



RAID Array 310
Deskside Subsystem (SWXRA-ZX)

Hardware User's Guide

EK-SMCPL-UG. A01

Digital Equipment Corporation
Maynard, Massachusetts

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Contents

| | |
|------------------------------|-----------|
| Revision Record | vi |
|------------------------------|-----------|

| | |
|-------------------------------|-----------|
| About This Guide | ix |
|-------------------------------|-----------|

1 Product Overview

| | | |
|-------|--|------|
| 1.1 | Product Description..... | 1-1 |
| 1.2 | Subsystem Features | 1-2 |
| 1.3 | Subsystem Cabinet..... | 1-2 |
| 1.4 | Subsystem Component Description | 1-4 |
| 1.4.1 | Storageworks Building Blocks (SBBs)..... | 1-5 |
| 1.4.2 | RAID Controller..... | 1-5 |
| 1.4.3 | Power Supply | 1-6 |
| 1.4.4 | Environmental Monitoring Unit (EMU)..... | 1-6 |
| 1.4.5 | Differential to Single-Ended SCSI Bus Converter..... | 1-9 |
| 1.5 | Specifications..... | 1-10 |

2 Re-configuring the Subsystem

| | | |
|-------|--|-----|
| 2.1 | Introduction..... | 2-1 |
| 2.2 | SCSI Buses | 2-1 |
| 2.3 | Re-configuring the Subsystem..... | 2-2 |
| 2.3.1 | Setting the Configuration Switch | 2-5 |
| 2.4 | Completing the Configuration | 2-8 |

3 RAID Array Controller

| | | |
|-------|--|-----|
| 3.1 | Overview..... | 3-1 |
| 3.2 | Write-Back Cache Battery..... | 3-4 |
| 3.3 | OCP Switches and Indicators..... | 3-4 |
| 3.3.1 | Reset Button..... | 3-5 |
| 3.3.2 | Cache Battery Backup Button and LED..... | 3-6 |
| 3.3.3 | Status LED..... | 3-6 |
| 3.3.4 | Fault LEDs..... | 3-6 |

4 Troubleshooting

| | | |
|-------|--|------|
| 4.1 | Introduction..... | 4-1 |
| 4.2 | Subsystem Status and Power Supply LEDs..... | 4-1 |
| 4.3 | SBB Status LEDs..... | 4-2 |
| 4.4 | Controller OCP Error Codes..... | 4-3 |
| 4.4.1 | OCP Error Codes During Self Test..... | 4-11 |
| 4.5 | EMU Error Reporting..... | 4-11 |
| 4.5.1 | EMU Error Conditions..... | 4-12 |
| 4.6 | Replacing Components (FRU's)..... | 4-12 |
| 4.6.1 | Removing the Subsystem Door..... | 4-13 |
| 4.6.2 | Replacing an SBB..... | 4-14 |
| 4.6.3 | Replacing a Power Supply..... | 4-15 |
| 4.6.4 | Replacing the RAID Array Controller..... | 4-17 |
| 4.6.5 | Replacing the EMU Board..... | 4-20 |
| 4.6.6 | Replacing the SCSI Bus Signal Converter Board..... | 4-23 |

Figures

| | | |
|------|---|------|
| 1-1 | RAID Array 310 Deskside Storage Subsystem | 1-1 |
| 1-2 | Subsystem Major Components | 1-3 |
| 1-3 | Rear Panel Power Supplies..... | 1-4 |
| 1-4 | EMU Circuit Board Location | 1-7 |
| 1-5 | EMU Rear Panel Components..... | 1-8 |
| 1-6 | SCSI Bus Converter Board Location | 1-9 |
| 2-1 | Removing Front Door | 2-3 |
| 2-2 | Removing Side Cover | 2-4 |
| 2-3 | Subsystem Cover Hand Hold..... | 2-5 |
| 2-4 | Subsystem Standard Configuration..... | 2-6 |
| 2-5 | Configuration Switch | 2-7 |
| 2-6 | Configuration Switch Assigned Slot Device Addresses | 2-7 |
| 3-1 | RAID Array Controller Block Diagram..... | 3-2 |
| 3-2 | RAID Array Controller OCP | 3-5 |
| 4-1 | Subsystem Status LEDs..... | 4-2 |
| 4-2 | SBB LEDs | 4-3 |
| 4-3 | Controller Error Code Fault LEDs..... | 4-5 |
| 4-4 | Removing the Door | 4-13 |
| 4-5 | Replacing an SBB | 4-15 |
| 4-6 | Replacing a Power Supply..... | 4-16 |
| 4-7 | Remove Angle Bracket Screws | 4-18 |
| 4-8 | Remove the Controller from the Subsystem | 4-19 |
| 4-9 | Remove Screws to Release Controller from Housing..... | 4-20 |
| 4-10 | Remove Connector Nuts from J9 and J6..... | 4-21 |
| 4-11 | Remove Connector Nuts from SCSI Connector..... | 4-21 |
| 4-12 | Remove Screw from Support Bracket..... | 4-22 |
| 4-13 | Remove Mounting Screws from EMU Board | 4-23 |
| 4-14 | Remove Mounting Screws from SCSI Bus Converter Board..... | 4-24 |

Tables

| | | |
|-----|---|------|
| 1-1 | Subsystem Specifications..... | 1-10 |
| 2-1 | SCSI Bus Length | 2-2 |
| 3-1 | Summary of RAID Controller Features | 3-3 |
| 4-1 | SBB Status LEDs..... | 4-3 |
| 4-2 | Solid OCP Error Codes | 4-6 |
| 4-3 | Flashing OCP Error Codes | 4-7 |

Revision Record

This Revision Record provides a concise publication history of this guide. It lists the revision levels, release dates, and reasons for the revisions. It also describes how the changes to affected pages are marked in the manual.

The following revision history lists all revisions of this publication and their effective dates. The publication part number is included in the Revision Level column, with the last entry denoting the latest revision. This publication supports the StorageWorks RAID Array 310 Deskside Subsystem.

| Revision Level | Date | Summary of Changes |
|-----------------------|-------------|---------------------------|
| EK-SMCPL-UG. A01 | March 1996 | Original release. |

About This Guide

This section identifies the audience of this guide and describes the contents (chapter by chapter) and structure. In addition, this section includes a list of associated documents and the conventions used in this guide.

Intended Audience

This guide is intended for installers and operators of StorageWorks RAID Array 310 Subsystems. Installing the subsystem requires a general understanding of basic SCSI terminology and SBus products installation procedures.

Document Structure

This guide contains the following chapters:

Chapter 1: Product Overview

Product Overview provides an overview and a physical hardware description of the RAID Array 310 Subsystem. It includes the major features, a brief description of the major components, and the specifications for the subsystem.

Chapter 2: Re-configuring the Subsystem

Re-configuring the Subsystem describes the standard subsystem configuration (Configuration 0) and how to re-configure it if desired.

Chapter 3: RAID Array Controller

RAID Array Controller describes the major features and characteristics of the controller in the RAID Array 310 subsystem.

Chapter 4: Troubleshooting

Troubleshooting describes how to interpret the status of the LEDs on the subsystem as a troubleshooting aid in case of a subsystem problem. The chapter also describes how to replace a Field Replaceable Unit (FRU).

Associated Documents

In addition to this guide, the following documentation is useful to the reader:

Table 1 Associated Documents

| Document Title | Order Number |
|--|--------------------|
| <i>StorageWorks RAID Array 310 Configuration and Maintenance Guide</i> | <i>EK-SMCS2-UG</i> |

Conventions

This guide uses the following documentation conventions:

Table 2 Style Conventions

| Style | Meaning |
|----------------------|--|
| plain monospace type | Text |
| boldface type | For the first instance of terms being defined in text, or both. |
| <i>italic type</i> | <i>For emphasis, manual titles, chapter summaries, keyboard key names.</i> |

1

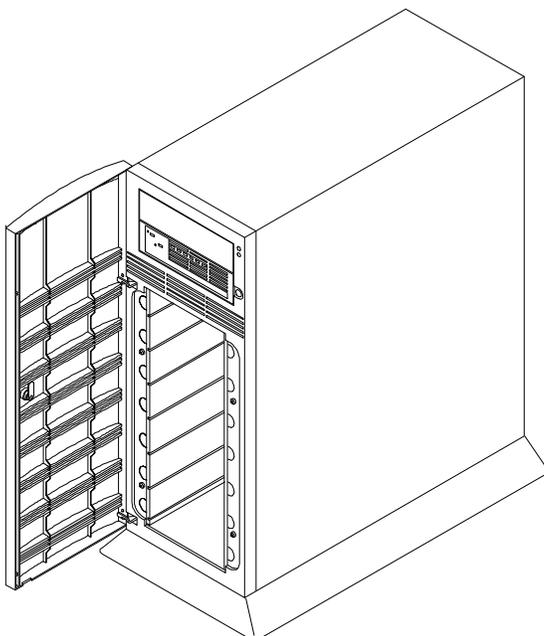
Product Overview

This chapter provides a description of the hardware components in the RAID Array 310 Deskside Storage Subsystem (SWXRA-ZX).

1.1 Product Description

The RAID Array 310 subsystem (Figure 1–1) is a deskside storage expansion subsystem offering the basic components required to create a user-designed storage array with a 16-bit differential SCSI bus. The subsystem can accommodate up to seven 3½-inch storage devices to form the array, and two power supplies which provide fault-tolerant operation.

Figure 1–1 RAID Array 310 Deskside Storage Subsystem (SWXRA-ZX)



RAID310-91

1.2 Subsystem Features

The major features of the subsystem are:

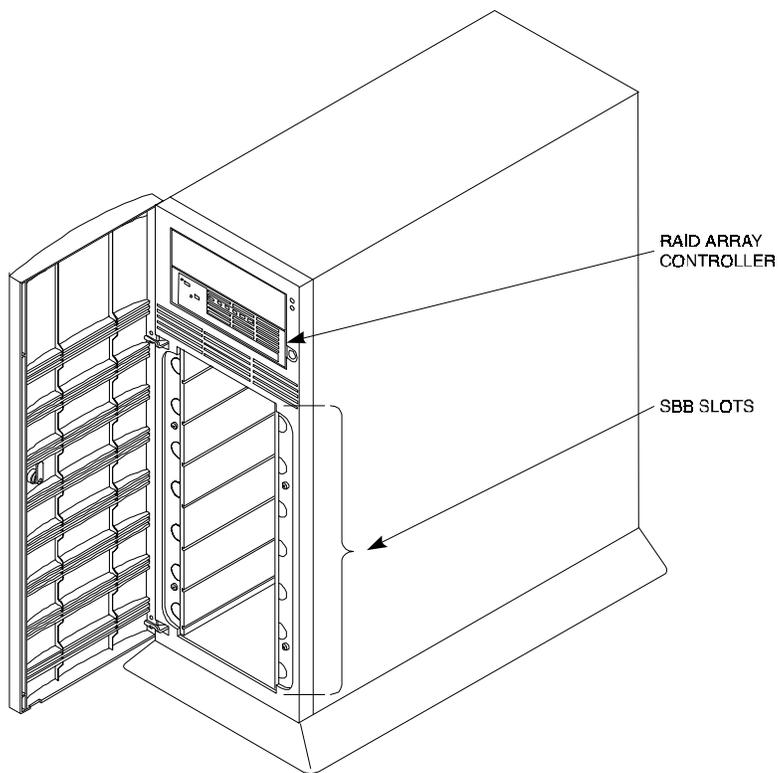
- Differential, 16-bit SCSI host bus
- Seven 3½-inch SBB slots
- Dual-channel RAID array controller
- Internal cooling fans
- Redundant power provided by two universal ac input power supplies (50/60 Hz, 100 to 240 V ac)
- Environmental monitor unit (EMU) for error detection
- Internal differential to single-ended 16-bit SCSI bus converter
- The ability to hot swap SBBs without powering down the system

1.3 Subsystem Cabinet

The deskside subsystem cabinet is a modular free-standing storage cabinet that is completely self contained with dual fan-cooled power supplies, an internal EMU circuit board, an internal SCSI signal converter, and a RAID array controller with front panel display. Figure 1–2 shows the major components in the subsystem. Figure 1–3 identifies the items on the rear panel power supplies. The characteristics of the subsystem are outlined below.

