POWER Onyx™ and Onyx® Rackmount Owner's Guide

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About This Guide

This document is designed to help you understand and operate your Onyx® rackmount graphics workstation. The information contained in this document is organized as follows:

Chapter 1	"The Power Onyx and Onyx Rackmount Graphics Workstation" provides an overview of the basic system and its capabilities.
Chapter 2	"Touring the Chassis" describes all of the system components and reviews all of the controls, indicators, and connectors.
Chapter 3	"Getting Started" describes the connection of the appropriate hardware and provides the power-on and boot procedures.
Chapter 4	"Installing and Using Optional Peripherals" supplies the information needed 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 and guidelines for system operation.
Appendix A	"Hardware Specifications" lists physical and electrical specifications.
Appendix B	"Drive Maintenance" describes the procedures required to properly maintain 1/4-inch, 4-mm DAT and 8-mm tape drives, as well as CD-ROM players.
Appendix C	"System Controller Error Messages" lists all of the possible error messages.

Appendix D	"Onyx 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 The section also lists maximum allowed configurations using the new InfiniteReality graphics pipes.
Appendix F	"Configuring a Multipipe Onyx System" provides information on setting up an Onyx rackmount system with up to three graphics subsystems.

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 helpful in operating your Onyx rackmount graphics workstationis is located in the following software guides:

- *IRIX Admin: Software Installation and Licensing* (P/N 007-1364-00x)
- *IRIX Admin: System Configuration and Operation* (P/N 007-2859-00x)

Style Conventions

This guide uses the following conventions:

- References to other documents are in *italics*.
- References to other chapters and sections within this guide are in quotation marks.
- Names of buttons are in *italics*.
- Names of menu choices are in quotation marks.

Compliance Statements

This sections lists various domestic and international compliance statements that pertain to the system.

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 the user will be required to correct the interference at personal expense.

VDE 0871/6.78

This equipment has been tested to and is in compliance with the Level A limits per VDE 0871.

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.

Canadian Deparment 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

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de Classe A prescrites dans le Reglement sur le Brouillage Radioelectrique etabli par le Ministere des Communications du Canada.

Japanese Compliance Statement

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　従って、住宅地域またはその隣接した地域で使用すると、ラジオ、テレビジョン受信機等に受信障害を与えることがあります。
　取扱説明書に従って正しい取り扱いをして下さい。

Figure In-1 VCCI Compliance Statement

CE

Figure In-2 CE insignia

Manufacturer's Regulatory Declarations

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.

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.

Chapter 1

The Power Onyx and Onyx Rackmount Graphics Workstation

The Onyx rackmount workstation (see Figure 1-1) is a high-performance computer graphics system installed in a configurable rack-mounted enclosure. Hereinafter, all Onyx systems are referred to generically as the Onyx system, unless otherwise specified. This guide contains detailed hardware and software information that is required for system operation.

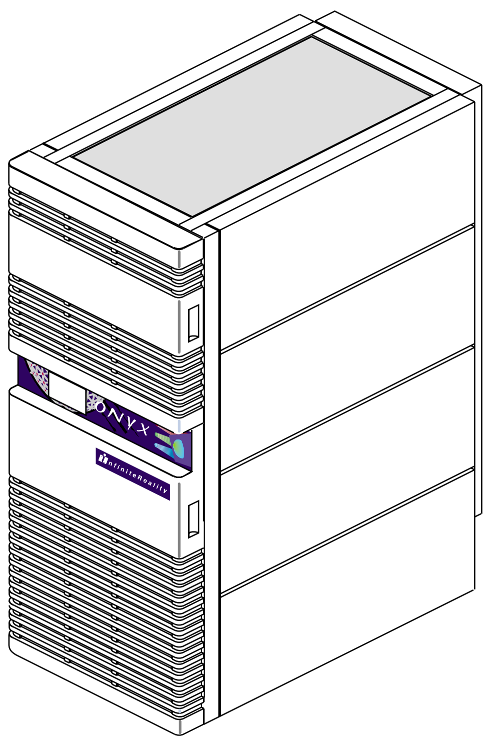

Figure 1-1 Onyx Rackmount Graphics Workstation

Features

Following is a list of the Onyx rackmount graphics workstation's standard features:

- The POWERpath-2 Onyx board set, which
  - supports a maximum of 24 R4400 or R10000 processors (6 IP19 or IP25 CPU boards), or up to 12 R8000 (6 IP21 CPU boards)

    Note: You may not mix different types of CPU boards in the same chassis.
  - can be configured with up to eight MC3 interleaved memory boards, each having a maximum of two gigabytes (GB) of memory
  - can be configured with a maximum of six POWERChannel 2 (IO4) interface boards, providing multiple graphics, VMEbus, and peripheral interfaces
  - utilizes a 256-bit system data bus (Ebus)
  - utilizes a 40-bit system address bus (Ibus)
  - supports a maximum of three InfiniteReality™, or RealityEngine^2™ graphics subsystems, or a single VTX™ graphics subsystem

    Note: InfiniteReality graphics systems are not supported in POWER Onyx (R8000-based) systems.
- The InfiniteReality graphics subsystem, which includes
  - a Geometry Engine® (GE12) board
  - a DG4 Display Generator board
  - up to four RM6 Raster Memory boards per graphics subsystem
  - a 21-inch color monitor
- The RealityEngine^2 graphics subsystem, which includes
  - a Geometry Engine (GE10) board
  - a DG2 Display Generator board
  - up to four RM4 or RM5 Raster Memory boards per graphics subsystem
  - a 21-inch color monitor

- The VTX graphics subsystem, which includes
  - a Geometry Engine (GE10) board
  - one RM4 Raster Memory board
  - a DG2 Display Generator board
  - a 21-inch color monitor
- Two separate cardcages provide eleven Ebus slots, four VMEbus slots, six graphics bus slots, and three Power board slots.
- SCSI drive enclosure (SCSIBox 2), supporting eight half-height SCSI devices or four full-height SCSI devices, that 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-controlled cooling system for quieter, more efficient operation.
- Modular power supplies (POWERmodules) and power boards.

Following is a list of available options:

- third cardcage with 12 graphics bus slots and 6 VMEbus slots
- third cardcage with 20 VMEbus slots
- additional I/O, VMEbus, and graphics interfaces
- second SCSIBox 2 (identical to the standard enclosure)
- memory upgrades using 16 MB and 64 MB SIMMs
- CPU upgrades using additional microprocessor boards (IP21 CPU upgrades are not available with InfiniteReality systems)
- additional POWERmodules and power boards

Operational Overview

The Onyx rackmount graphics workstation combines the power of the POWERpath-2 system board set with either the InfiniteReality, RealityEngine^2, or VTX graphics subsystems in a chassis designed for maximum expansion.

Note: You may not combine different types of graphics subsystems within the same rackmount Onyx workstation.

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 additional data storage resources.

In its maximum configuration, the Onyx workstation can combine 42 circuit boards and 16 disk or tape drives in a single enclosure. Because of the complexity that accompanies the large number of possible system configurations, the basic version of the system is described first, followed by brief descriptions of the available options.

All rack-mounted graphics systems are shipped with a standard set of POWERpath-2 system boards, a graphics board set(s), and a drive enclosure that supports eight half-height or four full-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 Onyx rackmount graphics workstation. Figure 1-3 illustrates the primary components of the system chassis.

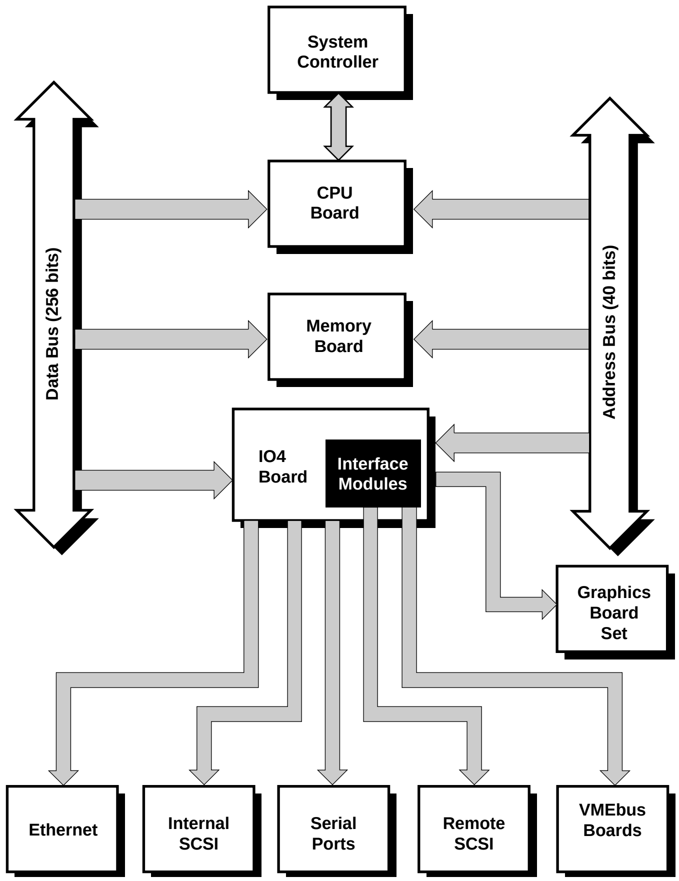

Figure 1-2 Onyx Rackmount Graphics Workstation Functional Block Diagram

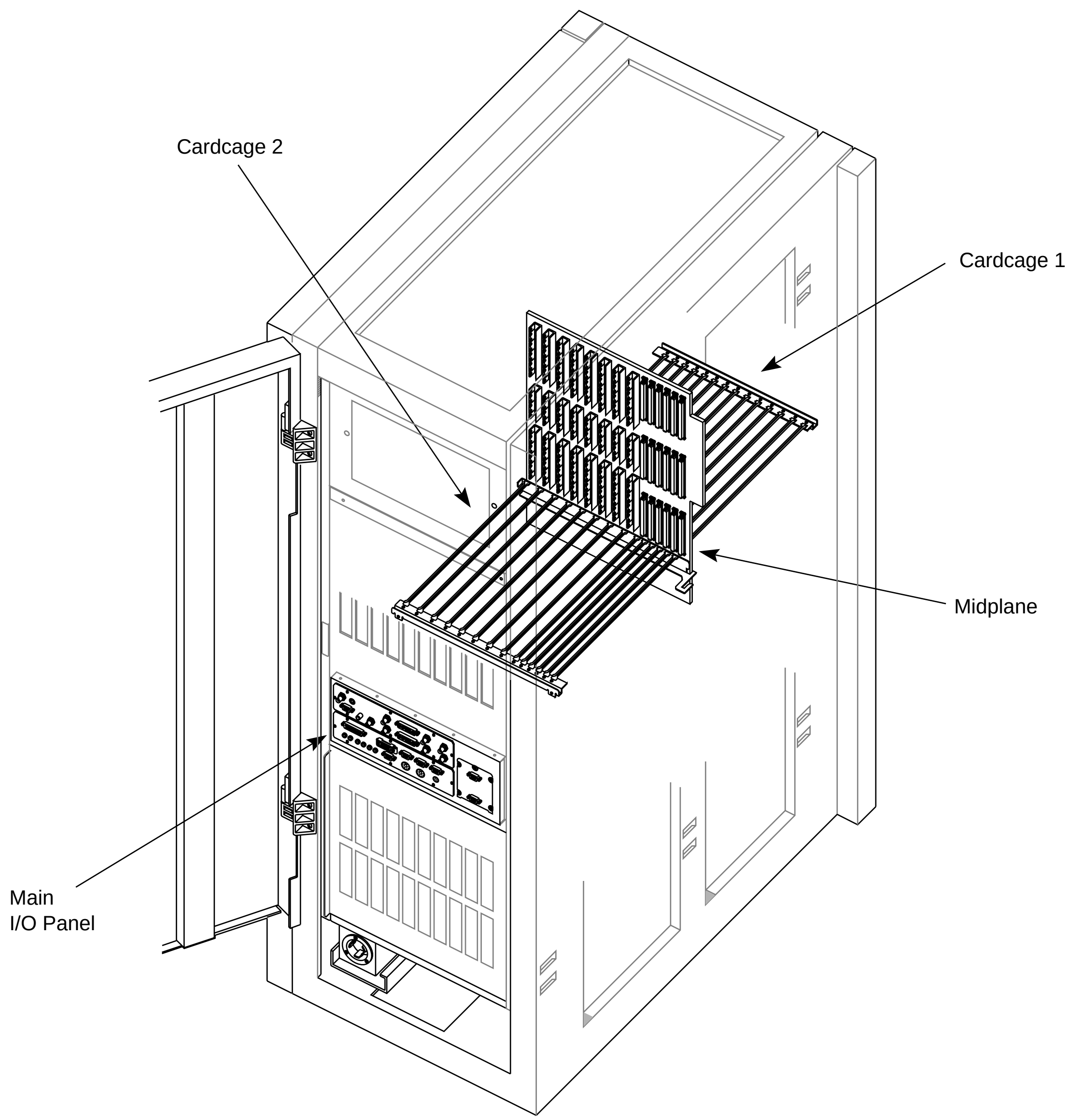

Figure 1-3 Onyx System Chassis

POWERpath-2 System Board Set

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

CPU Boards

The CPU board is the heart of the POWERpath-2 board set. The Onyx system uses either an IP19 CPU board, the IP21 CPU board, or the IP25 CPU board.

The IP19 is a multiprocessor CPU that is configured with either two or four 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 is also a multiprocessor CPU board and comes configured with either one or two processors. The IP21 delivers 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, which enables two data accesses at the same time, significantly improving processing speed. In its maximum configuration, the Power Onyx system supports up to 12 processors on 6 CPU boards. Note that InfiniteReality graphics are not supported in IP21 CPU-based systems.

The IP25 CPU board uses one, two, or four R10000 microprocessors. Each 3.3V R10000 uses a customized 2-way interleaved data cache, and has dedicated second-level cache support. A high-performance bus interface links the CPU directly with supporting SRAM.

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 Onyx system with all of the basic serial ports and interfaces needed for system operation. These interfaces include the video port, the keyboard and mouse interfaces, the SCSI bus interfaces, the Flat Cable Interface (FCI) to the graphics board set, the AUI Ethernet interface, three RS-232 serial ports, and an RS-422 serial port.

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 Ebus through the IA and ID ASICs, forming an asynchronous boundary that provides the Ibus with a bandwidth of 320 MB per second.

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 flat cable interfaces (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 Ebus. It is mounted on the first IO4 board, and the pair are installed in the system midplane as a unit. The IO4 occupies slot 15 on the Ebus, and the VCAM occupies the first VMEbus slot, located to the immediate right.

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 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 rate of 10 Mb per second 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 up to 300 KB per second.

The IO4 board also supports three RS-232 and one RS-422 serial port, 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 optional 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-2 controllers per IO4 board.

The Graphics Board Sets

The Onyx rackmount graphics workstation is available with up to three InfiniteReality or RealityEngine^2 graphics subsystems or a single VTX graphics subsystem.

InfiniteReality is the most powerful graphics subsystem available, and is made up of a GE12 Geometry Engine board, a DG4 Display Graphics board, and up to four RM6 Raster Manager boards.

Note: When using multiple RM6s, you may not mix 16 MB and 64 MB RMs in the same pipe.

The RealityEngine^2 (RE^2) and VTX graphics subsystems each comprise three board types: the Geometry Engine (GE10), the Display Generator (DG2), and the Raster Memory (RM4). RE^2 systems may also use RM5 raster boards.

InfiniteReality Graphics Functional Description

The GE12 Board

The GE12 board uses high-performance GE11 geometry engines. The GE12's host interface processor (HIP) ASIC interfaces with the host system through a Flat Cable Interface (FCI) on the IO4 board. The FCI is a 64-bit wide bus whose purpose is to provide an interface on the IO4 board between the graphics subsystems and the Ibus.

The RM6 Board

Communication between the Raster Memory (RM6) and the DG4 board is over the Video Frontplane bus. The readback bus (Rbus) provides a path for pixels flowing from the RM6 frame buffer to the geometry engine distributor (GED). The Video Control bus provides access to the color maps, window display modes, and cursor control modes. The RM6 board scan-converts triangle data from the triangle bus (Tbus) into pixel data. The RM6 then organizes the data into a series of spans (vertical strips of pixels) and transfers it to the frame buffer.

The DG4 Board

Following the transfer to the frame buffer, the RM6 hands off control of the graphics subsystem to the display generator (DG4). The DG4 subsystem receives digital frame buffer pixel data from the RM6 board over the video frontplane. Two display channels per DG4 board are standard. An additional six are optional on the multichannel display generator DG4-8.

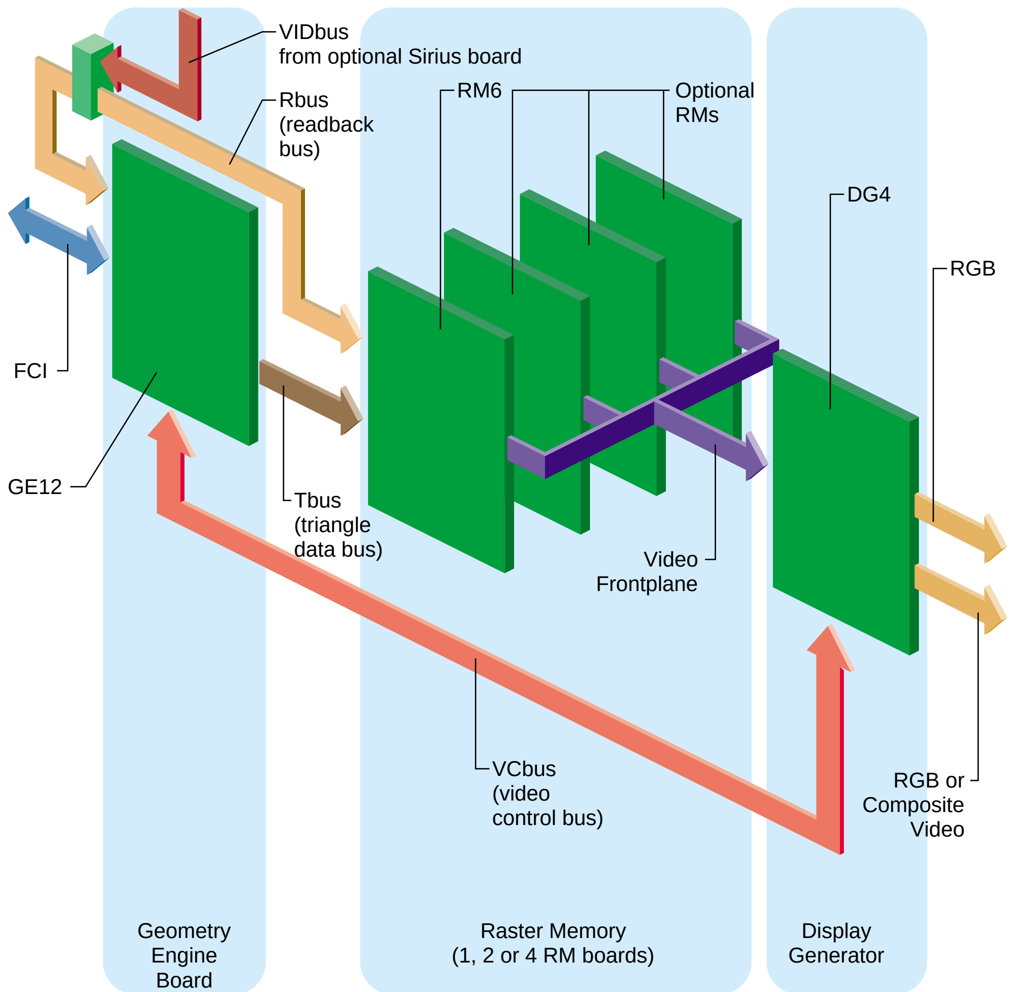

Figure 1-4 InfiniteReality Graphics Subsystem Functional Block Diagram

RE^2 and VTX Functional Description

See Figure 1-5 for a functional block diagram of the RealityEngine^2 and VTX graphics board sets. Unless otherwise indicated, the following information applies to both the RE^2 and VTX versions.

Geometry Engine

The Geometry Engine (GE10) board processes Graphics Library™ (GL) commands and data from the system and is the first stage of the graphics pipeline. The VTX GE10 has 6 GE processors. The RE^2 GE10 has 12 GE processors, giving it twice the processing capability of the VTX configuration.

Raster Memory (RM4 or RM5) Board

The Raster Memory (RM4) boards scan and convert triangle data from the Triangle bus into pixel data. The pixel data is then organized into a series of *spans*, or vertical strips of pixels. The graphics subsystems display images by projecting a continuous series of spans onto the screen. The RM transfers the spans to the frame buffer, which is a rectangular array of image memory processors. Following the transfer to the frame buffer, the RM hands off control of the graphics subsystem to the display generator (DG2).

The RE^2 board set can have up to four RM4 or RM5 boards per pipeline. The cost-reduced VTX supports one RM4 board. As more RM boards are added, the spans are interleaved, providing higher resolution and higher display quality.

Display Generator Subsystem (DG2)

The Display Generator (DG2) board receives digital frame buffer pixel data from the RM4 board over the video bus. The DG2 then processes the pixel data through digital-to-analog converters (DACs) to generate an analog pixel stream for display.

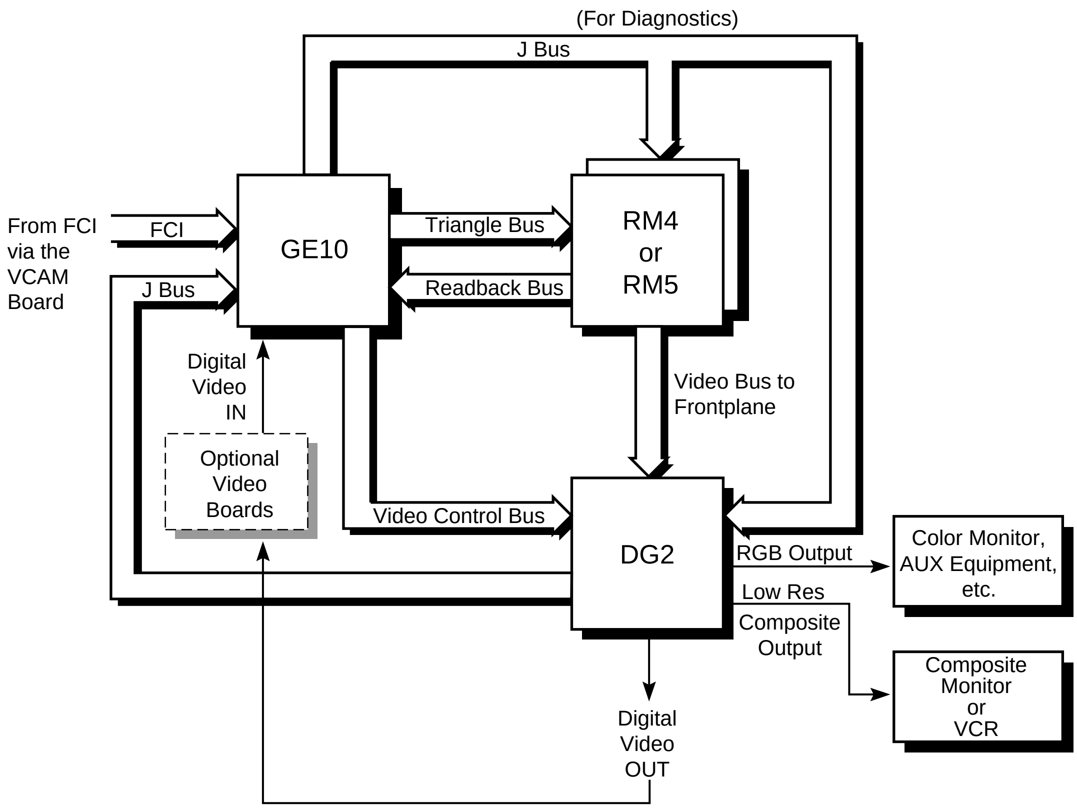

Figure 1-5 RE^2 Graphics Subsystem Functional Block Diagram

System Midplane and Backplane

The Onyx rackmount system midplane has a combination of POWERpath-2 (Ebus), graphics bus, and 9U VMEbus board connectors. The graphics workstation midplane has ten system bus, five graphics bus, and four VMEbus board slots.

