLI> show this_controller

Controller:
        SWXRC-04 ZG33400026 Firmware V020-3, Hardware 0000
   .
   .
   .
```

8.6.4.6 Messages

All patching must be exact or the firmware image in controller SRAM does not operate. For this reason, the Code Patch utility does not allow you to incorrectly enter or delete patch information at any time.

In these cases the program provides messages to assist you with understanding any problems and corrective actions. The messages appear during interactive use of Code Patch (rather than, for example, at the CLI prompt) as each condition arises. Following are messages you may encounter while using Code Patch to enter and delete patches.

Firmware Version *x* does not have any patches to delete.

> **Explanation:** You cannot delete a patch because the firmware version entered does not have any patches entered.

Firmware Version *x* does not have patch number *x* to delete.

> **Explanation:** You cannot delete this patch because the firmware version entered does not have the specified patch entered.

The patch you entered is already installed on this controller.

> **Explanation:** The specified patch is already present in the patch area of controller memory. If you wish to reenter this patch, first use the Delete Patch option.

The patch you are entering requires other patches to be entered.

> **Explanation:** You have attempted to enter a patch without first entering the lower numbered patches in the hierarchy. Enter all patches for this firmware version that have lower numbers than the current patch. Then enter the current patch.

WARNING The patch you are entering is not for the current firmware version *x*.

> **Explanation:** The patch you are entering applies to a firmware version other than the one currently installed in the controller. Code Patch allows you to enter the patch; however, the patch is not applied until its correct firmware version is installed.

You incorrectly entered the patch information.

> **Explanation:** The patch information was not entered exactly. The program prompts you for each line of the patch entry, with the default from your previous response. Verify that each entry is exactly the same as the patch release. If you choose not to continue, or if you abort during this review procedure, the patch information you entered is lost and you must enter the entire patch again. You may enter Ctrl/z [Return] at any prompt to choose the default for the remaining entries.

The patch you have just entered is not applied until the controller firmware is changed to Version *x*.

> **Explanation:** The patch entered applies to a firmware version other than the one currently installed in the controller. Code Patch does not apply the patch until its correct firmware version is installed.

You have requested deletion of a patch number that another patch requires.

Explanation: You are attempting to delete a patch in the hierarchy that has higher numbered patches entered. Code Patch allows you to proceed; however, the program deletes all the higher numbered patches in the heirarchy (for this firmware version) along with the specified patch.

8.7 Firmware Licensing System

The firmware licensing system (FLS) enables or disables the licensed value-added software features of the SWXRC–04 controller. You may use the FLS utility to perform the following tasks:

- Enable or disable optional functions for your controller
- Try an optional feature before purchasing the license to use it
- Change your license key for an option

Start FLS from the CLI prompt. After starting, the FLS display shows the current status of the value-added options for your controller and contains menu choices for each function of the utility.

Important Write-Back Cache Note

If your system contains write-back cache modules, their batteries were completely charged at the factory. It is normal for the batteries to have discharged slightly in shipment. To ensure absolute data integrity, the advanced write-back cache and RAID features of your controller require fully-charged batteries to operate. These advanced features may not be available immediately after installation, until the batteries have had an opportunity to completely recharge.

8.7.1 Preenabled Licensed Features

If you purchased the licensed features for your controller, it may have been shipped with a preentered license key, to allow you to immediately use those features. To verify which features are enabled, use the SHOW THIS_CONTROLLER CLI command to display the state of the licensed features in your controller. You will also receive a copy of your license key, for future use in controlling the licensed features in your controller using the FLS utility.

8.7.2 Enabling Options

You can turn on any option at any time with FLS, but if you enable an option for which you are not licensed, an error message appears on your CLI terminal and an error is logged in the host error log. These error indications are repeated at least once each hour while the unlicensed option remains enabled.

8.7.3 Disabling Options

You cannot disable an option if that option is currently in use. The following table lists the conditions under which you can disable an FLS option.

Option	Conditions Required to Disable
RAID	No RAIDset configured Write-back caching not in use
WBCA	Write-back caching not in use

8.7.4 License Key

When you first run FLS, the license key is cleared. If you purchase a license for a firmware option, you will receive a customer license key. This key contains two parts: a customer identification string from 6 to 32 characters long, and an 8-character cyclic redundancy check (CRC) string. You must enter the customer identification string with the CRC string appended to it when you use FLS.

8.7.5 Using the Menu

You can perform these operations from the FLS menu:

Select	Action	Submenu Choices	Result
1	Enable an option	List each option and its status	Selection enabled
2	Disable an option	List each option and its status	Selection disabled
3	Enter a license key	Prompt for new license key	Entered key checked for validity
4	Clear a license key	Prompt for license key to clear	Entered key becomes invalid

The following example shows the FLS main menu:

```
CLI> run fls

-----------------------------------------------------------------------------
      Firmware Licensing System (FLS)
Option❶   State❷       License❸       Key❹
-----------------------------------------------------------------------------
 RAID      ENABLED ******INVALID!****** *none*
 WBCA      ENABLED        VALID         ACME_WIDGET_CORP........

              RAID = Raid5 + Writeback Cache ❺
              WBCA = Writeback Cache ONLY
-----------------------------------------------------------------------------
    1. Enable a firmware option
    2. Disable a firmware option
    3. Enter a license key for a firmware option
    4. Clear a license key for a firmware option
    0. Exit FLS
Enter selection (0:4) [0] ?
```

❶ **Option**–The RAID and write-back cache (WBCA) options are available.

❷ **State**–Both RAID and WBCA are enabled. You may use any option that is enabled, regardless of whether you have a valid license key.

❸ **License**–RAID is running without a valid license. This status shows when you are running an option on a trial basis. The license becomes valid when you enter a license key that FLS verifies as valid. You receive this key when you purchase a software option.

❹ **Key+CRC**–The license key is ACME_WIDGET_CORP; the 8-character CRC portion of the key is shown as hidden text (........).

❺ **Description of Option**–A short description of each option is given.

8.7.6 Example

To perform an operation, enter the choice number and any information requested by the submenu or prompts. The following example demonstrates how to enter a license key and enable write-back caching.

```
CLI> run fls

-----------------------------------------------------------------------------
      Firmware Licensing System (FLS)
Option      State        License        Key
-----------------------------------------------------------------------------
 RAID     DISABLED      INVALID        *none*
 WBCA     DISABLED      INVALID        *none*

              RAID = Raid5 + Writeback Cache
              WBCA = Writeback Cache ONLY
-----------------------------------------------------------------------------
    1. Enable a firmware option
    2. Disable a firmware option
    3. Enter a license key for a firmware option
    4. Clear a license key for a firmware option
    0. Exit FLS
Enter selection (0:4) [0] ? 3

    1. Enter new license key+CRC for RAID   (current key is invalid)
    2. Enter new license key+CRC for WBCA   (current key is invalid)
    0. Return to main menu
Enter selection (0:2) [0] ? 2❶

Enter new WBCA key, including 8-character CRC, or enter 0
       to return to main menu: ACME_WIDGET_CORPVB8UWQ9C❷
```

```
*** License key verified ***

------------------------------------------------------------------------------
      Firmware Licensing System (FLS)
Option       State        License       Key
------------------------------------------------------------------------------
 RAID      DISABLED      INVALID       *none*
 WBCA      DISABLED       VALID        ACME_WIDGET_CORP........

                RAID = Raid5 + Writeback Cache
                WBCA = Writeback Cache ONLY
------------------------------------------------------------------------------
    1. Enable a firmware option
    2. Disable a firmware option
    3. Enter a license key for a firmware option
    4. Clear a license key for a firmware option
    0. Exit FLS
Enter selection (0:4) [0] ? 1

    1. Enable RAID
    2. Enable WBCA
    0. Return to main menu
Enter selection (0:2) [0] ? 2➌
*** WBCA enabled ***

------------------------------------------------------------------------------
      Firmware Licensing System (FLS)
Option       State        License       Key
------------------------------------------------------------------------------
 RAID      DISABLED      INVALID       *none*
 WBCA      ENABLED        VALID➍       ACME_WIDGET_CORP........

                RAID = Raid5 + Writeback Cache
                WBCA = Writeback Cache ONLY
------------------------------------------------------------------------------
    1. Enable a firmware option
    2. Disable a firmware option
    3. Enter a license key for a firmware option
    4. Clear a license key for a firmware option
    0. Exit FLS
Enter selection (0:4) [0] ?[Return]
FLS - Normal Termination

CLI>
```

➊ The user chooses to enter a new license key for WBCA.

➋ The user enters the new license key, along with the customer license key, which is displayed as it is entered.

➌ The user enables write-back cache.

➍ This entry in the FLS display shows that write-back cache is enabled under a valid license.

8.7.7 Messages

This section lists the message that you may receive from FLS.

option has been turned on without a valid license

Explanation: You have activated the option named by *option* without entering a valid license key. You can evaluate this option for a time to determine its value, and you will receive a valid license key when you purchase the license for the option.

Error *nnnn*: *option* support is not enabled on this controller

Explanation: The *option* you are attempting to use is not enabled in FLS. For example, if you try to turn on write-back caching, this error is displayed if either RAID or write-back caching is not enabled by FLS (the RAID option includes write-back caching).

WARNING: This is an invalid license Key+CRC

Explanation: The license key you entered is not between 6 and 32 characters, or the customer license key is not valid. Verify that the key is correct and reenter.

***Error: Disabling *option* is not possible at this time, option is in use ***

Explanation: You have attempted to disable the option named by *option* while it is in use. Refer to Section 8.7.3 for more information on disabling options.

8.8 Fault Management Utility

The Fault Management Utility (FMU) enables you to do the following:

- Control the spontaneous event logging and last failure logging displays
- Display controller last failure and memory system failure information.

FMU can also provide a convenient way to review some error log information during your terminal session. Run FMU interactively during a terminal session by invoking it from the CLI prompt:

```
CLI> run fmu
```

FMU only interprets errors that occur after you install and run controller firmware containing FMU. In other words, FMU cannot search for "older" errors, and you cannot install FMU in an attempt to troubleshoot a preexisting error.

After invoking FMU, you may perform the functions described in the following sections. Defaults are specified by "D."

8.8.1 SET Command

The SET command controls the output from the FMU utility. The SET command changes options for the two spontaneous displays:

- Event logging (EVL)
- Last failure logging (LFL)

Also, the SET command controls the options for the interactive displays available under the SHOW command.

SET EVENT_LOGGING
SET NOEVENT_LOGGING (D)

This command enables/disables the event log display on the maintenance terminal. With the event log display enabled, the controller spontaneously displays EIP information during your terminal session. The first line of an event log display begins with "%EVL."

Event log displays are inhibited during the execution of both CLI commands and utilities invoked from a maintenance terminal. Events that are reported while a maintenance terminal is in use do not appear when the terminal again becomes available. (The %EVL display is lost.)

Note

Execution of a CLI command or utility does not begin until you press [Return]. If FMU reports an event during command line input before [Return] is pressed, the %EVL display interrupts the input.

Following the %EVL display, the CLI prompt and command input entered prior to the interruption are redisplayed. You can then complete the current command line (unless FMU reports another event).

SET LAST_FAILURE_LOGGING
SET NOLAST_FAILURE_LOGGING (D)

This command enables/disables the last failure log display on the maintenance terminal. With the last failure log display enabled, the controller spontaneously displays information relevant to the sudden termination of executing firmware. The first line of a last failure log display begins with "%LFL."

In cases where an automatic hardware reset occurs (such as power failure, pressing the reset (//) button, and so on) the last failure log display is inhibited because automatic reset does not allow sufficient time to complete the display.

SET EVENT_LOGGING REPAIR_ACTION_DISPLAY
SET EVENT_LOGGING NOREPAIR_ACTION_DISPLAY (D)
SET LAST_FAILURE_LOGGING REPAIR_ACTION_DISPLAY
SET LAST_FAILURE_LOGGING NOREPAIR_ACTION_DISPLAY (D)

This command and qualifier enables/disables recommended repair action display for event logging and last failure logging displays. With recommended repair action display enabled, the controller displays all of the recommended repair actions associated with the Instance Code and/or Last Failure Code used to describe an event.

SET EVENT_LOGGING VERBOSE
SET EVENT_LOGGING NOVERBOSE (D)
SET LAST_FAILURE_LOGGING VERBOSE
SET LAST_FAILURE_LOGGING NOVERBOSE (D)

This command and qualifier enables/disables descriptive text for event logging and last failure logging displays.

The display always identifies the various fields and their numeric content that comprise an event/last failure log. With verbosity enabled, the controller also displays a description of the numeric value in each log field.

SET PROMPT_DISPLAY
SET NOPROMPT_DISPLAY (D)

This command enables/disables the CLI prompt string display within the first line of event logging and last failure logging displays, as shown in the following example (using %EVL):

```
%EVL-- Instance Code: 01010302
%EVL--CLI> -- Instance Code: 01010302
```

SET TIMESTAMP_DISPLAY
SET NOTIMESTAMP_DISPLAY (D)

This command enables/disables current timestamp string display within the first line of event logging and last failure logging displays, as shown in the following example (using %EVL):

```
%EVL-- Instance Code: 01010302
%EVL--07-JUL-1994 07:44:48-- Instance Code: 01010302
```

You can use combinations of the SET [NO]PROMPT_DISPLAY and SET [NO]TIMESTAMP_DISPLAY commands to provide the following types of event logging and last failure logging first line displays (examples using %EVL):

```
%EVL--CLI> --07-JUL-1994 07:44:48-- Instance Code: 01010302

%EVL--07-JUL-1994 07:44:48-- Instance Code: 01010302

%EVL--CLI> Instance Code: 01010302

%EVL-- Instance Code: 01010302
```

The last example shown is recommended when VCS is in use, since the controller identification (prompt string) and timestamp information is already supplied by VCS.

SET FMU REPAIR_ACTION_DISPLAY
SET FMU NOREPAIR_ACTION_DISPLAY (D)

This command enables/disables the recommended repair action display for FMU SHOW LAST_FAILURE and SHOW MEMORY_SYSTEM_FAILURE command output. With recommended repair action display enabled, the command output displays all of the recommended repair actions associated with the Instance Code and/or Last Failure Code used to describe an event.

SET FMU VERBOSE
SET FMU NOVERBOSE (D)

This command enables/disables descriptive text for FMU SHOW LAST_FAILURE and SHOW MEMORY_SYSTEM_FAILURE command output. The output always identifies the various fields and their numeric content that comprise an event/last failure log. With verbosity enabled, the controller also displays a description of the numeric value in each log field.

SET EVENT_LOGGING [qualifier ... qualifier] PERMANENT
SET NOEVENT_LOGGING PERMANENT
SET LAST_FAILURE_LOGGING [qualifier ... qualifier] PERMANENT
SET NOLAST_FAILURE_LOGGING PERMANENT
SET FMU [qualifier ... qualifier] PERMANENT

The PERMANENT qualifier stores the parameter setting specified by the primary keyword and optional qualifier(s) in nonvolatile memory so that the setting is preserved across controller resets. In addition, when PERMANENT is specified, the given setting takes effect immediately.

If the PERMANENT qualifier is not specified, the given setting takes effect immediately. However, it remains in effect only as long as the current FMU session remains active or until the setting is changed by a subsequent SET command.

When running FMU from a maintenance terminal, changing EVENT_LOGGING parameters without specifying the PERMANENT qualifier has no effect. However, the same action while running FMU from a virtual terminal is effective. This permits the EVENT_LOGGING operation to be changed on a temporary basis only from a virtual terminal.

You can specify multiple additional qualifiers on the same command line for the SET EVENT_LOGGING, SET LAST_FAILURE_LOGGING, and SET FMU commands. For example, the following are all valid commands:

```
FMU> set event_logging permanent

FMU> set last_failure_logging norepair_action_display permanent

FMU> set event_logging repair_action_display noverbose permanent
```

8.8.2 SHOW Command

The SHOW command controls the interactive reviewing of last failure and memory system failure information.

SHOW LAST_FAILURE qualifier [additional qualifier]

This command interactively displays the last failure information stored in nonvolatile memory. Information related to the most recent and three previous last failure events is stored in nonvolatile memory.

Qualifier	Description
MOST_RECENT	Displays the most recent last failure information.
ALL	Displays all the errors available in the buffer (up to four). Errors are displayed in descending order, starting with the most recent.
ENTRY *n*	Displays one of the entries from the buffer. You must supply an entry number (range 1–4).

Additional Qualifier	Description
FULL	When included on the same command line with the MOST_RECENT, ALL, or ENTRY qualifier, displays extended information valuable to DIGITAL Multivendor Customer Services.

SHOW MEMORY_SYSTEM_FAILURE qualifier

This command interactively displays memory system failure information from any of the last failure entries stored in nonvolatile memory.

Qualifier	Description
MOST_RECENT	Displays the most recent memory system failure information contained in any of last failure information entries. (Note that the most recent memory system failure may not be the most recent last failure.)
ALL	Displays all memory system failure information contained in any or all of the four last failure information entries, in most recent to least recent order.
ENTRY *n*	Displays memory system failure information contained in one last failure information entry (range 1–4). Note that the FULL additional qualifier is not available with the SHOW MEMORY_SYSTEM_FAILURE command. To obtain the extended information associated with the selected memory system failure, perform a SHOW LAST_FAILURE ENTRY *n* FULL, where *n* is the last failure entry number identified in the memory system failure display.

Note

The following message appears when FMU cannot access error information for the SHOW command:

```
(***Last Failure Entry x EDC bad; translation terminated***)
```

SHOW PARAMETERS

This command displays the current/permanent setting of parameters affected by the SET command.

8.8.3 DESCRIBE Command

The describe command displays decscriptive text for a numeric value contained in a particular event log field.

Event Log Field:

DESCRIBE ASC_ASCQ_CODE[3]
DESCRIBE COMPONENT_CODE
DESCRIBE CONTROLLER_UNIQUE_ASC_ASCQ_CODE[3]
DESCRIBE DEVICE_TYPE_CODE
DESCRIBE EVENT_THRESHOLD_CODE
DESCRIBE INSTANCE_CODE
DESCRIBE LAST_FAILURE_CODE
DESCRIBE REPAIR_ACTION_CODE
DESCRIBE RESTART_TYPE
DESCRIBE SCSI_COMMAND_OPERATION_CODE[3]
DESCRIBE SENSE_DATA_QUALIFIERS[3]
DESCRIBE SENSE_KEY_CODE
DESCRIBE TEMPLATE_CODE

[3] Requires entry of multiple numeric values

All DESCRIBE qualifiers require at least one numeric value parameter. DESCRIBE qualifiers requiring multiple numeric value parameters are footnoted as such.

Type a question mark (?) in place of a numeric value parameter in order to identify the value and range required, as shown in the following example. Note that when sequential values are required, you must supply values for the earlier parameters before entering a question mark for the later parameter in the sequence.

```
FMU> describe asc_ascq_code ?
Your options are:
   ASC value (range: 0 through FF hexadecimal)
FMU> describe asc_ascq_code 0 ?
Your options are:
   ASCQ value (range: 0 through FF hexadecimal)
FMU> describe asc_ascq_code 0 0 ?
Your options are:
   SCSI Device Type value (range: 0 through FF hexadecimal)
FMU>
```

8.8.4 EXIT Command

The EXIT command terminates FMU and returns you to the CLI prompt. (You may also enter Ctrl/C or Ctrl/Y to abort FMU.)

8.8.5 Examples

This section presents examples that show some of the output information available when using FMU. Values enclosed in parentheses are hexidecimal translations of decimal numbers.

```
FMU> show last_failure entry 4

Last Failure Entry: 4❶ Flags: 0007FA80❷

%FMU-01-Last Failure Event, Instance Code: 01010302❸
 Power On Time: 0 Years, 41 Days, 4 Hours, 49 Minutes, 8 Seconds❹
 ❺Controller Model: SWXRC-04 Serial Number: ZG30355555 Hardware Version: 0000(00)
 Controller Identifier:
  Unique Device Number: 000130355555 Model: 40(28) Class: 1(01)
 HSOF Version: V20(20)❻
 Informational Report
 ❼Instance Code 01010302 Description:
  An unrecoverable hardware detected fault occurred.
 ❽Last Failure Code: 018800A0 (No Last Failure Parameters)
 Last Failure Code 018800A0 Description:
  A processor interrupt was generated with an indication that the program
  card was removed.
```

```
FMU> show memory_system_failure entry 2

Last Failure Entry: 2❶ Flags: 0007FA8C❷
 Memory System Failure indicated

%FMU-14-Memory System Failure Event, Instance Code: 016E2D02❸
 Power On Time: 0 Years, 41 Days, 21 Hours, 5 Minutes, 39 Seconds❹
 ❺Controller Model: SWXRC-04 Serial Number: ZG30355555 Hardware Version: 0000(00)
 Controller Identifier:
  Unique Device Number: 000130355555 Model: 40(28) Class: 1(01)
 HSOF Version: V20(20)❻
 Reported via non-maskable interrupt
 ❽Memory Address: 40000000
 Byte Count: 0(00000000)
 DRAB Registers:
  DSR:  2D17403F  CSR:  8000A220 DCSR:  00003403  DER:  00001C00  EAR:  04000000
  EDR:  F4000003  ERR:  00000000  RSR:  09805432  CHC:  E7FFFFFC  CMC:  90A5FEF0
 Diagnostic Registers:
  RDR0: E7FFFFFC  RDR1: 90A5FEF0  WDR0: 7F021000  WDR1: FF06020D
 ❼Instance Code 016E2D02 Description:
  The CACHEA0 DRAB detected a Nonexistent Memory Error condition during an
  I960 attempt to read CACHEA0 memory.
```

❶ **Entry**—A number representing the error position in the buffer.

❷ **Flags**—This value should be recorded and reported to DIGITAL Multivendor Customer Services.

❸ **Instance Code**—The instance code (and description) associated with this failure.

❹ **Power On Time**—The time of failure.

❺ **Controller**—Information identifying your controller.

❻ **HSOF Version**—Firmware version.

❼ **Last Failure Code**—Last failure code and description.

❽ **Memory Address**—The memory address, byte count, and register contents should be recorded and reported to DIGITAL Multivendor Customer Services.

```
FMU> show last_failure entry 4 full

Last Failure Entry: 4 Flags: 0007FA80

%FMU-01-Last Failure Event, Instance Code: 01010302
 Power On Time: 0 Years, 41 Days, 4 Hours, 49 Minutes, 8 Seconds
 Controller Model: SWXRC-04 Serial Number: ZG30355555 Hardware Version: 0000(00)
 Controller Identifier:
  Unique Device Number: 000130355555 Model: 40(28) Class: 1(01)
 HSOF Version: V20(20)
 Informational Report
 Instance Code 01010302 Description:
  An unrecoverable hardware detected fault occurred.
 Last Failure Code: 018800A0 (No Last Failure Parameters)
 Last Failure Code 018800A0 Description:
  A processor interrupt was generated with an indication that the program
  card was removed.
 Current Thread: NULL Current I960 Priority: 001F0000
 Interrupt Stack Guard is intact
 Thread Stack Guard State Flags (ID# Bit; 0=intact,1=not intact): 00000000
 I960 Stack:
  Levels: 2
  Level 0:
   Return type: Interrupt
   PFP: 201C15F7  SP:  201FABD0  RIP: 200CF898  R3:  201C15F7
   R4:  00000000  R5:  00000000  R6:  00000000  R7:  00000000
   R8:  00000000  R9:  00000000  R10: 00000000  R11: 00000000
   R12: 00000000  R13: 00000000  R14: 00000000  R15: D87FA8FE
  Level 1:
   Return type: Local
   PFP: 00000000  SP:  201C1680  RIP: 200D0AC0  R3:  00000000
   R4:  00000000  R5:  00000000  R6:  00000000  R7:  00000000
   R8:  00000000  R9:  00000000  R10: 00000000  R11: 00000000
   R12: 00000000  R13: 00000000  R14: 00000000  R15: 00000000
   G0:  00000000  G1:  00000000  G2:  2011DFF4  G3:  00000000
   G4:  00000000  G5:  00400000  G6:  201148B0  G7:  00000003
   G8:  000000CC  G9:  00000001  G10: 00000004  G11: 2011F108
   G12: 200E969C  G13: 201D3D8C  G14: 00000000  FP:  201FAB50
 Diagnostic Registers:
  RDR0: E7FFFFFC  RDR1: E7FFFEF0  WDR0: 7F021000  WDR1: FF06020D
 Master DRAB Registers:
  DSR:  2D170CBC  CSR:  00000000 DCSR:  0009FFFF  DER:  00001C00  EAR:  00200400
  EDR:  00000000  ERR:  00000023  RSR:  00801432  CHC:  005BB41A  CMC:  002E853E
 CACHEA0 DRAB Registers:
  DSR:  2D17003F  CSR:  00000000 DCSR:  00003403  DER:  00001C76  EAR:  00000000
  EDR:  FFFFFFFF  ERR:  00000000  RSR:  09805432  CHC:  00000000  CMC:  00000000
 CACHEA1 DRAB Registers:
  Not Available.
 CACHEB0 DRAB Registers:
  DSR:  2C17003D  CSR:  00000000 DCSR:  00003402  DER:  00001C76  EAR:  00000000
  EDR:  FFFFFFFF  ERR:  00000000  RSR:  09805432  CHC:  00000000  CMC:  00000000
 CACHEB1 DRAB Registers:
  Not Available.
 FX Registers:
  PCX[0]:    00000000  PCX[1]:   00000001  PCX[2]:   00000201  PCX[3]:   00000401
  PCX[4]:    00000601  PCX[5]:   00000801  PCX[6]:   00000A01  PCX[7]:   00000000
  CSR:       0087E002  GEN_PCX:  00000000  UNUSED0:  00000000  UNUSED1:  00000000
  DILP:      00000000  DADDR:    00000000  DCMD:     00000000
 Host Port Registers (YACI):
  SET:    072E004A  CIA:    F8070700  PCS:    0505400F  RTS:    00000000
  RADILP: 201BEE08  RBDILP: 201BEE2C  TADILP: 201BEE50  TBDILP: 201BEE74
  RADFPA: 2063E760  RBDFPA: 20619560  TADFPA: 20637FA0  TBDFPA: 2062D5A0
  RADNPA: 2063E760  RBDNPA: 20619560  TADNPA: 20637FA0  TBDNPA: 2062D5A0
  REV:    00000003  DIAG:   00000000
 Device Port 0 Registers (NCR710):
  SCNTL0:  CA  SCNTL1:  20  SDID:    00  SIEN:    AF  SCID:    80  SXFER:   00
```

```
 SODL:     00  SOCL:     00  SFBR:     00  SIDL:     00  SBDL:     00  SBCL:     00
 DSTAT:    90  SSTAT0:   00  SSTAT1:   00  SSTAT2:   00  DSA:      00000000
 CTEST0:   70  CTEST1:   F0  CTEST2:   21  CTEST3:   08  CTEST4:   00  CTEST5:   00
 CTEST6:   FC  CTEST7:   80  TEMP:     00000000          DFIFO:    00  ISTAT:    00
 CTEST8:   21  LCRC:     00  DBC:      000000            DCMD:     54
 DNAD:     20578F50          DSP:      20578F50          DSPS:     0000015C
 SCRATCH:  00000000          DMODE:    80  DIEN:     27  DWT:      4E  DCNTL:    21
 ADDER:    205790AC
Device Port 1 Registers (NCR710):
 SCNTL0:   DA  SCNTL1:   20  SDID:     08  SIEN:     AF  SCID:     80  SXFER:    18
 SODL:     41  SOCL:     00  SFBR:     00  SIDL:     00  SBDL:     00  SBCL:     00
 DSTAT:    90  SSTAT0:   00  SSTAT1:   00  SSTAT2:   0F  DSA:      3E000000
 CTEST0:   70  CTEST1:   F0  CTEST2:   25  CTEST3:   41  CTEST4:   00  CTEST5:   00
 CTEST6:   B0  CTEST7:   80  TEMP:     205788B0          DFIFO:    00  ISTAT:    00
 CTEST8:   21  LCRC:     08  DBC:      000000            DCMD:     54
 DNAD:     205788B8          DSP:      205788B8          DSPS:     0000015C
 SCRATCH:  205788B0          DMODE:    80  DIEN:     27  DWT:      4E  DCNTL:    21
 ADDER:    20578A14
Device Port 2 Registers (NCR710):
 SCNTL0:   CA  SCNTL1:   20  SDID:     00  SIEN:     AF  SCID:     80  SXFER:    00
 SODL:     00  SOCL:     00  SFBR:     00  SIDL:     00  SBDL:     00  SBCL:     00
 DSTAT:    90  SSTAT0:   00  SSTAT1:   00  SSTAT2:   00  DSA:      00000000
 CTEST0:   70  CTEST1:   F0  CTEST2:   21  CTEST3:   08  CTEST4:   00  CTEST5:   00
 CTEST6:   FC  CTEST7:   80  TEMP:     00000000          DFIFO:    00  ISTAT:    00
 CTEST8:   21  LCRC:     00  DBC:      000000            DCMD:     54
 DNAD:     20578220          DSP:      20578220          DSPS:     0000015C
 SCRATCH:  00000000          DMODE:    80  DIEN:     27  DWT:      4E  DCNTL:    21
 ADDER:    2057837C
Device Port 3 Registers (NCR710):
 SCNTL0:   DA  SCNTL1:   20  SDID:     01  SIEN:     AF  SCID:     80  SXFER:    18
 SODL:     02  SOCL:     00  SFBR:     00  SIDL:     00  SBDL:     00  SBCL:     00
 DSTAT:    90  SSTAT0:   00  SSTAT1:   00  SSTAT2:   0F  DSA:      3E000000
 CTEST0:   70  CTEST1:   F0  CTEST2:   25  CTEST3:   02  CTEST4:   00  CTEST5:   00
 CTEST6:   80  CTEST7:   80  TEMP:     20577B80          DFIFO:    00  ISTAT:    00
 CTEST8:   21  LCRC:     01  DBC:      000000            DCMD:     54
 DNAD:     20577B88          DSP:      20577B88          DSPS:     0000015C
 SCRATCH:  20577B80          DMODE:    80  DIEN:     27  DWT:      4E  DCNTL:    21
 ADDER:    20577CE4
Device Port 4 Registers (NCR710):
 SCNTL0:   DA  SCNTL1:   20  SDID:     01  SIEN:     AF  SCID:     80  SXFER:    18
 SODL:     42  SOCL:     00  SFBR:     00  SIDL:     00  SBDL:     00  SBCL:     00
 DSTAT:    90  SSTAT0:   00  SSTAT1:   00  SSTAT2:   0F  DSA:      3E000000
 CTEST0:   70  CTEST1:   F0  CTEST2:   25  CTEST3:   42  CTEST4:   00  CTEST5:   00
 CTEST6:   E8  CTEST7:   80  TEMP:     205774E8          DFIFO:    00  ISTAT:    00
 CTEST8:   21  LCRC:     01  DBC:      000000            DCMD:     54
 DNAD:     205774F0          DSP:      205774F0          DSPS:     0000015C
 SCRATCH:  205774E8          DMODE:    80  DIEN:     27  DWT:      4E  DCNTL:    21
 ADDER:    2057764C
Device Port 5 Registers (NCR710):
 SCNTL0:   DA  SCNTL1:   20  SDID:     02  SIEN:     AF  SCID:     80  SXFER:    68
 SODL:     F6  SOCL:     00  SFBR:     00  SIDL:     00  SBDL:     00  SBCL:     00
 DSTAT:    90  SSTAT0:   00  SSTAT1:   00  SSTAT2:   0F  DSA:      3E000000
 CTEST0:   70  CTEST1:   F0  CTEST2:   25  CTEST3:   80  CTEST4:   00  CTEST5:   00
 CTEST6:   50  CTEST7:   80  TEMP:     20576E50          DFIFO:    00  ISTAT:    00
 CTEST8:   21  LCRC:     20  DBC:      000000            DCMD:     54
 DNAD:     20576E58          DSP:      20576E58          DSPS:     0000015C
 SCRATCH:  20576E50          DMODE.    80  DIEN:     27  DWT:      4E  DCNTL:    21
 ADDER:    20576FB4
```

❶ Information presented after this callout is extended information available with the FULL option. The output shows register contents for various hardware as well as other data. You should print a copy of this display so that DIGITAL Multivendor Customer Services has more information with which to troubleshoot the controller.

8.9 Crash Utility

CAUTION

The Crash utility causes a controller restart, and may result in the loss or corruption of data. Do not use the Crash utility.

The crash utility was designed for use by Digital personnel in system checkout only. It is not intended as a user utility.

8.10 Volume Serial Number Utility

The volume serial number utility, CHVSN, enables the operator to view and change storage device volume serial numbers. Following is an example of the use of the CHVSN program:

The user invokes the CHVSN program and views the volume serial number:

```
CLI> RUN CHVSN
Device (port target lun)  [EXIT] ? 4 1 0
CHVSN: Volume Serial Number is 00000000 00000000
```

The user chooses to change the volume serial number for this volume and enters a new number:

```
Update CHVSN (Y/N) [N] ? Y
CHVSN: Volume Serial Number is 00012010 00580010
```

The user exits the CHVSN program:

