

POWER CHALLENGE™ and
CHALLENGE® XL Rackmount
Owner's Guide

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About This Guide

This document is designed to help you understand and operate your POWER CHALLENGE™/CHALLENGE® XL rackmount server system. The information contained in this document is organized as follows:

- Chapter 1 “The Challenge Rackmount Server” provides an overview of the basic system and its capabilities.
- Chapter 2 “Touring the Chassis” describes the system components and reviews all of the controls, indicators, and connectors.
- Chapter 3 “Getting Started” describes the connection of the hardware and provides the power-on and boot procedures.
- Chapter 4 “Installing and Using Optional Peripherals” supplies the information to install and configure various peripherals.
- Chapter 5 “Having Trouble?” describes some common problems and possible solutions. The operation of the system controller is also explained.
- Chapter 6 “Safety and Comfort” describes basic human factors guidelines for system operation.
- Appendix A “Hardware Specifications” lists physical and electrical specifications.
- Appendix B “Drive Maintenance” describes the procedures required to properly maintain your 1/4-inch, 4 mm DAT and 8 mm tape drives, as well as CD-ROM drives.
- Appendix C “System Controller Error Messages” lists all of the possible error messages.
- Appendix D “Challenge IO4 PROM” supplies information about the IO4 PROM monitor.
- Appendix E “VMEbus Implementation” provides guidelines to help select third-party VME boards for the system.

Index The index provides a listing and location of terms and concepts that are unique to this guide.

Start at the beginning to familiarize yourself with the features of your new system, or proceed directly to the information you need by using the table of contents as your guide.

Software-specific information is located in the software guides included with your Challenge rackmount server system:

- IRIX™ Advanced Site and Server Administration Guide
- IRIS® *Software Installation Guide*

Style Conventions

This guide uses the following conventions:

- References to other documents are in *italics*.
- Names of buttons are in *italics*.
- References to other chapters and sections within this guide are in quotation marks.
- Names of menu choices are in quotation marks.
- Nonprinting keys are in angle brackets and <**bold**>.

Compliance Information

FCC WARNING

This equipment has been tested and found compliant with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case users will be required to correct the interference at their own expense.

This product requires the use of external shielded cables in order to maintain compliance with Part 15 of the FCC rules.

International Special Committee on Radio Interference (CISPR)

This equipment has been tested to and is in compliance with the Class A limits per CISPR publication 22, Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment; and Japan's VCCI Class 1 limits.

Canadian Department of Communications Statement

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications.

Attention

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Figure In-1 VCCI Information



Figure In-2 CE insignia

This workstation conforms to several national and international specifications and European directives as listed on the “Manufacturer’s Declaration of Conformity,” which is included with each computer system and peripheral. The CE insignia displayed on each device is an indication of conformity to the European requirements.

Caution: Your workstation has several governmental and third-party approvals, licenses, and permits. Do not modify this product in any way that is not expressly approved by Silicon Graphics, Inc. If you do, you may lose these approvals and your governmental agency authority to operate this device.

The POWER Challenge and Challenge XL

The POWER Challenge and Challenge rackmount system (model CMN A010) is a high-performance server installed in a configurable rackmounted enclosure (Figure 1-1). Hereinafter, both these systems are referred to as the Challenge system, unless otherwise specified. This guide contains information about Challenge system hardware and software, as well as information about a base set of supported peripherals.

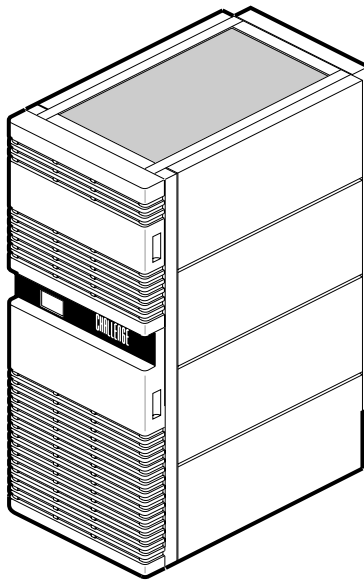


Figure 1-1 POWER Challenge and Challenge Rackmount Server

Features

The following is a list of the standard features of the Challenge rackmount server:

- The POWERpath-2 (Everest) board set, which
 - supports a maximum of 36 R4400™ processors in the Challenge system (on 9 IP19 CPU boards)
 - supports a maximum of 18 R8000® processors in the POWER Challenge system (on 9 IP21 CPU boards)
 - supports a maximum of 36 R10000™ processors in the Challenge 10000 or POWER Challenge 10000 (on 9 IP25 CPU boards)
 - can be configured with up to eight MC3 interleaved memory boards, each having a maximum of 2 GB of memory
 - can be configured with a maximum of five POWERChannel 2 (IO4) interface boards, providing multiple VMEbus, network, and peripheral interfaces
 - utilizes a 256-bit system data bus (Ebus)
 - utilizes a 40-bit system address bus (Ebus)
- Two separate cardcages, providing 15 Ebus slots, 6 VMEbus slots, and 3 Power board slots
- SCSI drive enclosure (SCSIBox), supporting 8 half-height SCSI devices or 4 full-height SCSI devices, which
 - has dual configurable SCSI channels, compatible with both 8- and 16-bit SCSI devices
- Standalone System Controller to monitor system status and to record error information in the event of a shutdown
- Microprocessor-controller cooling system for quieter, more efficient operation
- Modular power supplies (POWER modules) and power boards

Following is a list of available options:

- Third cardcage with 20 VMEbus slots
- Additional I/O and VMEbus interfaces

- Second SCSIBox 2 (identical to the standard box)
- Memory upgrade using 16 MB and 64 MB SIMMs
- CPU upgrades using additional microprocessor boards
- Additional POWERmodules and power boards
- A visualization console option providing a basic color graphics interface to the POWER Challenge system

Operational Overview

The Challenge rackmount server places the power of the POWERpath-2 system board set in a chassis designed for maximum expansion. A unique backplane design with board connectors on both sides (referred to as a *midplane*) allows the system chassis to house twice the number of boards that can be supported by a conventional chassis of the same size.

The modular power supplies and distribution system ensure that the system chassis can be easily configured to meet the increasing power requirements that accompany system expansion. The internal SCSIBox 2 drive enclosures and multiple interfaces for external drives provide virtually unlimited data storage resources.

In its maximum configuration, the Challenge server can combine 41 circuit boards and 16 disk/tape/CD drives in a single cabinet. Because of the complexity that accompanies the large number of possible configurations, the basic version of the system is described first, followed by brief descriptions of the available options.

All Challenge servers are shipped with a standard set of POWERpath-2 system boards and a drive enclosure that supports eight half-height SCSI devices. Each of these system components is described in the following sections. Figure 1-2 is a functional block diagram of a basic Challenge rackmount server. Figure 1-3 illustrates the primary components of the system chassis.

Note: The POWER Challenge does support an optional visualization console, providing a basic color graphics interface to the system.

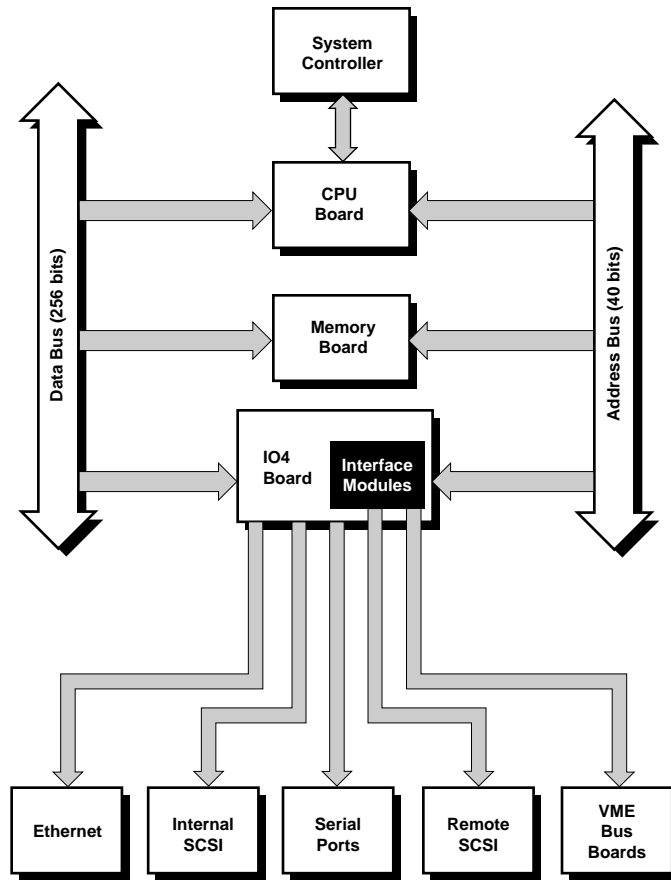


Figure 1-2 Challenge Rackmount Server Functional Block Diagram

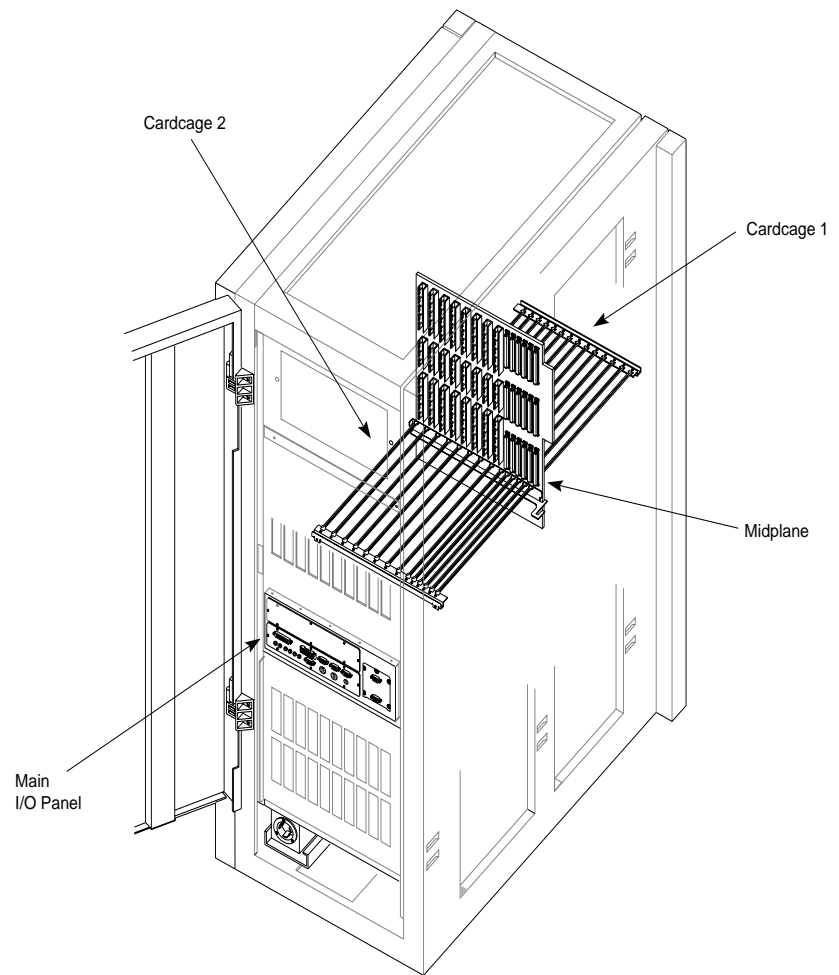


Figure 1-3 Challenge System Chassis

POWERpath-2 System Board Set

This section provides a brief description of the boards that compose the POWERpath-2 board set.

IP19/IP21/IP25 CPU Board

The CPU board is the heart of the POWERpath-2 board set. The Challenge system has an IP19 CPU board, and the POWER Challenge has the IP21 CPU board.

The IP19 (which resides in a Challenge system) is a multiprocessor CPU that is configured with either two or four R4400 processors. In its maximum configuration, the rackmount server supports nine IP19s, giving the system a total of 36 processors. The IP19 board logic is “sliced” so that each processor has its own dedicated supporting logic. This arrangement allows each processor to run independently of the others. The only board logic shared by the processors is the bus interface. A set of five ASICs (four data, one address) provides the interface between the CPUs and the system data and address buses.

The IP21 CPU (which resides in a POWER Challenge system) is also a multiprocessor CPU board and comes configured with either one or two R8000 processors. However, the IP21 delivers even more processing power and speed than the IP19 board, primarily by providing a dedicated floating point unit (FPU) chip and additional support hardware. This frees up the CPU to perform other required tasks and eliminates much of the wait states. The IP21 also implements dual-ported cache that enables two data accesses at the same time to improve processing speed significantly. In its maximum configuration, the POWER Challenge server supports up to 18 processors on nine CPU boards.

The IP25 board in your Challenge 10000 or POWER Challenge 10000 rackmount can house one, two, or four MIPS R10000 64-bit microprocessors. Your system can house up to nine IP25s with a potential system total of 36 microprocessors. The four-way superscalar R10000 microprocessor can fetch four instructions and issue up to five instructions per cycle. A superscalar processor is one that can fetch, execute and complete more than one instruction in parallel.

MC3 Memory Board

The MC3 interleaved memory board has 32 SIMM slots and can be populated with a combination of 16 MB and/or 64 MB SIMMs. In its maximum configuration, each board can supply 2 GB of random-access memory. The memory board supports up to eight-way interleaving, providing faster access times and allowing faulty components to be configured out of the memory map.

POWERChannel 2 Interface Board

The POWERChannel 2 interface board (also referred to as the IO4) provides the Challenge system with all of the basic serial ports and interfaces needed for system operation. These interfaces include the serial port, a parallel port, the SCSI bus interfaces, the Flat Cable Interface (FCI), the AUI Ethernet interface, three RS-232 serial ports, and an RS-422 serial connector.

The IO4 board also provides the “base” to which a variety of interface (mezzanine) boards can be mounted.

Note: The VMEbus Channel Adapter Module (VCAM) is the only mezzanine board installed as standard equipment on all systems. All of the other mezzanine boards are optional.

The IO4 device controllers transfer addresses and data between the various I/O interfaces and the Ebus over the 64-bit Interface bus (Ibus). The Ibus connects to the system buses through the IA and ID ASICs, forming an asynchronous boundary that provides the Ibus with a 320 MB per second bandwidth.

The IA and ID ASICs act as bus adapters that connect the Ibus to the much faster Ebus. In addition to making the necessary conversions back and forth between the two buses, the IA and ID ASICs perform virtual address mapping for DMA operations, and maintain cache coherency between the Ebus and the I/O subsystem.

The IO4 contains two FCIs that are proprietary to Silicon Graphics®. FCIs are synchronous, point-to-point interfaces that allow communication between devices. The FCIs are used to connect the VME64 bus or FDDI adapters to the IO4 board. The two FCIs on the first (or only) IO4 board in

the system are connected to the VME Channel Adapter Module (VCAM) board.

Note: FCIs can operate at up to 200 MB per second for VMEbus adapters.

The VCAM provides the interface between the VMEbus and the system buses. It is mounted on the first IO4 board, and the pair are installed in the system midplane as a unit.

VMEbus Interface

The VMEbus interface supports all protocols defined in Revision C of the VME™ Specification, plus the A64 and D64 modes defined in Revision D. The D64 mode allows DMA bandwidths of up to 60 MB per second. The VMEbus interface can operate as either a master or a slave. It supports DMA-to-memory transfers on the Ebus, as well as programmed I/O operations from the Ebus to addresses on the VMEbus.

The VMEbus is supported through a VCAM interface (GCAM with the visualization console option) connected to an IO4 board. This bus is standard equipment and is located in the main backplane, next to the Ebus. The VCAM or optional GCAM plugs directly into the IO4 board without any cabling. With the optional visualization console the GCAM covers one of the available mezzanine connectors on the standard IO4.

IO4 Board

The IO4 board contains two 16-bit SCSI-3 disk controllers. Each controller can operate with a bandwidth of up to 20 MB per second and can be configured for either single-ended or differential SCSI channels.

The IO4's Ethernet Interface operates at the standard Ethernet 10 MB per second rate and supports AUI (15-pin) physical connections. The controller is intelligent and requires no direct CPU involvement when packets are transmitted or received.

The IO4 contains a DMA-driven parallel port capable of operating printers, or performing high-speed data transfer to or from external equipment at rates of up to 300 KB per second.

The IO4 board also supports three RS-232 and one RS-422 serial ports, all of which are capable of asynchronous operation at rates up to 19.2 Kbaud. The RS-422 port may be operated at 38.4 Kbaud, provided the RS-232 ports are not all in use.

To accommodate extra disk controllers, the SCSI mezzanine board (S mezz) contains three 16-bit SCSI-3 controllers. Two of the controllers are differential only; the third is configurable as single-ended or differential. These controllers are identical to those used on the main IO4 board. S mezz boards can be plugged into either or both of the mezzanine card slots on an IO4 board, allowing up to eight SCSI-3 controllers per IO4 board.

System Midplane and Backplane

The Challenge rackmount system midplane has a combination of 15 POWERpath-2 (Ebus) connectors, six 9U VMEbus connectors, and three power board connectors. In addition to the midplane, an optional 20-slot VMEbus backplane is available. See Chapter 2, "Touring the Chassis," for more information and the locations of the midplane and backplane.

SCSI I/O Devices

SCSI devices are the only data storage devices internally supported by the Challenge system. The standard configuration is a single SCSIBox 2 that houses a maximum of 8 half-height SCSI devices. These devices include 1.2 GB and 2 GB disk drives; 1/4-inch, 4 mm DAT and 8 mm tape drives; and CD-ROM players.

All drives must be configured as Front Loading Devices (FLDs) before they can be mounted in the drive enclosure. An FLD is a SCSI storage device mounted on a P8 "drive sled." The drive sled adapts the drive's power and signal connectors to the connectors within the SCSIBox. Drives configured in this manner require no cabling; receptacles at the rear of the sled assemblies automatically engage the corresponding connectors on the drive box's backplane when the drive is installed. A second, identical drive enclosure is available as an option. Both SCSIBoxes have a pair of independent, configurable SCSI channels.

Though the system supports only SCSI devices internally, other drive types with a VMEbus-compatible controller board and IRIX-compatible device drivers can be supported remotely.

Note: Non-SCSI devices can be supported, but cannot be used as the boot device.

System Controller

The System Controller is a microprocessor with battery-backed memory that manages the system power-on sequence, as well as a portion of the boot process. During normal system operation, the System Controller monitors various system operating parameters such as fan speed, chassis temperature, the system clock, and backplane voltages. If the monitored operating parameters move out of their predetermined ranges, the System Controller can shut down the system. Error messages are stored in a log; therefore, you can retrieve messages in the event of a system shutdown.

A 128-character display is visible through a cutout in the system chassis' upper front door. This display gives you information about system status and detailed error messages in the event of a failure.

Four function buttons allow you to move through the menus and displays and to execute the controller functions. See Chapter 5, "Having Trouble?," for a detailed explanation of the System Controller features.

Visualization Console Option

POWER Challenge systems using the visualization console option have a Graphics Channel Adapter Module (GCAM) board. The GCAM contains a VME adapter subsystem and interfaces to the optional visualization console graphics board in the fifth VME slot. A flat-cable interface (FCI) is routed to a connector on the front of the optional GCAM.

Operating Considerations

The Challenge rackmount chassis is designed to be housed in a computer room meeting the following qualifications:

- The chassis should have a minimum air clearance of 5 inches around all sides (except the top and bottom).
- The top of the chassis should have a minimum air clearance of 3 feet. Do not place anything on top of the chassis that can restrict the exit airflow.
- The chassis should be kept in a clean, dust-free location to reduce maintenance problems.
- The power provided for the system and any attached peripherals should be rated for computer operation.
- The chassis should be protected from harsh environments that produce excessive vibration, heat, and similar conditions.
- The access doors should have clearance to swing completely open.

Additional specifications are provided in Appendix A, "Hardware Specifications." In addition, consult the *Challenge/Onyx Site Preparation Guide* for the specific guidelines and requirements for your system. If you have any questions concerning physical location or site preparation, contact your system support engineer or other authorized Silicon Graphics support organization before your system is installed.

Touring the Chassis

The Challenge XL rackmount server uses a highly configurable rackmount chassis, as shown in Figure 2-1. Access to the interior of the chassis is through the upper and lower front doors and through the single rear door. Figure 2-2 illustrates the chassis components that are visible with the access doors open.



Warning: To avoid electric shock and to prevent a fire hazard, do not disassemble the Challenge system. No user-serviceable parts are located within the chassis. All installation and maintenance must be performed by Silicon Graphics-trained personnel. Contact the Silicon Graphics Technical Education department for information about customer training.

This chapter is provided to give you a more thorough understanding of the Challenge server. It is not intended to be used to disassemble the machine. Many of the components described in the following pages are not user-serviceable, and no attempt should be made to access them.

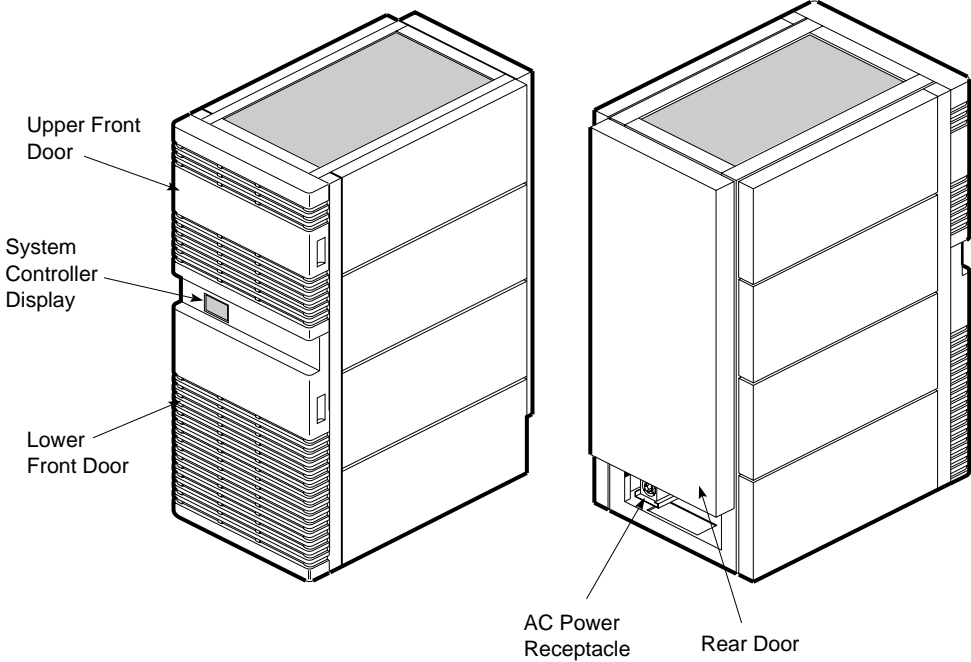


Figure 2-1 Chassis Front and Rear Views

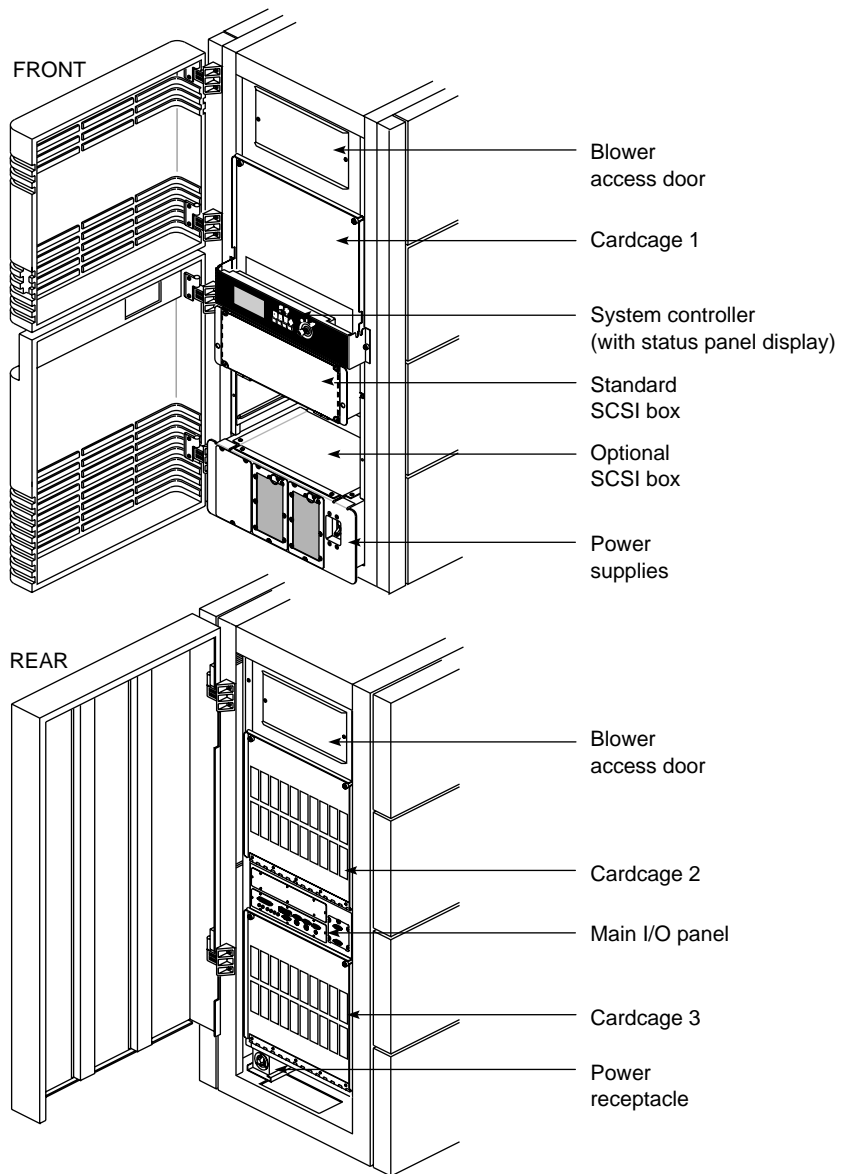


Figure 2-2 Challenge Rackmount Chassis With Doors Open

Power Switches and Indicators

The main power switch is located in the lower right corner of the front of the system chassis (see Figure 2-3). Immediately to the left of the power switch are the power supplies (referred to as offline switchers [OLSs]). Each OLS has a pair of LEDs (light-emitting diodes) mounted in the lower right corner of its front panel. They are visible through the metal mesh when lit. The amber input power/fault LED lights when AC power levels are normal, and the green DC output LED lights when DC outputs are normal.

The System Controller is located in approximately the center of the front of the chassis. Its display is visible through a cutout in the lower front access door. With the door open, the System Controller key switch, function buttons, and LEDs are visible.

The key switch turns on the system by applying the voltages converted by the OLSs to the various system components.

Caution: Remove the key from the key switch before closing the lower front access door. If you close the door without removing the key, the key will be broken off in the key switch.

The function buttons allow the operator to display various status and error messages (this is explained in more detail later in this chapter).

The green power-on LED lights to indicate that the DC voltage from the OLSs has reached the system midplane.

The amber LED lights briefly when power is applied to the System Controller. This LED remains lit until the System Controller successfully initializes and a series of power-on tests have completed.

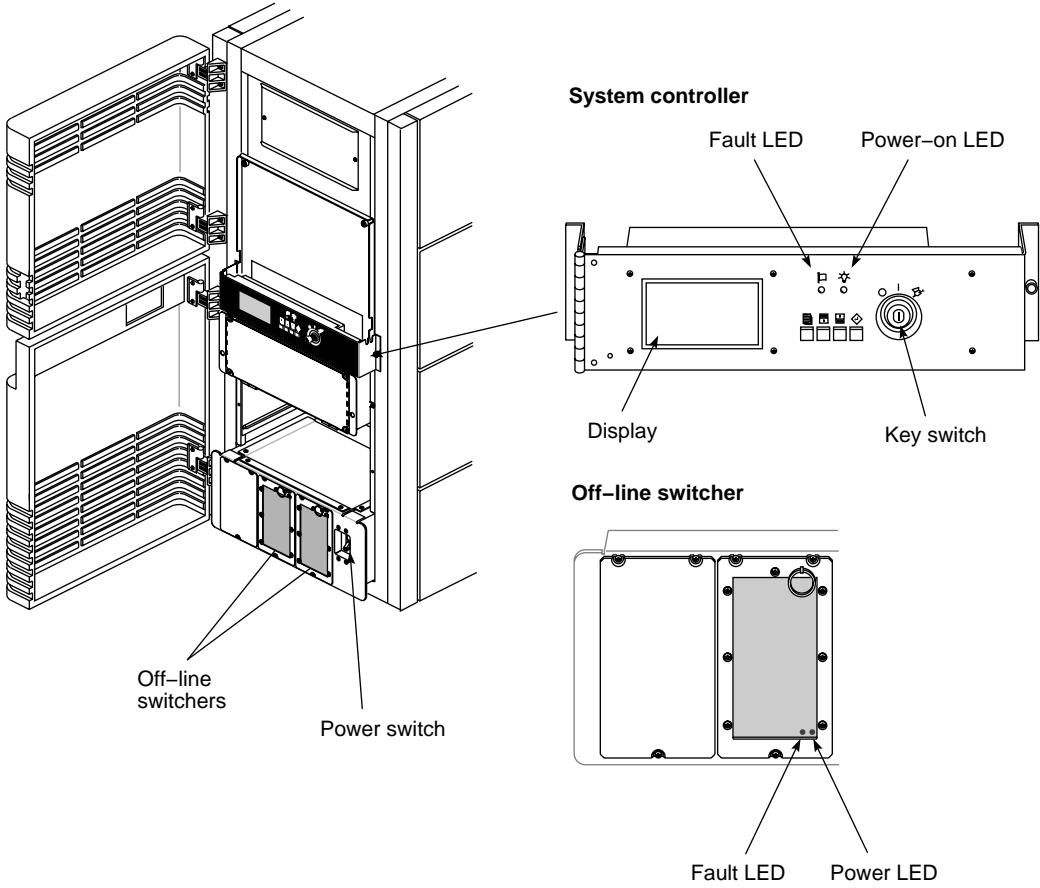


Figure 2-3 Power Switches and Indicators

I/O Panels and Connectors

This section describes the system’s I/O panels and their connectors. The main I/O panel is located in approximately the center of the rear of the system chassis. See Table 2-1 for a listing of the connectors and their descriptions. Two additional I/O panels are located above and below the main I/O panel, respectively (see Figure 2-4).

Main I/O Panel

The main I/O panel contains all of the standard system interfaces: the terminal connector, the AUI Ethernet port, two powered peripheral ports, three RS-232 serial ports, an RS-422 serial port, a parallel printer port, and six interrupt jacks. See Table 2-1 for a listing of the connectors and their descriptions, and Figure 2-5 for an illustration of the main I/O panel connectors.