In addition to the midplane, two optional backplanes are available. One provides an additional 6 VMEbus slots and 12 graphics bus slots. The other provides 20 VMEbus slots. See Chapter 2, “Touring the Chassis,” for more information and the locations of the midplane and backplanes.

SCSI I/O Devices

SCSI devices are the only data storage devices internally supported by the Onyx 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 drives, 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 2. 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-up 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.

Operating Considerations

This section covers the basic requirements for physical location to ensure proper chassis operation.

The Onyx rackmount chassis is designed to be housed in a computer room that meets 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, or other harmful conditions.
- The access doors should have sufficient clearance to swing completely open.

Additional specifications are provided in Appendix A, "Hardware Specifications."

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 Onyx system support engineer or other authorized Silicon Graphics support organization before your system is installed.

Chapter 2

Touring the Chassis

The Onyx rackmount graphics workstation uses a highly configurable rack-mounted 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 Onyx system. No user serviceable parts are located within the chassis. All installation and maintenance must be performed by personnel trained by Silicon Graphics. Contact the Silicon Graphics technical education department for information about customer training.**

This chapter is provided to give you a more thorough understanding of your graphics workstation. 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 you should not attempt to access them.

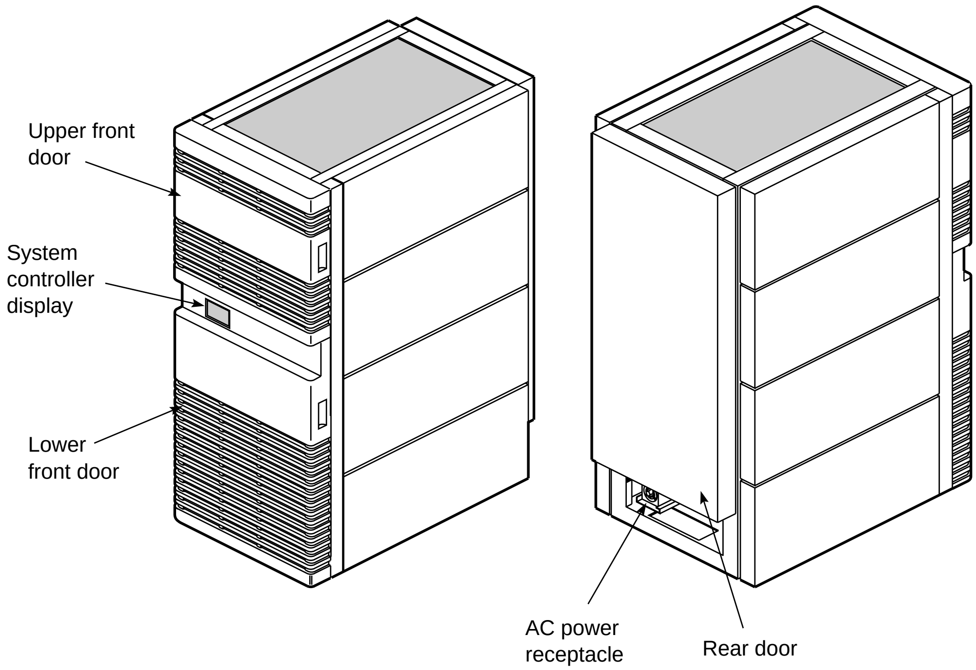

Figure 2-1 Chassis Front and Rear Views

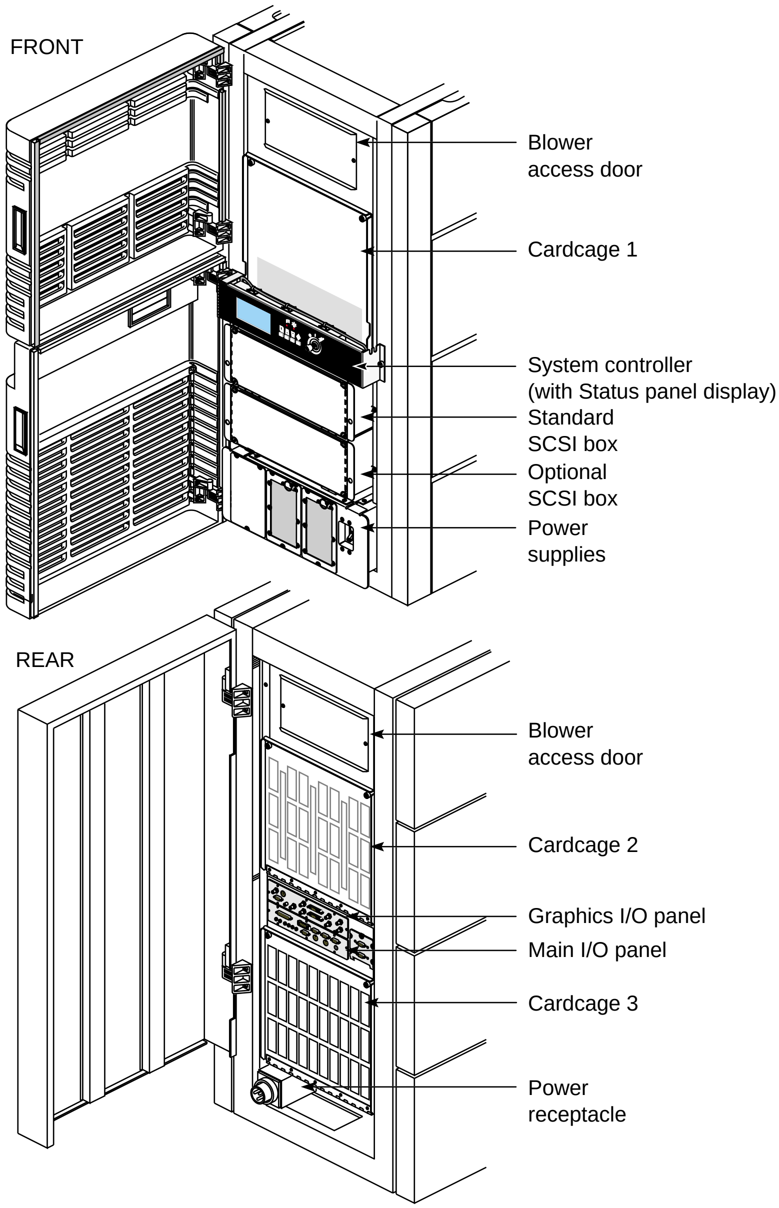

Figure 2-2 Onyx Rackmount Chassis With Doors Open

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 two or three POWERmodules (referred to as offline switchers [OLSs]). Each OLS has a pair of light-emitting diodes (LEDs) located in the lower right corner of its front panel. The LEDs are visible through the metal mesh when they are lit. The amber input power LED lights when AC power levels are normal, and the green output power LED lights when the DC voltage 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 may 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 fault 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.

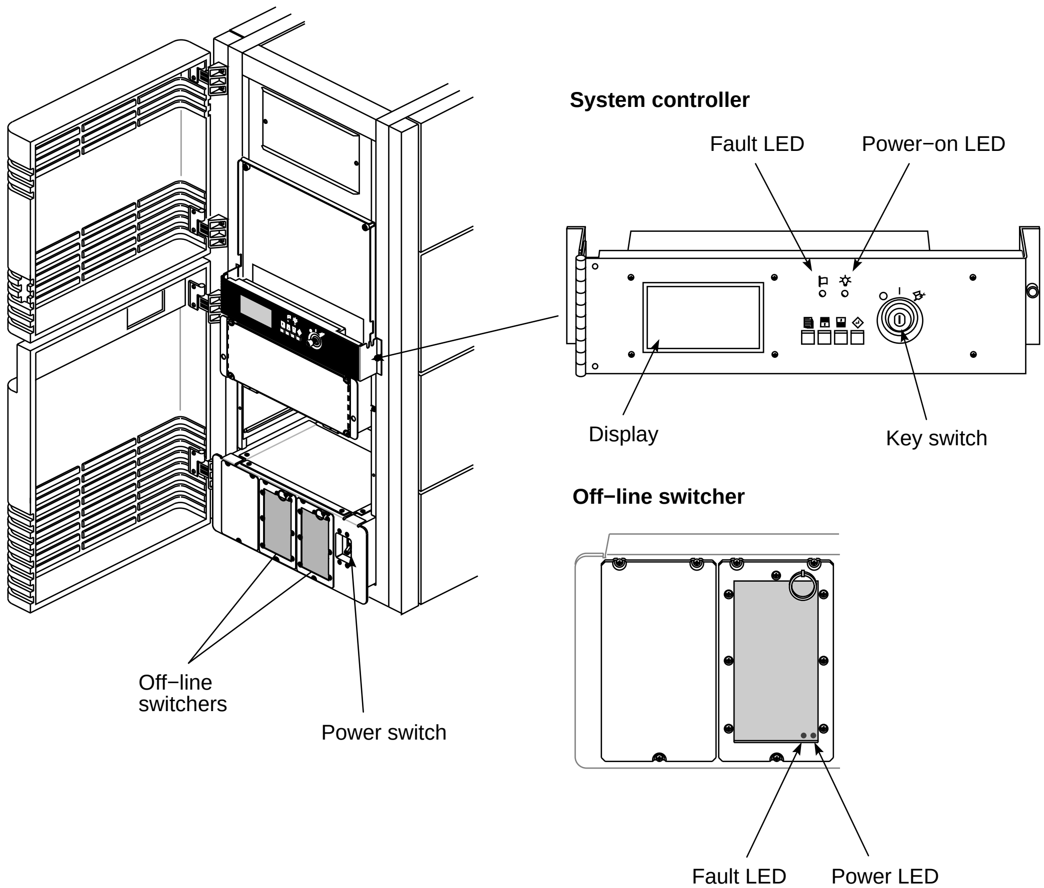

Figure 2-3 Power Switches and Indicators

I/O Panels and Connectors

This section describes the various I/O panels and their connectors. The system has two primary I/O panels: the main I/O panel and the graphics I/O panel. Both panels are located in approximately the center of the rear of the Onyx system chassis. Two additional I/O panels are located above and below the primary I/O panels (see Figure 2-4).

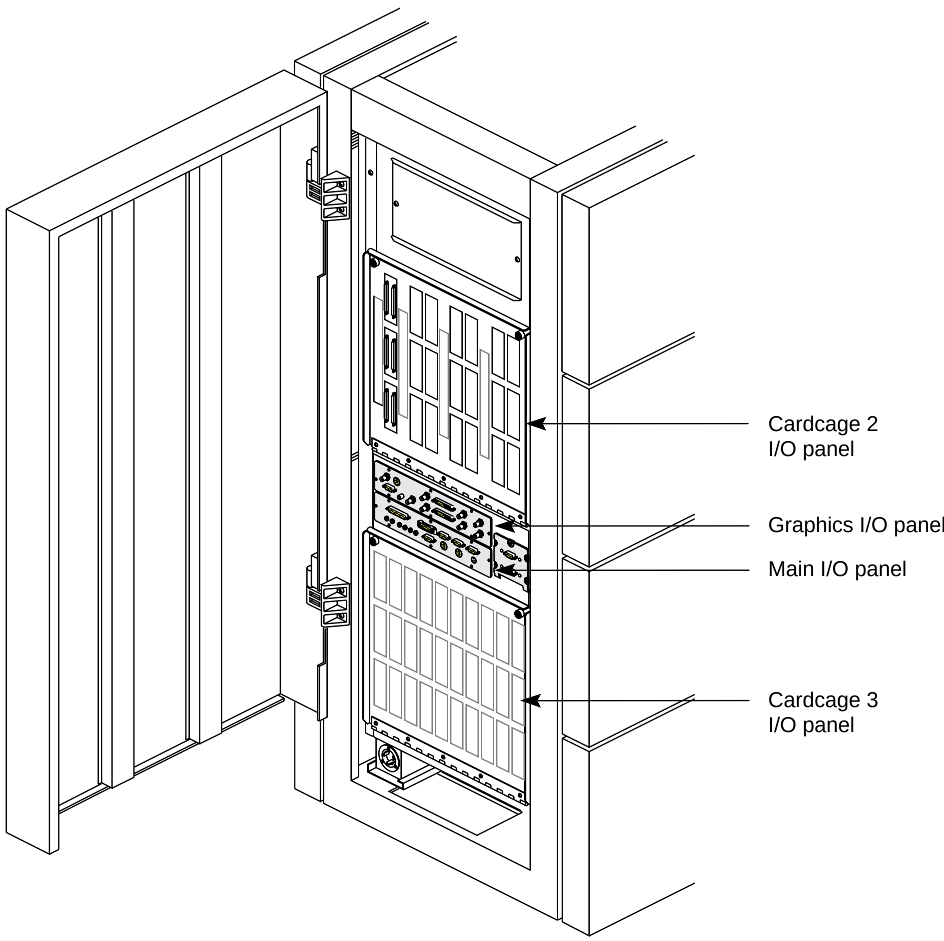

Figure 2-4 Onyx System I/O Panels

Graphics and Main I/O Panel

The InfiniteReality graphics I/O panel is just above the main panel. See Figure 2-5 for the location of each InfiniteReality graphics connector.

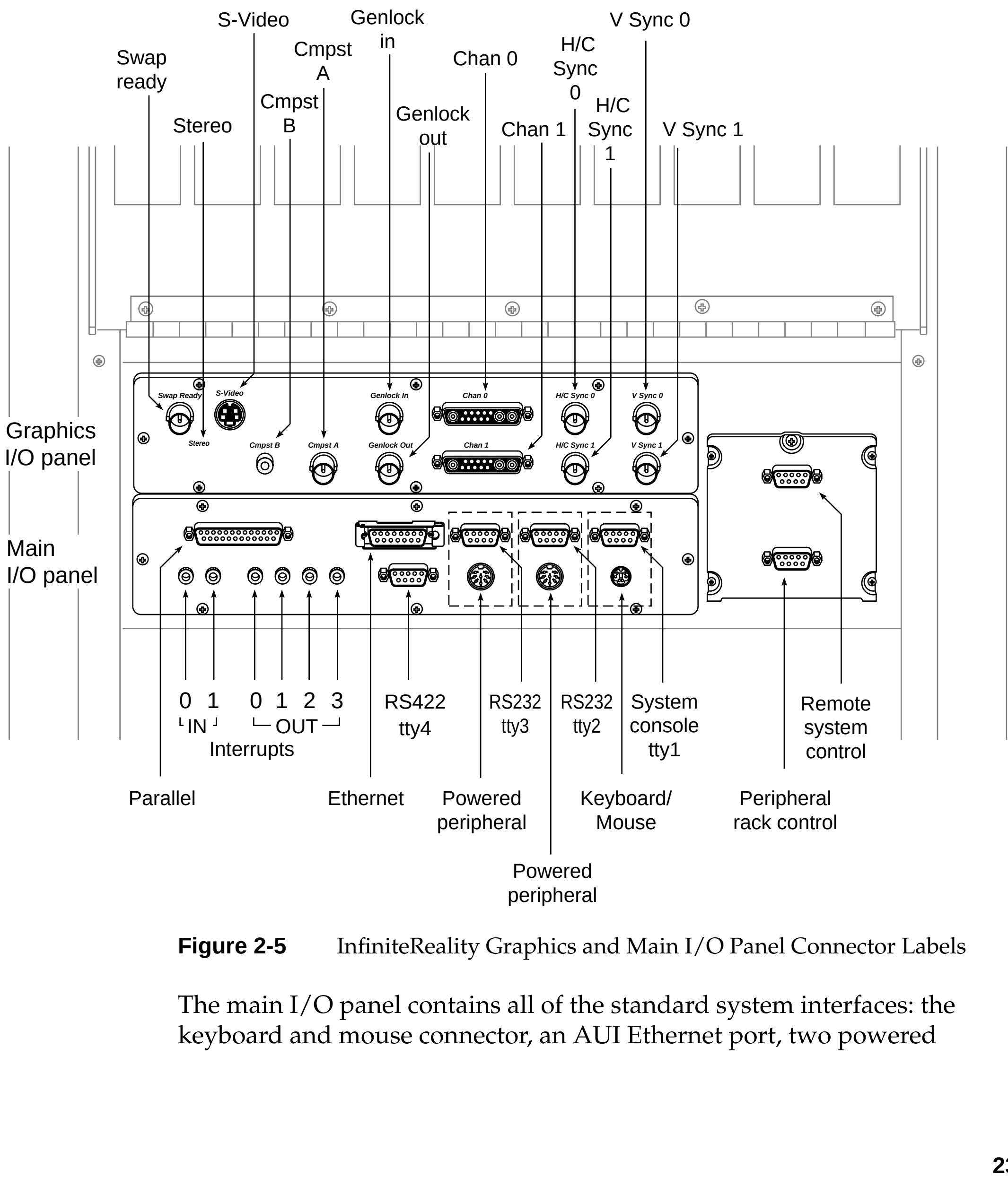

Figure 2-5 InfiniteReality Graphics and Main I/O Panel Connector Labels

The main I/O panel contains all of the standard system interfaces: the keyboard and mouse connector, an AUI Ethernet port, two powered peripheral ports, three RS-232 serial ports, an RS-422 serial connector, a parallel printer port, and six interrupt jacks.

See Figure 2-6 for an illustration of the RE^2 and main I/O panel connectors and Table 2-1 for a listing of the main I/O connectors and their descriptions.

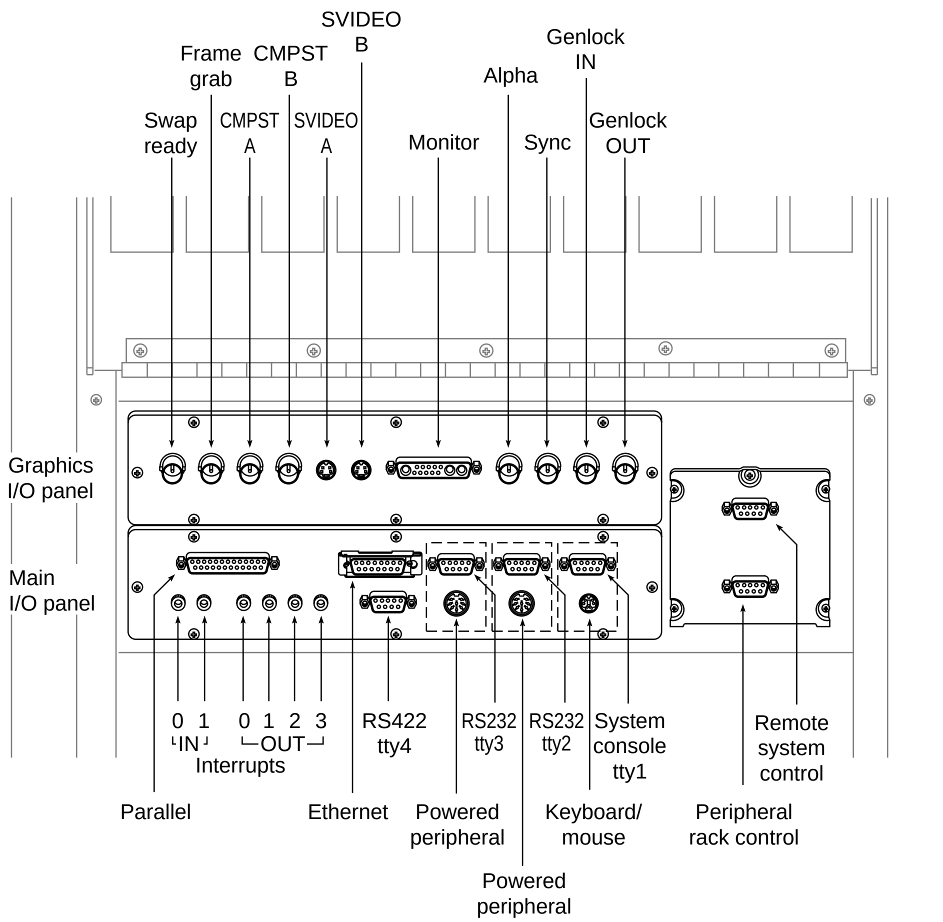

Figure 2-6 RE^2 and Main Graphics I/O Panel Connectors

Table 2-1 Main I/O Panel Connector Descriptions

Connector Description	Connector Type	Function
Keyboard/Mouse	6-pin mini-DIN	Keyboard and mouse connection
AUI Ethernet	15-pin sub-D	Standard Ethernet port
Serial 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

InfiniteReality Graphics I/O Panel

The InfiniteReality graphics I/O panel provides a set of interface connectors required to support a single graphics subsystem. The panel consists of a swap-ready port, a 9-pin StereoView connector, a 4-pin S-Video connector, composite video ports (0 and 1), Genlock (IN and OUT) connectors, two 13W3 monitor connectors, two horizontal sync, and two vertical sync BNC connectors.

Refer to Figure 2-5 for the locations of InfiniteReality graphics connectors. See Table 2-2 for a listing of the InfiniteReality connectors and their descriptions.

Table 2-2 InfiniteReality Graphics Connectors

Connector Type	Connector Description	Connector Function
BNC	Swap ready	Interface to other graphics systems
9-Pin sub-D	Stereoview	Interface to Stereoview device
4-Pin mini-DIN	S-Video	Interface to SVHS VCR or monitor
RCA jack	CMPST 1	Interface to composite monitor or VCR
BNC	CMPST 0	Interface to composite VCR or monitor
BNC	Genlock IN	Interface to video mixer
BNC	Genlock OUT	Loop through connection
13W3	Monitor connection	1280 x 1024 hi-res monitor
13W3	Monitor connection	1280 x 1024 hi-res monitor
BNC	Sync 0	Horizontal optional sync for monitors
BNC	Sync 1	Horizontal optional sync for monitors
BNC	Vsync 0	Vertical optional sync for monitors
BNC	Vsync 1	Vertical optional sync for monitors

Figure 2-7 shows the 13W3 connector pinouts for the InfiniteReality graphics panel. Note that optional expansion graphics panel 13W3 connectors all use the same pinout pattern as that shown in Figure 2-7.

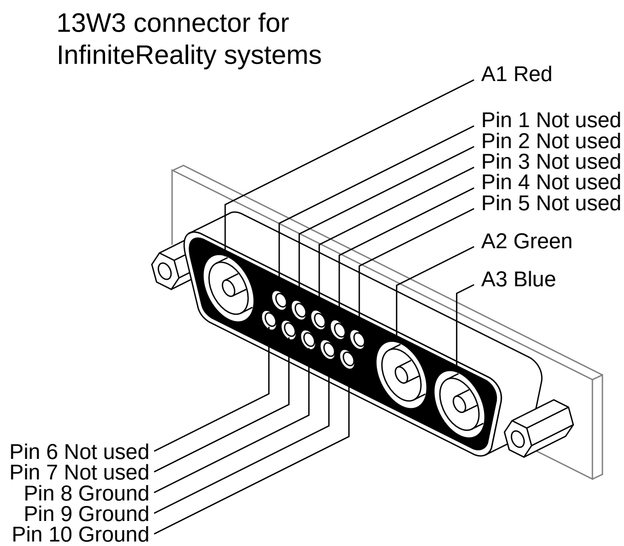

Figure 2-7 13W3 Connector Pins for InfiniteReality Monitor Connector

Figure 2-8 shows the 9-pin StereoView connector pinouts. Figure 2-9 shows the pinouts for the InfiniteReality graphics S-Video connector.

Figure 2-10 shows the 13W3 Monitor connector pinouts for VTX and RE^2.