```
Device (port target lun)  [EXIT] ? Return
CHVSN - Normal Termination
```

9 Removing and Replacing Field Replaceable Units

This chapter describes how to remove and replace or install the following field replaceable units (FRUs) in both dual-redundant and nonredundant configurations:

- Controller module (including its mounting bracket, OCP, and bezel)
- Cache module (including write-back cache batteries)
- Program card
- Internal CI host cable
- External CI host cables
- DSSI host cable
- SCSI host cable
- SCSI device port cables
- Shelf Blowers
- Shelf Power supplies

CAUTION

Do not attempt to replace or repair components within FRUs or equipment damage may result. Use the controller fault indications and error logs to isolate to the FRU level only.

This chapter also discusses how to warm swap controllers and storage devices.

9.1 Servicing Controller Modules

Servicing a controller module involves several considerations:

- Diagnosing the controller
- Shutting down the controller
- Deciding what to replace
  - A nonredundant controller
  - One dual-redundant controller
  - Both dual-redundant controllers

9.1.1 Diagnosing the Controller

Following are some general items to consider when troubleshooting controller faults:

Generally, if the green OCP reset (//) button is lit continuously, the controller module needs replacing. However, you need to be as familiar as possible with the failure or reason for replacing the module. Be sure you have followed troubleshooting basics:

1. Make a note of all visual indicators (OCP, device LEDs, and/or error messages) available to you.
2. For surviving controllers in dual-redundant pairs, try entering the RESTART OTHER_CONTROLLER command. The surviving controller may be keeping its companion from operating.
3. Errors can be intermittent. Reset the controller to see if the error clears. Record which devices have lit/flashing fault LEDs before resetting, as a reset may temporarily clear the LED even though the fault remains.
4. See if the error indication changes after resetting the controller. If the error remains the same, look up information for that error. If the indication changes, look up information for the newer error.
5. Always consider reseating the controller and/or cache module when troubleshooting. Poor connections between module and backplane can cause a variety of errors.

   Refer to Chapter 7 for detailed information about errors and repair actions.

CAUTION

Do not use a controller failure situation as an opportunity to move devices or otherwise reconfigure your subsystem. Doing so prevents the controller from communicating with its units once the fault is corrected.

Before Proceeding

You should decide exactly what you are servicing (a nonredundant controller, one dual-redundant controller, or both dual-redundant controllers) before proceeding to the following sections, as each procedure varies and has different consequences.

9.1.2 Shutting Down the Controller

Controller failures are not the only reason to remove and replace a controller module. You may be moving resources, or removing a functioning controller for use as a replacement somewhere else in your system.

Note

If you wish to quickly remove and replace one controller in a *dual-redundant* configuration, you may warm swap (see Section 9.8.2) the controller with a replacement, if you have one. This method provides the fastest, most transparent way of exchanging controllers with minimal system impact and no down time.

Even if you are warm swapping a controller, you *must* shut down an operating controller before removing it.

Use the following guidelines to shut down a controller:

- Always run down outstanding I/O, stop all processes on, and dismount devices attached to a controller you intend to shut down.
- To enter any CLI> SHUTDOWN command, your terminal must be connected to a fully or partially functional controller. A fully functional controller's green OCP reset (//) LED flashes at 1 Hz. A partially functional controller's green LED may flash at 3 Hz.
- You cannot enter CLI> SHUTDOWN commands from terminals connected to failed controllers (green LED lit continuously).
  - For dual-redundant configurations *only*:

    You may enter the CLI> SHUTDOWN OTHER_CONTROLLER command from a terminal connected to one of the controllers. The other (shutdown) controller's green LED lights continuously when shutdown completes.

    After you shut down one controller in a dual-redundant configuration, the surviving controller takes over service to the shut down controller's devices. This process is called failover. (Refer to Chapter 5 for more information on failover.)
  - For *both* nonredundant and dual-redundant configurations:

    You may enter the CLI> SHUTDOWN THIS_CONTROLLER command from a terminal connected to the controller you want to shut down. The shutdown controller's green LED lights continuously when shutdown completes.

See Appendix B for a complete description of the SHUTDOWN command and its qualifiers. Be sure to review and understand the consequences to data and devices when using any qualifiers.

9.1.3 Removing and Replacing a Nonredundant Controller

Nonredundant controllers in SWXSS–01 shelves are always installed in slot (SCSI ID) 7, the slot furthest from the SCSI device cable connectors. Nonredundant controllers in SWXSC–AA cabinet shelves may be installed in either slot (SCSI ID 6 or 7).

When you replace the controller module in a nonredundant configuration, device service is interrupted for the duration of the service cycle.

In effect, following any procedure to remove and replace an SWXRC–04 controller is a kind of "warm swapping." This is because *other* targets on the host SCSI bus remain unaffected. However, take care not to confuse simply removing and replacing an SWXRC–04 controller with the special warm swap procedure described in Section 9.8.2.

9.1.3.1 Tools Required

You need the following tools to remove or replace the controller module:

- ESD strap
- 3/32-inch Allen wrench
- Flat-head screwdriver
- Small flat-head screwdriver

9.1.3.2 Precautions

Refer to Chapter 1 for ESD, grounding, module handling, and program card handling guidelines.

Ground yourself to an appropriate place on the cabinet before servicing the controller module.

9.1.3.3 Module Removal

Use the following procedure to remove the controller module:

1. Access the controller modules in the cabinet.
2. Examine the green OCP reset (//) LED on the controller OCP. If the green LED stays lit continuously after troubleshooting (refer to Section 9.1.1), the controller has failed and is already shut down. Proceed to step 6.
3. If the controller is fully or partially functioning (green LED flashing), connect a maintenance terminal to its MMJ, shown in Figure 9–1, and enter the following commands:

```
CLI> SHOW THIS_CONTROLLER FULL
CLI> SHOW DEVICES FULL
CLI> SHOW UNITS FULL
```

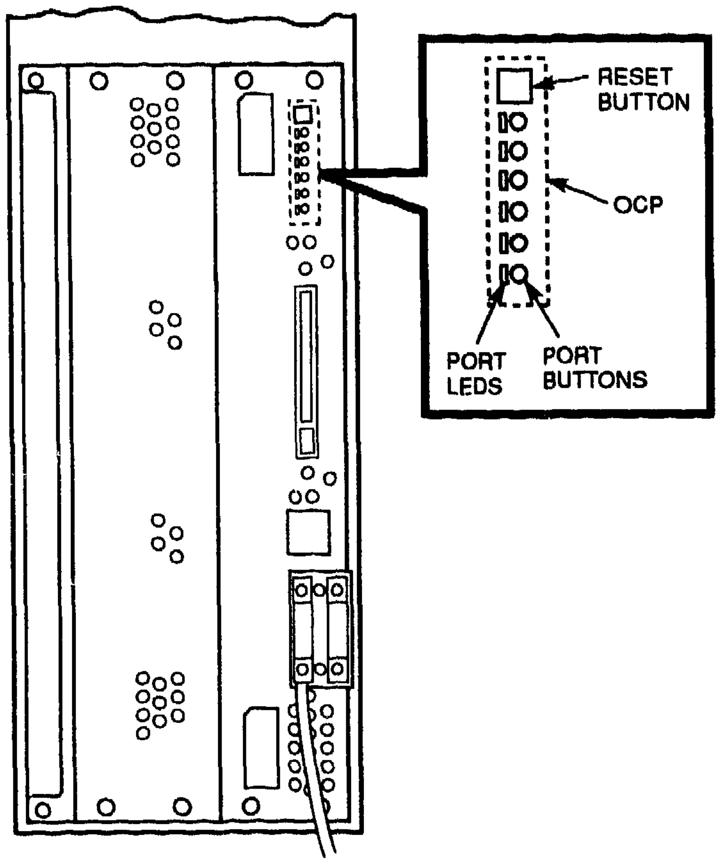
4. Record the output from the commands and keep it available for reference.

CAUTION

Never remove a controller while it is still servicing devices. Doing so may destroy customer data.

5. Because the controller is still functioning, you must shut down the controller by following the guidelines listed in Section 9.1.2.
6. Unsnap and remove the ESD shield covering the program card by pulling out on the two retainer buttons.
7. Remove the program card by pushing the eject button on the controller OCP. Pull the card out and save it for use in the replacement controller module.

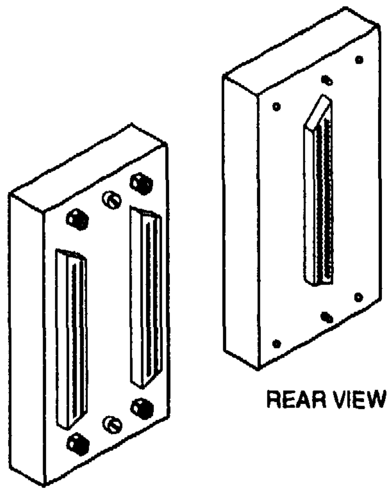
Figure 9–1 OCP Reset LED and Eject Button



With a small flat-head screwdriver, loosen the screws on the trilink connector and remove the trilink from the front of the controller. You must work around any SCSI cable or terminator connections when removing the trilink. Do *not* remove cables or terminators from the trilink or you will interrupt the host SCSI bus.

8. Remove the maintenance terminal cable (if attached).
9. Loosen the four mounting screws (refer to Figure 9–1) on each side of the front bezel with a flat-head screwdriver.
10. Use a gentle up-and-down rocking motion to loosen the module from the shelf backplane.
11. Slide the module out of the shelf (noting which rails the module was seated in) and place on an approved ESD work surface or mat.
12. If necessary, you may now remove the cache module as described in Section 9.2.4.3 or 9.2.1.4.

Figure 9–2 Trilink Connector



9.1.3.4 Module Replacement/Installation

Use the following procedure to replace or install the controller module:

1. You should replace the cache module now, if you removed it. See Sections 9.2.4.4 and 9.2.1.5 for further information on replacing or installing the cache module.
2. Slide the controller module into the appropriate slot in the shelf. The slot arrangement of the SWXSS–01 shelf is shown in Figure 9–3.
3. Use a gentle up-and-down rocking motion to help seat the module into the backplane. Press firmly on the module until it is seated. Finally, press firmly once more to make sure the module is seated.
4. Tighten the four screws on the front bezel using a flat-head screwdriver.
5. Connect a maintenance terminal to the MMJ of the new controller.

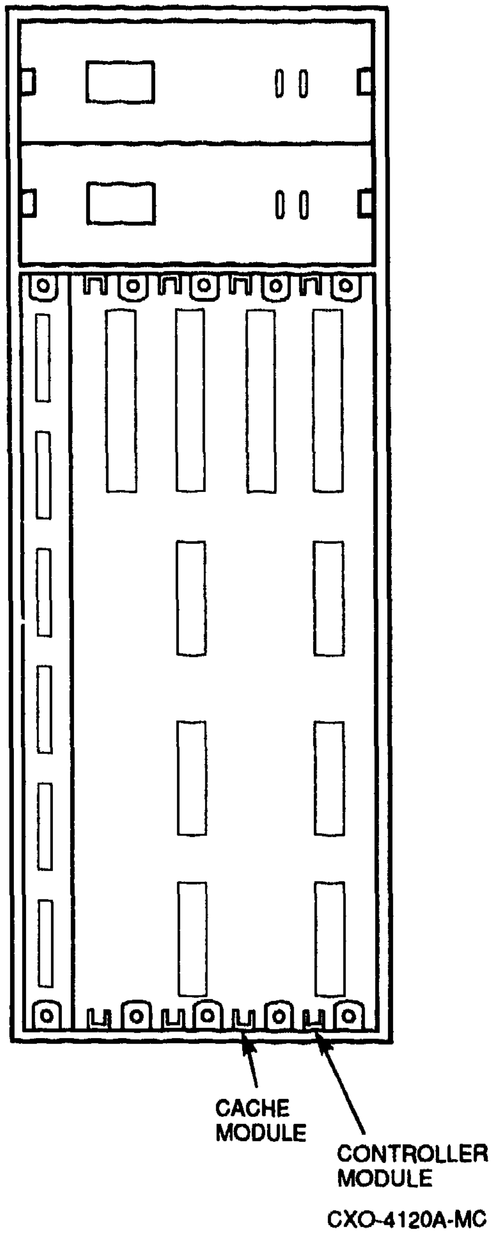
Before Proceeding

Set initial controller parameters by following the steps in Section 9.1.3.5.

6. Press and hold the controller's green reset (//) button. Then insert the program card into the new controller. The program card eject button extends when the card is fully inserted.
7. Release the reset button to initialize the controller.

   If the controller initializes correctly, its green reset LED begins to flash at 1 Hz. If an error occurs during initialization, the OCP displays a code. If necessary, refer to Chapter 7 to analyze the code.
8. Snap the ESD shield into place over the program card.

Figure 9–3 Controller Shelf Rails



9. If you wish, you may disconnect the maintenance terminal. The terminal is not required for normal controller operation.
10. Close and lock the cabinet doors.

9.1.3.5 Restoring Initial Parameters

A new controller module has no initial parameters, so you must use the maintenance terminal to enter them. Refer to information in a CONFIGURATION.INFO file or on the configuration sheet packaged with your system, whichever is most current, for parameters. Be sure to use the same parameters from the removed controller when installing a replacement.

After installation of a nonredundant controller, use the CLI to define its parameters in the following order (from a maintenance terminal).

1. Enter the following command to set a valid controller ID:

   ```
   CLI> SET THIS_CONTROLLER ID=n
   ```

   where *n* is the SCSI target ID(s) (0–7).

   Note

   Always restart the controller after setting the ID.

2. Restart the controller either by pressing the green reset (//) button, or by entering the following command:

   ```
   CLI> RESTART THIS_CONTROLLER
   ```

3. Enter the following command to verify the preceding parameters were set:

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   ```

4. Connect the host port cable to the front of the controller.

   Connect the SCSI cable trilink connector to the front of the controller and tighten its captive screws with a small flat-head screwdriver. You must work around any SCSI cable or terminator connections when replacing the trilink. Do *not* remove cables or terminators from the trilink or you will interrupt the host SCSI bus.

To quickly configure devices on the controller, use either the CONFIG or CFMENU utility described in Chapter 8.

For manual configuration, the following steps add devices, storagesets, and logical units. Use the CLI to complete these steps so that the host recognizes the storage device. (These steps can be run from a virtual terminal.)

1. Add the physical devices by using the following command:

   ```
   CLI> ADD device-type device-name scsi-location
   ```

   For example:

   ```
   CLI> ADD DISK DISK100 1 0 0
   ```

   where:

   device-type is the type of device to be added.

   device-name is the name to refer to that device. The name is referenced when creating units or storagesets.

   SCSI-location is the PTL for the device. When entering the PTL, at least one space must separate the port, target, and LUN.

2. Add the storagesets for the devices. Storagesets include stripesets and RAIDsets.

   See Appendix B for examples of adding storagesets. (If you do not desire storagesets in your configuration, skip this step.)

CAUTION

The INITIALIZE command destroys all data on a container. See Appendix B for specific information on this command.

3. Enter the following command to initialize the containers (devices, storagesets, or both) prior to adding logical units to the configuration.

   ```
   CLI> INITIALIZE container-name
   ```

   where *container-name* is a device or storageset that becomes part of a unit.

   When initializing a single-device container:

   - If NOTRANSPORTABLE (the default) was specified when the device was added, a small amount of disk space was made inaccessible to the host and used for metadata. The metadata is now initialized.
   - If TRANSPORTABLE was specified, any metadata on the device is now destroyed. See Appendix B for details on metadata and when INITIALIZE is required.

4. Add the units that use either the devices or the storagesets built from the devices by entering the following command:

   ```
   CLI> ADD UNIT logical-unit-number container-name
   ```

   where:

   logical-unit-number is the unit number the host uses to access the device.

   container-name identifies the device or the storageset.

5. Use the following commands to verify that your configuration matches the earlier, printed configuration:

   ```
   CLI> SHOW DEVICES FULL
   CLI> SHOW UNITS FULL
   ```

9.1.4 Removing and Replacing One Controller of a Dual-Redundant Pair

CAUTION

To perform the procedures in this section, at least one controller must be functioning.

To replace one controller in a dual-redundant configuration (or one at a time) while using the second controller to service devices, see the controller warm swap procedure in Section 9.8.2. Warm swap causes only a momentary service outage, but system performance decreases slightly while one controller does the work of two.

When you replace one dual-redundant controller module using the instructions in this section, device service is interrupted for the duration of the service cycle.

9.1.4.1 Tools Required

You need the following tools to remove or replace the controller module:

- ESD strap
- 3/32-inch Allen wrench
- Flat-head screwdriver

9.1.4.2 Precautions

Refer to Chapter 1 for ESD, grounding, module handling, and program card handling guidelines.

Ground yourself to an appropriate place in the cabinet before servicing the controller module.

9.1.4.3 Module Removal

Use the following procedure to remove the controller module:

1. If you have not done so already, unlock and open the cabinet doors to gain access to the controller modules.
2. Examine the green OCP reset (//) LED (refer to Figure 9–1) on both controllers. At least one green LED should not remain lit continuously after basic troubleshooting (refer to Section 9.1.1).

   If both green LEDs stay lit continuously, both controllers have failed. Refer to Section 9.1.5.
3. Connect a maintenance terminal to the MMJ (refer to Figure 9–1) of each functioning or partially functioning controller, and enter the following commands:

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   CLI> SHOW DEVICES FULL
   CLI> SHOW UNITS FULL
   ```
4. Record the output from the commands and keep it available for reference.

   CAUTION

   Never remove a controller while it is still servicing devices. Doing so may destroy customer data.

5. If the controller you are removing is still functioning (green LED flashing) you must shut down the controller by following the guidelines in Section 9.1.2.

   If the controller's green LED is lit continuously, it has already shut down, and the surviving controller has assumed service to its devices.
6. Shut down the controller you are not removing (refer to Section 9.1.2).
7. On the controller you are removing, unsnap and remove the ESD shield covering the program card.
8. Remove the program card by pushing the eject button (refer to Figure 9–1) next to the card. Pull the card out and save it for use in the replacement controller module.

With a small flat-head screwdriver, loosen the captive screws on the trilink connector and remove the trilink from the front of the controller. You must work around any SCSI cable or terminator connections when removing the trilink. Do *not* remove cables or terminators from the trilink or you will interrupt the host SCSI bus. (If necessary for controller access, loosen the captive screws on the trilink connector and remove it from the front of the companion controller.)

9. Remove the maintenance terminal cable (if attached).
10. Loosen the four screws (refer to Figure 9–1) on each side of the front bezel with a flat-head screwdriver.
11. Use a gentle up-and-down rocking motion to loosen the module from the shelf backplane.
12. Slide the module out of the shelf (noting which rails the module was seated in) and place on an approved ESD work surface or mat.
13. If necessary, you may now remove the cache module as described in Section 9.2.4.3 or 9.2.1.4.

9.1.4.4 Module Replacement/Installation

Use the following procedure to replace the controller module:

1. Replace the cache module now, if you removed it. Refer to Section 9.2.4.4 or 9.2.1.5.
2. Slide the controller module into the shelf and into the same slot.
3. Use a gentle up-and-down rocking motion to help seat the module into the backplane. Press firmly on the module until it is seated. Finally, press firmly once more to make sure the module is seated.
4. Tighten the four screws on the front bezel using a flat-head screwdriver.
5. Connect a terminal to the controller you did not replace, and enter the following command:

   ```
   CLI> RESTART THIS_CONTROLLER
   ```

   (Wait for the controller you did not remove to initialize.)
6. Connect a maintenance terminal to the MMJ of the new controller.

   Before Proceeding

   Restore initial controller parameters by following the steps in Section 9.1.4.5.

7. Press and hold both controllers' green reset (//) buttons. Then insert the program card into the new controller. The program card eject button extends when the card is fully inserted.
8. Release both reset buttons.
9. Enter the following command to initialize the controller:

   ```
   CLI> RESTART THIS_CONTROLLER
   ```

If the controllers initialize correctly, their green LEDs flash at 1 Hz. If an error occurs during initialization, the OCP displays a code. If necessary, refer to Chapter 7 to analyze the code.

10. Snap the ESD shield into place over the program card.
11. If you wish, you may disconnect the maintenance terminal. The terminal is not required for normal controller operation.
12. Close and lock the cabinet doors.

9.1.4.5 Restoring Initial Parameters

A new controller module has no initial parameters, so you must use a maintenance terminal to enter them. Refer to information in the CONFIGURATION.INFO file or on the configuration sheet packaged with your system, whichever is most current, for parameters. Be sure to use the same parameters from the removed controller when installing a replacement. Follow these steps:

CAUTION

SET FAILOVER establishes controller-to-controller communication and copies configuration information. Always enter this command on one controller only. COPY=*configuration-source* specifies where the *good* configuration data are located. *Never* blindly specify SET FAILOVER. Know where your good configuration information resides before entering the command.

---

1. Enter the following command to copy configuration information to the new controller:

   ```
   CLI> SET FAILOVER COPY=OTHER_CONTROLLER
   ```

   Both controllers return to the dual-redundant configuration and restart after entering this command.

2. Enter the following commands to verify the preceding parameters were set.

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   CLI> SHOW OTHER_CONTROLLER FULL
   ```

3. Connect the host port cables to the front of the controllers. Do *not* connect the controllers in a dual-redundant pair to separate, different host CPUs.

   Connect the SCSI cable trilink connector to the front of the controller and tighten its captive screws with a small flat-head screwdriver. You must work around any SCSI cable or terminator connections when replacing the trilink. Do *not* remove cables or terminators from the trilink or you will interrupt the host SCSI bus.

4. Use the following commands to verify your configuration matches the earlier, printed configuration before proceeding:

   ```
   CLI> SHOW DEVICES FULL
   CLI> SHOW UNITS FULL
   ```

9.1.5 Removing and Replacing Both Controllers in a Dual-Redundant Configuration

In the rare event that both controllers in your dual-redundant configuration fail, both controllers' green OCP reset (//) LEDs are lit continuously. You must replace both controller modules.

CAUTION

Simultaneously replacing both controllers in a dual-redundant configuration causes system down time for the duration of the service cycle. DIGITAL recommends only using this procedure if both controllers fail, or if your system is off line already for another reason.

Otherwise, to replace both controllers, follow the steps in Section 9.1.4. Replace the controllers one at a time and maintain device service.

Use the following guidelines to simultaneously replace both controllers:

1. Examine the green OCP reset (//) LED on both controllers. Follow basic troubleshooting guidelines (refer to Section 9.1.1), if necessary.
2. For any fully or partially functioning controller, connect a terminal and enter the following commands:

```
CLI> SHOW THIS_CONTROLLER FULL
CLI> SHOW DEVICES FULL
CLI> SHOW UNITS FULL
```

3. Record the output from the commands and keep it available for reference.

CAUTION

Never remove a controller while it is still servicing devices. Doing so may destroy customer data.

---

4. Shut down any fully or partially functioning controller (green LED flashing) by following the guidelines in Section 9.1.2.
5. Remove both controllers by referring to the steps 6 through 13 in Section 9.1.3.3.
6. Replace the first of the controllers as if this were a nonredundant configuration (refer to Section 9.1.3.4).
7. Replace the second controller by following the dual-redundant procedure (refer to Section 9.1.4.4).

9.2 Servicing Cache Modules

The following procedures cover the servicing of cache modules.

9.2.1 Removing and Replacing Write-Back Cache Modules

WARNING

Service procedures described in this guide that involve removing and replacing the write-back cache must be performed only by qualified service personnel.

CAUTION

In general, you should never service a write-back cache module that contains unwritten cache data, or data loss may result. Always use the SHOW THIS_CONTROLLER or SHOW OTHER_CONTROLLER command to check for unwritten cache data. (Note that RETRY_ERRORS UNWRITEABLE_DATA may flush unwritten cache data.)

In situations where losing unwritten cache data does not matter, you may proceed with service. However, the unwritten cache data can remain in the module (needlessly occupying memory) until you enter the CLEAR_ERRORS UNWRITEABLE_DATA command for that module. This command erases the data and enables you to use the full capacity of the module.

See the following sections to service a write-back cache module.

9.2.1.1 Tools Required

You need the following tools to remove or replace the write-back cache module:

- ESD strap
- Nonconductive ESD mat
- 3/32-inch Allen wrench
- Flat-head screwdriver

9.2.1.2 Precautions

Refer to Chapter 1 for ESD, grounding, module handling, and program card handling guidelines.

Ground yourself to appropriate place in the cabinet before servicing the write-back cache module.

9.2.1.3 Swapping Cache Modules Between Controllers

Digital does not recommend the swapping of cache modules from one controller to another. Is it best to repair or replace a failed cache module. However, if you need to reconfigure your storage system, and you decide to move a write-back cache module from one controller to another, do the following steps in sequence:

1. **Before** removing the write-back cache module from its original location, enter the CLI command SHUTDOWN THIS_CONTROLLER. Do not specify the IMMEDIATE_SHUTDOWN or IGNORE_ERRORS qualifiers.

2. After removing the write-back cache module from the backplane, reinstall the battery disable jumper (W1) over its two pins, then remove the jumper and place it over only one of the two pins. This action clears all unwriteable data in cache memory.
3. Install the write-back cache module in its new location.

9.2.1.4 Module Removal

1. The controller module's front bezel covers the write-back cache module. Any time you service a write-back cache, you must remove the controller module. You must shut down controller(s) based on considerations of configuration, down time, and so on. Refer to Section 9.1.

   WARNING

   The write-back cache is a high energy module. Do not allow the write-back cache to contact any conductive surface, or injury and/or equipment damage may result.

   CAUTION

   The write-back cache batteries add weight to the module. Grasp the module firmly by the side where the batteries are seated any time you handle the module.

2. Use a gentle up-and-down rocking motion to loosen the module from the shelf backplane.
3. Slide the write-back cache module out of the shelf, noting which rails it was seated in, and place it on an approved *nonconductive* ESD mat.

9.2.1.5 Module Replacement/Installation

1. To replace the write-back cache module, its controller module must already be removed. (You should replace the write-back cache before reinstalling the controller module.)

   WARNING

   The write-back cache is a high energy module. Do not allow the write-back cache to contact any conductive surface, or injury and/or equipment damage may result.

   CAUTION

   The write-back cache batteries add weight to the module. Grasp the module firmly by the side where the batteries are seated any time you handle the module.

2. Slide the write-back cache module into the shelf.

3. Use a gentle up-and-down rocking motion to help seat the module into the backplane. Press firmly on the module until it is seated. Finally, press firmly once more to make sure the module is seated.
4. Replace the controller module by referencing Section 9.1.

9.2.2 Battery Removal

You may want to remove the batteries to reuse them on another cache module or because they have failed.

A console message is displayed when the write-back cache batteries are low (refer to Chapter 7). However, to check the battery status, you may enter the SHOW *controller* command. The battery status is "GOOD," "LOW," or "BAD."

The steps in this section explain how to remove the batteries.

WARNING

The write-back cache batteries are high energy devices. Do not allow the battery contacts to touch any conductive surface, or injury and/or equipment damage may result.

Note

Although service described in this guide is limited to removing and replacing batteries, it is mandatory that DIGITAL Multivendor Customer Services *never* repair the write-back cache module while the batteries are installed.

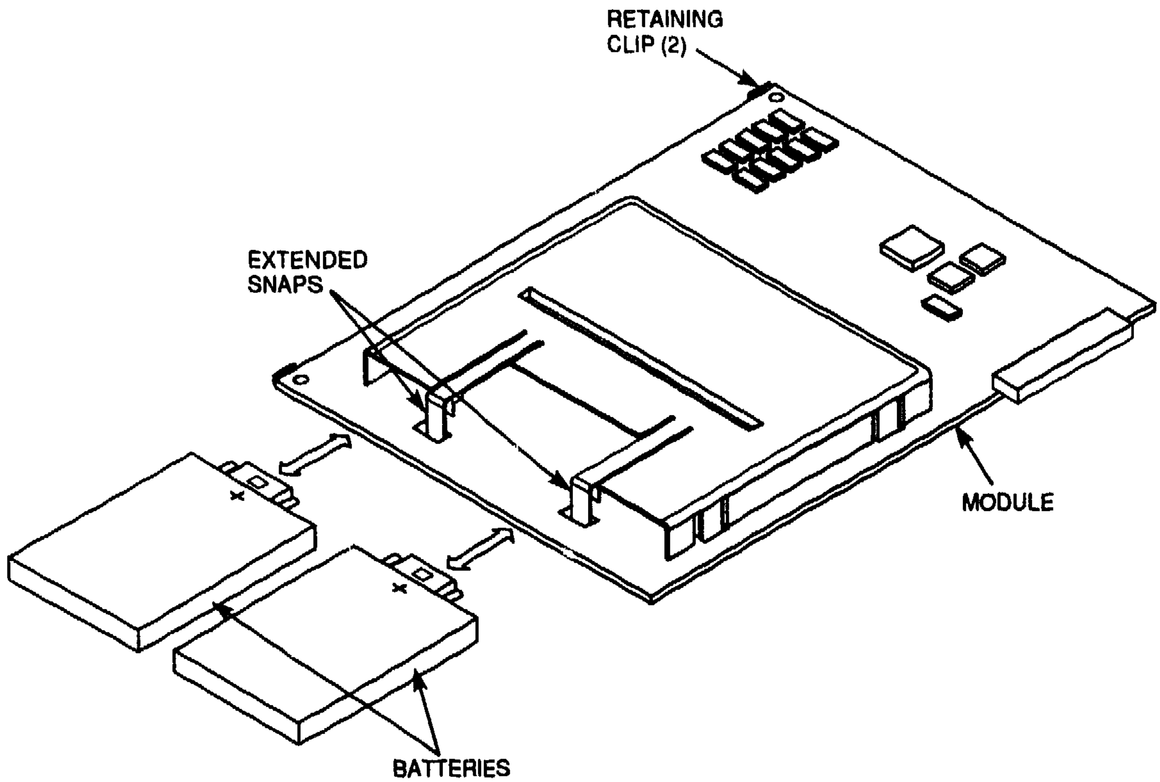
1. Locate the two write-back cache batteries seated under the plastic bracket at one end of the module.
2. Disengage and gently lift the extended snaps on the plastic bracket, and pull the batteries straight out of the module (see Figure 9–4). Place the batteries on an approved *nonconductive* ESD mat.

9.2.2.1 Battery Disposal

Dispose of batteries that are no longer capable of being recharged. Be aware that the write-back cache batteries contain lead. Therefore, follow disposal regulations applicable to their composition and marking in accordance with your local recycling laws.

Consult your service policies regarding hazardous materials handling for details. Do not simply discard spent batteries in the trash unless permitted by local regulations.

Figure 9–4 Write-Back Cache Batteries



9.2.2.2 Battery Replacement/Installation

WARNING

The write-back cache batteries are high energy devices. Do not allow the battery contacts to touch any conductive surface, or injury and/or equipment damage may result.

Note

Although service described in this guide is limited to removing and replacing batteries, it is mandatory that DIGITAL Multivendor Customer Services *never* repair the write-back cache module while the batteries are installed.

---

1. Disengage and gently lift the extended snaps on the plastic bracket and slide the batteries, positive (+) side up, straight into the module (refer to Figure 9–4).
2. Press the batteries firmly into the module so they are seated and the extended snaps close easily around the batteries.

   If you accidentally install a battery upside down, you will not be able to firmly seat the battery or close the retaining clip.

9.2.3 Upgrading Cache Modules

You can upgrade a cache module by increasing memory and/or converting from read to write-back caching.

Note

Some of the upgrade options involve simply replacing your old cache module with a new one. However, others include installing batteries on an existing module.

---

1. Determine your cache module type by entering the CLI> SHOW THIS_CONTROLLER command. Information similar to the following is displayed:

```
CLI> show this_controller full

Controller:
        SWXRC-04 ZG34901786 Firmware V020-0, Hardware  F01
        Configured for dual-redundancy with ZG31800221
            In dual-redundant configuration
        SCSI address 7
        Time: 31-JUL-1994 16:32:54
Host Port:

