StorageWorks™

Getting Started

RAID Array 410 for Digital Unix – Alpha

Installation Guide

Order Number: EK–SMRA7-IG. A01

Digital Equipment Corporation
Maynard, Massachusetts

EK-SMRA7-IG. A01 February 1996

Printed in U. S. A

Contents

Figures

Revision Record

This Revision Record provides a concise publication history of this manual. It lists the manual 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 410 Subsystem for Digital UNIX – Alpha systems.

Revision Level	Date	Summary of Changes
EK–SMRA7–IG. A01	February 1996	Initial 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.

This guide provides the following:

- Description of how to unpack and assemble the RAID Array 410 Subsystem
- How to install the KZPSA Host Adapter board into your system
- Configuring the RAID Array

Audience

This guide is intended for administrators and system integrators of StorageWorks RAID Array 410 Subsystems. Installing the StorageWorks RAID Array 410 Subsystem requires a general understanding of RAID concepts, Digital UNIX, and product installation procedures.

Document Structure

This guide contains the following chapters:

Chapter 1: Unpacking and Setting Up Your RAID Array 410 Subsystem Components

This chapter describes how to unpack and place the Office Expansion RAID Enclosure. The chapter also describes how install the SWXRC-04 RAID controller and its PC (Program) card, and how to recharge the write-back cache batteries.

Chapter 2: Creating an Initial Controller Configuration

This chapter contains instructions for creating an initial configuration for your RAID Array controller. It also briefly describes the CLI (Command Line Interpreter).

Chapter 3: Connecting to the RAID Array 410 Hardware

This chapter describes the steps required to connect the RAID Array 410 subsystem to your Alpha system.

Chapter 4: Working with RAID Array 410 in Digital UNIX

This chapter describes how to access the storage units on your RAID Array 410 storage subsystem from your Digital UNIX host system. It also includes descriptions of concepts and terms necessary to understand your RAID system.

Appendix A: *Setld* Script Example

This appendix provides an example of the script of the *setld* install utility.

Appendix B: Configuration Record

This appendix contains blank forms that may be used to provide a record of your system configuration.

Associated Documents

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

Table 1 Associated Documents

Document Title	Order Number
SWXSC-AA Office Expansion RAID Enclosure User's Guide	EK-SMCPD-UG
SWXRC RAID Array Controller User's Guide	EK-SMCS1-UG

Conventions

This guide uses the following documentation conventions:

Table 2 Style Conventions

Style	Meaning
`boldface monospace type`	To be input by the user
`plain monospace type`	Screen text
italic type	For emphasis, manual titles, utilities, menus, screens, and file-names

Getting Started

This section provides an overview for preparing and installing the RAID Array 410 for Digital Unix in your Alpha-based system. Detailed information is contained in Chapters 1 through 4.

Thank you for purchasing a StorageWorks RAID Array 410 Subsystem. You should have received the following:

- StorageWorks RAID Array 410 Manager for Digital UNIX platform kit
- StorageWorks RAID Array 410 Subsystem

Note

Installing the StorageWorks RAID Array 410 Subsystem requires a technical understanding of the following:

- Digital Alpha-based Computer Systems
- RAID array concepts
- Digital UNIX
- Basic hardware installation procedures
- Or, contact your supplier or service representative for installation assistance.

The major steps for installing and setting up the StorageWorks RAID Array 410 Subsystem include the following:

1. Performing the pre-installation steps listed below
2. Unpacking and locating the RAID Array 410 Subsystem, installing the SWXRC-04 RAID Array controller, PC (Program) card, and write-back cache module, if they have not been installed, and charging the write-back cache module batteries (Chapter 1)
3. Connecting the maintenance terminal and establishing communications (Chapter 2)
4. Using the Command Line Interpreter (Chapter 2)
5. Creating an Initial Configuration (Chapters 2 and 4)
6. Unpacking and installing the KZPSA host adapter in your Alpha-Based system and connecting the KZPSA host adapter to the RAID controller (Chapter 3)
7. Installing SWXRC install utilities for Digital UNIX (Chapter 4)
8. Creating device entries and filesystems on the units configured in Step 5 (Chapter 4)

Pre-installation Steps:

Before starting your installation, follow these pre-installation steps:

- Back up your system files using your normal procedure.
- Verify the availability of user-supplied hardware and software.
- Inventory the contents of the StorageWorks RAID Array 410 Subsystem platform kit.
- Inventory the contents of the StorageWorks RAID Array 410 Subsystem.

Perform a System Backup

Follow normal procedures to backup your system before installing the subsystem.

Verify User-Supplied Hardware and Software (System Requirements)

The StorageWorks RAID Array 410 Subsystem requires the following user-supplied hardware and software:

- Digital Alpha-based system with an available PCI slot
- The associated system hardware manual(s)
- Appropriate tools to service your computer
- The Digital UNIX operating system

Inventory the StorageWorks RAID Array 410 Subsystem Platform Kit Components

The Storage Works RAID Array 410 Platform Kit provides the following components:

- A Host Adapter – Model KZPSA-BB for Alpha-based systems
- SCSI cable, with a right-angle high-density 68-pin connector on one end and a straight high-density 68-pin connector on the other (BN21K)
- Media containing software to connect SWXRC-04 to KZPSA
- This *Getting Started – RAID Array 410 for Digital UNIX - Alpha Installation Guide*
- Release Notes containing version-specific instructions for system installation

The StorageWorks RAID Array 410 Subsystem provides the following components:

- The StorageWorks Storage Expansion Enclosure
- The SWXSC-AA Office Expansion RAID Enclosure User's Guide
- The StorageWorks RAID Array 410 controller (SWXRC-04)
- PC (Program) Card for SWXRC-04
- The SWXRC RAID Controller User's Guide
- Disk drive(s)
- Serial cable (RJ12 to 9-pin serial) for connecting the maintenance port of the RAID controller to the serial port of your system, PC, or maintenance terminal
- 9-pin to 25-pin adapter
- Power Cable
- Enclosure keys
- RAID Array 410 Controller Firmware License Keys

NOTE

Retain the Firmware License Keys information in a safe place. They are required if it becomes necessary to reinitialize the RAID Array Controller.

1

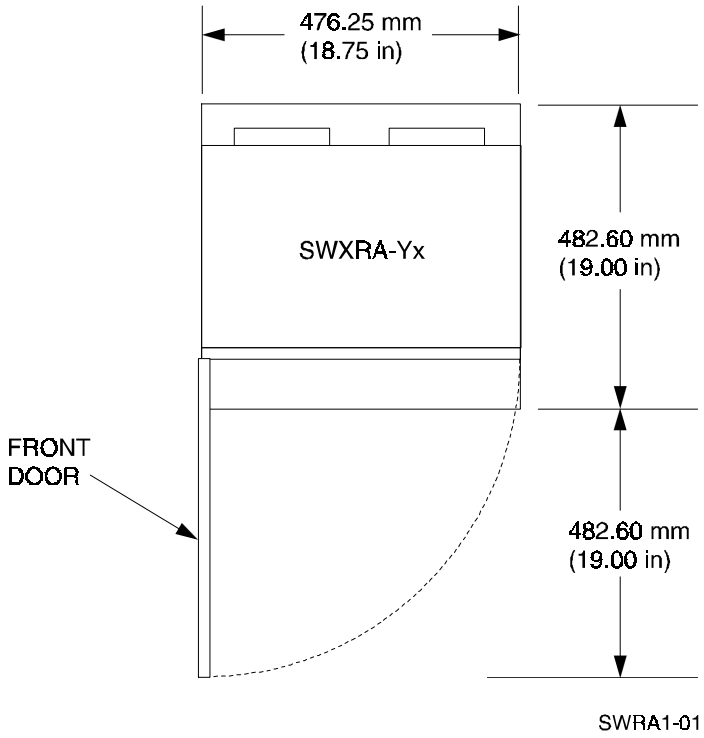
Unpacking and Setting Up Your RAID Array 410 Subsystem Components

This chapter describes the site preparation and unpacking procedures for the RAID Array 410 Subsystem. It also describes the procedure to recharge the controller write-back cache batteries.

1.1 Site Preparation

Before installing the enclosure, make sure that adequate space is available in front of the enclosure for opening the front door (19 inches clearance) and around the enclosure for adequate airflow. See Figure 1–1 for specific space requirements.

Figure 1–1 Minimum Installation Clearance Measurements



1.2 Unpacking the RAID Array 410 (SWXRA-Yx)

The RAID Array 410 is packed in a corrugated carton attached to a wooden shipping pallet, as shown in Figure 1–2A. Unpack the unit as follows:

NOTE

Before unpacking the equipment, inspect the shipping carton for signs of external damage. Report any damage to the local carrier and to your sales representative.

1. Remove the shipping straps (Figure 1–2A).
2. Remove the top cover (Figure 1–2B).
3. Remove the ramp from the top of the shipping carton (Figure 1–2B) and set it aside for subsequent use in moving the RAID Array 410 off the pallet.
4. Remove the two foam cushions from the top of the RAID Array 410 container (Figure 1–2B).
5. Remove the sealed cardboard box packed beside the subsystem unit. It contains a cable and documentation.
6. Remove the cardboard carton surrounding the RAID Array 410 (Figure 1–2B).
7. Remove the plastic barrier bag (Figure 1–2C).
8. Once the RAID Array 410 is exposed (Figure 1–2D), examine the equipment for any apparent damage. Report any such problems immediately to your sales representative.

1.3 Removing the RAID Array 410 from the Pallet

Use the following procedure to remove the RAID Array 410 from the shipping pallet:

WARNING

Serious personnel injury can result if correct safety precautions are not taken during the removal procedure.

We recommend that three people perform the task of unloading the RAID Array 410 Array from its shipping pallet. Failure to use sufficient personnel can result in personnel injury and equipment damage.

CAUTION

Do not drop the RAID Array 410 array from a height of more than two inches, as serious structural damage to the enclosure can result.

1. Attach the ramp to the shipping pallet by fitting the lip of the ramp into the groove on the pallet, as shown in Figure 1–3.
2. Lift the lock lever on each front caster to its *up* position so that the RAID Array 410 enclosure can be moved.