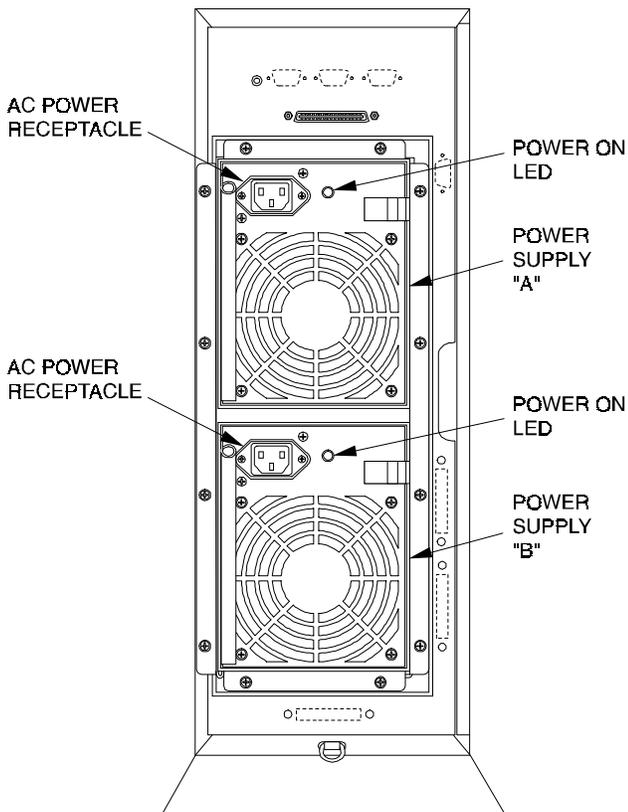
- The storage device capacity of the subsystem is seven 3½-inch SBBs
- The subsystem slots are numbered 0 through 6 from top to bottom
- There are seven SCSI bus device addresses (target IDs) 0 through 6 which can be assigned to the 3½-inch SBBs
- There is a single 68-pin high density female SCSI connector on the rear panel which interconnects the host system to the RAID array controller in the subsystem
- The rear panel contains an alarm switch, a UPS monitor connector, and an external fault condition connector
- The subsystem contains two identical fan cooled ac power supplies for redundant power
- A single-ended to differential SCSI Bus converter
- The subsystem is equipped with an internal configuration switch which selects one of the seven (0 through 6) subsystem configurations. Only the first two are used in the current RAID Array 310 subsystem configuration

Figure 1-2 Subsystem Major Components



RAID310-24

Figure 1-3 Rear Panel Power Supplies



RAID310-13

1.4 Subsystem Component Description

The components of the subsystem include the following items:

- Dual-channel RAID array controller
- Two 8-bit, single-ended SCSI buses (A and B)
- Environmental Monitor Unit (EMU)
- Differential to single-ended SCSI bus converter
- Two universal 50/60 Hz, 100 to 240 Vac fan-cooled power supplies

1.4.1 StorageWorks Building Blocks (SBBs)

The subsystem is equipped with seven 3½-inch disk drive SBB slots. The number of drives that make up the array is left to the end user with a maximum of seven storage devices.

1.4.2 RAID Array Controller

The RAID array controller uses a single, fast, 16-bit, single-ended dual SCSI bus for its connection to the host computer. The controller supports all of the standard SCSI-2 features as well as many of the optional ones. The controller is packaged in an industry-standard 5¼-inch, half-height case. It includes a write-back cache with internal battery backup as a standard feature. The cache memory is implemented with a 72-pin, single in-line memory module (SIMM).

The controller can be used in host environments where the host uses a differential SCSI adapter. The subsystem contains a single-ended, 16-bit, dual SCSI bus which is connected through a single-ended to differential SCSI bus converter to the subsystem SCSI output connector on the rear panel.

The user performs the configuration of storage devices into logical units with the CLI (Command Line Interpreter), which is accessible through the subsystem maintenance port (an EIA-423 serial interface) or via a host-resident virtual terminal program. The controller detects fault signals from the EMU and alerts the operator in the event of potential subsystem malfunction or damage.

The controller provides the following features to aid in maintenance and troubleshooting:

- **Initialization Diagnostics** – Firmware diagnostics ensure that the subsystem is ready to operate after the controller has been reset or powered on
- **Exerciser** –The disk in-line exerciser simulates high levels of user activity and provides performance information to determine the integrity of the controller and its attached devices
- **Terminal Access** – You can use a host software virtual terminal or a hardware maintenance terminal to check the controller's status and set its operating parameters. This connection provides access to the command line interpreter, firmware utilities and exerciser, and error messages
- **Device Hot Swap** – You can safely remove and replace storage devices that are not part of a stripeset while the system is operating
- **Operator Control Panel** – The operator control panel (OCP) is part of the front panel of the controller. LEDs report status and fault conditions
- **Restrictions and Capabilities** – Refer to Table 3–1 (summary of RAID controller features) in Chapter 3 for a listing of restrictions and capabilities for the subsystem

1.4.3 Power Supply

The subsystem is equipped with dual air cooled ac power supplies located at the rear of the unit. The power supplies provide redundant power in case one of the units should malfunction. Each supply provides +5 and +12 Vdc to power the RAID controller, EMU, SCSI bus signal converter, and the storage SBBs in the subsystem. The upper power supply is designated as "A" and the lower as "B". The unit contains an ac power receptacle, a power status LED, a fan, and a latching slider switch to secure the supply in the subsystem.

1.4.4 Environmental Monitor Unit (EMU)

The EMU is an internal circuit board which monitors the operation of the subsystem. Its primary function is to detect and report conditions that can cause the subsystem to malfunction and to report these malfunctions. The EMU also has the capability of exchanging signals with auxiliary devices and controllers.

The EMU is located internally in the top rear of the subsystem (Figure 1-4). The internal cables connect it to both the SCSI bus backplane and the power module backplane. The following external components on the rear panel of the subsystem are part of the EMU (see Figure 1-5):

- The alarm switch (S1) that enables (up) or disables (down) the audible alarm
- The UPS Monitor connector (J9) allows the EMU to monitor and report the status of an uninterruptible power supply (UPS)
- The External Fault Condition connector (J6) allows the EMU to monitor the status of a user-selected device

Figure 1-4 EMU Circuit Board Location

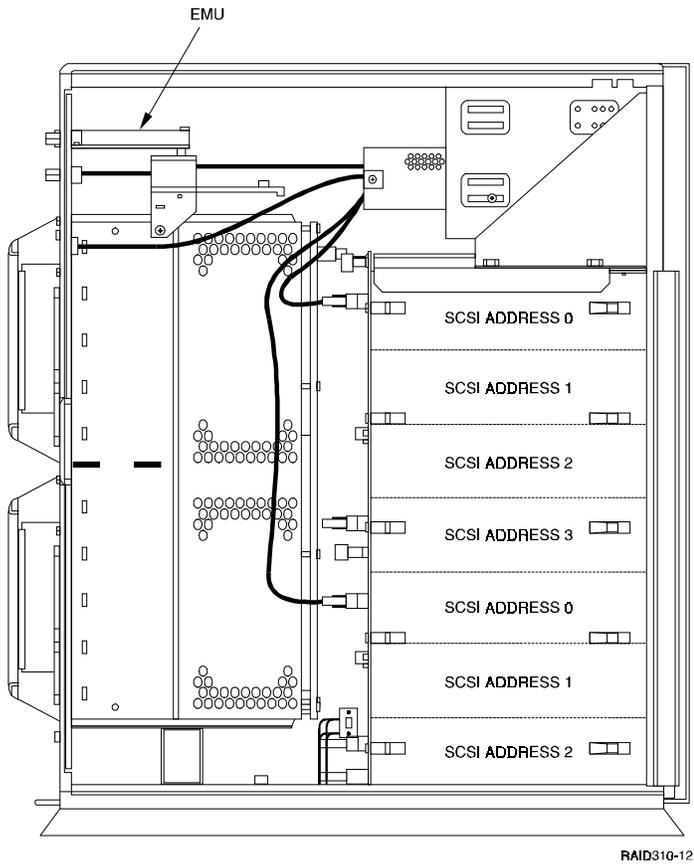
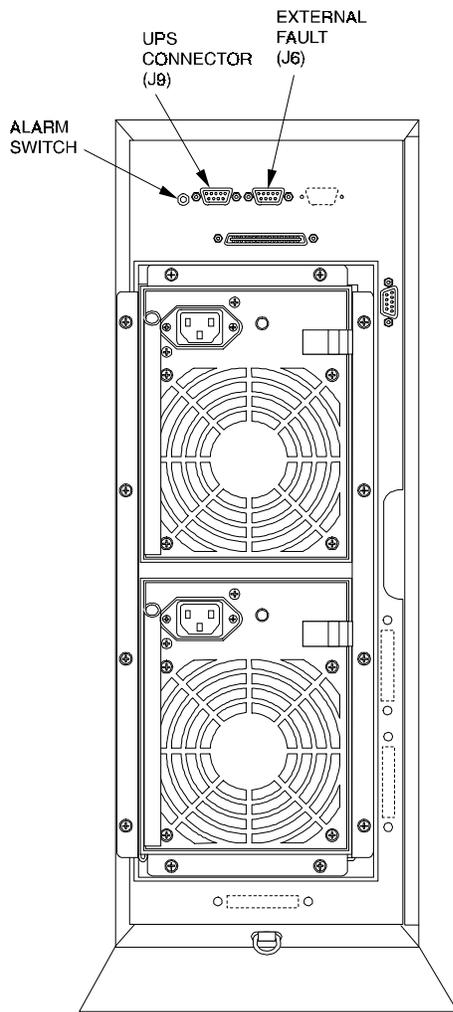


Figure 1-5 EMU Rear Panel Components

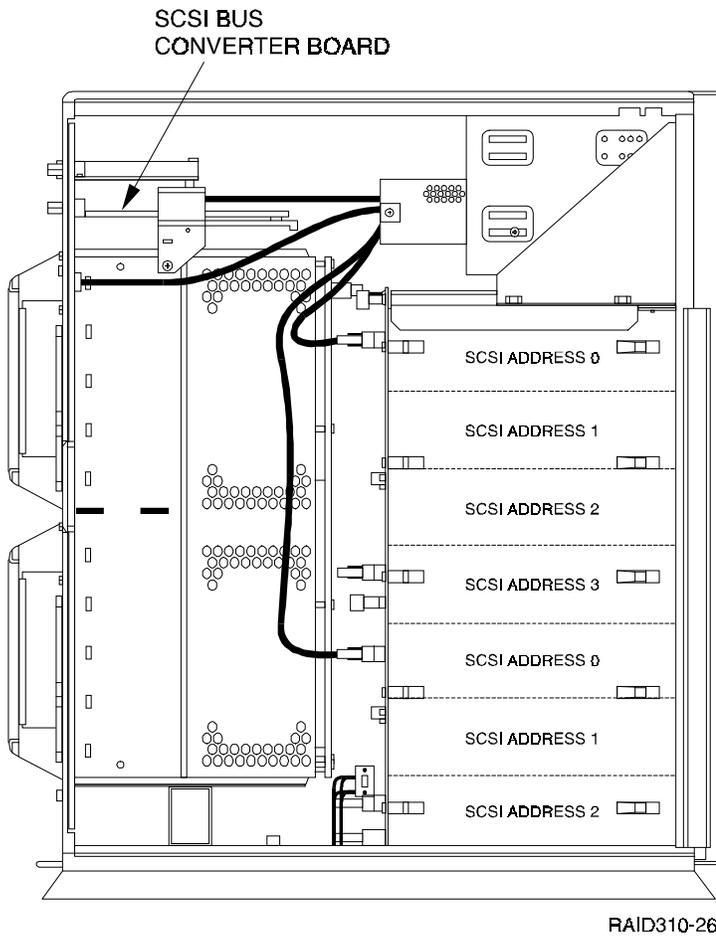


RAID310-07

1.4.5 Differential to Single-Ended SCSI Bus Converter

The differential to single-ended SCSI bus converter circuit board allows you to connect the subsystem's single-ended bus to a host system that uses a differential bus. The circuit board is located internally directly below the EMU board (see Figure 1–6) and is effectively inserted in series between the RAID controller hostSCSI connector and the SCSI output connector on the rear panel.