Cache:
        32 megabyte write cache, version 2
        Cache is GOOD
        Battery is GOOD
        No unflushed data in cache
        CACHE_FLUSH_TIMER = DEFAULT (10 seconds)
Licensing information:
        RAID (Raid5 + Writeback Cache) is ENABLED, license key is VALID
        WBCA (Writeback Cache ONLY) is DISABLED, license key is VALID
Extended information:
        Terminal speed 19200 baud, eight bit, no parity, 1 stop bit
        Operation control: 00000005  Security state code: 15723
```

   Note the cache module size, type, cache version number, and firmware version.

2. See Appendix A to find the part number you need for the upgrade. Note that batteries are not supplied with the 32 MB module. You must order new batteries and a battery mounting bracket, or transfer the batteries from the 16 MB module.

   Note

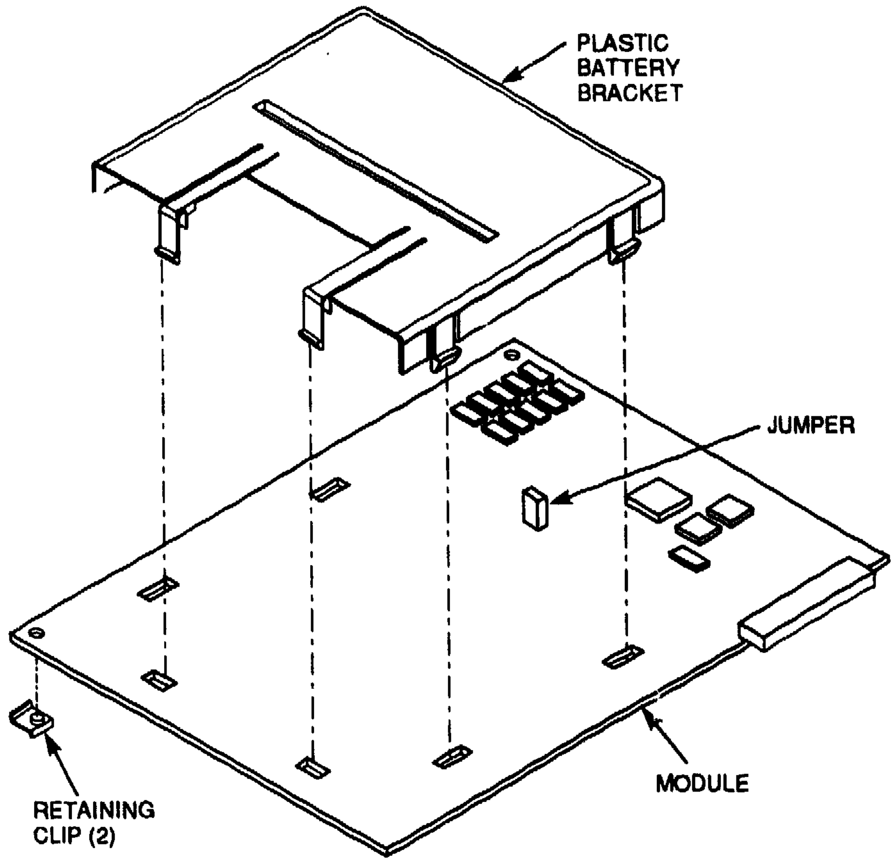
   If you upgrade from 16 to 32 MB read cache, you must return the 16 MB module to DIGITAL for replacement when you receive the 32 MB upgrade.

   ---

3. If necessary, remove the cache module as described in Section 9.2.4.3 or 9.2.1.4.

4. Snap the plastic battery bracket into the slots in the module as shown in Figure 9–5.

Figure 9–5 Plastic Battery Bracket Installation



5. Install the two lead acid batteries as described in Section 9.2.2.2.
6. Remove the jumper[5] on the component side of the module (see Figure 9–5).
7. Replace the jumper on its contact pins so that only one pin is covered. With the jumper now "sidestepped," the jumper is not easily lost.

Note

Replace the jumper so that it covers both pins if you need to return the module for service. When the jumper covers both pins, it disables the batteries and keeps them from discharging.

8. Insert the upgraded cache module by following the steps in Section 9.2.4.4 or 9.2.1.5.

[5] Preconfigured systems with write-back cache modules installed do not have the jumper installed.

9.2.4 Removing and Replacing Read Cache Modules

The following sections describe how to service a read cache module.

9.2.4.1 Tools Required

You need the following tools to remove or replace the read cache module:

- ESD strap
- nonconductive ESD mat
- 3/32-inch Allen wrench
- Flat-head screwdriver

9.2.4.2 Precautions

Refer to Chapter 1 for ESD, grounding, module handling, and program card handling guidelines.

Ground yourself to an appropriate place in the cabinet before servicing the read cache module.

9.2.4.3 Module Removal

Use the following procedure to remove the read cache module:

1. The controller module's front bezel covers the read cache module. Any time you service a read cache, you must remove the controller module. You must shut down the controller(s) based on considerations of configuration, down time, and so on. Refer to Section 9.1.
2. Use a gentle up-and-down rocking motion to loosen the cache module from the shelf backplane.
3. Slide the read cache module out of the shelf, noting which rails it was seated in, and place it on an approved ESD mat.

9.2.4.4 Module Replacement/Installation

Use the following procedure to replace the read cache module:

1. To replace the read cache module, its controller module must already be removed. (You should replace the read cache module before reinstalling the controller module.)
2. Slide the read cache module into the shelf.
3. Use a gentle up-and-down rocking motion to help seat the module into the backplane. Press firmly on the module until it is seated. Finally, press firmly once more to make sure the module is seated.
4. Replace the controller module. Refer to Section 9.1.

9.3 Servicing Program Cards

Whenever you remove a failed controller module (refer to Section 9.1), you remove the PCMCIA program card. However, there are times when you need to remove *only* the program card, such as when you install updated firmware.

You may remove one or both program cards from a dual-redundant configuration.

Note

When you update firmware, you must remove *both* program cards from a dual-redundant configuration. Furthermore, the two cards in a dual-redundant configuration *must* contain the same version of firmware.

Use the procedures in this section when you are removing and replacing *only* the program card.

9.3.1 Tools Required

None required.

9.3.2 Precautions

Refer to Chapter 1 for program card handling guidelines.

Ground yourself to the appropriate place on the cabinet before handling the program card.

9.3.3 Program Card Removal

Use the following procedure to remove the program card:

1. If you have not done so already, unlock and open the cabinet doors to gain access to the controller(s) and the program card(s).
2. Examine the green OCP reset (//) LED(s) on the controller(s). They should be flashing.

   If a green LED is lit continuously, its controller has failed. To service the controller, refer to Section 9.1.

   Note

   You need not record configuration information; the configuration infomation is not lost when removing a program card.

   ---

3. Connect a maintenance terminal to the MMJ of the controller(s) you are removing the program card from, and shut down the controller(s) by following the guidelines in Section 9.1.2.

   The green LED(s) should light continuously when shutdown completes.
4. Unsnap and remove the ESD shield(s) covering the program card(s) (refer to Figure 9–1).
5. Remove the program card(s) by pushing the eject button(s) (refer to Figure 9–1) next to the card(s).
6. Pull the card(s) out.

7. If you are updating firmware, follow the instructions included with your new firmware for used card return or disposal.

9.3.4 Program Card Replacement/Installation

Use the following procedure to replace the program card:

Note

If you are updating firmware, install your new program card(s) by following the instructions included with the card(s).

Otherwise, you may use the following guidelines to replace the program card(s).

---

1. **Nonredundant configuration:**

   Press and hold the controller green OCP reset (//) button. Then insert the program card. The program card eject button extends when the card is fully inserted.

   Dual-redundant configuration:

   Press and hold *both* green reset buttons at the same time, *even if you are only replacing one of the cards.* Then insert the program card(s). The program card eject button extends when the card is fully inserted.

2. Release the reset button(s) to initialize the controller(s).

   If the controller(s) initialize correctly, the green reset LED(s) flash at 1 Hz. If an error occurs during initialization, the OCP(s) display a code. If necessary, refer to Chapter 7 to analyze any codes.

3. Snap the ESD shield(s) into place over the program card(s).
4. If you wish, you may disconnect the maintenance terminal. The terminal is not required for normal controller operation.
5. Close and lock the cabinet doors.

9.4 Servicing SCSI Host Cables

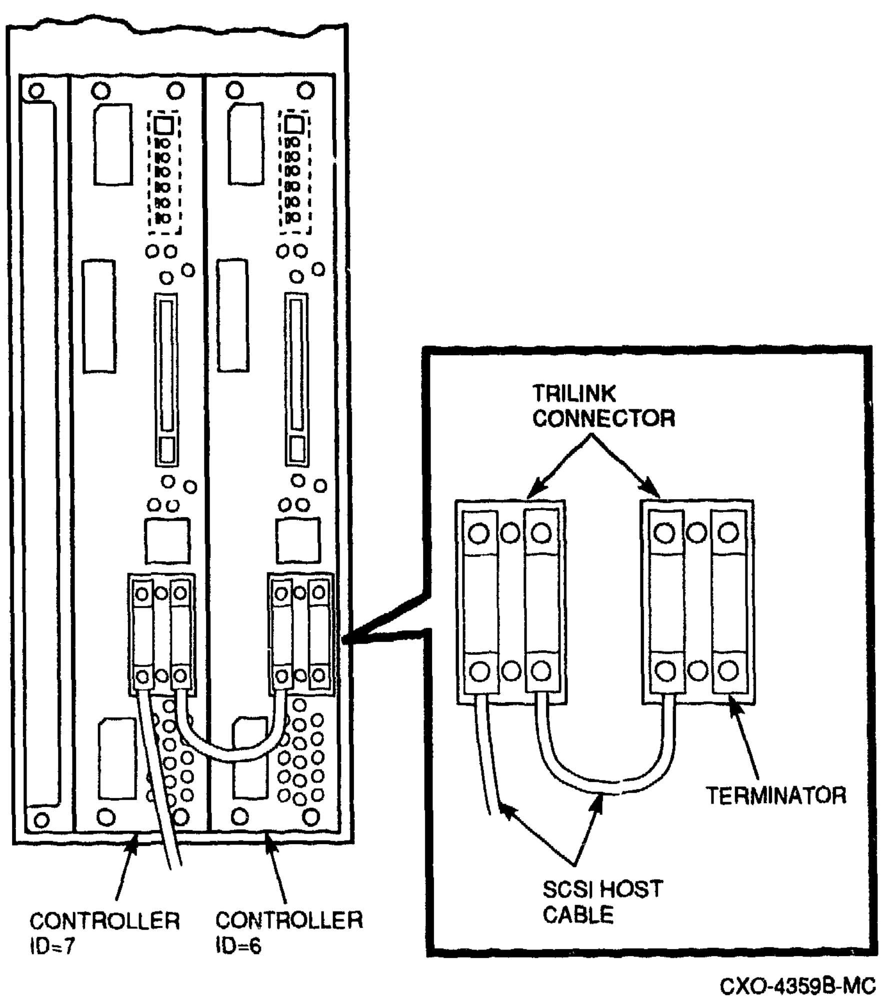
Servicing SCSI host cables (see Figure 9–6) may cause subsystem down time because the host path is disconnected from at least one controller for the duration of the procedure. (If you have a dual-redundant configuration, you should consider shutting down one controller and using the surviving controller to service devices while you replace the cable to its companion.) Use the procedures in this section when you are removing and replacing SCSI host cables.

CAUTION

Never leave active SCSI host buses unterminated during service. How you service your cables, and what devices you may leave running, depend upon your configuration.

(Optional) The trilink connector may be considered part of the SCSI host cable during service.

Figure 9–6 SCSI Host Cables



9.4.1 Tools Required

You need the following tools to remove or replace SCSI host cables:

- Tie wrap cutters
- Flat-head screwdriver

9.4.2 Precautions

Refer to Chapter 1 for general SCSI host cable handling guidelines.

9.4.3 Cable Removal

Use the following procedure to remove SCSI host cables:

1. Disconnect the SCSI host cable from the host or other device (the device at the other end of the cable from the controller).
2. If necessary to access the SWXRC–04 controller, unlock and open the cabinet to gain access to the cables.
3. Loosen the captive screws on the SCSI host cable where it attaches to the trilink connector on the front of the controller, and disconnect the cable.
4. Remove the SCSI host cable from the cabinet, cutting tie wraps as necessary.
5. (Optional) Loosen captive screws and remove the terminator or secondary SCSI host cable attached to the trilink connector.
6. (Optional) Loosen captive screws and remove the trilink connector from the front of the controller.

9.4.4 Cable Replacement/Installation

Use the following procedure to replace SCSI host cables:

1. (Optional) Attach the trilink connector to the front of the controller and tighten its captive screws.
2. Position and route the SCSI host cable within the cabinet.
3. Connect the SCSI host cable to the trilink connector on the front of the controller, and tighten the captive screws on the SCSI host cable connector.
4. (Optional) Connect and tighten captive screws for the terminator or secondary SCSI host cable (at the open connection of the trilink connector).
5. Install any tie wraps as necessary to hold the SCSI host cable in place.
6. Close and lock the cabinet doors.
7. Connect the other end of the cable to the appropriate device on the bus, removing terminators as necessary.

9.5 Servicing SCSI Device Port Cables

Servicing SCSI device port cables causes subsystem down time because you must remove devices to access SCSI connectors on the SWXSS–01 (controller) and SWXSS–02 (device) shelf backplanes.

Note

If the desired cable connects to a device shelf in the lower part of a cabinet, it may be easier to remove the device shelf rather than attempt this procedure with the shelf installed. Refer to the *StorageWorks Solutions Shelf and SBB User's Guide* for procedures to remove a device shelf and for correct SCSI cable lengths.

9.5.1 Tools Required

You need the following tools to remove or replace device port cables:

- ESD strap
- 3/32-inch Allen wrench
- Flat-head screwdriver

9.5.2 Precautions

Refer to Chapter 1 for ESD, grounding, module handling, and cable handling guidelines.

9.5.3 Cable Removal

Use the following procedure to remove device port cables:

1. Unlock and open the cabinet to gain access to the cables.
2. To gain access to the cables in the controller shelf, remove the controller(s) and cache module(s) using the procedures described in Sections 9.1 and 9.2.
3. Using a flat-head screwdriver, loosen the two captive screws on each side of the volume shield, and remove the shield (see Figure 9–7).
4. Remove the cable from the SWXSS–01 (controller) shelf backplane by pinching the cable connector side clips and disconnecting the cable.

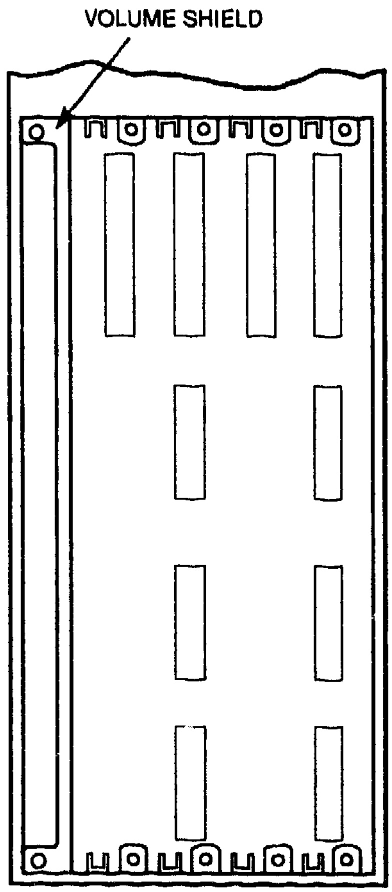
CAUTION

DIGITAL recommends labelling devices to indicate what slot they were removed from. If SBBs are removed and then returned to a different slot, *customer data may be destroyed.*

Let disk drives spin down for at least 30 seconds prior to removing them from the device shelf. Gyroscopic motion from a spinning disk may cause you to drop and damage the SBB.

5. Remove any SBBs necessary to allow access to the SCSI cables in the device shelf, as shown in Figure 9–8. (Press down on the two SBB mounting tabs to release it from the shelf, and pull the device straight out.)

Figure 9–7 Volume Shield



6. Remove the cable from the SWXSS–02 (device) shelf backplane by pinching the cable connector side clips and disconnecting the cable.

9.5.4 Cable Replacement/Installation

Use the following procedure to replace device port cables:

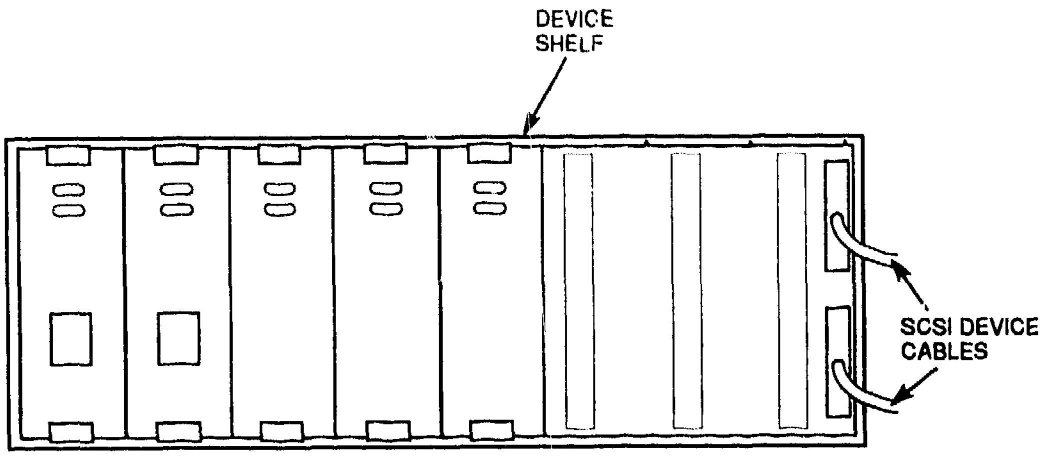
CAUTION

Be very careful when inserting cable connectors into connectors within the SWXSS–01 and SWXSS–02 shelves. Inserting a poorly aligned cable connector can damage the shelf connector.

You must replace the entire shelf if its connectors are damaged.

1. For the device shelf connector, *gently* slide the cable connector in from one side to the other, and rock the connector from top to bottom to seat it.
2. Listen for the connector to snap into place.

Figure 9–8 SCSI Device Cables



3. For the controller shelf connector, *gently* slide the cable connector in from one side to the other, and rock the connector from top to bottom to seat it.
4. Listen for the connector to snap into place.

CAUTION

Return a device to the slot from which it was removed. If SBBs are removed and then returned to a different slot, *customer data may be destroyed.*

---

5. Insert the SBBs into the device shelf *making sure that all SBBs are returned to their original slots.*

   The SBB mounting tabs snap into place as the SBBs are locked into the shelf.
6. Replace the volume shield in the controller shelf and tighten the captive screws finger tight using a flat-head screwdriver (refer to Figure 9–7).
7. Replace the cache module(s) and controller(s) using the procedures described in Sections 9.1 and 9.2.
8. Close and lock the cabinet doors.

9.6 Servicing Shelf Blowers

WARNING

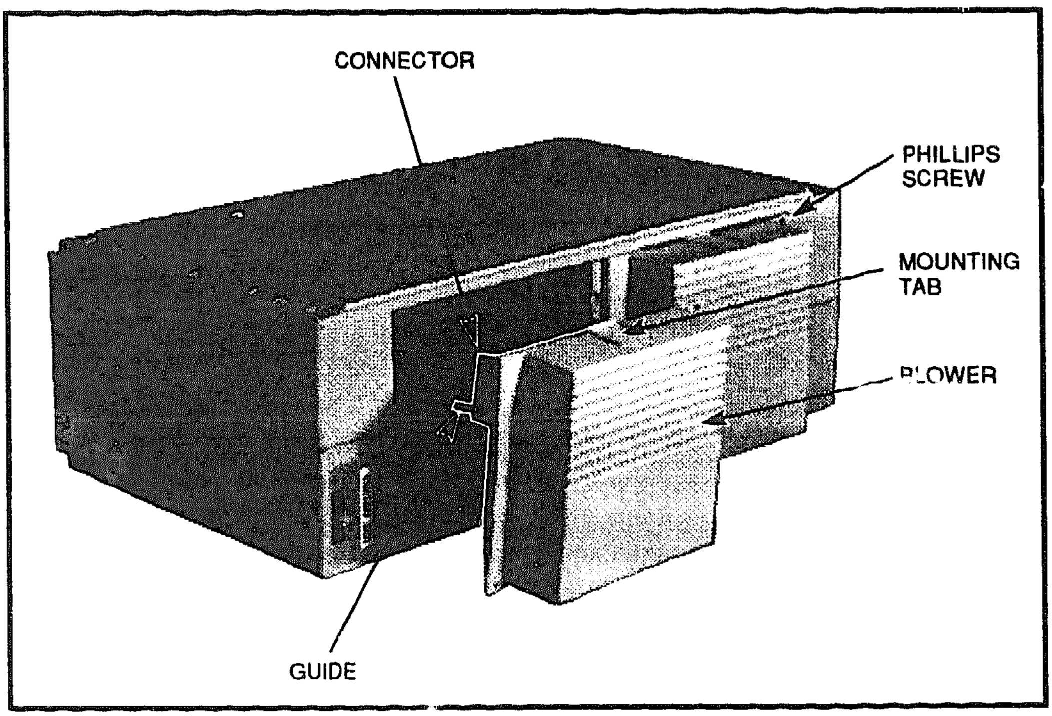
Service procedures described in this guide that involve shelf blower removal or access to the rear of the shelf must be performed only by qualified service personnel.

StorageWorks shelves have rear-mounted blowers that cool the controllers and storage devices (see Figure 9–9). Connectors on the shelf backplane provide +12 Vdc power to operate them.

When a blower in a SWXSS-series shelf fails, the shelf status (upper) LED on the power SBB turns off, and an error message is passed to the controller or host.

When a blower in a SWXSC–AA cabinet shelf fails, the condition is detected by the EMU and displayed on the EMU control panel.

Figure 9–9 Replacing a Blower



As long as one blower in an HA-000 or SWXSS–02 shelf is operating, there is sufficient air flow to prevent an overtemperature condition. If both blowers fail, the shelf can overheat in as little as 60 seconds. The SWXSC–AA cabinet can operate indefinitely with one failed blower.

9.6.1 Tools Required

You need the following tools to remove or replace the blower:

- Phillips screwdriver (#2)

9.6.2 Precautions

Refer to Chapter 1 for safety guidelines.

9.6.3 Blower Removal

WARNING

To reduce the risk of electrical energy hazard, disconnect the power cables from the shelf power supplies before removing shelf blower assemblies or performing service in the backplane area.

Use the following procedure to remove a blower:

1. Unlock and open the cabinet doors to gain access to the blowers. For SWXSC–AA cabinets, locate the dual-speed blowers on the rear of the cabinet.
2. If you cannot access the rear of the shelf, remove its SCSI device cables as described in Section 9.5. Then remove the shelf as described in the *StorageWorks Solutions Shelf and SBB User's Guide.*
3. Disconnect the power cables from the shelf power SBBs. The primary power supply cord is black. The secondary power supply cord is gray.
4. Use a Phillips screwdriver to remove the safety screw in the upper right corner or lower left corner of the blower. (This step is unnecessary for SWXSC–AA cabinets.)
5. Press the upper and lower blower mounting tabs together to release the blower.
6. Pull the blower straight out to disconnect it from the shelf power connector.

9.6.4 Blower Replacement/Installation

WARNING

To reduce the risk of electrical energy hazard, disconnect the power cables from the shelf power supplies before replacing shelf blower assemblies or performing service in the backplane area.

Use the following procedure to replace a blower:

1. Align the replacement blower connector and push the blower straight in, making sure it is fully seated and that both mounting tabs lock in place.
2. Replace the safety screw in the corner of the blower using a Phillips screwdriver. (This step is unnecessary for SWXSC–AA cabinets.)
3. If you had to remove the shelf to access the blowers, replace the shelf as described in the *StorageWorks Solutions Shelf and SBB User's Guide*. Then replace its SCSI device cables as described in Section 9.5.

4. Connect the shelf power cables and verify that the shelf and all SBBs are operating properly.

Note

If the upper power supply LED (shelf status) does not come on and all the shelf power supplies are operating, the second blower may have failed or the wrong blower may have been replaced.

---

5. Close and lock the cabinet doors.

9.7 Servicing Shelf Power Supplies

There are two methods for replacing shelf power supply SBBs: **hot swap** and **cold swap**.

- Use hot swap to replace a power supply *only* when there are redundant power supplies in a shelf. Hot swap enables you to remove defective power supplies while the other supplies furnish power.

Note

Hot swap does not disable the shelf or its contents.

- Use cold swap when the power is off to the shelf for some reason or when there are no redundant power supplies. Should this occur in an SWXSC–AA cabinet shelf or SWXSS–01 controller shelf, the controller, cache module, and all associated SCSI buses are disabled until power is restored. On a SWXSS–02 device shelf, those particular devices are disabled, though their controller still services devices on other shelves.

9.7.1 Tools Required

None required.

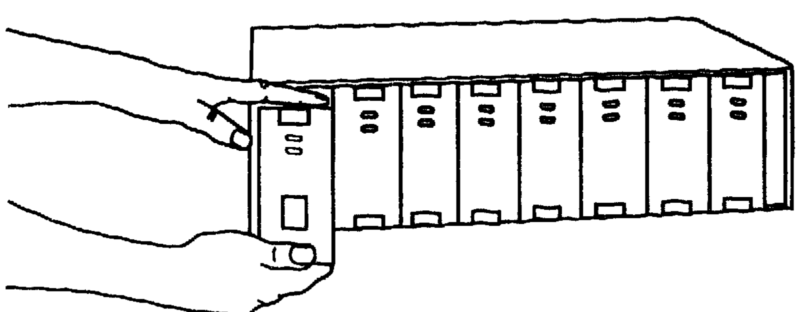
9.7.2 Precautions

Refer to Chapter 1 for safety guidelines.

9.7.3 Power Supply Removal

Use the following procedure to remove a power supply (see Figure 9–10):

Figure 9–10 Power Supply Removal



Note

The cold swap procedure is identical to hot swap, except you should shut down the shelf contents (devices or controllers) *before* removing the power supply.

---

1. Unlock and open the cabinet doors to gain access to the power supplies.
2. Make sure the power status (lower) LED on the power supply is off.
3. Unplug the power supply.
4. Press the two mounting tabs together to release the power supply from the shelf.

CAUTION

The power supply is relatively heavy and can be damaged if dropped. Always use *both* hands to fully support the power supply during removal.

5. Use both hands to pull the power supply out of the shelf.

9.7.4 Power Supply Replacement/Installation

Use the following procedure to replace a power supply (refer to Figure 9–10):

CAUTION

The power supply is relatively heavy and can be damaged if dropped. Always use *both* hands to fully support the power supply during replacement.

1. Hold the power supply in both hands and firmly push it into the shelf until you hear the mounting tabs snap into place.
2. Plug the power cord back into the power supply.
3. Observe the power and shelf status LEDs to make sure both turn on. If both LEDs do not turn on, refer to Chapter 7 for troubleshooting basics.
4. Close and lock the cabinet doors.

9.8 Warm Swapping Storage Subsystem Components

Industry definitions of cold, warm, and hot swap may vary considerably. For purposes of the StorageWorks family of products, these terms are defined as follows:

- **Cold swap:** a product replacement method where all system power and activity must be totally removed for the duration of service. This method is used when conditions preclude the use of the warm swap or hot swap methods.
- **Warm swap:** a replacement method where a product can be added, removed, or replaced while system power is on, but while some system activity is *momentarily* suspended during the procedure.
- **Hot swap:** a replacement method where the system remains powered on and fully active during product service. The product being removed or installed is the only item that cannot perform operations during this process.

When you warm swap a storage SBB or a controller, you quickly and safely remove the hardware and install a replacement. Warm swap is possible *without* taking your controllers out of service or adversely affecting activity on the rest of the subsystem. Using warm swap also preserves data integrity.

Note

Warm swap is not applicable to service on unpowered StorageWorks shelves. Do not attempt to execute warm swap on an unpowered shelf.

9.8.1 Warm Swapping Device SBBs

Device warm swap involves quickly removing and replacing a disk drive, tape drive, or other storage SBB. You can safely remove SBBs without taking your system or controller off line. However, before removing a device, either the controller or the operator must determine that the swap is necessary. You may also use the SBB warm swap procedure to add a device to an empty shelf slot.

- The controller determines that a device is bad by trying to access the device, receiving no response from the device, or detecting excessive errors from the device.
- The operator decides to remove a device by examining the OCP codes, the SBB LEDs, system messages, or system error log information.

Most devices can be warm swapped; however, see your firmware release notes for restrictions.

9.8.1.1 Tools Required

None required.

9.8.1.2 Precautions

Refer to Chapter 1 for safety guidelines.

9.8.1.3 Device Removal

CAUTION

Warm swap supports removal and replacement of only *one* SBB at a time. Should another SBB need to be swapped, you must repeat the entire warm swap procedure.

You must follow steps in this section in their exact order so that the following is ensured:

- Preserve data integrity (especially for devices with older SCSI interface designs).
- Reduce chances of making a port unusable for a long period, which can render several devices inaccessible.
- Prevent the controller from performing unpredictably.

Use the following procedure to remove a device:

1. For all configurations except those using RAIDsets, you must dismount the device from the host *before* proceeding. (For example, in VMS you use the DISMOUNT command.)

   Refer to your operating system documentation for procedures necessary for dismounting a device.

   RAIDsets *that are not already running as reduced* automatically adjust to the removal of a device (the RAIDset goes reduced). In this case there is no need to dismount the suspect device. However, you must dismount the device if the RAIDset is already reduced.

2. Unlock and open the cabinet doors to gain access to the device SBBs.

3. Quiesce the SBB's port by pressing and holding the controller port button for the SBB. Continue holding the button until all amber OCP LEDs light.

   Note

   Only one port may be quiesced at any time.

   If the button is not held long enough, or multiple buttons are pushed in quick succession, *all* buttons are ignored (no ports are quiesced). You must press and hold the button again to quiesce the port.

   ---

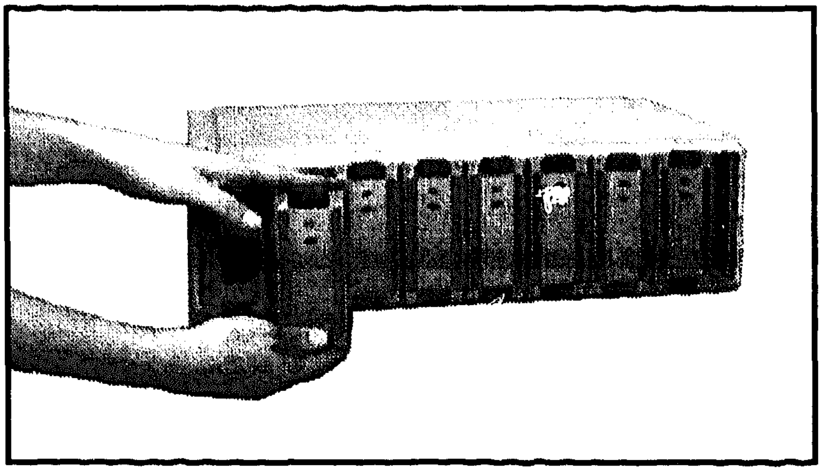
4. Wait until the chosen port LED flashes alternately with the other port LEDs (this indicates I/O has stopped). The alternating pattern flashes for approximately 30 seconds, during which you may remove (and, time permitting, replace) the SBB.

   If the pattern does not appear after a minute or two, another shelf is asserting a fault signal that prevents any quiesce function on this controller. To correct the problem, you must locate the suspect shelf and do one of three things:

   - Remove all devices from the shelf.
   - Disconnect the shelf's SCSI device cables (refer to Section 9.5).
   - Repair/replace the shelf power supply (refer to Section 9.7).

5. To remove the SBB, press its two mounting tabs together to release it from the shelf, and pull it out using both hands (see Figure 9–11).

Figure 9–11 SBB Warm Swap



CXO-3611B-PH

While the OCP LEDs are flashing, any SBBs on the quiesced port that have status LEDs also flash.

Note

The length of time required for I/O to stop can vary from zero seconds to several minutes, depending on load, device type, and cache status.

After you remove the SBB, the flashing pattern on the OCP stops, and normal operation on the ports resumes. At this time the removed SBB's port LED turns on. The LED stays on until the SBB is returned to its slot or until another SBB is inserted in the slot. The remaining port LEDs turn off.

9.8.1.4 Device Replacement

Use a replacement device of the same type as the removed device. Otherwise, subsystem failures such as the establishment of storagesets may occur. Use the following procedure to replace a device:

1. Quiesce the SBBs port by pressing and holding the port button for the SBB. Continue holding the button until all amber OCP LEDs light.

Note

Only one port may be quiesced at any time.

If the button is not held long enough, or multiple buttons are pushed in quick succession, *all* buttons are ignored (no ports are quiesced). You must press and hold the button again to quiesce the port.

---

2. Wait until the chosen port LED flashes alternately with the other port LEDs (this indicates I/O has stopped). The alternating pattern flashes for approximately 30 seconds, during which you may insert the SBB.

   If the pattern does not appear after a minute or two, another shelf is asserting a fault signal that prevents any quiesce function on this controller. To correct the problem, you must locate the suspect shelf and do one of three things:

   - Remove all devices from the shelf.
   - Disconnect the shelf's SCSI device cables (refer to Section 9.5).
   - Repair/replace the shelf power supply (refer to Section 9.7).

   While the OCP LEDs are flashing, any SBBs on the quiesced port that have status LEDs also flash.

   Note

   The length of time required for I/O to stop can vary from zero seconds to several minutes, depending on load, device type, and cache status.

3. Hold the SBB in both hands, and firmly push it into the shelf until you hear the mounting tabs snap into place.

9.8.1.5 Restoring the Device to the Configuration

After you insert the SBB, the flashing pattern on the OCP stops, and normal operation on the ports resumes. At this time the port LEDs turn off.

- If you inserted a new device in a previously *unused* slot, that port's LED remains lit until the device is added by entering the following command (see Appendix B):

  ```
  CLI> ADD device
  ```

- If a tape SBB is inserted in a slot where a disk SBB was previously installed, the port LED remains lit until the device is added using the ADD command, *and* you delete the previously installed disk device from the list of known devices, as follows:

  ```
  CLI> DELETE device-name
  ```

- If the new disk is to be part of a storageset, you must delete the storageset from the configuration and create (ADD) it again.
- Initialize a newly inserted disk by entering the following:

  ```
  CLI> INITIALIZE container
  ```

  where *container* is either the disk, or a group of disks linked as a storageset. This initializes the metadata on each disk in the container, including the one that was just swapped.

  CAUTION

  If you think you have failed to perform warm swap exactly as stated here, you should reinitialize the controller. Otherwise, the controller may perform unpredictably.

Remember to close and lock cabinet doors after finishing the device warm swap.

9.8.2 Warm Swapping Controllers

Use warm swap to safely remove and replace one controller in a dual-redundant configuration. When you warm swap a controller, you are changing out a controller in the most transparent method available to the subsystem.

Performing warm swap involves removing one controller, while forcing the other controller into failover. Because the remaining controller executes failover, it assumes control of the absent controller's devices. This minimzes impact to system performance and downtime.

Note

You must warm swap only one controller at a time. Never attempt to remove both controllers in your dual-redundant configuration using warm swap.

Try to have a replacement controller available prior to starting warm swap. Otherwise, you must terminate the warm swap program and restart it later when you have a replacement.

9.8.2.1 Tools Required

You need the following tools to warm swap a controller:

- ESD strap
- 3/32-inch Allen wrench
- Flat-head screwdriver
- Small flat-head screwdriver

9.8.2.2 Precautions

Refer to Chapter 1 for ESD, grounding, module handling, and program card handling guidelines.

Ground yourself to an appropriate place on the cabinet before servicing the controller module.

9.8.2.3 Controller Removal

Use the following procedure to remove the controller.

1. If the controller you are removing has totally failed, proceed to step 2.

   If the controller you are removing has any I/O outstanding or devices on line, shut down that controller (refer to Section 9.1.2).
2. Apply either a virtual terminal connection or a maintenance terminal to the controller you are *not* removing.
3. If the controller you plan to warm swap is still functioning (green LED blinking), shut down the controller using the CLI> SHUTDOWN command.
4. Enter the RUN C_SWAP command. The system responds with the following:

   ```
   Controller Warm Swap, Software Version -V2.0

   *** Sequence to REMOVE other SWXRC-04 has begun. ***

   Do you wish to REMOVE the other SWXRC-04 Y/N [N]?
   ```

5. Enter "Y" to continue the procedure.

```
Will its cache module also be removed Y/N [N]?
```

6. Enter "Y" only if you will be removing the controller's cache module as well.

```
Killing other controller.
Attempting to quiese all ports.

   Port 1 quiesced.
   Port 2 quiesced.
   Port 3 quiesced.
   Port 4 quiesced.
   Port 5 quiesced.
   Port 6 quiesced.

All ports quiesced.