Figure 1–2 Unpacking the RAID Array 410

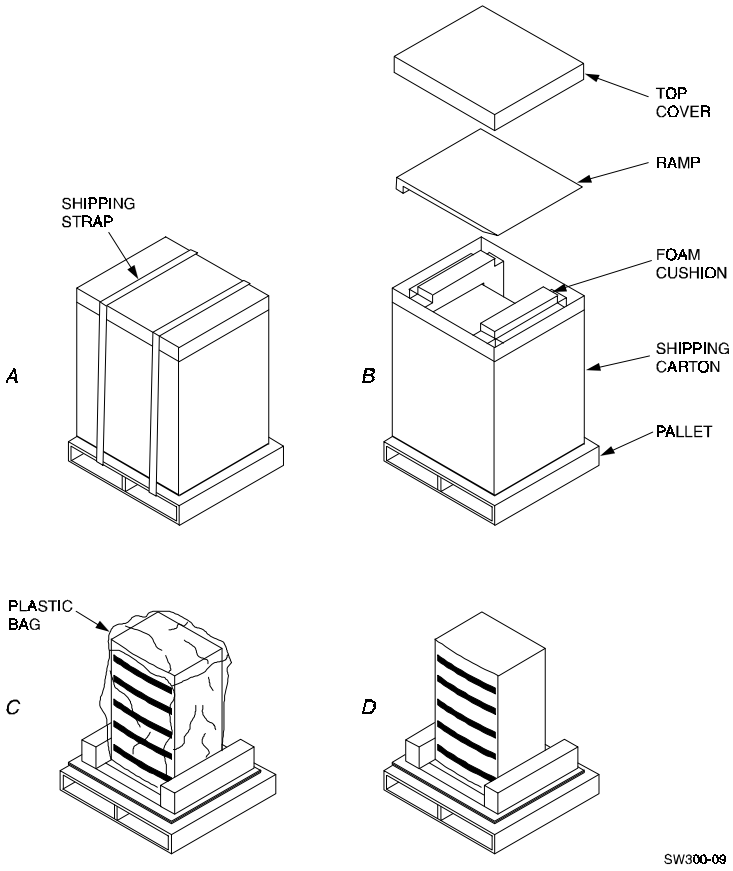
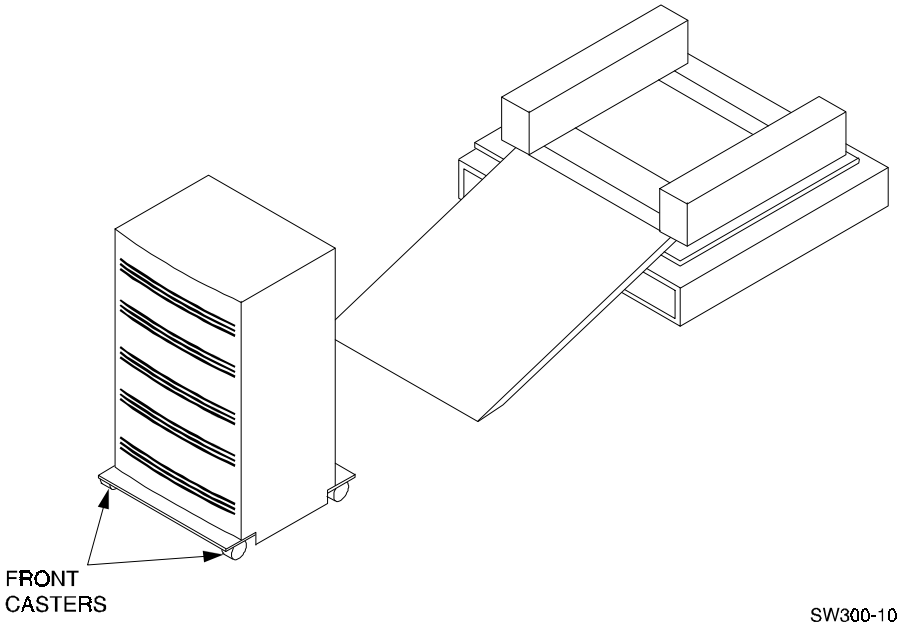


Figure 1–3 Installation of Ramp on Shipping Pallet



3. Grasping the sheet metal base assembly, carefully lift the rear of the RAID Array 410 enclosure over the "hump" in the center of the pallet and then roll the RAID Array 410 enclosure off the pallet and down the ramp to the floor. If any further lifting of the RAID Array 410 is required, grasp the sheet metal base assembly on the side and lift it carefully.
4. Retain the shipping container and all packing materials.

1.4 Placing the RAID Array 410 Enclosure

Use the following procedure to move the enclosure to its designated site:

WARNING

To prevent damage to the RAID Array and injury to personnel, make sure to provide a clear path for the casters.

1. Roll the enclosure to the desired location.
2. If required, engage the lock on each front caster to prevent the enclosure from moving.

1.5 Installing the SWXRC-04 Controller and Write-Back Cache Module

Unlock the enclosure, if necessary, using the keys provided. If the SWXRC-04 RAID Array controller and the write-back cache module have not been installed in your StorageWorks enclosure, you should install them at this time. Do so by referring to *Chapter 3, Installing the Storage Subsystem,* in the *SWXRC RAID Array Controller User's Guide* (EK-SMCS1-UG), included with the subsystem.

If your system is to be configured for dual-redundant controller operation, install the second controller and associated components at this time . Refer to *Chapter 3, Installing the Storage Subsystem,* in the *SWXRC RAID Array Controller User's Guide* (EK-SMCS1-UG).

NOTE

Review the information contained in any Release Notes included with the system. The Release Notes contain version-specific information, including controller configuration notes. Retain the Release Notes for future reference.

1.6 Installing the PC (Program) Card in the Controller

CAUTIONS

Follow these precautions and PC (program) card handling guidelines when installing or replacing the card. Install the (PC) program card in the SWXRC-04 RAID controller *after* the controller has been installed in a properly grounded SWXSC-AA cabinet. Otherwise, damage to the card may result.

The PC (program) card electrostatic discharge (ESD) shield must remain installed over the card during controller operation to protect it from electrostatic discharge that may cause the contents of the card to be damaged.

Follow these electrostatic discharge (ESD) precautions when handling the PC (program) card.

- Keep the PC (program) card in its original carrying case unless installing it.
- Do not twist or bend the card.
- Do not touch the contacts.
- Keep out of direct sunlight.
- DO NOT immerse the card in water or chemicals.
- Always push the eject button to remove the card (see Figure 1–4).
- A properly worn and attached ESD strap is required for installation and removal of the card.

1.6.1 PC (Program) Card Handling Precautions

- Obtain and attach an ESD wrist strap to your wrist. Make sure the strap fits snugly on your wrist.
- Plug (or clip) the other end to your cabinet's grounding stud (or other chassis grounding point).
- Remain grounded while working with the PC (program) card.
- Remove the ESD connection from the cabinet ground stud or other chassis grounding point.
- Remove the ESD wrist strap from your wrist.

1.6.2 Installing PC (Program) Card in Controller

Refer to Figure 1–4 for the location of the PC (program) card slot, the eject button, and the Operator Control Panel (OCP) LEDs on the controller.

For clarity, the ESD shield is not shown in the illustration. The ESD shield attaches to the controller and covers the exposed edge of the PC (program) card and the PC (program) card eject button.

Use the following procedure to install the PC (program) card:

1. Unsnap and remove the ESD shield covering the PC (program) card opening. The ESD shield covers the card opening and the card eject button. The ESD shield is secured to the controller with two “push/pull” fasteners. To remove the ESD shield, gently pull both fastener shafts outward, approximately one-eighth inch and remove the ESD shield.

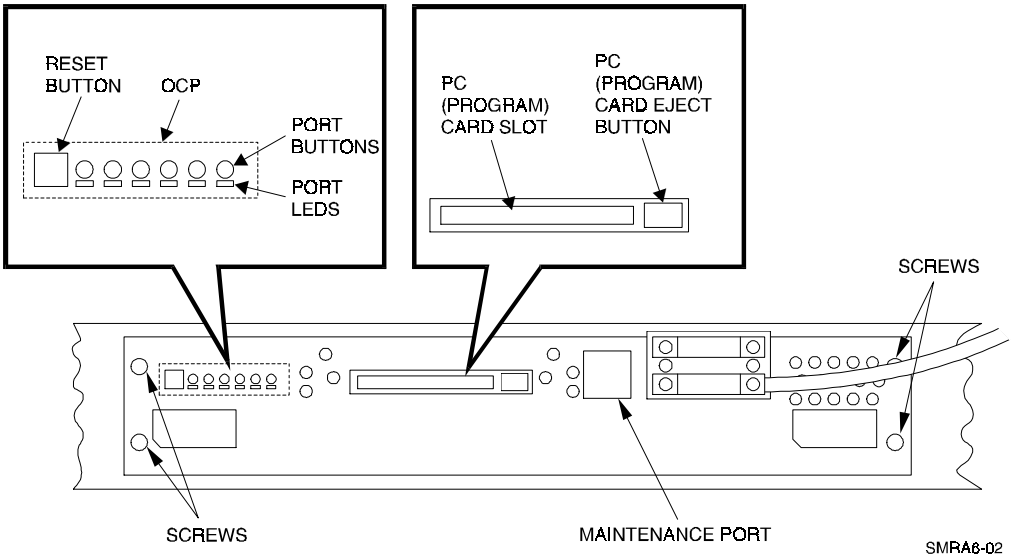
2. While holding the controller RESET depressed, insert the PC (program) card (label side up). The card eject button extends when the card is fully inserted.

NOTE

Keep the RESET button depressed while inserting the card to minimize the possibility of transients damaging the card contents and also to ensure that the controller reinitializes when the button is released.

3. Replace the ESD shield over the PC (program) card. To do so, first ensure the ESD shield fastener shafts are extended outward, away from the contact surface of the ESD shield. Place the ESD shield over the PC card and eject button and insert the ESD shield fastener clasps in their mounting holes on the controller chassis. Then, gently push the fastener shafts inward, approximately one-eighth inch, to engage the fastener clasps.

Figure 1–4 PC (Program) Card Slot Location



1.7 Connecting the Controller to Computer

Follow the steps below to connect the RAID Array 410 controller to a communications (serial) port on your Alpha-based system.

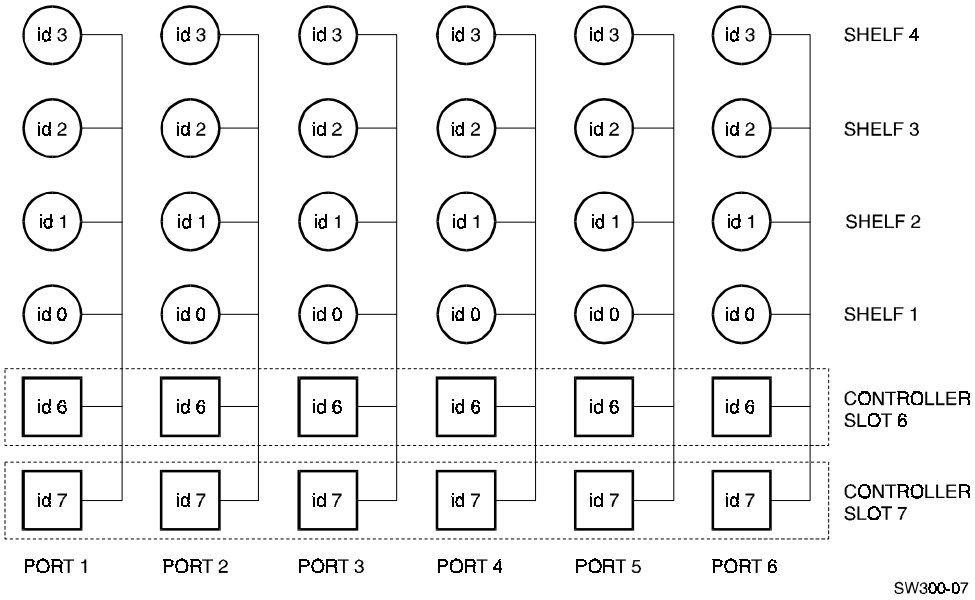
1. Locate the connecting cable that came with the RAID subsystem. It has an RJ12 connector (similar to some telephone plugs) on one end and a 9-pin serial connector on the other end.
2. Plug the RJ12 connector into the maintenance port on the RAID Array 410 controller (see Figure 1–4).
3. Plug the serial connector into an available 9-pin serial port on your Alpha-based system. If your system does not have a 9-pin serial port, use the 9-pin to 25-pin adapter supplied with your StorageWorks RAID Array 410 Subsystem. The 9-pin to 25-pin adapter includes the offset to center coupler (p/n: 12-43346-01) and the short cable for the offset (p/n: 17-03511-04). Note which serial port you use, because you will need that information when using the RAID 410 Manager program to set the communications parameters.