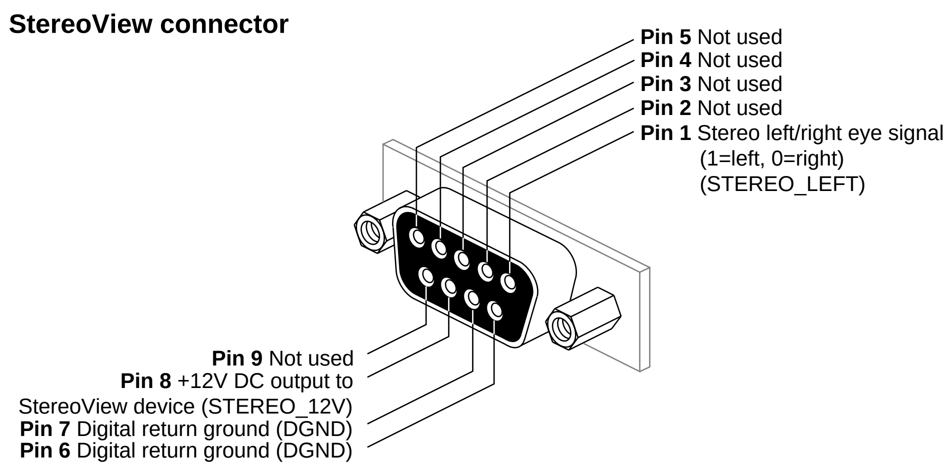

Figure 2-8 InfiniteReality StereoView Connector Pinouts

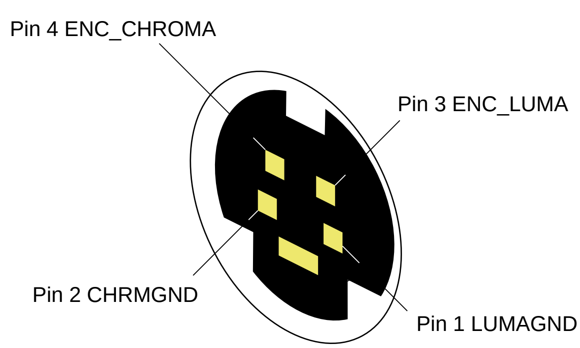

Figure 2-9 InfiniteReality S-Video Connector Pinouts

RE^2 and VTX Graphics I/O Panel

The RE^2 and VTX graphics I/O panel provides all of the interfaces required to support a single graphics subsystem. The panel consists of composite video ports (A and B), S-Video connectors (A and B), the color monitor connector, Frame Grab and Swap Ready ports, Alpha and Sync connectors, and Genlock (IN and OUT) connectors.

See Figure 2-10 for the 13W3 pinouts for RE^2 and VTX.

Refer to Figure 2-6 for the locations of the connectors and to Table 2-3 for a listing of the connectors and their descriptions.

Table 2-3 RE^2 or VTX Graphics I/O Panel Connector Descriptions

Connector Description	Connector Type	Function
Swap Ready	BNC	Interface to other graphics systems
Frame Grab	BNC	Interface to the grab trigger
CMPST A	BNC	Interface to composite SVHS VCR
CMPST B	BNC	Interface to composite video monitor
S-Video A	4-pin mini-DIN	Interface to Super VHS VCR
S-Video B	4-pin mini-DIN	Interface to Super VHS video monitor
Monitor	13W3	Main system color monitor
Alpha	BNC	Provides sync for other vendors’ monitors
Sync	BNC	Provides sync to monitors requiring external sync

Table 2-3 (continued) RE^2 or VTX Graphics I/O Panel Connector Descriptions

Connector Description	Connector Type	Function
Genlock IN	BNC	Allows the system to line-lock to an external video source
Genlock OUT	BNC	Enables master sync source to loop through the system to other equipment

Note: CMPST A and B are identical and can be exchanged.

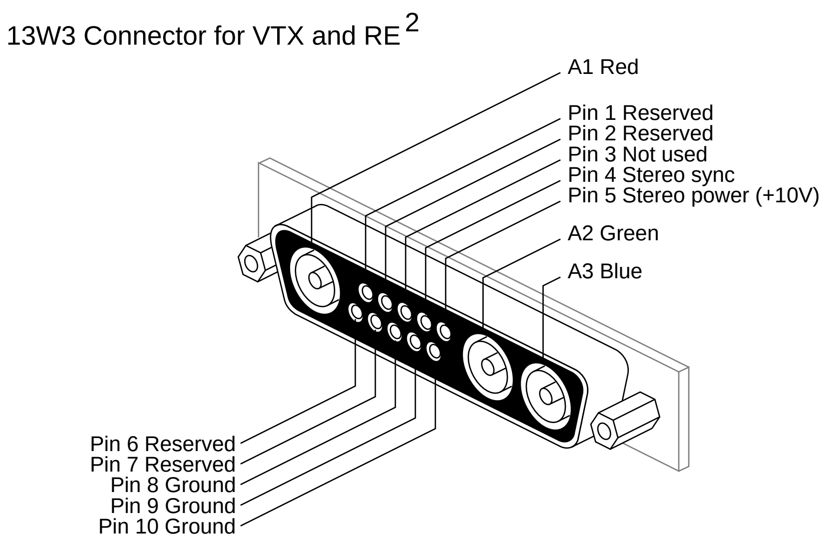

Figure 2-10 RE^2 and VTX 13W3 Monitor Connector Pinouts

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 the Cardcage 2 I/O panel with multiple SCSI connectors. The optional Cardcage 3 I/O panel contains the interfaces for the second and third graphics subsystems. The graphics interfaces are arranged exactly as they are on the graphics I/O panel, except that on the Cardcage 3 I/O panel, they are mounted vertically.

Figure 2-11 illustrates possible configurations for the two panels, and Table 2-4 lists the connectors and their descriptions.

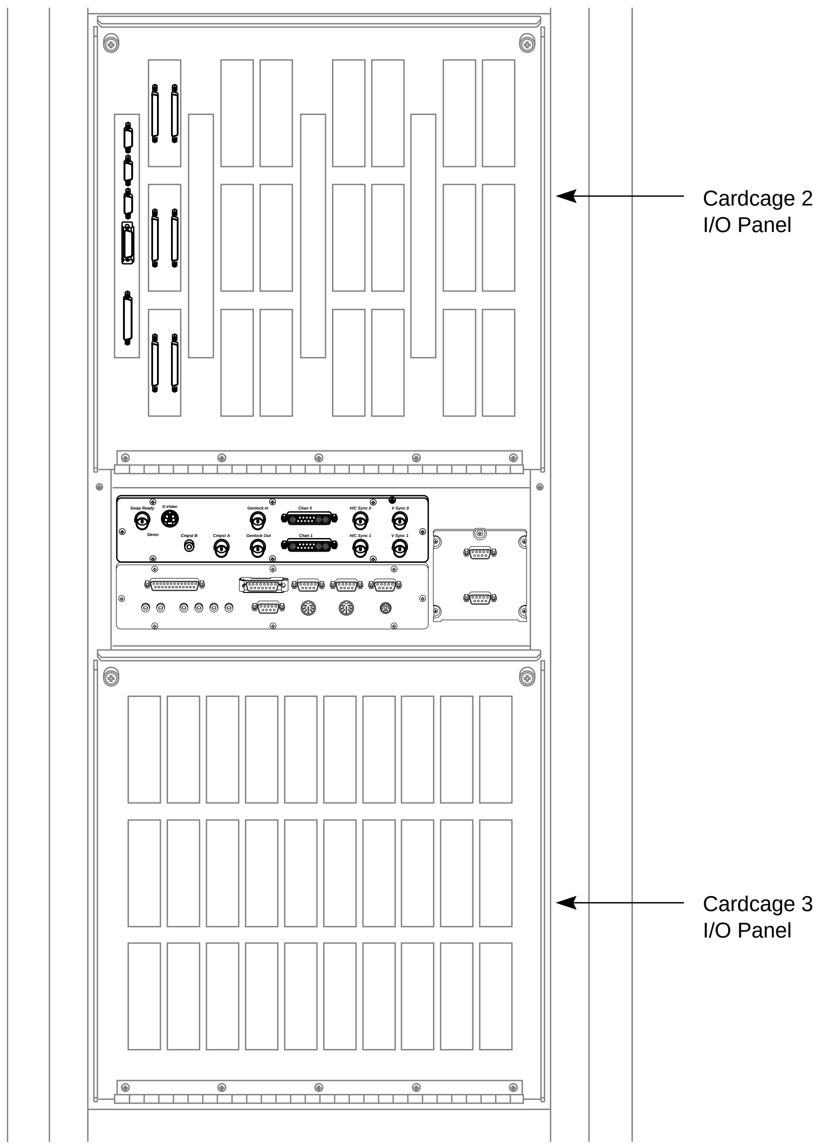

Figure 2-11 Cardcage 2 and 3 I/O Panels

Table 2-4 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 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 2-6). 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.

The two 8-pin powered connectors together support a total of 3 amps of current at +10 V for powered peripherals. You may connect one or two powered peripherals as long as the current drawn by the device(s) does not exceed 3 amps of current at +10 V.

The RS-232 standard recommends the use of cables no longer than 50 feet (15.2 meters). This standard should also be applied to the RS-422 connector. Longer runs introduce a greater possibility of line noise occurring. This can affect data transmission and cause errors. For serial cable runs longer than 50 feet (15.2 meters), use an appropriate extender device.

Figure 2-12 shows illustrations of the connector types and pin assignments.

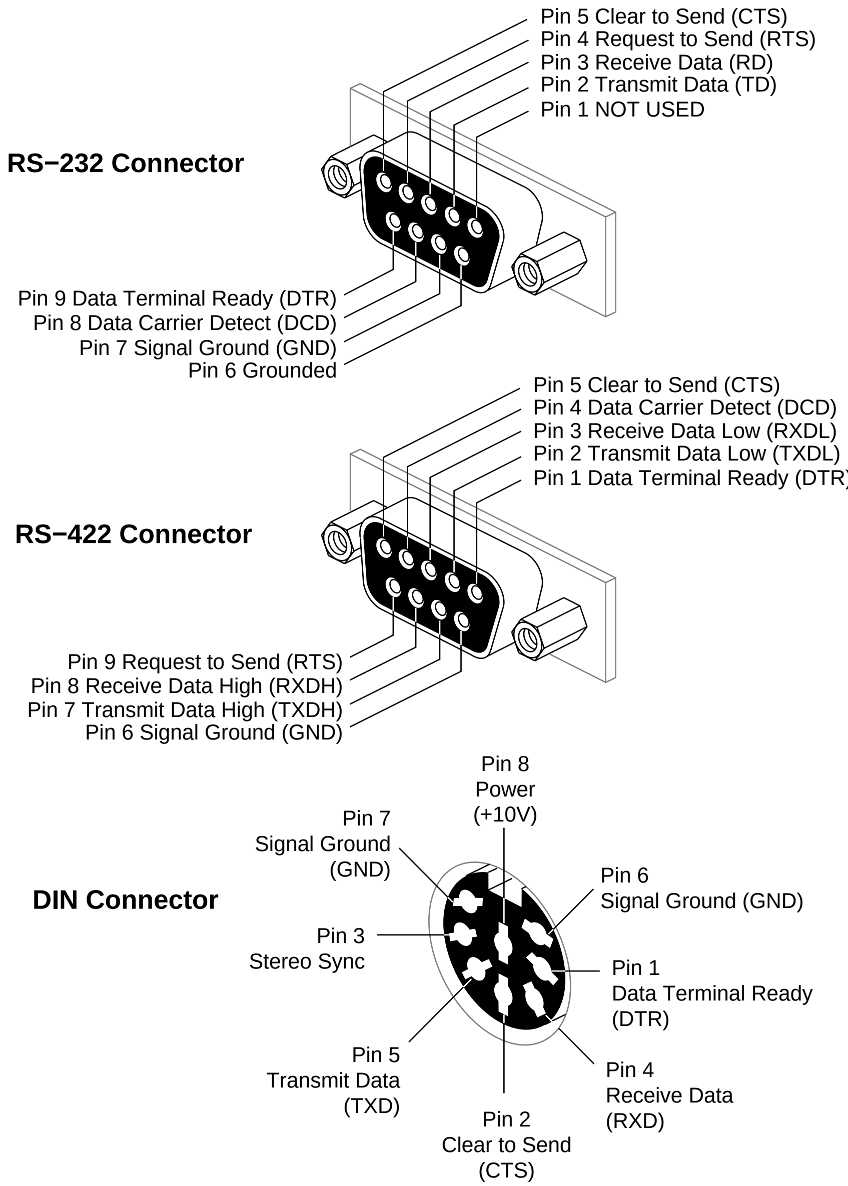

Figure 2-12 Powered and Unpowered Serial Connectors

Parallel Port and Video Connectors

The 25-pin parallel port is located on the main I/O panel. The parallel port connector and its pin assignments are shown in Figure 2-13. The parallel port connector pinouts are listed in Table 2-5.

Note: The parallel port is a 25-pin Centronics® compatible connector. The recommended cable length for a parallel port is 10 feet. The maximum allowable length is 20 feet.

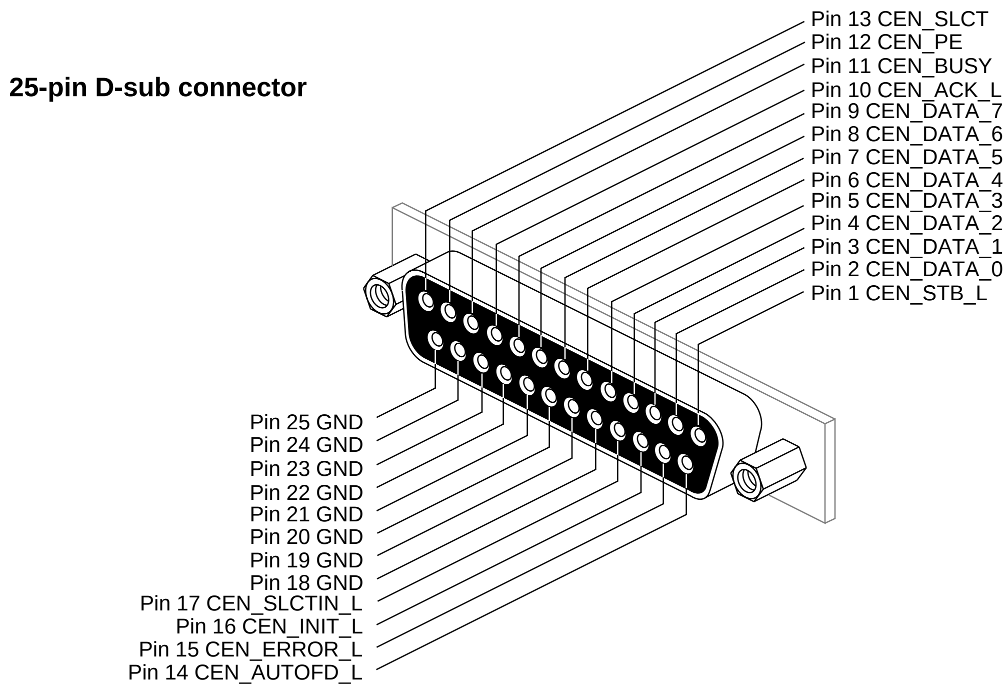

Figure 2-13 Parallel Port Connector Pinouts

Table 2-5 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

System Controller

The System Controller has three basic operating conditions:

- It acts as a control conduit when directed by the operator to power off 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. You can inspect previously logged errors by using the function buttons to select menus.
- The System Controller can 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 2-14). The display is visible through a cutout in the lower 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 lower 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's operation are found in Chapters 3 and 5.

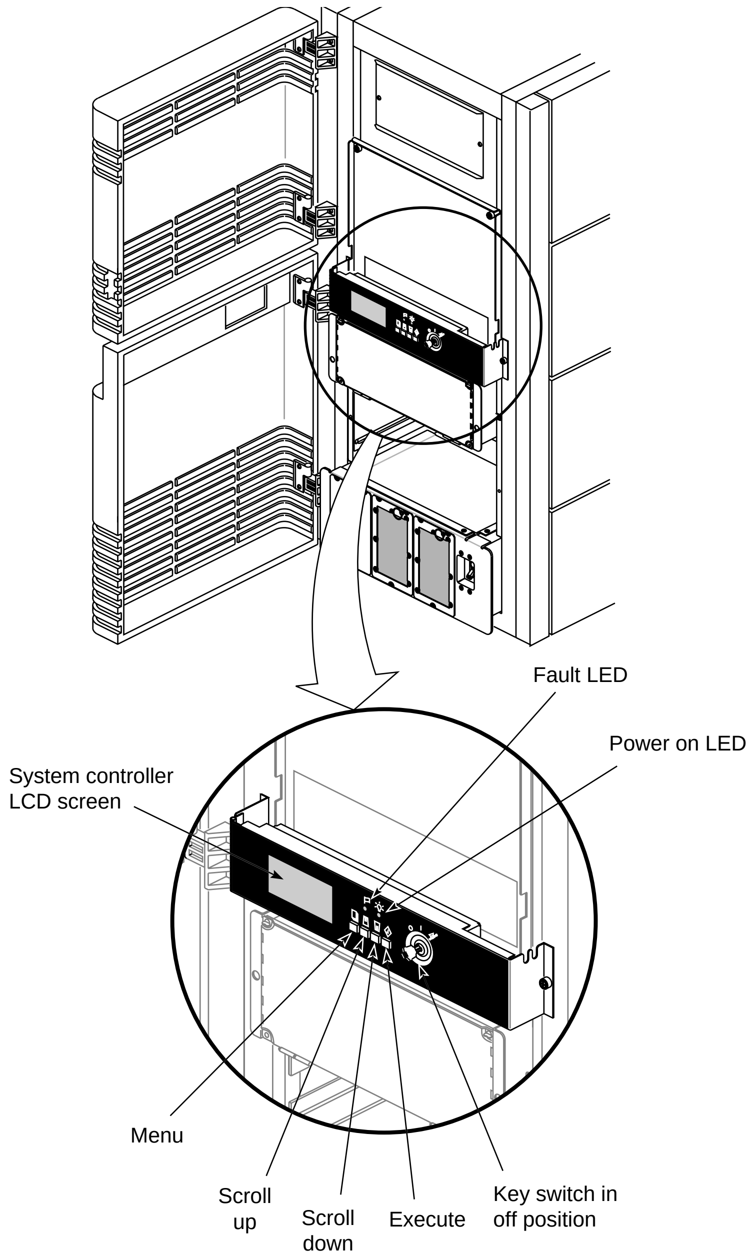

Figure 2-14 System Controller

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 2-15). 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 rackmount systems are the only Silicon Graphics products to use drive enclosures without power supplies. The SCSIBoxes found in other products, such as the CHALLENGE™ Vault XL expansion rack, are not interchangeable.

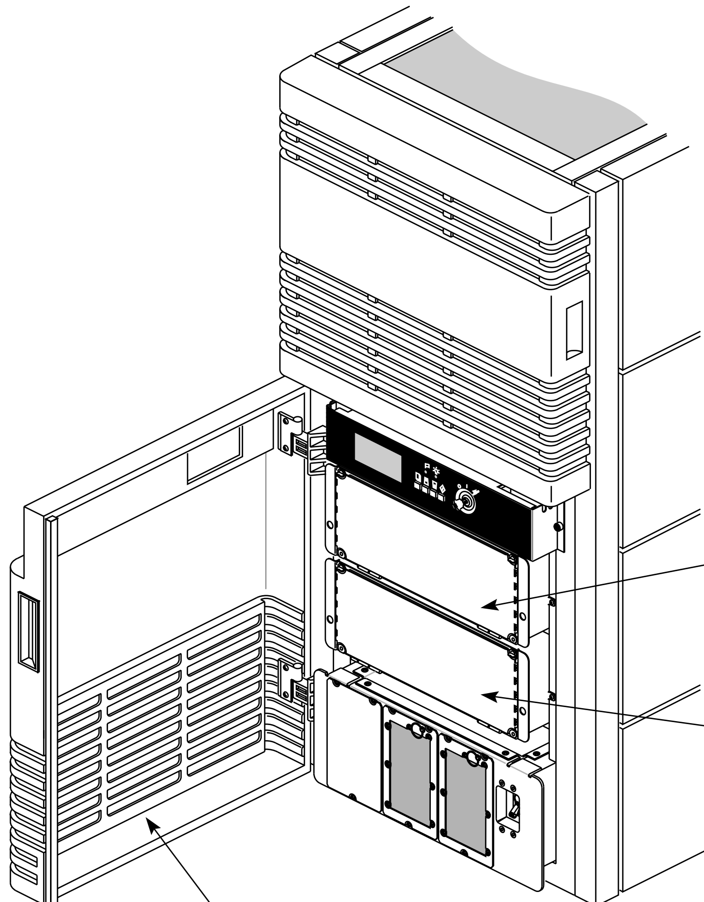

Figure 2-15 SCSIBox Drive Enclosures

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

Cooling System

The Onyx 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 chassis 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 chassis.

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 Onyx graphics workstation comes with two or three 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 2-16).

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

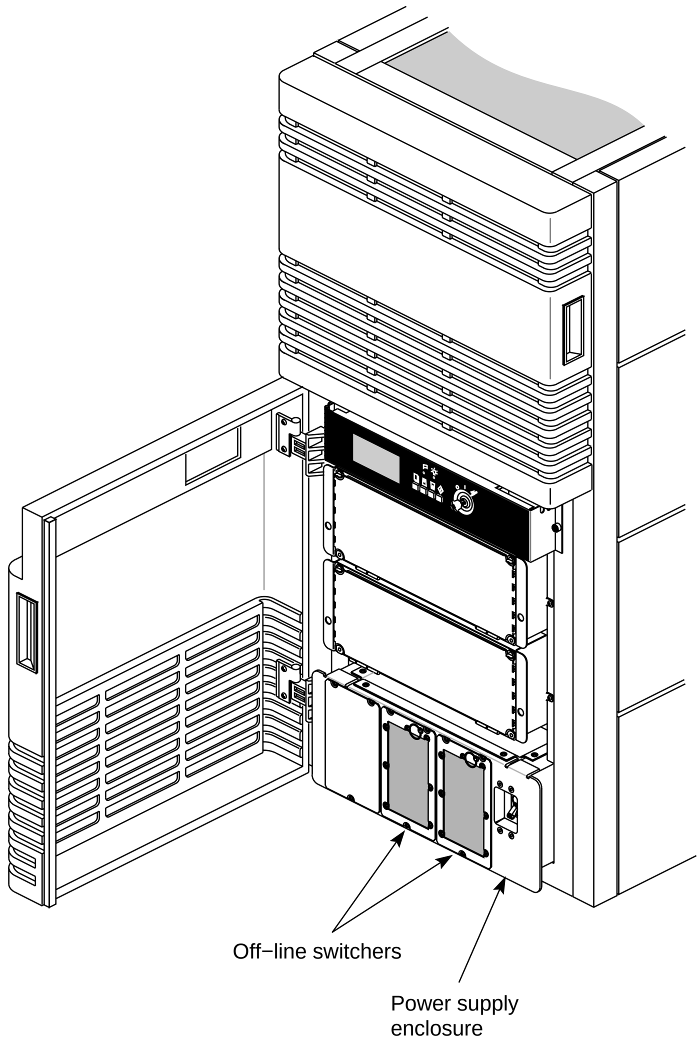

Figure 2-16 Power Supply Enclosure and OLSs

Chapter 3

Getting Started

This chapter describes how to configure and operate your system correctly.

Warning: The Onyx rackmount graphics workstation 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.

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

Caution: The Onyx system can weigh over 1000 pounds 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 Monitor

A high-resolution, 1600 x 1200-pixel 21-inch monitor ships as the standard monitor for the Onyx rackmount systems. This section describes how to install the 21-inch monitor. Connect the monitor you received by following the steps in the applicable section.

Caution: Before plugging any monitor into either a 110 VAC or a 220–240 VAC outlet, be sure that the electrical rating on the label is in either the 110 or the 220–240 range, whichever applies.

When using a monitor in locations that do not have either of these outlets, contact your Silicon Graphics system support engineer before plugging in the monitor power cable.

Note: If you use a monitor that has white switches below the RGB posts, make sure they are pressed in so that they are in the 75-ohm position; otherwise, the monitor displays the wrong colors.

Use only the cables specified to connect the monitor to the Onyx rackmount chassis.

Connecting a 21-Inch Monitor

The InfiniteReality, VTX, or RE^2 graphics system uses a 21-inch, high-resolution monitor. This monitor uses a 13W3-to-13W3 cable. Connect one of the 13W3 fittings to the I/O panel and the other to the back of the monitor. See Figure 3-1 for an example of the connectors on the 21-inch monitor.