Figure 1–6 SCSI Bus Converter Board Location



1.5 Specifications

Table 1–1 lists basic product specifications for the subsystem.

Table 1–1 Subsystem Specifications

| Physical Specifications | |
|---|---|
| Item | Dimension |
| Height | 533 mm (21 in.) |
| Width | 202 mm (8 in.) |
| Depth | 483 mm (19 in.) |
| Rear Clearance (air exhaust) | 305 mm (12 in.) |
| Front Clearance (door opening) | 305 mm (12 in.) |
| Weight (no devices) | 19.5 kg (43 lbs.) |
| Power Specifications | |
| Item | Rating |
| Total power per power supply (Total of +12 Vdc and +5 Vdc outputs) | 204 Watts, maximum |
| Nominal output voltages | +5 Vdc @ 15 amps, maximum +12 Vdc @ 12 amps, maximum |
| Device startup time | 4-second internal, minimum |

Re-configuring the Subsystem

This chapter describes how to set the configuration switch to re-configure (change device addresses of SBB slots) in the subsystem.

2.1 Introduction

Your subsystem is set at the factory to configuration “0” for dual-bus operation. The SCSI bus subsystem configuration is controlled by the internal configuration switch. This eight-position switch sets the assigned slot device addresses in the subsystem. To access and set the configuration switch, you must remove the side panel from the subsystem. This chapter presents a brief description of SCSI buses and the external cables. It also describes how to change the subsystem configuration using the internal configuration switch.

2.2 SCSI Buses

The reliability of data transfers on a SCSI bus depends on the following factors:

- The bus transmission rate
- The bus width
- The maximum SCSI bus length (a function of bus type, the transmission rate, and the use of SCSI bus converters)
- The total length of the SCSI bus (as measured from the host bus terminator to the subsystem terminator)
- MT/s (megatransfers per second) is the repetitive rate at which words of data are transferred across a bus. The number of megabytes per second (MB/s) is determined by the bus width (8- or 16-bit) and the number of bytes per word (1 or 2, respectively).

Table 2–1 lists the maximum SCSI bus lengths and the longest SCSI cables recommended by Digital.

NOTE

The recommended maximum cable lengths listed are not the same as the maximum bus length.

Table 2-1 SCSI Bus Length and External Cables

| Bus Speed | Rate | | Bus Length | | Longest Digital Cable | | |
|-----------|------|------|------------|------|-----------------------|--------|------|
| | MT/s | MB/s | Meters | Feet | Number | Meters | Feet |
| Fast | 10 | 20 | 25 | 82 | BN21K-23 BN21L-23 | 23 | 82 |

2.3 Re-configuring the Subsystem

Your subsystem is set at the factory to configuration “0” which is the correct setting for dual-bus operation. If you wish to change it, you must remove the side panel from the subsystem to gain access to the configuration switch. To remove the side panel, proceed as follows:

WARNING

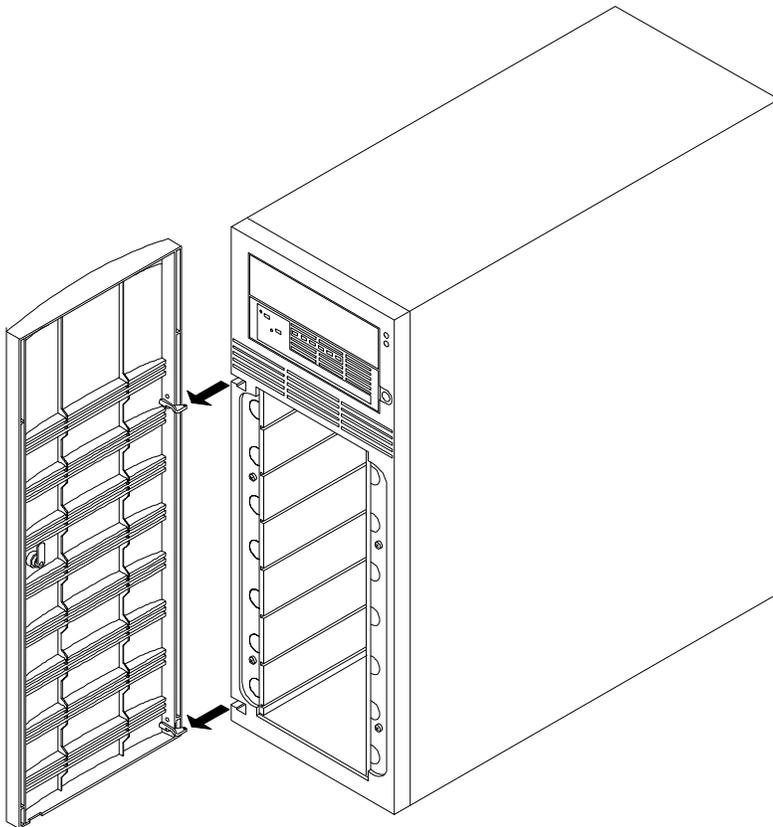
Dangerous voltages are present within the subsystem. To prevent electrical shock, always turn the subsystem off and disconnect the power cords before removing the side panel.

1. Turn off the power to the subsystem and disconnect the power cords.
2. Disconnect the external SCSI bus cable.
3. Unlock and remove the front door by lifting up and out (Figure 2-1).
4. Remove the left side cover screw using a # 10 TORX driver (Figure 2-2).
5. Grasp the side cover rear hand hold and pull it to the rear and remove as shown in Figures 2-2 and 2-3.

CAUTION

Never operate the subsystem with the side cover removed. When the side panel is removed, there is no air flow through the SBBs.

Figure 2-1 Removing Front Door



RAID310-25

Figure 2-2 Removing Side Cover

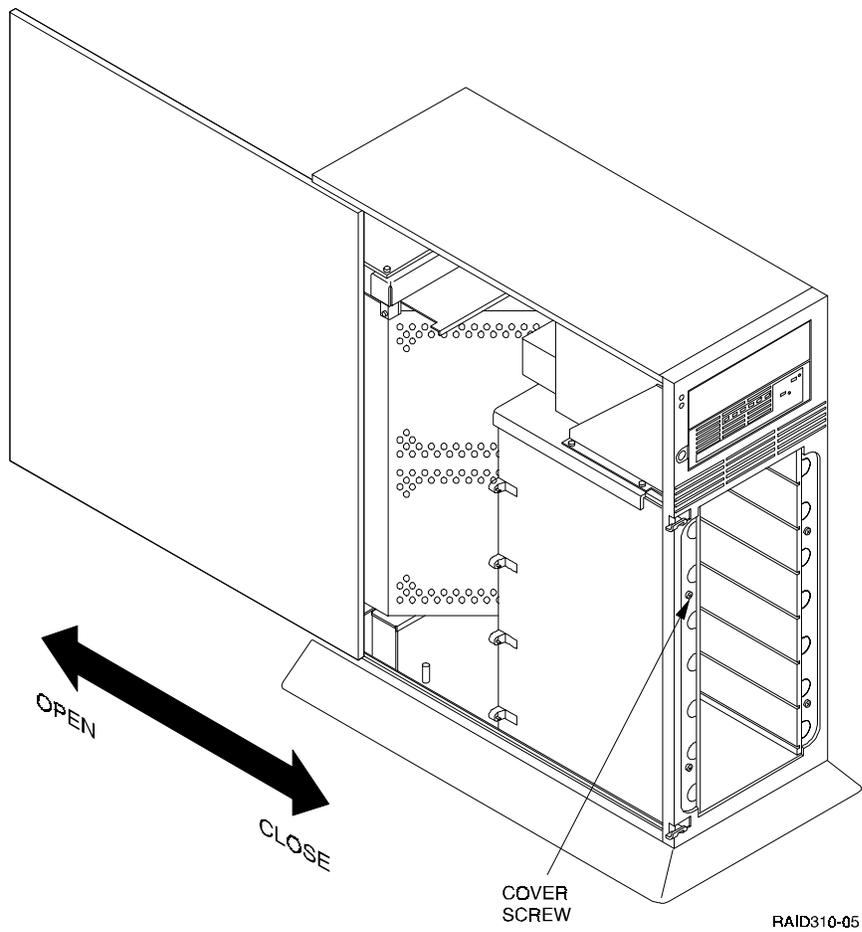
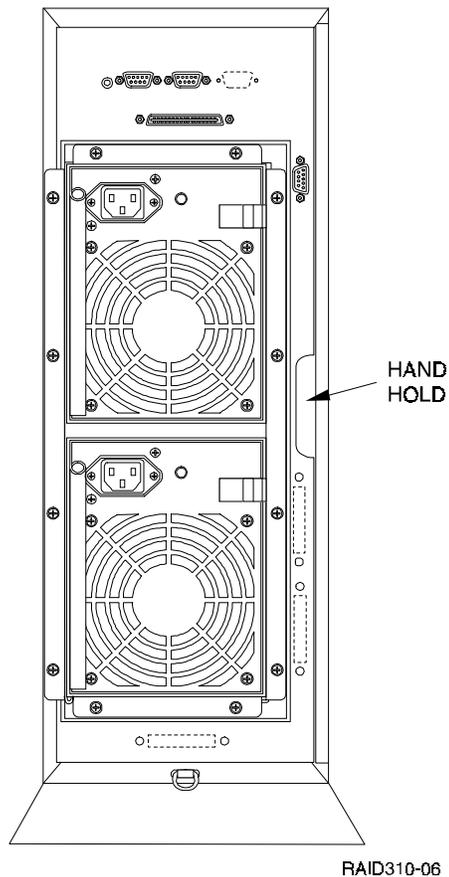


Figure 2-3 Subsystem Side Cover Hand Hold



2.3.1 Setting the Configuration Switch

The configuration switch selects the eight (0 - 7) subsystem configurations. Each configuration determines the slot device addresses for both 8-bit (addresses 0 - 6) and 16-bit devices.

NOTE

Device address 7 is the RAID array controller address. The controller allows a maximum of 7 disk devices on each of its device buses.

Figure 2-4 shows the location of the configuration switch and defines the slot device addresses assigned to each of the eight address configurations. Figure 2-5 identifies the individual step switches used to increase or decrease the configuration number. Figure 2-6 defines the slot device addresses assigned to each of the eight address configurations.

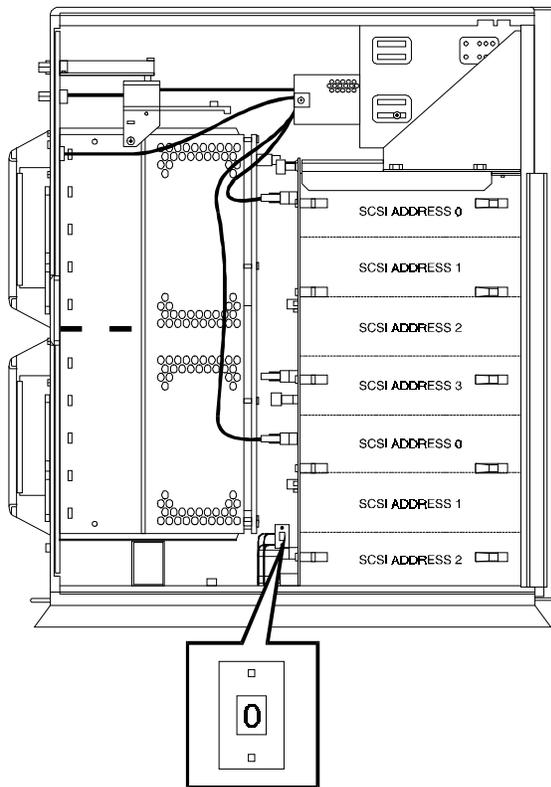
To decrease the configuration number:

Press the upper switch to step the address down one address at a time (decrement) until the configuration is displayed.