1.8 Installing Additional Disk SBBs in the StorageWorks Enclosure

You may install additional disk SBBs in the StorageWorks enclosure at this time. To improve performance and reliability, we recommend that you install additional SBBs in the StorageWorks enclosure from left to right, bottom to top (as viewed facing the front of the enclosure). Doing so improves reliability by permitting you to create RAIDsets that span more than one controller channel. Also, because more than one channel (bus) is being used, throughput is improved.

To install an SBB, hold it in both hands, insert it into the guide slots, and firmly push it into the shelf until the mounting tabs snap in place. Installing the SBBs in this sequence distributes the SBBs among the SCSI ports of the RAID Array 410. Figure 1–5 shows a layout of the SCSI bus ports and corresponding SCSI ID assignments in the enclosure. Refer to *Chapter 3, Configuration Rules and Restrictions*, in the *SWXSC-AA Office Expansion RAID Enclosure User Guide* (EK-SMCPD-UG), included with your system.

Figure 1–5 StorageWorks SCSI Bus Port and SCSI ID Assignment



1.9 Charging the RAID Array Controller Write-back Cache Batteries

The Write-back Cache Module contains batteries that may have discharged since the time the controller was factory-installed. If you place the controller into operation and attempt to initiate RAID commands when the battery charge is low, performance may be degraded. For more information on this subject, refer to the manual, *SWXRC RAID Array Controller User's Guide* (EK-SMCS1-UG).

We recommend that you wait until the batteries are *fully* charged before placing the RAID Array into operation.

We suggest you take this opportunity now to recharge the batteries. This is accomplished by doing the following:

1. Install the power cable by routing the power cable through the cable access holes at the bottom of the enclosure. Connect the female end of the power cable to the StorageWorks enclosure's AC Power Entry Controller, located in the lower portion of the enclosure (see Figure 1–6).
2. Connect the other end of the power cable into a 110/220 VAC line voltage source (the power supply automatically senses the voltage level and will work with either voltage).

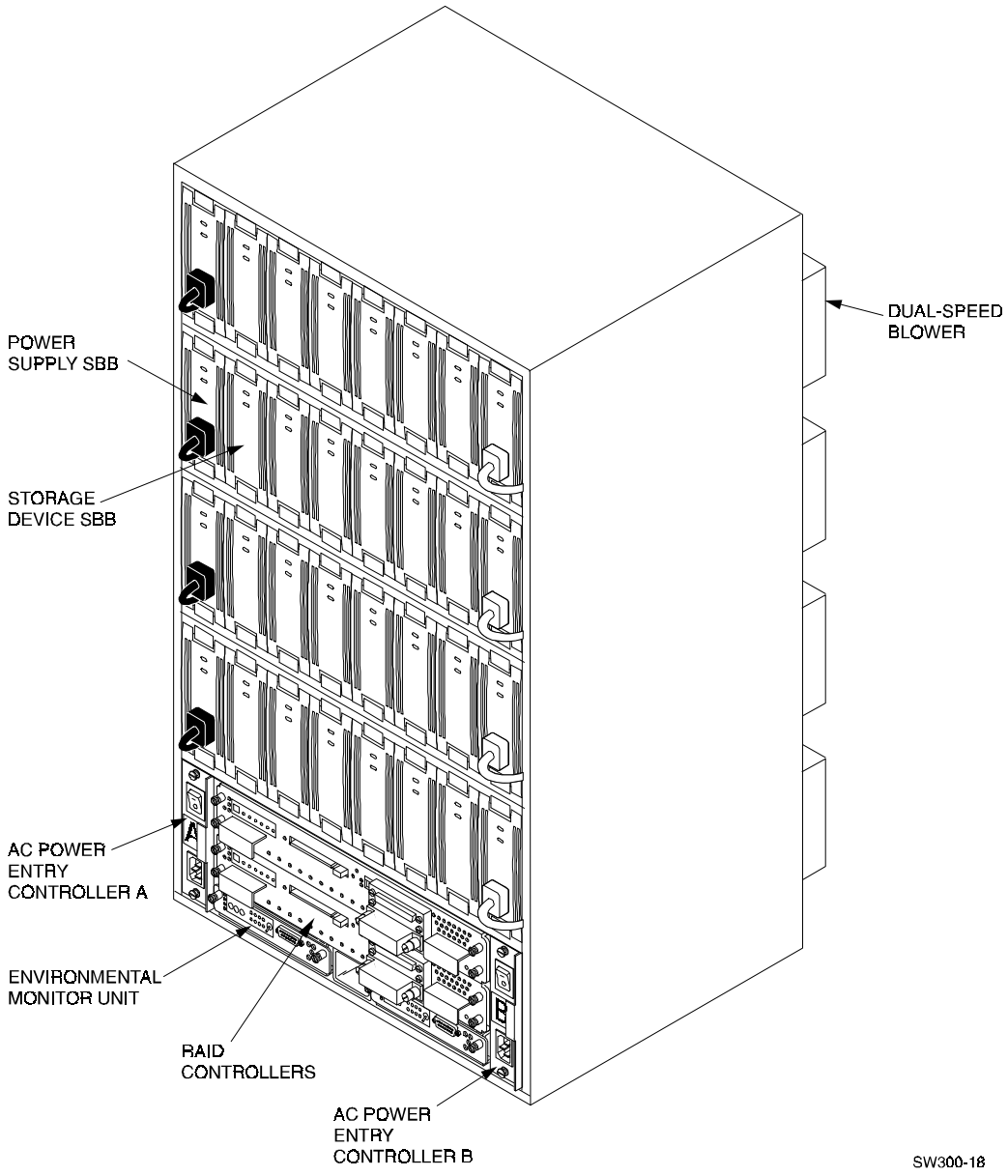
3. Apply power to the controller, by using the power switch on the AC Power Entry Controller. You should hear a momentary audible tone (beep), and see the indicator LEDs illuminate. In addition, the controller reset button (see Figure 1–4) contains a green LED, which should flash at approximately 1 Hz. For additional information, refer to the *SWXRC RAID Array Controller User's Guide* (EK-SMCS1-UG) and the *SWXSC-AA Office Expansion RAID Enclosure User's Guide* (EK-SMCPD-UG), included with these systems.

   Power on the RAID Controller. The batteries should be fully recharged within six hours.

> **NOTE**
>
> As an alternative to waiting six hours, you may proceed now with the installation and getting started steps described in subsequent chapters of this manual. Then, when you perform the steps described in *Chapter 2, Creating an Initial Controller Configuration,* you will be able to check the status of the batteries. This is described in *Section 2.3 Show Initial Configuration.* If the battery status shows "*good*," you may then continue, and create your configuration.

If the batteries do not show "good" status after six hours of charging, the jumper plug on the SWXRC-04 cache module should be checked to be sure it is in the unjumpered position. That is, the jumper plug should be installed only over one contact (to store the plug for possible future use). More information regarding the location of this jumper and its proper position can be found in the manual, *SWXRC RAID Array Controller User's Guide;* see *Chapter 9, Removing and Replacing Field Replaceable Units*.

Figure 1–6 SWXSC-AA Components (Cabinet removed for clarity)



2

Creating an Initial Controller Configuration

This chapter contains instructions for creating an initial configuration for your RAID Array Controller. It also briefly describes the CLI (Command Line Interpreter) and how to access it. The configuration steps include verifying the default configuration, adding drives, creating and initializing RAIDsets, stripesets, mirrorsets, and striped mirrorsets, declaring the storagesets as units to the host, and verifying and recording your final configuration.

2.1 What is the CLI?

The Command Line Interpreter (CLI) is the user interface to the RAID Array Controller. Using a connection between the controller's maintenance port and a maintenance terminal, the CLI can be used to view and modify the controller's configuration. The CLI can also be used to access reports and diagnostic tools. This chapter specifies the CLI commands required to create an initial configuration for the controller.

See "*Command Line Interpreter*" in the *SWXRC-04 RAID Array Controller User's Guide* for detailed descriptions of all CLI commands.

NOTE

The Maintenance Terminal can be any VT100 compatible terminal or terminal emulator. E.g.: PC with a terminal emulation program, such as the Microsoft Windows Terminal program.

You can also use most commercially-available communications programs, DEC VT100 or compatible terminal. On UNIX systems, 'tip' or 'cu' (see man pages) can be used as terminal emulation program.

2.2 Accessing the CLI

Access the CLI using a maintenance terminal. In our example, we describe the use of a PC with a terminal emulation program being used as a maintenance terminal.

2.2.1 Connect the Maintenance Terminal to the Controller

Follow the steps below to connect the controller to a serial port on a PC.

1. Locate the connecting cable that came with the RAID subsystem. It has an RJ12 connector on one end and a 9-pin serial D-type connector on the other end.
2. Plug the RJ12 connector into the receptacle on the controller.

3. Plug the serial connector into an available 9-pin serial port on the PC. If your PC does not have a 9-pin serial port, use the 9-pin to 25-pin adapter supplied with your StorageWorks RAID Array 410 Subsystem. Note which serial port you use, since you will need that information in the communications program.

2.2.2 Start the Communications Program

1. Start the communications program on your PC.
2. Set the communications program to use the serial port that is connected to the controller.
3. Set the communications parameters to:
   - 9600 baud
   - 8 bits
   - 1 stop bit
   - No parity

2.2.3 Establish the Connection with the Controller

From your communication program, issue a connect command to establish a connection with the controller, and then press the Enter key. You should see the CLI prompt, which looks similar to

```
SWXRC>
```

2.3 Show Initial Configuration

The RAID Array 410 Subsystem is pre-configured with the controller at SCSI target ID 0 and a single-drive logical unit D0.

Enter the following command to verify the controller's parameters:

```
SWXRC> SHOW THIS_CONTROLLER FULL
```

The controller responds with a display similar to the following:

```
CONTROLLER:
      SWXRC-04 CX44332211 FIRMWARE V27Z-0, HARDWARE A02
      SCSI ADDRESS 7
      TIME: NOT SET
HOST PORT:
      SCSI TARGET(S) (0)
CACHE:
      32 MEGABYTE WRITE CACHE, VERSION 2
      CACHE IS GOOD
      BATTERY IS GOOD
      NO UNFLUSHED DATA IN CACHE
      CACHE_FLUSH_TIMER = DEFAULT (10 SECONDS)
      CACHE_POLICY=A
      HOST FUNCTIONALITY MODE=A
LICENSING INFORMATION:
      RAID (RAID OPTION) IS ENABLED, LICENSE KEY IS VALID
      WBCA (WRITEBACK CACHE OPTION) IS ENABLED, LICENSE KEY IS VALID
      MIRR (DISK MIRRORING OPTION) IS ENABLED, LICENSE KEY IS VALID
EXTENDED INFORMATION:
      TERMINAL SPEED 9600 BAUD,EIGHT BIT,NO PARITY,1 STOP BIT
      OPERATION CONTROL:0000004 SECURITY STATE CODE:85780
      CONFIGURATION BACKUP DISABLED
```

NOTE

Refer to *Chapter 4, Working with RAID Array 410 in Digital UNIX*, in this guide for additional information regarding controller parameters and settings.

Examine the display to verify the following information. If you need to make changes, do so as described below.

> **NOTE**
>
> If you do make changes, you must restart/reboot the controller to cause the changed settings on the controller to take effect. Do so by using the *RESTART THIS*_CONTROLLER command, as described below.

SCSI ADDRESS 7

This SCSI Address is the controller's SCSI ID that will be used by the controller on all the device-side ports. This ID is hard-wired and is determined by the controller physical location in the controller shelf. This ID can not be set by the CLI. This ID is either 7 or 6 depending upon the controller's physical location in the controller shelf. This ID is *not* the SCSI ID that will be used on the host-side SCSI bus that connects the controller to the KZPSA.