Table 2-1 Main I/O Panel Connector Descriptions

Connector Description	Connector Type	Function
AUI Ethernet	15-pin sub-D	Standard Ethernet port
RS-232 Serial Port and System Console Port	9-pin sub-D	Standard RS-232 serial interface
Powered Peripheral Port	8-pin circular DIN	Provides power as well as RS-232 interface
Interrupt 0-1 Input Interrupt 0-3 Output	3.5-mm tip-ring-sleeve jacks	Provides external system CPU interrupts
Parallel Port	25-pin sub-D	Parallel printer interface
RS-422 Serial Port	9-pin sub-D	RS-422 differential serial interface
Peripheral Rack Control	9-pin sub-D	Connection to CHALLENGE XL Vault
Remote System Control	9-pin sub-D	Connection to CHALLENGE XL Vault

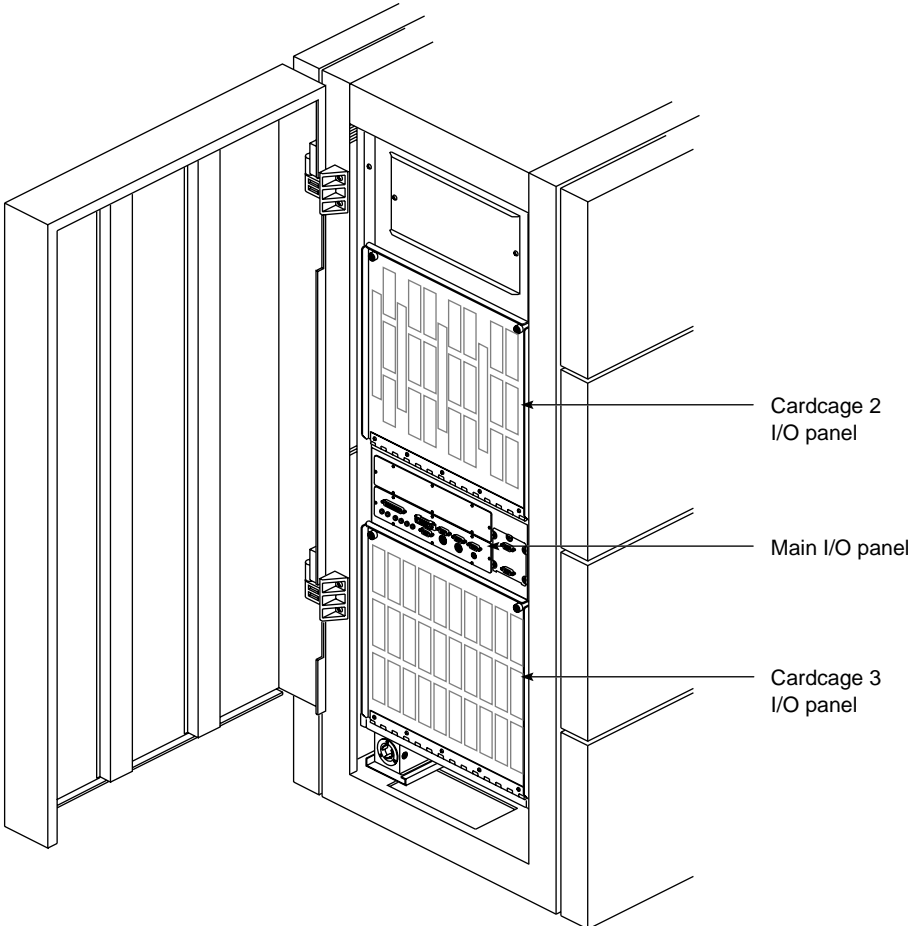


Figure 2-4 Challenge System I/O Panels

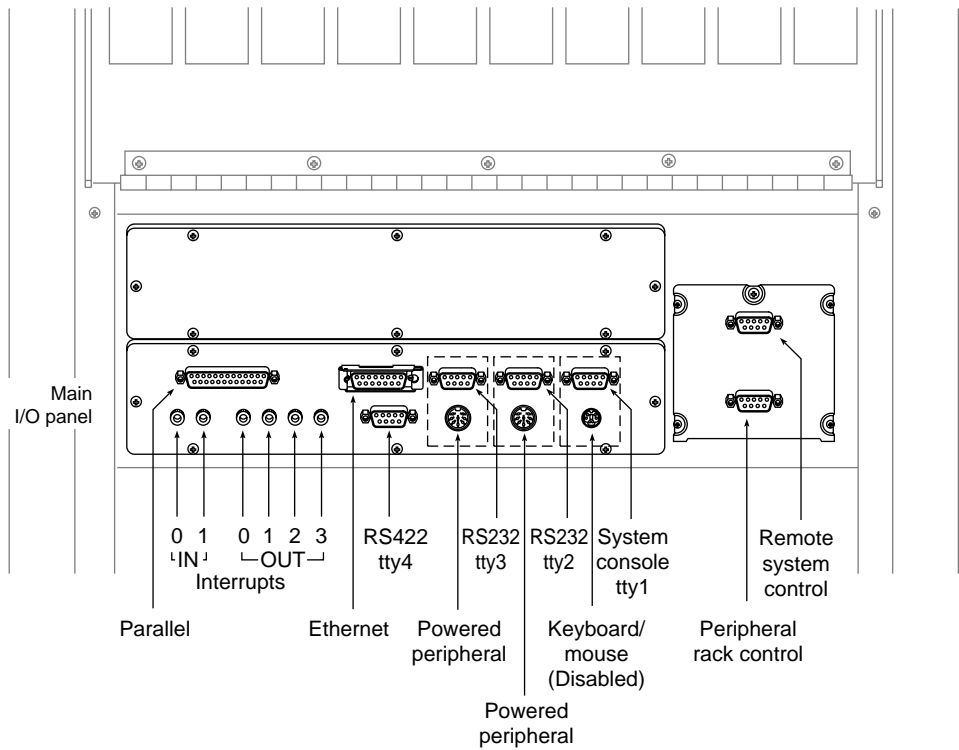


Figure 2-5 Main I/O Panel Connectors

Cardcage 2 and Cardcage 3 I/O Panels

The Cardcage 2 and optional Cardcage 3 I/O panels can contain a variety of connectors, depending on the system configuration. The most common configurations populate both I/O panels with a variety of I/O interfaces.

Figure 2-6 illustrates possible configurations for the two panels, and Table 2-2 lists the connectors and their descriptions.

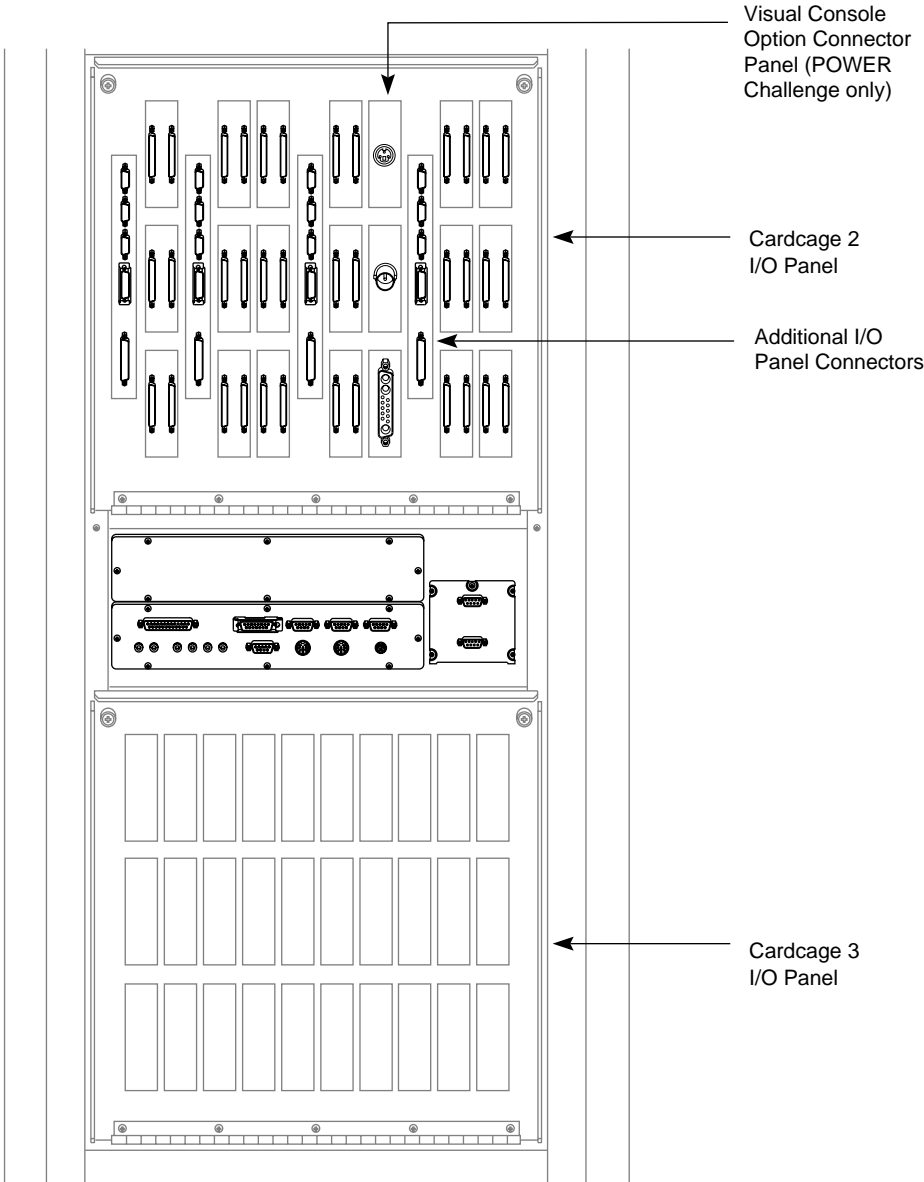


Figure 2-6 Cardcage 2 and 3 I/O Panels

Table 2-2 Cardcage 2 and 3 I/O Panel Connector Descriptions

Connector Description	Connector Type	Function
SCSI	68-pin high-density D-type	Small Computer System Interface
FDDI	Fixed Shroud Duplex (FSD)	Fiber Distributed Data Interface

Powered and Unpowered Serial Connectors

The Challenge system provides three types of serial ports (see Figure 2-7 and Table 2-3).

- A 9-pin RS-232 unpowered D-sub connector
- A 9-pin RS-422 unpowered D-sub connector
- An 8-pin RS-232 powered DIN connector

Caution: Neither of the two RS-232 connectors conform to EIA/TIA industry standards, so a serial cable must either be ordered through a Silicon Graphics supplier or be specially constructed.

The main I/O panel provides both powered and unpowered serial connectors. Terminals, modems, printers, and other peripherals with internal power sources use the unpowered 9-pin sub-D connectors. Peripherals without internal power supplies, such as Spaceball™ and StereoView™, use the 8-pin DIN connectors as both an interface and a power source.

Note that the two powered peripheral connectors, on the main I/O panel, are located immediately below two standard RS-232 ports (refer to Figure 2-5). Each powered peripheral connector is paired with the 9-pin serial port directly above it. Each pair of connectors is tied to the same RS-232 serial channel, meaning that only one port from each connector pair can have a peripheral attached to it. Devices will not operate if they are simultaneously attached to the same connector pair.

Note: For all POWER Challenge and Challenge systems, Silicon Graphics recommends the use of RS-232 serial cable no longer than 30 feet (9.15 meters). Longer runs introduce a greater possibility of line noise occurring. This can affect data transmission and cause errors. For cable runs longer than 30 feet (9.15 meters), use an appropriate extender device.

Table 2-3 Powered and Unpowered Serial Connector Pinouts

Connector Type	Description	Pin Number	Signal	Flow from chassis
RS-232 (see Figure 2-7)	Serial port tty1	1	not used	
	9-pin D-sub receptacle.	2	TXD	output
	RS-232 protocol.	3	RXD	input
	Serial ports 0 and 1 provide	4	RTS	output
	a choice of this or an 8-pin	5	CTS	input
	DIN receptacle. Only one	6	GND	
	receptacle from each port	7	GND	
	can be used at a given time.	8	DCD	input
		9	DTR	output
RS-232 (see Figure 2-7)	Serial ports tty2, tty3 for	1	not used	
	unpowered peripherals.	2	TXD	output
	9-pin D-sub receptacle.	3	RXD	input
	RS-232 protocol.	4	RTS	output
	Serial ports 0 and 1 provide	5	CTS	input
	a choice of this or an 8-pin	6	GND	
	DIN receptacle. Only one	7	GND	
	receptacle from each port	8	DCD	input
	may be used at a given time.	9	DTR	output

Table 2-3 (continued) Powered and Unpowered Serial Connector Pinouts

Connector Type	Description	Pin Number	Signal	Flow from chassis
RS-422 (see Figure 2-7)	Serial port tty4 RS-422 protocol. 9-pin D-sub receptacle.	1	DTR	output
		2	TXD low ^{-a}	output
		3	RXD low ^{-b}	input
		4	DCD	input
		5	CTS	input
		6	GND	
		7	TXD high ^{+a}	output
		8	RXD high ^{+b}	input
		9	RTS	output
RS-232 (see Figure 2-7)	Serials ports tty2, tty3 for powered peripherals. 8-pin DIN receptacle.	1	DTR	output
		2	CTS	input
		3	Stereo Sync	output
		4	RXD	input
		5	TXD	output
		6	GND	
		7	GND	
		8	Power +10V	output

a. Pins 2 and 7 must be a twisted pair in cable.

b. Pins 3 and 8 must be a twisted pair in cable.

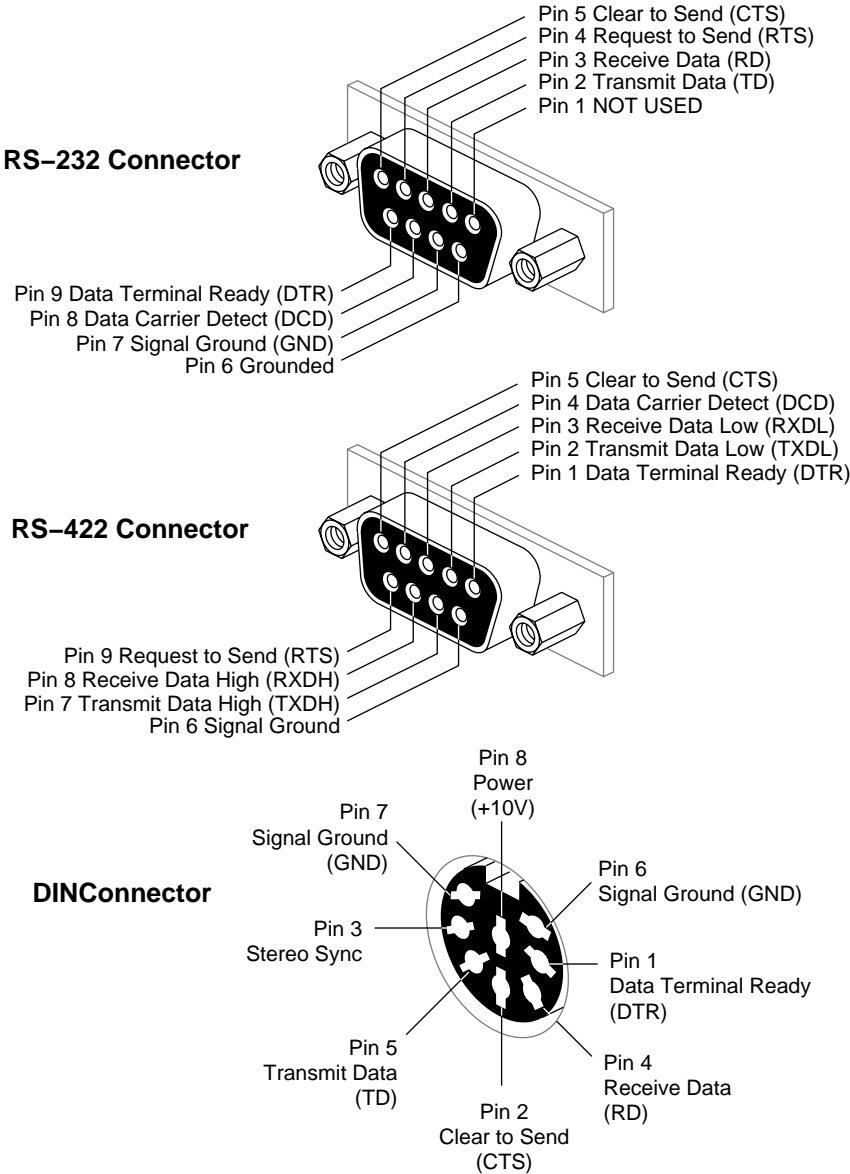


Figure 2-7 Powered and Unpowered Serial Connectors

Parallel Port

The parallel port is a 25-pin Centronics[®] compatible connector. Table 2-4 lists the pin assignments.

Table 2-4 Parallel Port Connector Pin Assignments

25-Pin DB-25 Connector	Signal Description
1	STB (Data Strobe)
2	DATA 0
3	DATA 1
4	DATA 2
5	DATA 3
6	DATA 4
7	DATA 5
8	DATA 6
9	DATA 7
10	DATA ACK
11	BUSY
12	PE (Paper Empty)
13	SLCT (Select)
14	AUTOFD (Autofeed)
15	ERROR
16	INIT (reset)
17	SLCTIN
18-25	GND

Visualization Console Option

The I/O panel configuration for the optional visualization console graphics connectors is shown in Figure 2-6. Table 2-5 lists the connector types and descriptions for the visualization console option.

Table 2-5 Optional Visualization Console Video Connector Description

Connector Type	Connector Description
Video	13W3
Genlock	BNC
Stereoview	4-pin powered peripheral

System Controller

The System Controller has three basic operating conditions:

- It acts as a control conduit when directed by the operator to power down or boot up the system. It actively displays a running account of the boot process and flags any errors encountered. It also sends the bootmaster CPU a message when a system event, such as a power-off or reboot, is initiated.
- When operating conditions are within normal limits, the System Controller is a passive monitor. Its front panel display provides a running CPU activity graph that shows the level of each processor's activity. Previously logged errors are available for inspection using the function buttons to select menus.
- The System Controller can also act independently to shut down the system when it detects a threatening condition. It can also adjust electromechanical parameters (such as blower fan speed) to compensate for external change. Parameters are monitored and problems are identified through a series of sensors, located throughout the system chassis.

The operator interface to the System Controller consists of a 128-character liquid crystal display (LCD), a key switch, and four function buttons (see Figure 2-8). The display is visible through a cutout in the front door of the

system chassis. During normal system operation, CPU activity is displayed as a histogram. A histogram is a series of vertically moving bars, where each bar represents the activity of one processor. If a system fault is detected, or if the function buttons are being used, the histogram is replaced with either error messages or menu selections.

The key switch has three positions: On, Off, and Manager (represented by an icon of a hand holding a wrench). The On position enables the system and provides access to four menus: the CPU Activity menu, the Event History Log menu, the Boot Status menu, and the Master CPU Selection menu. The Off position turns off the system power. The Manager position is used by system administrators or authorized service personnel only.

The function buttons are reached by opening the upper front door. The Scroll Up and Scroll Down buttons allow you to move back and forth through the display screens. Press the Menu button to display the executable options in the selected menu. Use the Execute button to execute the option currently displayed or highlighted.

More detailed explanations of the System Controller operation are found in Chapter 3 and Chapter 5.

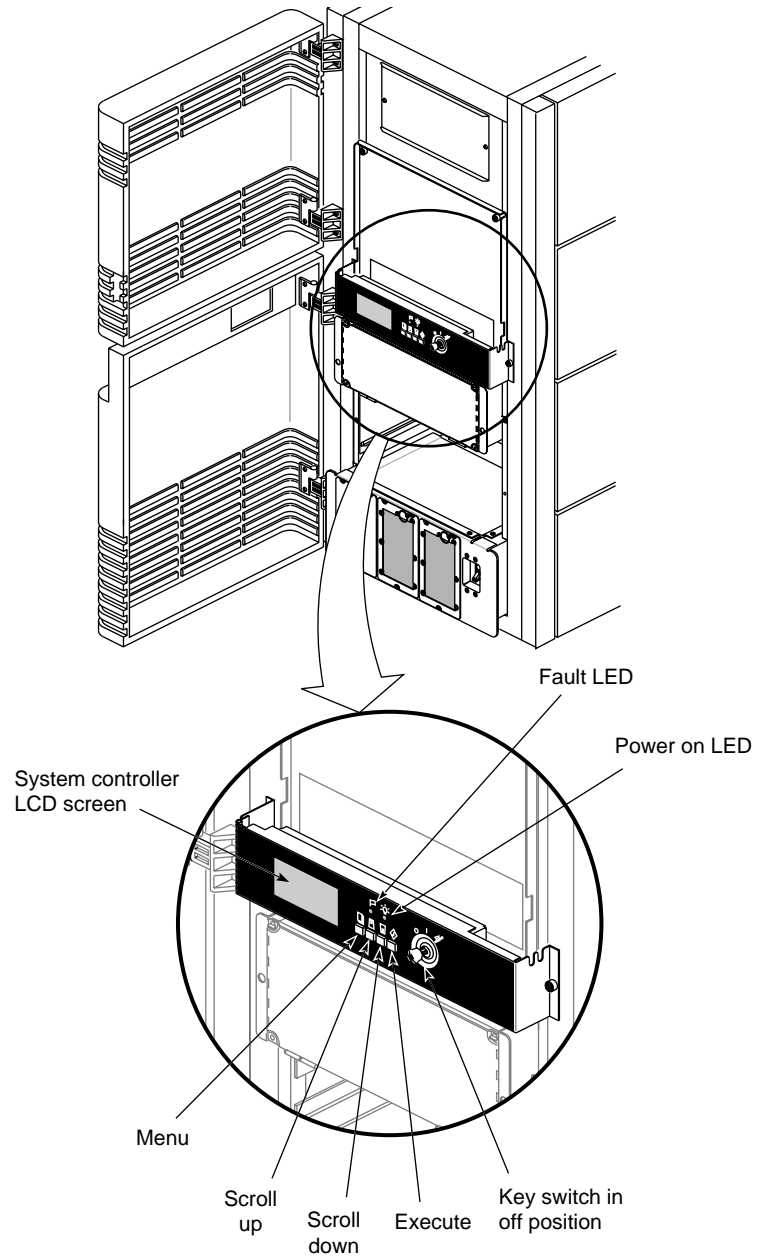


Figure 2-8 System Controller

SCSIBox 2 Drive Enclosures

The SCSIBox 2 drive enclosure is located at the front of the system chassis, below the System Controller. The optional, second SCSIBox is installed immediately below the first enclosure. Access to both SCSIBoxes is through the lower front door (see Figure 2-9). These SCSI drive enclosures are configured to accept eight half-height drives, but they can be reconfigured to house four full-height drives or a combination of the two types.

Note: See Chapter 4, “Installing and Using Optional Peripherals,” for instructions on reconfiguring the SCSIBoxes.

Each SCSIBox provides two SCSI channels; they can be used as either 8- or 16-bit SCSI buses and can be configured for either single-ended or differential SCSI (see Chapter 3, “Getting Started,” for a brief description of the two SCSI channel configurations).

The SCSIBoxes receive 48 VDC directly from the system backplane and convert that voltage to the levels used by the SCSI storage devices. This type of drive enclosure requires less physical space than the SCSI drive boxes used previously.

Note: The SCSIBoxes found in other products, such as the Challenge Vault XL expansion rack, are not interchangeable with the SCSIBoxes in your Challenge XL rackmount system.

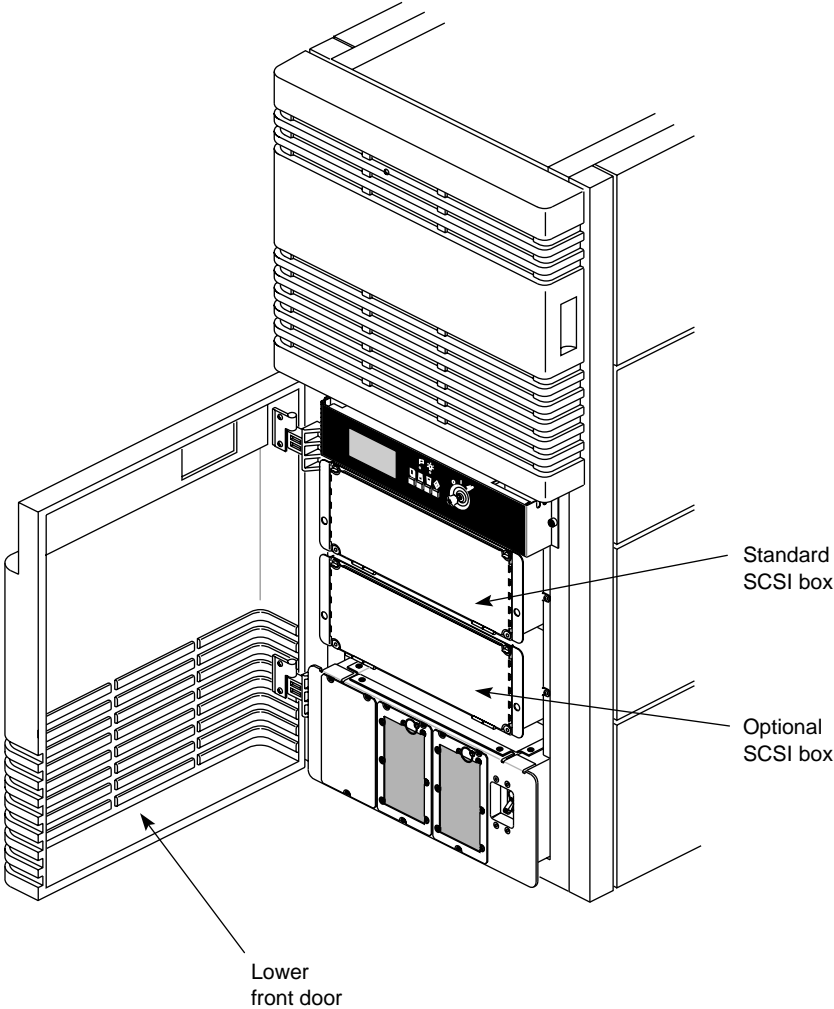


Figure 2-9 SCSIBox Drive Enclosures

Additional information about the SCSIBox, SCSI drive configuration requirements, and installing and removing drives, is found in Chapter 3.

Cooling System

The Challenge rackmount chassis is air cooled by two 11-inch vaned rotors (refer to Figure 2-2). The rotors are mounted in the top of the cabinet and draw air from floor level. The incoming air is drawn up through the drive boxes and cardcages and is finally exhausted through the screen in the top of the cabinet.

The rotors are connected directly to the System Controller, which monitors their speed. Temperature sensors in the cardcages and drive boxes allow the System Controller to adjust the rotor speed for the most efficient cooling.

Note: It is critical that there be an unobstructed flow of air through the system.

Power Supplies and Power Distribution

The Challenge server comes with up to three 1900-watt offline switchers (OLSs), depending on the system configuration. The OLSs are installed in a power supply enclosure at the lower front of the system chassis (see Figure 2-10).

The offline switchers convert the incoming AC line voltage to 48 VDC for use by the system midplane and optional Cardcage 3 backplane. The midplane and backplane voltages are, in turn, converted to the voltage levels needed for the circuit boards by a series of power boards.

The power boards are DC-to-DC voltage convertors that may be installed in dedicated slots in Cardcage 1, on the Cardcage 3 backplane, and on the SCSIBox backplanes. They are available in a variety of voltages and amperages, allowing the power subsystem to be precisely tailored to meet the needs of your particular system configuration.

Systems configured with the two standard cardcages have one or two OLSs, depending on the number of boards installed. These systems are wired to accept 220-volt two-phase AC power. Any system with the optional third cardcage is shipped with three OLSs mounted in a special power supply enclosure. Three-cardcage systems are wired for 208-volt three-phase power.

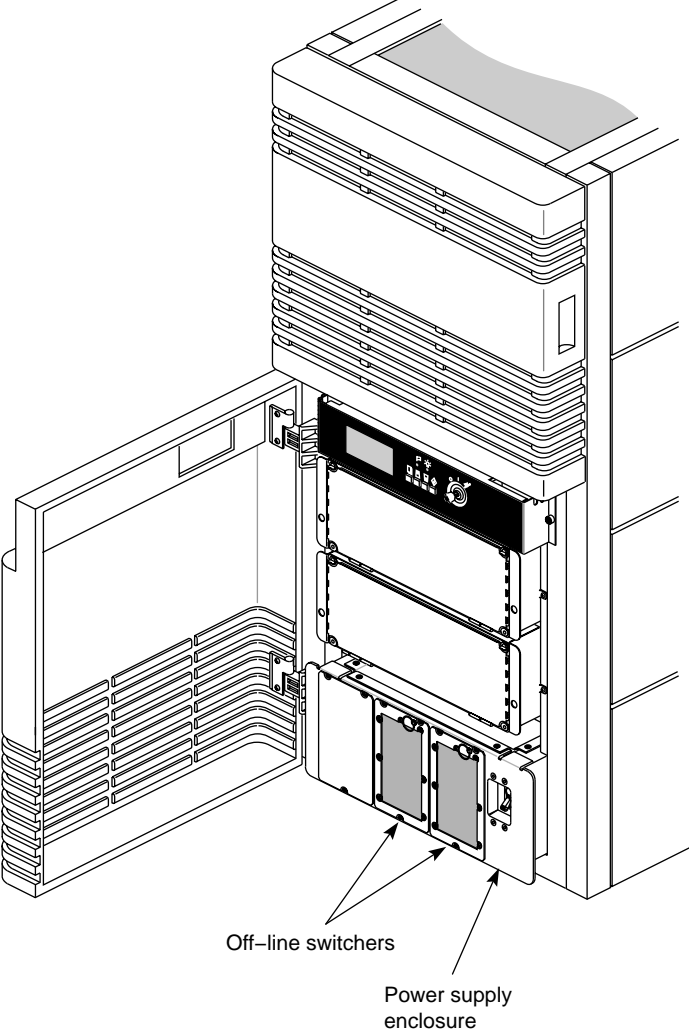


Figure 2-10 Power Supply Enclosure

Getting Started

This chapter describes the procedures you should use to configure and operate your Challenge server correctly.



Warning: The Challenge rackmount server operates on 220-400 VAC. Use extreme caution when working around this voltage. Never install or remove power cords without first turning off the equipment.

48 VDC is present on the system midplane. This voltage is present even if the system has been reset or halted.

Caution: The Challenge system can weigh over 1200 pounds (544 kg) when fully configured. Use at least two people when moving the system chassis, and take care to ensure that the system does not tip or become unbalanced. Two people should also be used to move the monitors. Be sure to practice proper lifting techniques.

Customer maintenance is limited to the outside of the chassis, which comprises the peripherals and cables attached to the I/O panel. No user-serviceable parts are found within the chassis.

Note: This product requires the use of external shielded cables in order to maintain compliance with Part 15 of the FCC rules.

Connecting Your Terminal

The Challenge rackmount server requires a customer-supplied American Standard Code for Information Interchange (ASCII) terminal. Note the following caution before attempting to connect your terminal.

Caution: Before plugging the terminal into either a 120 VAC or a 250 VAC outlet, be sure that the electrical rating on the UL-CSA label is in either the 100–120 VAC or the 200–240 VAC range, whichever applies.

Note: When using a terminal in locations that do not have either a 120 VAC or a 250 VAC outlet, contact your Silicon Graphics system support engineer before plugging in the terminal power cable. Use only the specified cable to connect the terminal to the system chassis.

An ASCII terminal uses a simple null modem cable with a 9-pin connector at one end and a 25-pin connector at the other. See Table 3-1 for the pin assignments for the two connectors.

Table 3-1 25-Pin Terminal Connector Pin Assignments

25-Pin (DB-25) Connector	9-Pin (DB-9) Connector at Challenge	Signal Description at Challenge
3	2	Transmitted Data (TXD)
7	7	Signal Ground (GND)
2	3	Received Data (RXD)

Note: This product requires the use of external shielded cables in order to maintain compliance with Part 15 of the FCC rules. Serial cables from different vendors are not compatible. Verify the pinout of your cable before making the connection.

Use the following procedure to connect the ASCII terminal to your system:

1. Open the lower front door of the system chassis and verify that the system power switch, located in the lower right corner, is off.
2. Make sure that the power switch on the terminal is turned off and that the power cord is not connected to an outlet.
3. Attach the end of the terminal cable with the 25-pin connector to the corresponding connector at the rear of the terminal.
4. Open the rear door of the chassis to expose the main I/O panel.
5. Attach the end of the cable with the 9-pin D-sub connector to the serial connector labeled “ty 1” on the main I/O panel, as shown in Figure 3-1.

6. Ensure that the terminal cable is routed through the cutout in the bottom of the access door and that it is not pinched or kinked when the door is shut.
7. Attach the terminal power cord to the rear of the terminal and to the appropriate power source.

Refer to the *IRIX Advanced Site and Server Administration Guide* for more information about configuring your terminal.