To increase the configuration number:

Press the lower switch to step the address up one address at a time (increment) until the new configuration number is displayed.

Figure 2-4 Subsystem Standard Configuration



RAID310-09

Figure 2-5 Configuration Switch

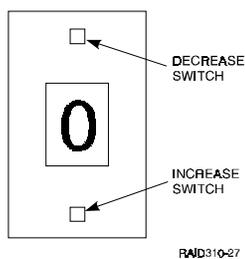


Figure 2-6 Configuration Switch Assigned Slot Device Addresses

| | | | | | | | |
|-----------------------|---|---|---|---|---|---|---|
| Slot Number | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Device Address | 0 | 1 | 2 | 3 | 0 | 1 | 2 |

Standard, factory-installed configuration.

| | | | | | | | |
|-----------------------|---|---|---|---|---|---|---|
| Slot Number | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Device Address | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

RAID310-21

2.4 Completing the Configuration

Perform the following procedure to complete the configuration and check the operation of the subsystem:

1. Replace the side cover and the locking screw.
2. Install the SBB(s) in the lower portion of the subsystem.
3. Connect the external SCSI cable and the ac power cords.
4. Turn on the subsystem and check that it is operating properly and that the devices respond when the SCSI bus is active.

RAID Array Controller

This chapter describes the major features and characteristics of the RAID array controller in the RAID Array 310 storage subsystem.

3.1 Overview

The subsystem RAID array controller uses a single, fast, 16 bit, single-ended SCSI bus for its connection to the host computer. The controller provides two, separately addressable, single-ended, fast, 8-bit SCSI buses as its device interface. It supports all of the standard SCSI-2 features as well as many of the optional ones.

Figure 3-1 is a block diagram of the RAID array controller.

The controller is packaged in an industry-standard 5¼-inch, half-height case. It includes a write-back cache with internal, battery backup as a standard feature. The cache memory is implemented with a 72-pin, 16 MB Single Inline Memory Module (SIMM).

NOTE

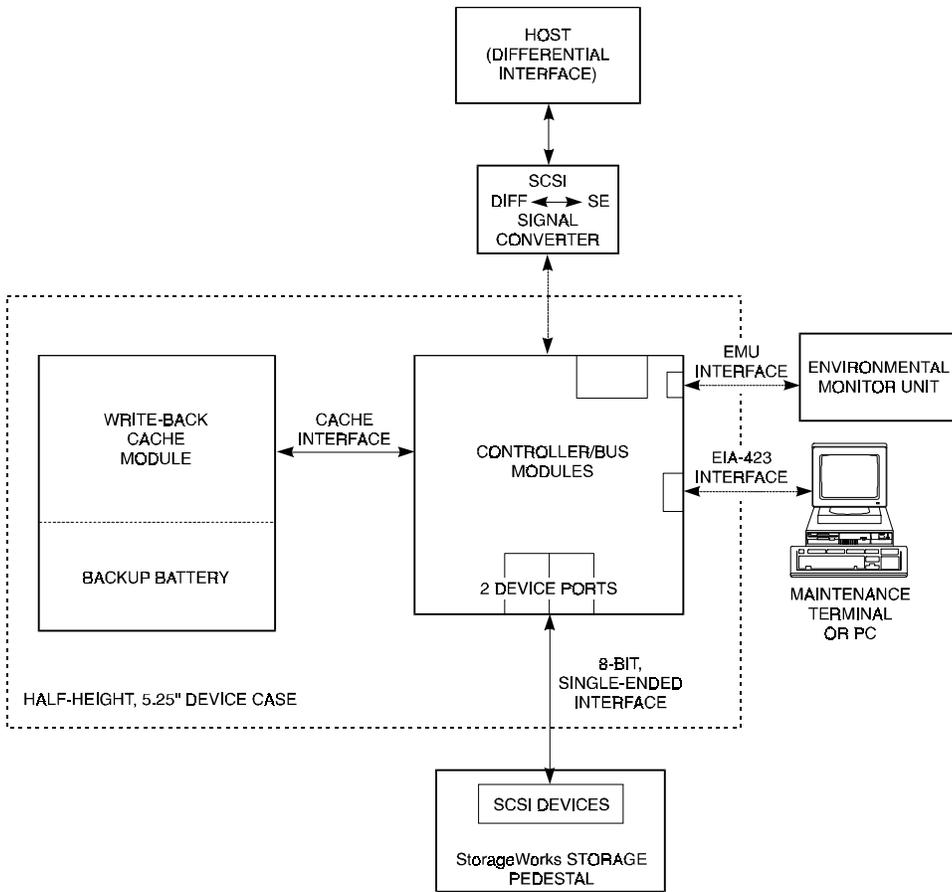
The memory module and program card are *not* field replaceable items.

The controller can be used in host environments where the host uses either single-ended or differential SCSI adapters. The RAID Array 310 subsystem provides a differential SCSI bus output.

The user accomplishes the configuration of storage devices into logical units with CLI (Command Line Interpreter), which is accessible through the subsystem's maintenance port EIA interface or through a host resident virtual terminal program. The controller operates in conjunction with the EMU to detect fault signals and alert the operator in the event of subsystem errors or malfunction.

Table 3-1 summarizes the main features of the RAID controller.

Figure 3-1 RAID Array Controller Block Diagram



RAID310-20

Table 3–1 Summary of RAID Controller Features

| Feature | Controller Characteristic |
|---|--------------------------------------|
| Host system bus | SCSI-2, fast, wide, single-ended |
| Storage device bus | SCSI-2, fast, narrow, single-ended |
| Number of SCSI device ports | 2 |
| Maximum number of SCSI-2 devices per port | 7 |
| Maximum number of SCSI-2 devices | 14 |
| Write-back cache module | 16 MB |
| Device warm swap | Yes |
| Controller-based device exerciser | Yes |
| Spontaneous messages to maintenance port | Yes |
| RAID level support | 0, 1, 0+1, 3, and 5 |
| Program card firmware update ¹ | By replacing or downloading the card |
| Error detection code (EDC) | Validation of program card firmware |
| Error detection code (EDC) on cache and shared memory | Yes |
| Tagged command queuing | Yes |
| Power fail write non-volatile journal | Yes |
| Data integrity and byte parity | Yes (all buses and memory) |
| Internal host bus termination | Yes (switchable) |
| Internal device bus termination | Yes (switchable) |

¹ The program card is not replaceable or upgradeable in the field.

3.2 Write-Back Cache Battery

You must disable the write-back cache battery after powering off the subsystem to avoid draining the device unnecessarily. To disable the write-back cache battery, press the cache backup battery disable push-button on the front panel of the controller (see Figure 3–2) using an appropriate tool such as a paper clip or a mechanical pencil. The cache backup battery LED stops flashing and your write-back cache is no longer being powered by the battery. When the subsystem is powered back up, the battery recharges.

NOTE

Once you have enabled the battery in the controller, the battery begins to discharge. Always power up the subsystem as soon as possible after enabling the battery to avoid an extended battery recharge time.

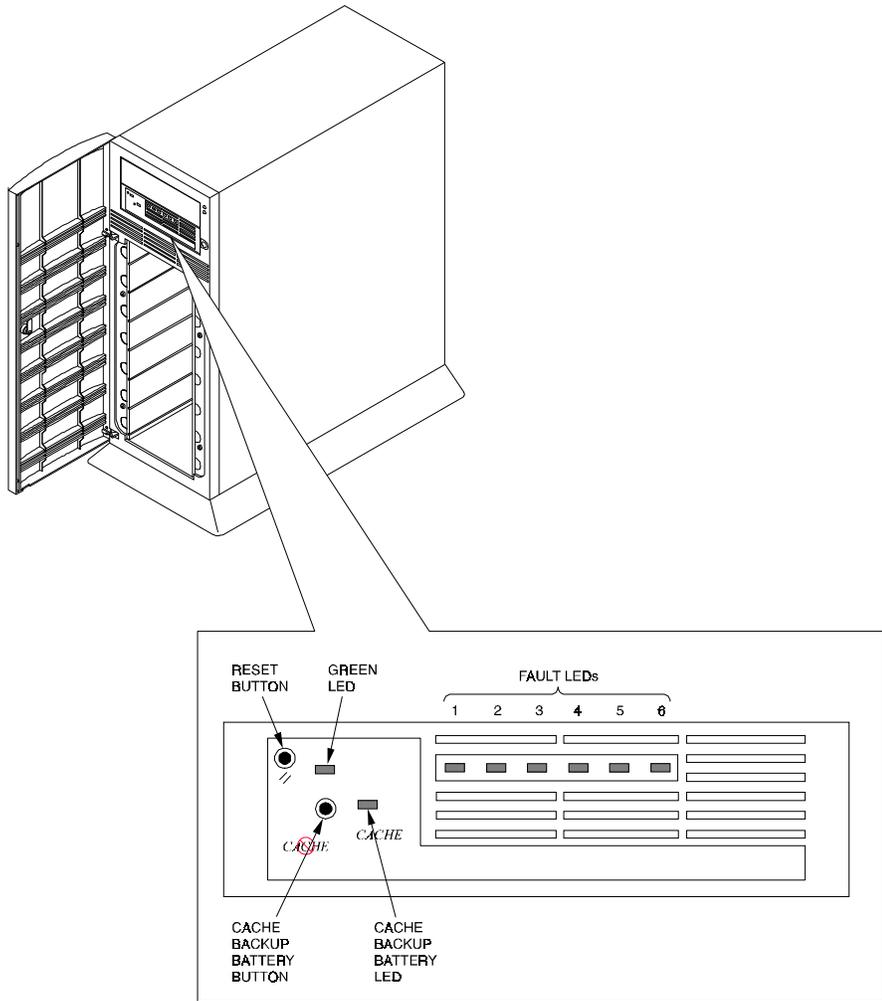
3.3 OCP Switches and Indicators

Figure 3–2 shows the operator control panel (OCP) switches and indicators on the front panel of the controller. They consist of:

- *Reset* button
- *Cache battery backup* button
- *Cache battery backup* LED
- *Status* LED (green)
- *Fault* LEDs (amber)

The *reset* switch, *cache battery backup* switch, and LED indicators are located on the RAID array controller's operator control panel. Their functions and status depend upon whether the controller is initializing or is in normal operation.

Figure 3–2 RAID Array Controller OCP



RAID310-16

3.3.1 Reset Button

The *reset* button halts all activity on the RAID array controller and activates the initialization process.

3.3.2 Cache Battery Backup Button and LED

The *cache battery backup* button is a momentary push-button switch. When pressed, the cache backup battery toggles between the enabled and disabled modes. When disabled, the battery is disconnected from the cache which forces the module to operate in the read-cache mode. The switch can also be used to disconnect the battery when shipping the subsystem to prevent from draining it.

A flashing *cache battery backup* LED indicates that the cache is being powered from either the battery or the primary subsystem ac power source. To disconnect the battery, primary power to the subsystem must be off when the switch is pressed. Pressing the switch while the subsystem power is on does not affect the controller.

CAUTION

Do not power on the subsystem within 15 seconds of disabling the cache battery with the *cache battery backup* button. The cache memory array needs this time to fully erase after the battery has been disabled. If you power on the subsystem prematurely, it may not boot and you must go through the power on procedure using a pause of at least 15 seconds.

3.3.3 Status LED

The green *status* LED reflects the state of the controller and the host interface. When the initialization operation begins, the controller firmware turns on the green LED. The LED flashes at approximately once per second when the initialization process is over and the controller is operating normally.