Remove the other SWXRC-04 (the one WITHOUT a blinking green LED) within
5 minutes.
```

Note

Do not remove the controller with the blinking green LED reset (//) button.

---

7. You have 5 minutes to remove the controller following the steps described in Table 9–1. Your terminal will update you with the time remaining to complete the removal procedure, as shown in the following example:

```
Time remaining 4 minutes, 40 seconds.
```

Note

If you fail to remove the controller within 5 minutes, the subsystem restarts the quiesced ports, and you must begin this procedure again.

Table 9–1 Module Removal

Step	Description
1	Ground yourself to an appropriate place on the cabinet.
2	Unlock and open the cabinet doors to gain access to the controllers.
3	Unsnap and remove the program card ESD shield (refer to Figure 9–1).
4	Remove the program card by pushing the eject button (refer to Figure 9–1) next to the card. Pull the card out and save it for use in the replacement controller module.
5	With a small flat-head screwdriver, loosen the captive screws on the trilink connector and remove the trilink from the front of the controller. You must work around any SCSI cable or terminator connections when removing the trilink. Do *not* remove cables or terminators from the trilink or you will interrupt the host SCSI bus.
6	Loosen the four screws on each side of the front bezel.
7	Use a gentle up-and-down rocking motion to loosen the module from the shelf backplane.
8	Slide the module out of the shelf (noting which rails the module was seated in) and place on an approved ESD work surface or mat.
9	If necessary, you may now remove the cache module as described in Section 9.2.4.3 or 9.2.1.4.

Once you remove the controller, you the following displays as the subsystem uses the remaining controller to service the quiesced ports:

```
Restarting ALL ports.
   Port 1 restarted.
   Port 2 restarted.
   Port 3 restarted.
   Port 4 restarted.
   Port 5 restarted.
   Port 6 restarted.
```

9.8.2.4 Controller Replacement

Use the following procedure to replace the controller.

1. The system prompts you with the following to replace the controller:

   ```
   Do you have a replacement SWXRC-04 readily available [N]?
   ```

   Try to have a replacement available. If you do not have one, you must answer with "N." Then, the warm swap sequence will terminate, and you must restart the routine later when you have a replacement.

2. When you find a replacement, you can restart the sequence by entering the RUN C_SWAP command again. The system responds with the following:

   ```
   Do you have a replacement SWXRC-04 readily available [N]?
   ```

   Answer "Y" if you have the controller.

3. The following is displayed next:

   ```
   *** Sequence to INSERT other SWXRC-04 has begun. ***

   Do you wish to INSERT the other SWXRC-04 [N]?
   ```

   Answer Y to insert the controller.

   Remember to first reinsert the cache module if applicable.

```
Attempting to quiese all ports.

   Port 1 quiesced.
   Port 2 quiesced.
   Port 3 quiesced.
   Port 4 quiesced.
   Port 5 quiesced.
   Port 6 quiesced.

All ports quiesced.

Insert the cache module, then insert the other SWXRC-04, WITHOUT its
program card, and press Return
```

4. Insert the cache (if applicable) and controller now. Follow the steps outlined in Table 9–2.

Table 9–2 Module Replacement

Step	Description
1	Ground yourself to an appropriate place on the cabinet.
2	You should replace the cache module now, if you removed it. Refer to Section 9.2.4.4 or 9.2.1.5.
4	Slide the controller module into the shelf.
5	Use a gentle up-and-down rocking motion to help seat the module into the backplane. Press firmly on the module until it is seated. Finally, press firmly once more to make sure the module is seated.
6	Tighten the four screws on the front bezel.
7	Connect a maintenance terminal to the MMJ of the other controller (the one you did not replace) if one is not already connected.

```
Restarting ALL ports.

   Port 1 restarted.
   Port 2 restarted.
   Port 3 restarted.
   Port 4 restarted.
   Port 5 restarted.
   Port 6 restarted.

The configuration has two contollers.
```

5. Follow the steps in the system message:

```
The Controller Warm Swap program has terminated. To restart the other
controller:

  1) Enter the RESTART OTHER command.
  2) Press and hold the Reset button (//) while inserting the program card.
  3) Release Reset (//) and the controller will initialize.
  4) Configure new controller by referring to the StorageWorks Controller
     User's Guide.
```

   If the controller initializes correctly, its green reset LED begins to flash at 1 Hz. If an error occurs during initialization, the OCP displays a code. If necessary, refer to Chapter 7 to analyze the code.

6. Snap the ESD shield into place over the program card.
7. Restore parameters for the new controller using the steps in Section 9.8.2.5.

9.8.2.5 Restoring Parameters

A new controller module has no initial parameters, so you must use a maintenance terminal to enter them. Refer to information in the CONFIGURATION.INFO file or on the configuration sheet packaged with your system, whichever is most current, for parameters. Be sure to use the same parameters from the removed controller when installing a replacement. Follow these steps:

CAUTION

SET FAILOVER establishes controller-to-controller communication and copies configuration information. Always enter this command on one controller only. COPY=*configuration-source* specifies where the *good* configuration data are located. *Never* blindly specify SET FAILOVER. Know where your good configuration information resides before entering the command.

---

1. Enter the following command to copy configuration information to the new controller:

   ```
   CLI> SET FAILOVER COPY=THIS_CONTROLLER
   ```

   SWXRC–04 controllers return to the dual-redundant configuration and restart after entering this command.

2. Connect the host port cable to the front of the controller. Do *not* connect the controllers in a dual-redundant pair to different host CPUs.

   Connect the SCSI cable trilink connector to the front of the controller and tighten its captive screws with a small flat-head screwdriver. You must work around any SCSI cable or terminator connections when replacing the trilink. Do *not* remove cables or terminators from the trilink or you will interrupt the host SCSI bus.

3. If you wish, you may disconnect the maintenance terminal. The terminal is not required for normal controller operation.

4. Close and lock the cabinet doors.

A
Field Replaceable Units

This appendix lists SWXRC–04 controller field replaceable units (FRUs), required tools and equipment, and related FRUs.

A.1 Controller Field Replaceable Units

The following FRUs come with the various controller modules. Part numbers are correct as of publication of this guide but are subject to change. Always verify your information in case part numbers or ordering methods have changed.

Table A–1 SWXRC–04 FRUs

FRU	Option Number	Part Number
SWXRC–04 controller module (including bezel and trilink connector)	SHS6Z–ZZ	70–31457–02
16 MB cache module	SHS61–ZZ	54–22910–02
32 MB cache module	SHS62–ZZ	54–22910–01
StorageWorks SWXRC–04 program flash card (blank)	—	23–000Z7–01
SCSI–2 device port cables	BN21H–02	
Trilink connector	H885–AA	12–39921–01 (included in 70–31457–02)
68-pin SCSI bus terminator	H879–AA	12–37004–03
Battery, sealed lead acid		12–40235–01
Bracket, dual battery		74–47465–02
Cover, memory card (ESD shield)		74–46416–01

A.2 Required Tools and Equipment

The following tools and equipment are required for controller maintenance:

- Portable antistatic kit, part number 29–26246–00
- ESD mat—for all module replacement service
- 5/32-inch Allen wrench—for opening the doors of an SWXSC–D*x*-series data center cabinet.
- Flat-head screwdriver—for replacing host cables
- Small flat-head screwdriver—for replacing trilink connectors while SCSI host cables are attached

- An EIA–423 compatible terminal is needed for setting the initial configuration. When using this terminal, a connecting cable (between the terminal and the controller) that supports EIA–423 communication is required.

A.3 Related Field Replaceable Units

The following FRUs are related to the SWXRC–04 controllers. (Refer to the appropriate StorageWorks documentation for removal and replacement procedures for these components if not found in this guide.)

Table A–2 Controller Related FRUs

FRU	Option Number
Controller shelf (with backplane)	SWXSS–01
Storage Enclosure	SWXSC–AA
Device shelf (with backplane)	SWXSS–02
Shelf power supply	P–131 P–145 P–150
NULL modem DECconnect laptop 9-pin cable	H8571–J
DEC connect cable	BC16E–*xx*†
SCSI–1-to-SCSI–2 transition cable, 0.2 meter (8-inch)	17–03831–01

†Where *xx* equals the length in feet.

B
Command Line Interpreter

Note

This chapter is based on version X18.00 of the command line interpreter (CLI) specification. The information contained in this chapter is included for reference only.

The display outputs of some CLI commands may depict information fields not related to the SWXRC–04 controller or to devices supported by the controller. Inclusion of information on such device support by certain utilities does not imply support by the controller.

This chapter describes the use and command syntax of the SWXRC–04 controller CLI.

B.1 Command Line Interpreter Overview

The CLI is the user command line interface to the controller. The CLI enables you to add to or modify the controller's configuration using CLI commands. The following sections explain how to set up a controller, to define a storage subsystem configuration, and to modify it when needed.

B.2 Accessing the CLI

The CLI is implemented in the controller's firmware, and can be accessed in either of two ways:

- Using an EIA–423-compatible maintenance terminal—The SWXRC–04 controller provides an EIA–423 hardware port to which a maintenance terminal can be connected. You can access the CLI directly via the EIA–423 port.
- Using a virtual host terminal—You can use a virtual maintenance terminal program to access the CLI from the host. The details of connecting to the CLI with a virtual host terminal depend upon which operating system and terminal program you are using. The CLI commands and the way you use them remains unchanged.

B.2.1 Accessing the CLI Using a Maintenance Terminal

The initial controller configuration is normally set using a maintenance terminal connected to the EIA–423 terminal port on the controller. Thereafter, you can use a virtual host terminal to modify the controller's configuration.

Note

Your CLI> prompt may be factory-set to reflect your controller model, such as "SWX>". See the information pertaining to the SET THIS_

CONTROLLER AND SET OTHER_CONTROLLER commands for details on changing the CLI> prompt. The examples in this document use the prompt "CLI>" to indicate the use of the CLI.

To access the CLI using a maintenance terminal, set the terminal for 9600 baud/8 data bits/1 stop bit/no parity, connect the terminal to the EIA–423 port, and make sure it displays the CLI prompt, "CLI>". If the terminal display is not at the prompt, press the RETURN key to display it.

B.2.2 Accessing the CLI Using a Virtual Host Terminal

If the default SCSI target ID (SCSI ID 3) of the controller does not conflict with the IDs of other units on the host bus, you can connect the controller to the bus and use virtual host terminal software in the host (HSZterm, for example) to set the initial controller configuration. The method of establishing a virtual terminal connection varies depending on the operating system and virtual terminal software. Use the procedures appropriate to your host system.

If the default controller target ID conflicts with other units on the host bus, you must use a maintenance terminal to set the controller ID to a nonconflicting ID. You can then establish and use the virtual terminal connection.

If you use a virtual host terminal program to access the CLI, you should log the session as you create a controller configuration. The method of doing this depends upon your operating system and your virtual terminal software.

If you are using the OpenVMS operating system, for instance, you use a SET HOST command to connect with the controller's CLI. Along with this command, you can use the /LOG=CONFIGURATION.INFO qualifier to create a file named CONFIGURATION.INFO, containing a record of your controller configuration session. Keep a copy of this file for reference each time you alter the configuration using the CLI.

B.2.3 Exiting the CLI

When exiting the CLI, keep the following guidelines in mind:

- If you are using a maintenance terminal, you cannot exit the CLI. Entering the EXIT command merely restarts the CLI and redisplays the controller type and any last fail error information.
- If you are using a virtual terminal connection, enter the following command to exit the CLI and return the terminal to the host:

```
CLI> EXIT
```

B.2.4 Setting the Initial Configuration for a Single Controller

After installing a single controller, use the CLI to define its initial parameters, as follows:

1. Access the CLI via either a maintenance terminal or virtual host terminal connection.
2. Enter the following command to set a valid controller ID:

```
CLI> SET THIS_CONTROLLER ID=n
```

Where *n* is the SCSI target ID(s) (0–7).

Note

Always restart the controller after setting the ID.

---

3. Restart the controller either by pressing the green reset (//) button, or by entering the following command:

   ```
   CLI> RESTART THIS_CONTROLLER
   ```

4. After the controller restarts and returns to the CLI prompt, enter the following command to verify the controller's parameters:

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   ```

The controller is now ready for storage subsystem configuration.

B.2.5 Setting the Initial Configuration for Dual-Redundant Controllers

In a dual-redundant configuration, one terminal can set both controller configurations. After installing both controllers, use the CLI to define their initial parameters as follows:

1. Access the CLI on one of the controllers via either a maintenance terminal or virtual host terminal connection.
2. Enter the following command to set a valid controller ID:

   ```
   CLI> SET THIS_CONTROLLER ID=n
   ```

   Where *n* is the SCSI target ID(s) (0–7) for the *first* controller.
3. Then enter the following command:

   ```
   CLI> SET OTHER_CONTROLLER ID=n
   ```

   Where *n* is the SCSI target ID(s) (0–7) for the *companion* controller. All SCSI IDs assigned to the controller pair must be unique, and there can be no more than a total of four (4) IDs assigned to the pair.

   Note

   Always restart the controllers after setting the ID.

   ---

4. Restart both controllers either by pressing the green reset (//) buttons, or by entering the following commands:

   ```
   CLI> RESTART OTHER_CONTROLLER
   CLI> RESTART THIS_CONTROLLER
   ```

5. Enter the following commands to verify the preceding parameters were set.

   ```
   CLI> SHOW THIS_CONTROLLER FULL
   CLI> SHOW OTHER_CONTROLLER FULL
   ```

   CAUTION

   The SET FAILOVER command establishes controller-to-controller communication and copies configuration information. Always enter this command on one controller only. COPY=*configuration-source* specifies where the *good* configuration data are located. *Never* blindly specify SET

FAILOVER. Know where your good configuration information resides before entering the command.

Once the initial parameters of both controllers are set, the storage subsystem can be configured. After configuring the controller's devices, the dual-redundant controllers are normally set to failover using the SET FAILOVER command.

B.2.6 Configuring Storage Devices

To automatically configure devices on the controller, use either the CONFIG or CFMENU utility described in Chapter 8.

For manual configuration, the following steps add devices, storagesets, and logical units. Use the CLI to complete these steps so that the host recognizes the storage device.

1. Add the physical devices by using the following command:

   ```
   CLI> ADD device-type device-name scsi-location
   ```

   For example:

   ```
   CLI> ADD DISK DISK100 1 0 0
   ```

   where:

   device-type is the type of device to be added. The device type used with the SWXRC–04 controller is DISK.

   device-name is the name to refer to that device. The name is referenced when creating units or storagesets.

   SCSI-location is the PTL for the device. When entering the PTL, at least one space must separate the port, target, and LUN.

2. Add the storagesets for the devices. Storagesets include stripesets and RAIDsets. See Section B.2.7 for examples of adding storagesets.

   CAUTION

   The INITIALIZE command destroys all data on a **container**.

   ---

3. Enter the following command to initialize the containers (devices, storagesets, or both) prior to adding logical units to the configuration.

   ```
   CLI> INITIALIZE container-name
   ```

   where *container-name* is a device or storageset that becomes part of a unit.

   When initializing a single-device container:

   - If NOTRANSPORTABLE (the default) was specified when the device was added, a small amount of disk space was made inaccessible to the host and used for **metadata**. The metadata is now initialized.
   - If TRANSPORTABLE was specified, any metadata on the device is now destroyed. See the information pertaining to the INITIALIZE command for details on metadata and when INITIALIZE is required.

4. Add the units that use either the devices or the storagesets built from the devices by entering the following command:

   `CLI> ADD UNIT logical-unit-number container-name`

   where:

   logical-unit-number is the unit number the host uses to access the device.

   container-name identifies the device or the storageset.

B.2.7 Device Configuration Examples

The following sections present device configuration examples using the CLI.

B.2.7.1 Creating a Unit from a Disk Device

```
CLI> ADD DISK DISK0 2 0 0
CLI> INITIALIZE DISK0
CLI> ADD UNIT D0 DISK0
```

B.2.7.2 Creating a Unit from a Four-Member Stripeset

```
CLI> ADD DISK DISK0 1 0 0
CLI> ADD DISK DISK1 2 0 0
CLI> ADD DISK DISK2 3 0 0
CLI> ADD DISK DISK2 1 1 0
CLI> ADD STRIPESET STRIPE0 DISK0 DISK1 DISK2 DISK3
Warning 3000: This storageset is configured with more than one disk per port
              This will cause a degradation in performance
CLI> INITIALIZE STRIPE0
CLI> ADD UNIT D0 STRIPE0
```

B.2.7.3 Creating a Unit from a Five-Member RAIDset

```
CLI> ADD DISK DISK0 1 0 0
CLI> ADD DISK DISK1 2 0 0
CLI> ADD DISK DISK2 3 0 0
CLI> ADD DISK DISK3 1 1 0
CLI> ADD DISK DISK4 2 1 0
CLI> ADD RAIDSET RAID0 DISK0 DISK1 DISK2 DISK3 DISK4
Warning 3000: This storageset is configured with more than one disk per port
              This will cause a degradation in performance
CLI> INITIALIZE RAID0
CLI> ADD UNIT D0 RAID0
```

B.2.7.4 Creating a Unit from a Disk Device and Setting It Write Protected

```
CLI> ADD DISK DISK0 2 0 0
CLI> INITIALIZE DISK0
CLI> ADD UNIT D0 DISK0 WRITE_PROTECT
```

B.2.7.5 Write Protecting an Existing Unit

```
CLI> ADD DISK DISK0 2 0 0
CLI> INITIALIZE DISK0
CLI> ADD UNIT D0 DISK0
CLI> SET D0 WRITE_PROTECT
```

B.2.7.6 Renumbering Disk Unit 0 to Disk Unit 100

```
CLI> ADD DISK DISK0 2 0 0
CLI> INITIALIZE DISK0
CLI> ADD UNIT D0 DISK0
CLI> DELETE D0
CLI> ADD UNIT D100 DISK0
```

Note that no INITIALIZE is required because DISK0 has already been initialized.

B.2.7.7 Creating a Transportable Unit from a Disk Device

```
CLI> ADD DISK DISK0 2 0 0 TRANSPORTABLE
CLI> INITIALIZE DISK0
CLI> ADD UNIT D0 DISK0
```

or

```
CLI> ADD DISK DISK0 2 0 0
CLI> SET DISK0 TRANSPORTABLE
CLI> INITIALIZE DISK0
CLI> ADD UNIT D0 DISK0
```

B.2.7.8 Changing the Replacement Policy of a RAIDset

```
CLI> ADD DISK DISK0 1 0 0
CLI> ADD DISK DISK1 2 0 0
CLI> ADD DISK DISK2 3 0 0
CLI> ADD DISK DISK3 4 0 0
CLI> ADD DISK DISK4 5 0 0
CLI> ADD RAIDSET RAID0 DISK0 DISK1 DISK2 DISK3 DISK4
CLI> INITIALIZE RAID0
CLI> ADD UNIT D0 RAID0
CLI> SET RAID0 POLICY=BEST_FIT
```

Note that the replacement policy can be changed at any time.

B.2.7.9 Deleting the Unit, Stripeset and All Disks Associated With a Stripeset

```
CLI> DELETE D0
CLI> DELETE STRIPE0
CLI> DELETE DISK0
CLI> DELETE DISK1
CLI> DELETE DISK2
CLI> DELETE DISK3
```

B.3 CLI Commands

The following sections detail each of the CLI supported commands, with required parameters and qualifiers. The defaults for each qualifier are indicated by (D). Examples are given after the command format, parameters, description, and qualifiers.

Remember these two guidelines when using the CLI:

- Not all configuration parameters need to be specified on one line. They can be entered by using multiple SET commands.

- Only enough of each command need be entered to make the command unique (usually three characters). For example, SHO is equivalent to SHOW.

B.3.1 Command Overview

The CLI consists of six basic command sets:

- **Controller commands** set up and show the basic parameters of the controller, controller SCSI ID, resident terminal characteristics, CLI prompt, and so on. In addition, the controller command set contains commands to restart the controller, failover devices, and run resident diagnostic and utility programs.
- **Device commands** enable you to specify and show the location of physical SCSI–2 devices that are attached to the controller.

Note

Only devices that were defined by the ADD command can be used by the controller. Devices that were placed in the shelf, but were not defined using the ADD command, are NOT used by the controller. Locations of devices are specified using a Port-Target-LUN (PTL) format. Use either the CONFIG or CFMENU utility to quickly add such devices.

- **Storageset** commands are used to add, modify, and show storagesets (stripesets, raidsets, the SPARESET and the FAILEDSET). These commands bind together containers and enable them to be manipulated as a single container.
- **Logical unit** commands add to, modify, and show logical units that were built out of either devices or storagesets. Depending on the device types that make up a logical unit, many different switches are available to control and tune the device specified.
- **Failover commands** support controllers in dual-redundant configurations.
- **Diagnostic and utility commands** are used for general support functions on the controller. These commands can invoke exercisers that test the data transfer capabilities on storage devices. The main exerciser is DILX, the disk inline exerciser. Refer to Chapter 8 for further information on diagnostic exercisers and utility programs.

ADD DISK

Adds a disk drive to the list of known disk drives.

Format

ADD DISK *container-name SCSI-location*

Parameters

container-name
Specifies the name that is used to refer to this disk drive. This name is referred to when creating units and stripesets. The name must start with a letter (A–Z) and can then consist of up to eight more characters made up of letters A–Z, numbers 0–9, periods (.), dashes (-), or underscores (_), for a total of nine characters.

SCSI-location
The location of the disk drive to be added in the form PTL where **P** designates the port (1–6 or 1–3, depending on the controller model), **T** designates the target ID of the device, (0–6, in a nonfailover configuration, or 0–5 if the controller is in a failover configuration), and **L** designates the LUN of the device (must be 0).

When entering the PTL, at least one space must separate the the port, target, and LUN numbers.

Description

Adds a disk drive to the list of known disk drives and names the drive. This command must be used when a new SCSI–2 disk drive is to be added to the configuration.

Qualifiers

TRANSPORTABLE
NOTRANSPORTABLE (Default)
In normal operations, the controller makes a small portion of the disk inaccessible to the host and uses this area to store metadata, which improves data reliability, error detection, and recovery. This vast improvement comes at the expense of transportability.

If NOTRANSPORTABLE is specified and there is no valid metadata on the unit, the unit must be initialized.

Note

Digital recommends that you avoid specifying TRANSPORTABLE unless transportability of disk drives or media is imperative and there is no other way to accomplish moving the data.

Examples

1. `CLI> ADD DISK RZ26_100 1 0 0`

   Adds a non transportable disk to port 1, target 0, LUN 0 and names it RZ26_100.

2. `CLI> ADD DISK DISK0 2 3 0 NOTRANSPORTABLE`

   Adds a non transportable disk to port 2, target 3, LUN 0 and names it DISK0.

3. `CLI> ADD DISK TDISK0 3 2 0 TRANSPORTABLE`

   Adds a transportable disk to port 3, target 2, LUN 0 and names it TDISK0.

ADD RAIDSET

Creates a RAIDset from a number of containers.

Format

ADD RAIDSET *container-name container-name1 container-name2 [container-nameN]*

Parameters

container-name
Specifies the name that is used to refer to this RAIDset. The name must start with a letter (A–Z) and can then consist of up to eight more characters made up of letters A–Z, numbers 0–9, periods (.), dashes (-), or underscores (_), for a total of nine characters.

container-name1 container-name2 container-nameN
The containers that make up this RAIDset. A RAIDset may be made up of from 3 to 14 containers.

Description

Adds a RAIDset to the list of known RAIDsets and names the RAIDset. This command must be used when a new RAIDset is to be added to the configuration.

Qualifiers

POLICY=BEST_FIT
POLICY=BEST_PERFORMANCE (Default)
NOPOLICY
Specifies the replacement policy to use when a member within the RAIDset fails.

BEST_FIT gives highest priority to finding a replacement device within the spareset that most closely matches the sizes of the remaining members of the RAIDset. After finding the most closely matching devices, the device that gives the best performance is selected.

BEST_PERFORMANCE (default) gives highest priority to finding a replacement device within the spareset that results in the best performance of the RAIDset. After finding the best performing devices, the device that most closely matches the size of the remaining members of the RAIDset is selected.

NOPOLICY retires a failing device from the RAIDset without selecting a replacement. This causes the RAIDset to run in a reduced state until a BEST_FIT or BEST_PERFORMANCE policy is selected, or a member is manually replaced in the RAIDset (see SET *raidset-container-name*).

RECONSTRUCT=NORMAL (Default)
RECONSTRUCT=FAST
NORECONSTRUCT
Specifies the speed at which a RAIDset is reconstructed when a new member is added to the RAIDset or immediately after the RAIDset is initialized.

RECONSTRUCT=NORMAL (default) balances overall performance of the controller against the demand of reconstructing the RAIDset.

RECONSTRUCT=FAST reconstructs the RAIDset at the fastest rate possible resulting in some loss of performance of the controller overall.

REDUCED
NOREDUCED (Default)
REDUCED specifies that the RAIDset being added is already missing one member. Use the REDUCED keyword when moving an already reduced RAIDset from one controller to another. NOREDUCED (default) identifies that all RAIDset members that make up the RAIDset are being specified.

Examples

1.
```
CLI> ADD RAIDSET RAID9 DISK0 DISK1 DISK2 DISK3
```
Creates a RAIDset with four disks (DISK0, DISK1, DISK2, and DISK3). The replacement policy is BEST_PERFORMANCE.

2.
```
CLI> ADD RAIDSET RAID9 DISK0 DISK1 DISK2 DISK3 POLICY=BEST_FIT
```
Creates a RAIDset with four disks (DISK0, DISK1, DISK2, and DISK3). The replacement policy is BEST_FIT, as specified.

3.
```
CLI> ADD RAIDSET RAID9 DISK0 DISK1 DISK2 DISK3 NOPOLICY
```
Creates a RAIDset with four disks (DISK0, DISK1, DISK2, and DISK3). If a member within the RAIDset fails, a replacement is *not* selected.

4.
```
CLI> ADD RAIDSET RAID9 DISK0 DISK1 DISK3 REDUCED
```
Creates a four member RAIDset with a raidset that was already reduced.

ADD SPARESET

Adds a disk drive to the spareset.

Format

ADD SPARESET *disk-container-name0 [disk-container-nameN]*

Parameters

disk-container-name0 disk-container-nameN
The disk drive container names to add to the spareset. Any number of disks may be added to the spareset using only one command.

Description

The **SPARESET** is a pool of drives available to the controller to replace failing members of a RAIDset. The ADD SPARESET command adds disk drives to the spareset and initializes the metadata on the drives so they may be used for replacements by RAIDsets.

Examples

1. `CLI> ADD SPARESET DISK0`

   Adds one disk to the spareset.

2. `CLI> ADD SPARESET DISK0 DISK1 DISK2 DISK3 DISK4`

   Adds five disks to the spareset.

ADD STRIPESET

Creates a stripeset from a number of containers.

Format

ADD STRIPESET *container-name container-name1 container-name2 [container-nameN]*

Parameters

container-name
Specifies the name that is used to refer to this stripeset. The name must start with a letter (A–Z) and can then consist of up to eight more characters made up of letters A–Z, numbers 0–9, periods (.), dashes (-), or underscores (_), for a total of nine characters.

container-name1 container-name2 container-nameN
The containers that make up this stripeset. A stripeset may be made up of from 2 to 14 containers.

Description

Adds a stripeset to the list of known stripesets and names the stripeset. This command must be used when a new stripeset is added to the configuration.

Examples

1.
```
CLI> ADD STRIPESET STRIPE0 DISK0 DISK1 DISK2 DISK3
```

Creates a STRIPESET with four disks (DISK0, DISK1, DISK2, and DISK3).

ADD UNIT

Adds a logical unit to the controller.

Format

ADD UNIT *unit-number container-name*

Parameters

unit-number
The unit number determines both the target (0–7) and the LUN (0–7) from which the device is made available. The hundreds place of the unit number is the target and the ones place is the LUN. The tens place is not currently used. For example, D401 would be target 4, LUN 1; D100 would be target 1, LUN 0, and D5 would be target 0, LUN 5.

Note

The only target numbers specified in the unit number *must* have been previously specified in the SET THIS_CONTROLLER ID=(*n*1, *n*2, ...) command. You can not specifiy a target number that has not been previously specified by the SET THIS_CONTROLLER ID=(*n*1, *n*2, ...) command.

container-name
The name of the container that is used to create the unit.

Description

The ADD UNIT command adds a logical unit for the host to access. All requests by the host to the logical unit number are mapped as requests to the container specified in the ADD UNIT command.

For disk devices (and stripesets and RAIDsets built from disk devices), the metadata on the container must be initialized before a unit may be created from it. If the container's metadata cannot be found, or is incorrect, an error is displayed and the unit is not created.

Qualifiers for a Unit Created from a TRANSPORTABLE Disk Drive

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

READ_CACHE (Default)
NOREAD_CACHE
Enables and disables the controller's read cache on this unit.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit is spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

Qualifiers for a Unit Created from a NOTRANSPORTABLE Disk Drive

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

READ_CACHE (Default)
NOREAD_CACHE
Enables and disables the controller's read cache on this unit.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit are spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

WRITEBACK_CACHE
NOWRITEBACK_CACHE (Default)
Enables and disables the controller's write-back cache on this unit.

Note

When initially added, NOWRITEBACK_CACHE is the default.

Qualifiers for a Unit Created from a RAIDset

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit is spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

Note

Writes may still be performed to a write-protected RAIDset to satisfy a reconstruct pass or to reconstruct a newly replaced member. However, write protect disables the writing of any new data.

WRITEBACK_CACHE
NOWRITEBACK_CACHE (Default)
Enables and disables the controller's write-back cache on this unit.

Qualifiers for a Unit Created from a Stripeset

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

READ_CACHE (Default)
NOREAD_CACHE
Enables and disables the controller's read cache on this unit.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit are spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

WRITEBACK_CACHE
NOWRITEBACK_CACHE (Default)
Enables and disables the controller's write-back cache on this unit.

Examples

1.
```
CLI> ADD UNIT D0 DISK0
```

Creates disk unit number 0 from container DISK0.

2.
```
CLI> ADD UNIT D170 RAID9 WRITE_PROTECT
```

Creates disk unit number 170 from container RAID9 and write protects it.

CLEAR_ERRORS CLI

Stops displaying errors at the CLI prompt.

Format

CLEAR_ERRORS CLI

Description

Errors detected by controller firmware are displayed before the CLI prompt. These errors are displayed even after the error condition is rectified, until the controller is restarted or the CLEAR_ERRORS CLI command is issued.

Note

This command does not clear the error conditions, it only clears displaying the errors at the CLI prompt.

Examples

1.
```
CLI>
All NVPM components initialized to their default settings.
CLI> CLEAR_ERRORS CLI
CLI>
```

Clears the message "All NVPM components initialized to their default settings." that was displayed at the CLI prompt.

CLEAR_ERRORS INVALID_CACHE

Clears all data from the cache and makes it usable by the specified controller.

Format

CLEAR_ERRORS INVALID_CACHE *controller*

Parameters

controller
Specifies which controller clears the INVALID_CACHE condition. Either THIS_CONTROLLER or OTHER_CONTROLLER must be specified.

Description

CAUTION

This command causes loss of customer data.

Note

Because this command causes loss of customer data, "INVALID_CACHE" must be completely spelled out, not abbreviated.

If a write-back cache module with dirty data from another controller is installed on this controller, or if the write-back cache module with dirty data is removed from this controller, an INVALID_CACHE error results. CLEAR_ERRORS INVALID_CACHE clears the invalid cache error, however *all customer data that was in cache is lost.*

For this reason, use great caution when considering using this command.

Entering the CLEAR_ERRORS INVALID_CACHE command on one controller causes the other controller in a dual-redundant configuration to restart.

Examples

1.
```
CLI> CLEAR_ERRORS INVALID_CACHE THIS_CONTROLLER
```

   Clears all cache information from this controller's cache and clears the invalid cache error.

CLEAR_ERRORS LOST_DATA

Clears the lost data error on a unit.

Format

CLEAR_ERRORS LOST_DATA *unit-number*

Parameters

unit-number
Specifies the logical unit number (D0–D7, D100-D107, and so forth) that has the lost data error cleared. The *unit-number* is the name given the unit when it was created using the ADD UNIT command.

Description

CAUTION

This command causes loss of customer data.

Note

Because this command causes loss of customer data, "LOST_DATA" must be completely spelled out, not abbreviated.

If customer data has been lost due to the removal or failure of the write-back cache, the lost data error is reported on the unit. CLEAR_ERRORS LOST_DATA clears the lost data error, however, *all customer data that had not been written to disk is lost.*

For this reason, use great caution when considering using this command.

When entering the CLEAR_ERRORS LOST_DATA command for a RAIDset-based unit, always enter the command on the controller that owns the unit (through the preferred path). Entering the command from the companion controller in a dual-redundant configuration does not clear the lost data.

Examples

1.
```
CLI> CLEAR_ERRORS LOST_DATA D13
```
Clears the lost data error on disk unit D13.

CLEAR_ERRORS UNKNOWN

Clears the UNKNOWN error from a device.

Format

CLEAR_ERRORS UNKNOWN *device-name*

Parameters

device-name
Specifies the device name of the device with the UNKNOWN error.

Description

Note

"UNKNOWN" must be completely spelled out, not abbreviated.

If a device has a failure such that the controller marks the device as UNKNOWN, the device is never automatically checked again to see if it has been repaired or if the failure condition was rectified. When you rectify a condition that caused a device to be marked UNKNOWN, this command must be issued for the controller to recognize the device.

Examples

1.
```
CLI> CLEAR_ERRORS UNKNOWN DISK300
```

Causes the controller to recognize DISK300, a previously UNKNOWN device.

CLEAR_ERRORS UNWRITEABLE_DATA

Clears the unwriteable data error on a unit.

Format

CLEAR_ERRORS UNWRITEABLE DATA *unit-number*

Parameters

unit-number
Specifies the logical unit number (D0–D7, D100-D107, and so forth) that has the unwriteable data error cleared. The *unit-number* is the name given the unit when it was created using the ADD UNIT command.

Description

CAUTION

This command causes loss of customer data.

Note

Because this command causes loss of customer data, "UNWRITEABLE_DATA" must be completely spelled out, not abbreviated.

If a container fails in a way that customer data in the write-back cache cannot be written to the container, the unwriteable data error is reported. CLEAR_ERRORS UNWRITEABLE_DATA clears the unwriteable data error, however, *all customer data that has not been written to disk is lost.*

For this reason, use great caution when considering using this command.

Examples

1.
```
CLI> CLEAR_ERRORS UNWRITEABLE_DATA D13
```
Clears the unwriteable data error on disk unit D13.

DELETE *container-name*

Deletes a container from the list of known containers.

Format

DELETE *container-name*

Parameters

container-name
Specifies the name that identifies the container. This is the name given the container when it was created using the ADD command (ADD DEVICE, ADD STRIPESET, and so forth).

Description

Checks to see if the container is used by any other containers or a unit. If the container is in use, an error is displayed and the container is not deleted.

If the container is not in use, it is deleted.

Note

The spareset and failedset containers cannot be deleted. See DELETE SPARESET and DELETE FAILEDSET commands.

Examples

1.
```
CLI> DELETE DISK0
```
Deletes DISK0 from the list of known containers.

2.
```
CLI> DELETE STRIPE0
```
Deletes STRIPE0 from the list of known containers.

3.
```
CLI> DELETE RAID9
```
Deletes RAID9 from the list of known containers.

DELETE FAILEDSET

Delete a disk drive from the failedset.

Format

DELETE FAILEDSET *disk-container-name0 [disk-container-nameN]*

Parameters

disk-container-name0 disk-container-nameN
The disk drive container names to delete from the failedset. Any number of disks may be deleted from the failedset using only one command.

Description

The **FAILEDSET** is a group of drives that were removed from RAIDsets because they failed or were manually removed (via the SET *raidset-container-name* REMOVE=*disk-container-name* command). Drives in the failedset should be considered defective and should be tested, then repaired or replaced. The DELETE FAILEDSET command removes drives from the failedset, typically before you remove them physically from the shelf for testing, repair, or replacement.

Examples

1.
```
CLI> DELETE FAILEDSET DISK0
```
Deletes one disk from the failedset.

2.
```
CLI> DELETE FAILEDSET DISK0 DISK1 DISK2 DISK3 DISK4
```
Deletes five disks from the failedset.

DELETE SPARESET

Delete a disk drive from the spareset.

Format

DELETE SPARESET *disk-container-name0 [disk-container-nameN]*

Parameters

disk-container-name0 disk-container-nameN

The disk drive container names to delete from the spareset. Any number of disks may be deleted from the spareset using only one command.

Description

The **SPARESET** is a pool of drives available to the controller to replace failing members of a RAIDset. The DELETE SPARESET command removes disk drives from the spareset.

Examples

1.
```
CLI> DELETE SPARESET DISK0
```
Deletes one disk from the spareset.

2.
```
CLI> DELETE SPARESET DISK0 DISK1 DISK2 DISK3 DISK4
```
Deletes five disks from the spareset.

DELETE *unit-number*

Deletes a unit from the list of known units.

Format

DELETE *unit-number*

Parameters

unit-number

Specifies the logical unit number (D0–D7, D100-D107, and so forth) that is to be deleted. The *unit-number* is the name given the unit when it was created using the ADD UNIT command.

Description

The DELETE command flushes any user data from the write-back cache to the disk and deletes the logical unit. If any errors occur when trying to flush the user data, the logical unit is not deleted.

In order to delete a unit that has cache errors, you must clear all cache errors associated with the unit via a CLEAR_ERRORS command.

Examples

1.
```
CLI> DELETE D12
```

Deletes disk unit number 12 from the list of known units.

DIRECTORY

Lists the diagnostics and utilities available on THIS_CONTROLLER.

Format

DIRECTORY

Description

The DIRECTORY command lists the various diagnostics and utilities that are available on THIS_CONTROLLER. A directory of diagnostics and utilities available on this controller is displayed.

For specific information about the diagnostics and utilities available, refer to the *StorageWorks Array Controllers HS Family of Array Controllers Service Manual.*

Examples

1.
```
CLI> DIRECTORY
DILX  X067   D
VTDPY X067   D
FLS   X067   D
ECHO  X067   D
DIRECTX067   D
CLI   X067   D
```

Displays directory listing.

EXIT

Exits the CLI and breaks the virtual terminal connection.

Format

EXIT

Description

When entering the EXIT command from a host using a virtual terminal connection, the connection is broken and control is returned to the host. If entered from a maintenance terminal, the EXIT command restarts the CLI, displaying the copyright notice, the controller type, and the last fail packet.

Examples

1.
```
CLI> EXIT

SWXRC-04 Firmware version V020-0, Hardware version 0000

Last fail code: 01800080

Press " ?" at any time for help.