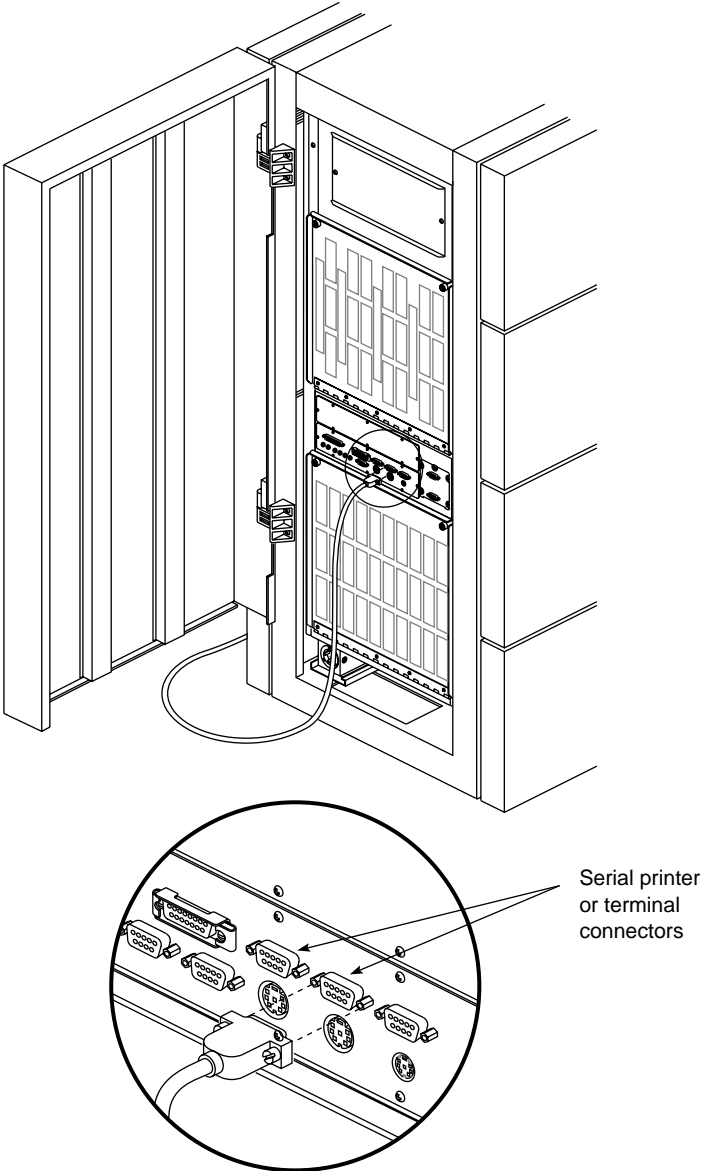


Figure 3-1 Connecting an ACSII Terminal

SCSI Requirements and Configurations

All Challenge rackmount systems are configured with a minimum of two fully independent SCSI channels provided by the IO4 board. In its maximum configuration, with the addition of multiple SCSI mezzanine boards, the Challenge server system can have 48 SCSI channels. A portion of these channels can be configured as either single-ended or differential SCSI.

The difference between single-ended and differential SCSI channels is defined as follows: a single-ended SCSI channel pairs each signal line with a ground line. A differential SCSI channel pairs each signal line with a second signal that is the balanced inverse of the first. This configuration makes differential SCSI less susceptible to signal degradation due to noise and more suitable for remote (longer) cabling.

The internal and external SCSI buses can be configured as either single-ended or differential. Generally, internal buses are configured as single-ended, and external buses that connect to remote storage devices are differential. The requirements and limitations of both single-ended and differential SCSI buses are described below.

The maximum allowable length for single-ended (standard) SCSI cabling is 19.6 feet (6 meters). This maximum length reflects the combined lengths of both the internal and external cables. A single-ended SCSI bus can support a maximum of eight SCSI devices (including the SCSI controller board).

The maximum allowable length for differential SCSI is 80 feet (25 meters). As with single-ended SCSI, this length is the sum of both the internal and external cables. A differential SCSI bus can support a maximum of 16 devices (including the controller board).

Note: The most common reason for SCSI device failure is insufficient noise margins due to exceeding the maximum cable length, cable impedance mismatches, or both. If you are having trouble with certain devices, particularly external devices, be sure to verify that you have not exceeded the maximum SCSI cable length.

Always use shortest cable possible. Route external cables away from potential damage due to foot traffic, cleaning, and so on.

If you have additional questions about SCSI connections and cable lengths, contact your Silicon Graphics representative.

Terminating SCSI Channels

SCSI channels must be terminated at both the IO4 board (or S mezz board) and at the last device on the channel. The internal SCSI channels (in the SCSIBoxes) are configured so that front loading devices (FLDs) can be added or removed without affecting the channel termination; however, if devices are being added or removed from an external SCSI bus, you must verify that the correct external channel termination is maintained.

Caution: Single-ended and differential SCSI buses must be terminated with single-ended and differential terminators, respectively. Terminating a bus with the wrong terminator can cause system damage.

Note: All installed IO4 boards and/or S mezz boards are terminated at the time of installation. Do not attempt to open the cardcages to verify channel termination.

Installing and Removing FLDs

This section describes the physical installation and removal of an FLD (front loading device) from the Challenge server. It is assumed that the server has already been configured for the drives being removed or installed.

Note: If the FLD is not configured, refer to Chapter 4, "Installing and Using Optional Peripherals," for configuration instructions.

Install an FLD in the SCSIBox drive enclosure as follows:

1. Ensure that the system power is not turned on. If the system is running, refer to "Powering Off the System" later in this chapter.
2. Open the lower front access door of the system chassis.
3. Release the two captive wing nuts securing the SCSIBox door and allow the door to swing down (see Figure 3-2).

4. Orient the FLD relative to the SCSIBox so that the drive is facing toward the right (see Figure 3-3).
5. Select a vacant drive bay and carefully align the rails on the drive sled with the corresponding rails in the drive bay.
6. Slide the FLD into the bay until the locking mechanism is engaged and the locking lever on the drive sled moves down to the locked position. Push the lever down to ensure that it is fully engaged.
Note: If the FLD is being installed for the first time, ensure that the drive is not terminated.
7. Verify that the device ID was not accidentally changed during the installation.
8. Close the SCSIBox door and secure the captive wing nuts.
9. Power on the system as described in the following section.
10. Close the lower front access door of the system chassis.
11. See the *IRIX Advanced Site and Server Administration Guide* for the information needed to configure the software.

Remove an FLD from the SCSIBox as follows:

1. Repeat steps 1 through 3 of the installation procedure.
2. Move the locking lever, on the drive sled, up as far as it will go.
3. Carefully withdraw the FLD from the SCSIBox.

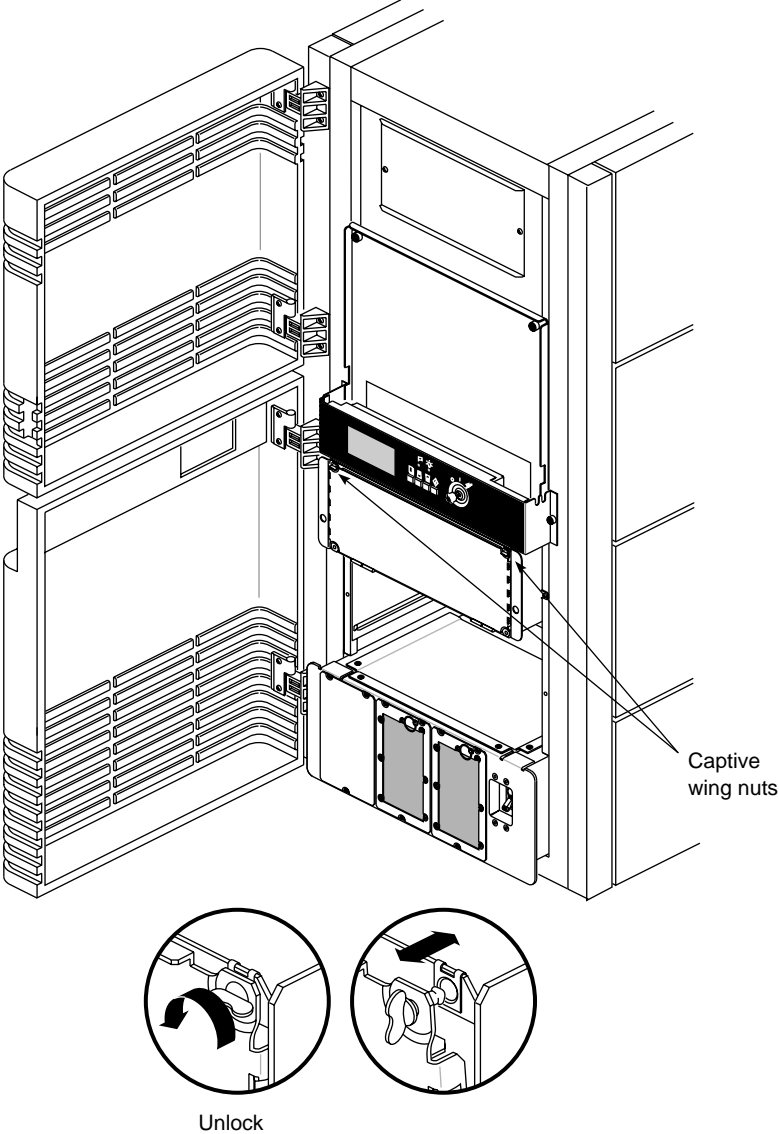


Figure 3-2 Opening the SCSIBox

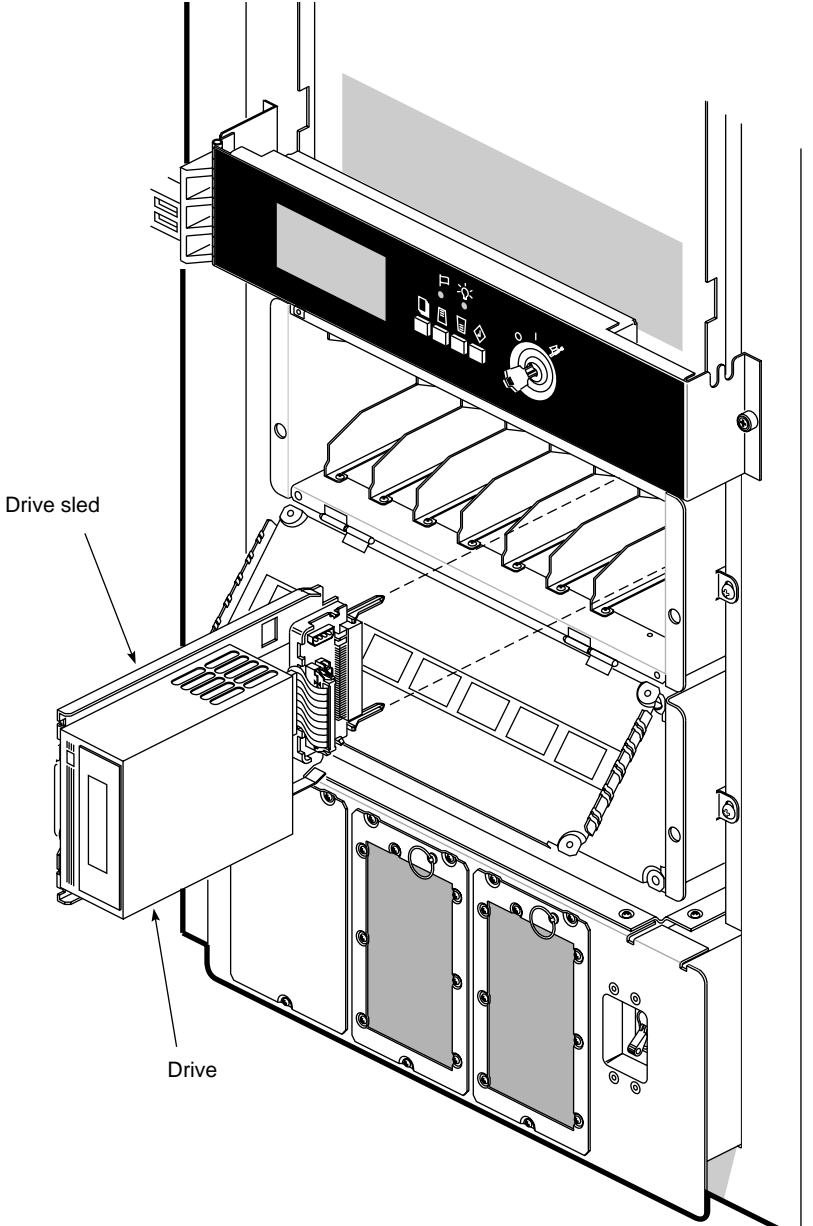


Figure 3-3 Installing a Front Loading Device

Connecting Your System to an Ethernet

The Challenge rackmount server comes with a 15-pin AUI Ethernet connector. You can order optional boards for additional Ethernet connections.

Powering On the System

Power on the Challenge rackmount server as follows:

1. Verify that the system power switch, located in the lower front corner of the system chassis, is turned off.
2. Insert the female end of the system power cable into the receptacle at the rear of the system chassis (see Figure 3-4). Secure the cable by turning the connector clockwise to engage the twist lock.
3. Connect the male end of the power cable to an AC power source using the appropriate receptacle. Your system has either a keyed connector with a locking collar or a twist-lock connector. Turn the locking collar on the keyed connector clockwise to engage the locating tabs on the AC outlet. Turn the twist-lock connector clockwise to secure it to the AC outlet.

Refer to the *Challenge/Onyx Site Preparation Guide* for the system's power requirements.



Warning: The Challenge rackmount server operates on 220-400 VAC. Use extreme caution when working around this voltage. Never install or remove power cords without first turning off the equipment.

4. If the terminal and peripherals are equipped with voltage select switches, verify that they are set for the appropriate AC voltage.
5. Connect the power cords from the terminal and any additional peripherals to the appropriate three-pronged grounded outlets.
6. Turn on the system power switch (see Figure 3-5).
7. Turn on the terminal, followed by any attached peripherals (for example, a printer).

Note: All internal storage devices are automatically powered on by the System Controller

8. Boot the system according to the following section.

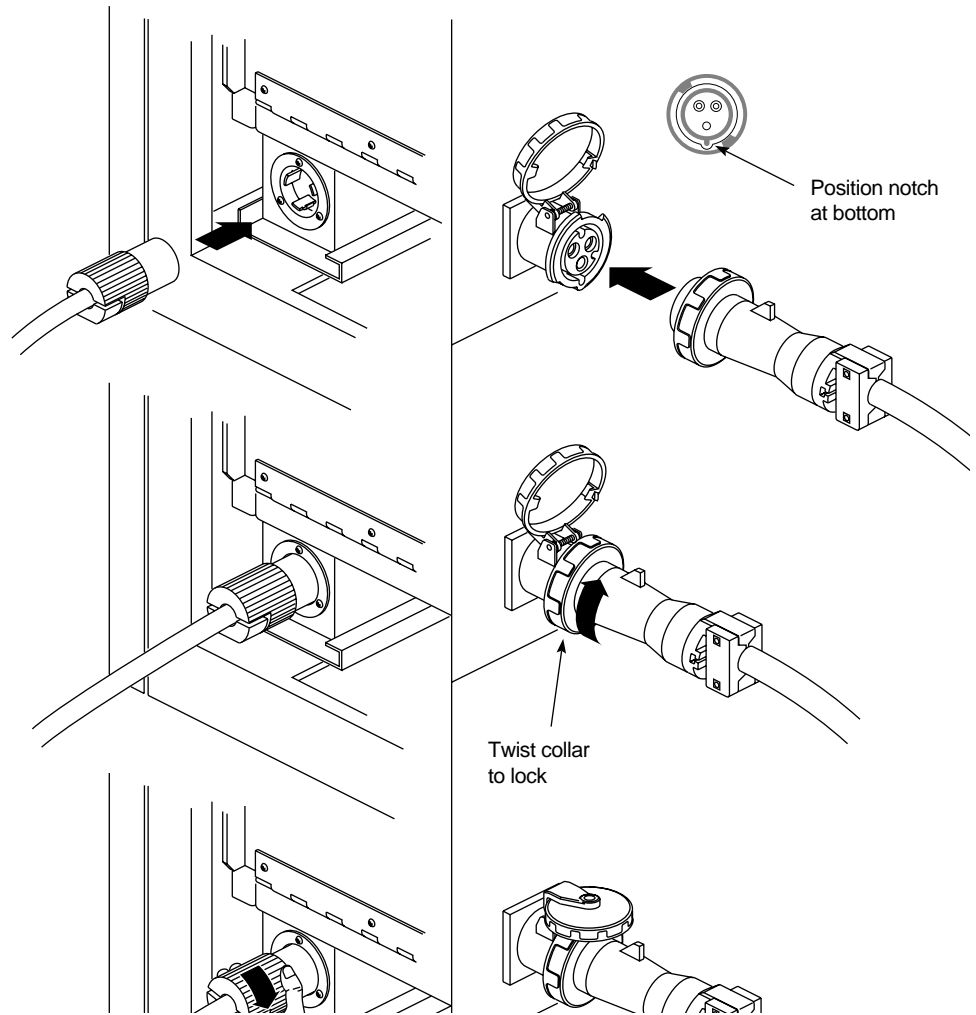


Figure 3-4 Connecting the System Power Cable

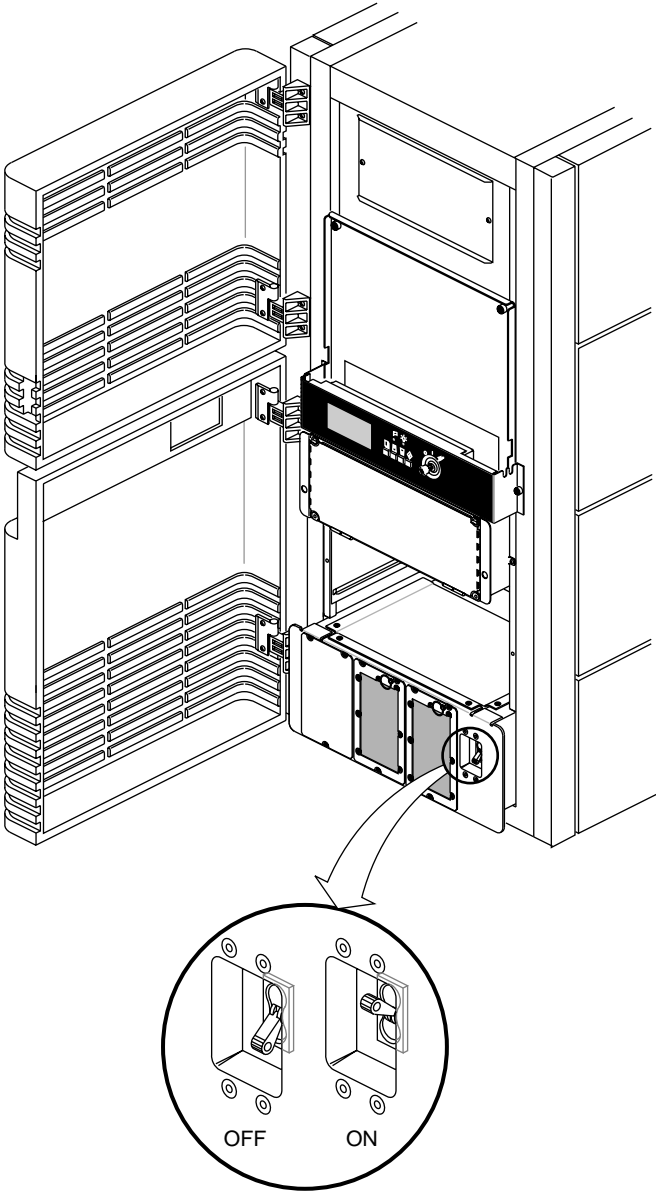


Figure 3-5 Power Switch

Booting the System

Boot your system by performing the following steps:

1. Power on the system, as described in the preceding section.
2. Open the lower front door to the system chassis.
3. Insert the key into the key switch, located to the right of the System Controller's display (see Figure 3-6).
4. Turn the key switch to the On position.

The System Controller begins the power-on sequence. The green power-on LED, located above the function buttons, lights up to indicate that power has been applied to the system midplane. The amber fault LED then lights up to indicate that power has been supplied to the System Controller. The fault LED goes out when the System Controller has successfully initialized and the power-on tests have completed.

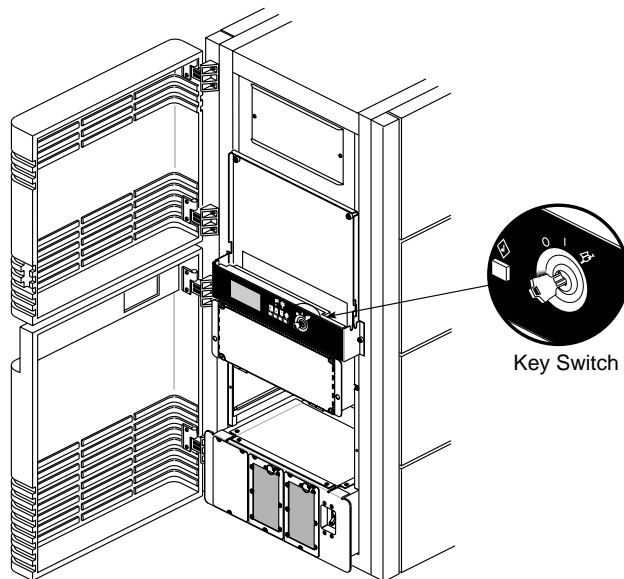


Figure 3-6 System Controller Key Switch

5. After the bootmaster CPU has been selected, the system’s progress can be monitored on the System Controller’s display. Use the function buttons to select the Boot Status menu, and a series of status messages are displayed during a normal boot cycle (see Table 3-2).

Note: Do not press any of the front panel buttons until the “Boot Arbitration is Complete” message is displayed by the System Controller. Pressing the buttons before the bootmaster CPU is identified aborts the boot arbitration process. When the power-on tests have completed, you see this message:

Starting up the system...

To perform System Maintenance instead, press <Esc>.

Table 3-2 System Controller Boot Status Messages

Boot Status Message	Message Description
BOOT ARBITRATION NOT STARTED	The system CPU boards have not begun the arbitration process.
BOOT ARBITRATION IN PROCESS	The system CPU boards are communicating to decide which one will be the bootmaster CPU.
BOOT ARBITRATION IS COMPLETE SLOT #xx PROC #yy	The chosen CPU has identified itself to the System Controller, and communication is fully established.

6. To reconfigure your system or to list your system’s hardware, press <Esc> within five seconds.

Note: If you don’t press <Esc> within five seconds, the system will come up and display the desktop. If this happens, log in, shut down the system using the “System Shutdown” command from the System Maintenance menu, and then restart it when prompted.

7. When the System Maintenance menu appears, type 5 to select “Enter Command Monitor.”
8. When the >> prompt appears, type **hinv**, then press <Enter> to display the hardware inventory of your system.

Note: See the *IRIX Advanced Site and Server Administration Guide* for information on reconfiguring your system.

9. Quit the Command Monitor by typing **Exit** at the >> prompt.
10. The System Maintenance menu reappears. Type **1** to select the "Start System" command. The system comes completely up.

Installing the Operating System

The basic IRIX® operating system is factory-installed on your system disk. No software installation is required. If additional software is desired, it must be downloaded either locally (using a CD player) or downloaded remotely, over the network. See the *IRIX Advanced Site and Server Administration Guide* for additional information about mounting and configuring drives. Refer to the *IRIS Software Installation Guide* for the steps required to download the software.

Note: A copy of the IRIX operating system is supplied with the system on a compact disc (1/4-inch tape can be special-ordered). Place the CD or tapes in a secure place in case you ever need to reinstall the operating system.

Powering Off the System

The system should be powered off only for routine maintenance or repair. Power your system off as follows:

1. Become superuser by typing **/bin/su** and pressing **<Enter>**.
2. Enter your superuser password, if prompted.
3. When the superuser prompt (**#**) appears, type **/etc/shutdown** and press **<Enter>**.

A message similar to the following appears on the screen:

```
Okay to power off the system now.  
Press any key to restart.
```

4. Open the lower front access door, insert the key in the key switch, and turn the key switch to the Off position.

5. Turn off the power switches for the system and the peripherals in the following order:
 - Printer (if installed)
 - Terminal
 - System chassis

Note: Before you power off the server, be sure to inform all of the server's clients in advance.

Resetting Your System

Reset your system by turning the key switch, next to the System Controller function buttons, to the Manager position. Use the scroll buttons to bring up the Reset menu. Press the Menu button to activate the menu, then press the Execute button to reset the system. Use only the Reset function, not the main power switch, to reboot your system if the system is completely unresponsive. If your system responds to input, use the *halt* command.

Installing and Using Optional Peripherals

This chapter describes how to add additional storage devices, as well as peripherals such as printers and modems, to your Challenge server.

Configuring and Installing Additional FLDs

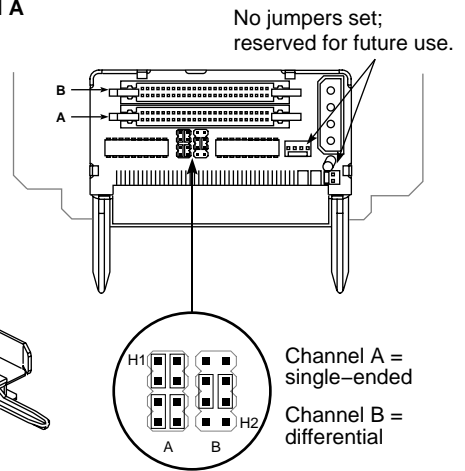
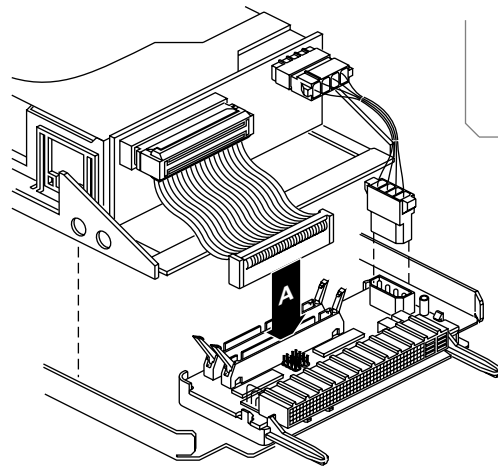
This section shows you how to configure and install a Silicon Graphics FLD. The information provided covers the hardware configuration. Refer to the chapter titled “Disks and Tape Drives” in the *IRIX Advanced Site and Server Administration Guide* to configure the system software.

Before you install an FLD in the SCSIBox 2 drive enclosure, perform the following four steps:

1. Determine whether or not the drive in the FLD is single-ended or differential.
2. Each FLD is shipped with a drive sled channel adapter that must be configured to match the attached drive. Then the FLD must be installed in a SCSI channel of the same configuration as the drive and the channel adapter. Ensure that your channel adapter configuration matches the configuration of your drive. Figure 4-1 and Figure 4-2 show the possible channel configurations.

Note: The channel adapter must be configured for *both* of the SCSIBox channels. Do not install an FLD in the SCSIBox with only one channel configured.

Single ended, 50-pin SCSI drive on channel A



Differential, 68-pin SCSI drive on channel B

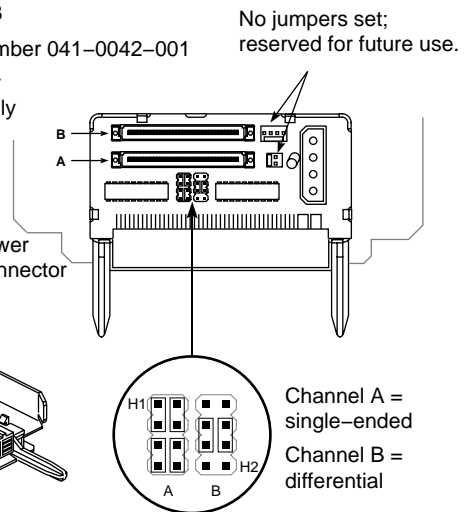
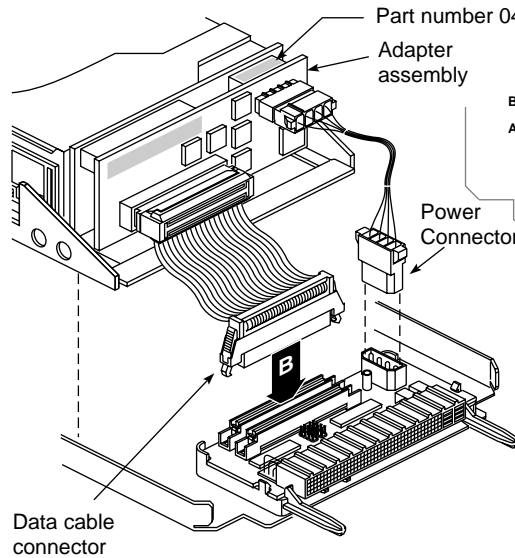
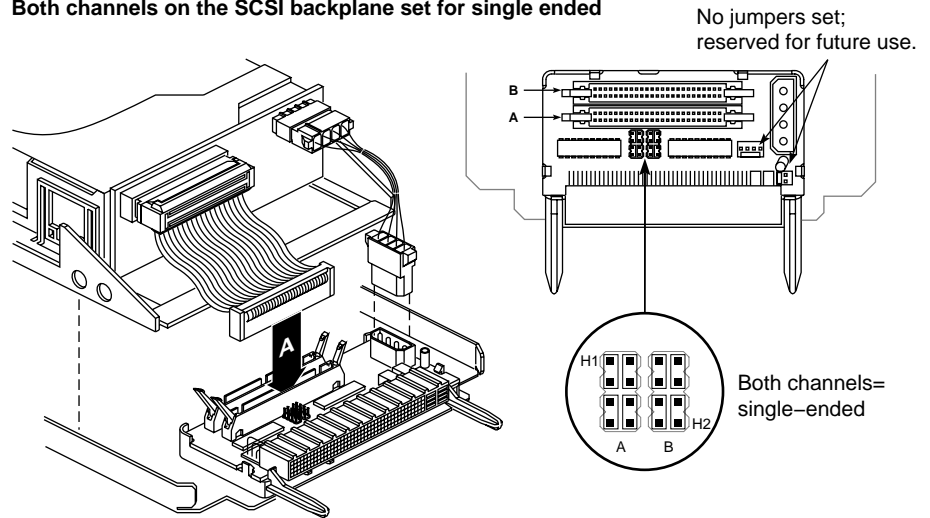


Figure 4-1 Channel Adapter Settings (Different Channel Configurations)

Both channels on the SCSI backplane set for single ended



Both channels on the SCSI backplane set for differential

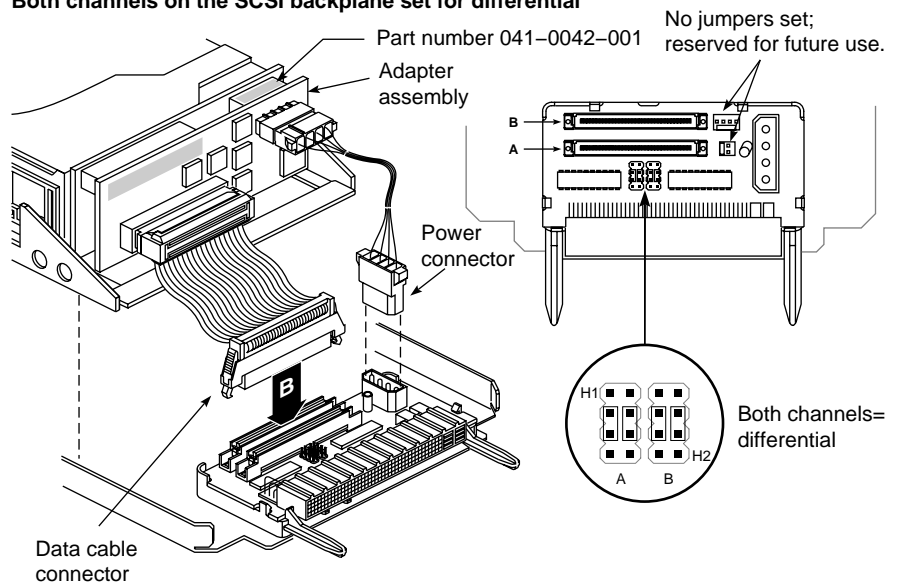


Figure 4-2 Channel Adapter Settings (Same Channel Configurations)

3. Verify that the SCSI bus ID for your drive is a number between 1 and 7 (for single-ended SCSI buses), or between 1 and 15 (for differential SCSI buses), and that the number is not assigned to any other drive on the SCSI channel to which you are attaching it.

Caution: 0 is reserved as the bus ID for the SCSI bus controller. Never change the drive ID while the drive is running or data loss could occur.

Check the drive IDs currently used by your system by opening a shell tool and typing `hinv` and pressing **<Enter>**. The system displays a complete hardware inventory, listing all of the devices seen by the CPU. The ID for the device you are installing is displayed in a small window at either the front or the rear of the device (depending upon manufacturer). The drive ID on newer drives is set by either turning a small thumbwheel or by pushing a select button. Older drives use jumpers to set the drive ID.

4. Confirm that the FLD is configured for the SCSI channel that you wish it to communicate on.

Note: The two standard SCSI channels, located on the IO4 board, are factory preconfigured. Channel 0 is configured as single-ended and channel 1 is configured as differential. Channels 0 and 1 correspond to the SCSIbox channels A and B, respectively.

To select the SCSI channel to which the FLD will be attached, insert the free end of the ribbon cable, coming from the drive, into the connector on the drive sled channel adapter that corresponds to the selected channel (see Figure 4-1 and Figure 4-2).

Install or remove an FLD from the SCSIBox drive enclosure by referring to the procedure in Chapter 3, "Getting Started."

Symptoms of Mismatched FLD and SCSI Channel Configurations

The following list describes the more common symptoms associated with misconfiguring an FLD for the channel to which it is attached:

- If you plug a single-ended drive into a channel configured for differential operation, nothing on the channel works.