3.3.4 Fault LEDs

The six amber *fault* LEDs (Figure 3–2) are used to display the progress of the initialization operation. When the initialization operation begins, the controller firmware turns the *fault* LEDs off. In the initialization stages before the diagnostics begin, the controller displays the following sequence of patterns (flashes) in the LEDs (if no errors occur):

1. Fault LEDs 1 and 6 on, all other LEDs off.
2. Fault LEDs 1 and 6 off, fault LEDs 2 and 5 on.
3. Fault LEDs 2 and 5 off, fault LEDs 3 and 4 on.
4. Repeat the previous sequence.

NOTE

Any flashing OCP codes present while initialization or self-test diagnostic error information is posted to the display terminal causes the LEDs to momentarily stop flashing (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.

If an error occurs during the initialization process, an error code is displayed on the *fault* LEDs. Refer to Section 4.4 (Controller OCP Error Codes) in Chapter 4 for further information on the interpretation of these codes.

Following initialization, when the controller is operating normally, the *fault* LEDs are used for fault indications. If an error condition occurs on one of the device buses, the fault LED corresponding to that bus is lit. When the bus devices are functioning correctly, the *fault* LEDs are all off. The LEDs are numbered 1 through 6 (from left to right).

CAUTION

Do not power the controller on within 15 seconds of disabling the cache battery with the cache battery button. This cache memory array needs this time to fully erase after the batteries have been disabled. If you power up the controller prematurely, it may not boot and you must go through the power-up procedure using a pause of at least 15 seconds.

4

Troubleshooting

This chapter describes how to interpret the status of the LEDs on the subsystem and use them as a troubleshooting aid during a subsystem malfunction. Both the subsystem LEDs and the LEDs on the major components are covered. The chapter also describes how to replace a Field Replaceable Unit (FRU) in the subsystem.

4.1 Introduction

Troubleshooting the subsystem is limited to monitoring the status of the external LEDs to determine if a major component is malfunctioning. The Field Replaceable Units (FRUs) in the subsystem are:

- Disk drives (SBBs)
- RAID array controller
- Power supplies
- Environmental Monitor Unit (EMU) circuit board
- SCSI bus signal converter circuit board

The information in this chapter is divided into the following major sections:

- Subsystem status and power supply LEDs
- SBB status LEDs
- Controller OCP (Operator Control Panel) error code LEDs
- EMU error reporting
- Replacing an FRU

4.2 Subsystem Status and Power Supply LEDs

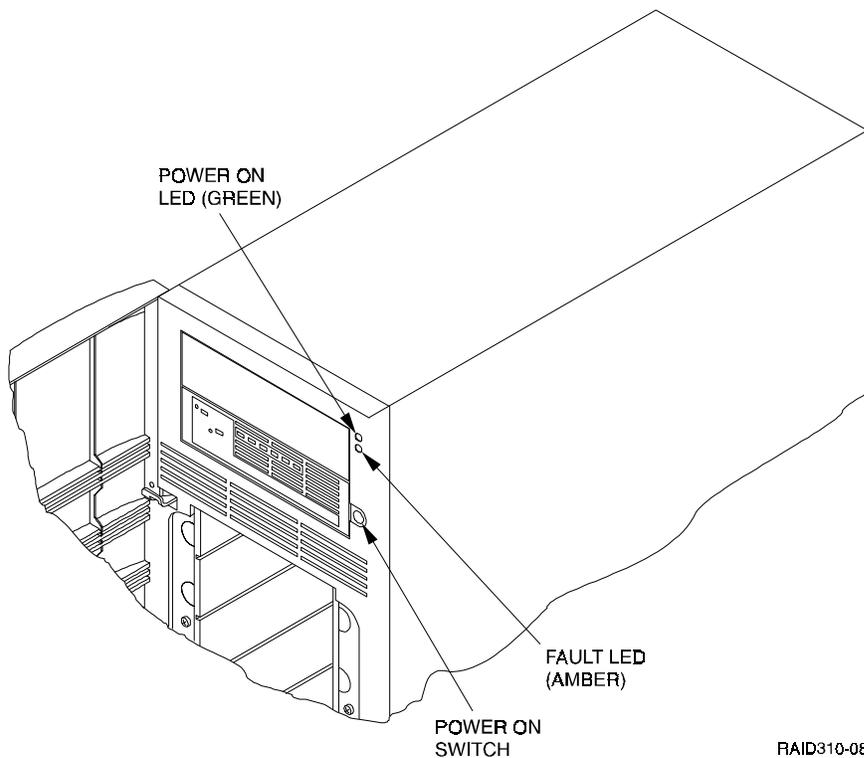
The subsystem is equipped with two front panel LEDs (Figure 4–1) which monitor the following error conditions:

- A power supply fan that is not operating
- An over-temperature condition exists
- A dc power problem

- External fault conditions
- Controller faults

When the subsystem is operating properly, The green subsystem *power* LED is on and the amber subsystem *fault* LED is off. Also, the green power supply LED on the rear of each power supply is on.

Figure 4-1 Subsystem Status LEDs



RAID310-08

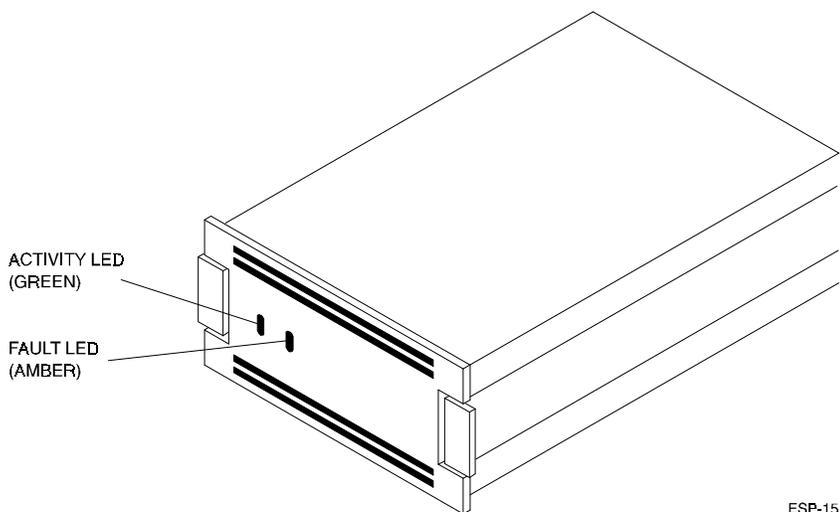
4.3 SBB Status LEDs

Each disk drive SBB in the subsystem has two status LEDs – a green *activity* LED and an amber *fault* LED as shown in Figure 4-2. When the subsystem is operating properly, the activity LED is flashing indicating normal disk activity on the SCSI bus, and the *fault* LED is off. Table 4-1 summarizes the states of the SBB LEDs.

Table 4–1 Storage SBB Status LEDs

| Activity LED | Fault LED | Indication |
|--------------|-----------|--|
| On | Off | Device is operating properly. |
| Off | Off | Device is inactive and operating normally. There is no fault. |
| On | On | Fault status: device is hung up. Recommend that you replace the device. |
| Off | On | Fault status: device is inactive and spun down. Recommend that you replace the device. |
| On | Flashing | Fault status: device is active and spinning down due to the fault. |

Figure 4–2 SBB LEDs



ESP-15

4.4 Controller OCP Error Codes

NOTE

The controller internal program card is *not* a field replaceable component. If the card is suspect, the controller must be replaced.

The OCP error code fault LEDs (Figure 4–3) display information when the controller encounters a problem with a device configuration, a device, or the controller itself. If a configuration or a device fault occurs during normal operation, the amber LED for the affected device's bus lights continuously. If there is no problem with the controller itself, the green LED continues to flash at approximately one Hz.

LED codes determined by internal diagnostics and operating firmware indicate either controller or program card faults. In either case, the green LED lights continuously when an error is detected. The amber fault LEDs on the front panel of the controller display the error codes in two different ways:

- The error code is lit continuously for faults detected by internal diagnostic and initialization routines. Table 4–2 describes the meaning of these codes and suggest maintenance actions that correspond to them.
- The error code flashes at a three-Hz rate representing faults that occur during normal controller operation. Table 4–3 describes the meaning of these codes and the suggest maintenance actions that correspond to them.

NOTE

Flashing OCP codes momentarily stop flashing while error information is being written to the maintenance terminal. Flashing resumes once the terminal display completes. Do not attempt to use OCP codes while error information is being written to the maintenance terminal.

Figure 4-3 Controller Error Code Fault LEDs

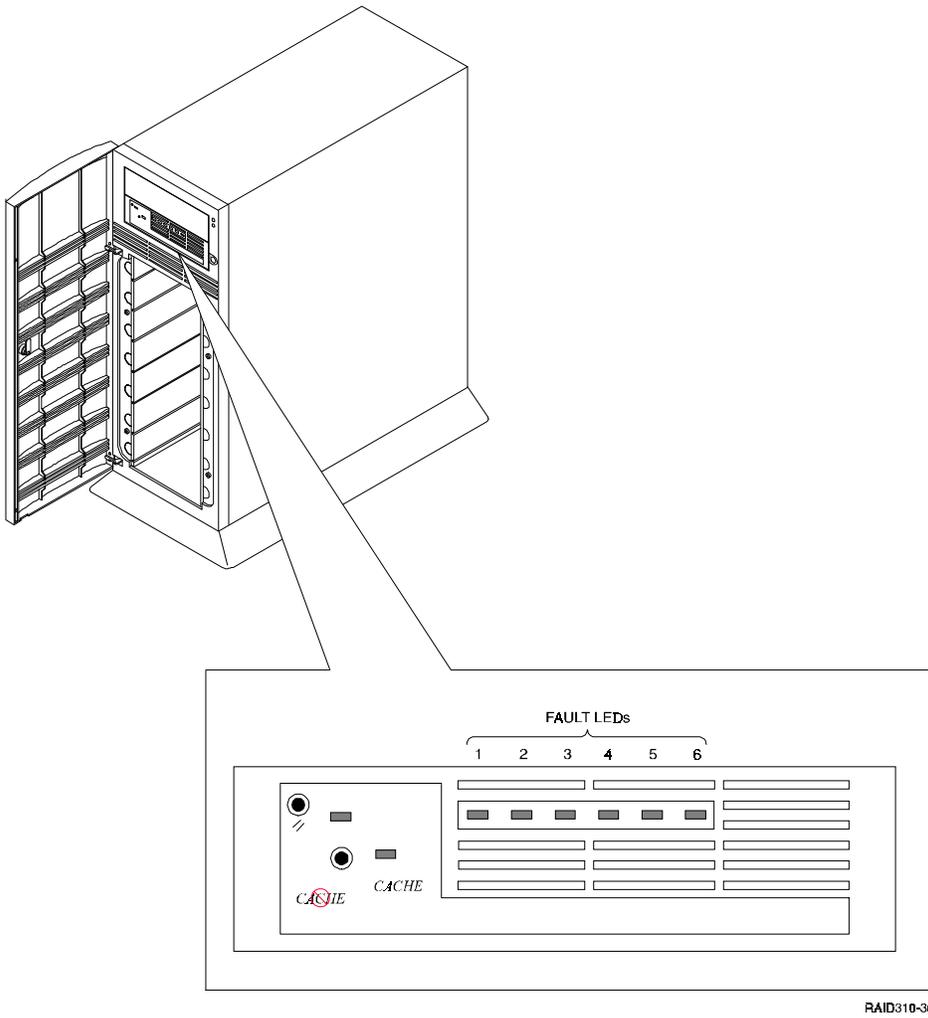


Table 4–2 Solid OCP Error Codes

| Reset | 1 | 2 | 3 | 4 | 5 | 6 | Description | Action | |
|--|---|---|---|---|---|---|-------------|--|----------------------------|
| ■ | ■ | ■ | ■ | ■ | ■ | ■ | 3F | DAEMON hard error. | Replace controller. |
| ■ | ■ | ■ | ■ | ■ | ■ | □ | 3E | Firmware bugcheck. | Replace controller. |
| ■ | ■ | ■ | ■ | ■ | □ | ■ | 3D | NVMEM version mismatch. | Replace controller |
| ■ | ■ | ■ | ■ | ■ | □ | □ | 3C | NVMEM write error. | Replace controller. |
| ■ | ■ | ■ | ■ | □ | ■ | ■ | 3B | NVMEM read error. | Replace controller. |
| ■ | ■ | ■ | ■ | □ | ■ | □ | 3A | NMI error within firmware bugcheck. | RESET (//) the controller. |
| ■ | ■ | ■ | ■ | □ | □ | ■ | 39 | Inconsistent NVMEM structures repaired ¹ | RESET (//) the controller. |
| ■ | ■ | ■ | ■ | □ | □ | □ | 38 | Bugcheck with no start. | RESET (//) the controller. |
| ■ | ■ | ■ | □ | ■ | ■ | ■ | 37 | Firmware induced restart following bugcheck failed to occur. | Replace controller. |
| ■ | ■ | ■ | □ | ■ | ■ | □ | 36 | Hardware induced restart following bugcheck failed to occur. | Replace controller. |
| ■ | ■ | ■ | □ | ■ | □ | ■ | 35 | Bugcheck within bugcheck controller. | RESET (//) the controller. |
| ■ | □ | □ | □ | □ | □ | □ | 00 | No program card seen | Replace controller. |
| <p>■ Off □ Lit continuously DAEMON = Diagnostic and Execution Monitor NVMEM = Nonvolatile Memory ¹ A power failure or controller reset during an NVMEM update causes this error.</p> | | | | | | | | | |