CLI>
```

An EXIT command issued on a maintenance terminal.

2.
```
CLI> EXIT
Control returned to host
$
```

An EXIT command issued on a terminal that was connected to the CLI via a DUP connection.

HELP

Displays an overview for getting help.

Format

HELP

Description

The HELP command displays a brief description for using the question mark "?" to obtain help on any command or CLI function.

Examples

1.

```
CLI> HELP
Help may be requested by typing a question mark (?) at the CLI prompt.  This
prints a list of all available commands

For further information you may enter a partial command and type a space
followed by a "?" to print a list of all available options at that point in
the command.  For example:

          SET THIS_CONTROLLER ?

Prints a list of all legal SET THIS_CONTROLLER commands
```

Displaying help using the HELP command.

2.

```
CLI> SET ?
Your options are:
   FAILOVER
   OTHER_CONTROLLER
   NOFAILOVER
   THIS_CONTROLLER
   Unit number or container name
```

Getting help on the SET command, using the "?" facility.

INITIALIZE

Initializes the metadata on the container specified.

Format

INITIALIZE *container-name*

Parameters

container-name
Specifies the container name to initialize.

Description

The INITIALIZE command initializes a container so a logical unit may be created from it. When initializing a single disk drive container, if NOTRANSPORTABLE was specified or allowed to default on the ADD DISK or SET *disk-name* commands, a small amount of disk space is made inaccessible to the host and used for metadata. The metadata is initialized. If TRANSPORTABLE was specified, any metadata is destroyed on the device and the full device is accessible to the host.

CAUTION

The INITIALIZE command destroys all customer data on the container.

The INITIALIZE command is required when:

- A unit is going to be created from a newly installed disk
- A unit is going to be created from a newly created storageset, (RAIDset or stripeset)

The INITIALIZE command specifically is *not* required when:

- A unit has been deleted, and a new unit is going to be created from the same container
- A storageset that was initialized in the past is deleted, then added again using the same members that were in the original storageset

Qualifiers

CHUNKSIZE=*n*
CHUNKSIZE=DEFAULT (Default)
Specifies the chunksize to be used. The chunksize may be specified in blocks (CHUNKSIZE=*n*), or you can let the controller determine the optimal chunksize (CHUNKSIZE=DEFAULT).

Examples

1.
```
CLI> INITIALIZE DISK0
```

Initializes container DISK0. If NOTRANSPORTABLE was specified (or allowed to default), metadata is written on the disk.

2.
```
CLI> INITIALIZE STRIPE0 CHUNKSIZE=20
```

Initializes container STRIPE0 and writes metadata on it.

3.
```
CLI> INITIALIZE RAID9 CHUNKSIZE=20
```

Initializes container RAID9 with a chunksize of 20 and writes metadata on it.

LOCATE

Locates units, storagesets, and devices by lighting the amber device fault LED on the front of the StorageWorks building block (SBB).

Format

LOCATE

Description

The LOCATE command illuminates the amber device fault LEDs (the lower LED on the front of an SBB) of the containers specified. The LOCATE command also can be used as a lamp test.

Qualifiers

ALL

The LOCATE ALL command turns on the amber device fault LEDs of all configured devices. This qualifier also can be used as a lamp test. See LOCATE CANCEL to turn off the LEDs.

An error is displayed if no devices have been configured.

CANCEL

The LOCATE CANCEL command turns off all amber device fault LEDs on all configured devices.

An error is displayed if no devices have been configured.

DISKS

The LOCATE DISKS command turns on the amber device fault LEDs of all configured disks. See LOCATE CANCEL to turn off the LEDs.

An error is displayed if no disks have been configured.

UNITS

The LOCATE UNITS command turns on the amber device fault LEDs of all devices used by units. This command is useful to determine which devices are not currently configured into logical units. See LOCATE CANCEL to turn off device the LEDs.

An error is displayed if no units have been configured.

PTL *SCSI-location*

The LOCATE PTL *SCSI-location* command turns on the amber device fault LEDs at the given SCSI location. *SCSI-location* is specified in the form PTL where **P** designates the port (1–6 or 1–3, depending on the controller model), **T** designates the target ID of the device (0–6 in a nonfailover configuration or 0–5 if the controller is in a failover configuration), and **L** designates the LUN of the device (0–7).

When entering the PTL, at least one space must separate the port, target, and LUN numbers. See LOCATE CANCEL to turn off the LEDs.

An error is displayed if the port, target, or LUN is invalid, or if no device is configured at that location.

device or storageset name or unit number (*entity*)
The LOCATE *entity* command turns on the amber device fault LEDs that make up the entity supplied. If a device name is given, the device's LED is lit. If a storageset name is given, all device LEDs that make up the storageset are lit. If a unit number is given, all device LEDs that make up the unit are lit. See LOCATE CANCEL to turn off the LEDs.

An error is displayed if no entity by that name or number has been configured.

Examples

1.
```
CLI> LOCATE DISK0
```
Turns on the device fault LED on device DISK0.

2.
```
CLI> LOCATE D12
```
Turns on the device fault LEDs on all devices that make up disk unit number 12.

3.
```
CLI> LOCATE DISKS
```
Turns on the device fault LEDs on all configured disk devices.

RENAME

Renames a container.

Format

RENAME *old-container-name new-container-name*

Parameters

old-container-name
Specifies the existing name that identifies the container.

new-container-name
Specifies the new name to identify the container. This name is referred to when creating units and storagesets. The name must start with a letter (A–Z) and can then consist of up to eight more characters made up of letters A–Z, numbers 0–9, periods (.), dashes (-), or underscores (_), for a total of nine characters.

Description

Gives a known container a new name by which to be referred.

Examples

1.
```
CLI> RENAME DISK0 DISK100
```
Renames container DISK0 to DISK100.

RESTART OTHER_CONTROLLER

Restarts the other controller.

Format

RESTART OTHER_CONTROLLER

Description

The RESTART OTHER_CONTROLLER command flushes all user data from the other controller's write-back cache (if present), then restarts the other controller.

If any user data cannot be flushed to disk, the controller does not restart unless the IGNORE_ERRORS qualifier is specified.

Specifying IMMEDIATE causes the other controller to restart immediately without flushing any user data to the disks, even if drives are online to the host.

The RESTART OTHER_CONTROLLER command does not cause a failover to this controller in a dual-redundant configuration. The other controller restarts and resumes operations where it was interrupted.

Qualifiers

IGNORE_ERRORS
NOIGNORE_ERRORS (Default)
If errors result when trying to write user data, the controller is not restarted unless IGNORE_ERROR is specified.

If the IGNORE_ERRORS qualifier is specified, the controller restarts even if all customer data cannot be written to disk from the write-back cache.

CAUTION

Customer data may be lost or corrupted if the IGNORE_ERRORS qualifier is specified.

IMMEDIATE
NOIMMEDIATE (Default)
If IMMEDIATE is specified, the controller is immediately restarted without checking for online devices or flushing user data from write-back cache to disk.

CAUTION

Customer data may be lost or corrupted if the IMMEDIATE qualifier is specified.

Examples

1.
```
CLI> RESTART OTHER_CONTROLLER
```

Restarts the other controller as long as the other controller does not have any units online.

RESTART THIS_CONTROLLER

Restarts this controller.

Format

RESTART THIS_CONTROLLER

Description

The RESTART THIS_CONTROLLER command flushes all user data from this controller's write-back cache (if present), then restarts this controller.

If any user data cannot be flushed to disk, the controller does not restart unless the IGNORE_ERRORS qualifier is specified.

Specifying IMMEDIATE causes this controller to restart immediately without flushing any user data to the disks, even if drives are online to a host.

The RESTART THIS_CONTROLLER command does not cause a failover to the other controller in a dual-redundant configuration. This controller restarts and resumes operations where it was interrupted.

Note

If you enter the RESTART THIS_CONTROLLER command and you are using a virtual terminal to communicate with the controller, the connection is lost when this controller restarts.

Qualifiers

IGNORE_ERRORS
NOIGNORE_ERRORS (Default)
If errors result when trying to write user data, the controller is not restarted unless IGNORE_ERROR is specified.

If the IGNORE_ERRORS qualifier is specified, the controller restarts even if all customer data cannot be written to disk from the write-back cache.

CAUTION

Customer data may be lost or corrupted if the IGNORE_ERRORS qualifier is specified.

IMMEDIATE
NOIMMEDIATE (Default)
If IMMEDIATE is specified, the controller is immediately restarted without checking for online devices or flushing user data from write-back cache to disk.

CAUTION

Customer data may be lost or corrupted if the IMMEDIATE qualifier is specified.

Examples

1.
```
CLI> RESTART THIS_CONTROLLER
```

Restarts this controller as long as this controller does not have any units that are online.

RETRY_ERRORS UNWRITEABLE_DATA

Tries to write the unwriteable data on a unit.

Format

RETRY_ERRORS UNWRITEABLE_DATA *unit-number*

Parameters

unit-number
Specifies the logical unit number (D0–D7, D100-D107, and so forth) which the write operation of the unwriteable data is attempted. The *unit-number* is the name given the unit when it was created using the ADD UNIT command.

Description

If a container fails in a way that customer data in the write-back cache cannot be written to the container, the unwriteable data error is reported. If possible the condition that is causing the unwriteable data should be corrected and the write operation should be attempted again. RETRY_ERRORS UNWRITEABLE_DATA attempts to write the unwriteable data error. No data is lost if the retry fails.

Examples

1.
```
CLI> RETRY_ERRORS UNWRITEABLE_DATA D13
```

Attempts to write the cached data on disk unit D13 that was previously marked unwriteable.

RUN

Runs a diagnostic or utility on THIS_CONTROLLER.

Format

RUN *program-name*

Parameters

program-name
The name of the diagnostic or utility to be run. DILX is an example of utilities and diagnostics that can be run from the CLI.

Description

The RUN command enables various diagnostics and utilities on THIS_CONTROLLER. Diagnostics and utilities can be run *only* on the controller where the terminal or DUP connection is connected.

For specific information about available diagnostics and utilities, refer to the *StorageWorks Array Controllers HS Family of Array Controllers Service Manual.*

Examples

1.
```
CLI> RUN DILX
Disk Inline Exerciser - version 2.0
          .
          .
          .
```
Runs the DILX diagnostic.

SELFTEST OTHER_CONTROLLER

Runs a self-test on the other controller.

Format

SELFTEST OTHER_CONTROLLER

Description

The SELFTEST OTHER_CONTROLLER command flushes all user data from the other controller's write-back cache (if present), shuts down the other controller, then restarts it in DAEMON loop-on-self-test mode. The OCP reset (//) button must be pressed to take the other controller out of loop-on-self-test mode.

If any user data cannot be flushed to disk, the controller does not self-test unless the IGNORE_ERRORS qualifier is specified.

Specifying IMMEDIATE causes the other controller to self-test immediately without flushing any user data to the disks, even if drives are online to the host.

Qualifiers

IGNORE_ERRORS
NOIGNORE_ERRORS (Default)
If errors result when trying to write user data, the controller does not start the self-test unless IGNORE_ERRORS is specified.

If the IGNORE_ERRORS qualifier is specified, the controller starts the self-test even if all customer data cannot be written to disk from the write-back cache.

CAUTION

Customer data may be lost or corrupted if the IGNORE_ERRORS qualifier is specified.

IMMEDIATE
NOIMMEDIATE (Default)
If IMMEDIATE is specified, the controller immediately starts self-test without checking for online devices or flushing user data from write cache to disk.

CAUTION

Customer data may be lost or corrupted if the IMMEDIATE qualifier is specified.

Examples

1.
```
CLI> SELFTEST OTHER_CONTROLLER
```

Starts the self-test on the other controller, as long as the other controller does not have any units online.

SELFTEST THIS_CONTROLLER

Runs a self-test on this controller.

Format

SELFTEST THIS_CONTROLLER

Description

The SELFTEST THIS_CONTROLLER command flushes all user data from this controller's write-back cache (if present), shuts down this controller, then restarts it in DAEMON loop-on-self-test mode. The OCP reset (//) button must be pressed to take this controller out of loop-on-self-test mode.

If any user data cannot be flushed to disk, the controller does not self-test unless the IGNORE_ERRORS qualifier is specified.

Specifying IMMEDIATE causes this controller to self-test immediately without flushing any user data to the disks, even if drives are online to a host.

Note

If you enter a SELFTEST THIS_CONTROLLER command, and you are using a virtual terminal to communicate with the controller, the connection is lost when this controller starts the self-test.

Qualifiers

IGNORE_ERRORS
NOIGNORE_ERRORS (Default)
If errors result when trying to write user data, the controller does not start the self-test unless IGNORE_ERRORS is specified.

If the IGNORE_ERRORS qualifier is specified, the controller starts the self-test even if all customer data cannot be written to disk from the write-back cache.

CAUTION

Customer data may be lost or corrupted if the IGNORE_ERRORS qualifier is specified.

IMMEDIATE
NOIMMEDIATE (Default)
If IMMEDIATE is specified, the controller immediately starts self-test without checking for online devices or flushing user data from write cache to disk.

CAUTION

Customer data may be lost or corrupted if the IMMEDIATE qualifier is specified.

Examples

1.
```
CLI> SELFTEST THIS_CONTROLLER
```

Starts the self-test on this controller as long as this controller does not have any units online.

SET *disk-container-name*

Changes the characteristics of a disk drive.

Format

SET *disk-container-name*

Parameters

disk-container-name
The name of the disk drive that has its characteristics changed.

Description

Changes the characteristics of a disk drive.

Qualifiers

TRANSPORTABLE
NOTRANSPORTABLE (Default)
In normal operations, the controller makes a small portion of the disk inaccessible to the host and uses this area to store metadata, which improves data reliability, error detection, and recovery. This vast improvement comes at the expense of transportability.

If NOTRANSPORTABLE is specified and there is no valid metadata on the unit, the unit must be initialized.

Note

Digital recommends that you avoid specifying TRANSPORTABLE unless transportability of disk drives or media is imperative and there is no other way to accomplish moving the data.

Examples

1.
```
CLI> SET DISK130 TRANSPORTABLE
```
Sets DISK130 to transportable.

SET FAILOVER

Places THIS_CONTROLLER and OTHER_CONTROLLER into a dual-redundant configuration.

Format

SET FAILOVER *COPY=configuration-source*

Parameters

COPY=configuration-source
Specifies where the "good" copy of the device configuration resides.

If THIS_CONTROLLER is specified for *configuration-source*, all the device configuration information on THIS_CONTROLLER (the one that either the maintenance terminal is connected to or the virtual terminal is connected to) is copied to the other controller.

If OTHER_CONTROLLER is specified for *configuration-source*, all the device configuration information on the OTHER_CONTROLLER (the controller that either the maintenance terminal or the virtual terminal connection is *not* connected to) is copied to this controller.

Description

The SET FAILOVER command places THIS_CONTROLLER and the OTHER_CONTROLLER in a dual-redundant configuration. After entering this command, if one of the two controllers fail, the devices and cache (if any) attached to the failed controller become available to and accessible through the operating controller.

CAUTION

All device configuration information on the controller *not* specified by the COPY= parameter is destroyed and overwritten by the configuration information found in the controller specified by the COPY= parameter. **Make sure you know where your good configuration information is stored, or you have a complete copy of the device configuration, BEFORE entering this command.**

A considerable amount of work and effort is lost by overwriting a good configuration with incorrect information if the wrong controller is specified by the COPY= parameter.

Also note that due to the amount of information that must be passed between the two controllers, this command may take up to 1 minute to complete.

Examples

1.
```
CLI> SET FAILOVER COPY=THIS_CONTROLLER
```

Places two controllers into a dual-redundant configuration, where the "good" data was on the controller that the maintenance terminal or virtual terminal connection was connected to.

2.
```
CLI> SET FAILOVER COPY=OTHER_CONTROLLER
```

Places two controllers into a dual-redundant configuration, where the "good" data was on the controller that the maintenance terminal or virtual terminal connection was *not* connected to.

SET NOFAILOVER

Removes THIS_CONTROLLER and OTHER_CONTROLLER (if reachable) from a dual-redundant configuration.

Format

SET NOFAILOVER

Description

The SET NOFAILOVER command removes THIS_CONTROLLER and the OTHER_CONTROLLER (if currently reachable) from a dual-redundant configuration. Before or immediately after entering this command, one controller should be physically removed because the sharing of devices is not supported by single controller configurations.

The controller on which the command was entered is always removed from a dual-redundant state, even if the other controller is not currently reachable. No configuration information is lost when leaving a dual-redundant state.

Examples

1.
```
CLI> SET NOFAILOVER
```

Removes the two controllers from a dual-redundant configuration.

SET OTHER_CONTROLLER

Changes the other controller's parameters (in a dual-redundant configuration the controller that the maintenance terminal is *not* connected to or the controller that is *not* the target of the DUP connection.

Format

SET OTHER_CONTROLLER

Description

The SET OTHER_CONTROLLER command enables you to modify the controller parameters of the other controller in a dual-redundant configuration.

Qualifiers

CACHE_FLUSH_TIMER=*n*
CACHE_FLUSH_TIMER=DEFAULT
Specifies how many seconds (1–65535) of idle time may elapse before the write-back cache flushes its entire contents to disk. After the specified time, the write-back cache flushes its contents to disk to ensure data integrity. You must restart the controller before any change to the CACHE_FLUSH_TIMER parameter takes effect.

ID=(*n1[,nN]*)
Specifies from one to four SCSI target IDs (0–7). If two or more target IDs are specified, they must be enclosed in parenthesis and separated by a comma.

Note

The unit number determines which target the LUN is available under. For example, D203 would be target 2, LUN 3. D500 would be target 5, LUN 0. D5 would be target 0, LUN 5.

If two SWXRC–04 controllers are in a dual-redundant configuration, each controller has the same IDs. When you change the IDs on one controller, the other is automatically updated. A maximum of four IDs may be specified in any combination between the two controllers.

PREFERRED_ID=(*n1[,nN]*)
NOPREFERRED_ID
In a dual-redundant configuration, PREFERRED_ID defines which targets are handled by the specified controller. If two or more PREFERRED_IDs are specified, they must be enclosed in parenthesis and separated by a comma. The only PREFERRED_IDs that can be specified must have already been configured using the ID= qualifier.

For example, if you configured a SWXRC–04 with IDs 0, 1, and 2, you could specify preferred ids 0, 1, and 2 in any combination on the two controllers. If one controller had preferred ids 0 and 1, it would handle unit numbers 0–7 and 100–107 and the other controller would handle unit numbers 200–207.

When you change the PREFFERRED_IDs on one controller, the other controller is automatically be updated to support the remaining (if any) IDs.

By specifying NOPREFERRED_ID the controller does not respond to any target ID on the host's SCSI bus. However, in a dual-redundant mode, if the controller with PREFERRED_IDs specified were to fail, the controller with NOPREFERRED_ID would pick up the targets of the failed controller.

PROMPT="*new prompt*"
Specifies a 1- to 16-character prompt enclosed in quotes that are displayed when the controller's CLI prompts for input. Only printable ASCII characters are valid.

When first installed, the CLI prompt is set to the first three letters of the controller's model number (for example, SC4>).

TERMINAL_PARITY=ODD
TERMINAL_PARITY=EVEN
NOTERMINAL_PARITY
Specifies the parity transmitted and expected. Parity options are ODD or EVEN. NOTERMINAL_PARITY causes the controller to not check for, or transmit any parity on the terminal lines.

When first installed, the controller's terminal parity is set to NOTERMINAL_PARITY.

TERMINAL_SPEED=*baud_rate*
Sets the terminal speed to 300, 600, 1200, 2400, 4800, 9600 or 19200 baud. The transmit speed is always equal to the receive speed.

When first installed, the controller's terminal speed is set to 9600 baud.

TIME=*dd-mmm-yyyy:hh:mm:ss*
The TIME= commmand specifies the date and time. If the controller is in a dual-redundant configuration, the time is communicated to the other controller.

Examples

1.
```
CLI> SET OTHER_CONTROLLER ID=5 SPEED=1200
```

Modifies the other SWXRC–04's controller's SCSI ID and sets the terminal speed to 1200 baud.

SET *RAIDset-container-name*

Changes the characteristics of a RAIDset.

Format

SET *RAIDset-container-name*

Parameters

RAIDset-container-name
The name of the RAIDset that has its characteristics modified.

Description

Changes the characteristics of a RAIDset.

Qualifiers

POLICY=BEST_FIT
POLICY=BEST_PERFORMANCE (Default)
NOPOLICY
Specifies the replacement policy to use when a member within the RAIDset fails.

BEST_FIT gives highest priority to finding a replacement device within the spareset that most closely matches the sizes of the remaining members of the RAIDset. After finding the most closely matching devices, the device that gives the best performance is selected.

BEST_PERFORMANCE (default) gives highest priority to finding a replacement device within the spareset that results in the best performance of the RAIDset. After finding the best performing devices, the device that most closely matches the size of the remaining members of the RAIDset is selected.

NOPOLICY retires a failing device from the RAIDset without selecting a replacement. This causes the RAIDset to run in a reduced state until a BEST_FIT or BEST_PERFORMANCE policy is selected, or a member is manually replaced in the RAIDset (see SET *raidset-container-name*).

RECONSTRUCT=NORMAL (Default)
RECONSTRUCT=FAST
NORECONSTRUCT
Specifies the speed at which a RAIDset are reconstructed when a new member is added to the RAIDset or immediately after the RAIDset is initialized.

RECONSTRUCT=NORMAL (default) balances overall performance of the controller against the demand of reconstructing the RAIDset.

RECONSTRUCT=FAST reconstructs the RAIDset at the fastest rate possible resulting in some loss of performance of the controller overall.

REMOVE=*disk-container-name*
Specifies the removal of a disk member from a RAIDset. If the RAIDset is already in a reduced state, an error is displayed and the command is rejected. If a replacement policy is specified, the replacement is taken from the spareset to replace the removed member using the specified policy. If NOPOLICY is

specified, the RAIDset continues to operate in a reduced state until a replacement is manually specified (see SET *RAIDset-container-name*) REPLACE=) or a policy is specified (see SET *RAIDset-container-name* POLICY=).

The disk removed via the REMOVE= command is added to the failedset.

Note

No other qualifiers to the SET *RAIDset-container-name* command may be specified if REMOVE is specified.

REPLACE=*disk-container-name*
Specifies the replacement of a disk member into a reduced RAIDset. If the RAIDset is not in a reduced state, an error is displayed and the command is rejected. If a replacement policy is already specified, an error is displayed and the command is rejected. If the disk specified is already being used by a configuration (including a spareset), an error is displayed and the command is rejected. Otherwise, the disk specified is added as a member to the specified RAIDset and a reconstruct operation begins immediately.

Note

No other qualifiers to the SET *RAIDset-container-name* command may be specified if REPLACE is specified.

Examples

1.
```
CLI> SET RAID9 POLICY=BEST_FIT
```
Changes RAIDset RAID9's policy to BEST_FIT.

2.
```
CLI> SET RAID9 REMOVE=DISK0
```
Removes RAIDset RAID9's member DISK0 from the RAIDset. If there is a replacement policy, a new disk is taken from the spareset and placed in the RAIDset automatically.

3.
```
CLI> SET RAID9 REPLACE=SPAREDISK
```
Adds disk SPAREDISK to the reduced RAIDset, RAID9. A reconstruct operation begins immediately on SPAREDISK.

SET THIS_CONTROLLER

Changes this controller's parameters (the controller that the maintenance terminal is connected to or the target of the DUP connection).

Format

SET THIS_CONTROLLER

Description

The SET THIS_CONTROLLER command enables you to modify controller parameters on THIS_CONTROLLER in single and dual-redundant configurations.

Qualifiers

CACHE_FLUSH_TIMER=*n*
CACHE_FLUSH_TIMER=DEFAULT
Specifies how many seconds (1–65535) of idle time may elapse before the write-back cache flushes its entire contents to disk. After the specified time, the write-back cache flushes its contents to disk to ensure data integrity. You must restart the controller before any change to the CACHE_FLUSH_TIMER parameter takes effect.

ID=(*n1[,nN]*)
Specifies from one to four SCSI target IDs (0–7). If two or more target IDs are specified, they must be enclosed in parenthesis and separated by a comma.

Note

The unit number determines which target the LUN are available under. For example, D203 would be target 2, LUN 3. D500 would be target 5, LUN 0. D5 would be target 0, LUN 5.

If two SWXRC–04 controllers are in a dual-redundant configuration, each controller has the same IDs. When you change the IDs on one controller, the other is automatically updated. A maximum of four IDs may be specified in any combination between the two controllers.

PREFERRED_ID=(*n1[,nN]*)
NOPREFERRED_ID
In a dual-redundant configuration, PREFERRED_ID defines which targets are handled by the specified controller. If two or more PREFERRED_IDs are specified, they must be enclosed in parenthesis and separated by a comma. The only PREFERRED_IDs that can be specified must have already been configured using the ID= qualifier.

For example, if you configured a SWXRC–04 with IDs 0, 1, and 2, you could specify preferred ids 0, 1, and 2 in any combination on the two controllers. If one controller had preferred ids 0 and 1, it would handle unit numbers 0–7 and 100–107 and the other controller would handle unit numbers 200–207.

When you change the PREFERRED_IDs on one controller, the other controller are automatically updated to support the remaining (if any) IDs.

By specifying NOPREFERRED_ID the controller does not respond to any target ID on the host's SCSI bus. However, in a dual-redundant mode, if the controller with PREFERRED_IDs specified were to fail, the controller with NOPREFERRED_ID would pick up the targets of the failed controller.

PROMPT="*new prompt*"
Specifies a 1- to 16-character prompt enclosed in quotes that are displayed when the controller's CLI prompts for input. Only printable ASCII characters are valid.

When first installed, the CLI prompt is set to the first three letters of the controller's model number (for example, SC4>).

TERMINAL_PARITY=ODD
TERMINAL_PARITY=EVEN
NOTERMINAL_PARITY
Specifies the parity transmitted and expected. Parity options are ODD or EVEN. NOTERMINAL_PARITY causes the controller to not check for, or transmit any parity on the terminal lines.

When first installed, the controller's terminal parity is set to NOTERMINAL_PARITY.

TERMINAL_SPEED=*baud_rate*
Sets the terminal speed to 300, 600, 1200, 2400, 4800, 9600 or 19200 baud. The transmit speed is always equal to the receive speed.

When first installed, the controller's terminal speed is set to 9600 baud.

TIME=*dd-mmm-yyyy:hh:mm:ss*
The TIME= commmand specifies the date and time. If the controller is in a dual-redundant configuration, the time is communicated to the other controller.

Examples

1.
```
CLI> SET THIS_CONTROLLER ID=5 SPEED=1200
```
Modifies this SWXRC–04 controller's SCSI ID and sets the terminal speed to 1200 baud.

2.
```
CLI> SET THIS_CONTROLLER ID=5
```
Sets this SWXRC–04 controller so it responds to requests for target 5.

3.
```
CLI> SET THIS_CONTROLLER ID=(2,5)
```
Sets this SWXRC–04 controller so it responds to requests for targets 2 and 5.

SET *unit-number*

Changes the unit parameters.

Format

SET *unit-number*

Parameters

unit-number
Specifies the logical unit number (D0–D7, D100-D107, and so forth) to modify the software switches. The *unit-number* is the name given the unit when it was created using the ADD UNIT command.

Description

The SET command is used to change logical unit parameters.

Qualifiers for a Unit Created from a TRANSPORTABLE Disk Drive

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

READ_CACHE (Default)
NOREAD_CACHE
Enables and disables the controller's read cache on this unit.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit are spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

Qualifiers for a Unit Created from a NOTRANSPORTABLE Disk Drive

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

READ_CACHE (Default)
NOREAD_CACHE
Enables and disables the controller's read cache on this unit.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit are spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

WRITEBACK_CACHE
NOWRITEBACK_CACHE (Default)
Enables and disables the controller's write-back cache on this unit.

Qualifiers for a Unit Created from a RAIDset

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit are spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

Note

Writes may still be performed to a write-protected RAIDset to satisfy a reconstruct pass or to reconstruct a newly replaced member. However, write protect disables the writing of any new data.

WRITEBACK_CACHE
NOWRITEBACK_CACHE (Default)
Enables and disables the controller's write-back cache on this unit.

Qualifiers for a Unit Created from a Stripeset

MAXIMUM_CACHED_TRANSFER=*n*
MAXIMUM_CACHED_TRANSFER=32 (Default)
Specifies the maximum size transfer in blocks to be cached by the controller. Any transfers over this size are not cached. Valid values are 1–1024.

READ_CACHE (Default)
NOREAD_CACHE
Enables and disables the controller's read cache on this unit.

RUN (Default)
NORUN
Enables and disables a unit's availibility to the host. When RUN (default) is specified, the devices that make up the unit are spun up and the unit is made available to the host. If NORUN is specified, the devices that make up the unit are still spun up, but the unit is not made available to the host.

WRITE_PROTECT
NOWRITE_PROTECT (Default)
Enables and disables write protection of the unit.

WRITEBACK_CACHE
NOWRITEBACK_CACHE (Default)
Enables and disables the controller's write-back cache on this unit.

Examples

1.
```
CLI> SET D1 WRITE_PROTECT NOREAD_CACHE
```

Sets the write protect and turns off the read cache on unit D1.

SHOW DEVICES

Shows physical devices and physical device information.

Format

SHOW DEVICES

Description

The SHOW DEVICES command displays all the devices known to the controller.

Qualifiers

FULL
If the FULL qualifier is specified, additional information may be displayed after each device.

Information contained in the additional information is dependent on the device type.

Examples

1.
```
CLI> SHOW DEVICES
Name          Type          Port Targ  Lun                      Used by
------------------------------------------------------------------------------

DI0           disk            1    0    0                       D100
DI1           disk            1    1    0                       D110
```

Shows a basic listing of devices attached to the controller.

2.
```
CLI> SHOW DEVICES FULL
Name          Type          Port Targ  Lun                      Used by
------------------------------------------------------------------------------

DI0           disk            1    0    0                       D100
        DEC       RZ35      (C) DEC X388
DI1           disk            1    1    0                       D110
        DEC       RZ26      (C) DEC T386
```

Shows a full listing of devices attached to the controller.

SHOW DISKS

Shows all disk drives and drive information.

Format

SHOW DISKS

Description

The SHOW DISKS command displays all the disk drives known to the controller.

Qualifiers

FULL
If the FULL qualifier is specified, additional information may be displayed after each device.

Examples

1.
```
CLI> SHOW DISKS
Name          Type          Port Targ  Lun                   Used by
--------------------------------------------------------------------------------

DI0           disk            1    0    0                    D100
DI1           disk            1    1    0                    D110
```

Shows a basic listing of disks attached to the controller.

2.
```
CLI> SHOW DISKS FULL
Name          Type          Port Targ  Lun                   Used by
--------------------------------------------------------------------------------

DI0           disk            1    0    0                    D100
          DEC       RZ35      (C) DEC X388
DI1           disk            1    1    0                    D110
          DEC       RZ26      (C) DEC T386
```

Shows a full listing of disks attached to the controller.

SHOW *disk-container-name*

Shows information about a disk drive.

Format

SHOW *disk-container-name*

Parameters

disk-container-name
The name of the disk drive to be displayed.

Description

The SHOW *disk-container-name* command is used to show specific information about a particular disk.

Examples

1.
```
CLI> SHOW DI3
Name          Type          Port Targ  Lun                       Used by
--------------------------------------------------------------------------------

DI3           disk            1    3    0                         D130
          DEC      RZ26      (C) DEC X388
```

Shows a listing of disk DI3.

SHOW FAILEDSET

Shows the members of the failedset.

Format

SHOW FAILEDSET

Description

The SHOW FAILEDSET command displays all the disk drives that are members of the failedset.

Examples

1.
```
CLI> SHOW FAILEDSET
Name          Storageset                     Uses          Used by
------------------------------------------------------------------------------

FAILEDSET     failedset                      DISK310
                                             DISK410
```

Shows a listing of the members of the failedset.

SHOW OTHER_CONTROLLER

Shows information for the other controller.

Format

SHOW OTHER_CONTROLLER

Description

Shows all controller, port, and terminal information for the other controller.

Qualifiers

FULL
If the FULL qualifier is specified, additional information is displayed after the basic controller information.

Examples

1.