When the system is booted, the monitors will operate in their default resolution of 1280 x 1024. To change the default video format, you may use the *setmon* command. For more information about the *setmon* command options, see the setmon reference (man) page.

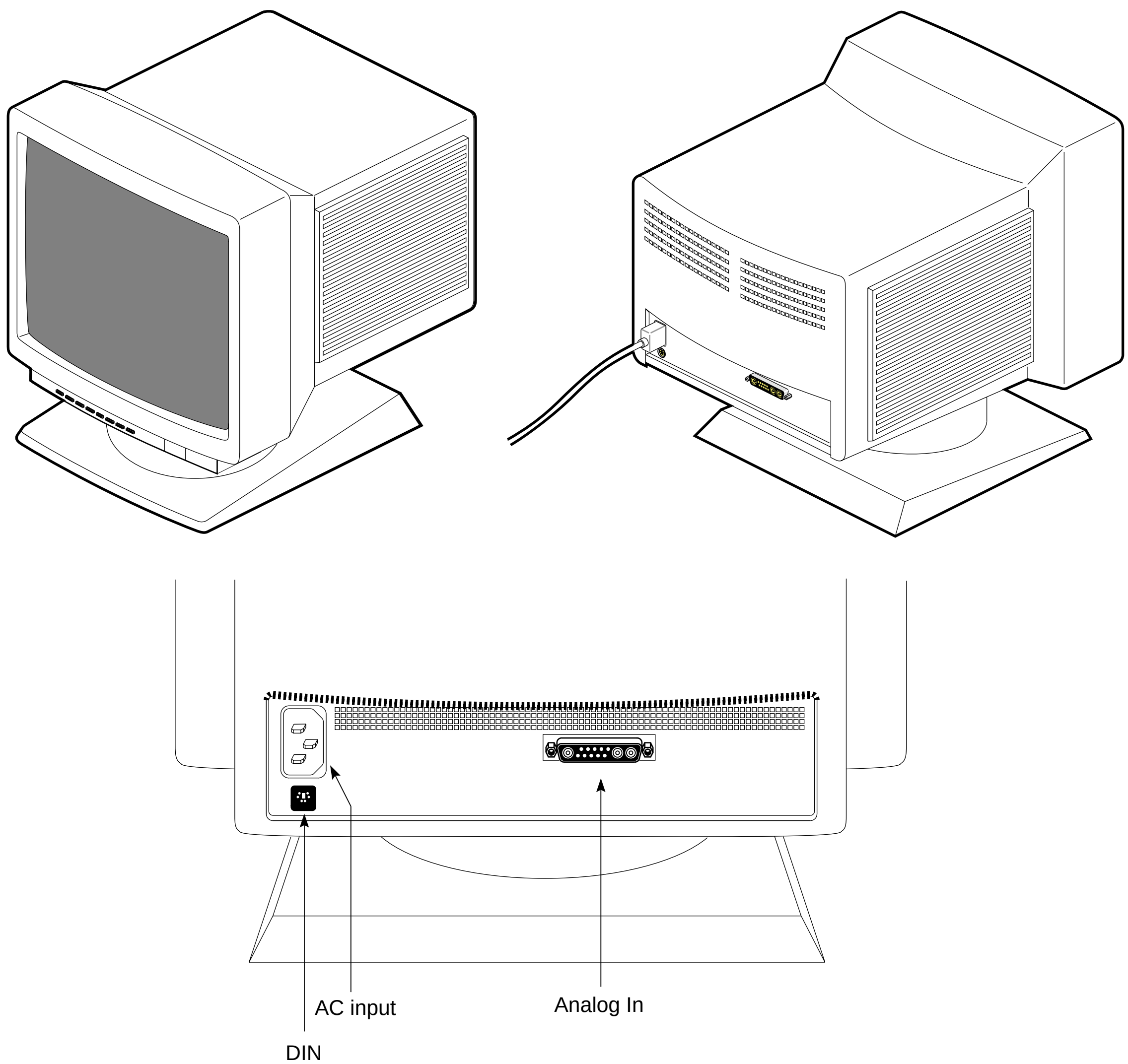

Figure 3-1 21-Inch Monitor Connectors

Figure 3-2 shows the front control locations for the 21-inch color monitor. Table 3-1 describes the 21-inch monitor controls. Table 3-2 shows the preset viewing modes for the 21-inch monitor.

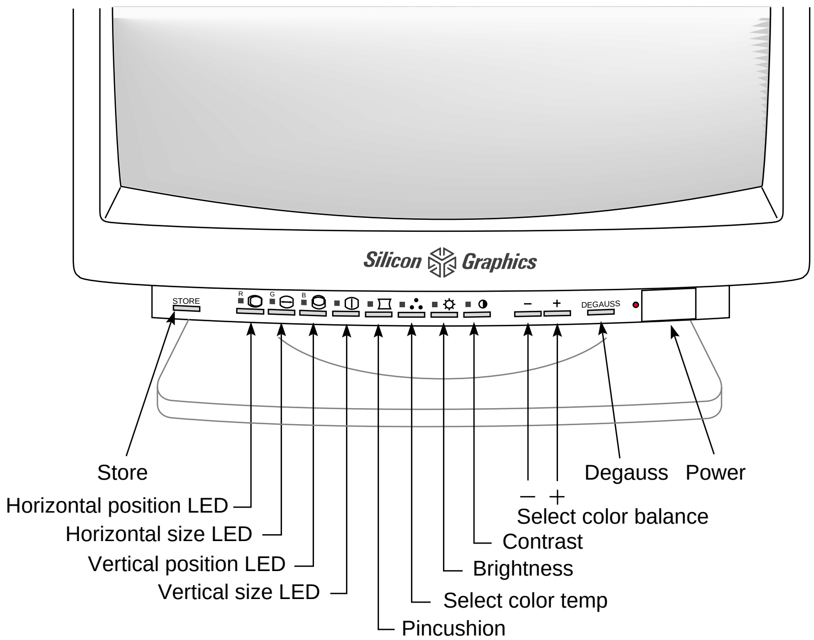

Figure 3-2 21-Inch Monitor Controls

Note: The 21-inch monitor has factory-set viewing modes (see Table 3-2) and memory for additional configurable settings.

Table 3-1 21-Inch Front-Panel Monitor Controls

Control	Description
Power On/Off	Press the switch to turn monitor power on or off (LED lights when power is on).
Degauss	Press and release the Degauss button to manually degauss the monitor. Use this method only when color impurities appear after turning on the monitor. The monitor is automatically degaussed at power on.

Table 3-1 (continued) 21-Inch Front-Panel Monitor Controls

Control	Description
Contrast (half moon icon)	Press the (+) button to make the display (excluding the background) brighter. Press the (–) button to make the display (excluding the background) darker.
Brightness control (sun icon)	Press the (+) button to make the display (including the background) brighter. Press the (–) button to make the display (including the background) darker.
Horizontal Position	Press the (+) button to move the display position to the right. Press the (–) button to move the display position to the left.
Horizontal Size	Press the (+) button to expand the display horizontally. Press the (–) button to shrink the display horizontally.
Vertical Position	Press the (+) button to move the display position up. Press the (–) button to move the display position down.
Vertical Size	Press the (+) button to expand the display vertically. Press the (–) button to shrink the display vertically.
Pincushion	Press the (+) button to curve the left and right sides of the display outwards. Press the (–) button to curve the left and right sides of the display inwards.

Table 3-2 Preset Viewing Modes for the 21-Inch Monitor

Mode Number	Resolution	Pixel Clock	Horizontal Frequency	Vertical Frequency
1	1280 x 1024	135 MHz	79.98 KHz	75 Hz
2	1280 x 1024	129.25 MHz	76.94 KHz	72 Hz
3	1280 x 1024	107.25 MHz	63.84 KHz	60 Hz
4	1280 x 1024	89.57 MHz	53.32 KHz	50 Hz

Table 3-2 (continued) Preset Viewing Modes for the 21-Inch Monitor

Mode Number	Resolution	Pixel Clock	Horizontal Frequency	Vertical Frequency
5	1280 x 1024	140.25 MHz	81.92 KHz	76 Hz
6	1024 x 768	78.75 MHz	60.02 KHz	75 Hz
7	1024 x 768	63.55 MHz	48.73 KHz	60 Hz
8	1920 x 1080	216 MHz	84.38 KHz	72 Hz
9	1600 x 1200	156.2 MHz	74.81 KHz	60 Hz
10	960 x 680	54.43 MHz	43.2 KHz	60 Hz

Note: Input signals with approximately the same frequencies may be regarded as the same signal.

Video Peripherals

The Onyx InfiniteReality, RE^2, or VTX graphics systems provide connections to a number of video peripherals.

InfiniteReality Graphics Peripherals

The standard InfiniteReality graphics board set allows for the connection of two high-resolution 21-inch monitors. The following peripherals can also be connected:

- composite video monitor
- composite video cassette recorder
- S-Video monitor or SVHS video cassette recorder
- video mixer and monitor
- StereoView devices

Before using the graphics software, connect the composite or S-Video monitor or VCR to the appropriate output ports on the I/O panel. Refer to Figure 3-4.

Both the CMPST ports use standard BNC video connectors. They are electrically identical: a tape deck or monitor can be connected to either port. Connect a cable to your composite monitor and to either of the CMPST ports. Connect another cable to your VCR and to the other composite port.

The S-Video port is an output port that connects to an S-Video monitor or SVHS video cassette recorder. The port uses a 4-pin mini DIN connector. The port can connect to either the S-Video monitor or to the VCR.

Caution: You must use the appropriate video peripherals. The composite video ports are connected to video monitors and VCRs that operate in NTSC or PAL video format. The S-Video port connects to VCR equipment that uses the SuperVHS format.

Video peripherals are connected to the InfiniteReality graphics I/O panel, as shown in Figure 3-4. Connections for Reality Engine^2 or VTX are shown in Figure 3-4 in the next subsection.

Note that frame grab functions in InfiniteReality are done with the Sirius Video™ option board. See the *Sirius Video Programming and Configuration Guide* (P/N 007-2238-00x).

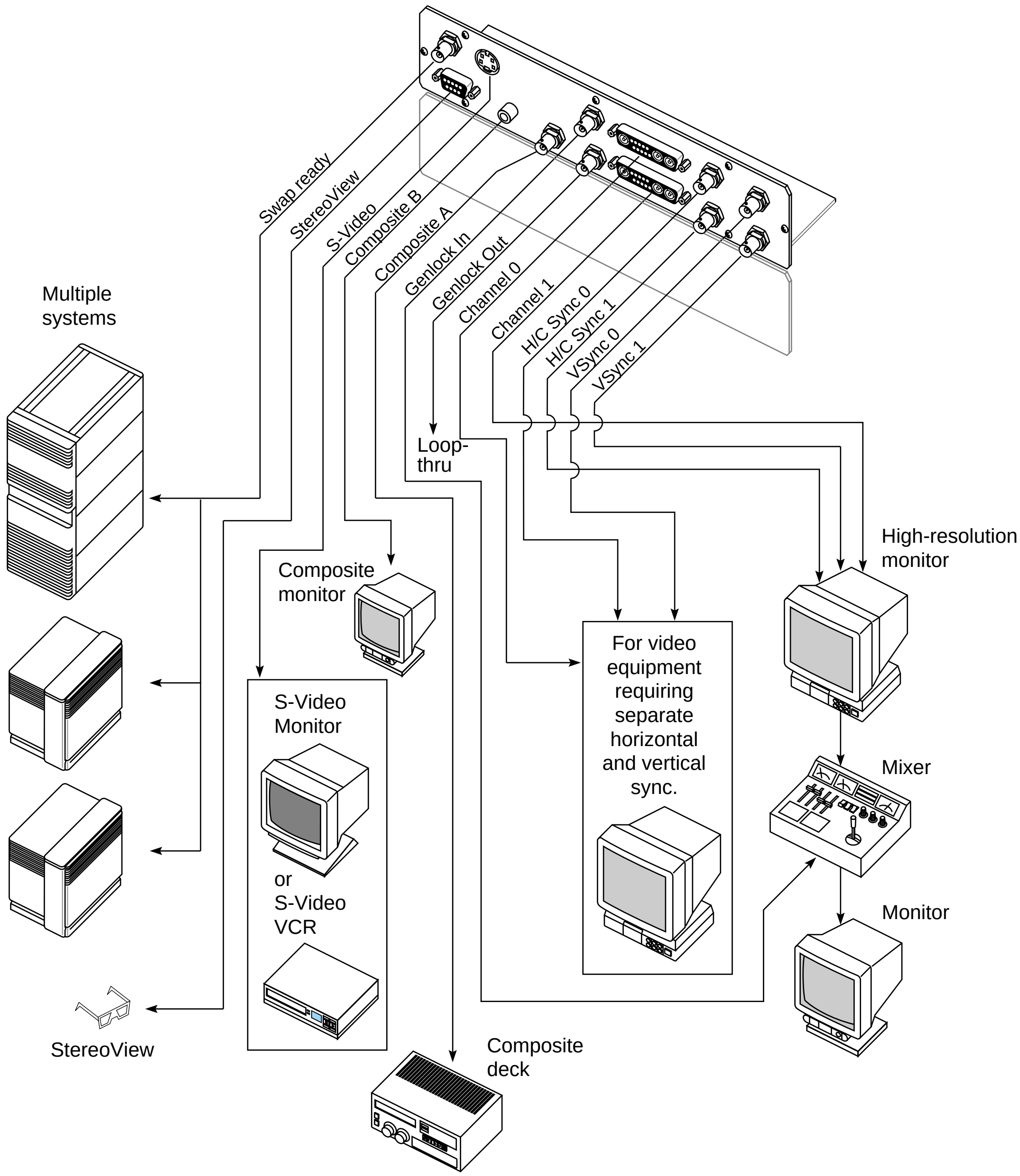

Figure 3-3 InfiniteReality Video Peripherals Connection Example

RE^2 and VTX Graphics Peripherals

In addition to the standard high-resolution 21-inch monitor, the following peripherals can be connected to RE^2 or VTX systems:

- composite video monitor
- composite video cassette recorder
- frame grab trigger
- S-Video monitor
- SVHS video cassette recorder
- video mixer and monitor

Before using the graphics software, connect the composite or S-Video monitor and VCR to the appropriate output ports on the I/O panel. Refer to Figure 3-4.

The CMPST A and CMPST B ports are standard BNC video connectors. They are electrically identical: a tape deck or monitor can be connected to either port. Connect a cable to your composite monitor and to either the CMPST A or CMPST B port. Connect another cable to your VCR and to the other composite port.

The video ports (S-Video A and S-Video B) are output ports that connect to an S-Video monitor and SVHS video cassette recorder. These ports use four-pin mini DIN connectors. They are also electrically identical: each port can connect to either the S-Video monitor or to the VCR. Connect a cable from your S-Video monitor to either S-Video A or S-Video B. Connect a cable from the tape deck to the remaining S-Video port.

Caution: You must use the appropriate video peripherals. The composite video ports are connected to video monitors and VCRs that operate in NTSC or PAL video format. The S-Video ports connect to VCR equipment that uses SuperVHS format.

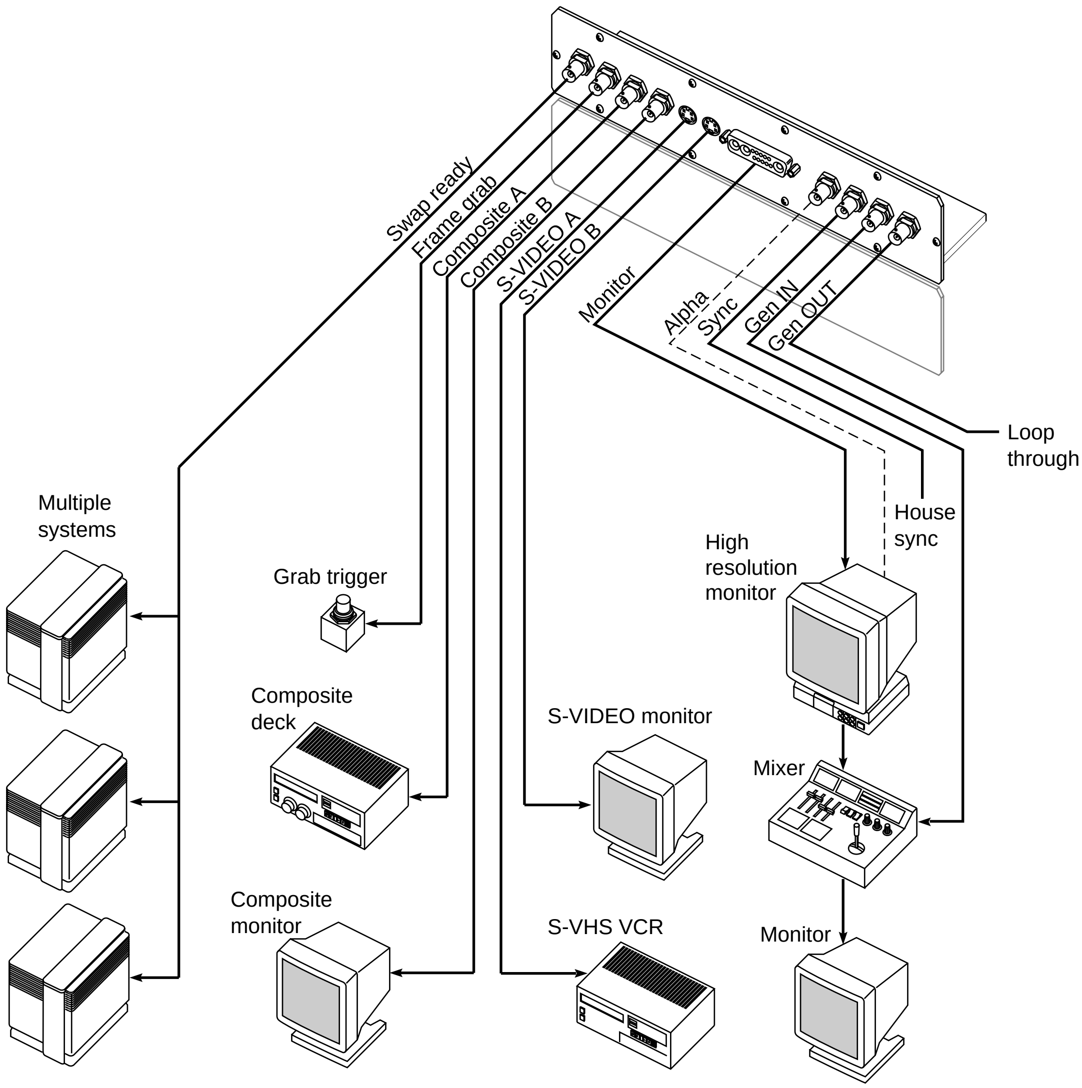

Figure 3-4 RE^2 and VTX Video Peripherals Connection Example

Connecting Your Keyboard and Mouse

Your system comes with a standard 101-key international keyboard. The keyboard has two identical plug receptacles, located in the upper right and left corners. These receptacles accepts the 6-pin mini-DIN connectors from either the keyboard cable or the mouse.

To install a keyboard:

1. Choose the side of the keyboard where the mouse will be located and insert the mouse cable connector into the nearest keyboard receptacle.
2. Attach one end of the keyboard cable to the remaining keyboard receptacle. Attach the other end of the keyboard cable to the keyboard connector on the main I/O panel (see Figure 3-5).

Caution: Do not unplug the keyboard cable from the I/O panel while the system power is on; system damage can result.

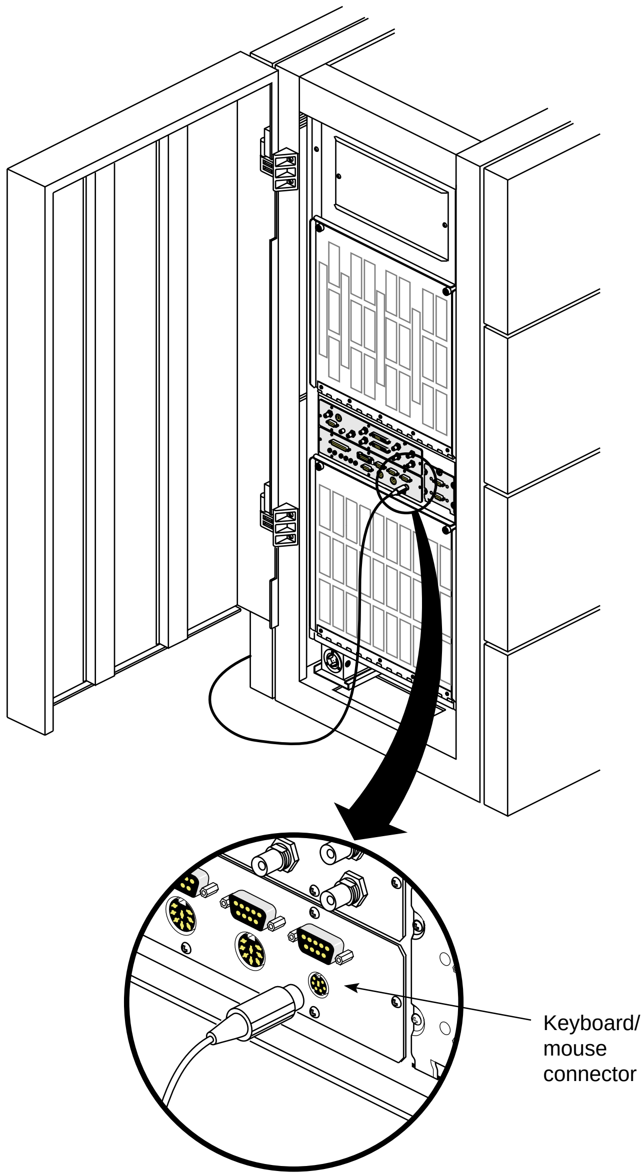

Figure 3-5 Keyboard Connection

SCSI Requirements and Configurations

All Onyx 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 Onyx rackmount graphics workstation 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. Differential SCSI channels pair 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 IO4 board can communicate with both internal and external SCSI devices over either single-ended or differential SCSI channels. Generally, external SCSI channels are differential, and internal channels are single-ended. The requirements and limitations of both single-ended and differential SCSI channels 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. The differential SCSI bus supports 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 a combination of 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 the 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.

Note: To operate multiple external SCSI devices, you must order your system's IO4 with extra mezzanine SCSI channel daughter boards. These are the mezzanine options mentioned in Chapter 1; they connect to the I/O panel and then to external devices.

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.

Caution: All installed IO4 boards and/or SCSI mezzanine 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 a front-loading drive (FLD) from the Onyx workstation. It is assumed that the system 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 turned off. If the system is running, refer to the “Powering Off the System” section, 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 3-6).
4. Orient the FLD relative to the SCSIBox so that the drive is facing toward the right (see Figure 3-7).
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 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 accidently changed during the installation.
8. Close the SCSIBox door.
9. Power on the system as described in the section entitled “Powering On the System.”
10. See the *IRIX Admin: Disks and Filesystems* manual, or the *IRIX Admin: System Configuration and Operation* manual, for information needed to configure software.