- If you plug a differential drive into a channel configured as single-ended, the differential drive will not work. Single-ended drives on the channel will continue to work.
- If you install a drive in the system and it refuses to reboot:
 - Power down the system, remove the drives, and recheck all the configuration settings on the FLD assembly.
 - Check to be sure that each drive on the channel has an individual SCSI ID number.
 - Contact your system administrator or service provider if the system refuses to boot after you reinstall the drives.

Caution: Never install a drive in a running system.

Configuring the SCSIBox 2 for Full-Height FLDs

Configure your SCSIBox 2 for full-height drives by following these steps:

1. Open the lower front door of the chassis and ensure that the system is powered off.
2. Open the door to the SCSIBox by releasing the 2 wing nuts (refer to Figure 3-2).
3. Identify the drive bay in which you want to install the full-height drive.

Note: A full-height drive occupies two SCSIBox drive bays. This means that wherever you decide to install the drive, the drive shelf to the immediate right must be removed.

4. Remove the two crosshead screws securing the upper and lower front corners of the drive shelf (see Figure 4-3). This requires a No. 0 crosshead screwdriver.

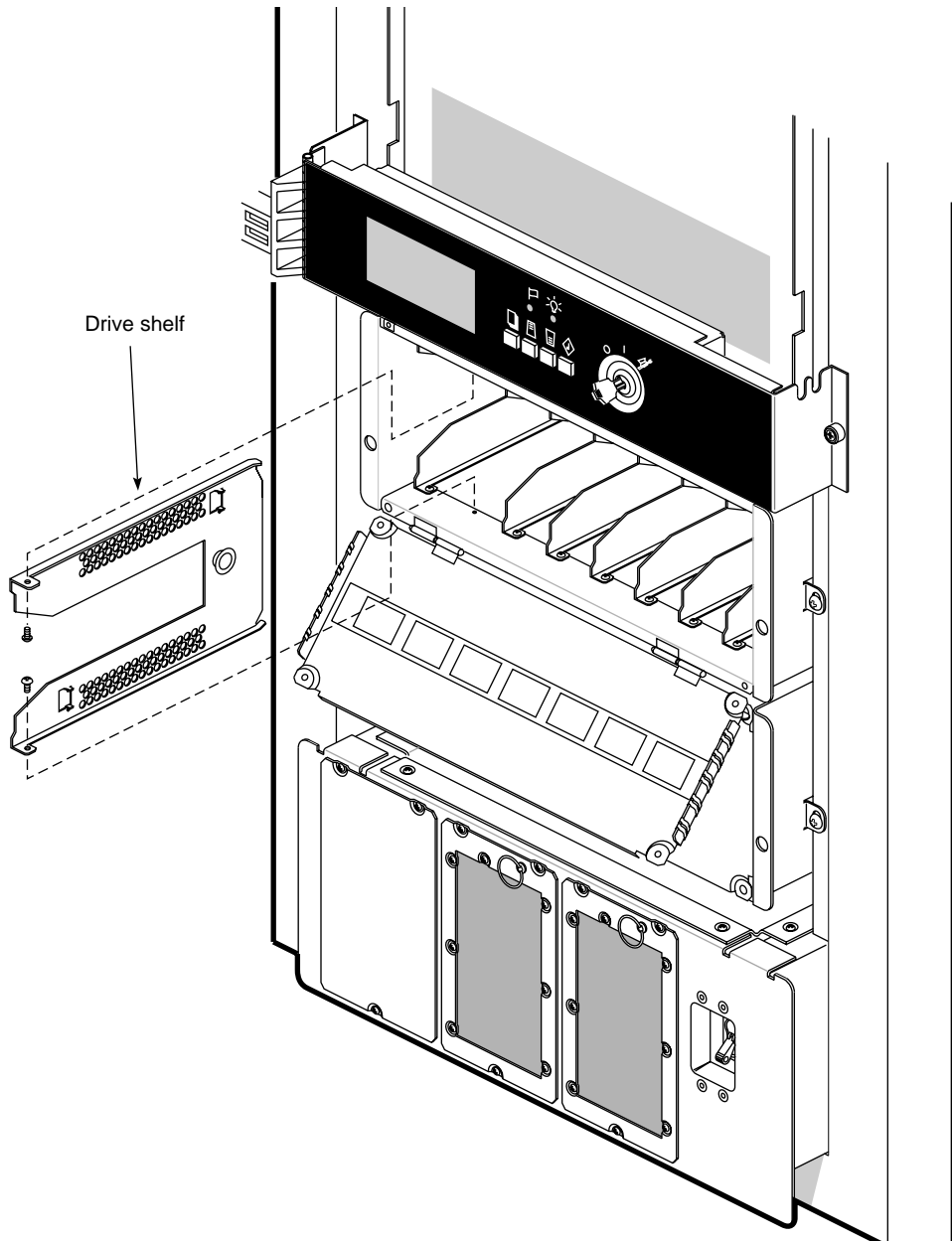


Figure 4-3 Removing a SCSIBox Drive Shelf

5. Remove the drive shelf from the front of the SCSIBox (note that the rear corners of the drive shelf have tabs to position them in the SCSIBox).
6. Store the drive shelf and its securing screws in a safe place in case you have to return the SCSIBox to its original configuration.
7. Configure the FLD, as described previously in this chapter. Refer to "Installing and Removing FLDs" in Chapter 3 for installation instructions.

Installing External SCSI Devices

External SCSI devices can be connected to the system if the Cardcage 2 I/O door is fitted with the appropriate connectors. External devices require either a 68-pin differential (DF SCSI) or a 68-pin single-ended (SE SCSI) connector. Figure 4-4 illustrates how to connect an external SCSI device. Table 4-1 and Table 4-2 provide pinout information for these connectors.

Note: See Chapter 3, "Getting Started," for limitations for SCSI cable lengths.

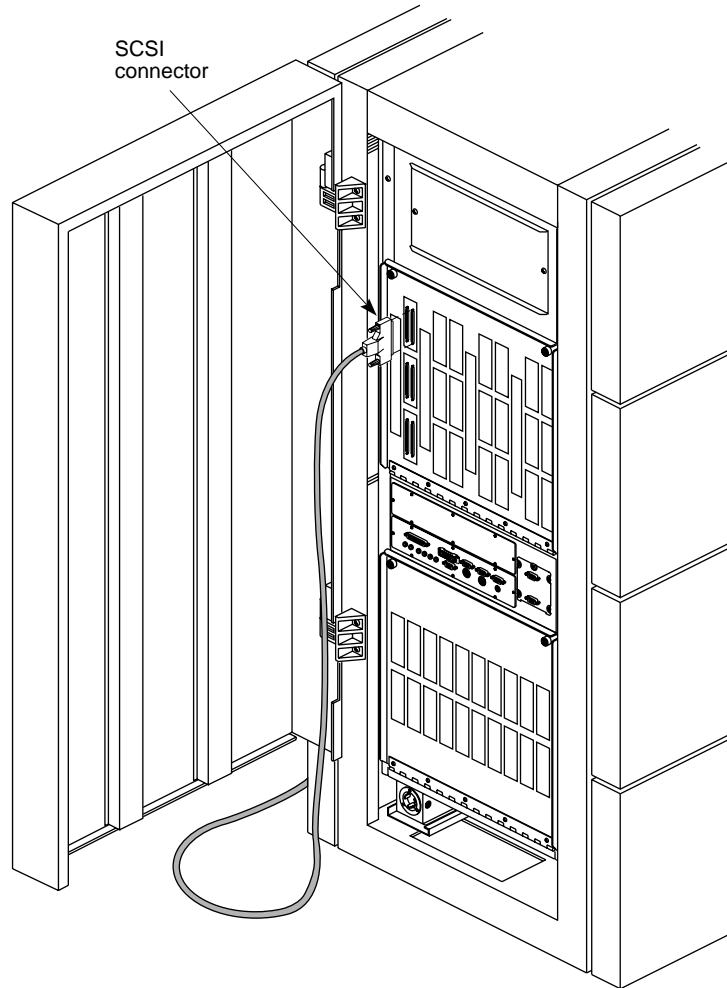


Figure 4-4 Connecting an External SCSI Device

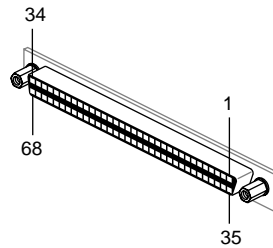
Note: A differential connector is labeled as DF SCSI, and a singled-ended connector is labeled as SE SCSI.

Table 4-1 68-Pin Single-Ended, High-Density SCSI Pinouts

Signal Name	Pin Number	Pin Number	Signal Name	Connector View
Ground	1	35	-DB(12)	See Figure 4-5.
Ground	2	36	-DB(13)	
Ground	3	37	-DB(14)	
Ground	4	38	-DB(15)	
Ground	5	39	-DB(P1)	
Ground	6	40	-DB(0)	
Ground	7	41	-DB(1)	
Ground	8	42	-DB(2)	
Ground	9	43	-DB(3)	
Ground	10	44	-DB(4)	
Ground	11	45	-DB(5)	
Ground	12	46	-DB(6)	
Ground	13	47	-DB(7)	
Ground	14	48	-DB(P)	
Ground	15	49	Ground	
Ground	16	50	Ground	
TERMPWR	17	51	TERMPWR	
TERMPWR	18	52	TERMPWR	
Reserved	19	53	Reserved	
Ground	20	54	Ground	
Ground	21	55	-ATN	
Ground	22	56	Ground	
Ground	23	57	-BSY	
Ground	24	58	-ACK	
Ground	25	59	-RST	
Ground	26	60	-MSG	
Ground	27	61	-SEL	
Ground	28	62	-C/D	
Ground	29	63	-REQ	
Ground	30	64	-I/O	
Ground	31	65	-DB(8)	
Ground	32	66	-DB(9)	
Ground	33	67	-DB(10)	
Ground	34	68	-DB(11)	

Table 4-2 68-Pin Differential, High-Density SCSI Pinouts

Signal Name	Pin Number	Pin Number	Signal Name	Connector View
+DB(12)	1	35	-DB(12)	See Figure 4-5.
+DB(13)	2	36	-DB(13)	
+DB(14)	3	37	-DB(14)	
+DB(15)	4	38	-DB(15)	
+DB(P1)	5	39	-DB(P1)	
Ground	6	40	Ground	
+DB(0)	7	41	-DB(0)	
+DB(1)	8	42	-DB(1)	
+DB(2)	9	43	-DB(2)	
+DB(3)	10	44	-DB(3)	
+DB(4)	11	45	-DB(4)	
+DB(5)	12	46	-DB(5)	
+DB(6)	13	47	-DB(6)	
+DB(7)	14	48	-DB(7)	
+DB(P)	15	49	-DB(P)	
DIFSENS	16	50	Ground	
TERMPWR	17	51	TERMPWR	
TERMPWR	18	52	TERMPWR	
Reserved	19	53	Reserved	
+ATN	20	54	-ATN	
Ground	21	55	Ground	
+BSY	22	56	-BSY	
+ACK	23	57	-ACK	
+RST	24	58	-RST	
+MSG	25	59	-MSG	
+SEL	26	60	-SEL	
+C/D	27	61	-C/D	
+REQ	28	62	-REQ	
+I/O	29	63	-I/O	
Ground	30	64	Ground	
+DB(8)	31	65	-DB(8)	
+DB(9)	32	66	-DB(9)	
+DB(10)	33	67	-DB(10)	
+DB(11)	34	68	-DB(11)	



68-pin Connector on I/O Panel

Figure 4-5 68-Pin Connector Pin Numbering

Using an Optional CD-ROM FLD to Load IRIX

Follow these instructions to use a CD-ROM drive, configured as an FLD, to load the IRIX operating system:

1. Verify that the CD-ROM drive is correctly mounted on a P8 drive sled and that it is configured for a single-ended SCSI channel.
2. Gain access to the SCSIBox drive enclosure and install the CD-ROM drive, as described in "Installing and Removing FLDs" in Chapter 3.
3. Locate the compact disc that contains the operating system.
4. Open a CD caddy by squeezing the corner tabs and simultaneously lifting the top cover.
5. Insert the CD into the caddy, as shown in Figure 4-6. The CD should fit under the lip at the end of the caddy.

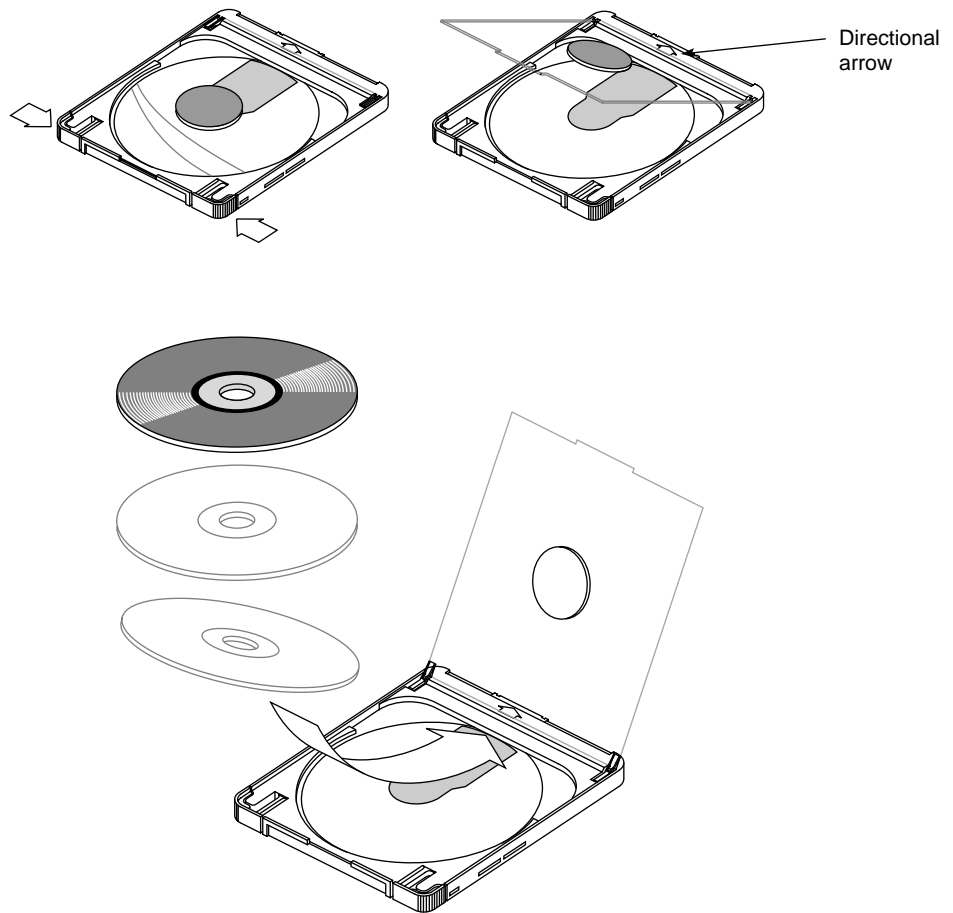


Figure 4-6 Loading a CD Into the Caddy

6. Close the caddy.
7. Hold the caddy by its tabs with the arrow pointing toward the CD-ROM drive (see Figure 4-7).
8. Insert the caddy into the CD-ROM drive.

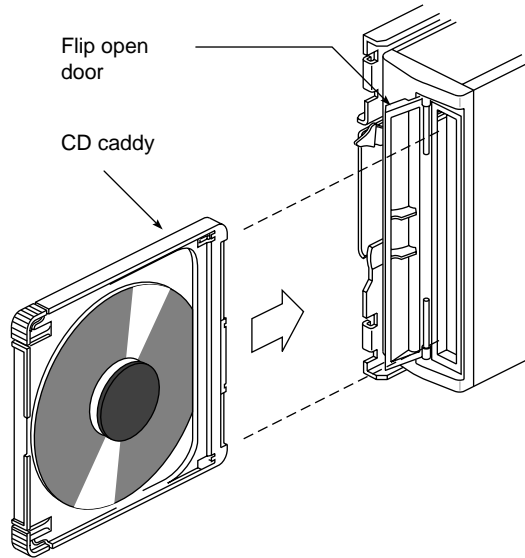


Figure 4-7 Inserting the CD and Caddy Into the Drive

9. Refer to the *IRIS Software Installation Guide* for complete instructions on loading the system software.
10. Load IRIX 5.0, or later, from the initial prompt. Select 2, as shown in the following example menu, to load the operating system from the CD-ROM drive.

```
Installing System Software
Select drive for installation:
1- tape tpsc (xxx,xx)
2- CDROM dksc (xxx,xx,x)
3- tape tpsc (xxx,xx)
which?
```

A series of dots displays as the operating system loads.

See Appendix B for information on proper maintenance and use of your CD-ROM drive and compact discs.

Figure 4-8 illustrates a typical CD-ROM drive and its controls.

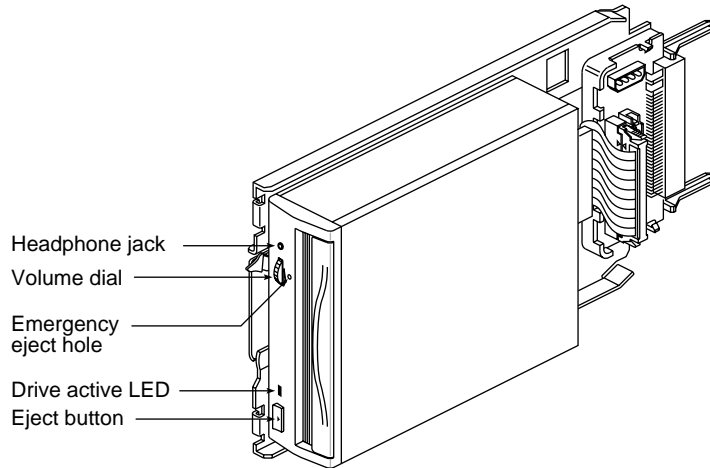


Figure 4-8 CD-ROM Front Panel Controls

Connecting a Serial Printer or an Additional ASCII Terminal

Connect a serial printer or second ASCII terminal to your system by attaching a printer cable to one of the 9-pin RS-232 connectors on the main I/O panel. If the peripherals that you are installing have 25-pin connectors, you must use a 9-pin to 25-pin adapter cable. The pin assignments for both connectors are shown in Table 4-3. Be sure that the pin assignments, not the pin numbers, on the system's serial port are properly matched to the pin assignments on your printer or terminal.

Table 4-3 Typical Null Modem Connector Pin Assignments

25-Pin (DB-25) Connector (Printer/Terminal)	9-Pin (DB-9) Connector (Challenge)	Signal Description (at Challenge)
3	2	Transmitted Data (TXD)
7	7	Signal Ground (GND)
2	3	Received Data (RXD)

Note: This product requires the use of external shielded cables in order to maintain compliance with Part 15 of the FCC rules. Serial cables from vendors other than Silicon Graphics may not be compatible. Verify the pinout of your cable before making the connection.

Connect a serial printer or terminal as follows:

1. Make sure the power switch on the printer or terminal is turned off and the power cord is not connected to an outlet.
2. Attach the appropriate cable to the printer or terminal.
3. Open the rear door of the system chassis to expose the main I/O panel.
4. Attach the free end of the printer or terminal cable to one of the serial connectors on the main I/O panel, as shown in Figure 4-9.
5. Attach the power cord and turn on the printer or terminal.
6. See the *IRIX Admin: Peripheral Devices Manual* for more information on configuring your printer and terminal.

Note: Your terminal should be configured for 9600 baud.

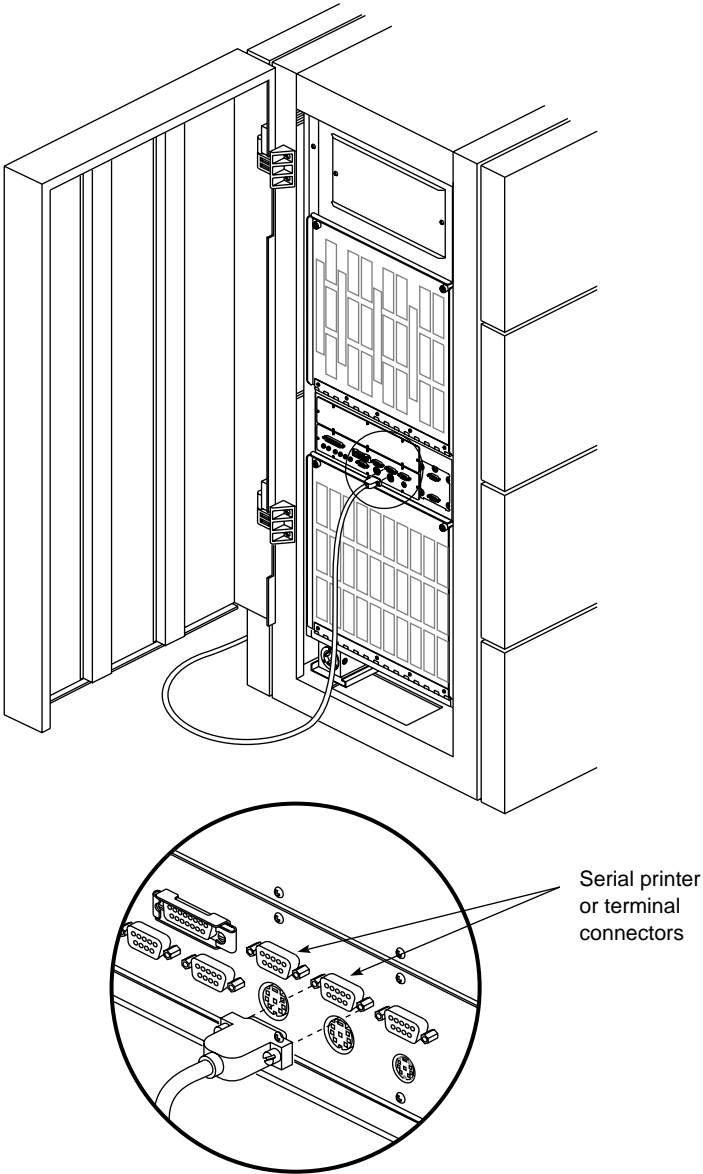


Figure 4-9 Connecting a Serial Printer or ASCII Terminal

Connecting a Parallel Printer

To connect a parallel printer to your system, attach the printer cable to the 25-pin parallel connector on the main I/O panel. The pin assignments for the Centronics compatible, 25-pin sub-D connector are shown in Table 4-4. Be sure that the pin assignments, not the pin numbers on the system's parallel port, are properly matched to the pin assignments on your printer.

Table 4-4 Parallel Printer Connector Pin Assignments

25-pin sub-D Connector	Signal Description
1	STB (Data Strobe)
2	DATA 0
3	DATA 1
4	DATA 2
5	DATA 3
6	DATA 4
7	DATA 5
8	DATA 6
9	DATA 7
10	DATA ACK
11	BUSY
12	PE (Paper Empty)
13	SLCT (Select)
14	AUTOFD (Autofeed)
15	ERROR
16	INIT (Reset)
17	SLCTIN
18-25	GND

Once you are sure that your cable is correctly configured, use the following procedure to connect the printer to your system:

1. Make sure the power switch on the printer is turned off and the power cord is not connected to an outlet.
2. Attach the appropriate cable to the printer.
3. Open the rear door of the chassis to expose the main I/O panel.
4. Attach the free end of the printer cable to the parallel connector on the main I/O panel, as shown in Figure 4-10.
5. Attach the power cord and turn on the printer.

See the *IRIX Admin: Peripheral Devices Manual* for more information on configuring your printer.

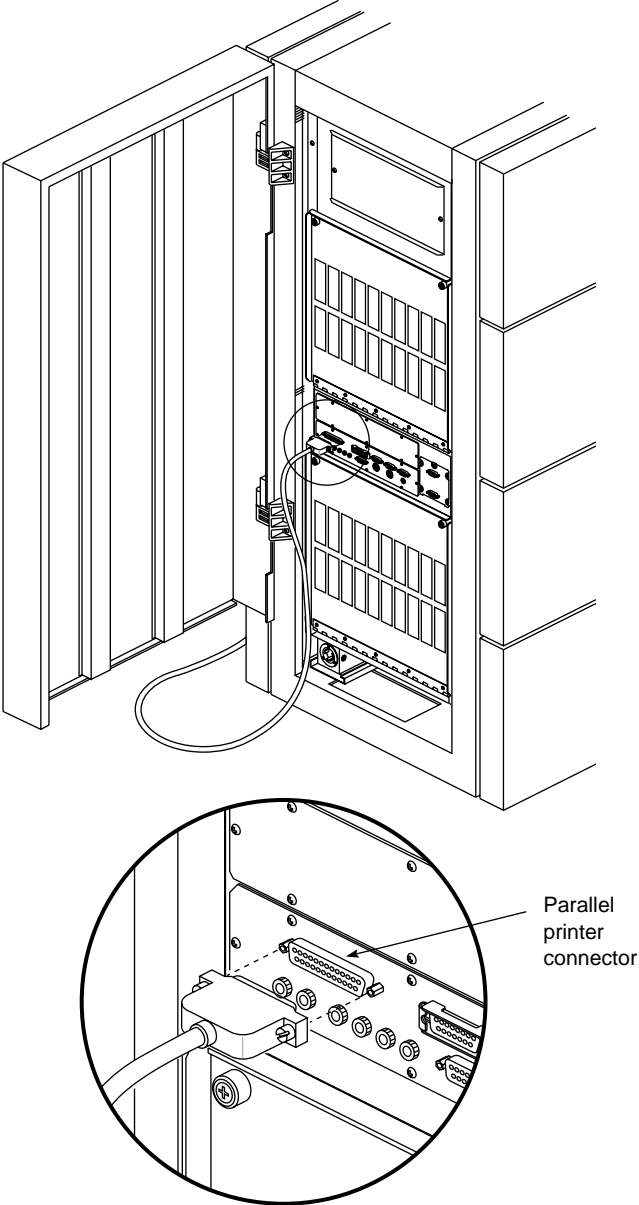


Figure 4-10 Connecting a Parallel Printer

Connecting a Modem

Attach a modem to your system using one of the 9-pin serial ports located on the main I/O panel, at the rear of the system chassis. Your modem has a 25-pin DB-25 female connector. To connect it to the system's 9-pin serial port, you need an RS-232 cable with a female DB-25 connector at one end and a male DB-9 connector at the other end.

Be sure that the pin assignments, not the pin numbers, on the system's serial port are properly matched to the pin assignments on your modem. The pin assignments for the 9- and 25-pin RS-232 connectors are shown in Table 4-5.

Table 4-5 25-Pin RS-232 Modem Connector Pin Assignments

25-Pin (DB-25) Connector at Modem	9-Pin (DB-9) Connector at Challenge	Signal Description at Challenge
20	9	Data Terminal Ready (DTR)
5	5	Clear to Send (CTS)
2	2	Transmitted Data (TXD)
3	3	Received Data (RXD)
4	4	Request to Send (RTS)
8	8	Data Carrier Detect (DCD)
7	7	Signal Ground (GND)

Request to Send (RTS) and Clear to Send (CTS) are the two signals that control the flow of data between the system and the modem. The modem turns on the CTS signal when it is ready to receive data and turns the signal off when it cannot accept any more information. The system uses RTS in the same way; RTS is turned on when the system can accept data and turned off when it cannot. These signals allow the system and the modem to exchange data at a high rate without running the risk of overflowing their respective data buffers and losing data.

Data Terminal Ready (DTR) tells the modem that the system is ready to begin a data exchange.

Transmitted Data (TXD) and Received Data (RXD) are the lines that transfer the data between the system and the modem. TXD carries data from the system to the modem, and RXD carries data from the modem to the system.

Data Carrier Detect (DCD) tells the system that a carrier signal is present at the modem.

Note: This product requires the use of external shielded cables in order to maintain compliance with Part 15 of the FCC rules. Serial cables from different vendors are not compatible.

Once you are sure that your cable is correctly configured, use the following procedure to connect a modem to your system:

1. Make sure the power switch on the modem is turned off.
2. Attach the cable to the modem.
3. Open the rear door of the chassis to expose the main I/O panel.
4. Attach the connector on the other end of the cable to one of the 9-pin serial connectors on the main I/O panel (refer to Figure 4-9).
5. Set the modem's baud rate to 9600.
6. Attach the modem power cord and turn on the modem.

Refer to the "Setting Up Modems" section in the *IRIX Advanced Site and Server Administration Guide*.

Activating Serial Ports on Additional IO4 Boards

If your system has more than one IO4 board, or if you have just added another IO4 board, you must perform the following procedure to activate the additional serial ports.

Note: If you don't know if your system has additional IO4 boards, you can check by looking at the IO panels. The system will have additional serial connectors as shown in Figure 2-6.

1. Using a text editor such as *jot* or *vi*, open the file `/var/sysgen/system/irix.sm` and find the following comment line:

```
*VECTOR: bustype=EPC module=epcserial unit=1 slot=? ioa=1
```

2. Remove the leading “*” to enable the comment line, and enter the appropriate slot number of the IO4 that has been added. The following is an example for a Challenge XL system with a second IO4 in slot 13 (the one next to the primary IO4).

```
VECTOR: bustype=EPC module=epcserial unit=1 slot=13 ioa=1
```

3. Write the file and save it.
4. Rebuild the kernel using the *autoconfig* command and then reboot.
5. Next, create the appropriate device nodes by typing:

```
/dev/MAKEDEV ttys
```

Note: Connectors are labelled sequentially, starting with the first IO4 board and proceeding through all installed IO4 boards. For example, the first serial connector on the first IO4 board is labelled `tty1`. See Table 4-6 for information on labelling a server system.

Table 4-6 Server System IO4 Board Connector Labelling

IO4 Board Number	IO4 Filter Board Label (Server)	Serial Connectors	Server Parallel Connectors	Network Connectors
1	EBus 15	RS-232: <code>tty1-3^a</code> RS-422: <code>tty4</code>	<code>plp15</code>	<code>et0</code>
2	EBus 13	<code>tty45-47^b</code>	<code>plp13</code>	<code>et1</code>
3	EBus 11	<code>tty49-51^b</code>	<code>plp11</code>	<code>et2</code>
4	EBus 9	<code>tty53-55^b</code>	<code>plp9</code>	<code>et3</code>

a. Connectors are labelled sequentially from right to left
 b. Connectors are labelled sequentially from top to bottom.

6. This creates the following files.

```
/dev/ttyd45 Major=0, Minor=5
/dev/ttyd46 Major=0, Minor=6
/dev/ttyd47 Major=0, Minor=7
/dev/ttyd48 Major=0, Minor=8
/dev/ttyf45 Major=0, Minor=101
/dev/ttyf46 Major=0, Minor=102
/dev/ttyf47 Major=0, Minor=103
/dev/ttyf48 Major=0, Minor=104
/dev/ttym45 Major=0, Minor=37
/dev/ttym46 Major=0, Minor=38
/dev/ttym47 Major=0, Minor=39
/dev/ttym48 Major=0, Minor=40
```

7. Afterwards, edit the */etc/inittab* file by changing the word “off” to “respawn” in the lines associated with the *ttys* that just been enabled, that is, *tyd45* through *tyd47*.

Note: The “tyd48” file corresponds to the RS422 port and does not need to have a getty started on it, since RS422 connectivity is supported only on the *primary* I/O panel, and is currently not supported on *secondary* I/O panels.

8. Execute *telinit q* to force the init process to reread */etc/inittab* and spawn gettys on the additional ports.

Device nodes of the form *ty[fm]** are used with modems. See the *getty(1M)*, *uugetty(1M)*, *init(1M)*, *gettydefs(4)*, and *inittab(4)* reference pages.

Note: Comments in the */etc/inittab* file are somewhat confusing since they refer to the older nomenclature and architecture used in previous Silicon Graphics systems. When “I/O” board is mentioned, you should infer “VME serial I/O controller”, and where “CPU board” is mentioned you should replace it “IO4 board”.

As alluded to earlier, the *MAKEDEV* script for *ttys* creates an extra set of device nodes for each IO4. For the second IO4, these are */dev/ttyd48*, */dev/ttyf48*, and */dev/ttym48*. Analogous nodes are created for subsequent IO4s. These nodes are benign and should cause no problem.

Activating Parallel Ports

Follow these instructions to enable the parallel ports for your system.

1. Type `cd /dev`.
2. Next, type `./MAKEDEV plp`.

The *MAKEDEV* command checks the hardware configuration of the system. It performs an *hinv* (hardware inventory) and, if the process sees an EPC (Everest peripheral controller), it makes parallel port device nodes for all 15 possible ports.

Having Trouble?