Table 4–3 Flashing OCP Error Codes (1 of 4)

| Reset | 1 | 2 | 3 | 4 | 5 | 6 | | Description | Action |
|---|---|---|---|---|---|---|----|--|---------------------|
| ■ | □ | □ | □ | □ | □ | ▨ | 01 | Program card EDC error | Replace controller. |
| ■ | □ | □ | □ | ▨ | □ | □ | 04 | Timer zero in timer chip will run when disabled. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | 05 | Timer zero in timer chip decrements incorrectly | Replace controller. |
| ■ | □ | □ | □ | ▨ | ▨ | □ | 06 | Timer zero in timer chip did not processor. | Replace controller. |
| ■ | □ | □ | □ | ▨ | ▨ | ▨ | 07 | Timer one in timer chip decrements incorrectly. | Replace controller. |
| ■ | □ | □ | ▨ | □ | □ | □ | 08 | Timer one in timer chip did not processor. | Replace controller. |
| ■ | □ | □ | ▨ | □ | □ | ▨ | 09 | Timer two in timer chip decrements incorrectly. | Replace controller. |
| ■ | □ | □ | ▨ | □ | ▨ | □ | 0A | Timer two in timer chip did not processor. | Replace controller. |
| ■ | □ | □ | ▨ | □ | ▨ | ▨ | 0B | Memory failure in the ID cache. | Replace controller. |
| ■ | □ | □ | ▨ | ▨ | □ | □ | 0C | No hit or miss to the ID cache when expected. | Replace controller. |
| ■ | □ | □ | ▨ | ▨ | □ | ▨ | 0D | One or more bits in the diagnostic registers did not match expected reset value. | Replace controller. |
| ■ | □ | □ | ▨ | ▨ | ▨ | □ | 0E | Memory error in non-volatile journal SRAM. | Replace controller. |
| ■ | □ | □ | ▨ | ▨ | ▨ | ▨ | 0F | Wrong image seen on program card. | Replace controller. |
| <p> ■ 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 </p> | | | | | | | | | |

Table 4–3 Flashing OCP Error Codes (2 of 4)

| Reset | 1 | 2 | 3 | 4 | 5 | 6 | | Description | Action |
|---|---|---|---|---|---|---|----|---|---------------------|
| ■ | □ | ▨ | □ | □ | □ | □ | 10 | At least one register in controller DRAB does not read as written. | Replace controller. |
| ■ | ■ | ▨ | □ | □ | □ | ▨ | 11 | Main memory is fragmented into too many sections. | Replace controller. |
| ■ | □ | ▨ | □ | □ | ▨ | □ | 12 | Controller DRAB chip does not arbitrate correctly. | Replace controller. |
| ■ | □ | ▨ | □ | □ | ▨ | ▨ | 13 | Controller DRAB chip failed to detect false parity when not forced. | Replace controller. |
| ■ | □ | ▨ | □ | ▨ | □ | □ | 14 | Controller DRAB chip failed to verify EDC. | Replace controller. |
| ■ | □ | ▨ | □ | ▨ | □ | ▨ | 15 | Controller DRAB chip failed to report forced ECC. | Replace controller. |
| ■ | □ | ▨ | □ | ▨ | ▨ | □ | 16 | Controller DRAB chip failed some operation in reporting ECC error. | Replace controller. |
| ■ | □ | ▨ | □ | ▨ | ▨ | ▨ | 17 | Controller DRAB chip failed some operation in reporting ECC error. | Replace controller. |
| ■ | □ | ▨ | ▨ | □ | □ | □ | 18 | Controller main memory did not write correctly in memory transfers. | Replace controller. |
| ■ | □ | ▨ | ▨ | □ | □ | ▨ | 19 | Controller did not cause an I-to N bus time-out. | Replace controller. |
| <p> ■ 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 </p> | | | | | | | | | |

Table 4–3 Flashing OCP Error Codes (3 of 4)

| Reset | 1 | 2 | 3 | 4 | 5 | 6 | | Description | Action |
|---|---|---|---|---|---|---|----|---|---------------------|
| ■ | □ | ▨ | ▨ | □ | ▨ | □ | 1A | Controller DRAB chip did not report an I-to-N bus time-out. | Replace controller. |
| ■ | □ | ▨ | ▨ | □ | ▨ | ▨ | 1B | Controller DRAB did not interrupt processor when expected. | Replace controller. |
| ■ | □ | ▨ | ▨ | ▨ | □ | □ | 1C | Controller DRAB did not report an NXM error. | Replace controller. |
| ■ | □ | ▨ | ▨ | ▨ | □ | ▨ | 1D | Controller DRAB did not report an address parity error when forced. | Replace controller. |
| ■ | □ | ▨ | ▨ | ▨ | ▨ | □ | 1E | Unexpected nonmaskable interrupt from DRAB during memory test. | Replace controller. |
| ■ | □ | ▨ | ▨ | ▨ | ▨ | ▨ | 1F | Diagnostic register indicates no cache module. | Replace controller. |
| ■ | ▨ | □ | □ | □ | □ | □ | 20 | Insufficient memory for code image. | Replace controller. |
| ■ | ▨ | □ | □ | □ | □ | ▨ | 21 | Insufficient memory in pool area for controller to run. | Replace controller. |
| ■ | ▨ | □ | □ | □ | ▨ | ▨ | 23 | Insufficient memory in buffer area for controller. | Replace controller. |
| ■ | ▨ | □ | □ | ▨ | □ | □ | 24 | Different code image than on program card. | Replace controller. |
| ■ | ▨ | □ | □ | ▨ | □ | ▨ | 25 | Diagnostic register indicates cache module exists, but access caused an error | Replace controller. |
| <p>■ 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</p> | | | | | | | | | |

Table 4–3 Flashing OCP Error Codes (4 of 4)

| Reset | 1 | 2 | 3 | 4 | 5 | 6 | | Description | Action |
|---|---|---|---|---|---|---|----|---|---------------------|
| ■ | ▨ | □ | □ | ▨ | ▨ | □ | 26 | Diagnostic register indicates cache module does not exist, but access did not cause an error. | Replace controller. |
| ■ | ▨ | ▨ | □ | □ | □ | □ | 30 | Journal SRAM battery bad. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | □ | ▨ | □ | 3A | Unexpected interrupt from read cache or present or lock bits not present. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | □ | ▨ | ▨ | 3B | Interrupt pending to controller's processor when there should be none. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | ▨ | □ | □ | 3C | Unexpected fault during initialization. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | ▨ | □ | ▨ | 3D | Unexpected maskable interrupt received during initialization. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | ▨ | ▨ | □ | 3E | Unexpected nonmaskable interrupt received during initialization. | Replace controller. |
| ■ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | 3F | Illegal process was activated during initialization. | Replace controller. |
| <p>■ Off □ Lit continuously ▨ Flashing</p> <p>I/D = Instruction/Data (cache on the controller module).</p> <p>DRAB = Dynamic RAM Controller and Arbitration Engine (operates controller shared memory)</p> <p>ECC = Error Correction Code.</p> <p>EDC = Error Detection Code</p> <p>SRAM = Static RAM</p> <p>NXM = Nonexistent Memory</p> | | | | | | | | | |

4.4.1 OCP Error Codes During Self Test

Self test is a special function of DAEMON (Diagnostic and Execution Monitor) when you set DAEMON to run in a continuous loop. Self test allows you to diagnose intermittent hardware failures because the loop continues until an error is detected. Tables 4–2 and 4–3 indicate directly which component has failed and should be replaced.

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 execute properly, you must have a valid configuration and enable the host paths.

To run self-test, enter the following command:

```
CLI> SELFTEST THIS_CONTROLLER
```

CAUTION

Do not use the OVERRIDE_ONLINE qualifier for the SELFTEST command as the customer data may be overwritten.

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 subsystem power off and on causing the subsystem to re-initialize.

4.5 EMU Error Reporting

The primary function of the EMU is to detect and report conditions that can cause the subsystem to malfunction and to report malfunctions. To accomplish this the EMU constantly monitors the following subsystem signals:

- +5 and +12 V dc
- ac input
- Power Supply present
- Total power
- Power OK (P_OK)
- Power Disabled
- Fan Speed (minimum and high speed)

- Fan exhaust temperature
- Shelf OK (S_OK)

The EMU has the capability of exchanging signals with auxiliary devices and controllers.

4.5.1 EMU Error Conditions

The EMU reports error conditions and malfunctions using an audible alarm and a LED. The user-enabled audible alarm and the amber fault LED on the front of the subsystem are the only error indicators.

Whenever any of the following error conditions occur, the amber fault LED on the front of the subsystem will turn on. When switch S1 is in the up (enabled) position, the audible alarm will sound whenever one of the following conditions occurs:

- Loss of ac power to one of the power supplies
- Failure of either power supply fan
- Temperature exceeds 50° C (123° F)
- One of the +12 V dc outputs is less than +9.85 V dc
- One of the +5 V dc outputs is less than +3.95 V dc
- Miscellaneous error condition
- A controller error condition exists (J2)
- External Fault (J6)

4.6 Replacing Components (FRU's)

This section describes how to replace an FRU in the RAID Array 310 subsystem. The information in this section is divided into the following subsections:

- Removing the subsystem door
- Replacing an SBB
- Replacing a power supply
- Replacing the controller
- Replacing the EMU board
- Replacing the SCSI bus signal converter board

WARNING

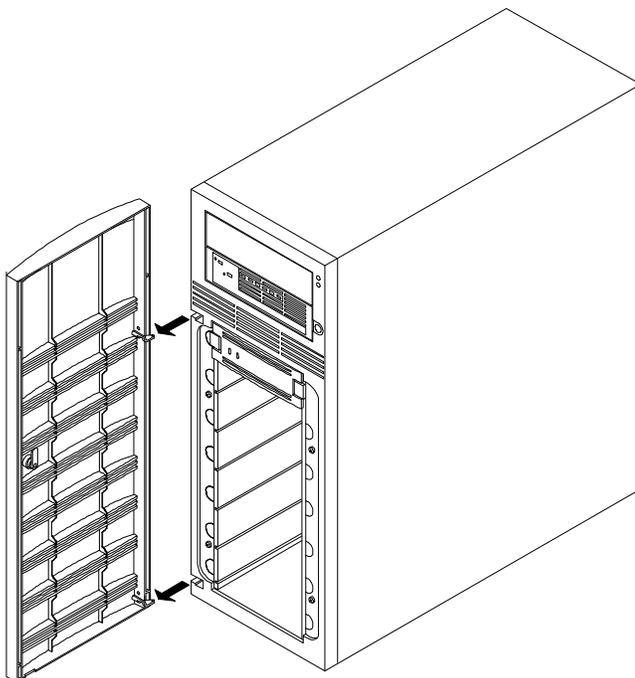
Dangerous voltages are exposed when the subsystem side panel is removed. Except for the SBBs and a power supply, always power off the subsystem and remove the power cords before replacing an FRU.