Remove an FLD from the SCSIBox as follows:

1. Repeat steps 1 through 3 from 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.

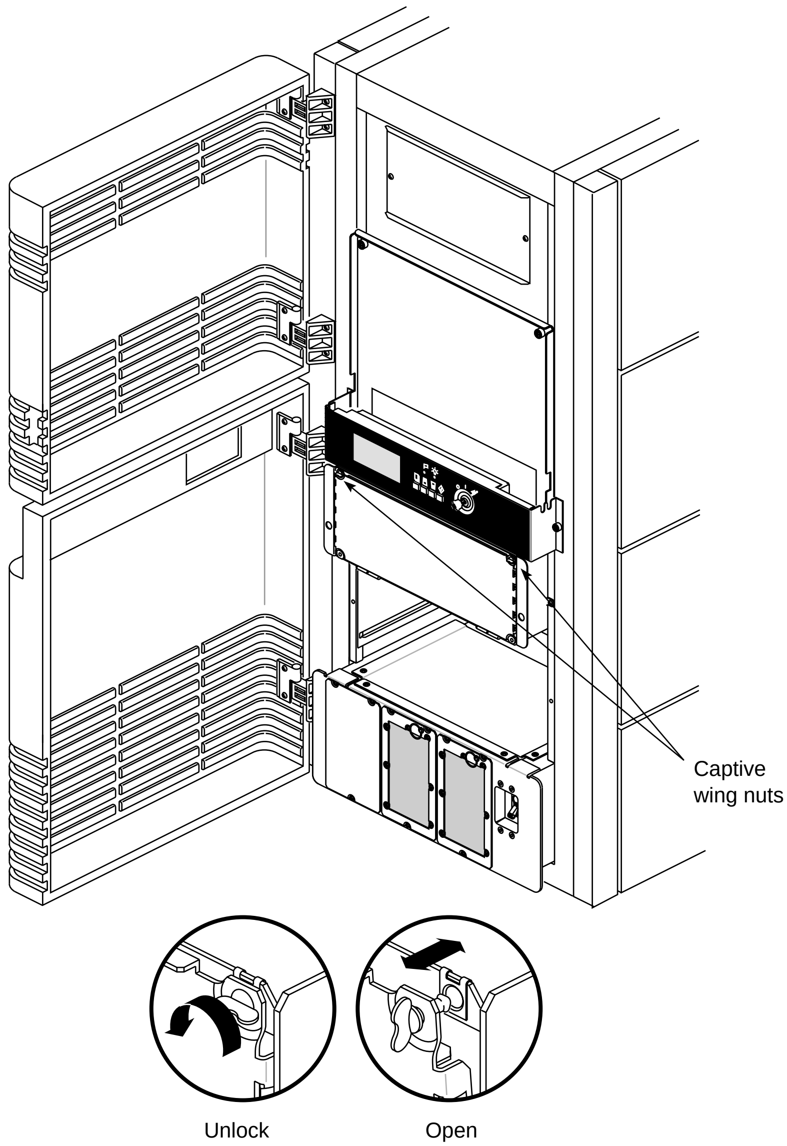

Figure 3-6 Opening the SCSIBox

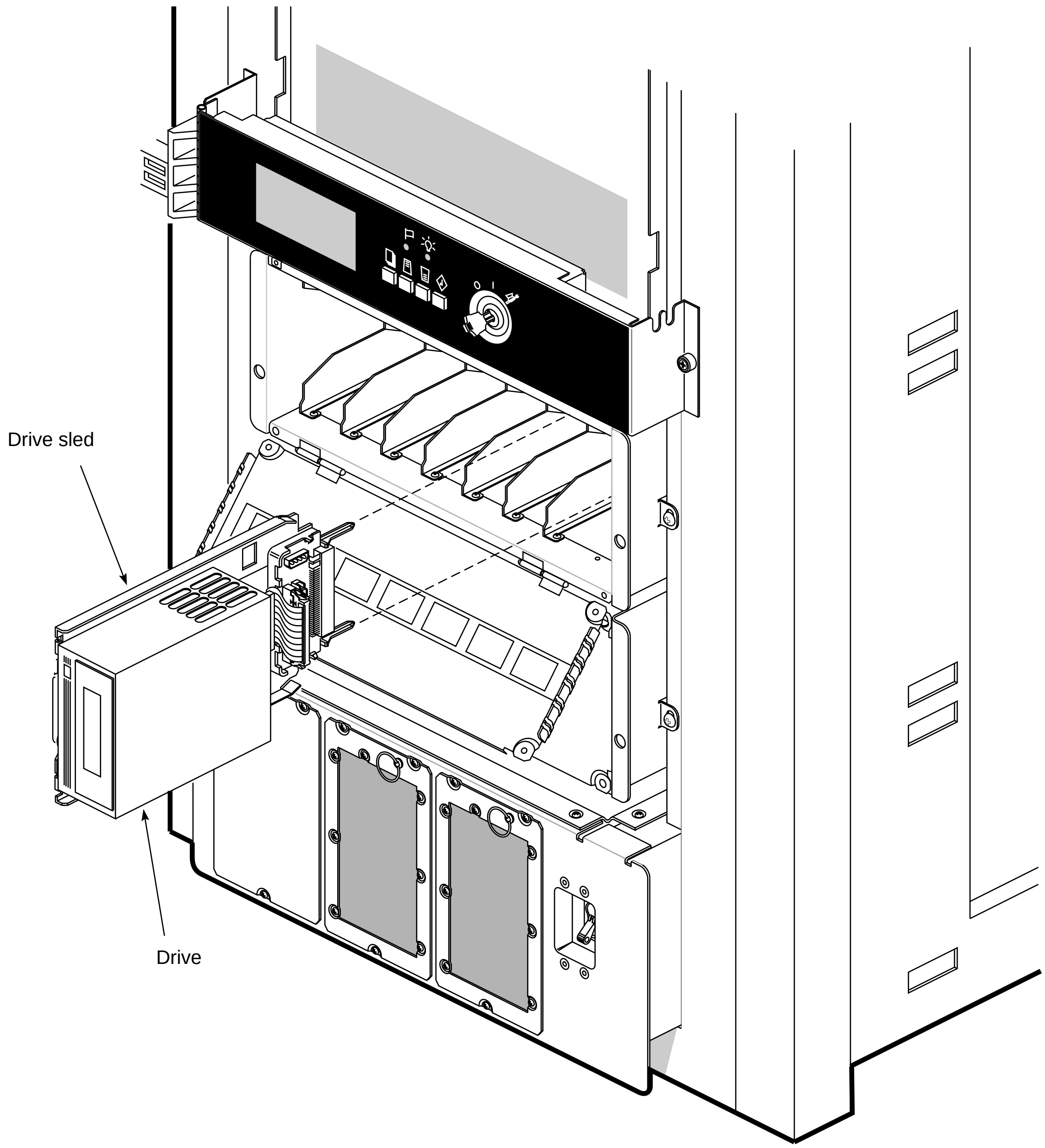

Figure 3-7 Installing a Front-Loading Device

Connecting Your System to an Ethernet

The Onyx graphics workstation comes with a 15-pin AUI Ethernet connector. You can order optional boards for additional Ethernet connections.

Powering On the System

Power on the Onyx rackmount graphics workstation 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 3-8). 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, either a locking collar or a twist-lock connector (see Figure 3-8). 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.

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

   Warning: The Onyx rackmount workstation 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 monitors 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 monitor(s) and additional peripherals to the appropriate three-pronged grounded outlets.
6. Turn on the system power switch (see Figure 3-9).
7. Turn on the monitors, followed by any attached peripherals.

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

8. Boot the system as described in "Booting the System."

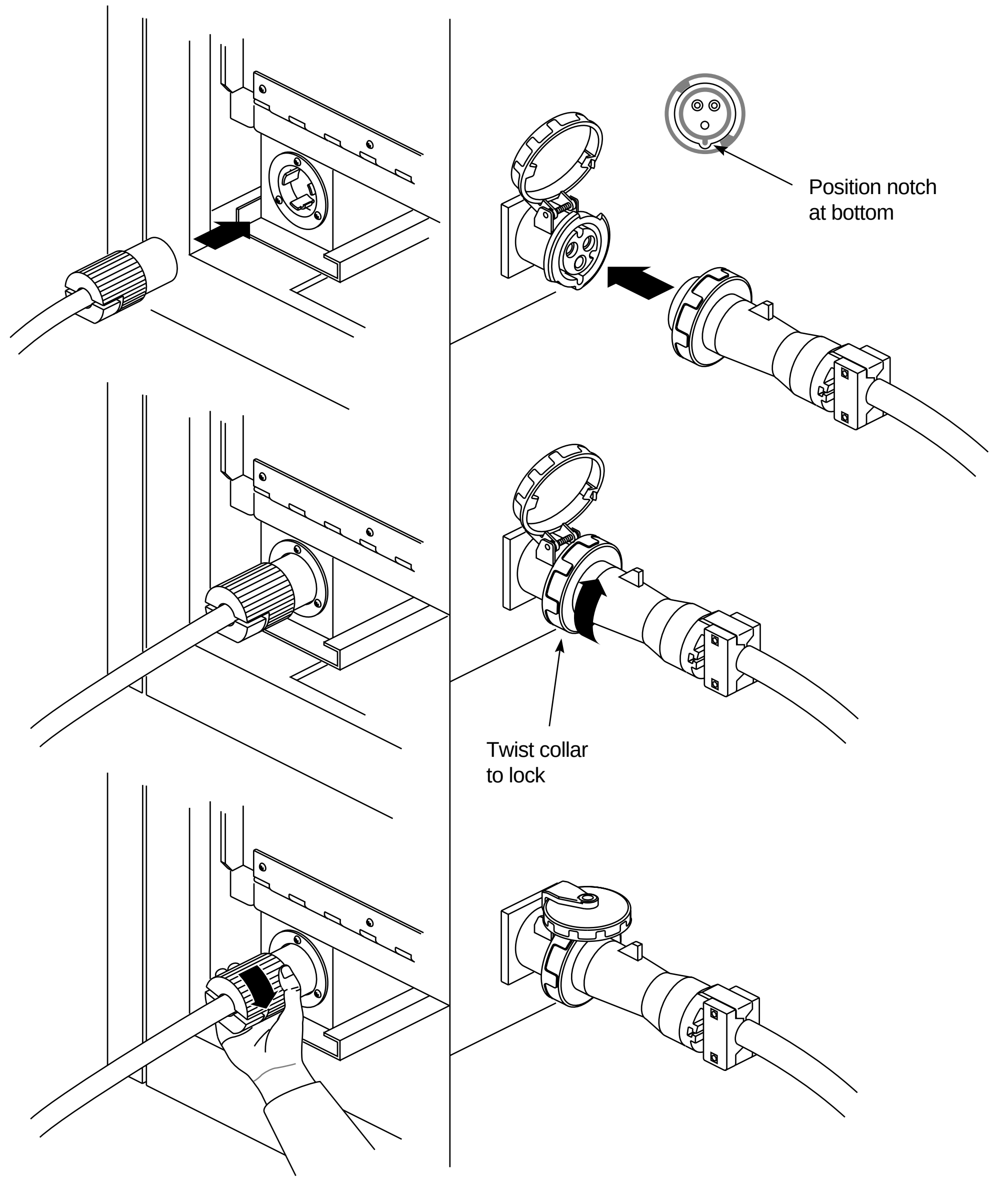

Figure 3-8 Connecting the System Power Cable

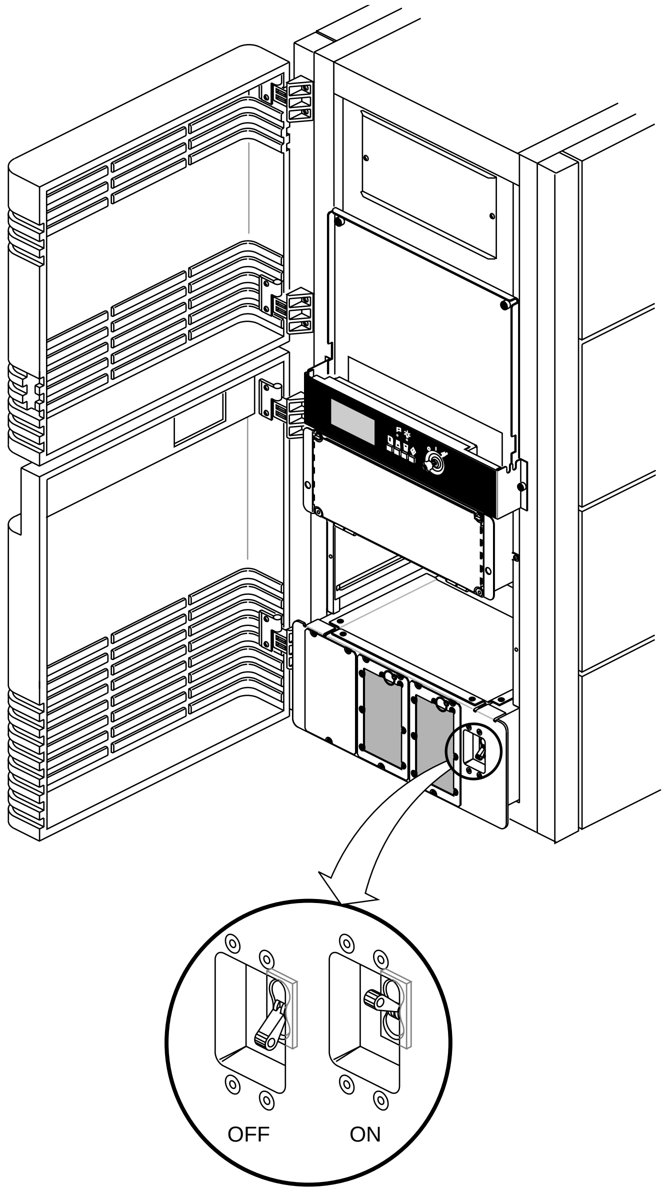

Figure 3-9 Power Switch

Booting the System

Boot your system by performing the following steps:

1. Power on the system, as described in the preceding section, “Powering On the System.”
2. Open the lower front door to the system chassis.
3. Insert the system key into the key switch, located to the right of the System Controller’s display. Turn the key switch to the On position (see Figure 3-10).

   Note: The System Controller begins the power-on sequence. The green power-on LED, located above the function buttons, lights to indicate that power has been applied to the system midplane. The amber fault LED then lights 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.

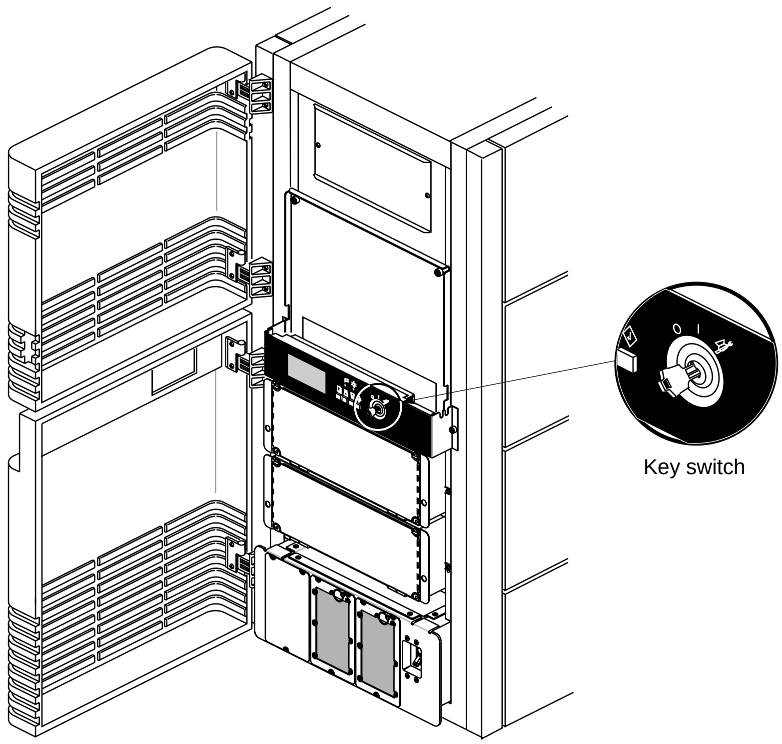

Figure 3-10 System Controller Key Switch

4. 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 3-3).

   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 will abort 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 3-3 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.
BOOT ARBITRATION INCOMPLETE FAULT NO MASTER	The system was unable to assign a bootmaster CPU.
BOOT ARBITRATION ABORTED	One of the front panel buttons was pushed while the System Controller was searching for a bootmaster.

5. 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.

   When the System Maintenance menu appears, type **5** to select "Enter Command Monitor."

6. When the >> prompt appears, type **hinv** then press **<Enter>** to display the hardware inventory of your system.

   Note: See the *IRIX Admin: System Configuration and Operation* manual for information on reconfiguring your system.

7. Quit the Command Monitor by typing **Exit** at the >> prompt.

8. The System Maintenance menu reappears. Type **1** to select the "Start System" command. The system comes up and displays the desktop.

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-ROM drive) or downloaded remotely over the network. See the *IRIX Admin: Disks and Filesystems* manual for additional information about mounting and configuring drives. Refer to the *IRIX Admin: Software Installation and Licensing* manual for the detailed steps required to download the software.

Note: A copy of the IRIX operating system is supplied with the system on a compact disc. Place the CD in a secure place in case you ever need to reinstall the operating system.

InfiniteReality Combiner Programming Overview

InfiniteReality graphics provides a programming utility, the Video Format Combiner, with two interfaces:

- the functional command-line interface *ircombine*
- the graphical user interface (GUI) *ircombine -gui*

This section is mainly concerned with the GUI version of *ircombine*. For information on the command-line version of *ircombine*, consult the ircombine(1G) reference (man) page.

Use the Combiner only with Onyx InfiniteReality or *i*-Station graphics systems.

For RE^2 and VTX graphics systems you must use the video out panel (described in the section "Operating the Optional RE2 and VTX Video Out Panel" on page 85), or other custom applications.

Both the command-line and GUI utilities create video format combinations—descriptions of raster sizes and timing to be used on video outputs—and configure the underlying framebuffer. You can use a video format combination as the current video configuration, store it as the default configuration to be used at system power on or graphics initialization, or save it in a video format combination file. You can create a video format combination from scratch. Also, you can modify a current or default combination or a previously saved combination.

The Combiner utility is useful for applications that need multiple channels, for such uses as visual simulation, virtual reality, or entertainment. The Combiner utility instructs the video subsystem to convert digital information stored in the graphics framebuffer into a variety of video signals (or channels), ranging from standard high-resolution (1280 x 1024 and higher) to low-resolution outputs. The output can then be displayed on additional monitors or projection devices, or stored on videotape, in any combination. Output can also be genlocked to an external reference signal.

The InfiniteReality pipeline can process image, geometric, and video data concurrently at real-time rates. The pipeline can convert a full-screen high-resolution display to a composite (NTSC or PAL) video output port: your application can record in real time whatever is being displayed on the screen.

To launch and display the Combiner's GUI, enter the following in any available IRIX window:

```
/usr/gfx/ircombine
```

To specify a different display from the current workstation, such as a remote workstation, or a specific pipe of a remote rackmount system, as the target on which to display the combination, use

`/usr/gfx/ircombine -target` *displayname*

Note: The first time InfiniteReality graphics was initialized, or during the first power on of the system with InfiniteReality graphics installed, the video output was defined for the channels available on the workstation. To reinitialize graphics, enter

`(/usr/gfx/stopgfx ; /usr/gfx/startgfx) &` at the IRIX prompt.

Note that the parentheses are necessary.

Using the Combiner Main Window

In the Combiner main window, click the button for the channel you want to define or modify. See Figure 3-11 for an example of the main window interface.

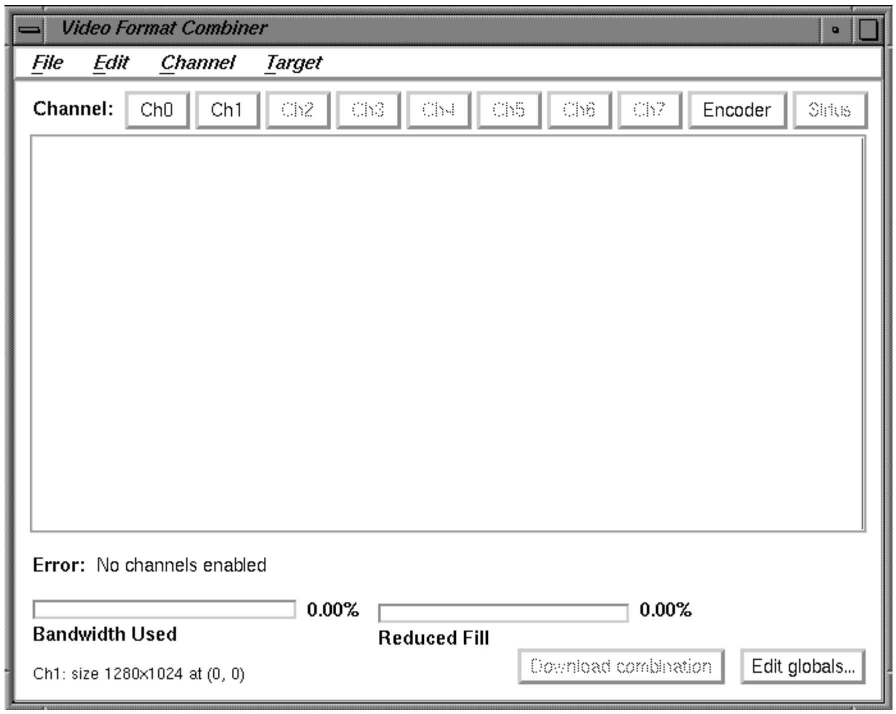

Figure 3-11 The Combiner Main Window

You might, for example, select Ch0 for the first channel. This selection corresponds to **Chan0** connections on the InfiniteReality system's I/O panel.

The *managed area* is the display surface taking up most of the Combiner main window. In the following sections you can perform example exercises designed to demonstrate some of the things you can do using the Combiner. Each example starts from the Combiner's main window.

Using the Combiner Examples

The example exercises in the following sections are based on the assumption that a Silicon Graphics multisync 21-inch monitor is connected to channel 0. If the monitor attached to channel 0 is unable to sync to any of the formats used in the example, it ceases displaying video.

If the monitor should stop displaying video during one of the examples, or during any other type of Combiner use, the following steps should provide a solution.

1. Plug in a monitor to channel 0 that can display the required format(s). If video is still not visible, go on to step two.
2. Log in to the system remotely or connect an ASCII terminal to serial port tty_1 if possible. Become superuser (root) and enter the command **`/usr/gfx/setmon -n 72`**. If this does not work, enter **`/usr/gfx/setmon -x 72`** and then restart the graphics by entering **(/usr/gfx/stopgfx ; /usr/gfx/startgfx) &**.
3. Reboot the system using the System Controller if the first two steps do not work. If, after rebooting, the video still does not display, wait for several minutes and go to the next step for an additional process.
4. Enter **`1`** on the system keyboard, then attempt to reboot the system to single-user by entering **`/usr/gfx/setmon -x 72`** (even though you are unable to see any screen display of your inputs). Once you believe you have succeeded, reboot again.

Call your Onyx service provider for additional information and assistance if none of the previous four procedures restores your system's video output.

Modifying Video Formats Example

Before starting this exercise, be sure to read the information in the previous section, "Using the Combiner Examples."

Prior to modifying and downloading new video format combinations, you should follow the steps below. This will enable you to avoid rebooting the graphics system if you select a combination of window sizes that do not encompass the combiner main window controls or an IRIX shell window.

1. Bring up an IRIX shell window and reduce it to 80 x 24 using the size option on the pulldown menu from mouse button three.
2. Drag the IRIX shell to the lower left corner of the screen.
3. Launch the Combiner main window (if you have not already done so).
4. Position the Combiner's main window in the upper left corner of the screen.
5. Resize the Combiner's main window so that none of the IRIX shell window is covered. Do this by clicking the lower right corner of the Combiner main window and moving it upward.

After completing these preliminary steps, go on to select the first channel. Figure 3-12 shows the main window with channels 0 and 1 in the managed area.