This chapter contains hardware-specific information that can be helpful if you are having trouble with your Challenge rackmount server.

Maintaining Your Hardware and Software

This section gives you some basic guidelines to follow to keep your hardware and software in good working order.

Hardware Do's and Don'ts

To keep your system in good running order, follow these guidelines:

- Do not enclose the system in a small, poorly ventilated area (such as a closet), crowd other large objects around it, or drape anything (such as a jacket or blanket) over the system chassis.
- Do not place terminals on top of the system chassis.
- Do not connect cables or add other hardware components while the system is turned on.
- Do not power off the system frequently; leave it running over nights and weekends, if possible.
- Do not leave the key switch in the Manager position.
- Do not place liquids, food, or heavy objects on the system, terminal, or keyboard.
- Ensure that all cables are plugged in completely.
- Ensure that the system has power surge protection.
- Route all external cables away from foot traffic.

Software Do's and Don'ts

When your system is up and running, follow these guidelines:

- Do not turn off power to a system that is currently running software.
- Do not use the root account unless you are performing administrative tasks.
- Make regular backups (weekly for the whole system, nightly for individual users) of all information.
- Protect all accounts with a password. Refer to the *IRIX Advanced Site and Server Administration Guide* for information about installing a root password.

System Behavior

The behavior of a system that is not working correctly falls into three broad categories:

Operational	You are able to log in to the system, but it doesn't respond as usual.
Marginal	You are not able to start up the system fully, but you can reach the System Maintenance menu or PROM Monitor.
Faulty	You cannot reach the System Maintenance menu or PROM Monitor.

If the behavior of your system is operational or marginal, first check for error messages on the System Controller display, then perform a physical inspection using the checklist in the following section. If all of the connections seem solid, restart the system. If the problem persists, run the diagnostic tests from the System Maintenance menu or PROM Monitor. See your *IRIX Admin: System Configuration and Operation Manual* for more information about diagnostic tests.

If your system is faulty, turn the power to the main unit off and on. If this does not help, contact your system administrator.

Physical Inspection Checklist

Check every item on this list:

- Make sure the terminal and main unit power switches are turned on.
- If the system has power, check the System Controller display for any messages, then reset the system.

Before you continue, shut down the system and turn off the power.

Verify all of these cable connections:

- The video cable is connected securely to the rear of the terminal and to the appropriate connector on the main I/O panel.
- The power cable is securely connected to the terminal at one end and to the power source at the other end.
- The keyboard cable is securely connected to the keyboard at one end and to the terminal at the other end.
- The system power cable is securely installed in the receptacle in the system chassis and in the proper AC outlet.
- The network cable is connected to the appropriate port. The key or lock used to secure the network connection is engaged.
- Serial port cables are securely installed in their corresponding connectors.

When you finish checking the hardware connections, turn on the power to the main unit and then to the terminal; then reboot the system. If your system continues to fail, restore the system software and files using the procedures described in the *IRIX Advanced Site and Server Administration Guide*. If the system fails to respond at all, call your service organization for assistance.

Using the System Controller

This section explains several ways to use the System Controller to diagnose system faults. The operator-selectable functions are described, as well as some common faults and the symptoms they exhibit.

You can select one of four menus when the System Controller key switch is in the On (middle) position:

- CPU Activity Display menu
- Boot Status menu
- Event History Log menu
- Master CPU Selection menu

The CPU Activity Display

The CPU Activity Display is a histogram that represents the activity of each system processor as a vertically moving bar. This is the default display and appears continuously unless an error occurs or a function key is pressed.

The Boot Status Menu

The Boot Status menu monitors the current state of the system during the boot arbitration process. Table 5-1 lists the messages that may appear in this menu.

Table 5-1 Boot Status Menu Messages

Master CPU Selection Message	Context and Meaning of Message
BOOT ARBITRATION NOT STARTED	The system CPU board(s) have not begun the arbitration process.
BOOT ARBITRATION IN PROCESS	The System Controller is searching for the bootmaster CPU processor.

Table 5-1 (continued) Boot Status Menu Messages

Master CPU Selection Message	Context and Meaning of Message
ARBITRATION COMPLETE BOARD O _x ZZ PROC O _x ZZ	The chosen bootmaster CPU has identified itself to the System Controller and communication is fully established.
BOOT ARBITRATION INCOMPLETE NO MASTER	An error has occurred in the boot process and no bootmaster CPU is communicating with the System Controller.

The Event History Log

The System Controller assigns space in its nonvolatile random access memory (NVRAM) for ten error and/or status messages. This space is referred to as the Event History Log.

If the system cannot completely boot, or if there are system problems, or if the system has shut down, check the System Controller display. The histogram in the display will have been replaced with one or more error messages from the Event History Log. Write down any error messages for use by your system administrator or by qualified service personnel. Refer to Appendix C for a complete listing of the possible error messages.

Note: When the system is rebooted, the System Controller will transmit the errors it has logged in NVRAM to the bootmaster CPU. They are then placed in */usr/adm/SYSLOG*.

The Master CPU Selection Menu

The Master CPU Selection menu displays the last message sent by the Master CPU after the bootmaster arbitration process has completed. The four possible messages are identical to the Boot Status menu messages listed in Table 5-1.

The Power-On Process

During a normal power-on sequence, both the green power-on LED and the amber fault LED light. When the System Controller initializes and completes its internal diagnostics, the amber LED goes out.

Note: If the amber fault LED stays on for more than a few seconds, a fault message should appear. If the LED stays on and no message appears, the display may be faulty or there may be a problem with the System Controller. Contact your system administrator or service provider.

The following steps describes what you should see when you bring up the system:

1. When the System Controller completes its internal checks and the system begins to come up, two boot messages appear:

```
BOOT ARBITRATION IN PROCESS  
ARBITRATION COMPLETE BOARD 0xZZ PROC 0xZZ
```

A flag message appears: Onyx C. 1993

2. The screen clears and the message `STARTING SYSTEM` appears.
3. A series of status messages scroll by. Most messages pass by so quickly that they are unreadable. These messages indicate the beginning or completion of a subsystem test.
4. After all of the system checks are complete, you receive a status message that looks similar to:

```
PROCESSOR STATUS  
B+++
```

The `B+++` shown in step 4 indicates that the bootmaster CPU is active, along with three other functioning processors on the CPU board. If the bootmaster CPU has only two slave processors on board, you see:

```
PROCESSOR STATUS  
B+
```

If you receive a processor status message followed by `B+DD`, you have a CPU board with two of its processors disabled. Contact your system administrator to determine why the processors were disabled.

If you receive a processor status message like B+-- or B+XX, the CPU board has defective processors on board. Make a note of the exact message and contact your service provider for help.

If the System Hangs

If the system does not complete step 3 in the power-on process, an error message will appear and remain on the System Controller's display. Make a note of the exact message where the system stops, and contact your service provider.

Note: The message displayed on the System Controller display can provide the service person with valuable information.

If an Over-Temperature Error Occurs

If the system shuts down because an OVER TEMP condition occurs, the entire system powers down, including the System Controller. To find the fault, turn the key switch off and then on again. The display should show the origin of the OVER TEMP error. If the system immediately shuts down again, wait for several minutes to allow the mechanical temperature sensor switch to cool below its trip point.

Recovering from a System Crash

Your system might have crashed if it fails to boot or respond normally to input devices such as the keyboard. The most common form of system crash is terminal lockup—a situation where your system fails to accept any commands from the keyboard. Sometimes when a system crashes, data becomes damaged or lost.

Using the methods described in the following paragraphs, you can fix most problems that occur when a system crashes. You can prevent additional problems by recovering your system properly after a crash.

The following list presents a number of ways to recover your system from a crash. The simplest method, rebooting the system, is presented first. If it fails, go on to the next method, and so on. Here is an overview of the different crash recovery methods:

- rebooting the system

Rebooting usually fixes problems associated with a simple system crash.

- restoring system software

If you do not find a simple hardware connection problem and you cannot reboot the system, a system file might be damaged or missing. In this case, you need to copy system files from the installation tapes to your hard disk. Some site-specific information might be lost.

- restoring from backup tapes

If restoring system software fails to recover your system fully, you must restore from backup tapes. Complete and recent backup tapes contain copies of important files. Some user- and site-specific information might be lost.

Refer to your *IRIX Admin: Backup, Security, and Accounting Manual* for instructions for each of the recovery methods listed above.

Safety and Comfort

This chapter gives you important information about setting up your Challenge rackmount server for maximum safety and comfort.

Human Factors Guidelines for Setting Up Your System

You can increase the comfort and safety of your work environment and decrease your chances of cumulative trauma disorders by following the guidelines given below. These guidelines can help you to create a healthy and productive work environment by

- properly choosing a site for your system and its components
- setting up your desk and chair correctly

ANSI Standard for VDT Terminal Workstations

Table 6-1 shows recommended guidelines for furniture and system adjustment, as developed by the American National Standards Institute (ANSI). Adjustment parameters are defined in Figure 6-1. Guidelines are shown for small persons (standing height of 150 cm or 59 in.) and large persons (standing height of 185 cm or 73 in.). Midpoints are also interpolated for persons of average height.

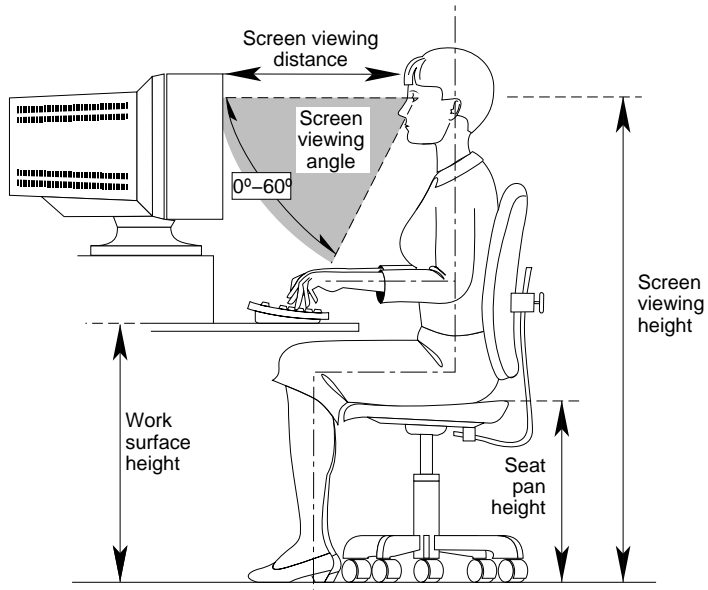


Figure 6-1 Basic Guidelines for VDT Workstation Adjustment (Adapted From ANSI/HFS 100, 1988)

Table 6-1 ANSI/HFS 100 Guidelines for VDT Workplace Adjustment (1988)

Adjustment	Small Person cm (in.)	Midpoint cm (in.)	Large Person cm (in.)
Seat pan height	40.6 (16.0)	46.3 (18.2)	52.0 (20.5)
Work surface height	58.5 (23.0)	64.75 (25.5)	71.0 (28.0)
Screen viewing height	103.1 (40.6)	118.1 (46.5)	133.1 (52.4)
Screen viewing distance	>30.5 (>12)	>30.5 (>12)	>30.5 (>12)
Screen viewing angle	0-60 degrees	0-60 degrees	0-60 degrees

Note: Local VDT guidelines issued by country, state, or municipality may apply and supercede the guidelines in Table 6-1.

CAD Operator Preferences

If you work on a CAD system, you may feel more comfortable using the ranges of adjustment shown in Table 6-2.

Table 6-2 Adjustments Preferred by CAD Users

Adjustment	Mean cm (in.)	Range cm (in.)
Seat pan height	54 (21.3)	50-57 (19.7-22.4)
Work surface height	73 (28.7)	70-80 (27.6 -31.5)
Monitor center above floor	113 (44.5)	107-115 (42.1-45.3)
Screen viewing distance	70 (27.6)	59-78 (23.2-30.7)
Work surface tilt	8.6 degrees	2-13 degrees
Monitor tilt	-7.7 degrees	-15 to +1 degree

Note: A negative tilt is a forward monitor inclination (top of the screen toward the operator)

Note: The information in Table 6-2 is derived from Grandjean, Etienne. *Ergonomics in Computerized Offices*. London: Taylor & Francis Ltd., 1987, p. 148.

Tips for Setting Up and Using Your System

The following tips may be useful for setting up an ergonomic work environment that is safe, comfortable, and productive. Although you may be able to perform this procedure yourself, it is useful to work with a friend to achieve the best fit.

Facilities Selection

1. A good work chair should swivel, and you should be able to adjust the seat height while sitting. The seat should have a rounded front edge. The chair should have a large enough base to remain stable when adjusted to its maximum height. It should have castors or glides. Many chairs rock, which may partially relieve the muscle tension from sitting in a fixed position. Some chairs can also be adjusted for seat tilt and depth, armrest height, back rest angle, and lower back support. Check the instructions that came with your chair to take advantage of its adjustability features.
2. Select a work surface that provides enough space to do your work without excessive turning, twisting, or stretching. The height of the work surface should be adjustable and, if possible, the workspace should be wide enough to use the mouse and keyboard at the same height. This will help your neck, shoulders, and upper arms to stay relaxed while you work.
3. Indirect lighting should be used, whenever possible, to prevent glare on the display screen. If you prefer lower levels of lighting (for example, 200–250 lux) than usually found in offices, separate task lighting may be needed for reading documents. Wearing dark-colored clothing helps minimize glare reflections on the screen.

Adjusting Your Chair, Work Surface, and Terminal

1. Adjust your chair first, from a seated position if possible. Your lower leg and thigh should form approximately a 90-degree angle at the knee, and your feet should rest flat on the floor. If you are short, you may want to use a footrest for better comfort.
2. Once your chair is adjusted, raise or lower your work surface to a height that allows you to keep the wrists flat and straight while using the keyboard. The angle between your lower and upper arm should be 70–90 degrees at the elbow. If necessary, use a padded wrist rest under the keyboard to support your wrists.
3. To minimize screen glare, position your terminal screen perpendicular to overhead lighting sources and windows. Do not set the terminal in front of or behind a window, or parallel to other sources of light. Tilting

the screen slightly forward helps avoid glare. Adjusting the terminal controls to minimize brightness and maximize contrast may also reduce the effects of glare.

4. Adjust your terminal height so your line of sight in your regular seated position is at or near the top the screen. You should be able to see the whole screen without tilting your head forward or backward, within a 60-degree viewing angle of the normal line of sight. With smaller terminals, this may require using a display stand under the terminal base. With larger terminals, it may require a longer viewing distance (refer to Table 6-2).

These adjustment steps should be done each time a different person uses the system.

System Usage

1. When using the keyboard, or other input devices, keep your wrists flat as much as possible, and do not rotate your hands inward toward the thumbs or outward toward the fingers.
2. Electronic keyboards and input devices do not require as much force to operate as manual typewriters. Type or click lightly on the keyboard.
3. Document stands can be mounted on the work surface or swing out on an arm to position documents next to the display. These can be helpful in maintaining a healthy posture for using the workstation (head in approximately a straight line with the body).
4. You may find it helpful to take rest breaks of several minutes every one to two hours. During breaks, focus your eyes on objects or scenery at least 30 feet away, stretch, and move around.

Electrostatic Discharge

Silicon Graphics designs and tests its products to be resistant to the effects of electrostatic discharge (ESD). ESD is a source of electromagnetic interference and can cause problems ranging from data errors and lockups to permanent component damage.

It is important that while you are operating your system, you keep all the covers and doors in place. The shielded cables that came with the system and its peripherals should be installed correctly, with all screws fastened securely.

To ensure the proper function and/or data integrity in your peripherals, electrostatic discharge precautions should be taken when removing or replacing the Front Loading Devices. An ESD wrist strap should be used, along with antistatic packaging materials, during peripheral transport or storage.

Hardware Specifications

The physical, electrical, and environmental specifications for the Challenge rackmount server are listed in Table A-1.

Table A-1 Challenge Rackmount Server Specifications

Parameter	Characteristics
Enclosure	
Dimensions	27" w (69 cm) x 48" d (122 cm) x 62.3" h (159 cm)
Weight	560 lbs (254 kg), base configuration 1200 lbs (544 kg), maximum
Lower vertical opening	23 inches (58 cm)
Total vertical opening	56 inches (124 cm)
Minimum Clearance	
Left side	33 inches (84 cm)
Right side	36 inches (91.4 cm)
Rear panel door	42 inches (106.7 cm)
Front	37 inches (94 cm)
Electrical	
Voltage	208-240VAC
Frequency	47-63 Hz, single phase
Current	30 amps, maximum
Power	5700 watts, maximum
Power supply	1900 watts, 1-3 Offline switchers

Table A-1 (continued) Challenge Rackmount Server Specifications

Parameter	Characteristics
Temperature	
Operating	15° to 35°C
Nonoperating	-40° to 50°C
Humidity	
Operating	20 to 80% relative humidity, noncondensing
Nonoperating	20 to 95% relative humidity, noncondensing
Thermal output	600 Btu/hr, maximum
Heat dissipation	10,900 Btu/hr chassis

Drive Maintenance

This appendix describes the preventive maintenance required for systems having 1/4-inch tape drives, 4 mm DAT and 8 mm tape drives, as well as CD-ROM drives.

Cleaning the 4 mm DAT and 8 mm Tape Drives

These are the manufacturers' recommended cleaning schedules:

- Clean the 4 mm DAT drive every 25 hours of use.
- Clean the 8 mm tape drive once every 30 GB of data transferred, or after 15 passes.

Note: When the drive heads are dirty and need cleaning, the units may exhibit either read or write errors.

Use only an approved cleaning kit when cleaning the drives. You can use a cleaning kit a limited number of times before you must replace it. For example, you can use the 4 mm drive cleaning kit approximately 60 times; however, you can use the 8 mm drive cleaning cartridge only 12 times. Refer to the information supplied with the cleaning kit to determine the replacement interval. Do not use cleaning kits that are intended for use in audio DAT units, since these cassettes are not recognized by the drives covered in this guide.

Archive Python 4320 NT (4 mm DAT Drive)

The Archive Python 4320 NT provides 1.3 GB of storage on a 60 m Digital Data Storage (DDS) DAT cassette and 2.0 GB of storage on a 90 m DDS DAT cassette. The 4320 NT drive complies with the American National Standards

Institute (ANSI) DDS format and uses a small DAT with 4 mm tape. The data transfer rate is 183 KB per second. Note that these capacity and transfer rate figures are approximate.

Loading and Unloading Cassettes

To load a tape cassette, insert it into the drive, so that the arrow on the top of the cassette enters the drive first. Then push gently on the middle of the cassette until the tape is fully recessed in the drive unit.

When you load a cassette into the drive, the unit checks to see if the tape is initialized. This checking process takes between 10 and 20 seconds. If the tape has never been initialized, the drive will initialize it when you first start to write data to the tape. Initializing the tape takes an extra 30 seconds beyond what is required to write the data.

Note: Do not remove the tape from the drive while it is being initialized.

To remove a cassette, press the unload button on the face of the drive. The unit automatically rewinds the tape and ejects it part way. Grasp the cassette and remove it from the drive. Note that the unload button is disabled when the drive is in use.

Cleaning the 4 mm DAT Drive

To clean a 4 mm DAT drive:

1. Insert the cleaning cassette into the drive. The drive automatically detects that the cassette is a cleaning cassette, then loads and runs the cassette. After about 10 to 15 seconds, the cleaning is complete and the drive ejects the cassette.
2. Remove the cleaning cassette from the drive and make a note, either in a log book or on the cassette itself, of the date when you used the cleaning kit.

Note: Every time you use the cleaning cassette, the drive uses a new, unused portion of the tape. Eventually, the entire tape is used and you must obtain a new cleaning cassette. Therefore, it is a good idea to keep track of the number of times you use each cleaning cassette.

4 mm Drive Front Panel Lights

The 4 mm drive has two LEDs, one green and one amber, that indicate the status of the unit (see Table B-1).

Table B-1 4 mm DAT Front Panel LEDs

LED	Action	Meaning
Amber	On (lit)	The drive is reading or writing the tape (normal operation).
Amber	Flashing rapidly	A hardware fault occurred, or condensation was detected in the unit (error).
Green	On (lit)	A cassette is loaded in the drive, and it does not generate excess errors (normal operation).
Green	Flashing slowly	A cassette is inserted, but is generating excess soft errors beyond a predefined error threshold (warning: heads may need cleaning).
Green	Flashing slowly with amber LED	A prerecorded audio cassette is inserted and is being played automatically.
Green	Flashing rapidly	The drive cannot write the tape correctly (error).

Removing a Jammed 4 mm Cassette

To remove a tape that has jammed in a 4 mm tape drive, follow these steps:

1. Power cycle the tape drive and then try ejecting it.
2. If this does not eject the drive, power cycle it while holding down the unload button.

If neither of these two steps ejects the jammed cassette, contact your service provider.

Exabyte 8 mm Tape Drive

The Exabyte[®] 8 mm tape drive provides 2.3 GB of data storage on a standard 8 mm cartridge tape.

Cleaning the 8 mm Tape Drive

Cleaning the tape drive requires use of an Exabyte or Exabyte-approved 8 mm cleaning cartridge.

Caution: Use of cleaning materials not approved by Exabyte can void the tape drive's warranty.

To clean the tape drive:

1. Check to see if an 8 mm tape cartridge is present in the drive. If so, press the unload button and remove the cartridge. Leave the drive's door open.
2. Insert the Exabyte or compatible cleaning cartridge and close the drive. The tape drive automatically runs through the 15-second cleaning cycle. The cleaning tape automatically ejects when the cleaning is complete.

Note: If the cleaning cartridge ejects from the drive before the 15-second cleaning cycle ends, the cartridge has been used up and should be discarded. Do not rewind the cleaning cartridge or use it for more than its specified number of cleaning cycles.

3. Remove the cleaning cartridge from the drive, record the date on the label, and store it for future use.

Front Panel Lights

The 8 mm tape drive has two front panel lights: an amber LED and a green LED. In general, the green LED indicates whether or not the drive is ready to accept commands, and the amber LED indicates that the drive is busy or an error has occurred. Table B-2 lists the LED status and error messages.

Table B-2 8 mm Tape Drive Front Panel LEDs

Amber LED	Green LED	Meaning and Corrective Action
On	On	Power-on initialization—approximately 60 seconds.
Off	Off	Passed power-on self tests.
Off	On	Tape is loaded, drive is ready.
Off or On	Slow Flashing	The drive is reading or writing a tape (normal operation).
On, Off, or Flashing	Flashes four times, then stays on	Servo error—press the unload button to reset the drive. If this does not clear the problem, power cycle the drive. If the problem persists, call your service provider.
Slow Flashing	On or Off	A CRC error occurred within the first two seconds of a power-on reset. Power-cycle the drive. If the problem persists, the drive needs service.
Slow Flashing	On or Off	An unrecoverable fault has occurred during operation. Press the unload button to reset the drive. If this does not correct the problem, power-cycle the unit and clean the tape heads. If these steps fail, call your service provider.
Fast Flashing	Off	The drive failed a power-on self test; try power-cycling the drive. If the problem persists, the drive needs service.

Removing a Jammed 8 mm Tape Cartridge

To remove a tape that has jammed in an 8 mm tape drive, follow these steps:

1. Power-cycle the tape drive and then try ejecting the tape.
2. If this does not eject the tape, power cycle the drive again while holding down the unload button.

If neither of these two steps ejects the jammed cassette, contact your service provider.

CD-ROM Care and Maintenance

CD-ROM drives are most vulnerable to damage when they are unpacked and not yet mounted in a computer system. When handling a drive after unpacking, there are two major types of damage to be aware of:

- rough handling (impact damage)
- electrostatic discharge (ESD)

Dropping an unpacked drive onto a hard surface can cause damage. A sharp jolt can cause the laser to track improperly.

Avoid touching the drive's printed circuit board (PCB). Leave the unit in ESD protective wrap as long as possible. Use a static-conductive mat and/or antistatic grounding devices when inspecting or handling the drive. Additional handling tips are:

1. Keep the drive in the packing box or antistatic bag until the installation.
2. Handle the drive by its frame; avoid touching the drive's PCB.
3. Install drives in a clean work area.
4. Wear a properly grounded ESD strap when handling the drive.

To remove dust or other particles from a CD, use compressed air. You may also clean the CD in running water and then blot it dry with a soft lintless cloth (do *not* use a paper towel). Wipe the cloth directly outward from the center of the disc. Do not rub in a circular motion as you would with a standard phonograph record.

Caution: Do *not* use solvents or other common cleaners, and *do not* use your mouth to blow dust or other particles off the disc.

Individual discs should be handled by the edges only (see Figure B-1). Touching or scratching the bottom of the disc can mar the finish and degrade the optical readability of the media. Do not write, label, or mark on any surface of the compact disc. An auto-eject occurs when you insert a very dirty or badly scratched disc (or a disc placed label-side down in the operating case caddy).

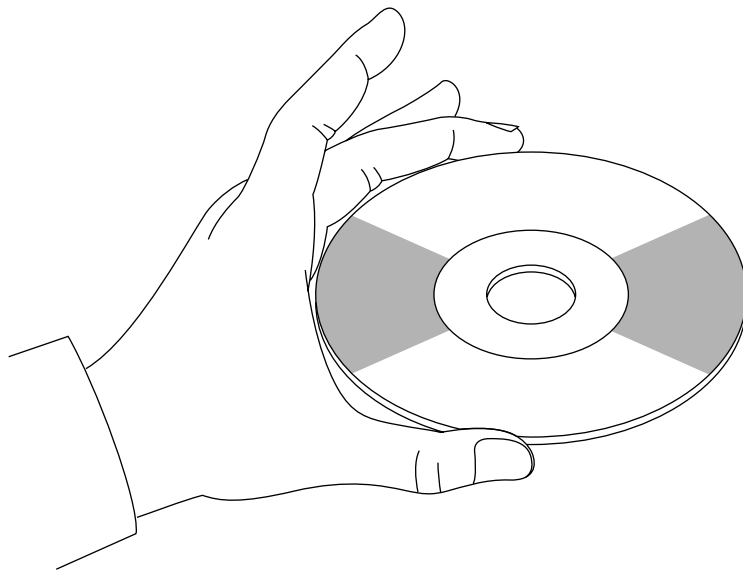


Figure B-1 Handling a Compact Disc

CD-ROM Environmental Considerations

Bringing a disc from a cold to a warm environment may cause moisture to form on its surface. Wipe any condensed moisture off with a soft lint-free cloth (not a paper towel) before use. Allow approximately one hour for the disc to acclimate to room temperature.

Protect the discs from dust, scratches, and warping by storing them in a caddy or non-functional plastic storage container (known as a jewel case). Never leave or store discs in the following areas:

- locations exposed to direct sunlight
- dusty and/or humid environments
- areas directly exposed to heating appliances or heat outlets
- in a vehicle parked in the sun

CD-ROM Front Panel Operational Features

A number of operation controls are located on the front panel of the CD-ROM drive:

- The *headphone jack* accepts a 3.5 mm diameter stereo plug. Monitoring of audio signals is available.
- The *volume control dial* (located to the right of the headphone jack) adjusts the sound level of the headphones.
- An *emergency eject hole* (located just above the volume control) ejects the caddy when normal procedure does not work. Power off the CD-ROM drive and insert the end of a large straightened paper clip into the hole until the caddy cartridge ejects.
- A *drive-active indicator LED* (located to the left of the eject button) blinks to indicate drive activity. The LED stays dark when no disc caddy is loaded in the drive. See Figure B-2 for details on blink patterns and the status they indicate for the drive.
- The *Eject button* works *only* when the CD-ROM drive is powered on. The caddy will not eject if the CD-ROM is in an active (busy) state. After pushing the Eject button, two to three seconds elapse before release occurs.

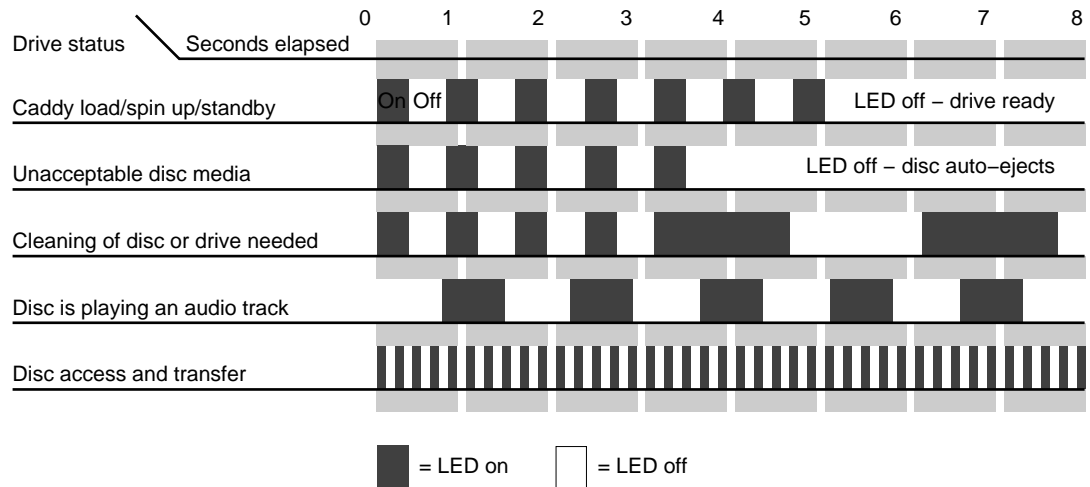


Figure B-2 CD-ROM Drive LED Status Indicators

150MB Tape Drive Preventive Maintenance

Head cleaning is the only preventive maintenance required by the 1/4-inch tape drive. The tape head should be cleaned after every eight hours of tape drive operation and after every two hours of operation when new tapes are used exclusively.

Note: The head cleaning procedure must be routinely done after every two to eight hours of operation to ensure proper tape drive function.

Clean the tape head by following these steps:

1. Remove the tape cartridge from the tape drive.
2. Push the head loading lever to the right, as if you had installed a tape. This engages the tape head, allowing you to reach it.
3. Dip a clean, non-fibrous cotton swab in either tape head cleaning fluid or Freon-TF, and wipe the tape head (see Figure B-3).

4. Use a second, clean swab and wipe the head again, to remove any residue.

Caution: Do not use cotton swabs that have wooden stems. The tip of the swab can break off and become lodged in the tape drive.

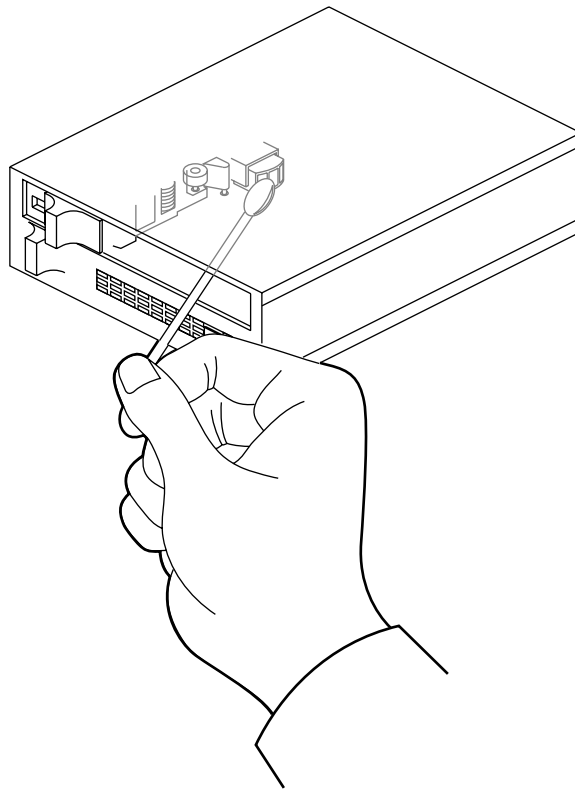


Figure B-3 Tape Head Cleaning

System Controller Error Messages

A complete list of all of the possible System Controller error messages is provided in Table C-1 through Table C-2.

Table C-1 Power-On Errors and Fault Identification

Error Message	Failure Area/Possible Solution
EBUS TEST 2 FAILED!	This comprehensive test of the Ebus indicates probable failure of the IP19 or a fault on the system midplane/backplane.
PD CACHE FAILED!	The primary data cache on the bootmaster microprocessor has failed.
NO IO4 FOUND!	No IO4 is seen during the system probe. Check for bent pins, reseal the IO4, or replace the IO4. A backplane problem is also possible.
NO IO4 UART FOUND!	IO4 probably bad.
MASTER IO4 FAILED!	IO4 probably bad.
IO4 UART FAILED!	IO4 probably bad.
INIT INV FAILED!	IO4 probably bad.
NO MC3 FOUND!	No MC3 was found during the system probe. Check for bent pins, reseal the MC3, or replace it. A backplane problem is also possible.
MC3 CONFIG FAILED!	The system MC3 has failed. If there is more than one MC3 present, there is a potential Ebus or IP19 board problem (if system uses a single CPU). Check system voltages with the System Controller. If voltages are out of range, swap out power board or OLS.
BUS TAGS FAILED!	There is a problem with the IP19.