4.6.1 Removing the Subsystem Door

To remove the subsystem door, refer to Figure 4-4 and proceed as follows:

1. Unlock and open the door to a 90° degree angle in relation to the subsystem.
2. Carefully lift up on the door until the hinge pins are against the top of the mounting holes.
3. Pull the door straight out until the hinge pins clear the bezel.

Figure 4-4 Removing the Door



RAID310-25

4.6.2 Replacing an SBB

There are two methods for replacing a disk drive SBB with an *identical* SBB:

- **Hot swap** – This method requires that the SCSI controller support removing and installing SBBs while the bus is active. Hot swap is supported by the RAID Array 310 controller
- **Cold swap** – Requires removing ac power from the subsystem to deactivate the bus

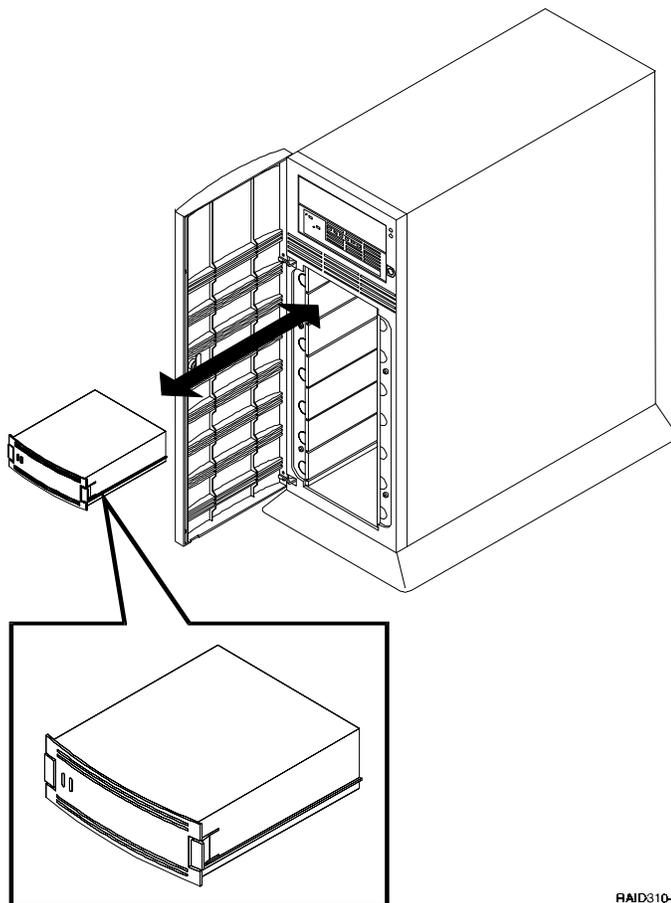
Perform the following procedure to replace an SBB in the subsystem (Figure 4–5).

CAUTION

Take care not to slam the replacement SBB into the subsystem enclosure.

1. Unlock and open the front door.
2. Press the mounting tabs on the SBB bezel together and pull the SBB out and clear of the subsystem.
3. Insert an identical model SBB on the slot and push it in until an audible click is heard indicating the SBB is fully seated (SBB front panel mounting tabs expand and engage the subsystem shelf).
4. Observe that the SBB status LEDs are operating.
5. Close the front door.

Figure 4-5 Replacing an SBB



RAID310-11

4.6.3 Replacing a Power Supply

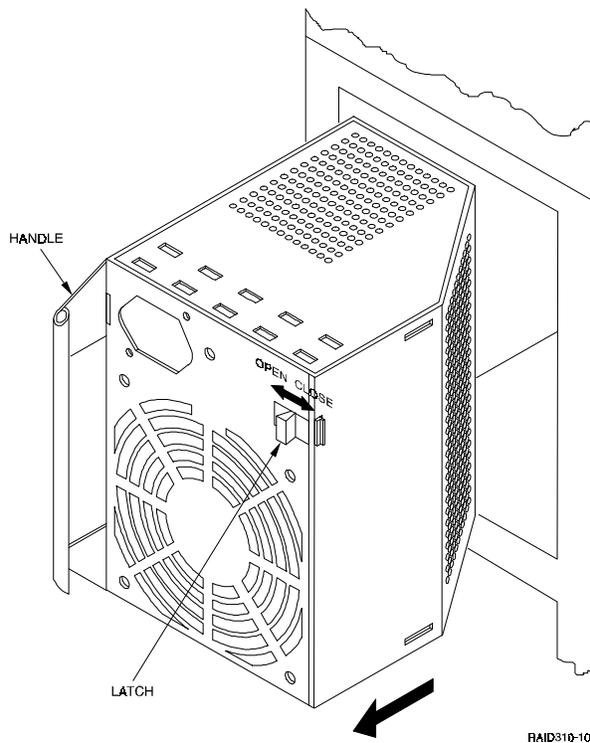
You can replace a power supply without affecting subsystem operation using the following procedure:

CAUTION

When you remove a power supply, the air flow through the SBBs is interrupted. Always install the replacement power supply as quickly as possible to prevent overheating.

1. Grasp the power supply handle shown in Figure 4-6.
2. Slide and hold the locking tab to the left and pull the supply out using a short jerking motion.
3. Insert the replacement power supply into the subsystem and carefully align it.
4. Push the power supply in until it is fully seated and the locking tab engages.
5. Until the fan is operating at the proper speed, the green power supply LED remains off. When the fan reaches the proper speed (several seconds), the LED should come on.

Figure 4-6 Replacing a Power Supply



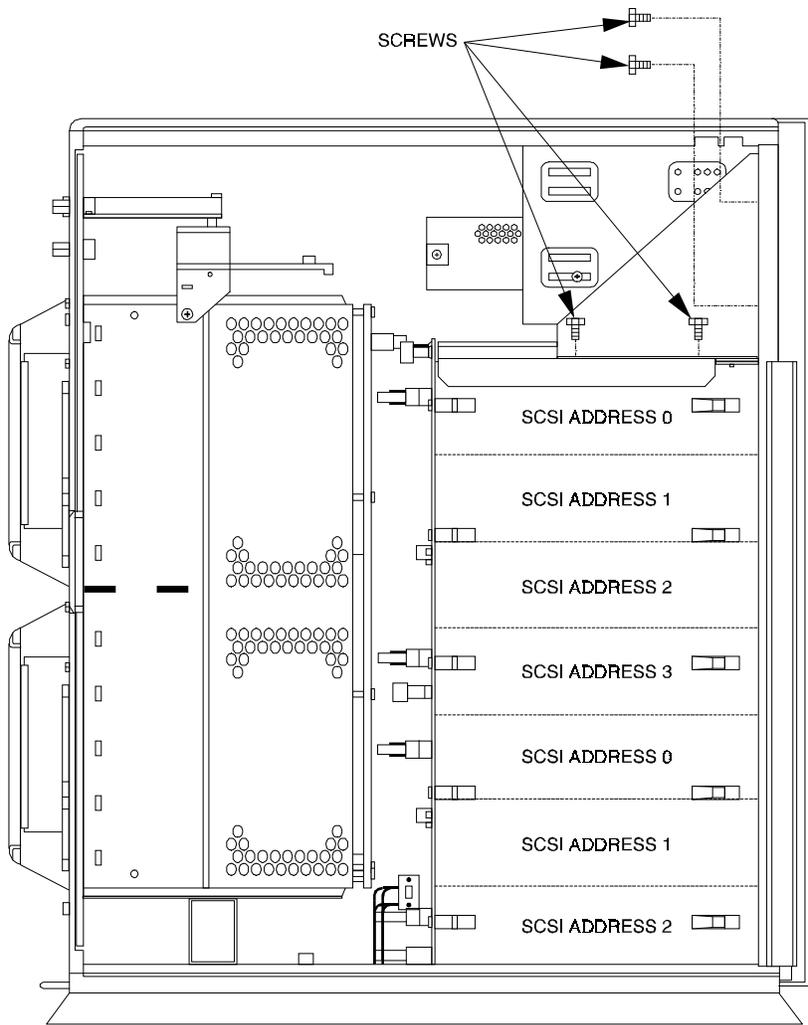
4.6.4 Replacing the RAID Array Controller

Perform the following procedure to replace the controller:

Tools required:

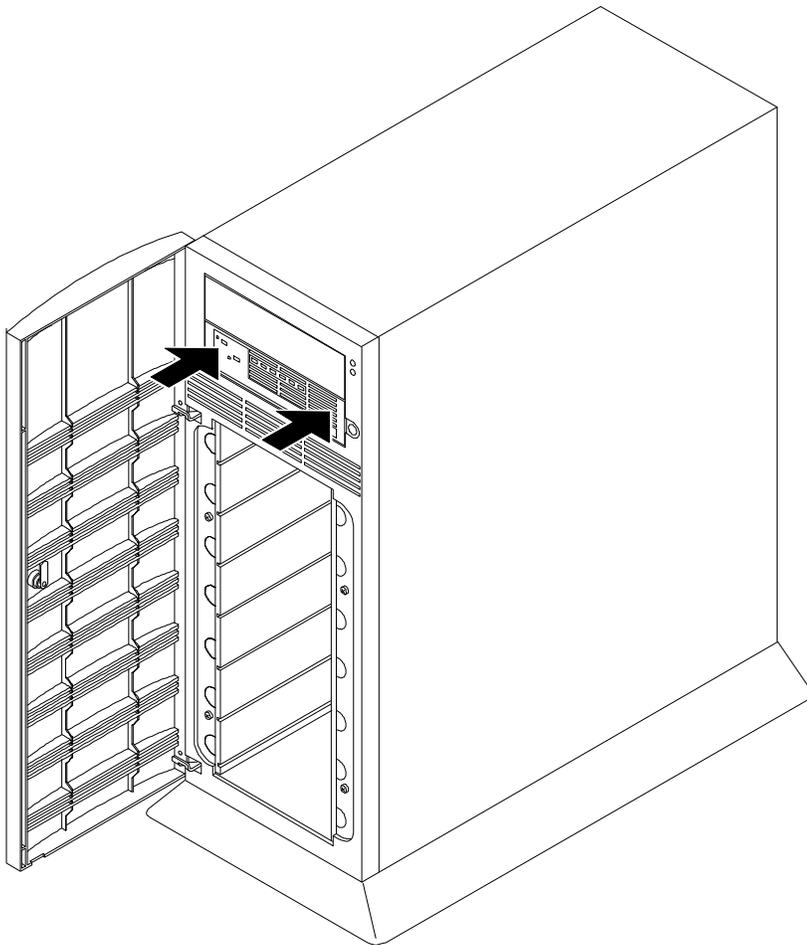
- Flat-head screwdriver
 - Phillips-head screwdriver
 - #10 TORX-head screwdriver
1. Power off the subsystem and disconnect the power cords.
 2. Remove the subsystem door (see section 4.6.1).
 3. Remove the left side cover from the subsystem (see section 2.3, Chapter 2).
 4. Remove the screws (2) that secure the bottom of the angle bracket on the side of the controller housing using a flat-head screwdriver (Figure 4–7).
 5. Remove the screws (2) that secure the angle bracket to the front bezel of the subsystem using a #10 TORX head screwdriver (Figure 4–7) and remove the bracket.
 6. Record the cable locations at the rear of the controller and then disconnect all cables.
 7. Press firmly at the ends of the front panel of the controller using both thumbs and gently push the controller 5¼-inch housing until it is free of the front bezel (Figure 4–8). Remove the housing/controller.
 8. Remove the four Phillips-head screws that secure the sides of the controller to the housing (Figure 4–9) and remove the controller by sliding it forward.
 9. Insert the new controller into the housing and secure using the four screws removed in step 8.
 10. Replace the housing/controller into the subsystem and slide forward until the front panel of the controller is flush with the top filler panel.
 11. Reconnect the cables at the rear of the controller.
 12. Replace the angle bracket and secure with the four screws removed in steps 4 and 5 above.
 13. Check all cable connections and replace the side cover on the subsystem.
 14. Replace the door.
 15. Reconnect the power cords, set the power switch to on, and allow sufficient time for the controller write-back battery to charge before placing the subsystem back online.