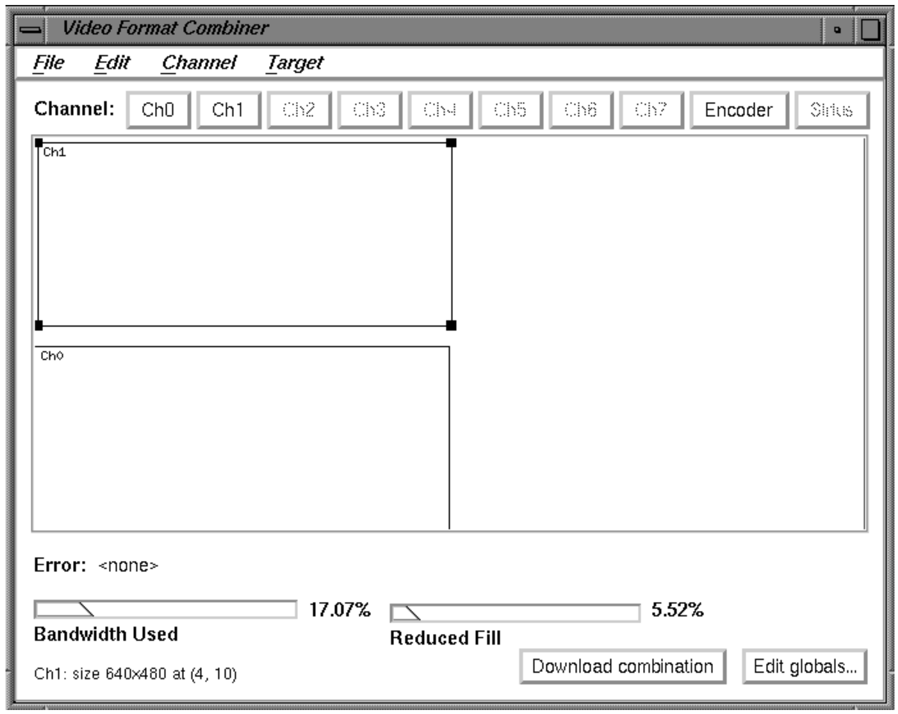

Figure 3-12 The Combiner Main Window With Channels Selected

Selecting a Video Format for Channel 0

Select the first channel to modify (channel 0) by following these steps:

1. Click the *Ch0* button on the Combiner main window.

   Note: When you click a channel pushbutton, the Files window appears. You can then select a video format for that channel (see Figure 3-13 for an example).

   Click the up or down arrows in the Files window to find the *640x480_60.vfo* file, then select it.

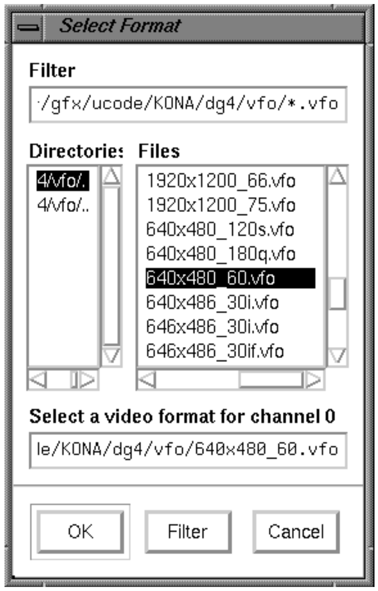

Figure 3-13 Selecting a Channel Format

2. Click *OK*. The Ch0 rectangle appears in the Combiner's main window.
3. Click on the bottom line (not the corner) of the rectangle and drag it to the bottom left corner of the main window.

Go on to the next section and select the format for channel 1.

Selecting a Video Format for Channel 1

Select and modify channel 1 using the following steps:

1. Click the *Ch1* button on the main window.
2. Move the cursor to the Files window and click the *640x480_60.vfo* file option. (This step assumes that the Files window was left open at the end of the last section).
3. Click the *OK* button. A channel 1 (Ch1) rectangle appears in the upper left portion of the Combiner main window.

Note: Just for this example, you will precisely set the origin of channel 1 to (4,10). This could be accomplished by clicking on the line of the rectangle and dragging it, as you did channel 0. However, the Ch1 origin will be numerically specified by editing the Ch1 attributes in the following steps.

4. Bring up the Attributes window by double-clicking the *Ch1* button in the Combiner main window. The Channel 1 Attributes window appears.
5. Click the cursor in the first (far left) "Origin" box.
6. Replace the value in the left Origin box (the x-origin box) with a **`4`** and then press **`<Enter>`**.
7. Move to the right Origin box (the y-origin box) and replace the value with a **`10`**, then press **`<Enter>`**. See Figure 3-14 for an example.

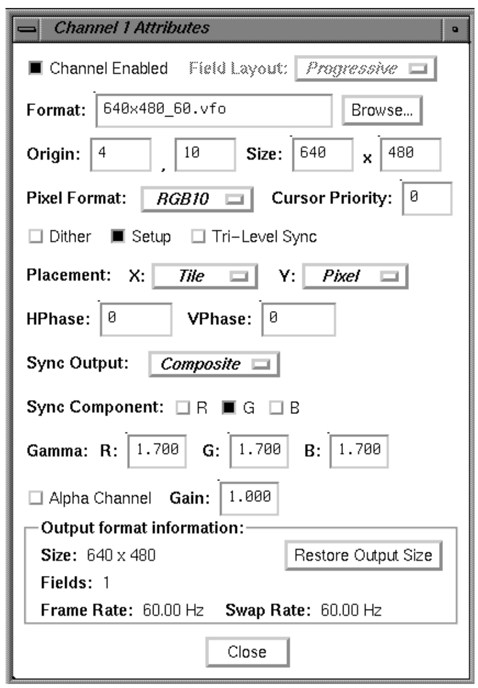

Figure 3-14 The Combiner Channel Attributes Window

8. Click the *Close* button on the Attributes window.

9. Move the cursor to the Combiner main window and click the *Download combination* button.

At this point, the video system is displaying the configuration specified in the exercise just completed:

- Channel 0 is displaying the lower left portion of the frame buffer where you originally placed the IRIX shell window.
- Channel 1 is displaying the upper left portion of the frame buffer where the InfiniteReality Combiner's main window was placed.

To return to the 1280 x 1024 video output, enter **`/usr/gfx/setmon -n 1280x1024_72`** in the IRIX shell window.

Go on to the next example or close the Combiner's main window.

Saving Video Format Combinations to the GE12 EEPROM

Before starting this exercise, be sure to read the information in the section "Using the Combiner Examples" on page 71.

This example assumes that the Combiner main window is open. If it is not, go to the section "InfiniteReality Combiner Programming Overview" on page 68, and launch the Combiner using the information in that section.

In the Combiner main window, select "New" from the File pulldown menu. Then click the *OK* button in the warning box. You are now ready to create and save a new video format combination to the GE12's EEPROM. The video format consists of two channels; each one is a *960x680_60.vfo* format. Use the following steps to make and save all the changes:

1. Click the *Edit globals* button in the main window's bottom right corner. The Combination Attributes window appears.
2. Change the Managed Area fields at the top of the Attributes window to read 1000 in the left hand box and 680 in the right hand box. See Figure 3-15 for an example of the Attributes window.
3. Click the Attributes window's *Close* button.

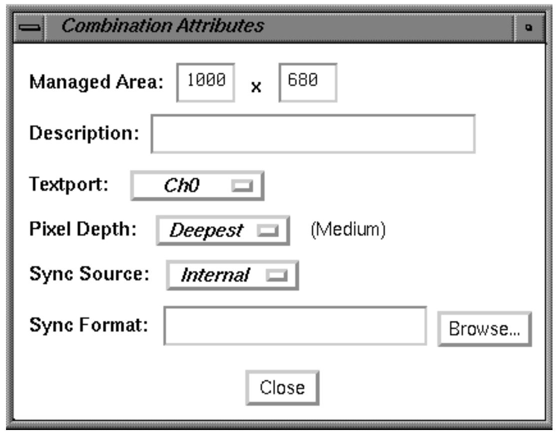

Figure 3-15 Combination Attributes Window Example

4. Click the *Ch1* button in the Combiner's main window. The Select Format box appears.
5. Find and double-click the *960x680_60.vfo* file format.

   Note: At this point, an error message appears at the lower left corner of the Combiner's main window. It says "Textport channel Ch0 invalid." (In this example, the error condition goes away after you define Ch0). While this or any other error message appears in the main window, you cannot use the "Download combination" or "Save to EEPROM" functions. See Figure 3-17 for an example error message.

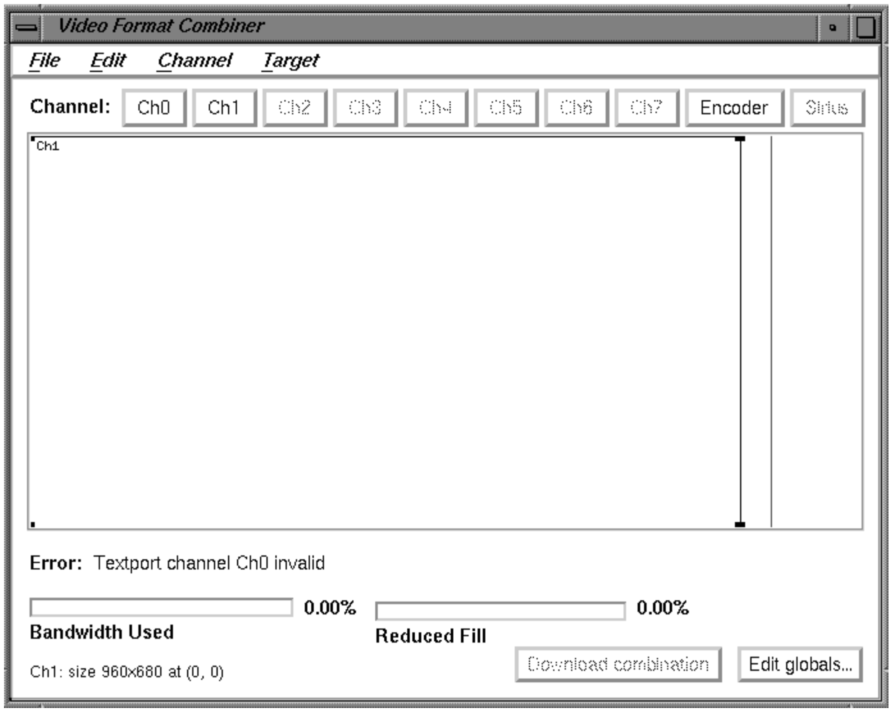

Figure 3-16 Textport Error Message on the Main Window

6. Click and drag the channel 1 (Ch1) box on the main window to the right until it is blocked by the red vertical line.

   Note: The red line represents the right-hand boundary of the specified Managed Area (1000) that you entered in step 2. The excess space to the right of the red line represents unusable area. The combiner does not permit you to position channels in that area.

7. Click the *Ch0* button in the Combiner main window. The Select Formats box appears.

8. Find and double-click the *960x680_60.vfo* file format.

   Note: At this point we have specified a video format combination with two video formats that are both equal to 960x680_60. The two channels are slightly offset, but mostly overlapping. See Figure 3-17 for an example of how the overlapping channels appear.

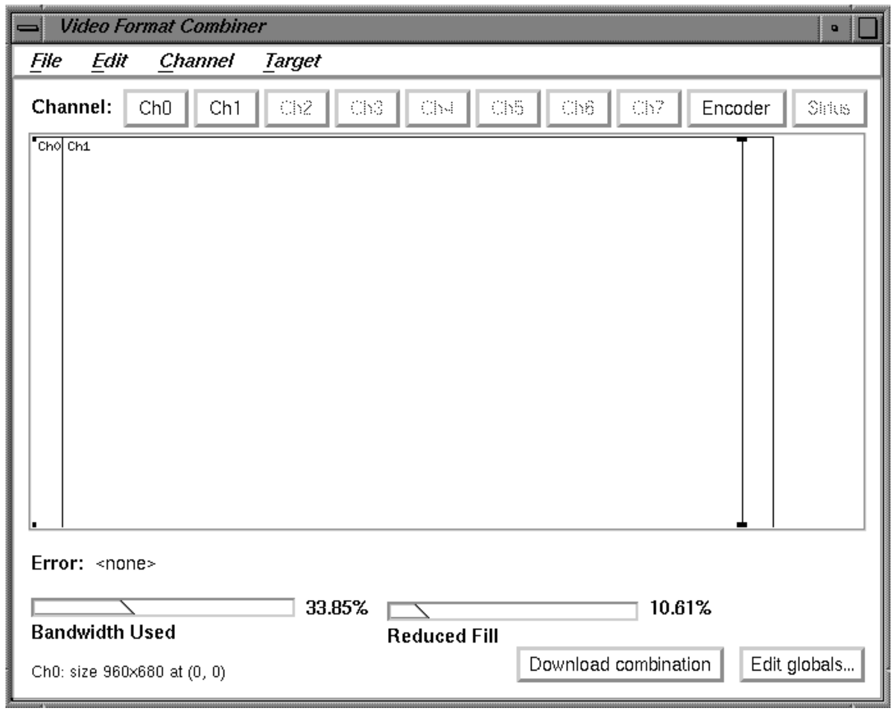

Figure 3-17 Combiner Main Window With Overlapping Channels

9. Go to the File pulldown menu in the Combiner's main window and select "Save to EEPROM." The "Saving to hardware" dialog box appears.
10. Click the *Download* button (see Figure 3-18).

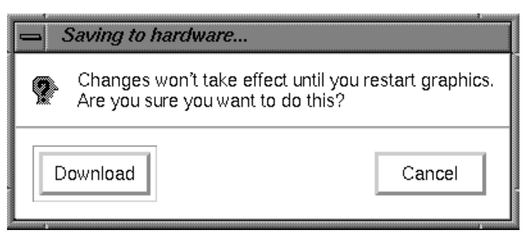

Figure 3-18 Saving to Hardware Dialog Box

Note: The format combination is now loaded in the GE12's EEPROM, but it does not take effect until the graphics subsystem is restarted.

11. Go to the File pulldown menu on the main window and select "Exit."
12. Click the *OK* button when the Warning dialog box appears (see Figure 3-19).

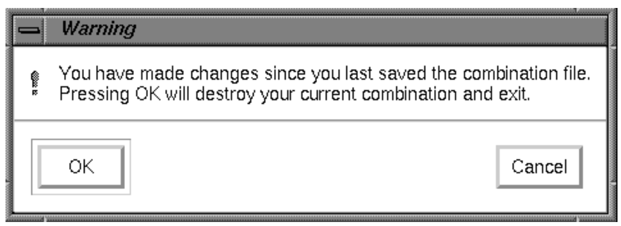

Figure 3-19 Exit Warning Dialog Box Example

13. Enter the following in the IRIX shell window to restart system graphics **`(/usr/gfx/stopgfx ; /usr/gfx/startgfx) &`**.
14. When the Login window appears, log in as root (superuser). The video system is now outputting a 960x680_60 format on channels 0 and 1.

    Note: The video system retains this configuration even after rebooting because the 960x680_60 Video Format Combination is saved in the GE12's EEPROM.

To reset the EEPROM to the standard 1280 x 1024 format combination, enter **`/usr/gfx/setmon -n 1280x1024_72`** at the IRIX prompt. Then restart the graphics system (as in step 13) to activate the format combination reset. When the Login window appears, log in as root.

Go on to the next example section for an additional Combiner exercise.

Resizing a Single-Channel Combination Example

Before starting this exercise, be sure to read the information in the section "Using the Combiner Examples" on page 71.

This example assumes that the Combiner main window is open. If it is not, go to the section "InfiniteReality Combiner Programming Overview" on page 68, and launch the Combiner using the information in that section.

In this final example you create a single-channel combination that is "static resized" and saved to and loaded from a combination file. Follow these steps:

1. Open an IRIX shell window, click the third mouse button, and use the Size pulldown menu to change the shell to 80 x 24.
2. Place the 80 x 24 shell window behind the Video Format Combiner main window, but make sure the command-line prompt is visible.
3. Click the *Ch0* button on the Combiner's main window. The Select Format window appears.
4. Find and double-click the *1280x1024_72.vfo* file. The channel 0 (Ch0) rectangle fills the entire 1280 x 1024 managed area in the main window.
5. In the Channel pulldown menu, select Grab Window. The cursor turns into a cross.
6. Move the cross (cursor) into the IRIX shell window and click the mouse button. The rectangle in the Combiner's main window representing Ch0 now represents the area of the frame buffer covered by the 80 x 24 IRIX shell that you clicked in. See Figure 3-20 for a screen example.

   Note: This area becomes resized to fit the entire channel 0 output when the combination is loaded. A channel's input area can also be resized by clicking and dragging any of the four corners of its main window rectangle. That resizing method is not covered in this exercise.

   Warning: Do not move the IRIX shell window until you complete this exercise.

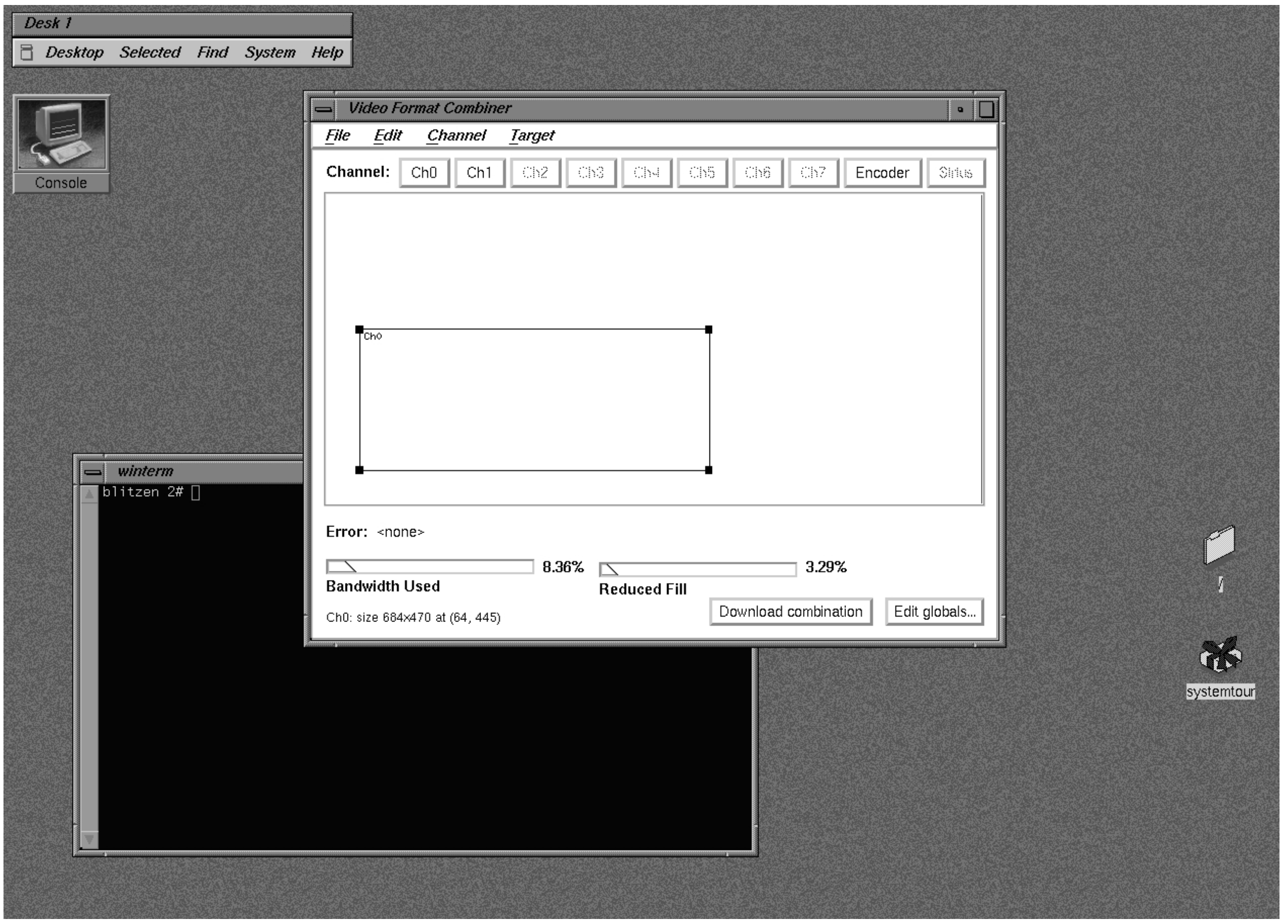

Figure 3-20 Static Resize Selection Example Screen

7. From the File pulldown menu on the Combiner main window, select Save As. The ircombine window appears (see Figure 3-21).
8. In the "Save combination as" field, enter **`test.cmb`** at the end of the path, then click the *OK* button.

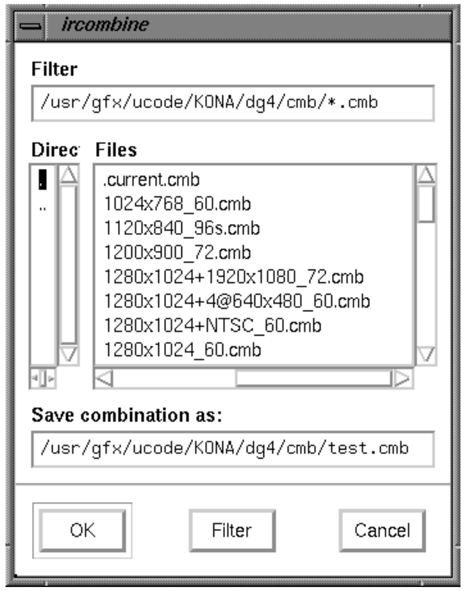

Figure 3-21 Save a Combination Using the ircombine Window

9. Select "Exit" from the File pulldown menu on the Combiner's main window.
10. Type **`/usr/gfx/setmon -n test`** at the IRIX prompt and press **`<Enter>`** in the shell window you clicked on in step 6. The screen blanks momentarily, then displays the IRIX shell window resized to 1280 x 1024 (the entire screen display).

    Note: If no usable window appears, use the following information to recover to the default video display combination.

    - Log in to the system remotely or connect an ASCII terminal to serial port tty_1 if available. Become superuser (root) and enter the command **`/usr/gfx/setmon -n 72`**. If this does not work, enter **`/usr/gfx/setmon -x 72`** and then restart the graphics by entering **`(/usr/gfx/stopgfx ; /usr/gfx/startgfx) &`**. Note that the brackets and ampersand are necessary.
    - Reboot the system using the System Controller if the previous methods do not work.

11. Revert to the previous display configuration by entering **/usr/gfx/setmon -n 1280x1024_72**. The entire screen should reappear in the standard 1280 x 1024 format.
12. Select “Exit” from the File pulldown menu on the Combiner’s main window to conclude the exercise.

Combiner Interface Summary

The Combiner interface has many functions besides those listed in the previous examples. You can use the Combiner to

- define a channel using an on-screen window as input
- copy an existing channel format and content to a new channel
- align one channel with another
- change the video format for a channel (or delete it entirely)
- edit the attributes (size, pixel format, and so on) of a channel
- select the “field layout” order in which data is scanned from the framebuffer
- select and copy a video format stored in a different file
- choose an output pixel format for a particular channel
- control cursor behavior in overlapping rectangles by setting the cursor priority
- allocate pixel width and depth for framebuffer fields
- set horizontal and vertical phase for a given channel
- specify whether sync components have sync enabled by default
- modify the brightness characteristics of the monitor
- change the default output video gain value for a channel
- save a combination of all the channels present in the Combiner’s main window and make global changes to them
- arrange the pixels (set pixel depth) in the framebuffer to optimize framebuffer output speeds

- select the InfiniteReality internal sync (or use an external source that is connected to the "Genlock In" port)
- save a video format combination as a default and write it to EEPROM
- run a user-defined hardware configuration simulating more RM6 boards than you have installed (used when an application is too large)

The information in this section is intended only as an introductory overview of the Combiner. For more detailed information on using the Combiner with your Onyx InfiniteReality graphics system, see the *InfiniteReality Video Format Combiner User's Guide* (P/N 007-3279-00x).

Operating the Optional RE^2 and VTX Video Out Panel

The Video Out Panel is a feature of the VTX and RealityEngine^2 graphics subsystems. The Video Out Panel is a software tool that allows you to selectively transmit screen displays and images to the composite or Super VHS (SVHS) monitor and VCR. For example, demos of 3-D graphics, or visual displays of mathematical functions that are displayed on the high-resolution 21-inch monitor, can be captured and displayed on the composite or SVHS monitor and recorded on a VCR.

Starting the Video Out Panel

With the Video Out Panel, you can control the video signals to the CMPST A and B and SVHS A and B ports. Popup menus allow you to select between NTSC and PAL video formats, standard or in-house video synchronization, and standalone or special genlock signals. An Options menu allows you to fine-tune the genlock delay, chrominance phase, chrominance color, and horizontal phase signals.

To start the Video Out Panel, type vo and press <Enter> in a text window. The Video Out Panel Controls menu now appears on your screen (see Figure 3-22).