Controller SCSI target number is recommended to be set to 0

This is the host-side SCSI target ID used to communicate with the host SCSI adapter. Be sure no other device on the SCSI bus is assigned SCSI target number 0. If the controller SCSI target number is not 0, use the following command to set its SCSI target ID:

```
SWXRC> SET THIS_CONTROLLER ID=0
```

Cache condition should be GOOD

If the Cache condition is BAD, call your sales person for unit service or replacement of the Cache module.

Battery condition should be GOOD

If the battery condition is LOW, allow the battery to charge with the subsystem power on for up to 6 hours. The battery must be fully charged to protect the data in the Write Back Cache. If the battery condition is still LOW after 6 hours of charging, then call your sales person for unit service or replacement of the batteries.

> **NOTE**
>
> The subsystem may be configured with the battery condition LOW, however the Write Back Cache cannot be initialized.

CACHE_POLICY should be A

```
SWXRC> SET THIS_CONTROLLER CACHE_POLICY=A
```

Host function mode must be set to A for Digital UNIX

```
SWXRC> SET THIS_CONTROLLER HOST_FUNCTION=A
```

License key should be VALID

If the License key is INVALID, enter the following:

```
SWXRC> RUN FLS
```

and follow the menu driven program to enable the license. You will need the WRITE-BACK CACHE, RAID5, and MIRROR License Key page that is provided in the subsystem documentation package.

Configuration backup can be enabled or disabled
Configuration backup will keep the RAID Array controller configuration stored on disk. For detailed information regarding configuration backup, see the *SWXRC-04 RAID Array Controller User's Guide.*

To cause the changed settings on the controller to take effect, restart the controller by:

```
SWXRC> RESTART THIS_CONTROLLER
```

2.4 Dual–Redundant Controller Configuration

An optional second controller and cache can be added to the RAID Array on the same host SCSI bus. This is called a dual-redundant controller configuration.
Dual redundant controllers offer automatic, intelligent fail-over of attached storage devices in the event of a controller failure.

In a dual-redundant configuration, one terminal sets both controller configurations. Installation procedures for the second controller can be found in the *SWXRC-04 RAID Controller User's Guide*. After installation of both controllers, use the CLI to define the controllers' parameters in the following order from a terminal connected to one controller:

Check the cache and battery conditions of the other controller using the following command:

```
SWXRC> SHOW OTHER_CONTROLLER FULL
```

- Cache condition should be GOOD
- Battery condition should be GOOD

Set the SCSI target number of the other controller different as the first controller:

```
SWXRC> SET OTHER_CONTROLLER ID=1
```

NOTE

Up to 24 devices can be supported by the RAID Array 410 controller, the controller or dual redundant controller pair can represent up to 4 target ID's on the Host SCSI-bus.

You can increase the number of addressable units by setting the controller to respond to up to 4 target ID's, as long as those IDs are not used by any other device on the host bus. For example,

```
SET THIS_CONTROLLER ID=(0,1,2,3)
```

would set the controller to respond to any of the four IDs. If you set the controller to more than one ID, you must enclose the numbers with parentheses and separate them with commas.

Balance the load on both controllers by setting one controller to respond to a subset of the controller target IDs. The other controller will respond to the remaining IDs. If either controller should fail, the remaining controller will respond to all target IDs set for the controllers.

```
SWXRC> SET THIS_CONTROLLER PREFERRED_ID=0
```

Enter the following command to copy parameters to the other controller; that is, the controller not connected to the terminal.

```
SWXRC> SET FAILOVER COPY=THIS_CONTROLLER
```

```
SWXRC> RESTART OTHER_CONTROLLER
```

```
SWXRC> RESTART THIS CONTROLLER
```

Enter the following commands to verify the preceding parameters were set:

```
SWXRC> SHOW THIS_CONTROLLER FULL
```

```
SWXRC> SHOW OTHER_CONTROLLER FULL
```

NOTE

In the examples we assume having two controllers in a dual-redundant configuration, with the following settings.
SET THIS_CONTROLLER ID=(0,2)
SET OTHER_CONTROLLER ID=(1,3)
SET THIS_CONTROLLER PREFERRED_ID=(0,2)
would set the controller pair to respond to any of the four possible SCSI-IDs. Where one controller will respond to ID 0 and 2 and the other to 1 and 3.

2.5 Remove Default Logical Unit

The subsystem was configured at the factory with a single drive (DISK100) as logical unit D0 available to the host. This configuration probably does not match the needs of your site, so you should remove the logical unit. Use the following CLI command to do so:

```
SWXRC> DELETE D0
```

NOTE

The last character in the command is a zero, not the letter “oh”.

2.6 Add Disks to the Configuration

The CONFIG utility locates and adds disks to the controller configuration. Run the CONFIG utility whenever you add new disks to the controller. Enter the following command to start the configuration utility:

```
SWXRC> RUN CONFIG
```

The controller responds with a display similar to that shown below.

In the example, the controller has located 17 new disks. Note that CONFIG did not list DISK100 because the controller was already aware of that disk. The 3 digit number associated with each disk corresponds to Bus Number, Target Number, and Logical Unit Number (LUN). The LUN is always 0. DISK400, in this example, corresponds to the disk located on Bus 4, controller Target 0, and LUN 0. DISK510 corresponds to the disk located on Bus 5, controller Target 1, and LUN 0.

The disk numbers will correspond to the disk locations for your subsystem.

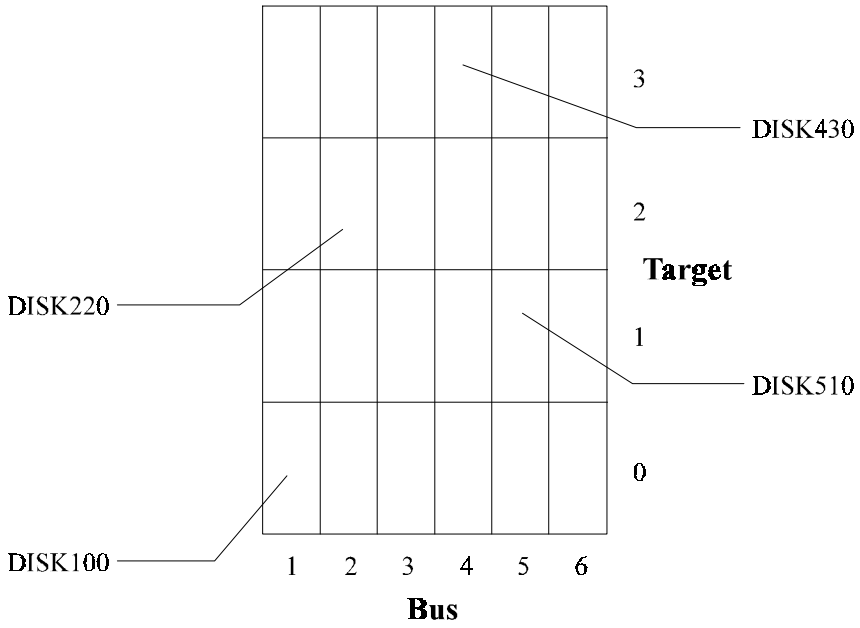
```
Config Local Program Invoked

Config is building its tables and determining what devices exist on the subsys-
tem. Please be patient.

add disk110 1 1 0
add disk120 1 2 0
add disk200 2 0 0
add disk210 2 1 0
add disk220 2 2 0
add disk300 3 0 0
add disk310 3 1 0
add disk320 3 2 0
add disk400 4 0 0
add disk410 4 1 0
add disk420 4 2 0
add disk500 5 0 0
add disk510 5 1 0
add disk520 5 2 0
add disk600 6 0 0
add disk610 6 1 0
add disk620 6 2 0

Config – Normal Termination
```

Figure 2–1 Bus and Target Mapping



Throughout this document, the following references apply:

- Stripeset refers to RAID 0
- Mirrorset refers to RAID 1
- Striped Mirrorset refers to RAID 0+1
- RAIDset refers to RAID 5

2.7 Create a RAIDset

If your site requires RAIDsets for storage, you must assign disks to each RAIDset. RAIDsets must have at least three members, and can have as many as fourteen. This example creates two 3-member RAIDsets using the ADD RAIDSET command.

```
SWXRC> ADD RAIDSET RAIDS1 DISK100 DISK200 DISK300

SWXRC> ADD RAIDSET RAIDS2 DISK400 DISK500 DISK600
```

In this example, “RAIDS1” and “RAIDS2” are the names of the RAIDsets, and they are followed by a list of disks to be included in each RAIDset. The names of the RAIDsets are user-defined. Performance of your RAIDsets will be optimized if each RAIDset includes disks from different buses as shown in Figure 3-1.The two examples above both contain disks from three different buses.

2.7.1 Initialize the RAIDset

You must initialize RAIDsets before you can put them into service.

When you initialize a RAIDset, you must specify a chunksize. A chunksize is the number of blocks of data that is transferred at one time. By using the default chunksize, the controller will select a chunksize that works well for most site requirements.

```
SWXRC> INITIALIZE RAIDS1 CHUNKSIZE=DEFAULT

SWXRC> INITIALIZE RAIDS2 CHUNKSIZE=DEFAULT
```

NOTE

Valid chunksizes are 16–682 blocks. You should use a larger chunksize for applications that make a lot of I/O requests. Use a smaller chunksize for applications that make relatively few I/O requests but need to move large amounts of data with each request.

2.7.2 Add the RAIDset as a Logical Unit

To make a RAIDset available to the host computer, you must add it as a host logical unit with a unique unit number. The unit number is a one or three digit number preceded by "D", such as "D0" or "D102". The unit number consists of the controller's target ID and the Logical Unit (LUN) of the RAIDset behind the target. Each target ID can have up to eight LUNs, numbered 0–7.

- Units identified with controller target ID 0 have a single digit number which corresponds to the LUN number. For example, D5 would be target 0, LUN 5.
- Units identified with all other controller targets (1–7) use a 3 digit number. The first digit corresponds to the controller target number, the second digit is always 0 and the third digit is the LUN number. For example, D205 would be target 2, LUN 5.

Identify the RAIDsets as host logical units by using the ADD UNIT command.

```
SWXRC> ADD UNIT D0 RAIDS1

SWXRC> ADD UNIT D1 RAIDS2
```

This example creates LUNs 0 and 1 behind controller target ID 0 (specified earlier with the SET THIS_CONTROLLER command).

2.7.3 Set Writeback Cache

The final step in creating a RAIDset is to enable the writeback cache. A single CLI command enables that feature for each RAIDset:

```
SWXRC> SET D0 WRITEBACK_CACHE

SWXRC> SET D1 WRITEBACK_CACHE
```

Where D0 and D1 represent the host logical units of the RAIDsets created above.

2.8 Create a stripeset

If your site requires stripesets for storage, you must assign disks to each stripeset. Stripesets must have at least two members, and can have as many as fourteen. This example creates a three-member stripeset using the ADD STRIPESET command.

```
SWXRC> ADD STRIPESET STRIPE1 DISK110 DISK210 DISK310
```

In this example, "STRIPE1" is the name of the stripeset, and it is followed by a list of the disks to be included in the stripeset. The names of the stripesets are user-defined. Performance of your stripesets will be optimized if each stripeset includes disks from different buses as shown in Figure 3-1. The example above contains disks from different buses.

2.8.1 Initialize the Stripeset

You must initialize stripesets before you can put them into service.

When you initialize a stripeset, you must specify a chunksize. The chunksize is the number of blocks of data that are transferred at one time. By using the default chunksize, the controller will select a chunksize that works well for most site requirements.

```
SWXRC> INITIALIZE STRIPE1 CHUNKSIZE=DEFAULT
```

NOTE

Valid chunksizes are 16 – 32768 blocks. You should use a larger chunksize for applications that make a lot of I/O requests. Use a smaller chunksize for applications that make relatively few I/O requests, but need to move large amounts of data with each request.