```
CLI> SHOW OTHER_CONTROLLER
Controller:
        SWXRC-04  CX44332211 Firmware XVDV-0, Hardware AX01❶
        Configured for dual-redundancy with CX55555555❷
            In dual-redundant configuration❸
        SCSI address 6❹
        Time: NOT SET❺
Host port:
        SCSI target(s) (0, 1, 2, 3), ❻Preferred target(s) (2, 3)❼
Cache:
        16 megabyte write cache, version 2❽
        Cache is GOOD❾
        Battery is GOOD❿
        No unflushed data in cache⓫
        CACHE_FLUSH_TIMER = DEFAULT (10 seconds)⓬
Licensing Information:
        RAID  (RAID5+Writeback Cache) is ENABLED, License key is VALID⓭
        WBCA  (Writeback Cache ONLY) is ENABLED, License key is VALID⓮
Extended Information:
        Terminal speed 19200 baud,eight bit,no parity,1 stop bit⓯
        Operation control:00000004⓰   Security state code:85780⓱
```

Shows the full SWXRC–04 controller information, where:

❶ The controller model and serial numbers, the firmware version number, and an indication of what type of host hardware to which the controller is connected.

❷ The serial number of the companion controller in a dual-redundant configuration.

❸ An indication as to whether the controller pair has been set by the operator for dual-redundant operation.

❹ The SCSI target ID of the controller on its device buses. The ID number also indicates which slot the controller is plugged into in the controller shelf.

- An indication as to whether the operator has set the time of day in the controller.
- The group of host target IDs to which the operator has enabled the controller to respond. In a nonredundant configuration, the controller always responds to all of the target IDs in this group. In a dual-redundant configuration, the controller normally only responds to those IDs in this group that are specified in the "Preferred target(s)" listing below. The companion controller responds to the remaining IDs.
- In a dual-redundant controller configuration not in a failover state, the host target IDs to which the controller responds.
- The size, type, and version number of the controller's cache module hardware.
- The results of the cache module hardware initialization diagnostics.
- An indication of the charge level of the cache battery, if a write-back cache is installed.
- An indication as to whether the cache currently contains data that has not been saved to disk.
- In a situation where there is no cache activity, the amount of time that elapses before a cache flush operation is automatically performed.
- The RAID configuration that has been selected by the operator, and an indication as to whether the operator-entered RAID license key is valid.
- The cache configuration that has been selected by the operator, and an indication as to whether the operator-entered cache license key is valid.
- The operating parameters set for the maintenance terminal connected to the controller.
- For factory use only.
- For factory use only.

2.

```
CLI> SHOW OTHER_CONTROLLER
Controller:
        SWXRC-04  CX44332211 Firmware XVDV-0, Hardware AX01
        Configured for dual-redundancy with CX55555555
            In dual-redundant configuration
        SCSI address 6
        Time: NOT SET
Host port:
        SCSI target(s) (0, 1, 2, 3), Preferred target(s) (2, 3)
Cache:
        16 megabyte write cache, version 2
        Cache is GOOD
        Battery is GOOD
        No unflushed data in cache
        CACHE_FLUSH_TIMER = DEFAULT (10 seconds)
```

Shows the basic SWXRC–04 controller information.

SHOW RAIDSETS

Shows RAIDsets and RAIDset information.

Format

SHOW RAIDSETS

Description

The SHOW RAIDSETS command displays all the RAIDsets known by the controller.

Qualifiers

FULL
If the FULL qualifier is specified, additional information may be displayed after each storage set.

Examples

1.
```
CLI> SHOW RAIDSETS
Name          Storageset                     Uses          Used by
------------------------------------------------------------------------------

R0            raidset                        DISK110       D401
                                             DISK220
                                             DISK310
                                             DISK400

R1            raidset                        DISK130
                                             DISK240
                                             DISK330
                                             DISK420
```

Shows a basic listing of all RAIDsets.

2.
```
CLI> SHOW RAIDSETS FULL
Name          Storageset                     Uses          Used by
------------------------------------------------------------------------------

R0            raidset                        DISK110       D401
                                             DISK220
                                             DISK310
                                             DISK400
        Switches:
          CHUNKSIZE = 63 blocks
          POLICY (for replacement) = BEST_PERFORMANCE
          RECONSTRUCT (priority) = NORMAL
        State:
          RECONSTRUCT 3% complete
```

```
R1          raidset                          DISK130
                                             DISK240
                                             DISK330
                                             DISK420
        Switches:
          CHUNKSIZE = 63 blocks
          POLICY (for replacement) = BEST_PERFORMANCE
          RECONSTRUCT (priority) = NORMAL
        State:
          RECONSTRUCT 0% complete
```

Shows a full listing of all RAIDsets.

SHOW *raidset-container-name*

Shows information about a RAIDset.

Format

SHOW *raidset-container-name*

Parameters

raidset-container-name
The name of the RAIDset to be displayed.

Description

The SHOW *raidset-container-name* command is used to show specific information about a particular RAIDset.

Examples

1.
```
CLI> SHOW RAID9
Name          Storageset                    Uses            Used by
------------------------------------------------------------------------------

RAID9         raidset                       DISK130
                                            DISK240
                                            DISK330
                                            DISK420
        Switches:
          CHUNKSIZE = 63 blocks
          POLICY (for replacement) = BEST_PERFORMANCE
          RECONSTRUCT (priority) = NORMAL
        State:
          RECONSTRUCT 0% complete
```

Shows a listing of RAIDset RAID9.

SHOW SPARESET

Shows the members of the spareset.

Format

SHOW SPARESET

Description

The SHOW SPARESET command displays all the disk drives that are members of the spareset.

Examples

1.
```
CLI> SHOW SPARESET
Name          Storageset                     Uses          Used by
------------------------------------------------------------------------------

SPARESET      spareset                       DISK150
                                             DISK350
                                             DISK440
```

Shows a list of the members of the spareset.

SHOW STORAGESETS

Shows storagesets and storageset information.

Format

SHOW STORAGESETS

Description

The SHOW STORAGESETS command displays all the storagesets known by the controller. A storageset is any collection of containers, such as stripesets, RAIDsets, the spareset and the failedset.

Stripesets are displayed first, followed by RAIDsets, sparesets, failedsets, and then passthrough containers.

Qualifiers

FULL

If the FULL qualifier is specified, additional information may be displayed after each storage set.

Examples

1.
```
CLI> SHOW STORAGESETS
Name          Storageset                    Uses            Used by
--------------------------------------------------------------------------------
S0            stripeset                     DISK500         D1
                                            DISK510
                                            DISK520
```

Shows a basic listing of all storagesets.

2.
```
CLI> SHOW STORAGESETS FULL
Name          Storageset                    Uses            Used by
--------------------------------------------------------------------------------
S0            stripeset                     DISK530
                                            DISK550
                                            DISK600
        Switches:
          CHUNKSIZE = 24 blocks
S1            stripeset                     DISK620
                                            DISK640
        Switches:
          CHUNKSIZE = 24 blocks
```

```
R0             raidset                         DISK110         D401
                                               DISK220
                                               DISK310
                                               DISK400
        Switches:
          CHUNKSIZE = 63 blocks
          POLICY (for replacement) = BEST_PERFORMANCE
          RECONSTRUCT (priority) = NORMAL
        State:
          RECONSTRUCT 3% complete
R1             raidset                         DISK130
                                               DISK240
                                               DISK330
                                               DISK420
        Switches:
          CHUNKSIZE = 63 blocks
          POLICY (for replacement) = BEST_PERFORMANCE
          RECONSTRUCT (priority) = NORMAL
        State:
          RECONSTRUCT 0% complete
SPARESET       spareset                        DISK150
                                               DISK350
                                               DISK440
FAILEDSET      failedset
CMD100         passthrough                     DISK100         D610
CMD240         passthrough                     DISK250         D624
CMD310         passthrough                     CD310           D631
```

Shows a full listing of all storagesets.

SHOW STRIPESETS

Shows stripesets and related stripeset information.

Format

SHOW STRIPESETS

Description

The SHOW STRIPESET command displays all the stripesets known by the controller.

Qualifiers

FULL
If the FULL qualifier is specified, additional information may be displayed after each storage set.

Examples

1.
```
CLI> SHOW STRIPESETS
Name          Storageset                    Uses          Used by
-----------------------------------------------------------------------

S0            stripeset                     DISK500       D1
                                            DISK510
                                            DISK520

S1            stripeset                     DISK400       D17
                                            DISK410
                                            DISK420
```

Shows a basic listing of all stripesets.

2.
```
CLI> SHOW STRIPESETS FULL
Name          Storageset                    Uses          Used by
-----------------------------------------------------------------------

S0            stripeset                     DISK530
                                            DISK550
                                            DISK600
       Switches:
         CHUNKSIZE = 24 blocks
S1            stripeset                     DISK620
                                            DISK640
       Switches:
         CHUNKSIZE = 24 blocks
```

Shows a full listing of all stripesets.

SHOW *stripeset-container-name*

Shows information about a specific stripeset.

Format

SHOW *stripeset-container-name*

Parameters

stripeset-container-name
The name of the stripeset to be displayed.

Description

The SHOW *stripeset-container-name* command is used to show specific information about a particular stripeset.

Examples

1.
```
CLI> SHOW STRIPE0
Name          Storageset                         Uses            Used by
------------------------------------------------------------------------------

STRIPE0       stripeset                          DISK530
                                                 DISK550
                                                 DISK600
         Switches:
           CHUNKSIZE = 24 blocks
```

Shows a listing of stripeset STRIPE0.

SHOW THIS_CONTROLLER

Shows information for this controller.

Format

SHOW THIS_CONTROLLER

Description

Shows all controller, port, and terminal information for this controller.

Qualifiers

FULL
If the FULL qualifier is specified, additional information is displayed after the basic controller information.

Examples

1.

```
CLI> SHOW THIS_CONTROLLER
Controller:
        SWXRC-04  CX44332211 Firmware XVDV-0, Hardware AX01
        Configured for dual-redundancy with CX55555555
            In dual-redundant configuration
        SCSI address 6
        Time: NOT SET
Host port:
        SCSI target(s) (0, 1, 2, 3), Preferred target(s) (2, 3)
Cache:
        16 megabyte write cache, version 2
        Cache is GOOD
        Battery is GOOD
        No unflushed data in cache
        CACHE_FLUSH_TIMER = DEFAULT (10 seconds)
Licensing Information:
        RAID  (RAID5+Writeback Cache) is ENABLED, License key is VALID
        WBCA  (Writeback Cache ONLY) is ENABLED, License key is VALID
Extended Information:
        Terminal speed 19200 baud,eight bit,no parity,1 stop bit
        Operation control:00000004   Security state code:85780
```

Shows the full SWXRC–04 controller information, where:

1. The controller model and serial numbers, the firmware version number, and an indication of what type of host hardware to which the controller is connected.

2. The serial number of the companion controller in a dual-redundant configuration.

3. An indication as to whether the controller pair has been set by the operator for dual-redundant operation.

4. The SCSI target ID of the controller on its device buses. The ID number also indicates which slot the controller is plugged into in the controller shelf.

- An indication as to whether the operator has set the time of day in the controller.
- The group of host target IDs to which the operator has enabled the controller to respond. In a nonredundant configuration, the controller always responds to all of the target IDs in this group. In a dual-redundant configuration, the controller normally only responds to those IDs in this group that are specified in the "Preferred target(s)" listing below. The companion controller responds to the remaining IDs.
- In a dual-redundant controller configuration not in a failover state, the host target IDs to which the controller responds.
- The size, type, and version number of the controller's cache module hardware.
- The results of the cache module hardware initialization diagnostics.
- An indication of the charge level of the cache battery, if a write-back cache is installed.
- An indication as to whether the cache currently contains data that has not been saved to disk.
- In a situation where there is no cache activity, the amount of time that elapses before a cache flush operation is automatically performed.
- The RAID configuration that has been selected by the operator, and an indication as to whether the operator-entered RAID license key is valid.
- The cache configuration that has been selected by the operator, and an indication as to whether the operator-entered cache license key is valid.
- The operating parameters set for the maintenance terminal connected to the controller.
- For factory use only.
- For factory use only.

2.

```
CLI> SHOW THIS_CONTROLLER
Controller:
        SWXRC-04  CX44332211 Firmware XVDV-0, Hardware AX01
        Configured for dual-redundancy with CX55555555
            In dual-redundant configuration
        SCSI address 6
        Time: NOT SET
Host port:
        SCSI target(s) (0, 1, 2, 3), Preferred target(s) (2, 3)
Cache:
        16 megabyte write cache, version 2
        Cache is GOOD
        Battery is GOOD
        No unflushed data in cache
        CACHE_FLUSH_TIMER = DEFAULT (10 seconds)
```

Shows the basic SWXRC–04 controller information.

SHOW UNITS

Shows all units and unit information.

Format

SHOW UNITS

Description

The SHOW UNITS command displays all the units known by the controller.

Qualifiers

FULL
If the FULL qualifier is specified after UNITS, additional information may be displayed after each unit-number, such as the switch settings.

Examples

1.
```
CLI> SHOW UNITS
  Unit                                     Uses
--------------------------------------------------------------

  D401                                     RO
```

Shows a basic listing of units available on the controller.

2.
```
CLI> SHOW UNITS FULL
MSCP unit                                    Uses
--------------------------------------------------------------

  D401                                       RO
        Switches:
          RUN                       NOWRITE_PROTECT        READ_CACHE
          NOWRITEBACK_CACHE
          MAXIMUM_CACHED_TRANSFER_SIZE = 32
        State:
          AVAILABLE
          No exclusive access
```

Shows a full listing of units available on the controller.

SHOW *unit-number*

Shows information about a specific unit.

Format

SHOW *unit-number*

Parameters

unit-number
The unit number of the unit that is to be displayed.

Description

The SHOW *unit-number* command is used to show specific information about a particular unit.

Examples

1.
```
CLI> SHOW D150
     Unit                                       Uses
-------------------------------------------------------------