Table C-1 (continued) Power-On Errors and Fault Identification

Error Message	Failure Area/Possible Solution
SCACHE FAILED!	The secondary cache on the bootmaster microprocessor failed. The SCACHE SIMM module is bad or the IP19 is faulty.
PROM DNLOAD FAILED!	The IO4 or MC3 path is blocked. A possible fault exists on the IO4's flash PROM. Check for bent pins and reseal the IO4(s) and MC3(s).
GRAPHICS FAILED!	The graphics self tests failed. Check individual graphics boards with console/laptop.
CONSOLE FAILED!	Check the console terminal configuration and cabling. Check the IO4 to I/O panel cable connection. There may be a fault in the IO4.

Table C-2 System Error Messages

Error Message	Error Meaning
1.5VDC HIGH FAULT	The system backplane 1.5-volt DC power source exceeded the upper tolerance limit.
1.5VDC LOW FAULT	The system backplane 1.5-volt DC power source dropped below the allowed limit.
12VDC HIGH FAULT	The system backplane 12-volt DC power source exceeded the upper tolerance limit.
12VDC LOW FAULT	The system backplane 12-volt DC power source dropped below the allowed limit.
48VDC HIGH FAULT	The system backplane 48-volt DC power source exceeded the upper tolerance limit.
48VDC LOW FAULT	The system backplane 48-volt DC power source dropped below the allowed limit.
5VDC HIGH FAULT	The system backplane 5-volt DC power source exceeded the upper tolerance limit.

Table C-2 (continued) System Error Messages

Error Message	Error Meaning
5VDC LOW FAULT	The system backplane 5-volt DC power source dropped below the allowed limit.
-12VDC HIGH FAULT	The system backplane -12-volt DC power source exceeded the upper tolerance limit.
-12VDC LOW FAULT	The system backplane -12-volt DC power source dropped below the allowed limit.
-5.2VDC HIGH FAULT	The system backplane -5.2-volt power source exceeded the upper tolerance limit.
-5.2VDCLOW FAULT	The system backplane -5.2-volt power source dropped below the allowed limit.
AMBIENT OVER TEMP	The incoming ambient air temperature is too high to provide proper system cooling.
BLOWER A FAILURE	The system A blower fan has failed.
BLOWER B FAILURE	The system B blower fan has failed.
BOOT ERROR	A system processor failed to respond to the System Controller during boot arbitration.
BRD/CHASSIS OVER TEMP	A detector in the cardcage or chassis sensed a temperature over the allowed limit.
CPU NOT RESPONDING	The CPU system master is not responding to requests transmitted over the serial link.
INVALID CPU COMMAND	The System Controller received an invalid CPU command from a system processor.
NO SYSTEM CLOCK	The system backplane clock has failed.
POKA FAIL	Power ok A (POKA); a voltage source supporting the Power Enable A signal failed.
POKB FAIL	Power ok B (POKB); a voltage source supporting the Power Enable B signal failed.
POKC FAIL	Power ok C (POKC); a voltage source supporting the Power Enable C signal failed.

Table C-2 (continued) System Error Messages

Error Message	Error Meaning
POKD FAIL	Power ok D (POKD); a voltage source supporting the Power Enable D signal failed.
POKE FAIL	Power ok E (POKE); a voltage source supporting the Power Enable E signal failed.

Table C-3 System Event Messages

Error Message	Error Meaning
SCLR DETECTED	The System Controller detected an SCLR (system clear) on the system backplane. The reset was initiated from the System Controller front panel by an operator.
SYSTEM OFF	The key switch was turned to the Off position and the System Controller powered off the system.
SYSTEM ON	The System Controller has successfully powered on the system.
SYSTEM RESET	The System Controller detected an SCLR and initiated a system boot arbitration process. SCLR can be generated by any processor board or by the System Controller.

Table C-4 Internal System Controller Error Messages

Error Message	Error Meaning
BAD ALARM TYPE	The firmware attempted to send an invalid alarm to the CPU.
BAD MSG: CPU PROCESS	The CPU or System Controller process received an invalid message.
BAD MSG: DISPLAY	The display process received an invalid message.
BAD MSG: POK CHK	The power ok check process received an invalid message.
BAD MSG: SEQUENCER	The sequencer process received an invalid message.
BAD MSG: SYS MON	The system monitor process received an invalid message.
BAD WARNING/ALARM	The routine that decodes alarm and warning messages detected an invalid message.
BAD WARNING TYPE	The firmware attempted to send an invalid warning to the CPU.
COP FAILURE	The Computer Operating Properly (COP) timer exceeded time limits. The System Controller firmware must write to a COP timer port before it times out. If the firmware exceeds the time allowed between writes to a COP port, an interrupt is generated. The System Controller firmware may have entered an endless loop.
COP MONITOR FAILURE	A Computer Operating Properly (COP) clock monitor failure was detected. The System Controller clock oscillator is operating at less than 10 KHz.

Table C-4 (continued) Internal System Controller Error Messages

Error Message	Error Meaning
DEBUG SWITCH ERROR	The System Controller detected data corruption in the nonvolatile RAM debug switch location.
FP CONTROLLER FAULT	An error was detected in the front panel LCD screen control process.
FP READ FAULT	A read of the front panel status register did not complete successfully.
FREE MSG NODE ERROR	The free message node queue overflowed.
FREE TCB NODE ERROR	The free timer control block queue overflowed.
ILLEGAL OP CODE TRAP	The System Controller’s microprocessor tried to execute an illegal instruction, probably because of a stack overrun followed by a process switch.
PULSE ACCU INPUT	An interrupt was detected on the pulse accumulator input port. The port is not used and an interrupt is treated as an error.
PULSE ACCU OVERFLOW	The pulse accumulator overflow port received an interrupt. This port is unused and the interrupt is treated as an error.
SPI TRANSFER	An interrupt was detected on the synchronous serial peripheral interface. This interface is not supported and the interrupt is treated as an error.
STACK FAULT PID 0–6	One of the seven stack areas used by a System Controller process overflowed its assigned boundaries.
TEMP SENSOR FAILURE	The System Controller detected an invalid measurement from the temperature sensor.
TIMER IN COMP 1	The timer input compare port received an interrupt. The port is not used and the interrupt is treated as an error.

Table C-4 (continued) Internal System Controller Error Messages

Error Message	Error Meaning
TIMER OUT COMP 1-5	One of the five timer output compare ports received an interrupt. The port is not supported and the interrupt is treated as an error.
XMITTER 1 TIMEOUT	The System Controller's 1st UART experienced a failure.
XMITTER 2 TIMEOUT	The System Controller's 2nd UART experienced a failure.

Challenge IO4 PROM, Mezzanine, and Troubleshooting

This appendix supplies information about the Challenge IO4 PROM (Programmable Read Only Memory) Command Monitor. This information is separated into hardware configuration commands, environment variables, and known bugs. Basic mezzanine board configurations on the IO4 and troubleshooting tips are also covered.

Hardware Configuration Commands

The IO4 PROM allows you examine and modify the hardware configuration of your system using a variety of commands.

Checking and Updating the Hardware Inventory

When the system first powers on, the IO4 PROM automatically examines all of the installed boards to determine if any of the components have failed. During this process, the IO4 PROM reads a copy of the system's hardware inventory from nonvolatile RAM and compares it to the system's current configuration. If there are differences between the current and stored hardware inventories, the IO4 PROM inventory checker will generate a warning message. When a difference is detected during this comparison of the hardware inventory, the PROM pauses to allow you to examine the error messages. In the following example, the PROM detected a missing processor on an IP19 board.

```
Checking inventory...
*** Slice 1 on the IP19 in slot 2 isn't visible
Press <ENTER> to continue
```

If system uptime is critical (for example, if your system is the central server) and operators are not available around the clock, you may not want the PROM to wait for operator intervention when the inventory checker notices a problem. You can configure the system so that it continues to boot in spite of nonterminal failures by setting the *nonstop* environment variable (see “Environment Variables” that follows).

Because the PROM’s hardware inventory checker is incapable of telling the difference between missing and broken hardware, you must explicitly update the system’s hardware inventory whenever you change the system configuration. Update the hardware inventory as follows:

1. Enter the PROM Command Monitor by selecting the “Enter Command Monitor” option from the PROM menu.
2. When the PROM Command Monitor prompt (>>) is displayed, type **update** and press <ENTER>. This tells the PROM that the system’s current hardware configuration is correct.
3. Type **reset** and press <ENTER> to reset your machine.

If you see error messages when there have been no modifications to the system’s hardware inventory, it may indicate a component failure. Call your service provider and do not update the hardware inventory until a field engineer has examined the system.

Displaying Information about the Current Hardware Configuration

Display a list of the boards currently installed in your system by typing **hinv -b**. The “-b” causes bus-specific information to be displayed. The “-v” (verbose) option, when used in conjunction with “-b”, causes more detailed information about the boards to be displayed. For example, typing

```
hinv -b -v <ENTER>
```

displays the configuration of all of the processors, memory banks, and I/O adapters in the system.

Power On Diagnostics (POD) Mode

In the unlikely event of an extreme hardware failure, the system may drop down into a low-level diagnostic environment known as POD mode. This mode is used as an aid to system diagnosis and is not intended for use by customers. If your system enters POD mode, contact your service provider.

Environment Variables

This section describes procedures that you can use to customize certain aspects of the PROM Command Monitor. Many aspects of the system startup process can be individually tailored by changing the PROM environment variables. These variables are changed using the *setenv* command while in the Command Monitor. Enter the Command Monitor by first selecting the "Stop for System Maintenance" option during the system startup. When the System Maintenance menu is displayed, enter the Command Monitor by typing 5.

Some common modifications are described in the following subsections. Additional information is provided in the *prom(1M)* reference page.

Booting From an Alternate Device

There are three environment variables in the PROM that are used to specify which device to boot from: the "SystemPartition," the "OSLoadPartition," and the "root" variable.

The "SystemPartition" variable specifies the location of the device volume header. Its default value is "dksc (0,1,8)," which specifies SCSI controller 0, disk 1, and partition 8 (by convention, the volume header is always partition 8).

The "OSLoadPartition" variable specifies the device from which the IRIX kernel should be loaded. Its default value is "dksc (0,1,0)," which tells the PROM to look for the kernel in partition 0 of disk 1, on SCSI controller 0 (by convention, the kernel location is always partition 0).

The root variable tells IRIX the name of the device that holds the root filesystem. Because this variable is used by IRIX, rather than the PROM, its format is different from the "SystemPartition" and "OSLoadPartition" variables. The default value for root is "dks0d1s0," which specifies that the root filesystem is stored on partition 0 of disk 1, on SCSI controller 0.

The following three examples show you what the command line looks like when you change the boot device.

To boot off of disk number 2 on controller 0, type the following:

```
setenv SystemPartition dksc (0,2,8)
setenv OSLoadPartition dksc (0,2,0)
setenv root dks0d2s0
```

To boot off of disk number 1 on controller 1, type the following:

```
setenv SystemPartition dksc (1,1,8)
setenv OSLoadPartition dksc (1,1,0)
setenv root dks1d1s0
```

To boot off of disk number 3 on controller 2, type the following:

```
setenv SystemPartition dksc (2,3,8)
setenv OSLoadPartition dksc (2,3,0)
setenv root dks2d3s0
```

Starting the System Automatically

Each time the system is powered on, the PROM waits briefly before starting the operating system. If the "Stop for System Maintenance" option is not selected, or if the <Esc> key is not pressed, the system loads the operating system from memory and begins to execute it. Setting the environment variable *autoload* to "yes" enables this feature. Setting *autoload* to "no" inhibits the automatic startup and causes the PROM to display the System Maintenance menu after running the power-on diagnostics.

Allowing the System to Boot in Spite of Nonterminal Hardware Failures

By default, the PROM stops and generates a warning message if it finds that a component has failed. However, the failure of a single processor or bank of memory may not be serious enough to prevent the system from coming up. To prevent a nonfatal hardware problem from stopping the system, set the *nonstop* variable to 1:

```
setenv nonstop 1
```

To ensure that the system displays a notification message in the event of any hardware failure, set the *nonstop* variable to 0:

```
setenv nonstop 0
```

Restoring Defaults

The PROM environment variables can be reset to their factory defaults by using the *resetenv* command while in the PROM Command Monitor. Since *resetenv* also resets the *netaddr* environment variable, note the machine's IP address before using this command.

Known Bug

Since the IO4 PROM is software-writable, this bug should be fixed by a PROM update in a future release of the operating system.

A bug in the CD-ROM volume size code causes the SCSI driver to display an erroneous "No Medium Found" message if the CD-ROM caddy is empty when the system is booted. This message can be ignored.

Mezzanine Board Configurations

Each system comes with one standard IO4 interface board. See Chapter 1 for a technical overview of the IO4. The first IO4 in the system always supports either the VME Channel Adapter Module (VCAM) board or the Graphics Channel Adapter Module (GCAM) board.

Note: The GCAM board is used only on systems that have the visualization console option installed.

If you are unsure of the system's hardware configuration, type the *hinv* command at the console. You should see something similar to the following:

```
% hinv <Enter>
2 100 MHZ IP19 Processors
CPU: MIPS R4400 Processor Chip Revision: 4.0
FPU: MIPS R4010 Floating Point Chip Revision: 0.0
Data cache size: 16 Kbytes
Instruction cache size: 16 Kbytes
Secondary unified instruction/data cache size: 1 Mbyte
Main memory size: 256 Mbytes, 2-way interleaved
I/O board, Ebus slot 5: IO4 revision 1
Integral IO4 serial ports: 4
Extreme Graphics option installed ???tbd???
Integral Ethernet controller: et0, Ebus slot 3
Integral SCSI controller 2: Version WD33C95A
Tape drive: unit 6 on SCSI controller 2: DLT
Integral SCSI controller 1: Version WD33C95A
Disk drive: unit 1 on SCSI controller 1
Integral SCSI controller 0: Version WD33C95A
Disk drive: unit 4 on SCSI controller 0
Disk drive: unit 3 on SCSI controller 0
Disk drive: unit 2 on SCSI controller 0
Disk drive: unit 1 on SCSI controller 0
VME bus: adapter 0 mapped to adapter 3
VME bus: adapter 3
Integral IO4 parallel port: Ebus slot 5
```

Each system may be slightly different, but all systems will have at least one IO4 installed. The number of IO4s installed in your system determines the number of HIO mezzanine option boards it can support. It also determines the type of mezzanine options you can order. The VCAM or GCAM on the first IO4 precludes you from using "long" mezzanine boards. Long

mezzanine boards stretch nearly to the backplane and do not fit on the IO4 when a VCAM or GCAM is installed. Table D-1 describes some of the HIO mezzanine option boards and their lengths.

Table D-1 Optional Mezzanine Board Descriptions

Board Name	Size	Number of Connectors
Flat Cable Interface	Long	2
Flat Cable Interface	Short	1
Three-Channel SCSI	Short	3

Mezzanine Options Available With One IO4

Figure D-1 shows the two possible configurations of the Challenge equipped with a single IO4. In the standard server configuration, the IO4 uses a VCAM, and may use up to two optional short mezzanine boards. With the visualization console option and graphics, use of the GCAM allows only one optional short mezzanine board.

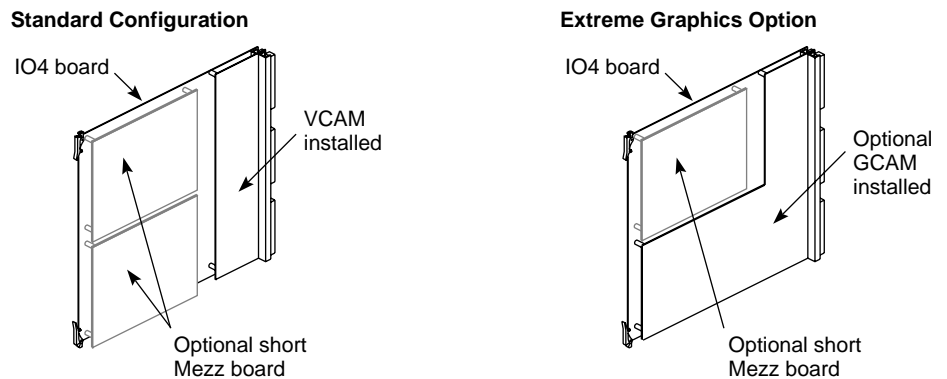


Figure D-1 IO4 With VCAM and GCAM

Mezzanine Options Available With Two IO4s

You can always have one or two short optional mezzanine boards installed on the primary IO4. This is determined by whether you have the visualization console option installed in your system. When you order a second optional IO4, you can have one of the following mezzanine configurations installed:

- One or two long mezzanine option boards
- Up to two short mezzanine option boards
- One long and one short mezzanine option board

Figure D-2 shows the optional second IO4 and the potential configurations for additional optional mezzanine boards that might be installed.

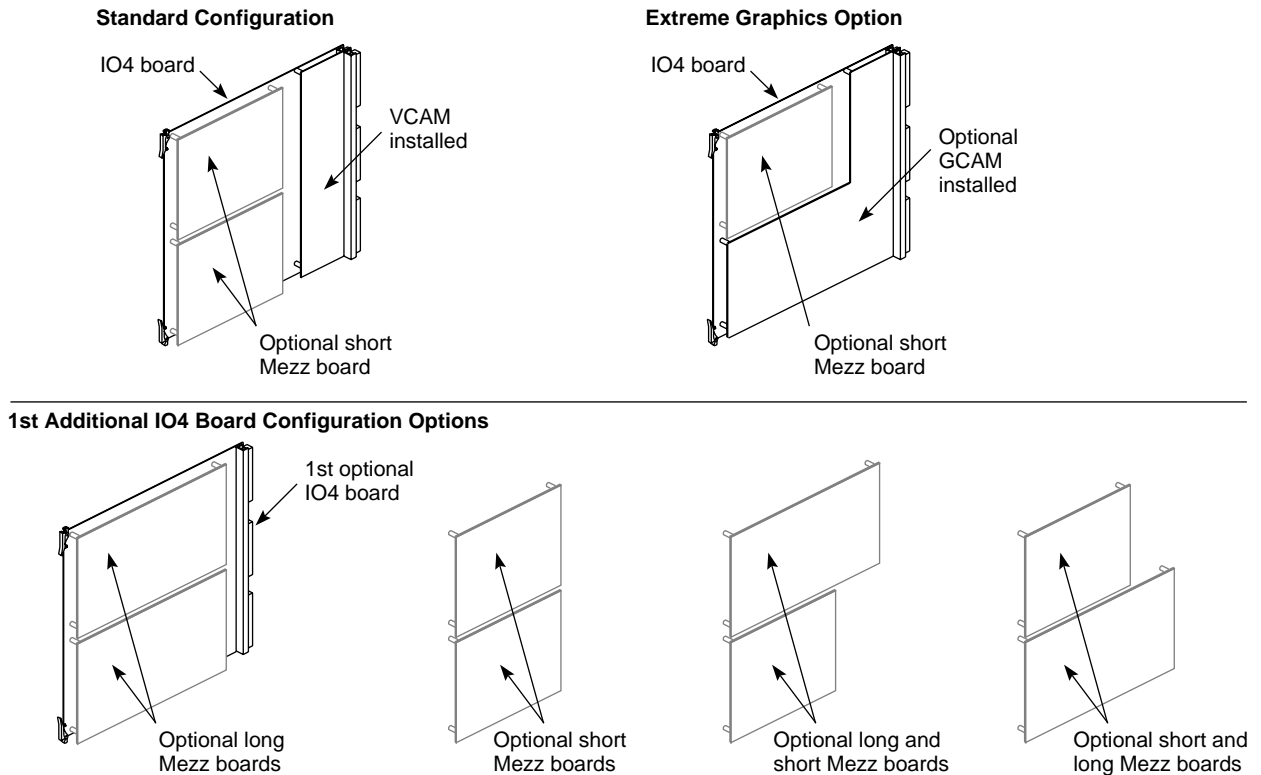


Figure D-2 Mezzanine Types Available With Optional Second IO4

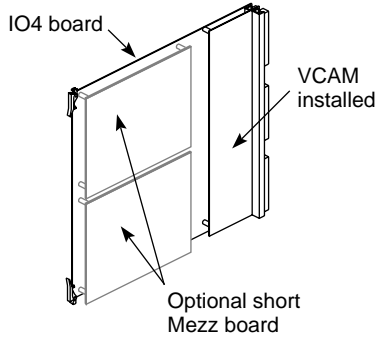
Mezzanine Options Available With Three IO4s

You can have one or two short optional mezzanine boards installed on the primary IO4. When you order a third optional IO4, you can choose the option of having one of the following mezzanine configurations installed:

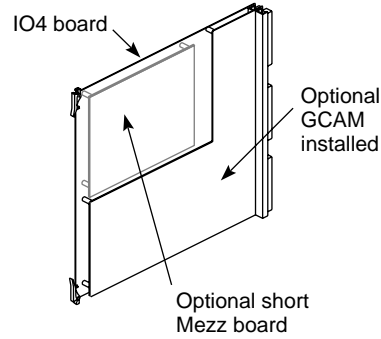
- Up to two long mezzanine option boards
- Up to two short mezzanine option boards
- One long and one short mezzanine option board

Figure D-3 shows both optional IO4s and the potential configurations for additional optional mezzanine boards that might be installed.

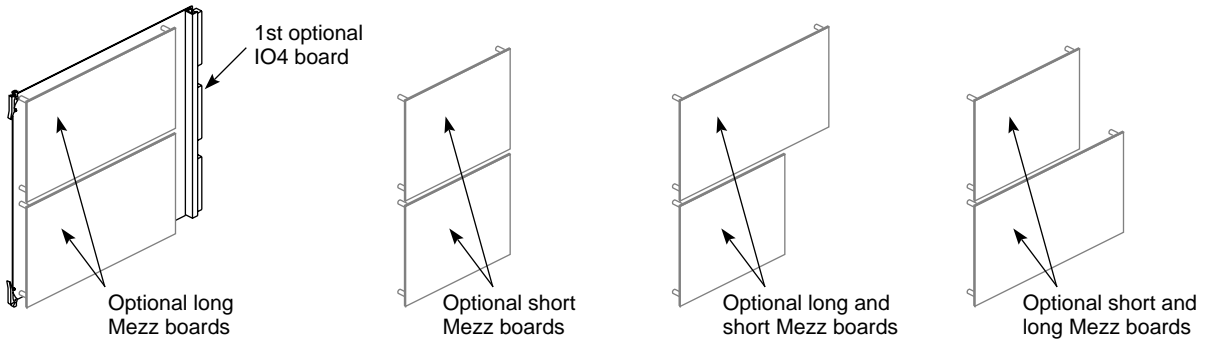
Standard Configuration



Extreme Graphics Option



1st Additional IO4 Board Configuration Options



2nd Additional IO4 Board Configuration Options

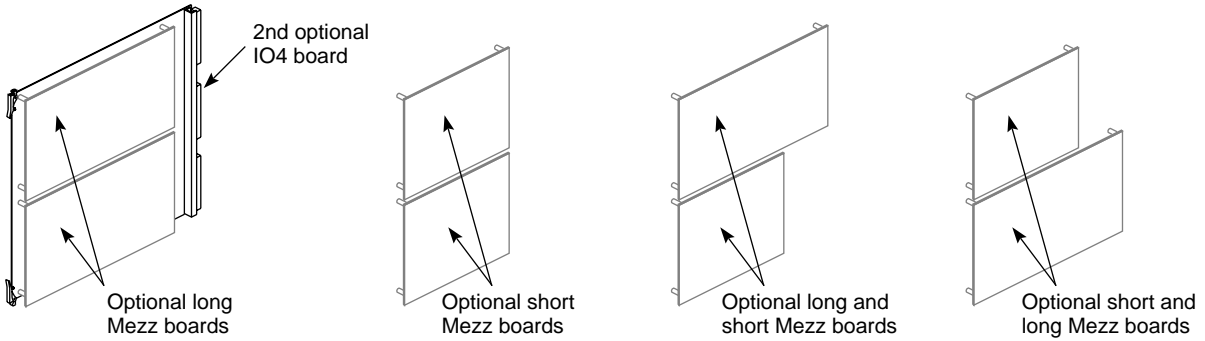


Figure D-3 Optional Second and Third IO4 Configuration

IO4 Troubleshooting

There are a number of troubleshooting steps you can use to identify if the IO4 is the cause of system level faults. Always check for loose connections or damaged cables when trouble with IO4 peripherals occurs.

Never plug the Ethernet connector in while the system is powered on. This action may result in a current surge that blows the filter on the I/O adapter or IO4. Symptoms resulting from this problem include:

- Ethernet not working
- Keyboard and mouse not working
- Powered peripheral ports not working

This problem requires a visit from a trained field service engineer.

There is no mechanical connection available for the RS-422 connector on an optional second or third IO4.

Ethernet and RS-232 connectors connected to additional optional IO4 boards may need to be initialized to work properly after installation. See “Activating Serial Ports on Additional IO4 Boards” in Chapter 4 for an example of how this is done.

Additional parallel printer ports on optional IO4s may also need to be initialized before they will work properly. For information on this topic see “Activating Parallel Ports” in Chapter 4.

VMEbus Implementation

The VME (versa modular European) interface in the Challenge and POWER Challenge system supports all protocols defined in Revision C of the VME specification, plus the A64 and D64 modes defined in Revision D. For the acceptable VME address ranges, read the `/var/sysgen/system/irix.sm` file.

Note: The Challenge systems do not support VSBbus mode. In addition, unless otherwise stated, the term Challenge refers to both the Challenge and POWER Challenge systems.



Warning: All board installations or removals should be performed *only* by personnel certified by Silicon Graphics. Unauthorized access to the cardcage area could result in system damage, or possible bodily harm, and could void the warranty for the system.

This appendix provides information to help users integrate third-party VME boards into the Challenge and POWER Challenge rackmount systems. The information is divided into four major sections.

- “VMEbus Architecture and Interface,” provides a detailed discussion of the VMEbus architecture in the Challenge system. This section also briefly describes the overall bus structure, VME interrupt generation, and address mapping.
- “Hardware Considerations,” discusses pertinent physical and electrical requirements and issues such as the required board dimensions, available power, airflow, VME pin assignments, the VME slots, and VME backplane jumpering.
- “Accessing Multiple VMEbuses,” discusses the multiple VMEbus capability with the optional cardcage 3.
- “VMEbus Board Design Considerations,” provides third-party VME board design considerations and guidelines.

Note: This appendix primarily provides VMEbus hardware-related information. For software-related information on VMEbus implementation, consult the *IRIX Device Driver Programming Guide* (P/N 007-0911-xxx).

VMEbus Architecture and Interface

The VMEbus interface circuitry for the Challenge and POWER Challenge systems resides on a mezzanine board called the VMEbus Channel Adapter Module (VCAM) board. The VCAM board is standard in every system and mounts directly on top of the IO4 board in the system cardcage (see Figure E-1). The VCAM is located on the master IO4 (in slot 15) and provides the VME connection for cardcage 2.

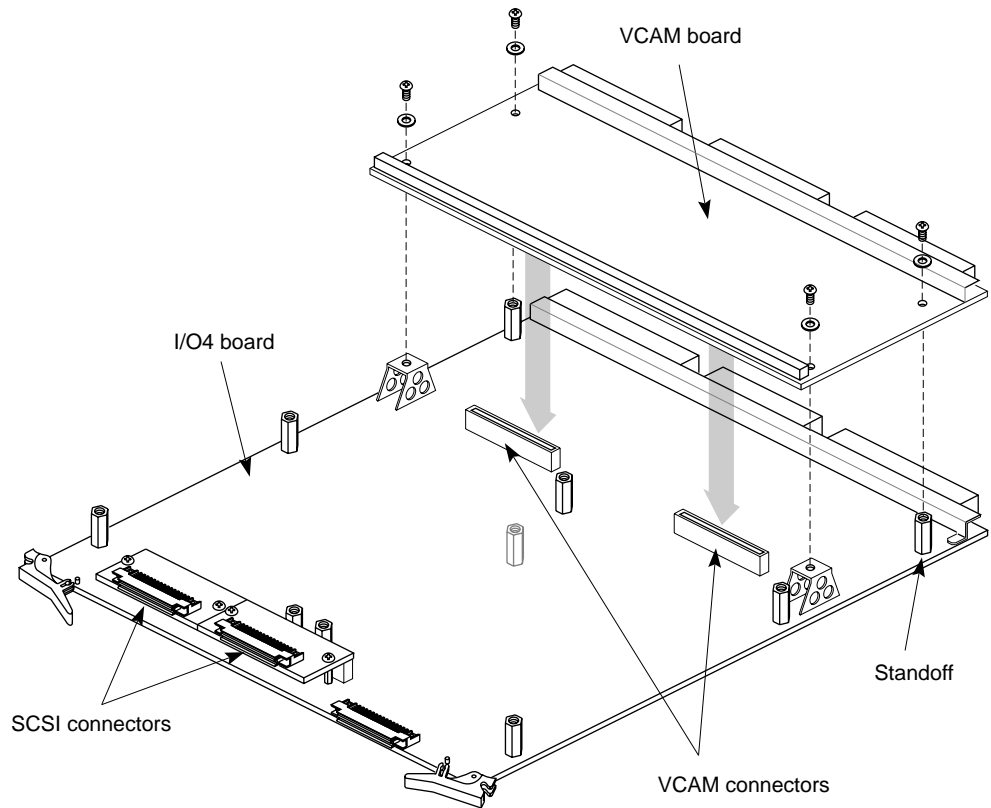


Figure E-1 Placement of the VCAM Board on the IO4 Board for CC2

The IO4 board is the heart of the I/O subsystem. It supplies the system with a basic set of I/O controllers and system boot and configuration devices such as serial and parallel ports, and Ethernet.

In addition, the IO4 board provides these interfaces:

- two Flat Cable Interconnects (FCIs) for connection to the CC3
- two SCSI-2 cable connections
- two Ibus connections

See Figure E-2 for a functional block diagram of the IO4 board.

System Bus Architecture

This section describes the bus structure of the system.

Main System Bus

The main set of buses in the CHALLENGE/Onyx system architecture is the Everest address and data buses, Ebus for short. The Ebus provides a 256-bit data bus and a 40-bit address bus that can sustain a bandwidth of 1.2 GB per second.

The 256-bit data bus provides the data transfer capability to support a large number of high-performance RISC CPUs. The 40-bit address bus is also wide enough to support 16 GB of contiguous memory in addition to an 8 GB I/O address space.

Ibus

The 64-bit Ibus (also known as the HIO bus) is the main internal bus of the I/O subsystem and interfaces to the high-power Ebus through a group of bus adapters. The Ibus has a bandwidth of 320 MB per second that can sufficiently support a graphics subsystem, a VME64 bus, and as many as eight SCSI channels operating simultaneously.

Bus Interfacing

Communication with the VME and SCSI buses, the installed set or sets of graphics boards, and Ethernet takes place through the 64-bit Ibus (see Figure E-2). The Ibus interfaces to the main system bus, the 256-bit Ebus, through a set of interface control devices, an I address (IA) and, four I data (ID) ASICs. The ID ASICs latch the data, and the IA ASIC clocks the data from each ID to the flat cable interface (FCI) through the F controller (or F chip).

Two FCI controllers (or F controllers) help handle the data transfers to and from an internal graphics board set (if applicable) and any VMEbus boards in optional CC3 applications. The SCSI-2 (S1) controller serves as an interface to the various SCSI-2 buses. The Everest peripheral controller (EPC) device manages the data movement to and from the Ethernet, a parallel port, and various types of on-board PROMs and RAM.