2.8.2 Add the Stripeset as a Logical Unit

To make a stripeset available to the host computer, you must add it as a host logical unit with a unique unit number.

The unit number is a one or three digit number preceded by "D", such as "D0" or "D102". The unit number is comprised of the controller's target ID and the Logical Unit (LUN) of the stripeset behind the target.

Each target ID can have up to eight LUNs, numbered 0–7.

- Units identified with controller target ID 0 have a single digit number which corresponds to the LUN number. For example, D5 would be target 0, LUN 5.
- Units identified with all other controller targets (1–7) use a 3 digit number. The first digit corresponds to the controller target number, the second digit is always 0 and the third digit is the LUN number. For example, D205 would be target 2, LUN 5.

Identify the stripesets as host logical units by using the ADD UNIT command.

```
SWXRC> ADD UNIT D100 STRIPE1
```

This example creates LUN 0 behind controller target ID 1 (specified earlier with the SET THIS_CONTROLLER command).

2.8.3 Set Writeback Cache

The final step in creating a stripeset is to enable the writeback cache. A single CLI command enables that feature for the entire stripeset:

```
SWXRC> SET D100 WRITEBACK_CACHE
```

Where D100 represents the host logical unit of the stripeset created above.

2.9 Create a Mirrorset

If your site requires mirrorsets for storage, you must assign disks to each mirrorset. Mirrorsets must have at least two members, and can have as many as six. This example creates a two-member mirrorset using the ADD MIRRORSET command.

```
SWXRC> ADD MIRRORSET MIRROR1 DISK120 DISK220
```

In this example, "MIRROR1" is the name of the mirrorset, and it is followed by a list of the disks to be included in the mirrorset. The names of the mirrorsets are user-defined. Performance of your mirrorsets will be optimized if each mirrorset includes disks from different buses as shown in Figure 3-1. The example above contains disks from two different buses.

2.9.1 Initialize the Mirrorset

You must initialize a mirrorset before you can put it into service.

```
SWXRC> INITIALIZE MIRROR1
```

2.9.2 Add the Mirrorset as a Logical Unit

To make a mirrorset available to the host computer, you must add it as a host logical unit with a unique unit number. The unit number is a one or three digit number preceded by "D", such as "D0" or "D102". The unit number is made of the controller's target ID and the Logical Unit (LUN) of the mirrorset behind the target.

Each target ID can have up to eight LUNs, numbered 0–7.

- Units identified with controller target ID 0 have a single digit number which corresponds to the LUN number. For example, D5 would be target 0, LUN 5.
- Units identified with all other controller targets (1–7) use a 3 digit number. The first digit corresponds to the controller target number, the second digit is always 0 and the third digit is the LUN number. For example, D205 would be target 2, LUN 5.

Identify the mirrorsets as host logical units by using the ADD UNIT command.

```
SWXRC> ADD UNIT D200 MIRROR1
```

This example uses the controller target ID of 2 and LUN 0.

2.9.3 Set Writeback Cache

The final step in creating the mirrorset is to enable the writeback cache. A single CLI command enables that feature for the entire mirrorset:

```
SWXRC> SET D200 WRITEBACK_CACHE
```

Where D200 represents the host logical unit of the mirrorset created above.

2.10 Create a Striped Mirrorset

If your site requires striped mirrorsets for storage, you must assign disks to mirrorsets and then assign the mirrorsets to a stripeset.

2.10.1 Create the Mirrorsets

Mirrorsets must have at least two members, and can have as many as six. This example creates 2, two-member mirrorsets using the ADD MIRRORSET command.

```
SWXRC> ADD MIRRORSET MIRROR3 DISK320 DISK420

SWXRC> ADD MIRRORSET MIRROR4 DISK520 DISK620
```

In this example, “MIRROR3” and “MIRROR4” are the names of the mirrorsets, and they are followed by a list of the disks to be included in each mirrorset.

2.10.2 Create a Stripeset from the Mirrorsets

Striped mirrorsets must have at least two members, and can have as many as fourteen. This example creates a two-member stripeset using the ADD stripeset command.

```
SWXRC> ADD STRIPESET MIRSTR1 MIRROR3 MIRROR4
```

In this example, “MIRSTR1” is the name of the striped mirrorset, and it is followed by a list of mirrorsets to include in the stripeset. The name of the stripeset is user-defined. Performance of your striped mirrorset will be optimized if each mirrorset includes disks from different buses.

2.10.3 Initialize the Striped Mirrorset

You must initialize the striped mirrorset before you can put it into service.

When you initialize a stripeset, you must specify a chunksize. The chunksize is the number of blocks of data that are transferred at one time. By using the default chunksize, the controller will select a chunksize that works well for most site requirements.

```
SWXRC> INITIALIZE MIRSTR1 CHUNKSIZE=DEFAULT
```

NOTE

Valid chunksizes are 16–32768 blocks. You should use a larger chunksize for applications that make a large number of I/O requests. Use a smaller chunksize for applications that make relatively few I/O requests, but need to move large amounts of data with each request.

2.10.4 Add the Striped Mirrorset as a Logical Unit

To make a striped mirrorset available to the host computer, you must add it as a host logical unit with a unique unit number. The unit number is a one or three digit number preceded by “D”, such as “D0” or “D102”. The unit number is made of the controller’s target ID and the Logical Unit (LUN) of the striped mirrorset behind the target.

Each target ID can have up to eight LUNs, numbered 0–7.

- Units identified with controller target ID 0 have a single digit number which corresponds to the LUN number. For example, D5 would be target 0, LUN 5.
- Units identified with all other controller targets (1–7) use a 3 digit number. The first digit corresponds to the controller target number, the second digit is always 0 and the third digit is the LUN number. For example, D205 would be target 2, LUN 5.

Identify the striped mirrorset as a host logical unit by using the ADD UNIT command.

```
SWXRC> ADD UNIT D300 MIRSTR1
```

Where 300 represents the host logical unit of the striped mirror set created above.

2.10.5 Set Writeback Cache

The final step in creating the mirrorset is to enable the writeback cache. A single CLI command enables that feature for the entire striped mirrorset:

```
SWXRC> SET D300 WRITEBACK_CACHE
```

Where D300 represents the host logical unit of the striped mirrorset described above.

2.11 Add Individual Disks as Logical Units

Before you can put an individual disk into service, it must be initialized:

```
SWXRC> INITIALIZE DISK410
```

```
SWXRC> INITIALIZE DISK510
```

If you require individual Disks to be available to the host as Logical Units, you must now identify the Disks as host logical units by using the ADD UNIT command.

```
SWXRC> ADD UNIT D2 DISK410
```

```
SWXRC> ADD UNIT D3 DISK510
```

In this example, disks DISK410 and DISK510 were identified to the host as units D2 (Target 0, LUN 2) and D3 (Target 0, LUN 3) respectively.

2.12 Create a Spareset

If a disk in a RAIDset or mirrorset goes bad, the controller will replace it with a disk from the Spareset, if one exists. If the Spareset is empty, a RAIDset will run “reduced,” and you should replace the disabled disk as soon as possible. For maximum availability, you should keep at least one drive in the spareset.

The Spareset always exists in the controller configuration, even if there are no drives assigned to it. Assign drives to the Spareset with the ADD SPARESET command.

```
SWXRC> ADD SPARESET DISK610
```

In this example, DISK610 is assigned to the Spareset.

2.13 Verify and Record Your Configuration

> **NOTE**
>
> Your configuration may be saved on disk using the SAVE CONFIGURATION or the RESTORE INITIAL CONFIGURATION commands. These commands are described in the Release Notes included with this product.

You have now completed all the steps required to create an initial configuration on your controller. In the following steps, verify and record your configuration for future reference. Additional worksheets are provided in Appendix B for recording changes to the configuration.

First, verify the Logical Units you have configured:

```
SWXRC> SHOW UNITS
```

The controller responds with a display similar to that shown below:

```
LUN                              Uses
-----------------------------------------
D0                               RAIDS1
D1                               RAIDS2
D2                               DISK410
D3                               DISK510
D100                             STRIPE1
D200                             MIRROR1
D300                             MIRSTR1
```

Record the information in the following table:

Date_____	
LUN	Uses

Next, verify the storagesets you have configured:

```
SWXRC> SHOW STORAGESETS
```

The controller responds with a display similar to that shown below:

```
Name              Storageset    Uses            Used by
------------------------------------------------------------------
MIRSTR1           stripeset     MIRROR3         D300
                                MIRROR4
STRIPE1           stripeset     DISK110         D100
                                DISK210
                                DISK310
MIRROR1           mirrorset     DISK120         D200
                                DISK220
MIRROR3           mirrorset     DISK320         MIRSTR1
                                DISK420
MIRROR4           mirrorset     DISK520         MIRSTR1
                                DISK620
RAIDS1            raidset       DISK100         D0
                                DISK200
                                DISK300
RAIDS2            raidset       DISK400         D1
                                DISK500
                                DISK600
SPARESET          spareset      DISK610
FAILEDSET         failedset
```

Record the information in the following table. In the event of a controller failure, the information that you recorded here will assist you in reconstruction of the storagesets on your RAID Array 410.

Date_____

Name	Storageset	Uses	Used By

Single-device units and devices that have not been added to units are not shown in this report. To display these devices, enter the following:

```
SWXRC> SHOW DEVICES
```

The controller responds with a display similar to that shown below:

```
Name       Type    Port Targ Lun            Used by
-------------------------------------------------------------
-
DISK100    disk     1    0    0             RAIDS1
DISK110    disk     1    1    0             STRIPE1
DISK120    disk     1    2    0             MIRROR1
DISK200    disk     2    0    0             RAIDS1
DISK210    disk     2    1    0             STRIPE1
DISK220    disk     2    2    0             MIRROR1
DISK300    disk     3    0    0             RAIDS1
DISK310    disk     3    1    0             STRIPE1
DISK320    disk     3    2    0             MIRROR3
DISK400    disk     4    0    0             RAIDS2
DISK410    disk     4    1    0             D2
DISK420    disk     4    2    0             MIRROR3
DISK500    disk     5    0    0             RAIDS2
DISK510    disk     5    1    0             D3
DISK520    disk     5    2    0             MIRROR4
DISK600    disk     6    0    0             RAIDS2
DISK610    disk     6    1    0             SPARESET
DISK620    disk     6    2    0             MIRROR4
```

Record the information in the following table:

Date_____

Name	Type	Port Targ LUN	Used By

3

Connecting to the RAID Array 410 Hardware

In preparing your array for first time use, you need to connect your AlphaServer and RAID Array 410 subsystem through the host adapter board. This chapter, along with your Alpha system and the associated StorageWorks RAID Array 410 Subsystem manuals, provides instructions for preparing and installing the host adapter and the subsystem enclosure.

3.1 Installing the KZPSA, Digital PCI to SCSI Adapter

The PCI to SCSI-2 host adapter (KZPSA) is a PCI to FAST SCSI-2, 16-bit differential host adapter. You connect your computer to the StorageWorks Raid Array 410 Subsystem through the host adapter and a connection cable.

You need the following to begin:

- The PCI SCSI-2 host adapter board (use precautions to protect the board from static discharge)
- Your computer system hardware manual
- Appropriate tools to service your computer
- The BN21K-03 SCSI cable, three meters long, with a right angle high density 68-pin connector on one end and a straight high density 68-pin connector on the other.