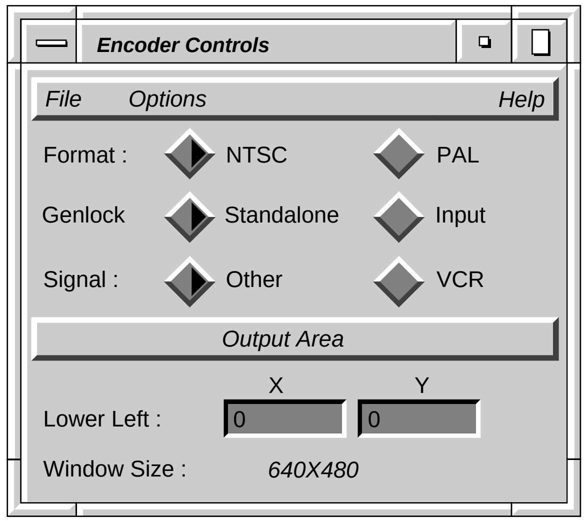

Figure 3-22 Controls Menu

The Controls menu has buttons that select different video options. These options are described in Table 3-4.

Table 3-4 Options on the Controls Menu

Option	Function
Format	*NTSC* or *PAL*. These two buttons select between the two most common composite video standards. You must select the correct format that matches your composite video monitor. **Note**: **When you select a video format, the rest of the controls will default to the most appropriate setting for that video format.**
Genlock	Genlocking is used to synchronize to another video signal. This is normally set to *Standalone*. The *Input* setting is used with special "in-house" signals.

Table 3-4 (continued) Options on the Controls Menu

Option	**Function**
Signal	*Other* or *VCR*. These buttons select the type of synchronization signal to be sent to the monitor/VCR. This should normally be set to *Other*.
Output Area	Clicking this button causes a window to appear on the screen. By holding down the mouse button, you can move this window over your screen until it covers the display that you want to transmit or capture.
Lower Left	As an alternative to the *Output Area* button, you can enter the lower left *x* and *y* coordinates in these boxes to position the output screen precisely.
Window Size	This display shows the screen resolution for the video mode you have selected. It automatically shows the appropriate mode when you click *NTSC* or *PAL*.

You can control the video signals through the Options menu. Click the Options field in the Controls menu to invoke the Options menu (see Figure 3-23).

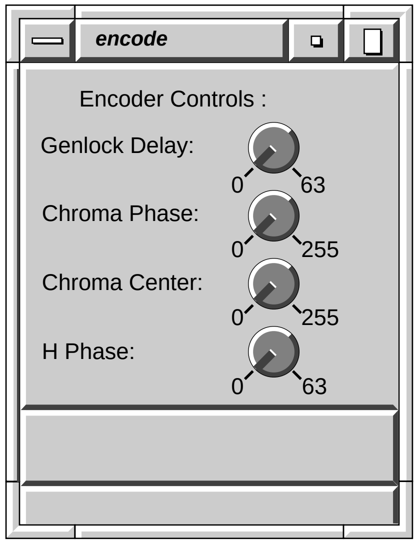

Figure 3-23 Options Menu

The Options menu has buttons that control the video signals through the ports. The buttons are controlled by the mouse. Place the cursor on the button, and click and hold down the mouse button. As you move the mouse in an arc, the button turns just like a rotating knob. The options are described in Table 3-5.

In most cases, the Options menu is not needed. For most uses, the default settings are perfectly suitable.

Table 3-5 Options on the Options Menu

Option	Function
Genlock Delay	Genlocking is synchronized with another video signal. This control allows you to minutely control the advance or delay of the synchronization. The control cycles through a range of 0 to 63.
Chroma Phase	Chrominance is a separate signal that contains color information. It is derived from the I and Q signals in the NTSC video format and from the U and V signals in the PAL video format. This control regulates the amount of light in each pixel comprising the R, G, and B signals. It is roughly analogous to the HUE control on a color television. It cycles through a range of 0 to 255.
Chroma Center	This control is analogous to the TINT control of a color television. It controls the color saturation of the display and cycles through a range of 0 to 255.
H Phase	This control regulates the horizontal sync, which is the lowest portion of the horizontal blanking part of the video signal. It provides a pulse for synchronizing video input with output and cycles through a range of 0 to 63.

A Practice Session

This section takes you through a sample session with the Video Out Panel. Assume that you have a graphic image or animation sequence running on the 21-inch high-resolution monitor. Size the window in which the display is running so that it doesn’t take up the entire screen.

1. Type the command **vout** and press **<Enter>**. The Controls menu appears.
2. Click either the *NTSC* or *PAL* button, depending on the video format of your monitor and VCR. Your choice here determines the default settings for the rest of the controls.
3. Click the *Output Area* button. A black rectangle appears on the screen. The rectangle has the correct format, that is, aspect ratio, for either PAL or NTSC. This rectangle is much smaller than the full screen area because NTSC and PAL operate at a much lower resolution than your VTX or RealityEngine^2 graphics system does.
4. Use the mouse to move this window. Move the cursor over the frame of the window and hold down the mouse button. You can now move the window over the portion of the image or animation that you wish to send to the composite monitor or VCR. If the image is too large to be captured in the window, resize the display window, then pull the black output window over the image again.

Once you have covered the display with the output window, you see the demo or image appear in the output window and also on your composite video monitor. If you have a VCR connected, you can begin recording immediately.

Caution: The Video Out Panel captures images only when the high-resolution monitor is running at its default configuration of 1280 x 1024, or at the high resolution of 1600 x 1200. While other video resolutions are supported, the images do not appear on the composite or SVHS monitor.

Powering Off the System

The system should be powered off only for routine maintenance or repair. You can power your system off in either of two ways:

1. Choose “System Shutdown” from the System menu.
2. Bring the system down from a shell.
   - Become superuser by typing **/bin/su** and pressing **<Enter>**.
   - Enter your superuser password, if prompted.

- When you see the superuser prompt (#), 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.
```

3. Turn off the power switches for the system and the peripherals in the following order:
   - printer (if installed)
   - monitors
   - Onyx system

Resetting Your System

Reset your system by turning the key switch on the System Controller 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. If the system is completely unresponsive, use only the Reset function, not the main power switch, to reboot your system. If your system responds to input, use the shutdown option in the System Maintenance menu or the *halt* command.

Chapter 4

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 Onyx graphics workstation.

Configuring and Installing Additional FLDs

This section shows you how to configure and install a Silicon Graphics FLD (front-loading drive). The information provided covers the hardware configuration. Refer to the *IRIX Admin: Disks and Filesystems* manual, or the *IRIX Admin: Peripheral Devices* manual, for additional system and software configuration information.

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. Possible channel configurations are shown in Figure 4-1 and Figure 4-2.

   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.

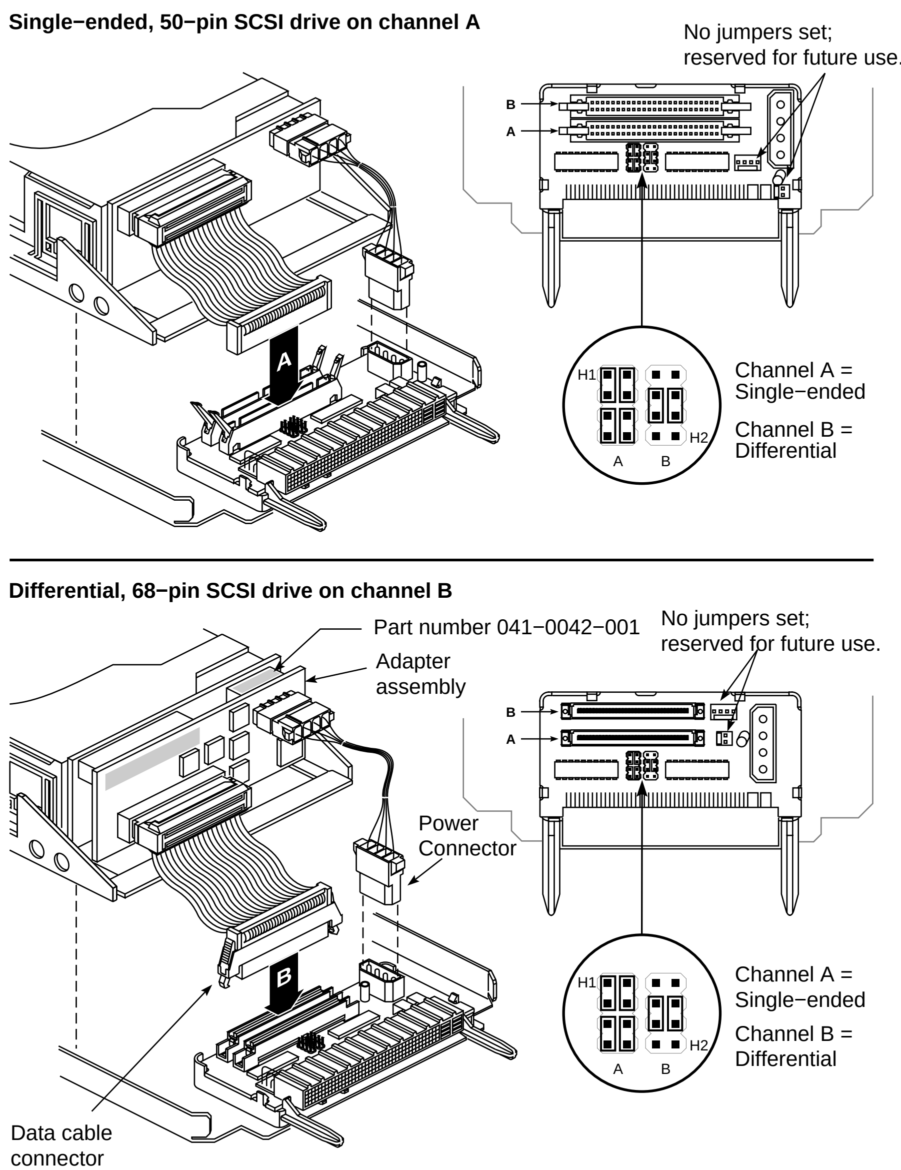

Figure 4-1 Channel Adapter Settings (Different Channel Configurations)

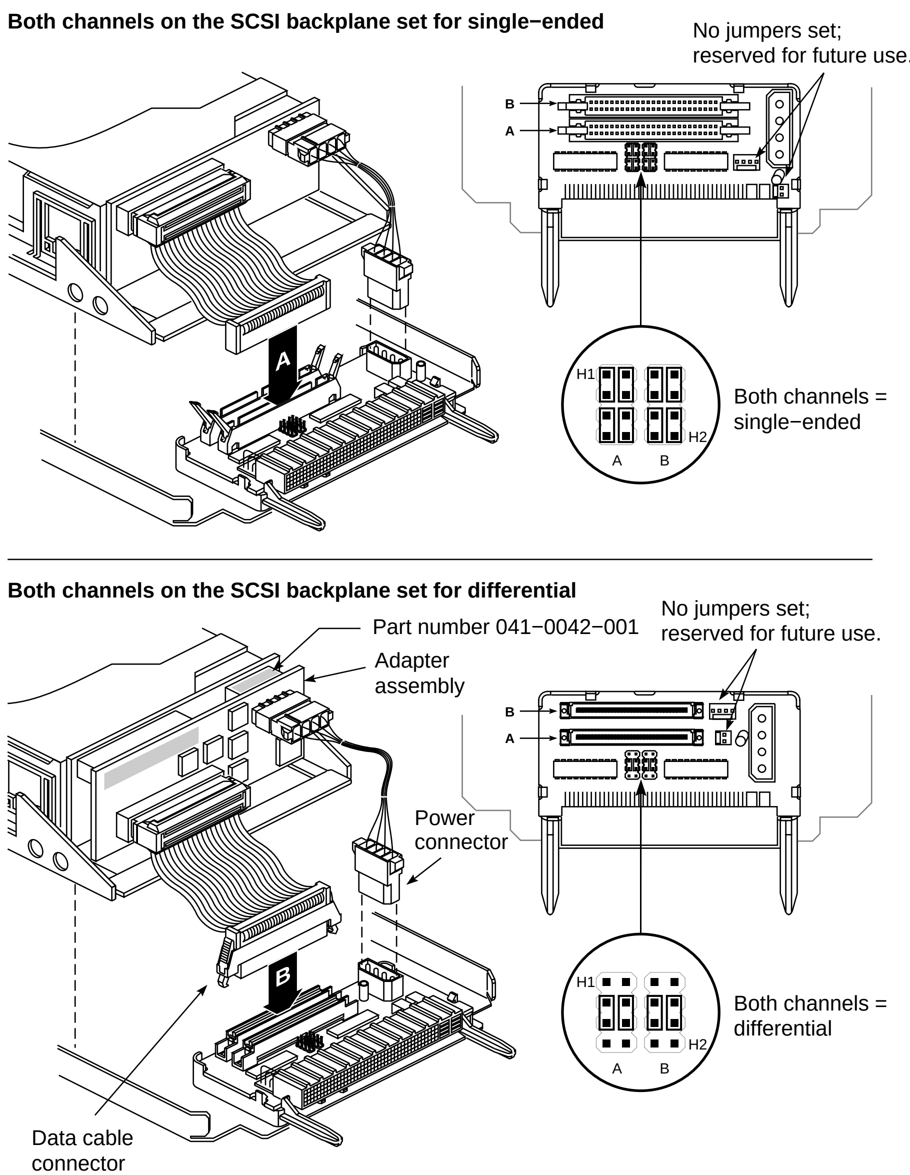

Figure 4-2 Channel Adapter Settings (Same Channel Configurations)

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.

   Note: 0 is reserved as the bus ID for the SCSI bus controller. Never change the drive ID while the drive is running.

   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 the 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 a section called “Installing and Removing FLDs” in Chapter 3.

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 will work.

- 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, follow these steps:
  - Power off 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 plug a drive into your system while it is powered on.

Configuring the SCSIBox 2 for Full-Height FLDs

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

1. Open the lower front door of the chassis and ensure that the system is powered down.
2. Open the door to the SCSIBox by releasing the two wing nuts (see Figure 3-6).
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.

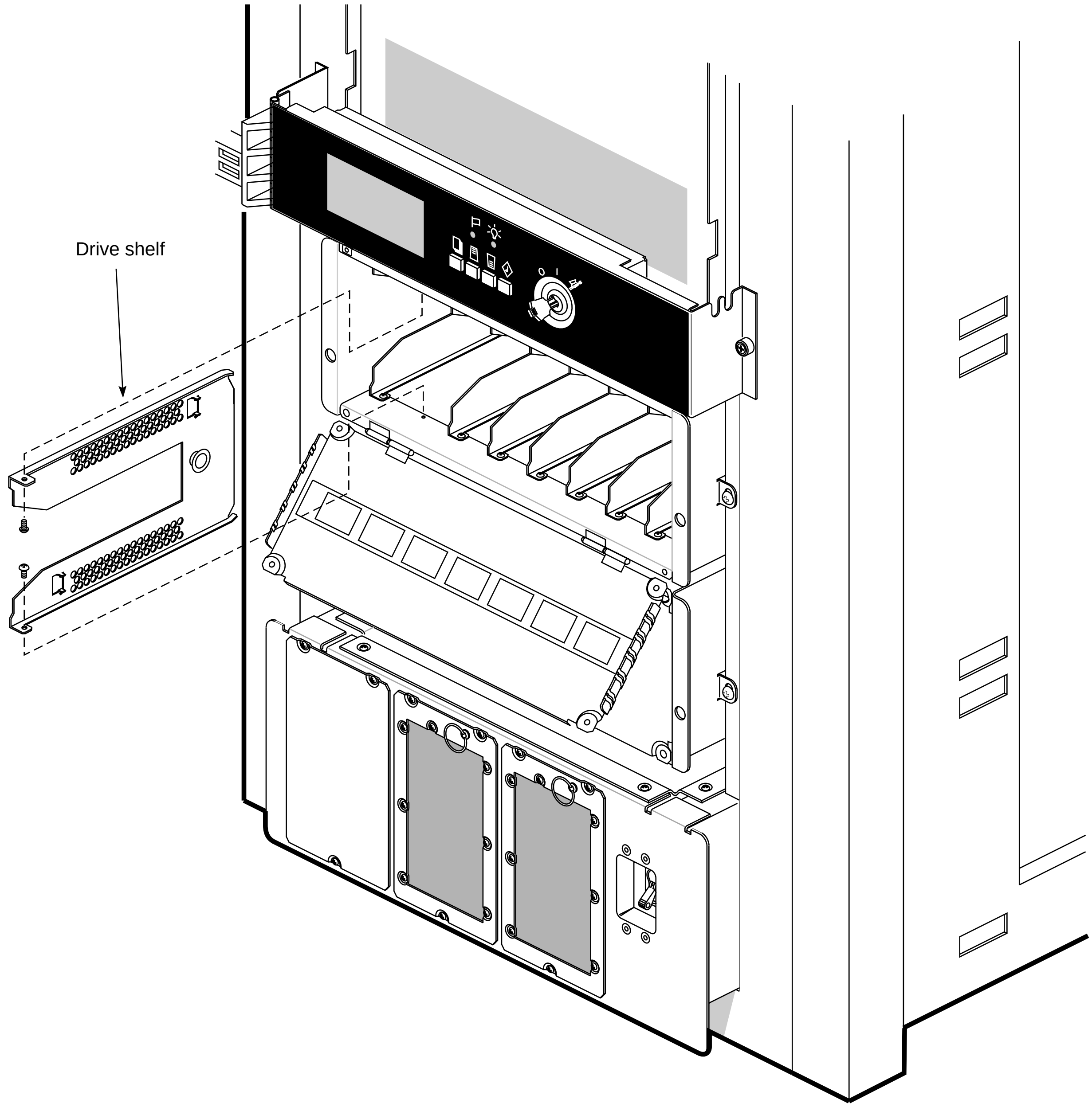

Figure 4-3 Removing a SCSIBox Drive Shelf

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 SCSI cable length limitations.

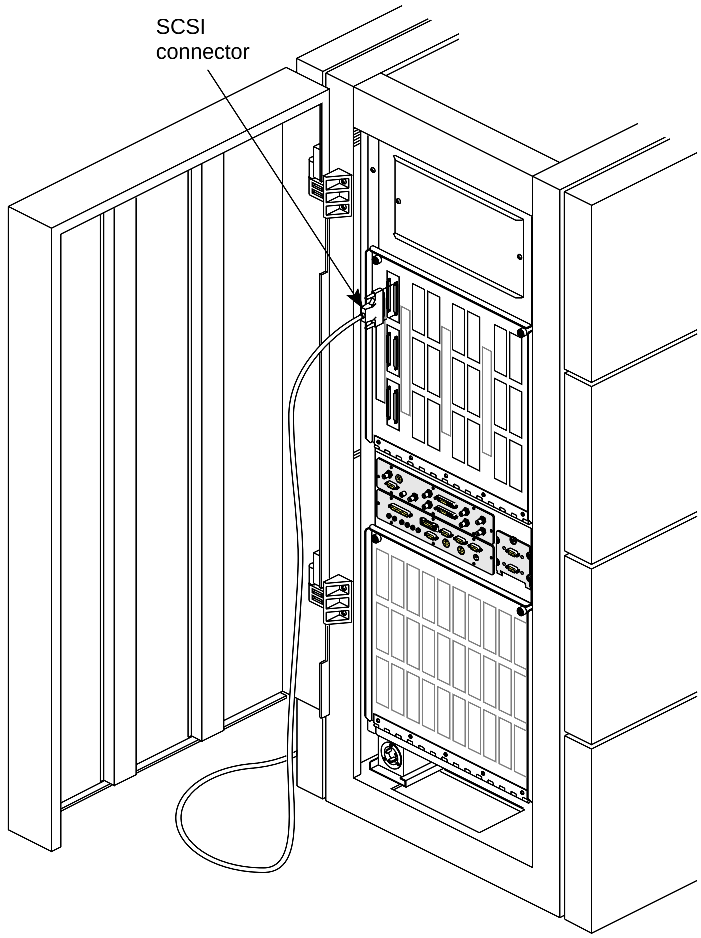

Figure 4-4 Connecting an External SCSI Device

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)	
DIFFSENS	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)	

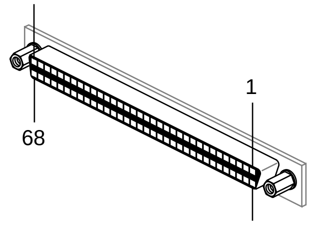

Figure 4-5 68-Pin Connector Pin Numbering

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 the CD-ROM drawer, pull back two of the retaining latches and insert the CD-ROM into the drawer, as shown in Figure 4-6.

   Note: If you are using an older CD-ROM drive that does not have a built-in drawer (caddy), do not insert the disc into the drive without using a caddy.
5. With the compact disc secure under the lips of the four retaining latches, close the CD drawer.
6. See the *IRIX Admin: Software Installation and Licensing* manual for complete instructions on loading software.

7. Load the appropriate IRIX operating system version from the initial prompt. Select 2, as shown in the following example menu, to load the operating system from a CD-ROM FLD.