Figure 4-7 Remove Angle Bracket Screws



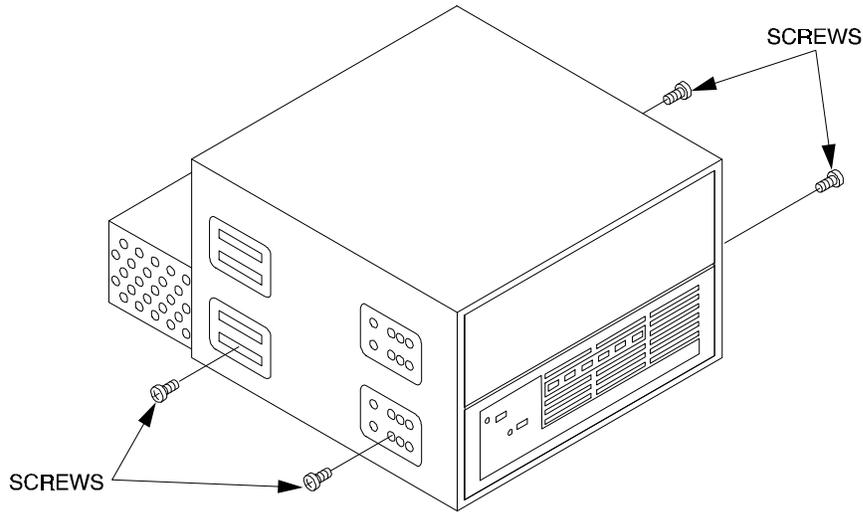
RAID310-32

Figure 4-8 Remove the Controller from the Subsystem



RAID310-33

Figure 4–9 Remove Screws to Release Controller from Housing



RAID310-34

4.6.5 Replacing the EMU Board

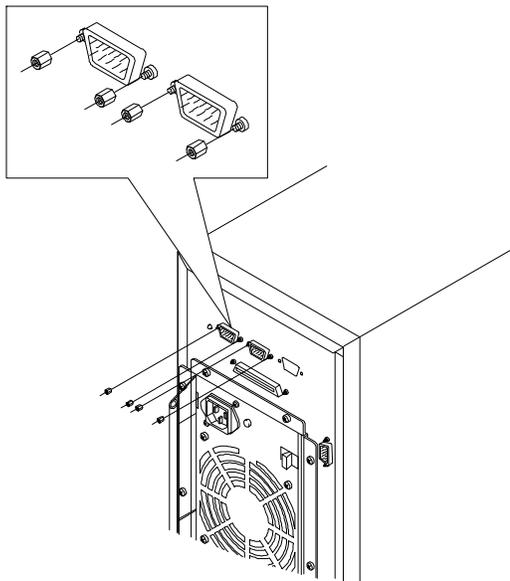
Perform the following procedure to replace the EMU Board:

Tools required:

- Flat-head or 3/16 (5 mm) hex-head screwdriver
- Phillips-head screwdriver
- #10 TORX-head screwdriver

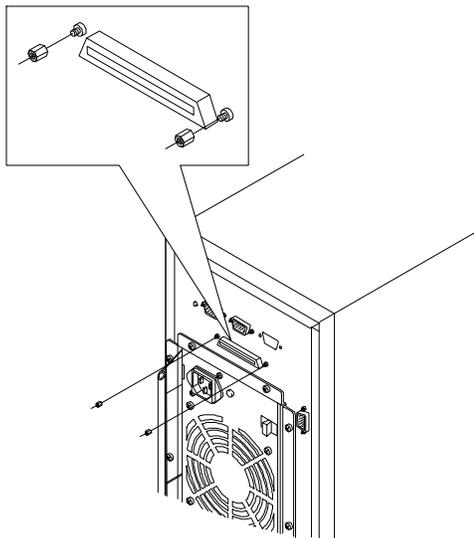
1. Power off the subsystem and disconnect the power cords.
2. Remove the subsystem door (see section 4.6.1).
3. Remove the left side cover from the subsystem (see section 2.3, Chapter 2).
4. Record the orientation of the two cables connected to the EMU board and disconnect the cables.
5. Remove the mounting nuts from the UPS (J9) and EXTERNAL FAULT (J6) connectors on the rear panel using a hex-head driver or a flat-blade screwdriver (see Figure 4–10).
6. Remove the mounting nuts from the SCSI bus connector on the rear panel (see Figure 4–11).

Figure 4-10 Remove Connector Nuts from J9 and J6



RAID310-17

Figure 4-11 Remove Connector Nuts from SCSI Connector



RAID310-18

7. Remove the Phillips-head screw from the support bracket which secures the EMU and signal converter boards to the chassis (see Figure 4–12).
8. Carefully pull out the bracket assembly to gain access to the top of the EMU board, remove the two mounting screws from the rear of the EMU board (see Figure 4–13), and then remove the board from the bracket assembly.
9. Install the new board on the bracket assembly using the same screws removed in step 8.
10. Align the EMU and signal converter connectors with the connector holes on the rear panel and re-install the bracket assembly (tip: set the alarm switch on the EMU in the down position to facilitate the installation).
11. Replace the mounting studs on all rear panel connectors and reconnect the two cables to the EMU board.
12. Replace the Phillips head screw to secure the support bracket assembly.
13. Replace the side cover on the subsystem and secure it with the TORX-head screw on the front bezel of the subsystem.
14. Replace the door on the subsystem.

Figure 4–12 Remove Screw from Support Bracket

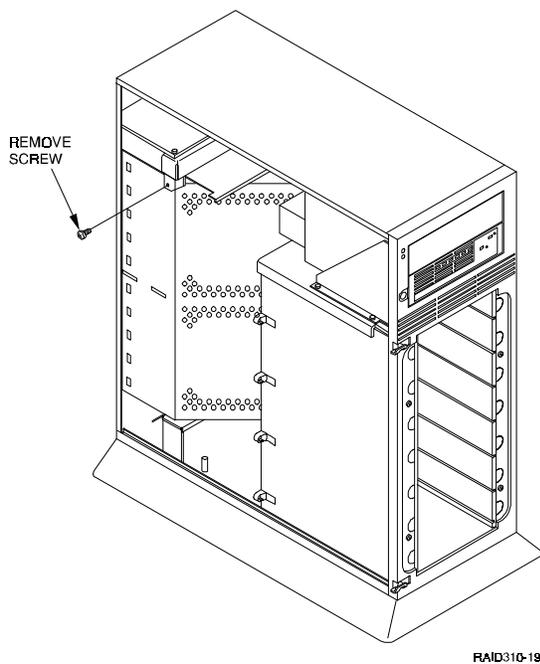
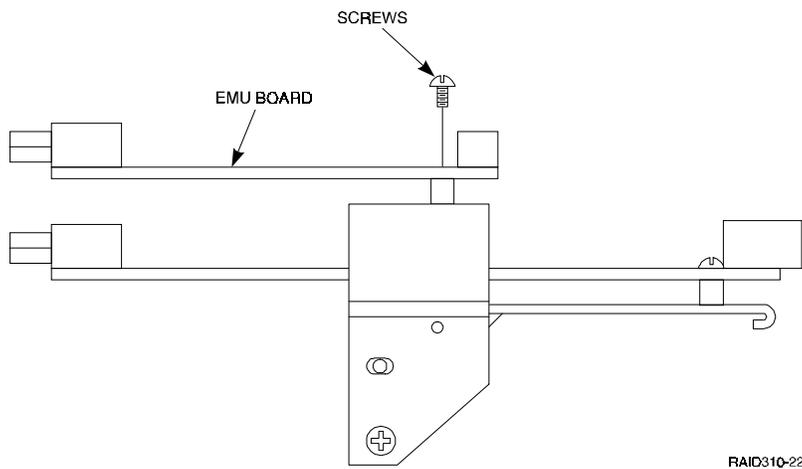


Figure 4–13 Remove Mounting Screws from EMU Board



4.6.6 Replacing the SCSI Bus Signal Converter Board

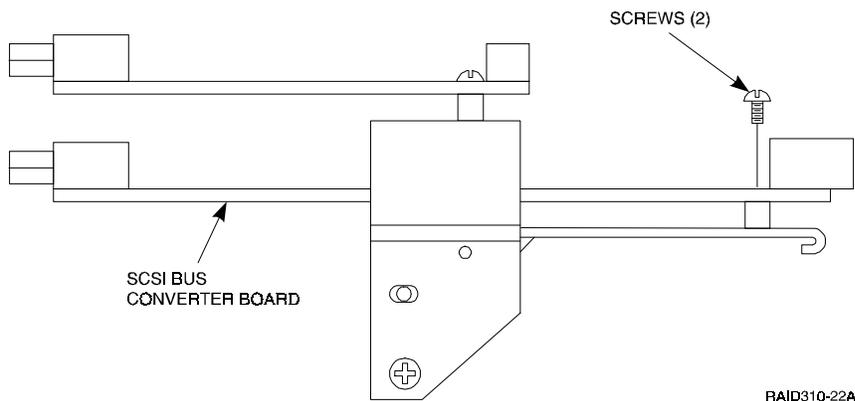
Perform the following procedure to replace the signal converter board:

Tools required:

- Flat-head or 3/16 (5 mm) hex-head screwdriver
 - Phillips-head screwdriver
 - #10 TORX-head screwdriver
1. Power off the subsystem and disconnect the power cords.
 2. Remove the subsystem door (see section 4.6.1).
 3. Remove the left side cover from the subsystem (see section 2.3, Chapter 2).
 4. Record the orientation of the two cables connected to the EMU board and disconnect the cables.
 5. Disconnect the SCSI bus ribbon cable from the rear of the signal converter board.
 6. Remove the mounting nuts from the UPS (J9) and EXTERNAL FAULT (J6) connectors on the rear panel using a hex-head driver or a flat-blade screwdriver (see Figure 4–10).
 7. Remove the mounting nuts from the SCSI bus connector on the rear panel (see Figure 4–11).

8. Remove the Phillips-head screw from the support bracket assembly which secures the EMU and signal converter boards to the chassis (see Figure 4–12).
9. Carefully pull out the support bracket assembly to gain access to the top of the signal converter board, remove the two mounting screws from the rear of the board (see Figure 4–14), and then remove it from the bracket assembly.
10. Install the new board on the bracket assembly using the same screws removed in step 9.
11. Align the EMU and signal converter connectors with the connector holes on the rear panel and re-install the bracket assembly (tip: set the alarm switch on the EMU in the down position to facilitate the installation).
12. Replace the mounting nuts on all rear panel connectors and re-connect the two cables to the EMU board.
13. Connect the SCSI bus ribbon cable to the rear of the new signal converter.
14. Replace the Phillips head screw to secure the support bracket assembly.
15. Replace the side cover on the subsystem and secure it with the TORX-head screw on the front bezel of the subsystem.
16. Replace the door on the subsystem.

Figure 4–14 Remove Mounting Screws from SCSI Bus Converter Board



Reader's Comments

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RAID Array 310 Deskside Subsystem Hardware User's Guide

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