Refer to your system manual and the *KZPSA PCI-to-SCSI Storage Adapter User's Guide* for physical installation of the adapter board into your computer system.

3.1.1 Preparing to Install the Host Adapter

Before performing the installation of the host adapter into your Alpha system, take precautions to protect the board from electrostatic discharge. Then perform the following steps.

CAUTION

To protect the board from static discharge wear an electrostatic discharge (ESD) wrist strap. Do not remove the board from the anti-static protective cover until instructed to do so in the following procedures.

- Perform system backups of your operating system filesystems.
- Shutdown your computer system.

```
# shutdown -h now
```

3.2 Installing the KZPSA adapter

This procedure describes how to install the KZPSA adapter and how to verify the correct installation and revisions for correct functioning of the RAID Array 410 for Digital UNIX.

Use the following steps to install the adapter hardware and SCSI connection.

- When your systems is halted (in the '>>>' console prompt), power down your system and install the KZPSA adapter as described in the *KZPSA's Users Guide*, which comes with the adapter.
- Connect the KZPSA to the RAID Array 410, with the straight connector attached to the KZPSA.
- Set the boot sequence to "interactive" using the following console command:

```
>>> set boot_osflags I
```

3.2.1 Verifying the KZPSA is installed correctly.

To verify if the KZPSA is installed correctly, power up your system without booting the operating system. (Stay in the >>>, console prompt).

NOTES

The SRM and ARC console firmware revisions are noted in the KZPSA release notes and depend on the type of Alpha system. The revision of the KZPSA must be rev. A09 or higher. The verification examples are taken from an AlphaServer 1000; the contents can vary depending on the Alpha system you have.

The KZPSA in this system example is adapter PKC0 set to SCSI-ID=7, hardware rev. L01, and firmware Rev. A09. (6 units created.) dkc0 refers to D0, dkc1 to D1, dkc2 to D2, dkc3 to D3, dkc100 to D100, dkc200 to D200, and dkc300 to D300).

- Verify the KZPSA adapter is correctly installed, the connection with the RAID Array 410 is correct, and all created units are seen as devices in console mode. The following will also show the revision levels of the attached devices.

  Use the following command to verify this.

```
>>> show device
```

The response will be similar to the following; only the lines regarding KZPSA are listed:

```
                              .
dkc0.0.0.11.0          DKC0                SWXRC-04  V27Z
dkc1.0.0.11.0          DKC1                SWXRC-04  V27Z
dkc100.1.0.11.0        DKC100              SWXRC-04  V27Z
dkc2.0.0.11.0          DKC2                SWXRC-04  V27Z
dkc200.2.0.11.0        DKC200              SWXRC-04  V27Z
dkc3.0.0.11.0          DKC3                SWXRC-04  V27Z
dkc300.3.0.11.0        DKC300              SWXRC-04  V27Z
                              .
pkc0.7.0.11.0          PKC0           SCSI Bus ID 7   L01  A09
```

- Review the release notes, which are supplied with KZPSA adapter, to check if your Alpha system console firmware (SRM and ARC) are at the correct revision level to support the KZPSA.

  If the console revision level is too low, call your sales person for unit service to upgrade the console firmware to the required level.

  Use the following procedure to verify the installation and console revision level.

  ```
  >>>show config
  ```

A response, similar as following, will be shown:

```
Firmware
SRM Console:      V3.0-12
ARC Console:      4.26
PALcode:    VMS PALcode X5.48-101, OSF PALcode X1.35-66
Serial Rom: V1.1

Processor
DECchip (tm) 21064-2

MEMORY
   96 Meg of System Memory
   Bank 0 = 64 Mbytes(16 MB Per Simm) Starting at 0x00000000
   Bank 1 = 32 Mbytes(8 MB Per Simm) Starting at 0x04000000
   Bank 2 = No Memory Detected
   Bank 3 = No Memory Detected


PCI Bus
   Bus 00  Slot 06: NCR   810 Scsi Controller
                         pka0.7.0.6.0          SCSI Bus ID 7
                         dka0.0.0.6.0           RZ28
                         dka100.1.0.6.0         RZ26
                         dka200.2.0.6.0         RZ29B
                         dka400.4.0.6.0         RRD43

   Bus 00  Slot 07: Intel   8275EB PCI to Eisa Bridge


   Bus 00  Slot 11: Digital KZPSA
                         pkc0.7.0.11.0         SCSI Bus ID 7
                         dkc0.0.0.11.0          SWXRC-04
                         dkc1.0.0.11.0          SWXRC-04
                         dkc100.1.0.11.0        SWXRC-04
                         dkc2.0.0.11.0          SWXRC-04
                         dkc200.2.0.11.0        SWXRC-04
                         dkc3.0.0.11.0          SWXRC-04
                         dkc300.3.0.11.0        SWXRC-04
```

3.2.2 Boot your system with the *genvmunix* kernel

After the previous sections were completed successfully, you may boot the operating system using the *genvmunix* kernel. This is a requirement to configure the adapter and devices into the kernel.

NOTE

If you use *genvmunix* after the initial installation of UNIX, you are going to create a configuration file that will be based upon the current devices that are seen. However, if any customization to the existing configuration file has been performed, these changes will be lost. For these situations, the user should first save the existing configuration file; then, after the *genvmunix* has completed, any customized changes in the old configuration file must be put into the new configuration file. This must be accomplished before building the kernel.

Boot the operating system, using a boot command similar to the following:

```
>>> boot -file /genvmunix dka0
```

This assumes that ‘dka0’ is the boot (holding /genvmunix) device.

When your system has booted the Digital UNIX operating system and is running the ‘genvmunix’ kernel in single or multi-user mode, with /, /usr and /var mounted, you are able to finish the installation by continuing with Chapter 4.

4

Working with RAID Array 410 in Digital UNIX

This Chapter describes how to access the storage units on your RAID Array 410 storage subsystem from your Digital UNIX host computer. It includes a description of concepts and terms that you need to know, a discussion on device naming, instructions for loading the StorageWorks RAID utilities and instructions for creating device special files in Digital UNIX plus tips on some helpful utilities.

NOTE

Digital UNIX was formerly called DEC OSF/1. The term “Digital UNIX” is used throughout this Chapter.

You must perform all configuration set up and parameter definitions, and run all utilities from a maintenance terminal or a terminal emulator connected to your controller's terminal port. As an alternative, you can use the HSZterm utility, although it is not covered in this Chapter. See the *StorageWorks HSZ40 Array Controller Utility for Digital UNIX, System Manager's Guide for HSZterm*. The utility and documentation are on Digital UNIX Consolidated software distribution CD-ROM.

4.1 Basic Configuration Steps

Once you have completed the initial setup and configuration of your RAID Array 410 subsystem, you will be able to use RAIDsets and other storage containers much like single disks, including using them as boot devices (see Section 4.5 in this chapter). The initial configuration steps that you must follow are:

1. Locate the devices in the RAID Array 410 with the CONFIG command (see Chapter 2).
2. Create storagesets (containers) from the devices (see Chapter 2).
3. Initialize the containers (see Chapter 2).
4. Make the containers available to the host with the ADD UNIT command (see Chapter 2).
5. Connect the RAID Array 410 to the KZPSA (see Chapter 3).
6. Run the *setld* utility to install the StorageWorks RAID Array installation utilities. (A sample of the installation script appears in Appendix A of this guide).

   Device special files are explained later (see Section 4.2.2 in this chapter). Before proceeding, make sure that you are familiar with the terminology in the next section so that you can fully understand the discussions that follow.
7. Create device special files (Section 4.2.4 in this chapter).
8. Create disklabels and partitions on the containers (see Section 4.4.1, Step 3).
9. Create filesystems on the previously created partitions (see Section 4.4.2).

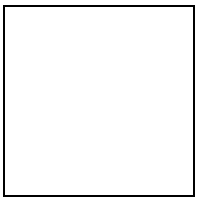
4.1.1 Words and Concepts That You Need to Know

You will be better able to work with your RAID Array 410 subsystem if you keep one concept in mind:

The RAID Array 410 controllers in the subsystem are active on several SCSI buses.

The controllers communicate with the Digital UNIX host computer on the Host SCSI bus and communicate with the devices in the RAID Array 410 on six device SCSI buses. In other words, the controllers are targets on the host SCSI bus and initiators on the device SCSI buses.

Figure 4–1 Block diagram of storage connections in RAID Array 410 subsystem



The following terms appear in the block diagram and throughout this chapter:

- **Host SCSI Bus** – The SCSI bus that connects the host adapter to the RAID Array 410 controller. This is sometimes called the “front end” SCSI bus or the “host-side” bus.
- **Device SCSI Bus** – The six SCSI buses that connect the RAID Array 410 controller to the SCSI–2 devices. These are sometimes called the “back end” SCSI buses or the “device-side” buses. These buses are also referred to as device ports and are numbered 1 to 6. The device buses are built into the backplane in your RAID Array 410 cabinet; there are no device bus cables.
- **Controller SCSI IDs** – Each controller is assigned SCSI IDs on both the host bus and all device buses.

  Host SCSI Bus – On the host SCSI bus, a RAID Array 410 controller can be assigned from one to four target IDs. The controller can present up to eight units through each target ID. The ability to respond to four target IDs instead of just one allows the controller to present more units to the host computer. A controller with four host-side target IDs can present up to 32 units.

Target IDs must be in the range of 0–7, but they must not conflict with any other devices on the host SCSI bus, such as the host's KZPSA SCSI adapter itself. (The host's adapter is usually set to ID 7.) Dual-redundant controllers are assigned the same target IDs so that if one controller fails the other can continue to respond to the same addresses.

The controller's host-side target IDs are set using the controller's Command Line Interpreter (CLI). The CLI is accessed using a maintenance terminal connected to the port on the front bezel of the controller.

Device SCSI Buses – The RAID Array 410 controller occupies one SCSI ID on each device bus (port). The device-side ID is determined by the slot in which the controller is installed. In a single controller configuration, the controller should be in the bottom slot and is SCSI ID 7 on all device buses. In a dual-redundant controller configuration, the bottom controller is SCSI ID 7 and the top controller is ID 6.

- **Controller Storage Container** – A single- or multiple-device storageset. A single disk can be a container; all stripesets, mirrorsets, and RAIDsets are containers.
- **Controller Unit** – "Unit" is the controller term for a storage container that is available for use by the Digital UNIX host. Until a storage container is made into a unit with the ADD UNIT command, it is not available to the host.
- **Digital UNIX Disk Device** – (As used in reference to a RAID Array 410 controller subsystem.) "Disk device" is the Digital UNIX term for a controller unit. You must create device special files to associate the controller units with Digital UNIX disk device names.
- **LUN and Logical LUN** – The term LUN refers to two different entities in an RAID Array 410 controller environment, the host-side LUN and the device-side LUN.

  Host-side LUN – The host-side Logical Unit Number is used by the host operating system to uniquely identify a container.

  Device-side LUN – In current HSOF firmware, this LUN is always 0. The device-side target ID and the port number are the only entities that are currently used by the RAID Array 410 controller to uniquely identify a device on the device-side SCSI Bus.

4.2 Installing the StorageWorks RAID Array Installation Utility for Digital UNIX

The installation of the StorageWorks RAID Array Utility for Digital UNIX takes less than one hour to complete. The installation procedures included in this chapter will get the utility loaded onto your system and prepare Digital UNIX to run the utility and interact with the StorageWorks RAID Array subsystem.
You must perform each of the procedures specified in the following to complete the installation and configuration:

- Run the *setld* install utility to install the RAID utility (A sample of the installation script appears in Appendix A of this guide.).
- Prepare LUNs for access by the Digital UNIX filesystem.