  D150                                          RO
        Switches:
          RUN                     NOWRITE_PROTECT        READ_CACHE
          NOWRITEBACK_CACHE
          MAXIMUM_CACHED_TRANSFER_SIZE = 32
        State:
          AVAILABLE
          No exclusive access
```

Shows a listing of a specific disk unit.

SHUTDOWN OTHER_CONTROLLER

Shuts down and does not restart the other controller.

Format

SHUTDOWN OTHER_CONTROLLER

Description

The SHUTDOWN OTHER_CONTROLLER command flushes all user data from the other controller's write-back cache (if present), then shuts down the other controller.

If any user data cannot be flushed to disk, the controller does not restart unless the IGNORE_ERRORS qualifier is specified.

Specifying IMMEDIATE causes the other controller to shut down immediately without flushing any user data to the disks, even if drives are online to the host.

Qualifiers

IGNORE_ERRORS
NOIGNORE_ERRORS (Default)
If errors result when trying to write user data, the controller is not shut down unless IGNORE_ERROR is specified.

If the IGNORE_ERRORS qualifier is specified, the controller shuts down even if all customer data cannot be written to disk from the write-back cache.

CAUTION

Customer data may be lost or corrupted if the IGNORE_ERRORS qualifier is specified.

IMMEDIATE
NOIMMEDIATE (Default)
If IMMEDIATE is specified, the controller shuts down immediately without checking for online devices or flushing user data from write-back cache to disk.

CAUTION

Customer data may be lost or corrupted if the IMMEDIATE qualifier is specified.

Examples

1.
```
CLI> SHUTDOWN OTHER_CONTROLLER
```

Shuts down the other controller as long as the other controller does not have any units online.

SHUTDOWN THIS_CONTROLLER

Shuts down and does not restart this controller.

Format

SHUTDOWN THIS_CONTROLLER

Description

The SHUTDOWN THIS_CONTROLLER command flushes all user data from this controller's write-back cache (if present), then shuts down this controller.

If any user data cannot be flushed to disk, the controller does not shut down unless the IGNORE_ERRORS qualifier is specified.

Specifying IMMEDIATE causes this controller to shut down immediately without flushing any user data to the disks, even if drives are online to a host.

Note

If you issue a SHUTDOWN THIS_CONTROLLER command, communication with the controller is lost when this controller shuts down.

Qualifiers

IGNORE_ERRORS
NOIGNORE_ERRORS (Default)
If errors result when trying to write user data, the controller is not shut down unless IGNORE_ERROR is specified.

If the IGNORE_ERRORS qualifier is specified, the controller shuts down even if all customer data cannot be written to disk from the write-back cache.

CAUTION

Customer data may be lost or corrupted if the IGNORE_ERRORS qualifier is specified.

IMMEDIATE
NOIMMEDIATE (Default)
If IMMEDIATE is specified, the controller shuts down immediately without checking for online devices or flushing user data from write-back cache to disk.

CAUTION

Customer data may be lost or corrupted if the IMMEDIATE qualifier is specified.

Examples

1.
```
CLI> SHUTDOWN THIS_CONTROLLER
```

Shuts down this controller as long as this controller does not have any units online.

B.4 CLI Messages

The following sections describe messages you can encounter during interactive use of the CLI.

B.4.1 Error Conventions

An Error *nnnn:* message means that the command did not complete. Except for a few of the failover messages (6000 series), no part of the command was executed. When encountering an error entering or exiting dual-redundant mode, some synchronization problems are unavoidable; the error message in such a case tells you what to do to get things back in synchronization.

Multiple error messages may result from one command.

Items in angle brackets (<>) are replaced at run time with names, numbers, and so on.

B.4.2 CLI Error Messages

For SWXRC–04 controllers:

Error 1000: The LUN portion of the unit number must be from 0 to 7

Explanation: This error results from an ADD UNIT command when the *n* in the D*n* or T*n* specified is out of range. The MSCP or TMSCP unit number after the "D" or "T" must be in the range of 0 to 4094.

Retry the ADD UNIT command with a correct number.

Error 1010: Maximum cached transfer size must be 1 through 1024 blocks

Explanation: This error results from a SET <unit number> or an ADD UNIT command when MAXIMUM_CACHED_TRANSFER_SIZE was specified. MAXIMUM_CACHED_TRANSFER_SIZE must be in the range 1 through 1024. Retry the SET or ADD command with a correct number.

Error 1020: CHUNKSIZE must be from <minimum> to <maximum>

Explanation: This error results from an INITIALIZE *storageset-container-name* command when CHUNKSIZE was specified. The chunk size must be DEFAULT or greater than 15. Retry the INITIALIZE command with DEFAULT or a correct number.

Error 1100: Disk unit numbers must start with the letter 'D'

Explanation: All disk unit numbers are of the form "D*n*." This error is displayed if you add a disk unit that does not begin the unit number with the letter "D."

Retry the ADD command with the letter "D" at the beginning of the unit number.

Error 1110: Unit numbers may not have leading zeros

Explanation: Tape and disk unit numbers may not be of the form "D03," for example, "D3" should be specified.

Retry the ADD command without any leading zeros.

Error 1120: LUN <lun> is already used

Explanation: Lun number <lun> has already been used by a disk or tape.

Retry the ADD command specifying a different LUN.

Error 1130: The unit number cannot exceed <max unit>

Explanation: You specified a unit number that was out-of-bounds.

Try to add the unit again using a unit number that is less than or equal to <max unit>.

Error 1140: Invalid unit number. Valid unit number range(s) are: <start> to <end>

Explanation: You attempted to create a unit out of the valid unit ranges. The valid unit ranges are given by the <start> and <end> values.

Retry the ADD command specifying a unit number in the correct range.

Error 1150: A restart of THIS_CONTROLLER is required before units may be added

Explanation: You changed the target IDs that the controller supports without restarting the controller, tehn tried to add a unit that is supported by the new target IDs. Before the new target ids may be used, a resart is required.

Restart the controller.

Error 2010: Target must be 0 - <maximum target number>

Explanation: When adding a device, you specified a target greater than <maximum target number>.

In single controller configurations, <maximum target number> is 6. In dual-redundant configurations, <maximum target number> is 5.

Error 2020: LUN must be 0 - 7

Explanation: When adding a device, you specified a LUN greater than 7.

Error 2030: This port, target LUN combination already in use by another device

Explanation: When adding a device, you specified PTL that is already specified by another device.

Error 2040: Cannot set TRANSPORTABLE when device in use by an upper layer

Explanation: A disk cannot be set to TRANSPORTABLE when it is being used by an upper level (unit or storageset).

Error 2050: Cannot set NOTRANSPORTABLE when device in use by an upper layer

Explanation: A disk cannot be set to NOTRANSPORTABLE when it is being used by an upper level (unit or storageset).

Error 2060: Can only clear UNKNOWN errors on a device

Explanation: You attempted to clear UNKNOWN on a storageset or a unit.

Check the name of the device and reissue the command.

Error 3050: <disk name> could not be initialized as a spare disk

Explanation: When adding spare disks to the spareset, they are initialized with special spare disk metadata. If the metadata cannot be written, error 3050 results.

Error 3060: <disk name> is not a member of the spareset

Explanation: You attempted to delete a disk drive from the spareset that was not a member of the spareset.

Error 3070: <disk name> is not a member of the failedset

Explanation: You attempted to delete a disk drive from the failedset that was not a member of the failedset.

Error 3080: <setname> can't be deleted

Explanation: You attempted to delete the spareset or the failedset. These containers cannot be deleted.

Error 3090: <licensable feature> support is not enabled on this controller

Explanation: You attempted to use a feature that requires a license, and the license was not enabled on this controller.

Error 3100: <licensable feature> support is not enabled on other controller

Explanation: You attempted to use a feature that requires a license, and the license was not enabled on the other controller.

Error 3110: <disk name> is not a member of <container name>, cannot remove it

Explanation: When issuing a SET <container name> REMOVE=<disk name>, the disk specified was not part of the container.

Check the device and container names and reissue the command.

Error 3120: <container name> is already reduced. Another member cannot be removed

Explanation: When issuing a SET <container name> REMOVE=<disk name>, the container was already in a reduced state. Add another disk added before removing another member.

Error 3130: Unable to remove <disk name> from <container name>

Explanation: When issuing a SET <container name> REMOVE=<disk name>, the controller was unable to remove the device from the RAIDset.

Check for error conditions, and if none exist, contact Digital Multivendor Customer Services.

Error 3140: <disk name> is in a spareset. Remove it from the spareset first.

Explanation: When issuing a SET <container name> REPLACE=<disk name>, the disk specified was part of the spareset. A disk to be used as a replacement must not be part of any configuration.

Error 3150: <disk name> is still part of a configuration. Delete upper configuration first.

Explanation: When issuing a SET <container name> REPLACE=<disk name>, the disk specified was part of an existing configuration. A disk to be used as a replacement must not be part of any configuration.

Error 3160: <disk name> is not a disk. Can only use disks for replacement in a raidset.

Explanation: When issuing a SET <container-name> REPLACE=<disk-name>, the device identified by <disk name> was not a disk.

Error 3170: <container name> is not reduced. Cannot replace a member.

Explanation: When issuing a SET <container-name> REPLACE=<disk-name>, the container specified was not reduced.

Remove a member before replacing it.

Error 3180: <container name> has a replacement policy specified. Cannot manually replace a member.

Explanation: When issuing a SET <container-name> REPLACE=<disk-name>, it was discovered that the container specified already had a replacement policy specified. A manual replacement cannot be done on a container with an automatic replacement policy.

Set the replacement policy for the container to NOPOLICY and try the replacement again.

Error 3190: Unable to replace <disk name> in <container name>

Explanation: When issuing a SET <container name> REPLACE=<disk name>, the controller was unable to replace the device into the RAIDset.

Check for error conditions, and if none exist, contact Digital Multivendor Customer Services.

Error 3200: No other switches may be specified on a REMOVE operation.

Explanation: When issuing a SET <container name> REMOVE=<disk name>, no other switches (such as POLICY) may be specified.

Error 3210: No other switches may be specified on a REPLACE operation.

Explanation: When issuing a SET <container name> REPLACE=<disk name>, no other switches (such as POLICY) may be specified.

Error 3220: A REPLACE may not be done on a raidset that is not configured as a unit

Explanation: A REPLACE operation may not be done on a RAIDset that has not been configured as a unit.

Error 3230: <container name> is reconstructing <disk name>. Only <disk name> may be removed

Explanation: When issuing a SET <container name> REMOVE=<disk name> on a RAIDset that is already reconstructing, only the disk drive that is being reconstructed may be removed.

Error 3240: <storageset type> can't be initialized

Explanation: Sparesets and failedsets cannot be initialized.

Check the name of the container that you wish to initialize and try again.

Error 3250: A REMOVE may not be done on a raidset that is not configured as a unit

Explanation: A RAIDset must be configured as a unit before a disk can be removed to reduce the RAIDset.

Create a unit from the RAIDset and then remove the member.

Error 3260: <disk name> is a TRANSPORTABLE disk. TRANSPORTABLE disks cannot be used by storagesets. Do a SET <disk name> NOTRANSPORTABLE before using this disk in a storageset

Explanation: You cannot place a TRANSPORTABLE disk into a reduced RAIDset.

Set the disk NOTRANSPORTABLE and retry the command.

Error 4000: The CLI prompt must have 1 to 16 characters.

Explanation: This error results from a SET THIS_CONTROLLER or SET OTHER_CONTROLLER command with the qualifier PROMPT=. The length of the CLI prompt must be at least one character and may not exceed 16 characters.

Retry the command with the correct number of characters.

Error 4010: Illegal character in CLI prompt.

Explanation: A nonprintable character was specified. Only ASCII characters space " " through tilde "~" may be specified (hex 20–7E).

Error 4020: Terminal speed must be 300, 1200, 2400, 4800, 9600 or 19200

Explanation: This error results from a SET THIS_CONTROLLER or SET OTHER_CONTROLLER command with the argument TERMINAL_SPEED=. The only valid baud rates that may be specified are 110, 300, 1200, 2400, 4800, 9600 or 19200 baud.

Retry the command with a correct terminal speed.

Error 4090: Module has invalid serial number. This controller cannot be used Call Digital Services.

Explanation: This error is typically the result of faulty Non-Volatile memory. This error cannot be fixed in the field.

A replacement controller must be orderd. Contact Digital Multivendor Customer Services.

Error 4100: Unable to RESTART other controller.

Explanation: A communication error occurred when trying to restart the other controller.

Retry the RESTART command.

Error 4110: Unable to SHUTDOWN other controller.

Explanation: A communication error occurred when trying to shutdown the other controller.

Retry the SHUTDOWN command.

Error 4120: Unable to SELFTEST other controller.

Explanation: A communication error occurred when trying to self-test the other controller.

Retry the SELFTEST command.

Error 4130: Unable to setup controller restart.

Explanation: A communication error occurred when trying to restart or self-test the other controller.

Retry the RESTART or SELFTEST command.

Error 4140: Unable to lock the other controller's NV memory

Explanation: Most configuration commands such as ADD, DELETE, and SET require both controllers in a dual-redundant configuration to be running so configuration changes can be recorded in both controllers. If one controller is not running, the above message results when you attempt to change the configuration.

Restart the other controller and try the command again, or SET NOFAILOVER on the remaining controller.

Error 4150: Unable to rundown the following units on the other controller: <list of problem units>

Explanation: When attempting to shut-down, restart or selftest the other controller, some units could not be successfully run down. This can be caused either by online units or errors when trying to rundown the units. Either rectify the problems on the problem units or issue the SHUTDOWN, RESTART or SELFTEST command with the IGNORE_ERRORS qualifier.

Error 4160: Unable to rundown the following units on this controller: <list of problem units>

Explanation: When attempting to SHUTDOWN, RESTART or SELFTEST this controller, some units could not be successfully run down. This can be caused either by online units or errors when trying to rundown the units.

Either rectify the problems on the problem units or issue the SHUTDOWN, RESTART or SELFTEST command with the qualifier IGNORE_ERRORS.

Error 4170: Only <max targets> targets may be specified

Explanation: When setting THIS_CONTROLLER or OTHER_CONTROLLER ID=, you specified too many IDs; you can only specify up to <max targets> IDs.

Retry the SET THIS_CONTROLLER ID= command with no more than <max targets> IDs specified.

Error 4180: Invalid unit number(s) still present that must be deleted before the controller ID may be changed. All unit numbers must be in the range(s): <start> to <end>

Explanation: You attempted to change the controller IDs when there were still units using those IDs. The current valid unit ranges are given by the <start> and <end> values.

Either delete the units that use the ID that is no longer specified, or Retry the SET THIS_CONTROLLER ID= specifying the ID being used by the existing units.

Error 4190: The time must be specified in the format dd-mmm-yyyy:hh:mm:ss

Explanation: On the SWXRC–04 controllers only, the time must be specified as shown.

Retry the command using the correct time format.

Error 4200: CACHE_FLUSH_TIMER must be in the range 1 to 65535

Explanation: The value given for the CACHE_FLUSH_TIMER is out of range.

Reissue the command specifying a number in the range shown.

Error 4210: IDs specified as preferred must be a subset of the IDs specified by the ID= argument first

Explanation: SWXRC–04 only. The PREFERRED_IDs specified must be a subset of the IDs (targets) supported by the controller. When changing either the supported targets or the preferred ids, it was found that the PREFERRED_IDs were not a subset of teh IDs.

Reissue the command with valid PREFERRED_ID= arguments or change the IDs supported by the controller.

Error 5000: A program name must be from 1 to 6 characters in length

Explanation: This error results from a "RUN <program name>."

Error 5010: The requested program is currently busy.

Explanation: This error results from a "RUN <program name>." The program requested is being run by someone else.

Error 5020: The requested program is unknown.

Explanation: This error results from a "RUN <program name>."

Enter "DIR" to get a list of available programs.

Error 5030: Insufficient memory for request.

Explanation: This error results from a "RUN <program name>" resource problem. Retry the command later.

Error 6000: Communication failure with the other controller.

Explanation: There was a communication problem with the other controller. This typically happens if the other controller is shutting down. If these messages happen often when the other controller is not shutting down, call Digital Multivendor Customer Services.

Error 6010: Other controller not present

Explanation: When asked to communicate with another controller (the result of any one of a number of commands), the other controller was found not to be running.

If the other controller is in the process of restarting, retry the command later. If the other controller is shut down or turned off, start it. If the other controller is no longer present, enter a SET NOFAILOVER command to take it out of dual-redundant mode.

Error 6020: Initial failover handshake not yet complete

Explanation: For a short period of time after start up, the two controllers must communicate to set up a dual-redundant mode. This setup time is typically less than 1 minute. If commands that require controller-to-controller communication are entered during this setup time, error 6020 results.

Retry the command later.

Error 6030: Unable to communicate with the other controller to setup FAILOVER

Explanation: Could not setup FAILOVER due to communication problems between the controllers.

Retry the command later.

Error 6040: The write of the other controller's configuration information did not succeed; information may be in an inconsistent state. Before further use both controllers should be removed from dual-redundant mode (SET NOFAILOVER) and then placed back into dual-redundant mode (SET FAILOVER) to assure consistency

Explanation: Communication was lost in the middle of a SET FAILOVER command.

Follow the instructions included in the error message.

Error 6050: Communication failure with other controller while putting controllers into dual-redundant mode. Reissue SET FAILOVER command

Explanation: Communication was lost in the middle of a SET FAILOVER command.

Follow the instructions included in the error message.

Error 6070: Illegal command—this controller not configured for dual-redundancy

Explanation: A command was entered to a single controller configuration that requires two controllers to be in dual-redundant mode.

If two controllers are supposed to be in dual-redundant mode, enter a SET FAILOVER command. If not, do not enter the command that resulted in the error.

Error 6080: Illegal command—this controller not currently in dual-redundant mode

Explanation: A command was entered to a dual-redundant-configured controller, but the other controller was not available for communication.

Restart the other controller and wait until it is communicating with this controller. If this controller is no longer supposed to be in dual-redundant mode, enter a SET NOFAILOVER command.

Error 6090: In failover no device may be configured at target 6 <device type> <device name> is at PTL <port> <target> <lun>

Explanation: Target addresses 6 and 7 are used by the controllers when in a dual-redundant configuration. When in a single controller configuration, target 6 is available for use by devices. If devices are configured at target 6 and you attempt to install a dual-redundant configuration, this error is displayed for all devices that use target 6 and the controllers are not placed in a dual-redundant configuration.

Reconfigure the drives both logically and physically so that target 6 is not used.

Error 6110: Controllers already configured for failover

Explanation: A SET FAILOVER cannot be issued on a controller already in failover.

Error 6130: RAID5 in use on this controller but not enabled on the other controller.

Explanation: When trying to SET FAILOVER, it was discovered that there were RAID5 configurations on this controller but the other controller did not have the RAID5 feature enabled.

If RAID5 is licensed on the other controller, enable it. If it is not licensed, either contact Digital Multivendor Customer Services for licensing information, or do not use the two controllers in dual-redundant mode, or do not use a RAID5 configuration.

Error 6140: Writeback cache in use on this controller but not enabled on the other controller.

Explanation: When trying to SET FAILOVER, it was discovered that there were write-back cache switches set on this controller but the other controller did not have the write-back cache feature enabled.

If write-back cache is licensed on the other controller, enable it. If it is not licensed, either contact Digital Multivendor Customer Services for licensing information, or do not use the two controllers in dual-redundant mode, or do not use the write-back cache switches.

Error 6150: RAID5 in use on other controller but not enabled on this controller

Explanation: When trying to SET FAILOVER, it was discovered that there were RAID5 configurations on the other controller but this controller did not have the RAID5 feature enabled.

If RAID5 is licensed on this controller, enable it. If it is not licensed, contact Digital Multivendor Customer Services for licensing information or do not use the two controllers in dual-redundant mode, or do not use a RAID5 configuration.

Error 6160: Writeback cache in use on other controller but not enabled on this controller.

Explanation: When trying to SET FAILOVER, it was discovered that there were write-back cache switches set on the other controller but this controller did not have the write-back cache feature enabled.

If write-back cache is licensed on this controller, enable it. If it is not licensed, either contact Digital Multivendor Customer Services for licensing information or do not use the two controllers in dual-redundant mode, or do not use the write-back cache switches.

Error 7000: Can only clear LOST_DATA cache errors on a unit.

Explanation: you specified something other than a unit for clearing the LOST_DATA cache error.

Error 7010: Can only clear UNWRITEABLE_DATA cache errors on a unit.

Explanation: You specified something other than a unit for clearing the UNWRITEABLE_DATA cache error.

Error 7020: Can only retry UNWRITEABLE_DATA cache errors on a unit

Explanation: You specified something other than a unit for retrying a write on a UNWRITEABLE_DATA cache error.

Error 7030: Unable to force write of unwriteable data

Explanation: A RETRY UNWRITEABLE_DATA command could not write the UNWRITEABLE_DATA.

Error 7040: Unable rundown unit before clearing error

Explanation: To clear UNWRITEABLE_DATA and LOST_DATA errors, the unit must be rundown before the error is cleared. If the unit could not be rundown, the above error results. If this error persists, call Digital Multivendor Customer Services.

Error 7050: Unable to runup unit after clearing error. This controller must be restarted

Explanation: To clear UNWRITEABLE_DATA and LOST_DATA errors, the unit must be rundown before the error is cleared. If the unit was rundown and the error was cleared and then the unit was unable to be run back up, the unit remains unavailable until the controller is restarted.

Error 9000: Cannot rename a unit

Explanation: Only devices and storagesets may be renamed. If you attempt to rename a unit, the above message results.

Error 9010: <name> is an illegal name, it must be from 1 to 9 characters.

Explanation: This error results from an ADD command with an illegal name given.

Error 9020: <name> is an illegal name, it must start with A-Z

Explanation: This error results from an ADD command with an illegal name given.

Error 9030: <name> is an illegal name, characters may consist only of A-Z, 0-9, ., - or _

Explanation: This error results from an ADD command with an illegal name given.

Error 9040: <name> conflicts with keyword <keyword>

Explanation: The name given in an ADD command conflicts with a CLI keyword.

Specify another name.

Error 9050: Configuration area full

Explanation: The total number of units, devices, and storagesets that can be configured is 195 in any combination. This error results when you exceed that number of nodes.

Delete some units or devices in order to recover some configuration nodes.

Error 9060: <name> does not exist

Explanation: Some operation (SET, DELETE, INITIALIZE, and so forth) specified a name that does not exist.

Check the name and retry the command.

Error 9070: <name> is part of a configuration

Explanation: Devices may not be deleted if they are still in use by storagesets or units. Storagesets may not be deleted if they are still used by units.

Delete configurations from the top down; delete units, then stripesets, and RAIDsets (if any), and then finally devices.

Error 9080: <name> is already used

Explanation: An ADD command specified a name that is already in use.

Specify another name.

Error 9090: A <device type> cannot be used in a <storageset type>

Explanation: The device specified cannot be used in the storageset specified, for example, tapes cannot be bound into a stripeset.

Reexamine the configuration and correct the incompatibility.

Error 9100: A <storageset type> must have from <minimum> to <maximum> entities

Explanation: The wrong number of devices was specified for this storageset. Different storagesets require different numbers of devices.

Reexamine the configuration, then correct the number of devices.

Error 9130: Cannot delete ONLINE unit

Explanation: Unit specified in a DELETE command is online to a host.

Dismount the unit at the host then retry the command.

Error 9140: Cannot delete exclusive access unit

Explanation: Unit specified in a DELETE command is set up for exclusive access.

Take the unit out of exclusive access mode and retry the command.

Error 9150: INITIALIZE is no longer supported at the unit level. You must INITIALIZE the container that makes up this unit

Explanation: You tried to initialize a unit. Units may no longer be initialized. The container that makes up the unit must be initialized before a unit is created out of the container.

Error 9170: <device type> <device name> at PTL <port> <target> <lun> No device installed

Explanation: When a unit is added or initialized, the configuration of the devices that makes up the unit is checked. If no device is found at the PTL specified, this error is displayed.

Check both the logical and physical configuration of the unit and correct any mismatches.

Error 9180: <device type> <device name> at PTL <port> <target> <lun> Incorrect device type installed

Explanation: When a unit is added or initialized, the configuration of the devices that make up the unit is checked. If a non disk device is found at the PTL specified, this error is displayed.

Check both the logical and physical configuration of the unit and correct any mismatches.

Error 9190: Unit <unum> is currently online

Explanation: When a SHUTDOWN, RESTART, or SELFTEST command is entered without the OVERRIDE_ONLINE qualifier and online devices are found, the command is aborted and the units currently online are listed.

Dismount all devices from the hosts.

Error 9200: <name> conflicts with unit names

Explanation: This error results from an ADD command. Names in the format of D*n* and T*n*, when *n* is a number from 0 to 4094, are reserved for units. Rename the storageset or device that is being added so it does not conflict with the unit names and retry the command.

Error 9210: Cannot check if drives are online to the other controller

Explanation: When trying to check for online drives on the other controller, there was a communication failure.

Retry the command.

Error 9230: Unable to modify switches requested

Explanation: This error results from a SET command. The system is currently busy.

Retry the SET command later.

Error 9240: Cannot delete unit in maintenance mode

Explanation: When trying to delete a unit, the unit was found to be in maintenance mode. This is typically the result of trying to delete a unit that is in use by DILX.

Ensure that DILX is not being run against the unit that is to be deleted, and retry the command.

Error 9250: Initialize of disk failed

Explanation: Unable to write metadata on disk.

Make sure the disk is not broken.

Error 9260: Cannot INITIALIZE a container that is still part of a configuration. Delete upper configuration first

Explanation: A container cannot be initialized that is part of another configuration or is being used by a unit.

Delete the upper configuration and reissue the INITIALIZE command.

Error 9270: No metadata found on container, unit not created. An INITIALIZE <container name> must be issued before this container may be used

Explanation: You attempted to create a unit from a container that did not have valid metadata.

INITIALIZE the metadata on the container, then create a unit out if it.

Error 9290: Communication failure with other controller, cannot check other controller's licensing

Explanation: Unable to communicate with the other controller to check licensing before creating a RAIDset or enabling write-back cache.

Check to make sure that both controllers are running. If one is broken, take this controller out of failover (SET NOFAILOVER) and reissue the command.

Error 9320: Bad write-back cache or battery on <controller> controller

Explanation: If you attempt to set writeback cache on a device or create a RAIDset, and there is a bad cache or cache battery on a controller, writeback is not set, or the RAIDset is not created and the above message is displayed.

Error 9330: NV memory write collision. Please try again

Explanation: Two people were trying to configure the CLI at the same time.

Check the configuration you were trying to modify to make sure it's unchanged and retry the command.

Error 9340: Reduced raidsets cannot be INITIALIZED

Explanation: You cannot INITIALIZE a RAIDset that is running in reduced state.

Replace a member and try again.

Error 9380: Unable to allocate unit for NORUN to RUN transition

Explanation: The unit could not be allocated so the controller could do a RUN/NORUN transition.

Retry the command. If this error persists, call Digital Multivendor Customer Services.

Error 9400: Cannot rundown or allocate unit in order to delete it

Explanation: Retry the command. If this error persists, call Digital Multivendor Customer Services.

Error 9410: Cannot delete unit—<type> error exists on unit that must be cleared first. To clear error type: <clear error string>

Explanation: Units cannot be deleted if cache errors exist. Any cache errors must be cleared before a unit can be deleted.

Issue the <clear error string> command and then delete the unit.

Error 9420: Unit <unit number> has unflushed data or a cache error and must be deleted on this controller

Explanation: When trying to set failover a unit with unfluhed data or a cache error was detected on this controller.

Delete the unit as requested and then retry the SET FAILOVER command.

Error 9430: Cannot check if drives have unflushed data or cache errors on the other controller

Explanation: Communication error when trying to SET FAILOVER.

Retry the command. If this error persists, call Digital Multivendor Customer Services.

Error 9440: Unit <unit number> has unflushed data or a cache error and must be deleted on the other controller

Explanation: When trying to set failover a unit with unfluhed data or a cache error was detected on the other controller.

Delete the unit as requested and then retry the SET FAILOVER command.

B.4.3 Warning Conventions

A Warning *nnnn:* message means that the command completed, but there is a situation that you should be aware of. Typically, but not always, a warning results in an unusable configuration; you must either logically reconfigure the cabinet using the CLI or physically reconfigure the cabinet by moving the disks around.

Multiple warning messages may result from one command.

Items in angle brackets (<>) are replaced at run time with names, numbers, and so on.

B.4.4 CLI Warning Messages

Warning 1000: You should have read the user guide and fully understand the implications of setting WRITEBACK_CACHE

Explanation: Using writeback cache introduces behaviors that you should completely understand before using. See the full documentation on writeback cache in the user guide.

Warning 3000: This storageset is configured with more than one disk per port. This causes a degradation in performance

Explanation: This warning results from an ADD *storageset-type* command. The storageset specified has more than one member per port. One method of increasing the controller's performance is through parallel transfers to members of a storageset. If multiple members of a storageset are on one port, transfers must be done in serial to those members.

Though multiple storageset members on one port do work, it is strongly recommended that the storageset be deleted and reconfigured with one member per port.

Warning 3010: Unable to check all device types that make up this storageset. If the storageset is made up of different device types, it may result in a storageset of reduced size

Explanation: This warning results from an ADD *storageset-type* command. Device types being added to a storageset are checked to assure that they are the correct device types. If one or more devices could not be checked, the above warning is displayed.

You should check all the devices to assure that they are correctly installed and configured.

Warning 3020: This storageset is configured with different device types. This may result in a storageset of reduced size

Explanation: This warning results from an ADD *storageset-type* command. Device types being added to a storageset are checked to assure that they are the same types. If all devices are not the same, the above warning is reported. Storageset size is determined by the size of the smallest device, so the storageset configured is of reduced size.

If a reduced size storageset is acceptable, nothing needs to be done in response to the above warning. To realize the maximum storageset size, all devices that make up the storageset should be identical.

Warning 4000: A restart of this controller is required before all the parameters modified will take effect

Explanation: This warning results from a SET THIS_CONTROLLER command. Some controller parameters require a restart before they can take effect. If any of those parameters are changed, this warning is displayed.

It is recommended that a restart via the "RESTART THIS_CONTROLLER" command be done as soon as possible.

Warning 4010: A restart of the other controller is required before all the parameters modified will take effect

Explanation: This warning results from a SET OTHER_CONTROLLER command. Some controller parameters require a restart before they can take effect. If any of those parameters are changed, this warning is displayed.

Restart the controller and retry the command.

Warning 4020: A restart of both this and the other controller is required before all the parameters modified will take effect

Explanation: This warning results from a SET THIS_CONTROLLER or a SET OTHER_CONTROLLER command. Some controller parameters require a restart of both controllers before they can take effect. If any of those parameters are changed, this warning is displayed. Restart both controllers and retry the command.

Warning 6000: Communication failure with the other controller while taking controllers out of dual-redundant mode. Issue a SET NOFAILOVER command on the other controller

Explanation: This warning results from a SET NOFAILOVER command. This controller was unable to communicate with the other controller to notify it that it is no longer in dual-redundant mode. Typically, this occurs when the other controller has already been removed prior to the SET NOFAILOVER command.

Enter a SET NOFAILOVER command on the other controller as soon as possible.

Warning 6010: Licensing different between the two controllers

Explanation: If the licensing is not identical on both controllers in a dual-redundant configuration, the above warning is displayed.

You should check the licensing on both controllers and make sure they are identical.

Warning 7000: Data written successfully before clearing unwriteable data error

Explanation: As a result of a CLEAR UNWRITEABLE_DATA, if the last-ditch attempt to write data before clearing the error was successful, the above warning is displayed.

Note

This means that no customer data was lost, so this warning is actually good.

Warning 7010: Unable to clear LOST_DATA on other controller

Explanation: When trying to clear LOST_DATA on the other controller, a communication error occurred.

Retry the command. If the failure persists, contact Digital Multivendor Customer Services.

Warning 7020: Unable to clear UNWRITEABLE_DATA on other controller

Explanation: When trying to clear UNWRITEABLE_DATA on the other controller, a communication error occurred.

Retry the command. If the failure persists, contact Digital Multivendor Customer Services.

Warning 9030: Cannot determine if the correct device type is at the PTL specified

Explanation: When a device is added, the location specified is checked to see if the correct device type is present. This warning results when no device responds from the location specified.

Check the physical configuration and the PTL that was specified.

Warning 9040: There is currently a <device type> at the PTL specified

Explanation: When a device is added, the location specified is checked to see if the correct device type is present. This warning results when a device different from the one specified is found at the location specified (for example, a tape is found where a disk was added).

Check the physical configuration and the PTL that was specified.

Warning 9050: <device type> <device name> at PTL <port> <target> <lun> No device installed

Explanation: When a unit is added, the configuration of the disks that make up the unit is checked. If no device is found at the PTL specified, this warning is displayed.

Check both the logical and physical configuration of the devices that make up the unit and correct any mismatches.

Warning 9060: <device type> <device name> at PTL <port> <target> <lun> Incorrect device type installed

Explanation: When a unit is added, the configuration of the disks that make up the unit is checked. If a non disk device is found at the PTL specified, this warning is displayed.

Check both the logical and physical configuration of the devices that make up the unit and correct any mismatches.

Warning 9080: <license> support is not licensed on <controller> controller. Any use of this feature requires licensing. Continued use does not comply with the terms and conditions of licensing for this product.

Explanation: You have a licensed feature enabled on this controller but it is not licensed. This is against the contractual agreement between Digital and your company. Please disable the licensed feature and contact Digital Multivendor Customer Services if you wish to purchase it.

Warning 9090: Metadata found on container. Are you sure this is a TRANSPORTABLE container?

Explanation: When a transportable disk was initialized, metadata was found.

Verify that this disk in fact should be marked transportable. No action is required to correct this warning.

Warning 9100: Bad or low battery or bad write cache on <controller> writeback cache will not be used

Explanation: The battery is low or bad on the specified controller. The unit specified does not use writeback cache until the battery is charged or repaired.

Warning 9110: Bad or low battery or bad write cache on <controller> this unit cannot be used by <controller>

Explanation: The battery is low or bad on the specified controller. The unit specified requires the use of writeback cache, so its use has been disabled until the battery is charged or repaired.

C
Working with RAIDsets

C.1 SWXSC-series Controller RAID

Note

In this guide, the term RAIDsets refers to RAID level 5 and the term stripesets refers to RAID level 0.

Important Write-Back Cache Note

If your system contains write-back cache modules, their batteries were completely charged at the factory. It is normal for the batteries to have discharged slightly in shipment. To ensure absolute data integrity, the advanced write-back cache and RAID features of your controller require fully-charged batteries to operate. These advanced features may not be available immediately after installation, until the batteries have had an opportunity to completely recharge.

The disk striping and RAID level 5 facilities of SWXSC-series controllers provide you with a variety of options for controlling the cost, performance, and data availability characteristics of disk storage attached to the controllers. The disk striping facility included with the basic firmware, provides high I/O performance for applications requiring either high I/O request rates or high data transfer rates. The RAID facility available as an optional feature in conjunction with the write-back cache module, combines elements of RAID level 5 and RAID level 3 technology to provide affordable data availability (compared to RAID Level 0) without the I/O performance penalties normally associated with RAID level 5.

To use these RAID facilities effectively, you need to make some configuration decisions. Study the controller's CLI commands listed in this appendix and in Appendix B to configure your RAIDsets and stripesets.

In the SWXSC-series controller firmware, the RAID level 5 facility uses a distributed data mapping technique just like that used for disk striping. A powerful measure of protection against hardware component failure is added by reserving some of the blocks in each RAIDset's disk containers for the storage of redundant information. This redundant information allows the contents of any block of application data stored in the RAIDset, to be *regenerated* in the case of a disk container failure on which the data is stored (as long as the remaining RAIDset members are functioning properly).

RAID levels 3 and 5 are sometimes called parity RAID levels, because the redundant information they store is in the form of a parity block which corresponds to data blocks in each of the RAIDset's disk containers. *Parity* is any kind of checksum that allows the regeneration of unretrievable data.

Parity is typically combined with data stored in positionally corresponding blocks of other disk containers in the RAIDset to regenerate the missing data.

For detailed information about RAID technology, refer to *The RAIDBOOK—A Source for RAID Technology* published by The RAID Advisory Board, St. Peter, MN.

C.1.1 RAID Level 0

RAID level 0 is known as striping. Striping spreads data across multiple disks, breaking the user data into segments designated as "chunks." In a four disk stripeset, A, B, C, and D, for example, the first chunk is written on disk A, the second on disk B, the third on disk C, the fourth on disk D, the fifth on disk A, and so on.

CAUTION

If any member of a RAID level 0 stripeset fails, all data is lost from the entire set.

The system administrator sets the chunksize based upon application requirements. If the chunksize is set to be relatively large related to the average input/output (I/O) size, all of the disks may be able to execute different read/write requests simultaneously. If there are large numbers of frequently accessed files, this may be especially beneficial.

If the chunksize is set significantly smaller than the average I/O size, then most or all of the disks in the stripeset are able to transfer data for a single request in parallel. This method increases the data transfer rate for large I/Os.

RAID level 0 provides high performance for a wide variety of I/O intensive applications. Depending on the hardware configuration and the chunksize set, RAID level 0 improves either data transfer rate or I/O request rate.

C.1.2 RAID Level 5

RAID level 5 stripes data and rotates parity across all disks in the RAIDset. The controller combines incoming data with existing parity data.

RAID level 5 is suited for applications whose I/O loads consist predominantly of a large number of asynchronous read requests. Transaction processing and office automation applications often fall into this category. It also is good for data transfer intensive applications, such as image analysis, which make mostly read requests. It is not as well suited for write intensive applications (such as data entry, scientific or engineering data collection).

Note

If using RAID level 5, all data in the RAIDset are lost if a second drive fails in the same set before the first failed drive is repaired.

C.1.3 RAID Level 3

Industry-standard, RAID level 3 achieves higher bandwidths by transferring data to and from the disks, as a result of transferring a part of each I/O's data from each RAIDset member in parallel. To achieve high bandwidths with conventional fixed-block disks (typically 512 data bytes in size), all I/O requests must specify an amount of data equal to the member block size, multiplied by the number of members in the RAIDset, minus one. Also, the requests' starting addresses must be aligned so that correspondingly located data from each member is transferred. To permit this data transfer to take place in parallel, industry standard RAID level 3 often requires special disks or configurations to ensure that all disks in the RAIDset are rotating in perfect synchronization.

Industry standard RAID level 3 performs as though the RAID level 3 RAIDset is a single disk with a specific large (virtual) sector size. This results in substantial performance penalties for I/Os that are not perfectly aligned multiples of the 2048 (or larger) data byte size. Few applications use extremely large I/O sizes (and these may not easily be modified to use a multiple of the RAID level 3 virtual sector size). In any event, many operating systems can not easily accommodate virtual disks with unconventional sector sizes.

Digital's implementation of RAID level 3 for the SWXSC-series controller, achieves higher bandwidth levels without the virtual sector size or special device/configuration disadvantages. This is achieved with special algorithms related to RAID level 5 technology, but without the write performance penalty associated with conventional RAID level 5 (not occurring with conventional RAID level 3) implementation.

For convenience, this capability is controlled by setting the RAIDset's chunksize to a lower value, and performing many sequential write operations (in write-back mode). This permits higher bandwidth performance results approaching industry standard RAID level 3 operation. With the capability of setting chunksize, you can conveniently choose between more bandwidth-oriented or more throughput-oriented performance using the same configuration and CLI commands. When you specify intermediate chunksizes, you realize very large I/O benefits from RAID level 3 technology, while getting small I/O benefits from RAID level 5 technology.

Note

References to RAID level 5 in this document relate to higher level RAID operation for SWXSC-series controllers.

Chunksize is set with the CLI INITIALIZE CHUNKSIZE= command (refer to Appendix B).

C.1.4 RAIDset Terminology

The following are terms used with SWXSC-series controller RAIDset technology:

- Chunksize—The number of blocks written to one RAIDset member before data is written to the next RAIDset member.
- Container—Any entity capable of storing data, whether it is a physical device or a group of physical devices. A disk, a stripeset, and a RAIDset are examples of containers.

- Failedset—A group of disk drives that have been removed from RAIDsets due to a failure or manual removal. Disk drives in the failedset should be considered defective and should be tested and repaired before being placed in the spareset pool or back in their original locations.
- Parity—Any kind of checksum that allows the regeneration of unretrievable data. Parity is typically combined with data stored in positionally corresponding blocks of other disk containers in the RAIDset to regenerate the missing data.
- RAIDset—A virtual disk drive with its physical data spread across multiple physical disks. A RAIDset contains parity data to be used to regenerate data in the event that one member fails.
- RAIDset states
  - Normal state—All members are present and all data is redundant.
  - Reduced state—A failed RAIDset member has been detected and removed from the RAIDset.
  - Reconstructing state—All members are present and redundancy is being restored.
    * Reconstruct types (process of restoring redundancy to the RAIDset)

      There are two different types of reconstruct: one that takes place when a unit is created from a RAIDset; the other takes place during the replace operation of a failed RAIDset member. Each kind indicates a different error recovery operation/choice that the controller makes.

      - Initial reconstruct—Establishes initial redundancy following an ADD RAIDset...ADD UNIT command sequence. Note that all data written by the host is immediately fully redundant.

        When a RAIDset is initialized using the INITIALIZE container-name command, the controller does not take the lengthy period of time to make all the parity blocks consistent with the data. Instead, the controller marks all the parity blocks as bad and starts a reconstruct. The reconstruct recalculates and rewrites the parity blocks and marks them as good. This process allows the RAIDset to be used immediately. All new data written to the RAIDset is immediately fully redundant.

      - Reconstructing a replaced member—Regenerates the data for that member and restores redundancy.

        Reconstruct means to restore redundancy. This could be either recalculating the parity, or recalculating a user data block, using the remaining blocks.

        When a reduced RAIDset has a member added back to it, all the blocks on the replacement member are marked as bad (parity and user data blocks), and a reconstruct scan is started. The reconstruct recalculates the parity blocks on the new member and recalculates the user data blocks on the new member, writes the blocks, and marks the blocks good.

Note

If a second RAIDset member fails during a reconstruct operation, the RAIDset goes inoperative.

To determine which type of reconstruct is taking place, enter the SHOW RAIDset command. If a reconstructing member is not identified, the controller is performing an initial reconstruct.

- Redundancy—A RAIDset is considered to be redundant when user data is recorded directly to one member, and all of the other members and associated parity also are recorded. If a member is missing from the RAIDset, its data can be regenerated as needed, but the RAIDset is no longer redundant until the missing member is replaced and reconstructed.
- Regenerate—The process of calculating missing data from the redundant data.
- Replacement policy—The firmware controlled method by which a spare disk is selected to replace a disk that has failed in a RAIDset. Your replacement policy choices are BEST_FIT, BEST_PERFORMANCE, or NOPOLICY. Refer to the ADD RAIDSET and SET *raidset-container-name* CLI commands in Appendix B.
- Spareset—A pool of disk devices available to the controller to replace failed RAID level 5 RAIDset members.
- Stripe—The data and parity from the associated chunks of each member of the RAIDset.
- Stripe size—The capacity determined by n–1 times the chunksize. (n is the number of RAIDset members.)
- Stripeset—A virtual disk drive with its physical data spread across multiple physical disks.

C.1.5 RAIDset Rules and Important Information

The following list gives rules to remember about RAIDsets:

- You must always have a write-back cache module when creating RAID level 5 RAIDsets.
- Do not attempt to use any RAIDset commands with mismatched cache modules. Both cache modules must be write-back cache, and both must have the same number of megabytes.
- You must purchase licenses for write-back caching and RAID level 5 functionality. If you turn on write-back caching without entering a valid license key, you receive an hourly error message at the terminal, and an hourly error in the host error log. Once you enter your key, the error message stops.

Note

You may activate write-back caching and RAID level 5 after turning them on via the firmware licensing system (FLS) utility.

- NOWRITEBACK_CACHE (write-through caching) is automatically set for units created from RAIDsets. To increase the unit's performance, switch to WRITEBACK_CACHE.
- RAIDsets may be made up of 3 to 14 members.

For SWXSC-series controllers, RAIDsets in a dual-redundant configuration do not failover if the write-back cache battery has a low charge.

- RAIDsets go inoperative (and write-protected) if *both* write-back cache modules' batteries fail, or if a RAIDset belongs to a nonredundant controller. Any other storagesets (stripesets) flush cache data and become write-through (cache module acts as read cache) instead of write-back. RAIDsets become operational when the batteries become fully charged again.

Note

When the power for the write-back cache module batteries is too low, a console message is displayed. You can check the status of the batteries at any time by entering the CLI SHOW THIS_CONTROLLER command (or SHOW OTHER_CONTROLLER as appropriate).

- Your RAIDsets can achieve the high performance characteristics of RAID level 3 provided you set your RAIDset chunksize to the minimum value (16) and your application calls for large sequential I/O operations.
- RAIDsets can contain disks of different sizes, but the disk space used by the RAIDset is limited to the maximum size of the smallest disk in the RAIDset.
- Place RAIDset members on different ports. This keeps your RAIDset from going inoperative in the event that a single port bus failure occurs.

C.2 Planning Your RAIDsets

The following items should be considered before creating your RAIDsets:

- RAIDset size (3 to 14 members)
- RAIDset chunksize
- RAIDset replacement policy
- RAIDset reconstruction rate
- RAIDset spares
- RAIDset configurations for availability and performance
- RAIDset hardware requirement

C.2.1 Creating a RAIDset

Enter the following commands to create a RAIDset:

1. Use the ADD DISK *container-name SCSI-location* command to add new disk drives to your configuration and name them.
2. Use the ADD RAIDSET *container-name container-name1 container-name2 [container-nameN]* command and set the appropriate replacement policy and reconstruct qualifiers. You are not required to set a replacement policy.

   The following is an example for using the replacement policy and reconstruct qualifiers on the same command line as the ADD RAIDSET command:

   ```
   CLI> ADD RAIDSET R3 DISK100 DISK200 DISK300 POLICY=BEST_FIT
       RECONSTRUCTION=NORMAL
   ```

   Where: *R3* is the name assigned to the RAIDset.

DISK100, *DISK200*, and *DISK300* are the names assigned to the RAIDset members of a three member RAIDset.

POLICY=BEST_FIT is the replacement policy qualifier that is used when a RAIDset member fails. (You can choose between three different replacement policy qualifiers: POLICY=BEST_FIT, POLICY=BEST_PERFORMANCE, or NOPOLICY.)

RECONSTRUCTION= *rate or no rate* is the reconstruction rate qualifier that is used when a RAIDset member fails and a new member is taken from the spareset as a replacement for the failed device. You can choose between three reconstruct qualifiers: RECONSTRUCT=NORMAL (the default), RECONSTRUCT=FAST, or NORECONSTRUCT.

3. Enter the INITIALIZE command for your RAIDset. This is the time to specify your chunksize. The metadata on the container (in this case, the RAIDset) must be initialized before a unit may be created from it. If the container's metadata cannot be found, or is incorrect, an error is displayed and the unit is not created.

   ```
   CLI> INITIALIZE R3 CHUNKSIZE=n
   ```

   Where *n* is the chunksize in blocks.

   or

   ```
   CLI> INITIALIZE R3 CHUNKSIZE=DEFAULT
   ```

   Where the controller determines the optimal chunksize.

4. Enter the ADD UNIT *unit-number container-name* command to create a logical unit from the RAIDset for the host to access, followed by the appropriate qualifier for cache transfer sizes, preferred path, cache access, write protection, and so forth (as described in Appendix B).

   ```
   CLI> ADD UNIT D170 R3
   ```

   Where D170 is the unit name, and R3 is the RAIDset name.

5. Enter the SHOW RAIDSETS command to display all of the RAIDsets known to the controller. By adding the FULL qualifier, more information concerning all of the known RAIDsets is displayed.

   To show information about a particular RAIDset, enter the SHOW *raidset-container-name* command. Where *raidset-container-name* is the name assigned to the particular RAIDset.

6. Using the ADD SPARESET command, populate the spareset pool with disk drives that closely match the geometry of the other disk drives in your subsystem.

Refer to Appendix B for descriptions and examples for choosing and using the appropriate ADD UNIT qualifiers.

C.2.2 Storageset SHOW Commands

The following CLI SHOW commands are used to display the status of your (RAIDsets, stripesets, and storagesets.

Enter the following CLI command to display all RAIDsets known to the controller:

```
HSJ> SHOW RAIDSETS

Name          Storageset                  Uses          Used by
------------------------------------------------------------------------

RAID0         raidset                     DISK100       D0
                                          DISK300
                                          DISK400
                                          DISK500
```

Enter the following CLI command to display additional information about all RAIDsets known to the controller:

```
HSJ> SHOW RAIDSETS FULL

Name          Storageset                  Uses          Used by
------------------------------------------------------------------------

RAID0         raidset                     DISK100       D0
                                          DISK300
                                          DISK400
                                          DISK500
       Switches:
         CHUNKSIZE = 64 blocks
         POLICY (for replacement) = BEST_PERFORMANCE
         RECONSTRUCT (priority) = NORMAL
       State:
         RECONSTRUCT 3% complete on member DISK500
```

Enter the following CLI command to display information about a particular RAIDset:

```
HSJ> SHOW RAID0

Name          Storageset                  Uses          Used by
------------------------------------------------------------------------

RAID0         raidset                     DISK100       D0
                                          DISK300
                                          DISK400
                                          DISK500
       Switches:
         CHUNKSIZE = 64 blocks
         POLICY (for replacement) = BEST_PERFORMANCE
         RECONSTRUCT (priority) = NORMAL
       State:
         RECONSTRUCT 3% complete on member DISK500
```

Enter the following CLI command to display all information about all stripesets known to the controller:

```
HSJ> SHOW STRIPESETS FULL

Name          Storageset                  Uses          Used by
------------------------------------------------------------------------

STRIPE0       stripeset                   DISK110       D1
                                          DISK210
       Switches:
         CHUNKSIZE = 64 blocks
```

Enter the following CLI command to display all information about all storagesets known to the controller:

```
HSJ> SHOW STORAGESETS FULL
Name          Storageset                   Uses           Used by
---------------------------------------------------------------------------

STRIPE0       stripeset                    DISK110        D1
                                           DISK210
       Switches:
         CHUNKSIZE = 64 blocks
RAID0         raidset                      DISK100        D0
                                           DISK300
                                           DISK400
                                           DISK500
       Switches:
         CHUNKSIZE = 64 blocks
         POLICY (for replacement) = BEST_PERFORMANCE
         RECONSTRUCT (priority) = NORMAL
       State:
         RECONSTRUCT 4% complete on member DISK500
SPARESET      spareset                     DISK310
                                           DISK600
FAILEDSET     failedset                    DISK200
```

C.2.3 Adding and Deleting Spareset Members

The spareset is a pool of disk drives available to the controller to replace failing members of a RAIDset. The ADD SPARESET command adds disk drives to the spareset pool and initializes the metadata on the drives so they may be used for replacements into RAIDsets. The DELETE SPARESET command removes disk drives from the spareset.

Note

The spareset cannot be deleted, it is always available. It may contain no spares.

Enter the following CLI commands to add one or more disks to the spareset:

```
CLI> ADD SPARESET disk-container-name0 [disk-container-nameN]