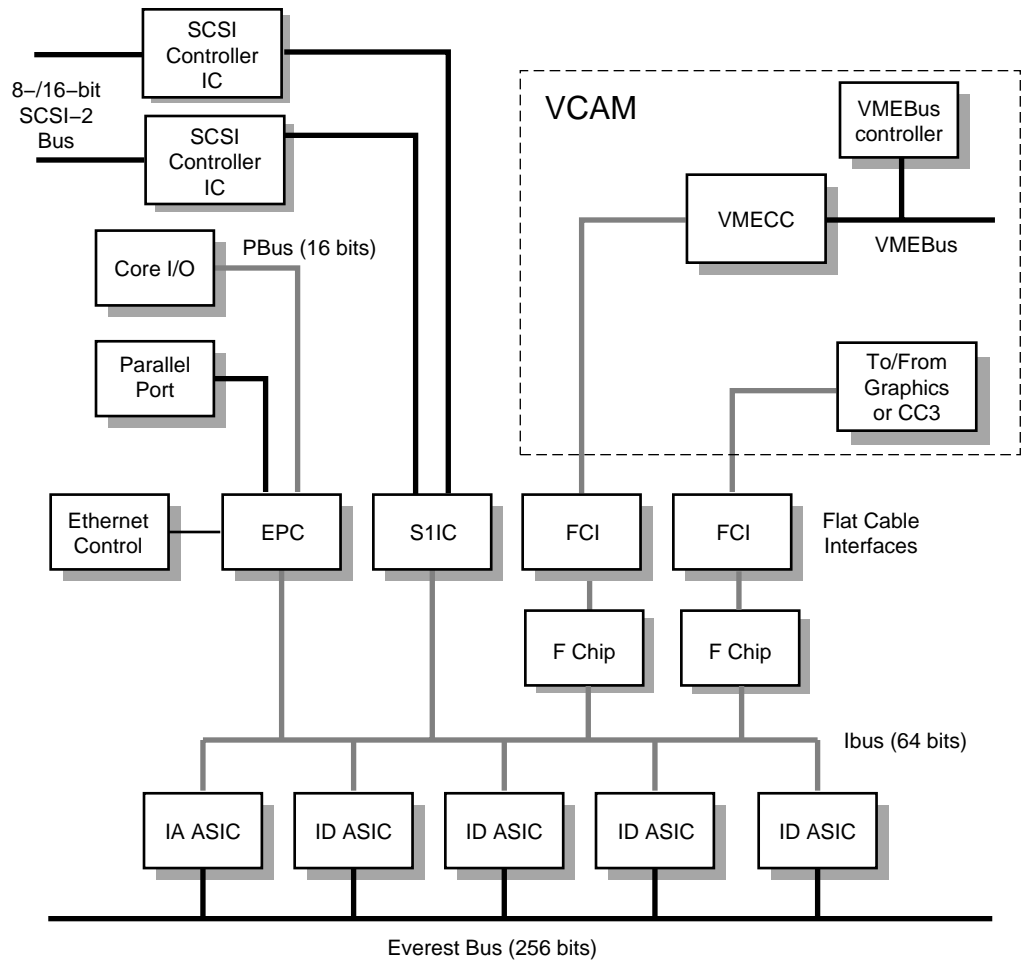


Figure E-2 IO4 Base Board Functional Block Diagram

VMEbus Channel Adapter Module (VCAM) Board

The VCAM board provides the interface between the Ebus and the VMEbus and manages the signal level conversion between the two buses. The VCAM also provides a pass-through connection that ties the graphics subsystem to the Ebus.

The VCAM can operate as either a master or a slave. It supports DMA-to-memory transactions on the Ebus and programmed I/O (PIO) operations from the system bus to addresses on the VMEbus. In addition, the VCAM provides virtual address translation capability and a DMA engine that increases the performance of non-DMA VME boards.

VMECC

The VMECC (VME cache controller) gate array is the major active device on the VCAM. The VMECC interfaces and translates host CPU operations to VMEbus operations (see Figure E-3). The VMECC also decodes VMEbus operations to translate them to the host side.

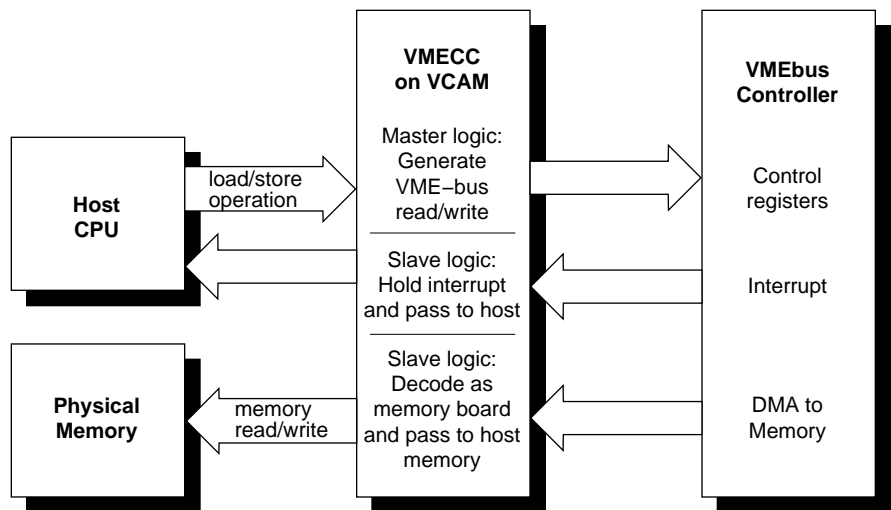


Figure E-3 VMECC, the VMEbus Adapter

The VMECC provides the following features:

- An internal DMA engine to speed copies between physical memory and VME space
 - Note:** For information on DMA memory mapping, see “DMA Multiple Address Mapping.”
- A 16-entry deep PIO FIFO to smooth writing to the VMEbus from the host CPUs

- A built-in VME interrupt handler and built-in VMEbus arbiter
- An explicit internal delay register to aid in spacing PIOs for VME controller boards that cannot accept back-to-back operations
- A16, A24, A32, and A64 addressing modes (see Table E-1) that can be issued as a bus master with PIOs.
- Single item transfers (D8, D16, D32, and D64) that can be issued as a bus master with PIOs
- A24, A32, and A64 addressing modes that can be responded to as a memory slave to provide access to the Ebus
- Single item transfers (D8, D16, and D32) that can be responded to as a memory slave to provide access to the Ebus
- Block item transfers (D8, D16, D32, and D64—see Table E-1) that can be responded to as a memory slave

Table E-1 Supported Address and Data Sizes

Size	Term
A16 and D8 modes	Short
A24 and D16 modes	Standard
A32 and D32 modes	Extended
A64 and D64 modes	Long

The VMECC also provides four levels of VMEbus request grants, 0-3 (3 has the highest priority), for DMA arbitration. Do not confuse these *bus request levels* with the interrupt priorities described in “VMEbus Interrupts.” Bus requests prioritize the use of the physical lines representing the bus and are normally set by means of jumpers on the interface board.

F Controller ASIC

Data transfers between VME controller boards and the host CPU(s) take place through the VMECC on the VCAM board, then through a flat cable interface (FCI), and onto the F controller ASIC.

The F controller acts as an interface between the Ibus and the flat cable interfaces (FCIs). This device is primarily composed of FIFO registers and synchronizers that provide protocol conversion and buffer transactions in both directions and translate 34-bit I/O addresses into 40-bit system addresses.

Two configurations of the F controller are used on the IO4 board; the difference between them is the instruction set they contain. One version is programmed with a set of instructions designed to communicate with the GFXCC (for graphics); the other version has instructions designed for the VMECC. All communication with the GFXCC or VMECC ICs is done over the FCI, where the F controller is always the slave.

Both versions of the F controller ASICs have I/O error-detection and handling capabilities. Data errors that occur on either the Ibus or the FCI are recorded by the F controller and sent to the VMECC or GFXCC.

ICs must report the error to the appropriate CPU and log any specific information about the operation in progress. FCI errors are recorded in the error status register. This register provides the status of the first error that occurred, as well as the cause of the most recent FCI reset.

VMEbus Interface Overview

The Challenge and POWER Challenge VMEbus interface supports all protocols defined in Revision C of the VME specification plus the A64 and D64 modes defined in Revision D. The D64 mode allows DMA bandwidths of up to 60 MB. This bus also supports the following features:

- Seven levels of prioritized processor interrupts
- 16-bit, 24-bit, and 32-bit data addresses and 64-bit memory addresses
- 16-bit and 32-bit accesses (and 64-bit accesses in MIPS III mode)
- 8-bit, 16-bit, 32-bit, and 64-bit data transfer
- DMA to/from main memory

The VMEbus does not distinguish between I/O and memory space, and it supports multiple address spaces. This feature allows you to put 16-bit

devices in the 16-bit space, 24-bit devices in the 24-bit space, 32-bit devices in the 32-bit space, and 64-bit devices in 64-bit space.¹

The VMEbus provides 32 address bits and six address-modifier bits. It supports four address sizes: 16-bit, 24-bit, 32-bit, and 64-bits (A16, A24, A32, and A64). The VMEbus allows the master to broadcast addresses at any of these sizes. The VMEbus supports data transfer sizes of 8, 16, 32, or 64 bits.

Note: To best understand the VME-bus addressing and address space, think of the device as consisting of two halves, master and slave. When the CPU accesses the address space of a device, the device acts as a VME slave. When the VME device accesses main memory through direct memory access operations, the VME device acts as a VME master.

DMA Multiple Address Mapping

In the Challenge and POWER Challenge systems, a DMA address from a VME controller goes through a two-level translation to generate an acceptable physical address for the R4400, R8000, and R10000. This requires two levels of mapping. The first level of mapping is done through the map RAM on the IO4 board. The second level is done through the map tables in system memory. This mapping is shown in Figure E-4.

R4400 and R8000 Mapping

The second level mapping requires system memory to be reserved for the mapping tables. The limit on the number of pages that is allocated for map tables is 16 pages, and the maximum memory allotted for the map tables is 64 KB. The R4400 provides a 4 KB page size for 16 pages (4 KB * 16 pages = 64 KB). The R8000 provides an 8 KB page size for 8 pages (8 KB * 8 pages = 64 KB).

The R4400 pointer size is 4 bytes and the R8000 pointer size is 8 bytes. There are 1 K mapping entries for the R4400 for each page and 8 K mapping entries in the R8000. In the R4400, if you divide the amount of memory allocated for

¹ 64-bit data transfers, accesses, and memory addresses do not depend on a 64-bit IRIX kernel, so they can be mapped to all MIPS R4000 and R8000 series platforms.

the map tables (64 KB) by the pointer size (4 B) and then multiply it by the page size (4 KB), you derive 64 MB of VME DMA mapping. This is the maximum allowed by IRIX. The 64 MB address space applies to the R8000, as well.

R10000 Virtual Address Translation

In the R10000 processor, the size of each page may be selected from a range between 4 KB to 16 MB, inclusive, in powers of 4 (that is, 4 KB, 16 KB, 64 KB, and so on). The virtual address bits that select a page (and thus are translated) are called the page address.

Page size is defined in each TLB entry's PageMask field. This field is loaded or read using the PageMask register (see the *R10000 Microprocessor User's Manual* from MIPS Technology for additional information). Translations are maintained by the operating system using page tables in memory. A subset of these translations are loaded into a hardware buffer called the translation-lookaside buffer or TLB.

The contents of this buffer are maintained by the operating system; if an instruction needs a translation which is not already in the buffer, an exception is taken so the operating system can compute and load the needed translation. If all the necessary translations are present, the program is executed without any delays.

VME Physical Address Generation

Referring to the top of Figure E-4, bits 32 and 33 from the IBus address come from the VMECC. These two bits determine a unique VMEbus number for systems with multiple VMEbuses. Of the remaining 32 bits (31 to 0), 12 are reserved for an offset in physical memory, and the other 20 bits are used to select up to 2^{20} or 1 million pages into the main memory table. However, as stated earlier, only 64 KB is allocated for map tables.

As shown in Figure E-4, 13 bits go to the static RAM table. Recall that 2 of the 13 bits are from the VMECC to identify the VMEbus number. The static RAM table then generates a 29-bit identifier into the main memory table. These 29 bits select a table in the main memory table. An additional 9 bits select an entry or element within the table. A 00 (two zeros) is appended to form a 40-bit address into the main memory table.

The main memory table then generates a 28-bit address, which is then appended to the 12-bit offset of the IBus to form the final 40-bit physical address.

Note: Address conflicts with other boards in the system should not be a problem as long as the drivers and the VME controllers adhere to the semantics for DMA mapping defined in the *IRIX Device Driver Programming Guide* (p/n 007-0911-xxx).

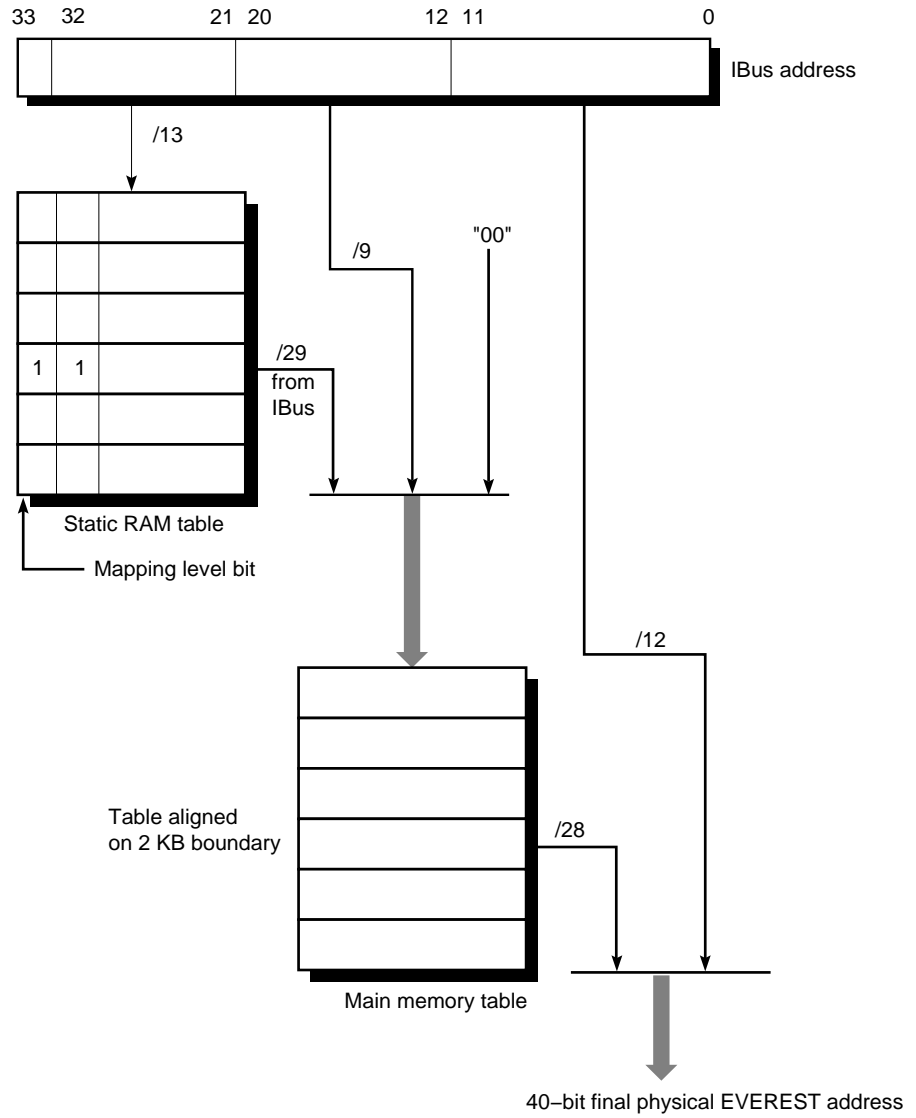


Figure E-4 I/O Address to System Address Mapping

VMEbus Cycles Operation

This section describes the VMEbus operation for the following address and data cycles:

- write (non-block)
- read (non-block)
- read-modify-write (issued only by the VMECC)

Word Length Conventions

Table E-2 shows the word length conventions used in this document.

Table E-2 Word Length Conventions

Parameter	Number of Bits
Byte	8 bits
Half-word	16 bits
Word	32 bits
Double or long word	64 bits

Write Cycle

The write cycle begins when the master gets the bus and asserts WRITE*. The master places the address on the address bus (A01 to A31) and also places the address modifier on the bus (AM0 through AM5) to indicate the type of access and address space (for example A16, A24, A32, or A64). The address strobe (AS*) is then asserted to indicate a stable address.

The master then places the data on the data bus (D00 through D31) and asserts the data strobes DS0* AND DS1* and LWORD*. This combination determines the data size (for example, D32, D16, or D8).

The slave takes the data and responds by asserting the DTACK* line. When the master releases the data strobes (DS0* and DS1*), the slave releases DTACK* and the cycle is completed as the AS* signal is released. If a

mismatch in the data transfer size or other errors occur, the slave asserts BERR* and the bus error terminates the cycle.

Read Cycle

The read cycle is the same as the write cycle except that the slave places the data on the data bus (D00 through D31) in response to data strobes and long word combinations (DS0, DS1, and LWORD) from the host CPU. The slave asserts DTACK* when the data is driven and the master reads it. The master then releases the strobe and the slave releases DTACK* and AS, and the cycle is completed.

VMEbus Read-Modify-Write Cycle

The read-modify-write (or RMW) allows a master to read data, modify it, and write it back without releasing the bus. This bus cycle allows users to read and change the contents of a device register or memory location in a single atomic operation. Although this feature is typically used to implement synchronization primitives on VME memory, you may occasionally find this feature useful for certain devices.

Note: Silicon Graphics products do not support VME read-modify-write operations initiated by a VME master to host memory.

VMEbus Interrupts

The VMEbus supports seven levels of prioritized interrupts, 1 through 7 (where 7 has the highest priority). The VMECC has a register associated with each level. When the system responds to the VMEbus interrupt, it services all devices identified in the interrupt vector register in order of their VMEbus priority (highest number first). The operating system then determines which interrupt routine to use, based on the interrupt level and the interrupt vector value.

Note: On systems equipped with multiple VMEbuses, adapter 0 has the highest priority; other adapters are prioritized in ascending order (after 0).

No device can interrupt the VMEbus at the same level as an interrupt being serviced by the CPU because the register associated with that level is busy.

A device that tries to post a VMEbus interrupt at the same VMEbus priority level as the interrupt being serviced must wait until the current interrupt is processed.

Note: All VME interrupt levels map into one CPU interrupt level through IRIX.

VMEbus Interrupt Generation

The following steps and Figure E-5 outline how a VMEbus interrupt is generated. The step numbers correspond to the ordered numbers in the figure.

1. A VME controller board asserts a VME interrupt.
2. The built-in interrupt handler in the VMECC chip checks if the interrupt level is presently enabled by an internal interrupt mask.
3. The interrupt handler in the VMECC issues a bused IACK (interrupt acknowledge) response and acquires the vector from the device. The 3-bit response identifies one of the seven VME address.

Note: Once an interrupt is asserted and the bus is granted to the handler, a 3-bit code that identifies the interrupt level being acknowledged is placed on address bits 1 to 3 and IACK* and AS* are asserted.

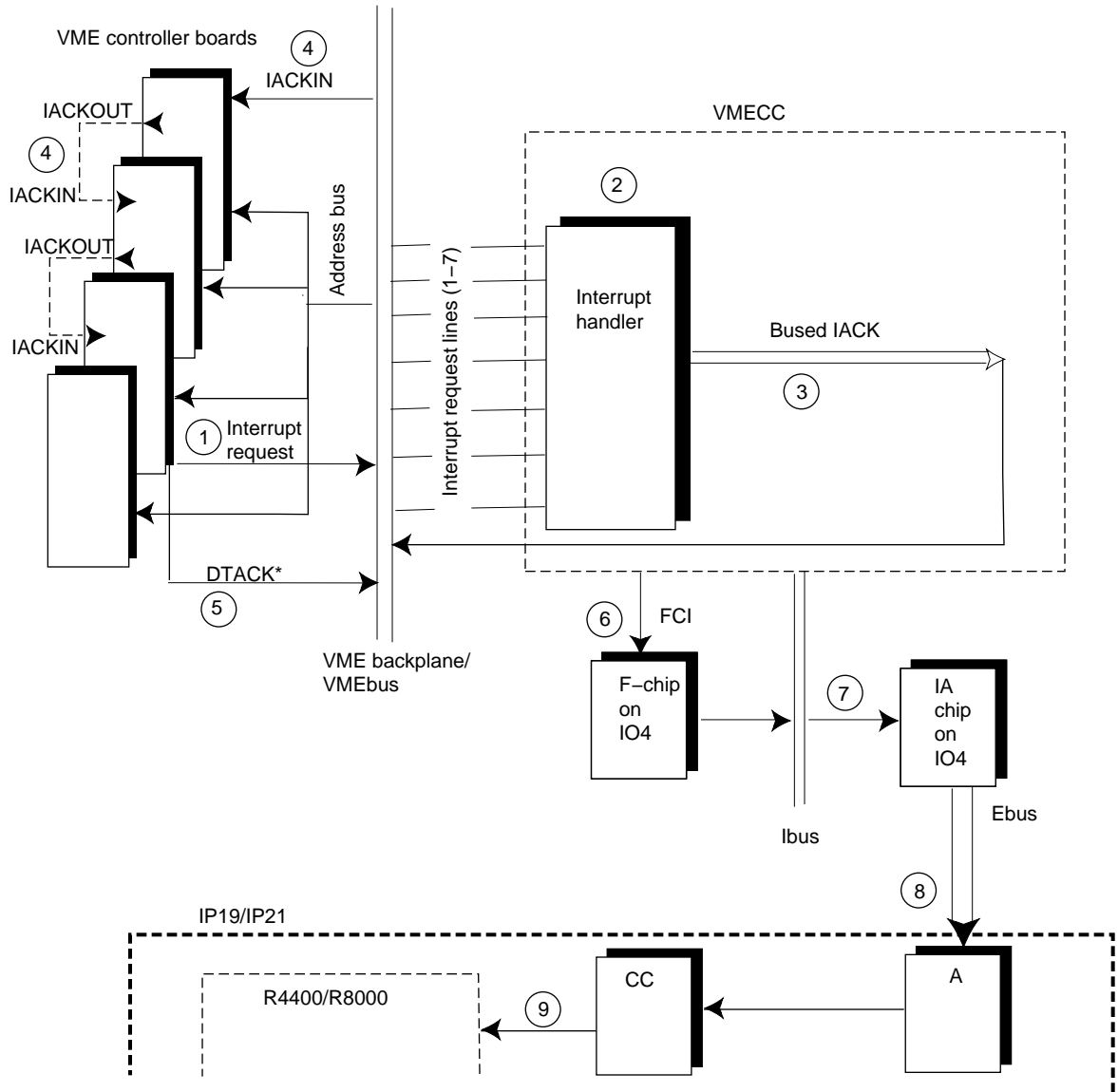


Figure E-5 VMEbus Interrupt Generation

4. If multiple VME boards are present, the bused IACK signal is sent to the first VME controller as an IACKIN. As shown in Figure E-5, since the first controller is not the requesting master, it passes the IACKIN signal to the next board (in the daisy-chain) as IACKOUT.

Note: Each board compares the interrupt level with the interrupt level it may or may not have asserted. If the board did not generate an interrupt, or if the interrupt level does not match its own level, the board passes on the IACKOUT signal to the next board.

In addition, the board closest to the master IO4 normally wins access to the bus.

5. The requesting board responds by issuing a DTACK* (data acknowledge signal), blocking the IACKOUT signal to the next board in line (if present), and placing an 8-bit status word on the data bus.
6. After acceptance and completion through the VMECC, the interrupt signal is sent over the FCI interface to the F-chip and is queued awaiting completion of other F-chip tasks.
7. The F-chip (or F controller ASIC) requests the Ibus and sends the interrupt to the IA chip.
8. The IA chip requests the Ebus and sends the interrupt over the Ebus to the CC chip on the IP19/IP21 board.
9. The CC chip interrupts the R4400/R8000, provided that the interrupt level is not masked.

While the interrupt handler is executing, it prevents another interrupt at an equal or lower level from being serviced. Furthermore, all pending interrupts that are equal to or higher than the priority of a new interrupt must complete execution before the new interrupt is serviced.

The time for this to complete is normally less than 3 microseconds, but will be queued to await completion of other VME activities.

VME Interrupt Acknowledgments

VME boards have two methods of interrupt acknowledge:

- Release on acknowledge of interrupt
- Release on register acknowledge of interrupt

The first release policy is where the interrupting device removes the IRQ request once the VMECC acknowledges the interrupt. In other words, the VME board assertion of the IRQ line is dropped when the board transfers its interrupt vector to the VMECC.

The second release policy occurs when the interrupting VME board does not drop the IRQ line until a register on the board has been accessed or modified. Therefore, after the interrupt vector has been transferred, the device still asserts IRQ.

Potential VME Interrupt Problems

These VME interrupt problems can result in VME interrupt error messages, such as: `WARNING: stray VME interrupt, vector=0xff.`

- Noise occurs on one of the IRQ lines. If the noise pulse (signal) is wider than 20 ns, then the VMECC attempts to issue an IACK cycle. If the signal is just noise and not an actual interrupt, no expected response to the IACK takes place. This lack of a response from a VME board results in a timeout, causing the VMECC to issue an eventual error message.
- A VME board accidentally asserts an IRQ line and doesn't respond.
- One of the boards in front of the requesting board improperly blocks the IACKIN signal and doesn't respond.

Ignoring Interrupts

The VMECC responds only to those interrupt levels that it is configured to recognize. You can therefore prevent the VMECC from responding to particular interrupt levels. For example, if the kernel is configured to have two VME devices configured at `ipl=3` and `4`, then the VMECC responds to interrupt levels 3 and 4 only. The VMECC does not respond to any other interrupt level, thereafter.

Bus Arbitration

The VMEbus supports two arbitration schemes: priority and round robin. The VMECC designates the highest priority to its internal bus masters, the interrupt handler, and the PIO master. These two bus masters have a higher priority than the four backplane request levels (BRQ3 through BRQ0). BRQ3

has the highest priority level. BRQ2 through BRQ0 use round-robin arbitration.

The master relinquishes the bus based on an internal policy of release on request or release when done. Most VME masters can set their arbitration scheme through jumper selectors or by software.

In round-robin scheduling, the arbitration keeps track of the history of the bus grants to different levels. The last bus request level to have the bus becomes the lowest priority. For example, if the bus current request level is 1, all bus request level 1s are pushed back to the end of the queue, after a bus grant. The bus request level that is adjacent to the lowest priority then becomes the highest priority.

As an example, at a given time, say that level 3 is currently the highest priority. After a bus grant takes place, level 3 then becomes the lowest priority, and level 2 (since it was previously adjacent to level 3) is now the highest bus level priority.

Hardware Considerations

This section defines physical and electrical parameters for implementing VMEbus boards and provides VMEbus slot-specific information for the Challenge and POWER Challenge systems.

VME Board Dimensions

The Challenge board slots have a 9U (vertical) form factor and measure 15.75 inches (400 mm) horizontally. The board edges *must* also be less than or equal to 0.062 inches (1.57 mm). If the board is thicker, the edge of the board must be milled to fit into the card guide. In addition, the center-to-center board spacing is 0.8 inch (20.3 mm).

Note: If you wish to install a 6U form-factor VMEbus board into the system, you need to obtain a 6U-to-9U converter board from Silicon Graphics. See “Using a 6U-to-9U Converter Board” on page 156, for further information.

Cardcage 1 and 2 VME Issues

Cardcage 2 (CC2) provides five 9U VME board slots and receives 1000 watts of 5 VDC power (see Table E-3) from the system. Approximately 200 watts of the 5 VDC power are reserved for the VME boards. Nominally, 40 watts are allowed per each of the five VME slots in cardcage 2. However, it is possible to exceed this power rating. See “Exceeding the Nominal VME Power Rating Per Slot” on page 146 for further information

Cardcage 2 also receives approximately 200 to 250 linear feet per minute (LFM) of air flow.

Note: There are no VME slots in cardcage 1 in the Challenge or POWER Challenge systems.

The IO4, VCAM, and mezzanine boards all draw their power from the same source as the VME cards. The CPU boards (such as the IP19) and the MC3 memory boards draw 48 V power directly from the OLS’s, and do not compete for power directly with the IO4, VCAM, mezzanine, and VME boards.

Table E-3 Power Specifications for Cardcage 2

Category	Parameter
Total 5 V power available	1000 watts
Total 12 V power available	200 watts
Each IO4 draws	64 watts (5 V); 20 watts (12 V)
VCAM	35 watts (5 V); 24 watts (12 V)
Backplane requirement	50 watts (5 V)

Cardcage 3 VME Issues

Cardcage 3 (CC3), which is optional on the Challenge XL rackmount system, supplies up to 20 additional VME slots (see Figure E-8). The CC3 provides approximately 70 W of +5 V power per VME slot. This assumes the presence of three 505 power boards and one 512 power board (see Figure E-6). The

power boards are included with the optional CC3 upgrade. Cardcage 3 also receives approximately 200 to 250 LFM of air flow through the chassis.

Note: The CC3 provides the capability of having multiple VMEbuses for improved system throughput. See “Accessing Multiple VMEbuses” on page 158, for further information.

Table E-4 Power Specifications for Cardcage 3

Category	Parameter
Total 5 V power available	1400 watts
Total 12 V power available	200 watts
Remote VCAM	35 watts (5 V); 24 watts (12 V)
Backplane requirement	50 watts (5 V)

Determining the System Power Budget

Use the information in Table E-3 and Table E-5 to help determine the power budget for your system. With this information, you should be able to calculate the power available for VME cards in your particular configuration, as required.

Table E-5 5 VDC Power Consumption Chart for Various System Boards

Board Type	Power Consumption at 5 VDC
Master IO4 board and VCAM	130 watts
Slave IO4 board	47 watts
Slave IO4 board with 2 Asynchronous Transfer Mode (ATM) mezzanine boards	121 watts
S1 mezzanine board	20 watts
SCIP mezzanine board	20 watts
F-chip mezzanine board	35 watts
FDDI mezzanine board	25 watts

Table E-5 5 VDC Power Consumption Chart for Various System Boards

Board Type	Power Consumption at 5 VDC
ATM board	37 watts
HIPPI board	75 watts

Challenge Slot Assignments

As mentioned earlier, cardcage 1 has no available VME slots. See Figure E-7 and Figure E-8 for the location of the VME slots in cardcage 2 and the optional cardcage 3.