4.2.1 Running the *setld* Install Utility

Before running the *setld* install utility, do the following:

- Have your system booted with the '/genvmunix' kernel.
- Load the distribution diskette into your floppy drive.
- The distribution diskette has been created as a *tar* image diskette.

Extract the subsets from the *tar* diskette using *tar*:

```
# cd /tmp

# tar xpf /dev/rfd0c
```

To install the subset package from the Bourne shell (*sh*) root account, type:

```
# setld -l /tmp SWRAID100
```

where: */tmp* is the name of the directory where you extracted the *tar* diskette to.

Installing the package performs the following tasks. The tasks do not need your intervention.

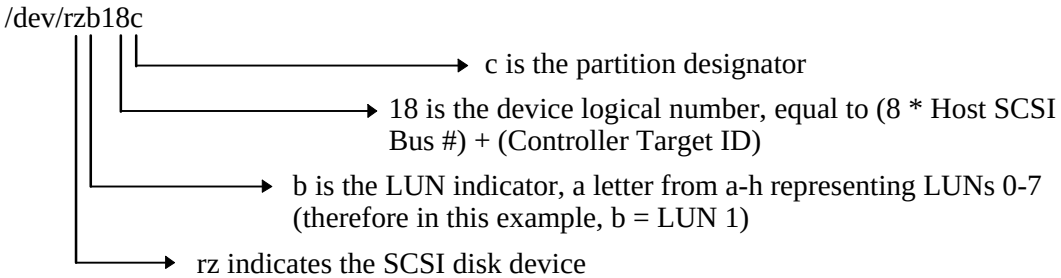
- Checks for the necessary file system space (1MB)
- Displays copyright information
- Checks the current revision of your Digital UNIX operating system and will, according to this, install/update specific files or utilities
- Checks if you have the /genvmunix kernel booted (which is required to detect all connected hardware)
- Installs your StorageWorks RAID Array Installation Utility for Digital UNIX
- Creates symbolic links for new installed utilities and boot device support
- Creates device special files using the MAKEDEV.hsz script
- Updates the system config files
- Prompts you just before the kernel rebuild starts

4.2.2 Device special files

Digital UNIX does not strictly enforce one format for naming device special files; however, the format below is recommended.[1]

- *rzxnny* for block mode device special files, example:

  Block device: /dev/rzb18c
  where the components of rzb18c, an example of a device name, are as follows:



[1] Some Digital UNIX utilities, such as *iostat*, and certain startup procedures, do not recognize this device naming format, and recognize only LUN-0 devices; e.g., rz18c.

- *rrzxnny* for character device special files, example:

  Character device: /dev/rrzb18c
  where the components of rrzb18c, an example of a device name, are as follows:

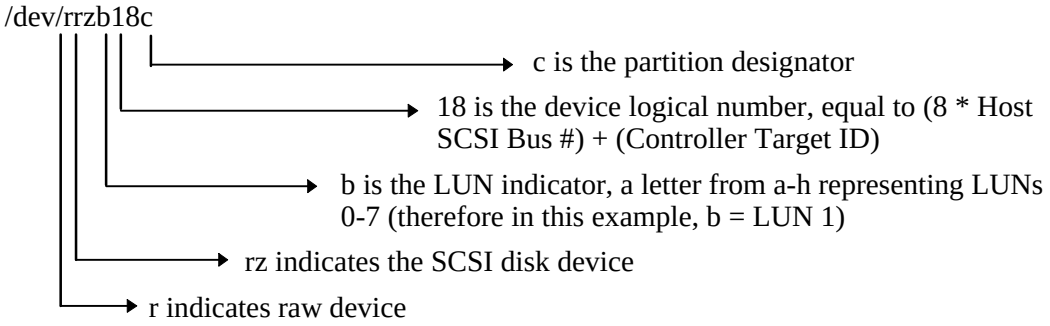
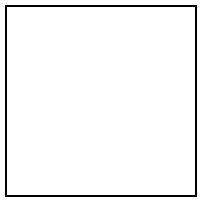


Figure 4-2 is a sample configuration of a single unit in a storage subsystem.

Figure 4-2 Device naming example



The sample configuration has the following characteristics:

- Host SCSI Bus = 2
- Controller Target ID = 2
- Storage Container = LUN 1
- Unit number = D201
- host partition letter c (not shown)

Using these values to derive the device name looks like this:

"rz" + LUN letter + ((8 * Host SCSI Bus #) + (Controller Target ID)) + partition letter

or

"rz" + b + ((8 * 2) + (2)) + c

or

rzb18c

The equivalent character mode device name would be:

rrzb18c

The preceding naming scheme is used throughout this chapter. However, be aware that Digital UNIX device naming schemes do not have to follow this format. This particular naming scheme was chosen to avoid conflicts with the Digital UNIX default SCSI device naming conventions.

4.2.3 Creating Character Device Special Files

Before a storage container (unit) can be accessed by the host, you must create character device special files and block mode device special files to associate a Digital UNIX device name with the controller storage unit. All eight possible partitions of a Digital UNIX disk device must have special files.

The Device Special files must be located in the */dev* directory on the Digital UNIX host operating system. The following information must be known to create the device special files for a RAID Array 410 unit:

- Host SCSI bus number
- Target ID of the controller
- LUN of the controller unit

4.2.4 Creating Device Special Files

Digital UNIX contains a utility that can make all of the device special files for any single unit in a storage subsystem. It creates block and character files for all eight partitions of the unit. Each device special file references the major and minor number of a specific partition. You may use one of the following methods:

- The StorageWorks RAID utilities subset contains a simple utility which scans the available SCSI buses and will create RAID Array 410 special device file entries.

  To perform this task, type:

  ```
  # cd /dev
  # ./MAKEDEV.hsz
  ```

This will scan the buses and create device special files as needed. The following is an example output:

```
#./MAKEDEV.hsz
Scanning buses, please be patient.................done.
rza8 @ bus1, D100 on DEC SWXRC-04 V27Z
MAKEDEV: special file(s) for rza8:

rzb8 @ bus1, D101 on DEC SWXRC-04 V27Z
MAKEDEV: special file(s) for rzb8:

rza9 @ bus1, D100 on DEC SWXRC-04 V27Z
MAKEDEV: special file(s) for rza9:

rzc9 @ bus1, D102 on DEC SWXRC-04 V27Z
MAKEDEV: special file(s) for rzc9:

Done
```

- Determine the device name as described earlier in this chapter. You do not need to add the partition letter at the end of the device name.

  As an example, this creates special device file entries for rzb18 (explained earlier):

  ```
  # cd /dev
  # ./MAKEDEV rzb18
  ```

In this example, the utility creates block mode files rzb18a through rzb18h and character files rrzb18a through rrzb18h. You have to repeat this step for each RAID Array 410 unit you have created.

4.3 Kernel Information Files Updates

For full support of the RAID Array 410 with Digital UNIX operating system, the following kernel information files are updated by the *SWRAID100, RAID Array Utility*:

- Device parameter file
  The file which makes device names and sets their functionality to the operating system has to be updated for the RAID Array 410 controller.
- Kernel configuration file
  This file needs to be updated to make the KZPSA known to the kernel and add the device entries to the kernel so it will recognize the devices at boot time.

> **NOTE**
>
> In this chapter, we reference the RAID Array 410 subsystem controller as SWXRC-04. The device we create will have an identical geometry as the device created for the HSZ40.

4.3.1 Updating the Device Parameter File

For making use of the full functionality of the RAID Array 410, an entry is added into the device data files during the installation process. The Digital UNIX will then recognize the RAID Array 410 SCSI inquiry string (SWXRC-04) and will present the RAID Array 410 to the applications as a HSZ40 device.

4.3.2 Kernel Configuration File Entries for RAID Array 410 Units

You can access RAID Array 410 storage units using the standard SCSI-CAM driver without making entries in the configuration file. However, to see the units from the startup procedure, and to make the output of the *iostat* utility easier to read, you must create entries for the units. (See the manual pages on Digital UNIX for reference, *man* SCSI, *man* rz and *man* raid.)

Entries for RAID Array 410 units in the configuration file have the following format:

device disk *name* at scsi*z* drive *number*

Where:

- *z* in the entry "at scsiz" is the host SCSI bus number
- *name* is in the format rz*nn.* The *nn* is calculated as:

  (8 * z) + (SWXRC-04 Target ID)
- *number* is unique drive number for each controller unit and is calculated as:

  (64 * z) + (8 * SWXRC-04 Target ID) + controller unit LUN

  You only need to calculate the drive number of the first controller unit LUN (as determined in the above formula). You can then add 1 for each subsequent LUN.

> **NOTE**
>
> The configuration file name format is not the same as the format for device special files. You must use the *rznn* format in your configuration file, and it is recommended that you use the *rzxnny* format for device special files. The different names do not conflict since they are used by different pieces of the operating system.

As an example, the configuration file for the controller unit numbers D00 to D07 on host-side SCSI bus # 2 are constructed as follows:

- *name* = (8 * 2) + 0 = 16
- *first unit number* = (64 * 2) + (8 * 0) + 0 = 128

Assuming scsi2 is at pza0, the entries in the Digital UNIX configuration file could be:

```
bus             pza0      at pci0    slot  11  vector pzaintr
controller      scsi2     at pza0    slot  0
device disk     rz16      at scsi2   drive     128
device disk     rz16      at scsi2   drive     129
device disk     rz16      at scsi2   drive     130
device disk     rz16      at scsi2   drive     131
device disk     rz16      at scsi2   drive     132
device disk     rz16      at scsi2   drive     133
device disk     rz16      at scsi2   drive     134
device disk     rz16      at scsi2   drive     135
```

4.4 Preparing LUNs for Access by Digital UNIX Filesystem

DIGITAL UNIX treats a RAID Array 410 LUN much like a SCSI disk; therefore, to prepare your factory default configured LUN for access by the DIGITAL UNIX filesystem, you must do the following:

- Create the partitions on the LUN using *disklabel*.
- Create a filesystem on the LUN.
- Mount the filesystem to be able to access it.

4.4.1 Creating the Partitions on a LUN Using *disklabel*

You create the partitions on a LUN by issuing a *disklabel* command. The *disklabel* command partitions the LUN for access by the DIGITAL UNIX operating system. Digital UNIX defines only partitions a, b, c, and g for the RAID Array 410 controller. In addition, refer to the *rz* and *disktab man* pages for more information about the *disklabel* utility.

To create the read/write partitions on a LUN using the default partition sizes, enter the following:

```
# disklabel -rw device HSZ40
```

HSZ40 defines this LUN as attached to the RAID Array 410 array controller. Always use the device label HSZ40 , regardless of what drive types make up the LUN.

device is the character device name as defined in Section 4.2.2.

For example, to create partitions on block device, rza16, enter:

```
# disklabel -rw rza16 HSZ40
```

To view a LUN partition, enter:

```
# disklabel -r device
```

An example output of reading a disklabel is show below. Note that some partitions overlap each other.

```
# disklabel -r rza8
# /dev/rrza8a:
type: SCSI
disk: HSZ40
label:
flags: dynamic_geometry
bytes/sector: 512
sectors/track: 85
tracks/cylinder: 16
sectors/cylinder: 1360
cylinders: 12085
sectors/unit: 16435880
rpm: 3600
interleave: 1
trackskew: 0
cylinderskew: 0
headswitch: 0           # milliseconds
track-to-track seek: 0  # milliseconds
drivedata: 0

8 partitions:
#         size   offset   fstype   [fsize    bsize   cpg]
 a      131072        0   unused     1024     8192         #  (Cyl.     0 - 96*)
 b      262144   131072   unused     1024     8192         #  (Cyl.    96*- 289*)
 c    16435880        0   4.2BSD     1024     8192    16   #  (Cyl.     0 - 12085*)
 d           0        0   unused     1024     8192         #  (Cyl.     0 - -1)
 e           0        0   unused     1024     8192         #  (Cyl.     0 - -1)
 f           0        0   unused     1024     8192         #  (Cyl.     0 - -1)
 g    16042664   393216   unused     1024     8192         #  (Cyl.   289*- 12085*)
 h           0        0   unused     1024     8192         #  (Cyl.     0 - -1)
```

4.4.2 Creating a Filesystem on a LUN

NOTE

The *newfs* command is given here as an example. For Advanced File System (ADVFS) and for making devices available for Logical Storage Manager (LSM), similar types of commands exist. For additional information, please consult the related documentation.