Example: CLI> ADD SPARESET DISK100
         CLI> ADD SPARESET DISK100 DISK200 DISK300
```

Enter the following CLI commands to remove one or more disks from the spareset:

```
CLI> DELETE SPARESET disk-container-name0 [disk-containter-nameN]

Example: CLI> DELETE SPARESET DISK100
         CLI> DELETE SPARESET DISK100 DISK200 DISK300
```

Enter the following command to show the spareset:

```
HSJ> SHOW SPARESET

Name          Storageset                    Uses            Used by
------------------------------------------------------------------------------

SPARESET      spareset                      DISK310
                                            DISK600
```

C.2.4 Showing and Deleting Failedset Members

The Failedset is a group of disk drives that were removed from RAIDsets because they failed or were manually removed (via the SET *RAIDset-container-name REMOVE=disk-container-name command*). Drives in the Failedset should be considered defective. These drives must be tested and repaired before placing them back in operation.

The DELETE FAILEDSET command removes drives from the failedset so that they can be physically removed from the device shelves for testing and repair. Enter the following commands to show, and then remove, one or more disk drives from the failedset:

```
CLI> DELETE FAILEDSET DISK99
CLI> DELETE FAILEDSET DISK99 DISK88 DISK77
```

Enter the following CLI command to show a failedset:

```
HSJ> SHOW FAILEDSET

Name          Storageset                    Uses            Used by
------------------------------------------------------------------------------

FAILEDSET     failedset                     DISK200
```

Note

A failedset cannot be deleted, it is always available. It may contain no devices.

C.2.5 Changing RAIDset Characteristics

To change certain characteristics of a RAIDset, use the SET *RAIDset-container-name* command.

When a RAIDset looses a member, a new member is automatically added to the RAIDset from the spareset pool (providing you have a replacement policy set, and an appropriate spare is in the spareset). If you specified NOPOLICY, when you created your RAIDset, or you wish to change your replacement policy, enter one of the following commands:

```
CLI> SET RAIDset-container-name POLICY=BEST_FIT
CLI> SET RAIDset-container-name POLICY=BEST_PERFORMANCE
CLI> SET RAIDset-container-name NOPOLICY
```

To change the speed at which a RAIDset is reconstructed when a new member is added to the RAIDset, or immediately after the RAIDset is initialized, enter one of the following commands:

```
CLI> SET RAIDset-container-name RECONSTRUCT=NORMAL
CLI> SET RAIDset-container-name RECONSTRUCT=FAST
```

If you do not want your RAIDset to be reconstructed, enter the following command:

```
CLI> SET RAIDset-container-name NORECONSTRUCT
```

If you need to remove a disk member from a RAIDset, enter the following command:

```
CLI> SET RAIDset-container-name REMOVE=disk-container-name
```

For example:

```
CLI> SET R3 REMOVE=DISK100
```

If the RAIDset is already in a reduced state when the REMOVE= qualifier is used, an error is printed and the command is rejected. If a replacement policy is specified, the replacement drive is automatically taken from the spareset to replace the removed member using the specified policy.

If NOPOLICY is specified, the RAIDset continues to operate in a reduced state until a replacement is manually specified or a policy is specified. The disk drive removed via the REMOVE= qualifier is automatically added to the failedset.

To manually place a disk member into a reduced RAIDset when NOPOLICY was specified, enter the following command:

```
CLI> SET RAIDset-container-name REPLACE=disk-container-name
```

For example:

```
CLI> SET R3 REPLACE=DISK550
```

Where *R3* is the RAIDset name, and *DISK550* is the replacement disk name.

The disk called DISK550 is added to the reduced RAIDset (R3). A reconstruct operation begins immediately on the newly added disk (as long as the reconstruct is not disabled).

Note

No other qualifiers can be used with the SET *RAIDset-container-name* command when either the REPLACE or REMOVE qualifiers are specified.

C.2.6 Deleting a RAIDset

Use the DELETE *container-name* command to delete a RAIDset. This command determines whether the container (RAIDset) is used by a unit. If the container is in use, an error is printed and the container is not deleted. If the container is not is use, it is deleted.

Enter the following command to delete a RAIDset:

```
CLI> DELETE container-name
```

For example:

```
CLI> DELETE R3
```

Where *R3* is the name of the RAIDset being deleted.

C.2.7 Moving a RAIDset

You may physically relocate some or all of a RAIDset's member devices according to the following procedure:

CAUTION

If you lose track of the RAIDset members at any point during this procedure, you must attempt to restore the RAIDset by guessing where its members are installed. There is currently no way to retrace your steps using the controller or operating firmware.

To move a RAIDset you must do the following:

1. Make note of all devices comprising the RAIDset. Digital recommends marking them after using the CLI> LOCATE command to find all RAIDset members.
2. Delete the UNIT that uses the RAIDset with the DELETE *unit-number* command.
3. Delete the RAIDset with the DELETE *container-name* command.
4. Delete each disk from that RAIDset with the DELETE *container-name* command.
5. Physically remove the disks from the storage shelf.
6. Move the disks to the new port/target/LUN (PTL) location.
7. Add each disk with the ADD DISK *container-name SCSI-location* command using the new PTL location.
8. Re-add the RAIDset with the ADD RAIDSET *container-name container-name1 container-name2 [container-nameN]* command. Make sure you create it from the exact, original set of drives.

   CAUTION

   Do *not* initialize the RAIDset or you will destroy its data.

9. Recreate the logical unit from the RAIDset with the ADD UNIT *unit-number container-name* command.

The following example shows the unit "D100" made of RAIDset "RAID99." "RAID99" has member disks at PTLs 200, 210, and 400. The member at PTL 210 can be relocated to PTL 300 as follows:

```
CLI> DELETE D100
CLI> DELETE RAID99
CLI> DELETE DISK210

(Move the disk to PTL 300.)

CLI> ADD DISK DISK300 3 0 0
CLI> ADD RAIDSET RAID99 DISK200 DISK300 DISK400
CLI> ADD UNIT D100 RAID99
```

If you move a RAIDset from one controller to another and you damage one member, you must specify all of that RAIDset's members when you re-add the RAIDset to the new controller. The controller automatically reduces the RAIDset when it discovers that one member is inoperative.

Using the REDUCED Qualifier with the ADD RAIDset Command

Only use the REDUCED qualifier (with the ADD RAIDSET command) when you want to move a RAIDset that is already reduced. For example, you have a four member RAIDset that has been reduced to a three member RAIDset on Controller A and you wish to move the RAIDset to Controller B. Physically move the three members to Controller B and enter the following command:

```
CLI> ADD RAIDSET container-name container-name1 container-name2
    container-name3 REDUCED
```

For example:

```
CLI> ADD RAIDSET R3 DISK100 DISK300 DISK400 REDUCED
```

C.3 Adding a Stripeset (RAID Level 0)

Use the ADD STRIPESET *container-name container-name1 container-name2* command to add a stripeset and to name that stripeset. This command must be used when a new stripeset is added to a controller's configuration. A stripeset may contain from 2 to 14 members. To create a stripeset, add the individual disks, add the stripeset and name it, initialize the stripeset, and then create and name a unit from the stripeset as shown in the following example:

```
CLI> ADD DISK DISK99 1 0 0
CLI> ADD DISK DISK88 2 0 0
CLI> ADD DISK DISK77 3 0 0
CLI> ADD STRIPESET STRIPE0 DISK99 DISK88 DISK77
CLI> INITIALIZE STRIPE0
CLI> ADD UNIT D0 STRIPE0
```

C.3.1 Moving a Stripeset or Stripeset Member

You may physically relocate some or all of a stripeset's member devices. However, if you lose track of the stripeset members at any point during the relocation, you must attempt to restore the stripeset by guessing where its members are installed. There is currently no way to retrace your steps using the controller or operating firmware.

You the same procedure as described in Section C.2.7 to move a stripeset or stripeset member.

C.3.2 Showing Stripesets

The SHOW STRIPESET command displays all the stripesets known by the controller. The SHOW STRIPESET FULL gives more information about all stripesets known to the controller. By entering the SHOW *stripeset-container-name* command, you are given specific information about a particular stripeset.

```
CLI> SHOW STRIPESET
CLI> SHOW STRIPESET FULL
CLI> SHOW stripeset-container-name
CLI> SHOW UNITS FULL
```

C.4 Configuring RAIDsets for Availability, Performance, and Cost

RAIDset size (and RAID level) recommendations depend on whether availability, performance, or cost is the priority for creating RAIDsets. Tradeoffs must be made because no single RAID level provides the perfect balance of availability, performance, and cost. You need to determine what your priorities are before creating your RAIDsets or stripesets.

For availability and performance, it is important to put each RAIDset member on a different port (bus). This keeps the RAIDset from going inoperative in the event of a single port failure, and also provides better performance.

RAID level 5 is more economical for large RAIDsets than smaller RAIDsets because the cost of the parity blocks is amortized across a larger number of devices. However, large RAIDsets statistically have higher failure rates.

Stripesets provide high performance and a lower cost (no parity disk to buy), but do not provide redundancy for availability.

C.5 Miscellaneous RAID User Notes

Following is general information pertaining to the use of RAID configurations with the SWXRC–04 controller.

- Information on companion controller's devices and parameters — Certain information related to the companion controller in a dual-redundant configuration may not always appear. When device or parameter information does not appear after entering a command from one controller, enter the same command from the other controller.

  For example, a SHOW RAIDSET command entered from one controller when the RAIDset is part of a unit owned by the companion controller results in a chunksize of "NOT YET KNOWN." If you attach a terminal to the companion controller and show the same RAIDset, the correct chunksize appears.

  Another example occurs when RAIDsets are reconstructing. When using one controller to view a reconstructing RAIDset that is part of a unit attached to the companion controller, the RAIDset appears as zero percent reconstructed, even though reconstruction is making progress. The correct percentage appears once you attach your terminal to the companion controller.

- Adding RAIDsets in dual-redundant configurations — The ADD RAIDSET command fails if either controller's write-back cache battery is low or bad. Make sure both controllers in your dual-redundant configuration have fully charged write-back cache batteries before attempting to add RAIDsets to your configuration.

- RAIDset chunksize — Digital recommends that the chunksize for RAIDsets not be set larger than $2048 \div (n - 1)$ blocks where n is the number of RAIDset members. The default chunksize is equal to the track size (approximately 80 blocks). Setting larger chunksizes may result in degraded performance and conditions requiring controller reinitialization.

  For RAID 3 applications, an approximation of optimum chunksize is $Requestsize \div (n - 1)$ where n is the number of RAIDset members.

- The minimum chunksize for stripesets is 16 blocks (8 KB). The maximum chunksize is $2^{31} - 1$ blocks, but because this is larger than any supported disk, it is not a practical limitation.

- Version 2.0 of the SWXRC–04 operating firmware supports only the NORMAL RAIDset reconstruct priority.
- Do not manipulate the membership of a RAIDset if the RAIDset is not associated with a UNIT. If you have not created a UNIT (with the ADD UNIT command) from your RAIDset, do not use the SET RAIDSET POLICY= command, the SET RAIDSET REMOVE=*disk-container-name* command, or the SET RAIDSET REPLACE=*disk-container-name* command.
- You may mix different disks within one controller storageset (stripeset or RAIDset). However, the member with the smallest capacity determines the capacity for *all* members of the storageset. In other words, a storageset comprised of two 2 GB disks and one 3 GB disk would have a total capacity of 6 GB. One gigabyte of space on the 3 GB disk would remain inaccessible.

  Be aware that mixing device capacities in one storageset may result in degraded performance due to different disk geometry.
- Whenever possible, do not simply remove (hot swap) a failed RAIDset member to force the RAIDset to replace the member with a device from the spareset. Follow correct device removal procedures as described in product documentation.
- Storagesets (stripesets and RAIDsets) usually consist of devices on different controller ports for best performance and availability. However, storagesets may be built from devices on the same ports (if, for example, the number of member devices is greater than the number of available ports) with only a slight reduction in availability.

StorageWorks Glossary

ac distribution

The method of distributing ac power in a cabinet.

ac power supply

A power supply designed to produce dc power from an ac input.

adapter

Also called a *signal converter*. An adapter converts the protocol and hardware interface of one bus type into that of another without changing the function of the bus.

allocation class

A numerical value assigned to an integrated storage element to indicate which hosts on a cluster it is served by.

American National Standards Institute

See *ANSI*.

ANSI

American National Standards Institute. ANSI is an organization that develops and publishes electronic and mechanical standards.

array controller

A hardware/software device that facilitates communications between a host and one or more devices organized in an array. SWXSC-series controllers are array controllers.

bad block

A block containing a defect that:

- Exceeds the correction capability of the subsystem error correction scheme.
- Exceeds a drive-specified error threshold. Once a block exceeds this threshold, data integrity is not guaranteed.
- Imposes too great a strain on system performance. In this case, the subsystem still assures data integrity, but the extensive error correction required for each block access causes too great a strain on system performance.

bad block replacement

See *BBR*.

battery backup unit

See *BBU*.

BBR

Bad block replacement. BBR is the substitution of defect-free disk blocks for those found to have defects. BBR locates a replacement block, marks the bad block as replaced, and moves the data from the bad block to the replacement block.

BBU

Battery backup unit. A BBU extends power availability after the loss of primary ac power or a power supply to protect against the corruption or loss of data.

BIST

Built-in self-test. BIST is the internal self-test routine for the SWXSC-series controller module microprocessor chip.

block

A stream of data transferred as a unit. Block is used interchangeably with the term "sector" for disk drives to represent 512 bytes (for 16- and 32-bit host architectures) or 576 bytes (for 36-bit architectures). A block is the smallest data unit addressable on a subunit. It occupies a specific physical position relative to the index and is available for reading or writing once per disk rotation. The five types of blocks follow:

1. Diagnostic block—Used for drive read or write diagnostics. The diagnostic block area is not visible to the host operating system. However, it is visible to the controller. Diagnostic block addresses are 28 bits wide and are called diagnostic block numbers (DBNs).
2. External block—Contains the format control tables. The external block area is not visible to the host operating system. However, it is visible to the controller. External block addresses are 28 bits wide and are called external block numbers (XBNs).
3. Logical block—Contains the host applications area and the Replacement Control Table. All logical blocks are visible to the host operating system. Logical block addresses are 28 bits wide and are called logical block numbers (LBNs).
4. Physical block—Contains all the blocks on a subunit. DBNs, LBNs, RBNs, and XBNs are subsets of the physical block area. Physical block addresses are 28 bits wide and are called physical block numbers (PBNs).
5. Replacement block—A reserved block used as a replacement for a bad block on a subunit. Replacement block addresses are 28 bits wide and are called replacement block numbers (RBNs).

blower

An airflow device mounted in a StorageWorks shelf.

built-in self-test

See *BIST*.

cable distribution unit

See *CDU*.

carrier

Sometimes called an SBB carrier. A carrier is a standard, StorageWorks shelf-compatible, plastic shell into which a device can be installed.

CDU

Cable distribution unit. The CDU is the power entry device for StorageWorks cabinets. The unit provides the connections necessary to distribute ac power to cabinet shelves and fans.

CER

CLI error report. The CER spontaneously posts controller error messages to a terminal, if one is connected.

CLI

Command line interpreter. Operator command line interface for the SWXSC-series controller.

CLI error report

See *CER*.

cluster

A collection of processors, called nodes, attached to each other by a high-speed bus. These processors are independent and survivable. They may be general-purpose computers or special-purpose servers, providing a special set of services to the rest of the nodes.

cold swap

A method of device replacement that requires that power be removed from all shelves in a cabinet. This method is used when conditions preclude the use of the warm swap or hot swap methods.

command disk

A special storage configuration for communication with generic SCSI devices. The command disk is a virtual unit (in controller memory) that acts as a conduit for SCSI communication between a device such as a *loader* and an MSCP-based host.

command line interpreter

See *CLI*.

container

Data storage consisting of either a single disk device, or group of disk devices linked as a storageset. Examples of containers include disk drives, stripesets, and RAIDsets.

controller

A hardware/software device that facilitates communications between a host and one or more devices. A controller translates bus protocols and hardware interfaces and adds functions to the host/device communication.

controller shelf

A StorageWorks shelf designed to contain controller and cache memory modules.

CRC

A checkword (polynomial checksum) generally appended to a disk data transfer. CRC is computed using data message bits as coefficients divided by a generating polynomial. The resulting remainder is the CRC. When a transmitter computes and transmits a CRC following a data transfer, the receiver can recompute and compare it with the received version to verify correct reception. EDC and ECC (both used by disks) are examples of CRC checkwords.

cyclic redundancy check

See *CRC*.

DAEMON

Diagnostic and execution monitor. DAEMON is a part of SWXSC-series controller self-testing that includes port and cache initialization and self-test routines.

DAT

Digital Audio Tape. A format for recording digital data on a cartridge tape.

data center cabinet

A generic reference to the large cabinets, such as the SWXSC–D*x* series, in which StorageWorks components can be mounted.

device driver

An operating system software module used to physically control an I/O device.

device shelf

A StorageWorks shelf designed to contain SBBs.

diagnostic and execution monitor

See *DAEMON*.

Diagnostics and Utilities Protocol

See *DUP*.

differential SCSI bus

A SCSI bus in which a signal's level is determined by the potential difference between two lines. A differential bus is more robust and less subject to electrical noise than is a single-ended bus.

digital audio tape

See *DAT*.

DIGITAL Standard Disk Format

See *DSDF*.

DILX

Disk inline exerciser. DILX is diagnostic firmware used to test the data transfer capabilities of disk drives in a way that simulates a high level of user activity.

Disk Inline Exerciser

See *DILX*.

dual cabinet power configuration

A cabinet ac power configuration in which two ac sources and two ac power supplies are used to provide redundant dc power to each of the cabinet's SBB shelves.

dual data link

See *DDL*.

dual porting (or dual access)

The ability of a disk or tape drive to be accessed by two controllers. All DSA drives have a standard dual-port feature. DSA drives can be on line to only one controller at a time. However, they are able to disconnect themselves from a failed controller (or be disconnected by a failing controller) and become available for continued service through the other controller.

dual shelf power configuration

A cabinet ac power configuration in which one ac source and two ac power supplies are used to provide redundant dc power to each of the cabinet's SBB shelves.

dual universal asynchronous receiver transmitter

See *DUART*.

dual-redundant

Two controllers in one controller shelf, sharing access to each other's devices. This configuration provides for one controller to take over the work of a failed controller.

DUART

Dual universal asynchronous receiver transmitter. A DUART is an integrated circuit containing two serial, asynchronous transceiver circuits.

DUP

Diagnostic and Utilities Protocol. DUP is host application software that enables a host operator terminal to connect to the controllers' command line interpreter. See also *virtual terminal*.

ECC

Error correction code. The ECC is one or more cyclic redundancy check (CRC) words that enable detection of a mismatch between transmitted and received data in a communications system, or between stored and retrieved data in a storage system. The ECC allows for location and correction of an error in the received/retrieved data. All ECCs have limited correction power.

EDC

Error detection code. The EDC is one or more checksum words that enable detection of a mismatch between transmitted and received data in a communications system, or between stored and retrieved data in a storage system. The EDC has no data correction capability.

EIP

Error information packet (or event information packet). The EIP includes bytes of data translated into information explaining error events.

electromagnetic interference

See *EMI*.

electrostatic discharge

See *ESD*.

EMI

Electromagnetic interference. EMI is the impairment of a signal by an electromagnetic disturbance.

EMU

Environmental monitor unit. The EMU provides increased protection against catastrophic subsystem faults in the SWXSC–AA cabinet .

environmental monitor unit

See *EMU*.

error correction code

See *ECC*.

error detection code

See *EDC*.

error information packet

See *EIP*.

ESD

Electrostatic discharge. ESD is the discharge of a potentially harmful static electric voltage as a result of improper grounding.

event logging

See *EVL*.

EVL

Event logging. EVL is the spontaneous posting of EIP information to a connected terminal. The EVL display enables the user to read event log information without invoking a separate utility for translation.

EXEC

Firmware executive. EXEC is the kernel portion of SWXSC-series controller firmware.

extended status

An additional set of status information maintained by the drive that is of interest to a host error log. Extended status is drive-type specific and is not utilized by the controller except as input to the host error log and diagnostic processes.

failedset

A disk drive or group of disk drives that has been removed from a RAIDset due to a failure or manual removal. Disk drives in the failedset should be considered defective and should be tested, then repaired or replaced.

failover

A process that takes place when one controller fails in a dual-redundant configuration, and the other controller takes over service to the devices of the failed controller.

fan

An airflow device mounted in a StorageWorks cabinet.

fast, differential SCSI

See *FD SCSI*.

fast, wide, differential SCSI

See *FWD SCSI*.

Fault Management Utility

See *FMU*.

FD SCSI

Fast, differential SCSI. This differential SCSI bus has an 8-bit data transfer rate of 10 MB/s. See also *FWD SCSI* and *SCSI*.

field replaceable unit

See *FRU*.

filler panel

A sheet metal or plastic panel used to cover unused mounting areas in StorageWorks cabinets and shelves.

firmware executive

See *EXEC*.

Firmware Licensing System

See *FLS*.

FLS

Firmware Licensing System. The FLS enables a user to enter license keys and activate licensed features (such as RAIDsets) on the SWXSC-series controller.

flush

To write cache data to storage media.

FMU

Fault Management Utility. The FMU controls certain spontaneous error displays to a maintenance terminal. FMU also provides for interactive review of last failure and memory system failure information.

FRU

Field replaceable unit. An FRU is the lowest-level hardware component that can be replaced by field personnel.

full-height device

A single device that occupies an entire 5.25 inch SBB carrier. StorageWorks full-height devices have an order number suffix of "–VA."

FWD SCSI

Fast, wide, differential SCSI. This differential SCSI bus has a 16-bit data transfer rate of up to 20 MB/s. See also *FD SCSI* and *SCSI*.

SWXSS–01 controller shelf

The StorageWorks controller shelf used for SWXSC-series controller modules, cache modules, and shelf power units.

SWXSC–AA storage enclosure

A StorageWorks shelf that can contain an entire subsystem, including storage devices, power supplies, and controllers. It is normally housed in an SWXSC–AA cabinet.

SWXSS–02 SBB shelf

A StorageWorks shelf used for only power units and SBBs.

half-height device

A device that occupies half of a 5.25 inch SBB carrier. Two half-height devices can be mounted in a 5.25 inch SBB carrier. The first half-height device is normally mounted in the lower part of the carrier. The second device is normally mounted in the upper part of the carrier.

HIS

Host Interconnect Services. The firmware that communicates with the host in SWXSC-series controllers.

host

The primary or controlling computer to which a storage subsystem is attached.

Host Interconnect Services

See *HIS*.

host logical unit

See *logical unit*.

host terminal

See *virtual terminal*.

Host-Based Volume Shadowing

See *HBVS*.

hot swap

A method of device replacement whereby the complete system remains on line and active during device removal and reinstallation. The device being removed or reinstalled is the only device that cannot perform operations during this process.

IBR

Initial boot record. The IBR is a table of information placed in memory in accordance with i960 processor specifications. The i960 reads the IBR during initialization in order to configure itself, as well as position the program counter at the start of core MIST.

initial boot record

See *IBR*.

initiator

The SCSI bus member that requests an operation to be performed by another member (the target). When an SWXSC-series controller interacts with its physical storage devices, it is the initiator. Another example is when the host CPU interacts with the SWXSC-series controller, the host is the initiator.

instance code

The four-byte value transmitted in the error log packet that is key to interpreting the error.

KILL line

The controller-to-controller disable signal used in a dual-redundant configuration.

last failure

Last failure refers to event/error information specifically generated upon the sudden termination of executing firmware. For example, last failure occurs when there is an abrupt controller failure (such as when power is removed).

last failure logging

See *LFL*.

least recently used

See *LRU*.

LFL

Last failure logging. LFL is the spontaneous posting of last failure information to a connected terminal. The LFL display enables the user to read last failure information without invoking a separate utility for translation.

loader

A robotic mechanism for selecting and loading media into associated drive devices. Such mechanisms are also known as "jukeboxes" or medium changers. A loader is a good application for a *command disk* because SCSI commands are needed to control its robotic movement.

logical unit

Also called a host logical unit or simply a unit. A logical unit is a device or group of devices addressable as one unit by the host. (A logical unit is not necessarily a *LUN*.)

logical unit number

See *LUN*.

LRU

Least recently used. LRU is the block replacement algorithm for the read cache.

LUN

Logical unit number. A LUN is a value from 0–7 that identifies a subset of a SCSI target to a SCSI initiator. LUNs use their target's bus connection to communicate on the SCSI bus.

maintenance terminal

The operator terminal used to identify a controller, to enable its host paths, to define its subsystem configuration, and to check its status. The maintenance terminal interface is designed to accept any terminal conforming to EIA–423. A maintenance terminal is only required to configure a storage subsystem and is not required for normal operations.

metadata

Special data written to a disk device and inaccessible to the host CPU. Metadata improve error detection and media defect management for the disk device.

MIST

Module integrity self-test. MIST tests controller functions upon initialization. See also *DAEMON*.

module integrity self-test

See *MIST*.

node

An intelligent entity in a distributed computing configuration. Nodes are independent but linked, as in a network or a cluster, becoming parts of a whole.

nonredundant

A configuration in which there is no backup hardware in place for the hardware that is present.

nontransportable

An operator device assignment that indicates the device contains metadata. Devices assigned as nontransportable can be moved amongst SWXSC-series controller subsystems, but cannot be moved directly to non-SWXSC-series controller systems. See also *transportable*.

nonvolatile

See *NV*.

nonvolatile memory

See *NVMEM*.

nonvolatile parameter memory

See *NVPM*.

NV

Nonvolatile. NV describes memory, the contents of which survive loss of power.

NVMEM

Nonvolatile memory. NVMEM is the battery backed-up SRAM on the controller module.

NVPM

Nonvolatile parameter memory. NVPM is a portion of NVMEM used to store controller configuration data.

OCP

Operator control panel. The OCP is the control/indicator panel associated with a device. The OCP is usually mounted on the device and is accessible to the operator.

offline

One of the possible status conditions of a mass storage device or server. When a device is offline, it is not capable of communicating with the controller. When the controller is offline, it is inaccessible to any node in the configuration.

operator control panel

See *OCP*.

PCMCIA

Personal Computer Memory Card Industry Association. PCMCIA is an organization that develops standards for ROM memory cards.

Personal Computer Memory Card Industry Association

See *PCMCIA*.

port

The hardware and software used to connect a controller to a communication bus, such as a SCSI bus.

port/target/LUN

See *PTL*.

program card

The PCMCIA card containing the SWXSC-series controller operating firmware.

PTL

Port/target/LUN. PTL is a three-number hierarchical value representing a device location to a SCSI initiator. For example, PTL 143 is a device on port 1 of the initiator, target 4 on port 1, and LUN 3 under target 4.

qualified device

A device that has been fully tested in all appropriate StorageWorks hardware and software configurations, and is in complete compliance with DIGITAL and country-specific standards (for example, FCC and TÜV).

quiesce

To make a bus inactive or dormant. The operator must quiesce SCSI bus operations, for example, during a device warm swap.

radio frequency interference

See *RFI*.

RAID

Redundant array of independent disks. RAID is a set of storage techniques devised to increase the performance and availability of a storage subsystem.

RAIDset

Three to fourteen physical disks configured as a container. RAIDsets enable one physical disk to fail without loss of data.

read cache

A block of high-speed memory used by a controller to buffer data being read from storage devices by a host. A read cache increases the controller's effective device access speed by satisfying host read requests from its local cache memory when possible, instead of from external storage devices. The controller maintains in the cache copies of data recently requested by the host, and may fetch blocks of data ahead in anticipation that the controller accesses the next sequential blocks. In a normal read cache, host write requests are handled as usual, without involving the caching mechanism. See also *write through cache*.

reconstruction

The process of regenerating the data from one failed RAIDset member. Reconstruction is possible through XORing the surviving members' data with the parity data (or recalculating parity data, if a parity member failed). When the missing data is reconstructed it is placed on a disk from the spareset, if one is available. If there is no spare disk, the RAIDset goes *reduced* and does not reconstruct.

reduced

A RAIDset that has one failed member is said to be running reduced. RAID functions enable the missing data from the failed member to be reconstructed and accessed on an as-needed basis, using the surviving members' data and parity data. A RAIDset does not run reduced (or at all) if more than one member has failed.

Redundant Array of Independent Disks

See *RAID*.

replacement

The process of changing a *spareset* device into an active member of a RAIDset (replacing a failed RAIDset device). Spareset members are selected as replacements based on either "best fit" or "best performance." Data previously backed up on tape is retrieved for disk storage using the normal priority. Backup is used to preserve information in the event of a disk failure. Restore is used to recover the information.)

replacement policy

The firmware-controlled method by which a spare disk (from the spareset) is selected to replace a disk that has failed in a RAIDset.

restore

Data previously backed up on tape is retrieved for disk storage using the normal priority. Backup is used to preserve information in the event of a disk failure. Restore is used to recover the information.

RFI

Radio frequency interference. RFI is the impairment of a signal by an unwanted radio signal or radio disturbance.

SBB

StorageWorks building block. An SBB is a device housed in a standard StorageWorks SBB carrier. An SBB has a standard physical and electrical interface that is compatible with those of StorageWorks shelves and enclosures.

SBB shelf

StorageWorks building block shelf. This is a StorageWorks shelf, such as the BA350-S*x*, designed to house plug-in SBB modules.

SCSI

Small Computer System Interface. SCSI is an ANSI interface defining the physical and electrical parameters of a parallel I/O bus used to connect hosts to a maximum of seven devices. The StorageWorks device interface is implemented according to the SCSI–2 standard, enableing the synchronous transfer of 8-bit data at rates of up to 10 MB/s.

SCSI device

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

SCSI device ID

Also referred to as a *target ID*. This ID is the physical address an initiator uses to connect with a target. Each target is assigned a unique target address.

SCSI–A cable

A 50-conductor, 25 twisted-pair cable used for single-ended, SCSI bus connections.

SCSI–P cable

A 68-conductor, 34 twisted-pair cable used for differential bus connections.

shelf brackets

Sheet metal components designed to attach and position StorageWorks shelves in their associated enclosures.

signal converter

Also called an *adapter*. A signal converter converts the protocol and hardware interface of one bus type into that of another without changing the function of the bus.

single cabinet power configuration

A cabinet ac power configuration in which only one ac source and one ac power supply is used to supply dc power to the cabinet's SBB shelves.

skirt

A trim panel designed to mount around the base of a cabinet.

Small Computer System Interface

See *SCSI*.

software product description

See *SPD*.

spareset

A pool of disk drives from which a controller can draw to replace failed members of a RAIDset.

SPD

Software product description. The SPD describes the function of a program.

storageset

A grouping of disk drives that make up a new distinct container. Stripesets and RAIDsets are examples of storagesets.

StorageWorks

DIGITAL's family of modular data storage products that enables customers to design and configure their own storage subsystems. Components include power, packaging, cabling, devices, controllers, and software. Customers can integrate devices and array controllers in StorageWorks enclosures to form storage subsystems.

StorageWorks building block

See *SBB*.

stripeset

A virtual disk drive with its physical data spread across from 2–14 physical disks. Stripeset configurations do not include a data recovery mechanism.

supported device

A device tested as functionally compatible with an approved StorageWorks hardware and software configuration.

surviving controller

The controller in a dual-redundant pair that assumes service to its companion's devices when the companion fails. See also *failover*.

tagged command queuing

A technique that enables a device to have multiple I/O requests outstanding to it at one time.

Tape Inline Exerciser

See *TILX*.

target

A member of a SCSI bus that carries out operations requested by an initiator. Physical storage devices are targets of all HS controllers, for example. Another example is the SWXSC-series controller, which is a target of its host CPU.

target ID

Also referred to as *SCSI device ID*. This ID is the physical address an initiator uses to connect with a target. Each target is assigned a unique target address.

template

The group or type to which an error event log to the host belongs. Template type determines how the EIP is formatted.

TILX

Tape Inline Exerciser. TILX is diagnostic firmware used to test the data transfer capabilities of tape drives in a way that simulates a high level of user activity.

transportable

An operator device assignment that indicates the device is not MSCP compliant and does not contain metadata. Transportable devices can be moved between SWXSC-series controller subsystems and non-SWXSC-series controller systems. However, such devices do not support forced error, and should not be set to transportable after correct installation in an SWXSC-series controller subsystem. See also *nontransportable*.

unit

See *logical unit*.

unwritten cache data

Data suspended in write-back cache memory which has not been written to storage media yet, even though the host operation using the data has completed.

value-added firmware

The firmware that provides optional, licensed features such as logical block mapping, cache, RAID, and so on.

VAXcluster System Console

See *VCS*.

VCS

VAXcluster System Console. This terminal enables access to hosts (by networks). VCS is another method of accessing the controller. See also *DUP*.

virtual terminal

A software path from an operator terminal on the host to the controller's CLI interface. The path can be established via the host port on the controller (for example, using DUP) or via the maintenance port through an intermediary host (VCS). A virtual terminal is also sometimes called a host terminal.

warm swap

A controller function that enables devices to be added, removed, or replaced whild the subsystem remains operational. All activity on the device's SCSI bus must normally be halted for the duration of the warm swap operation.

write hole

Undetectable RAID level 5 data corruption. A write hole is caused by the successful writing of cached data but not the data parity, or vice versa. Write holes occur under conditions such as power outages, where the writing of these two elements can be abruptly interrupted. A battery backed-up cache design eliminates the write hole, because data is preserved and writes can be retried.

write-back cache

A cache configuration that increases the performance of host write requests. When the host requests a write operation, the cache writes the host's data first to the cache memory, completing the host's request quickly. It performs the slower operation of flushing the data to the external storage device at a later time. The host sees the write operation as complete when the data have reached the cache.

write-through cache

A technique for handling host write requests in read caches. When the host requests a write operation, the cache writes data directly to the external storage device and updates the cache memory to ensure that the memory does not contain obsolete data. This technique increases the chances that future host read requests can be filled from the cache. The host sees the write operation as complete only after the external storage device has been updated. See also *read cache*.

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