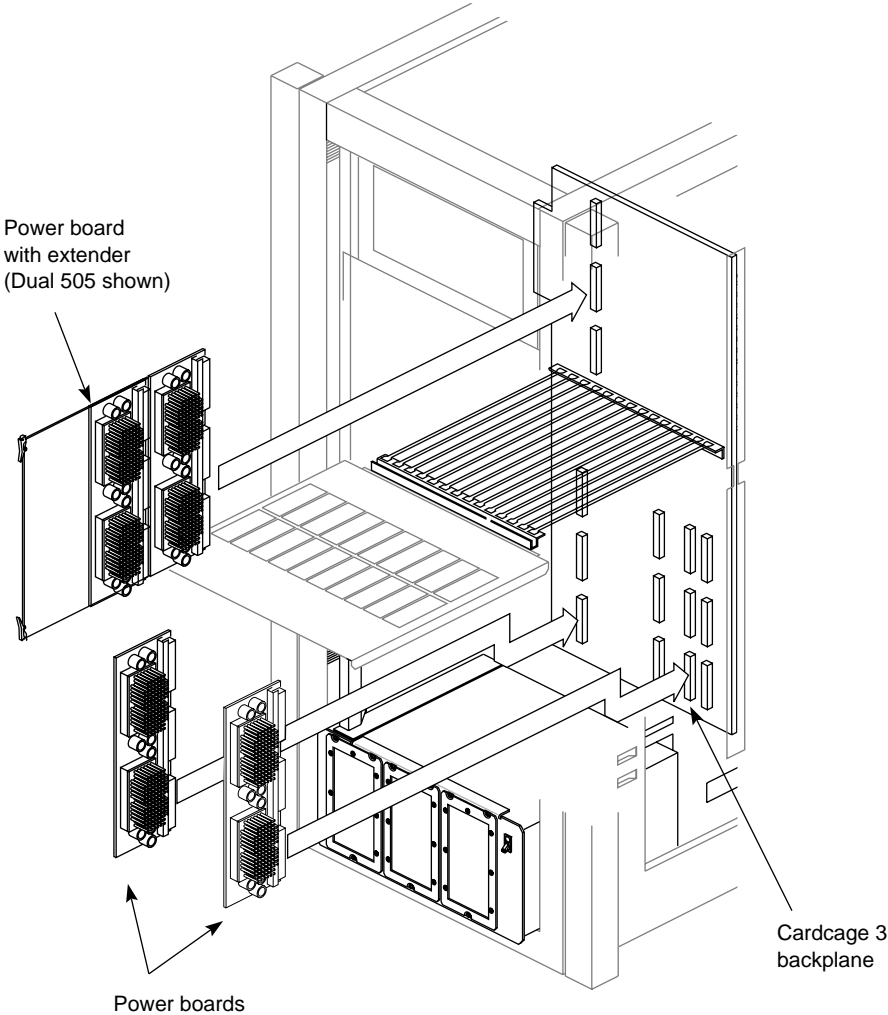


Figure E-6 Power Board Locations in the Cardcage 3

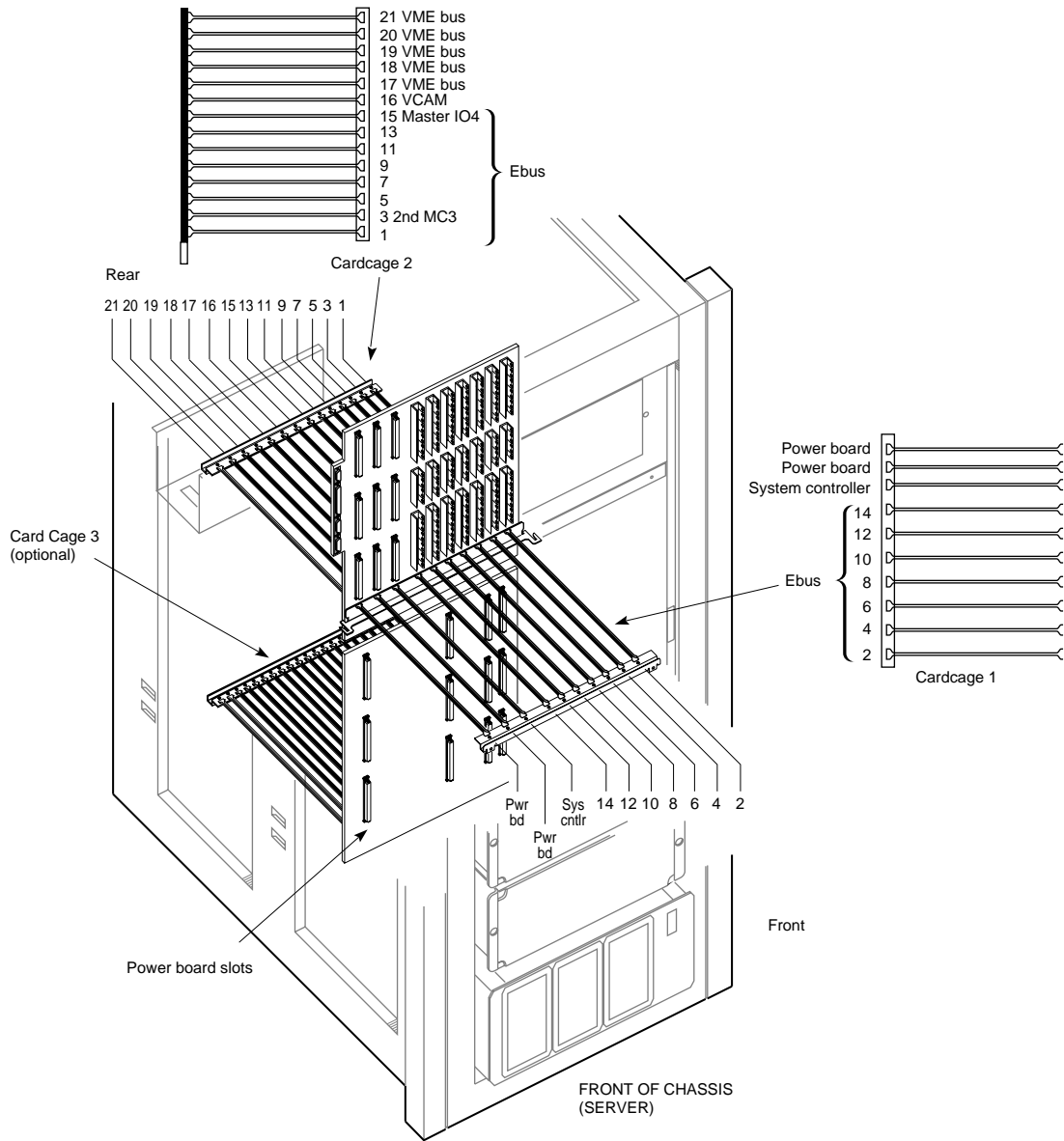


Figure E-7 Rackmount Server System Cardcage 1 and 2 Slot Assignments

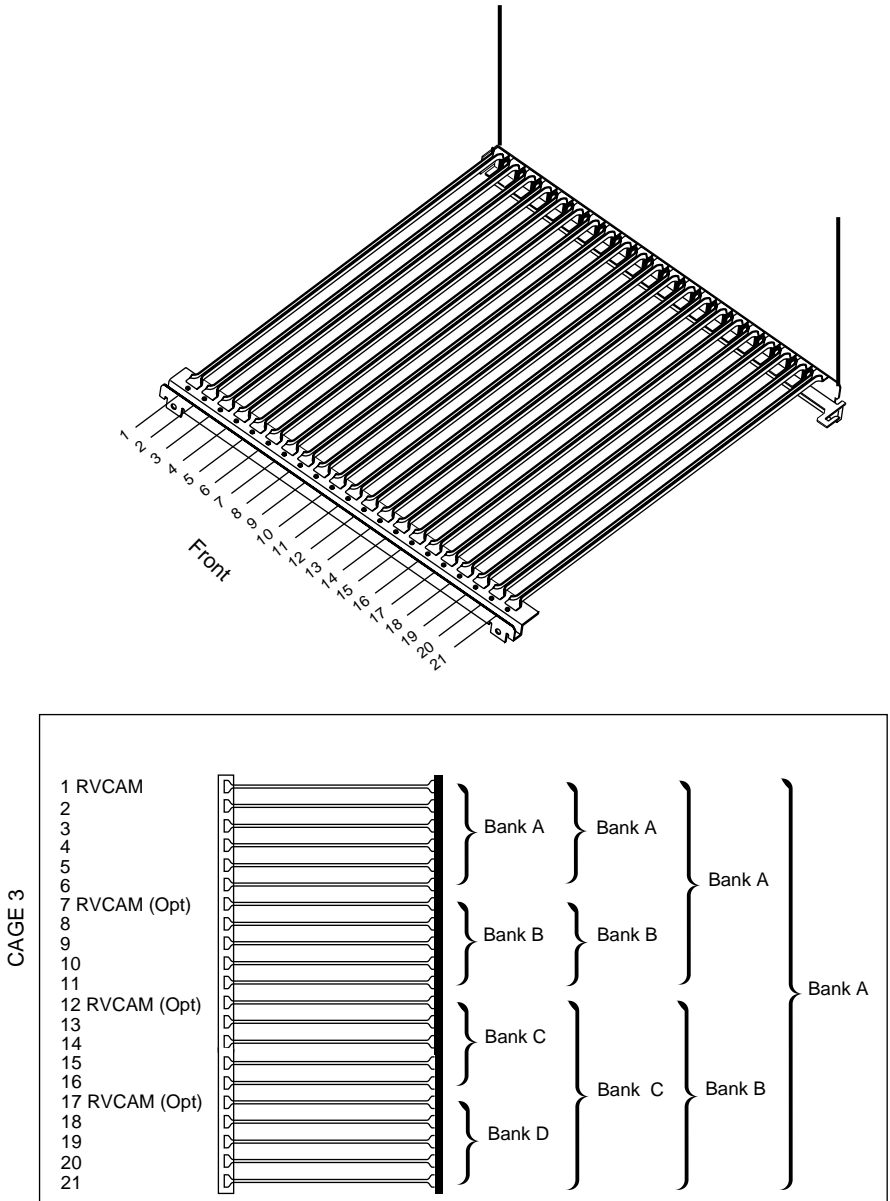


Figure E-8 Rackmount Server System Cardcage 3 Slot Assignments

Exceeding the Nominal VME Power Rating Per Slot

If a VME board requires more than the nominal slot power allotment (approximately 40 watts of +5 V power per slot in CC2 or approximately 70 watts in a cardcage 3), the board still can be used providing that the following cooling and power guidelines are met.

Cooling Guidelines

The user needs to ensure that the board has the proper air flow (for cooling purposes) and sufficient available power. To help maintain proper cooling (according to manufacturer's specifications), the board may need special custom baffles or a set of non-component, enclosure boards to surround the VME board with sufficient air flow.

Note: These custom air flow devices must be supplied by the customer.

VME Power Guidelines

To use a third-party VME board that requires more than the normal VME slot power, be sure to observe these guidelines.

- The board does not draw more than the amount of power allocated for VME board use.
- The board does not exceed the power rating for the VME pins (approximately 200 watts).
- The board uses all three "P" connectors on the system backplane: the P1, P2, and P3. See Table E-6 through Table E-8) for pinout information.

If these guidelines are followed along with the proper cooling requirements, a single VME board can draw as much as 150 watts of +5 V power.

Note: See also "Determining the System Power Budget" on page 141 for additional reference information.

In cardcage 2, you can install two 75-watt VME boards (providing the boards are sufficiently cooled). However, as a result, you cannot install any additional VME boards, since the VME power allotment would already be saturated. It is also possible to use a single 150-watt VMEbus board in cardcage 2, providing the remaining VME slots are not used.

In cardcage 3, you can install up to nine 150-watt boards, assuming that all potential power boards (three 505 and one 512) are installed (see Figure E-6). However, as a result, the remaining VME slots cannot then be used.

VME Pin Information

Table E-6 through Table E-8 list the pin assignments of the VME P1, P2, and P3 connectors. Table E-9 describes the pin signals.

Note: No connections are made to rows A and C of connector P2. These lines are not bused across the backplane. The P3 connector uses the Sun power convention. In addition, the Challenge system does not generate ACFAIL* or SYSFAIL*. The SERCLK and SERDAT* are also unused.

The Challenge system supplies the defined voltages to the bus, asserts SYSREST*, and drives SYSCLK (SYSCLK is driven at 16 MHz).

On the Challenge backplanes, the unused VME pins are *no connects*.

Caution: The Challenge system does not support VSBbus boards.

Table E-6 P1 VME Pin Assignments

Pin	Row A	Row B	Row C
1	D00	BBSY*	D08
2	D01	BCLR*	D09
3	D02	ACFAIL	D10
4	D03	BG01N*	D11
5	D04	BG0OUT*	D12
6	D05	BG1IN*	D13
7	D06	BG1OUT*	D14
8	D07	BG2IN*	D15
9	GND	BG2OUT*	GND
10	SYSCLK	BG3IN*	SYSFAIL*

Table E-6 (continued) P1 VME Pin Assignments

Pin	Row A	Row B	Row C
11	GND	BG3OUT*	BERR*
12	DS1	BR0*	SYSRESET*
13	DS0	BR1	LWORD*
14	WRITE*	BR2*	AM5
15	GND	BR3*	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18
21	IACKIN*	SERCLK	A17
22	IACKOUT*	SERDAT*	A16
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	-12V	+5VSTDBY	+12V
32	+5V	+5V	+5V

Table E-7 P2 VME Pin Assignments

Pin	Row A (Note: This row is user-defined.)	Row B	Row C (Note: This row is user-defined.)
1		+5V	
2		GND	
3		RESERVED	
4		A24	
5		A25	
6		A26	
7		A27	
8		A28	
9		A29	
10		A30	
11		A31	
12		GND	
13		+5V	
14		D16	
15		D17	
16		D18	
17		D19	
18		D20	
19		D21	
20		D22	
21		D23	
22		GND	

Table E-7 (continued) P2 VME Pin Assignments

Pin	Row A (Note: This row is user-defined.)	Row B	Row C (Note: This row is user-defined).
23		D24	
24		D25	
25		D26	
26		D27	
27		D28	
28		D29	
29		D30	
30		D31	
31		GND	
32		+5V	

Table E-8 P3 VME Pin Assignments

Pin	Row A	Row B	Row C
1 through 25	+5 V	Not connected	GND
26, 27	+12 V	Not connected	+12V
28, 29	-12 V	Not connected	-12V
30 through 32	-5 V	Not connected	-5V

Note: In the Challenge VME backplanes, P3B is used for Silicon Graphics purposes.

Table E-9 Signal Definitions

Signal Name	Definition
D00 through D31	Data lines. These lines are tri-stated and are not defined until the data strobes (DS0* and DS1*) are asserted by the MASTER.
A00 through A31	Address lines. These lines are tri-stated and are not defined until the address strobe (AS*) is asserted by the MASTER.
AM0 through AM5	Address modifier lines. Asserted by the MASTER and indicate the type of data transfer to take place. VME SLAVES look at the lines to determine if they will respond and what type of response to make.
DS0, DS1	Data Strobe lines. Asserted by the MASTER and indicate stable data on the data bus.
AS	Address strobe. Asserted by the MASTER and indicates a stable address is present on the address lines.
BR0 through BR3	Bus request lines. MASTER requests a busy bus via these prioritized levels.
BG0IN through BG3IN	Bus grant in (daisy-chained).
BG0OUT through BG3OUT	Bus grant out (daisy-chained).
BBSY	Bus busy.
BCLR	Bus clear. (Hint to bus master: VME MASTERS are not required to comply.)
IRQ1 - IRQ7	Interrupt request lines.
IACK	Interrupt acknowledge. Asserted by MASTER to indicate the VME interrupt level to be serviced.
IACKIN	Interrupt acknowledge in (daisy-chained).
IACKOUT	Interrupt acknowledge out (daisy-chained).

Table E-9 (continued) Signal Definitions

Signal Name	Definition
DTACK	Data transfer acknowledge. Asserted by SLAVE to indicate a successful bus transfer.
WRITE	Write not or read.
LWORD	Indicates long word transfer (D32).
SYSCLK	16 MHz system clock. (Does not control bus timing.)
SERCLK	Serial data clock.
SERDAT	Serial data line.
BERR	Bus error line.
SYSFAIL	Indicates a board has failed.
ACFAIL	AC power failure notify line.
SYSRESET	Reset signal for VMEbus.

Skipping a VME Slot

Skipping a slot is occasionally required to fit oversized VME boards or to improve air flow. A slot can be skipped if jumper blocks are placed on the appropriate VME jumper block pins.

Note: If you install the VME boards in order (from left to right), then no jumpering is required. In addition, if you have no VME boards installed, you do not need to install any jumpers.

The general guideline is to have jumpers in the jumper banks correspond to the VME slot number that you are skipping (see Table E-10). For example, if you are skipping VME slot 17, you need to insert five jumpers into jumper bank 1 (see Figure E-9).

Table E-10 Correspondence of VME Jumpers to VME Slots

Jumper Bank	Cardcage 2 VME Slot
1	17
2	18
3	19
4	20

Jumpering Examples

See the following examples:

- If you are skipping the first two VME slot and wish to use the third VME slot, you must place jumpers in jumper banks 1 and 2 (see Figure E-9).
- If you wish to skip over VME slots, for example, from the first VME slot over to the third VME slot, you must place jumpers in bank 2 (see Figure E-10).

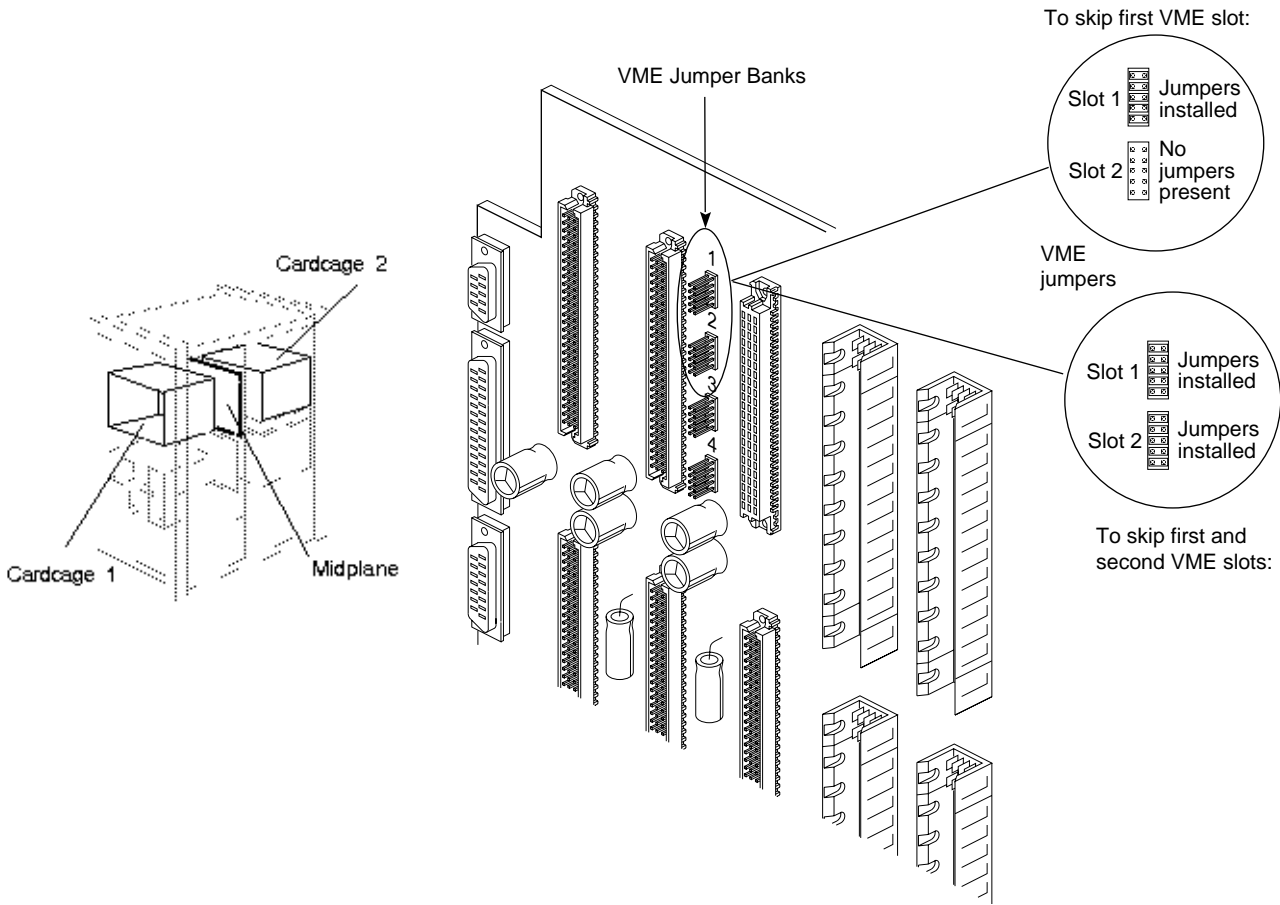


Figure E-9 VMEbus Midplane Jumpers

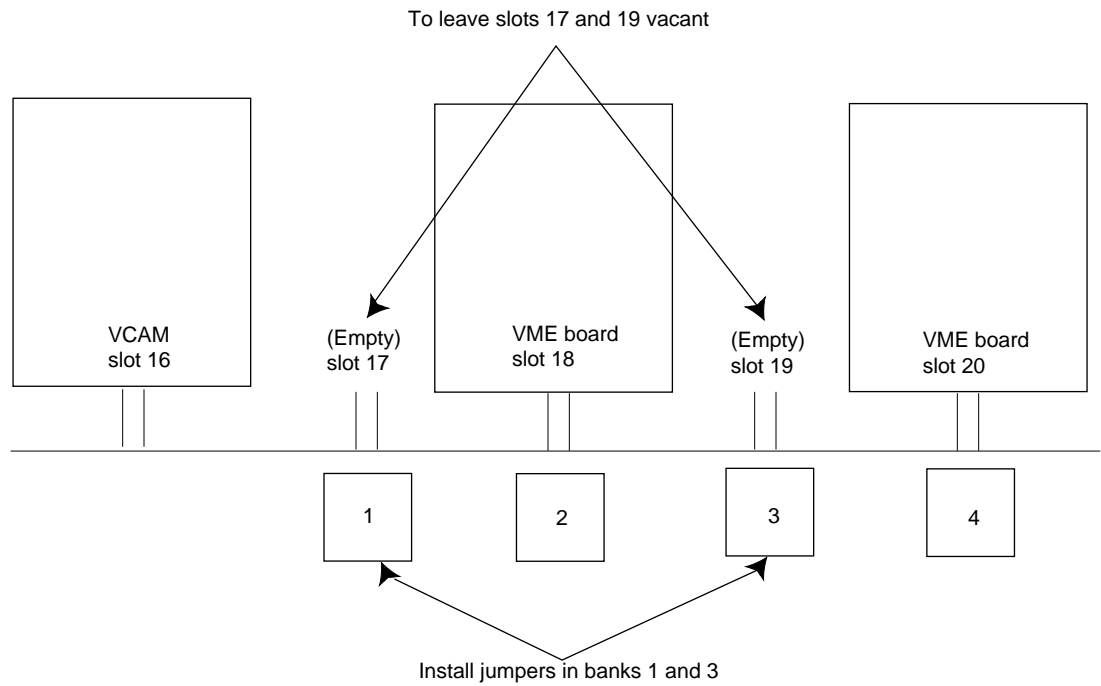


Figure E-10 Skipping a VME slot

Cardcage 3 Jumpering

The optional cardcage 3 VMEbus backplane does not have jumper banks as the midplane does. Skipped VMEbus slots in cardcage 3 are jumpered using PCA CC3 VME jumper board (p/n 030-0516-001) from the cardcage side.

Caution: You must install this board *only* in the top VME connector, P1, or damage may occur to the system. Bus jumpers are signals on the P1 connector.

Using a 6U-to-9U Converter Board

Some third-party VMEbus boards have a 6U form factor and require a Silicon Graphics 6U-to-9U converter (or extender) board assembly to be used in the Challenge or POWER Challenge system (see Figure E-11).

Note: Contact your Silicon Graphics sales office to obtain a 6U converter board (p/n 030-0519-001).

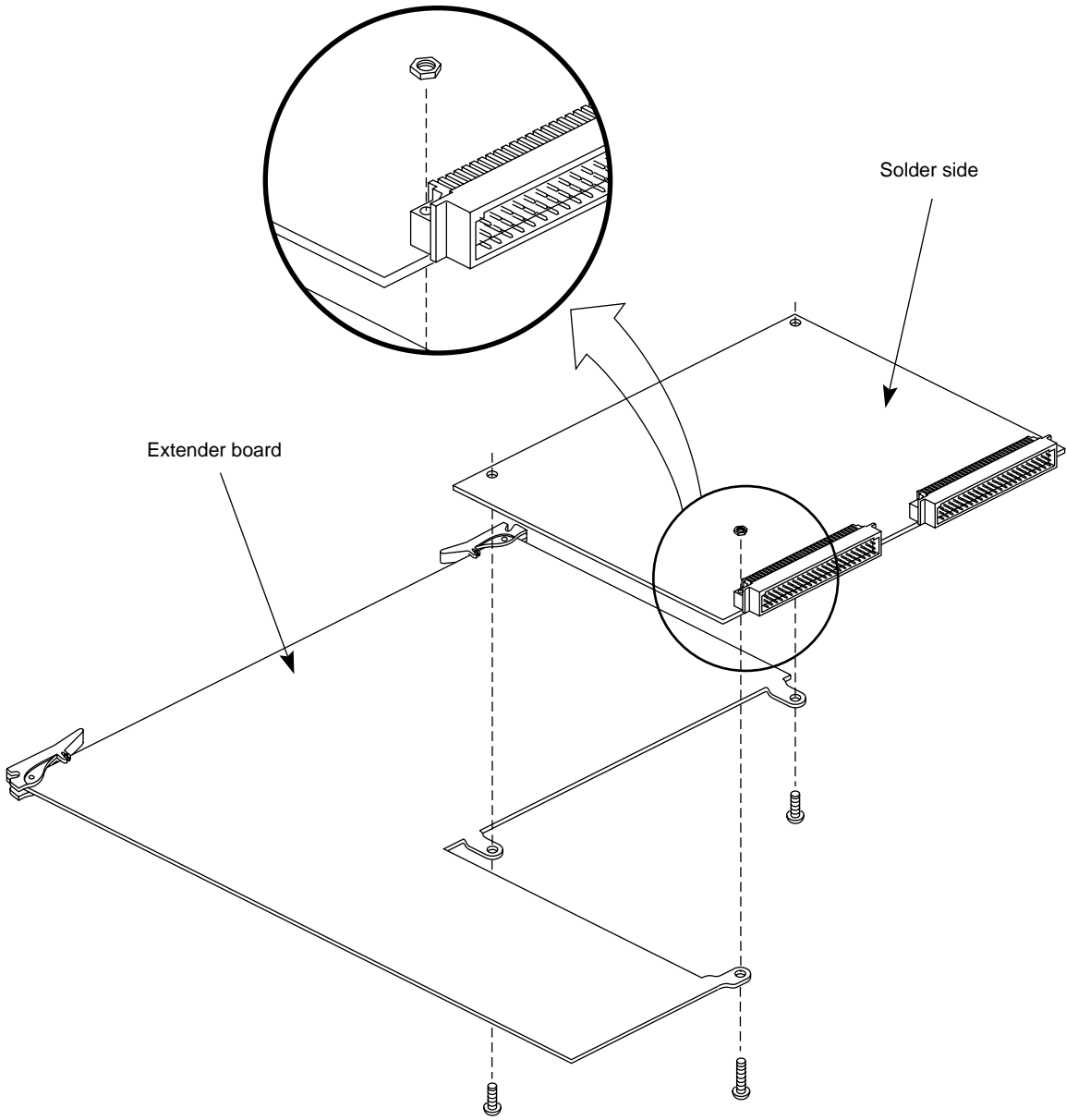


Figure E-11 Silicon Graphics 6U Converter Board

Accessing Multiple VMEbuses

The cardcage 3 (CC3) option allows access to up to four additional VMEbuses on a Challenge and POWER Challenge system to help increase overall system throughput.

Note: The system can have a maximum of five VMEbuses (four from the third cardcage option, plus the primary VMEbus).

Your system must already have the cardcage 3 (CC3) option and other associated hardware installed, before you can access multiple VMEbuses. If you do not know whether your system has been configured with the CC3 option, type `hinv` at an IRIX prompt. You should get a display similar to the following:

```
VME bus: adapter 0 mapped to adapter 45
VME bus: adapter 37
VME bus: adapter 36
VME bus: adapter 45
```

Note: The adapter numbers may be different in your system.

Configuring a Third-Party VME Board to Use a Secondary VMEbus

The CC3 must be installed by a Silicon Graphics system support engineer (SSE). Contact your Silicon Graphics sales office to order this option.

If your system already has the CC3 option, and you wish to you add a third-party VME board on a secondary VMEbus, follow these guidelines.

1. As superuser, open the `/var/sysgen/system/irix.sm` file.
2. Locate the appropriate vector statement in the file. Be sure the board controller number matches the vector line you modify. See the following example:

```
VECTOR: bustype=VME module=jag ipl=1 ctlr=0 adapter=0
iospace=(A16S, 0, 0x800)
probe_space=(A16S, 0, 1)
```

Note: During this procedure, you will change the adapter number (that is, `adapter=0`) to reflect the position of the F Mezz board on the IO4 board. The adapter number, 0, designates the primary bus in the midplane.

3. Determine the slot position of the IO4 board that has the targeted F Mezz board mounted on it using the `hinv -v -b` command. See Figure E-7 as required.
4. Determine the adapter position(s) of the F Mezz board that you are using through the `hinv -v -b` command.
5. Translate the adapter position number into its corresponding *virtual* adapter number using Table E-11. For example, physical adapter 5 translates to position 2 and adapter 6 translates to position 3.

Table E-11 IO Adapter Translation

I/O Adapter Number	Translated Adapter Number
2	0
3	1
5	2
6	3

Note: The software requires this virtual translation to help determine the corresponding VMEbus bank.

6. You can now determine and change the adapter number (that is, `adapter=0`) in the vector statement by using the following formula and entering the values just derived:

```
adapter number = [IO4 slot# x (multiplied by) 4] +
translated adapter_position
```

As an example, say you wish to enable a separate VMEbus for VME boards attached through Short F Mezz board connector 6 on an IO4 board in slot 15. According to the formula, take the IO4 slot number 15, multiply it by 4, and then add the translated adapter position number 3 to obtain a value of 63.

Then change the default adapter number, 0 (that is, `adapter=0`) to a value of 63. This tells the driver where its controller can be found.

7. If applicable, remove the * (asterisk) from the desired vector line and edit the statement with the new adapter number value.
8. If you wish to add another VME device or enable another VMEbus, edit the next vector line with the desired adapter number.
9. Reboot the system. During power-on, you should see a message similar to the following:

... automatically reconfiguring the system ...

If you do not see this message, either the hardware was not properly configured or that the software file was not properly modified.

Note: The *hinvo* command does not display non-Silicon Graphics boards.

VMEbus Board Design Considerations

This section provides design guidelines for implementing third-party VME boards. Be sure to observe these general rules to avoid possible damage to the VMEbus and system.

- Devices should require 8-bit interrupt vectors *only*. This is the only interrupt vector size that is recognized by the IRIX kernel.
- Devices must not require UAT (unaligned transfers or tri-byte) access from the Challenge system.
- Devices in Slave mode must not require address modifiers, other than Supervisory/Nonprivileged data access.
- While in VME Master mode, devices must only access the system memory using Nonprivileged data access or Nonprivileged block transfers.
- Devices must have the ability to be configured so that their address range does not conflict with those used by the Challenge system. The device should also be able to respond to addresses generated by the system. See the */var/sysgen/system/irix.sm* file for acceptable ranges.
- The Challenge system does not support VSBbus boards. In addition, there are not any pins on the back of the VME backplane. This area is inaccessible for cables or boards.

- Be sure to place boards starting in the first VME slot, or jumper the daisy-chained signals across the empty slots. If you don't place boards this way, the interrupt acknowledge and bus arbitration schemes breaks.
- Metal face plates or front panels on VME boards may need to be removed. The plate could prevent the I/O door from properly closing and possibly damage I/O bulkhead.

Note: In some VME enclosures, these plates supply the required additional EMI shielding. However, the Challenge chassis already provides sufficient shielding for boards inside the chassis, so these plates are not necessary.

Design Guidelines

This section presents basic timing numbers to aid in designing a VMEbus master for the Challenge and POWER Challenge systems.

The first word of a:

- read is delivered to the master in 3 to 8 μ sec.
- write is retrieved from the master in 1 to 3 μ sec.

The VME spec has a burst length of:

- 265 bytes in D08, D16, and D32 modes
- 2 KB in D64 mode

The Challenge hardware has a 20-bit counter for a burst length of 2 MB in all sizes. The burst length occurs in bytes and not transfer cycles.

VME Handshake

Figure E-12 illustrates the VME handshake.

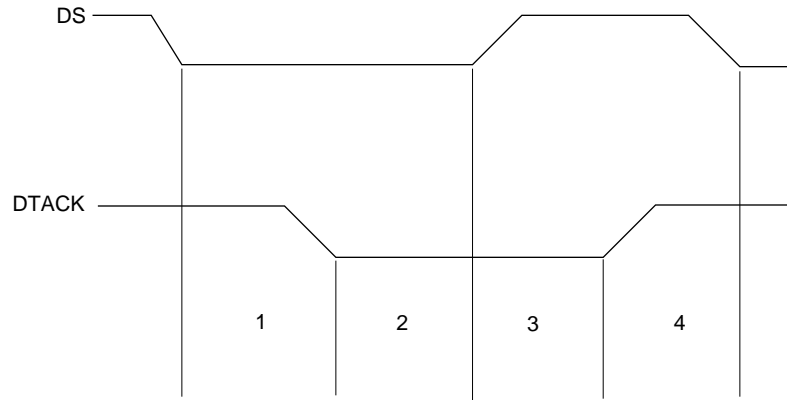


Figure E-12 VME Handshake

Parts 1 and 3 are controlled by the slave, the Challenge and POWER Challenge hardware.

Parts 2 and 4 are controlled by the master, the VME controller board.

Note: Part 1 is about 40 ns and Part 3 is about 20 to 25 ns. The total Challenge and POWER Challenge contribution is about 60 to 65 ns.

F Controller ASIC Address Mapping

The F controller does the mapping from A32 mode into system memory and automatically crosses the page boundaries. You do not have to have AS go high and then low on 4 KB boundaries.

If you use A64 addressing, then you may have to change the address on the 4 KB boundaries and cause a transition on AS low to high, and then back to low. This incurs the delays mentioned at the beginning of this section, “Design Guidelines.”

Note: The delays are averages and may occasionally be longer. The system design does not have any guaranteed latency. For this reason, longer transfers are better than shorter ones. If you decide to exceed the VMEbus specifications, it is recommended that you place a field in a control register on your VME board that enables/disables this feature. This allows you to put the board in standard mode so it can be used on other VME systems.

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