Use the *newfs* command to create a UFS filesystem on a LUN the same way that you would create a filesystem on a disk device by entering the following:

```
# newfs devicepartition
```

partition is the letter representing the partition, a, b, c, or g on which you want to create a filesystem (usually c for the whole drive).

device is the character device name as defined in Section 4.2.2.

For example, to create a UFS filesystem on partition c of character device rrza16, enter the following:

```
# newfs /dev/rrza16c
```

This creates a UFS-filesystem on LUN 0 of this subsystem at SCSI-bus address 2, target ID 0 on the C partition (whole disk-device).

4.4.3 Mounting the Filesystem

To access the LUN, mount it as a device filesystem to a mount point. For example:

```
# mount /dev/rza16c /mnt
```

To view the mounted filesystem, enter: **df**

The LUN is now accessible to the filesystem just as a disk device would be. The filesystem can not see the RAID functionality and number of physical devices attached to the RAID Array 410 controller. This device appears as a single LUN or "disk" to the user as viewed by the filesystem.

4.5 Controller-Attached Disks as Digital UNIX Initialization (boot) Devices

The RAID Array 410 units that are visible to the host as LUN 0 can be used as system boot devices. After the unit has been created from the controller CLI, install the Digital UNIX operating system on the unit.

Units at LUN 0 have a 0 (zero) as the last digit in the unit number. Examples of LUN 0 units are: D000 or D0 , D100 , D200, and so forth. So, D102 can not be used as boot device.

4.6 DECsafe Available Server Environment (ASE)

RAID Array 410 disk devices can be used with the DECsafe Available Server Environment (ASE) for Digital UNIX provided a valid host configuration (including host adapters) is used to support them. Refer to the *Digital UNIX ASE Installation and User's Guide, Software Product Description (SPD: 44.17.xx)* for further information. Refer to the release notes for supported host adapters and Digital UNIX version levels for ASE.

4.7 Using *genvmunix*

If you use *genvmunix* to initialize the system and *doconfig* to build a new configuration file, the new configuration file will only list the RAID Array 410 LUN 0 units; nonzero LUNs will not appear in the new configuration file.

Before rebuilding a configuration file using *genvmunix*, save any existing customized configuration file that has entries for RAID Array 410 units. After rebuilding the configuration file, add the entries from the saved configuration file to the new configuration file.

4.8 RAID Array 410 Units and Digital UNIX Utilities

This section contains notes on the interactions of some Digital UNIX utilities with storage units in your RAID Array 410 subsystem.

4.8.1 *File*

You can use the Digital UNIX *file* utility to determine if a controller unit can be accessed from the host.

The unit that you want to test must already have a character mode device special file and the correct disk label.

The following example uses the RAID Array 410 unit D101. Run the file command and specify the character mode device special file, such as:

```
# /usr/bin/file /dev/rrzb17a
```

The device activity indicator (green light) will illuminate on the device if the information is not in cache. If the unit is a multi-device container, only one of the devices from that container will illuminate. The Digital UNIX operating system should display something like the following output after the command is entered:

```
/dev/rrzb17a character special (8/33856) SCSI #2 HSZ40 disk #146 (SCSI ID #1)
```

- 8 is the major number
- 33856 represents the minor number
- 2 is the SCSI host-side bus number
- 146 is the drive number as listed in the Configuration File
- 1 is the controller target ID

If the only output that is returned from the file command is the major and minor number, then either the device is not answering or the device special file does not have the correct minor number. Check the minor number to be sure that it matches the host SCSI bus number, the controller target ID, and the LUN of controller unit.

If an error occurs regarding the disk label, there is good probability that the device can be accessed. This error can usually be fixed by creating the disk label with the Digital UNIX *disklabel* utility.

> **NOTE**
>
> For major and minor number calculations see the reference pages on *Digital UNIX, man SCSI.*

4.8.2 Reading from the device, *dd*

Check the created device using *dd* on the 'raw' device to see if there is a full communication path between devices and Digital UNIX; for example:

```
# dd if=/dev/rrzb17a of=/dev/null
```

This will read the full disk-device until you hit ^*c* or the device has been read. If the test is successful, the device activity LED (green) on the device lights. If the device consists of multiple disks, all these will be lit.

4.8.3 *scu*

You can use the *SCSI CAM Utility (scu)* program to see which RAID Array 410 units are available to the Digital UNIX operating system. It is located in the /sbin directory and documented in the REF Pages.

The *scu* command, *scan edt*, polls all devices on the host-side SCSI buses. This allows you to show what devices are available from all host-side SCSI buses. The device special files do not have to exist for *scu* to see the devices. Example: scan SCSI bus 2, where your Raid Array 410 is connected:

```
# /sbin/scu scan edt bus 2
# /sbin/scu show edt bus 2

 CAM Equipment Device Table (EDT) Information:

 Bus: 2, Target: 1, Lun: 0, Device Type: Direct Access
 Bus: 2, Target: 1, Lun: 1, Device Type: Direct Access
 Bus: 2, Target: 1, Lun: 2, Device Type: Direct Access
 Bus: 2, Target: 1, Lun: 3, Device Type: Direct Access
```

For detailed information about one of the unit's, you may use:

```
# /sbin/scu show device bus 2 target 1 lun 0
```

The preceding command line gives you the SCSI inquiry of the selected device.

RAID Array 410 units appear like any other SCSI device. All four entries for Bus 2 Target 1 in the example display are RAID Array 410 units. The last entry would be for unit D103 on host SCSI bus 2.

4.8.4 *iostat*

You can use the *iostat* utility to view performance statistics on RAID Array 410 storage units. (Set your terminal screen to 132 columns before running *iostat*.)

The output from *iostat* shows the number of devices (LUNs) that have been defined in the configuration file. It is much easier to interpret the output if the configuration file contains entries for all eight devices. If the configuration file does not contain entries for all devices, the *iostat* output has fewer columns and it is difficult to correlate each column with a specific device.

The *iostat* utility only recognizes device names in the format rznn where nn is calculated as:

(8 * Host SCSI Bus #) + (SWXRC-04 Target ID)

(This is the same formula and format that is used for the configuration file.)

Invoke the *iostat* utility using the following format:

```
iostat rznn s t
```

Where:

- *rznn* is the device name
- The *s* is optional and denotes the amount of time, in seconds, between screen updates
- The *t* is optional and denotes the total number of screen updates

The output from *iostat* shows all devices that have device name rznn. The information for LUN 0 is in the first column, the information for LUN 1 is in the second column, and so forth.

```
# iostat rz16 5 4

 rz16     rz16     rz16     rz16     rz16     rz16     rz16     rz16
bps tps  bps tps  bps tps  bps tps  bps tps  bps tps  bps tps  bps tps
 0   0    0   0    0   0    0   0    0   0    0   0    0   0  126   3
 0   0    0   0    0   0    0   0    0   0    0   0    0   0 1618  34
 0   0    0   0    0   0    0   0    0   0    0   0    0   0 1639  34
 0   0    0   0    0   0    0   0    0   0    0   0    0   0 1610  34
```

The above display shows activity on all 8 LUNs attached to one SCSI-bus (2) one Target 0. The above list represents information on rza16, rzb16 ... rzh16. The device with activity is device rzh16.

A

setld Script Example

This Appendix provides an example of the script of the setld *install utility.*

Example script of the *setld* install utility.

```
# cd /tmp
# ls
.X11-unix
# tar xpf /dev/rfd0c
# ls
.X11-unix  SWRAID100  instctrl
# setld -l /tmp SWRAID100

Checking file system space required to install specified subsets:

File system space checked OK.

StorageWorks RAID Utilities
   Copying from /tmp (disk)
   Verifying

Configuring "StorageWorks RAID Utilities" (SWRAID100)

Configuring the system to run the StorageWorks RAID Array support V1.0.

This procedure will modify several system files and optionally
rebuild the kernel.

Modifying /sys/conf/OSF1KF

Creating special device files
Modifying sys/data/cam_data.c

This installation procedure can rebuild and move a kernel to /vmunix.
You may choose to skip this phase of the installation if you are
installing more than one subset which will require a kernel build.

If you choose to rebuild the kernel at this time, you will be
asked whether you want to edit the configuration file during
the rebuild procedure.  The default is no; select the default.

Remember you must build a kernel and reboot at some point to activate
the StorageWorks RAID Array support V1.0 software.


Build a kernel as part of this install? (y/n):  y
```

```
The rest of the procedure will take approximately 15 minutes to
rebuild your kernel, depending on your processor type.

Starting kernel rebuild...

*** KERNEL CONFIGURATION AND BUILD PROCEDURE ***

Saving /sys/conf/OSF1KF as /sys/conf/OSF1KF.bck

Do you want to edit the configuration file? (y/n) [n]:


*** PERFORMING KERNEL BUILD ***
        Working....Fri Jan 26 12:51:55 WET 1996
        Working....Fri Jan 26 12:53:55 WET 1996

The new kernel is /sys/OSF1KF/vmunix
Saving /vmunix as /vmunix.preSWRAID100
Moving /sys/OSF1KF/vmunix to /vmunix

#
```

B

Configuration Records – Blank Forms

This contains copies of the three tables used in Chapter 2 to record the configuration of your system. If additional copies are required, these tables can be reproduced as necessary.

Date__________________

LUN	Uses

Date_____

LUN	Uses

Date_____

Name	Storageset	Uses	Used By

Date_____

Name	Storageset	Uses	Used By

Date_____

Name	Type	Port Targ LUN	Used By

Date_____

Name	Type	Port Targ LUN	Used By

Reader's Comments

Manual Order Number:

_____

Digital is committed to providing the best possible products and services. Since our manuals are important components of our products, we value your comments, corrections, and suggestions for improvements. Please take a few minutes to fill out and return this form, attaching additional sheets, if needed. Thank you.

Manual Rating	**Excellent**	**Good**	**Fair**	**Poor**
Accuracy (correct presentation of facts)	[ ]	[ ]	[ ]	[ ]
Completeness (adequate information)	[ ]	[ ]	[ ]	[ ]
Clarity (easy to understand)	[ ]	[ ]	[ ]	[ ]
Organization (logical sequence of information)	[ ]	[ ]	[ ]	[ ]
Layout (easy to follow subject matter)	[ ]	[ ]	[ ]	[ ]
Indexing (easy to locate desired information)	[ ]	[ ]	[ ]	[ ]

Errors Noted *(please include page, paragraph, table or figure number)*

Most-Liked Features

Least-Liked Features

Suggestions for Improvement

Return Address:

Customer Research
Response Center
Attn: Nan Andrews Amish
Digital Equipment Corporation
334 South Street, SHR3-2/S27
Shrewsbury, MA 01545

Name Phone

Title

Company

Street Address

Mail Stop

City State ZIP

Country (if other than USA)