```
Installing System Software

Select drive for installation:

1-tape tpsc (xxx,xx)

2-CDROM dksc (xxx,xx,x)

3-tape tpsc (xxx,xx)

which?
```

8. A series of dots appears as the operating system loads.

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

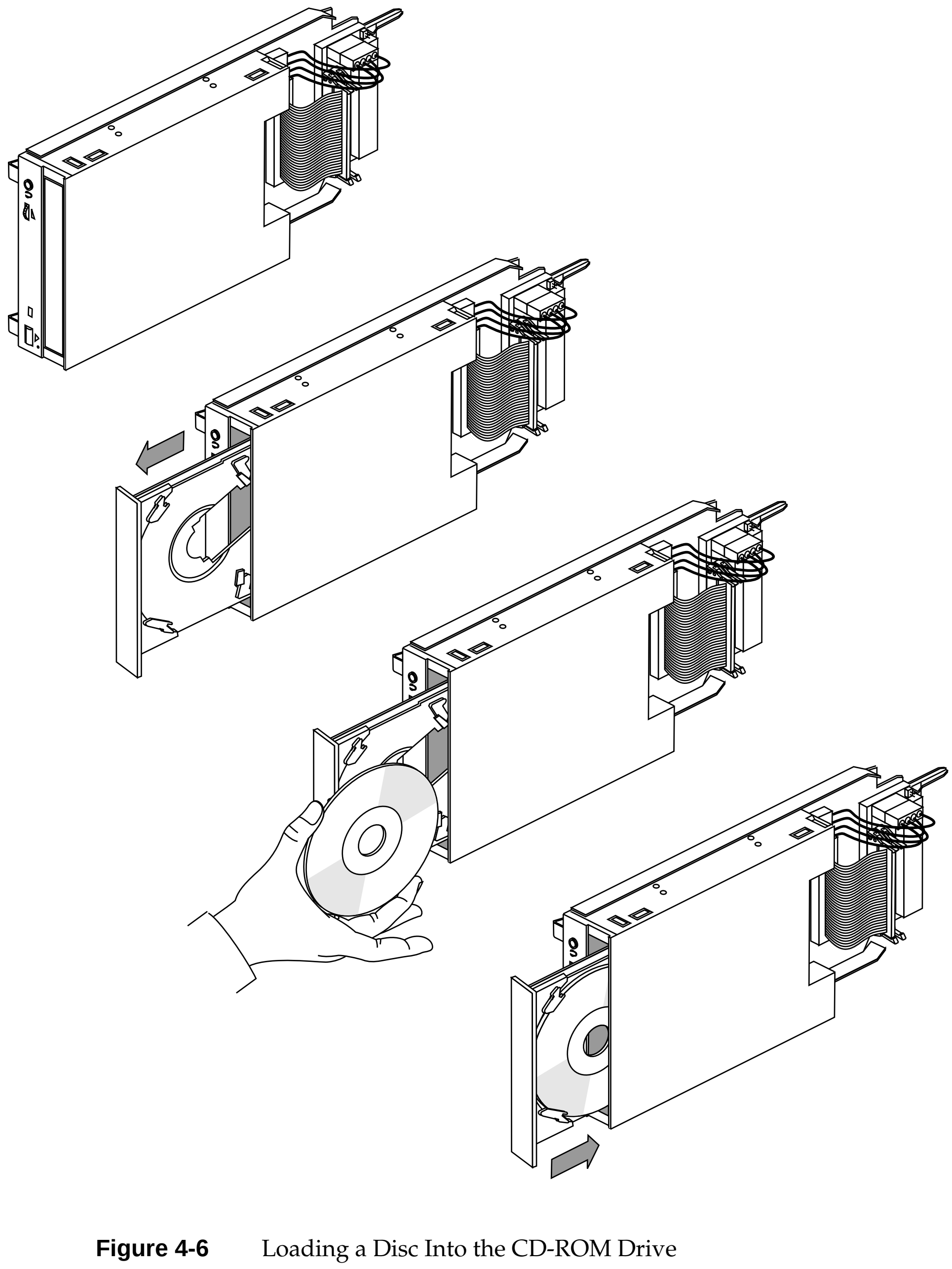

Figure 4-6 Loading a Disc Into the CD-ROM Drive

Connecting a Serial Printer or ASCII Terminal

Connect a serial printer or 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 (Onyx)	Signal Description (at Onyx)
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 4-7.

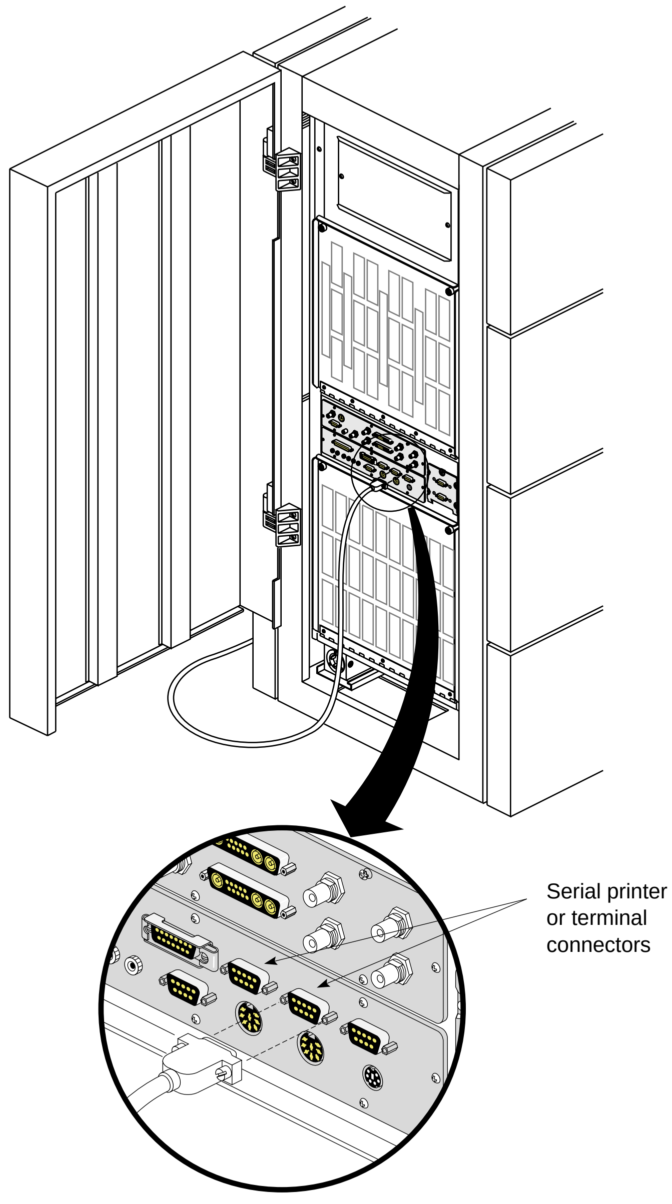

Figure 4-7 Connecting a Serial Printer or ASCII Terminal

5. Attach the power cord and turn on the printer or terminal.
6. If you have installed a printer, select the printer icon from the System Manager menu to configure the software to recognize it. If you have connected a terminal to your system, select the Serial Ports icon from the System Manager menu to configure it. Note that your terminal should be configured for 9600 baud.

See the *IRIX Admin: Peripheral Devices* manual for more information on configuring your printer and 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 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

Table 4-4 (continued) Parallel Printer Connector Pin Assignments

25-Pin Connector	Signal Description
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 4-8.
5. Attach the power cord and turn on the printer.
6. Use the System Manager's "Printers" tool to configure the software to recognize the printer.

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

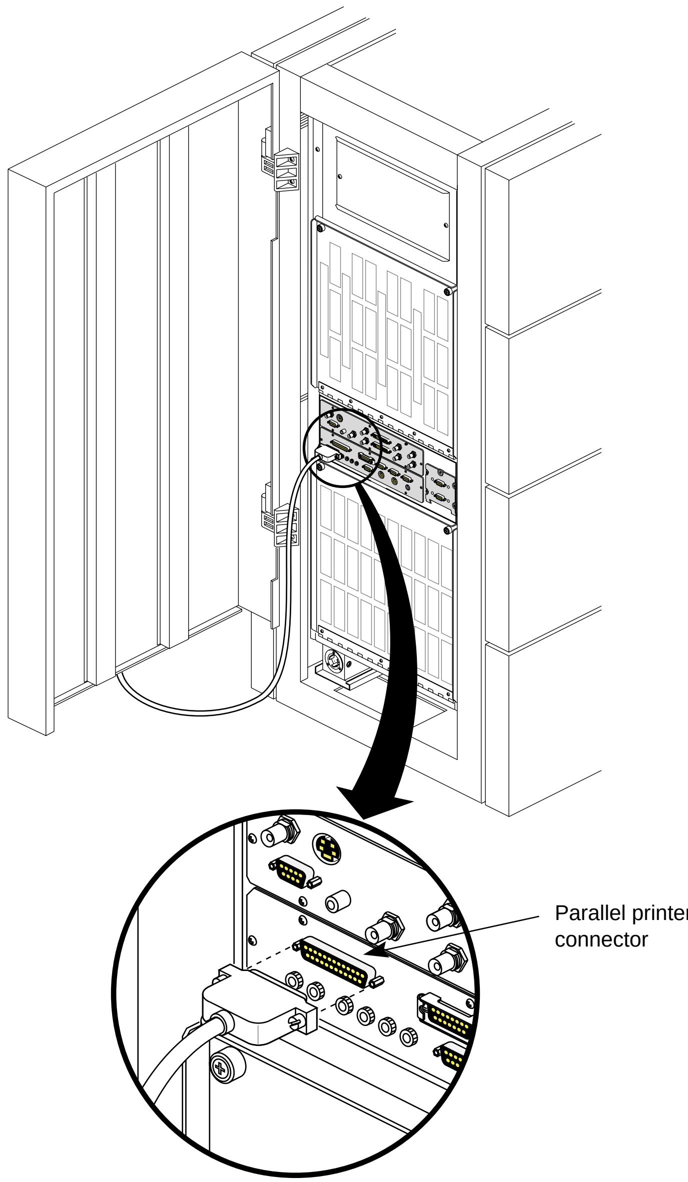

Figure 4-8 Connecting a Parallel Printer

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 RS-232 Modem Connector Pin Assignments

25-Pin (DB-25) Connector	9-Pin (DB-9) Connector	Signal Description (at Onyx)
20	9	Data Terminal Ready (DTR)
5	5	Clear to Send (CTS)
2	2	Transmit Data (TXD)
3	3	Receive 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, that is, 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.

Transmit Data (TXD) and Receive 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 4-7).
5. Set the modem's baud rate to 9600.
6. Attach the modem power cord and turn on the modem.

Refer to the *IRIX Admin: Peripheral Devices* manual for information about configuring your modem.

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: To check if your system has additional IO4 boards, check the IO panels in the front of the system for extra serial connectors. See Figure 2-11 in Chapter 2, "Touring the Chassis," as required.

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 9 (the one next to the primary IO4).

   ```
   VECTOR: bustype=EPC module=epcserial unit=1 slot=9 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 entering:

   `/dev/MAKEDEV ttys`

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 was just enabled, that is, *ttyd45* through *ttyd47*.

   Note: The “ttyd48” file corresponds to the RS422 port and does not need to have 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 *tty[fm]** are used with modems. See the getty(1M), uugetty(1M), init(1M), gettydefs(4), and inittab(4) reference (man) 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 with "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`** **<Enter>**.
2. Type **`./MAKEDEV plp`** **<Enter>**.

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

Chapter 5

Having Trouble?

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

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.
- Degauss the monitor every few days by pressing the *Degauss* button on the front of the monitor.
- 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 Admin: System Configuration and Operation* manual 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 can log in to the system, but it doesn’t respond as usual. For example, the screen looks strange or the windows don’t respond to input from the mouse or keyboard.
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 monitor 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.
- Make sure the mouse is connected and is on the mouse pad.

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 monitor and to the appropriate connector on the graphics I/O panel.
- The power cable is securely connected to the monitor or 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 mouse cable is securely connected to the keyboard.
- 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 Admin: Software Installation and Licensing* manual. If the system fails to respond at all, call your system administrator or 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 OxZZ PROC OxZZ	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 OxZZ PROC OxZZ
   ```

   A flag message appears: `Onyx C. 1996`
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. Read the following section for information on file restoration.

Restoring a Filesystem From the System Maintenance Menu

If your root filesystem is damaged and your system cannot boot, you can restore your system from the System Maintenance Menu. This is the menu that appears when you interrupt the boot sequence before the operating system takes over the system. To perform this recovery, you need two different tapes: your system backup tape and a bootable tape with the miniroot.

If a backup tape is to be used with the System Recovery option of the System Maintenance Menu, it must have been created with the System Manager or with the *Backup(1)* command, and must be a full system backup (beginning in the root directory (/) and containing all the files and directories on your system). Although the *Backup* command is a front-end interface to the *bru(1)* command, *Backup* also writes the disk volume header on the tape so that the “System Recovery” option can reconstruct the boot blocks, which are not written to the tape using other backup tools. For information on creating the system backup, see the *IRIX Admin: Backup, Security, and Accounting* manual.

If you do not have a full system backup made with the *Backup* command or System Manager—and your *root* or *usr* filesystems are so badly damaged that the operating system cannot boot—you have to reinstall your system.

If you need to reinstall the system to read your tapes, install a minimal system configuration and then read your full system backup (made with any backup tool you prefer) over the freshly installed software.

This procedure should restore your system to its former state.

Caution: Existing files of the same pathname on the disk are overwritten during a restore operation, even if they are more recent than the files on tape.

When you first start up your machine, you see the following prompt:

```
Starting up the system....
```

```
To perform system maintenance instead, press <Esc>
```

1. Press the **`<Esc>`** key. You see the following menu:

   ```
   System Maintenance Menu
   1   Start System
   2   Install System Software
   3   Run Diagnostics
   4   Recover System
   5   Enter Command Monitor
   ```

2. Enter the numeral **`4`** and press **`<Return>`**. You see the message:

   ```
   System Recovery...
   ```

   ```
   Press Esc to return to the menu.
   ```

   After a few moments, you see the message

   ```
   Insert the installation tape, then press <enter>:
   ```

3. Insert your bootable tape and press the **`<Enter>`** key. You see some messages while the miniroot is loaded. Next you see the message

   ```
   Copying installation program to disk....
   ```

   Several lines of dots appear on your screen while this copy takes place.

4. You see the message

   ```
   CRASH RECOVERY
   ```

   ```
   You may type sh to get a shell prompt at most questions.
   ```

```
Remote or local restore: ([r]emote, [l]ocal): [l]
```

5. Press **<Enter>** for a local restoration. If your tape drive is on another system accessible by the network, press **r** and then the **<Enter>** key. You are prompted for the name of the remote host and the name of the tape device on that host. If you press **<Enter>** to select a local restoration, you see the message

   ```
   Enter the name of the tape device: [/dev/tape]
   ```

   You may need to enter the exact device name of the tape device on your system, since the miniroot may not recognize the link to the convenient */dev/tape* filename. As an example, if your tape drive is drive #2 on your integral SCSI bus (bus 0), the most likely device name is */dev/rmt/tps0d2nr*. If it is drive #3, the device is */dev/rmt/tps0d3nr*.

6. The system prompts you to insert the backup tape. When the tape has been read back onto your system disk, you are prompted to reboot your system.

Recovery After System Corruption

From time to time you may experience a system crash due to file corruption. Systems cease operating ("crash") for a variety of reasons. Most common are software crashes, followed by power failures of some sort, and least common are actual hardware failures. Regardless of the type of system crash, if your system files are lost or corrupted, you may need to recover your system from backups to its pre-crash configuration.

Once you repair or replace any damaged hardware, you are ready to recover the system. Regardless of the nature of your crash, you should reference the information in the section "Restoring a Filesystem From the System Maintenance Menu" in the *IRIX Admin: Backup, Security, and Accounting* manual.

The System Maintenance Menu recovery command is designed for use as a full backup system recovery. After you have done a full restore from your last complete backup, you may restore newer files from incremental backups at your convenience. This command is designed to be used with archives made using the *Backup* utility or through the System Manager. The System Manager is described in detail in the *Personal System Administration Guide*. System recovery from the System Maintenance Menu is not intended for use with the *tar*, *cpio*, *dd*, or *dump* utilities. You can use these other utilities after you have recovered your system.

You may also be able to restore filesystems from the miniroot. For example, if your root filesystem has been corrupted, you may be able to boot the miniroot, unmount the root filesystem, and then use the miniroot version of *restore*, *xfs_restore*, *bru*, *cpio*, or *tar* to restore your root filesystem. Refer to the reference (man) pages on these commands for details on their application.

Refer to the *IRIX Admin: System Configuration and Operation* manual for instructions on good general system administration practices.

Chapter 6

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 using these guidelines. You can 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.

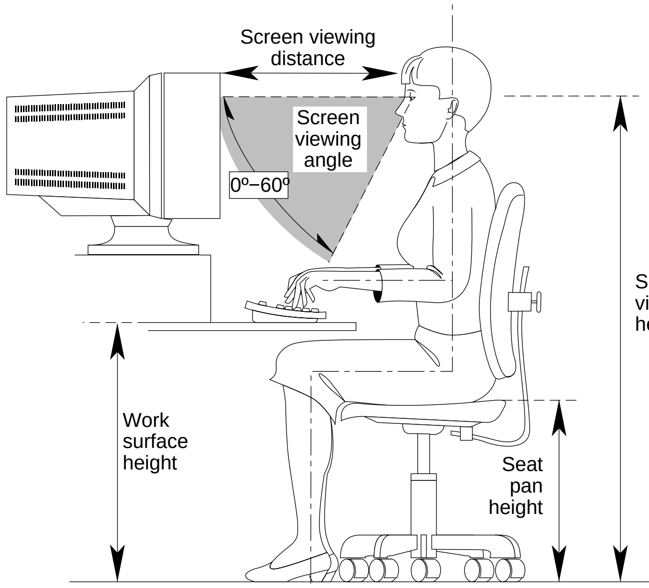

Figure 6-1 Basic Guidelines for VDT Workstation Adjustment (Adapted From ANSI/HFS 100, 1988)

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). 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 are 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, precautions against electrostatic discharge when removing or replacing the front loading devices. You should use an ESD wrist strap along with antistatic packaging materials, whenever you transport or store peripherals.

Hardware Specifications

The physical, electrical, and environmental specifications for the Onyx rackmount graphics workstation are listed in Table A-1.

The 21-inch color monitor specifications and characterstics are listed in Table A-2.

Table A-1 Onyx Rackmount Graphics Workstation Specifications

Parameter	Characteristics
Enclosure	
Dimensions	27″ wide (69 cm) x 48″ deep (122 cm) x 62.3″ high (159 cm)
Weight	560 lbs (254 kg), base configuration 800 lbs (363 kg), maximum
Lower vertical opening	33 inches (84 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 panel doors	37 inches (94 cm)
Noise level (CC1 and 2 only)	67.5 dB (approximate) with RE^2, VTX, or InfiniteReality
Noise level (InfiniteReality with CC3)	74 dB (approximate) with InfiniteReality and CC3 installed

Table A-1 (continued) Onyx Rackmount Graphics Workstation Specifications

Parameter	Characteristics
Electrical	
Power supply	2400 watt, 1-3 offline switchers
Voltage	208-240 VAC
Frequency	47-63 Hz, single phase
Current (with 2 OLS units)	30 amps, maximum
Current (with 3 OLS units)	45 amps, maximum
Power (with 2 OLS units)	4800 watts, maximum
Power (with 3 OLS units)	7200 watts, maximum
Temperature	
Operating	15^{o} to 35^{o}C
Nonoperating	-40^{o} to 50^{o}C
Humidity	
Operating	20% to 80% relative humidity, noncondensing
Nonoperating	20% to 95% relative humidity, noncondensing
Heat dissipation (with 2 OLS units)	20,000 Btu/hr, chassis maximum
Heat dissipation (with 3 OLS units)	30,000 Btu/hr, chassis maximum

Table A-2 Onyx 21-Inch Monitor Specifications

Parameter	Characteristics
CRT Type	21 inches diagonal (20 vertical), 0.26 mm dot pitch, black matrix, short persistence phosphors with A/R coating
Brightness (Luminance)	>25 FL (85.6 nits) +0/-7FL maximum (with anti-reflective (A/R) coating)
Brightness (color temperature) fixed selectable settings (center of CRT)	9300K+8 MPCD (100 +/- 15 cd per m^2) 6500K+8 MPCD (85 +/- 15 cd per m^2)
Video Input Signal	0.714 Vp-p, analog
Sync	Separate H, V, or composite H/V, TTL level or sync on green at 0.3 Vp-p
Resolution	Up to 1600 x 1200 (1280 x 1024 standard)
Video Clock Frequency	200 MHz (maximum)
Video Input Impedance	75 ohms
Active Horizontal Display Area	395 mm
Active Vertical Display Area	295 mm
Note: Active display area is changed by the graphics board standard.	
Misconvergence	Less than 0.3 mm
AC Power Supply	100-120 VAC or 200- 240 VAC
Dimensions	488 mm wide x 474 mm high x 534 mm deep (including tilt-and-swivel base)
Weight	33kg (72.6 lbs) [36 kg (79 lbs) Gross]
Environmental Conditions	5 to 35°C, operating –20 to +60°C, nonoperating
Operating Humidity	10 to 80%, noncondensing
Nonoperating Humidity	10 to 90%, noncondensing

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.

4-mm DAT Drive

The 4-mm DAT drive provides data storage on 60-, 90-, and 120-meter digital data storage (DDS) DAT cassettes. The drive complies with the American National Standards Institute (ANSI) DDS and DDS-2 formats 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

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

When you load a tape 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 partway. Grasp the cassette and remove it from the drive. Note that the unload button is disabled when the drive is in use.

Removing a Jammed 4-mm Cassette

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

1. Power-cycle the tape drive and then try ejecting it.
2. If that 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.

Cleaning the 4-mm DAT Drive

Note: Every time you use the cleaning cassette, the drive uses a new, unused portion of the tape. After about 30 uses, the tape is used up and you must obtain a new one. Always note the number of times you use each cleaning cassette. Never use an audio DAT cleaning cartridge in your DDS-2 drive.

Using only a DDS-qualified DAT drive cleaning cassette:

1. Insert the cleaning cartridge 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, that you used the cleaning kit.

Front Panel Lights

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

Table B-1 4-mm DAT Front Panel LED Status Indicators

LED	Action	Meaning
Yellow	On (lit)	The drive is reading or writing the tape (normal operation).
Yellow	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 (beyond a predefined error threshold): this is normal operation.
Green	Flashing Slowly	A cassette is inserted, but is generating excess soft errors (warning: heads may need cleaning).
Green	Flashing Slowly with Yellow LED	A prerecorded audio cassette is inserted and is being played automatically.
Green	Flashing Rapidly	The drive cannot write the tape correctly (error). Clean the heads or confirm tape is writable.

Care and Cleaning of the Exabyte 8-mm Tape Drive

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

Caution: Use of cleaning materials not approved by Exabyte may 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 Exabyte compatible cleaning cartridge and close the drive. The tape drive automatically runs through the 15-second cleaning cycle. The tape ejects automatically when cleaning is complete.

Note: If the cleaning cartridge is ejected from the drive before the 15-second cleaning cycle ends, the cartridge has reached the maximum number of cleaning cycles and should be discarded. Do not rewind the cleaning cartridge or use it for more than its specified number of cleaning cycles. Remove the cartridge, record the date on the label, and store it for future use.

Front Panel Lights

The 8-mm tape drive has three front panel lights (see Figure B-1).

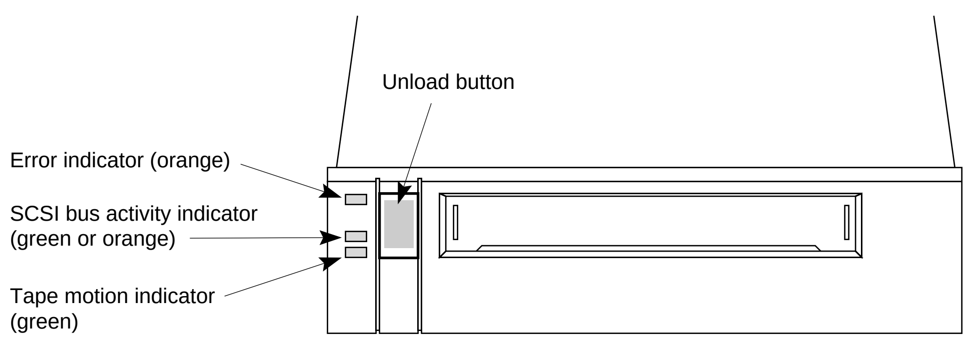

Figure B-1 8-mm Tape Drive Front Panel

Table B-2 shows a specific combination of LEDs that may occur during tape drive operation and the tape drive states that they indicate.

Table B-2 LED States and Interpretations

LED State	Top LED (errors)	Middle LED (SCSI)	Bottom LED (motion)
Self-test start	On	On (green)	On
Self-test end	On	Flashing (irregularly)	Off
Self-test fails	Flashing (fast)	Flashing (irregularly)	Off
Ready (no tape)	Off	Flashing (irregularly)	Off
Ready (tape)	Off	Flashing (irregularly)	On
Normal tape motion	Off	Flashing (irregularly)	Flashing (slowly)
High-speed tape motion	Off	Flashing (irregularly)	Flashing (fast)
SCSI bus reset	On	Flashing (irregularly)	On
Error	Flashing (slowly)	Flashing (irregularly)	Off
Time to clean	Flashing (fast)	Flashing (irregularly)	Flashing (fast)

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 it.
2. If that does not eject the drive, power-cycle it while holding down the unload button.

If neither of these steps ejects the cartridge, 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 given below:

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-2). 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 drive).

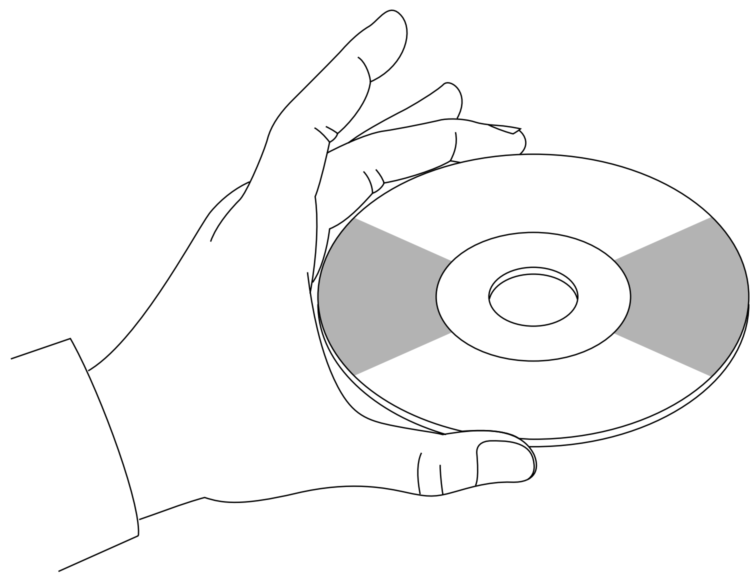

Figure B-2 Handling a Compact Disc

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 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
- a vehicle parked in the sun

CD-ROM Front Panel Operational Features

A number of operational items (see Figure B-3) are located on the drive's front panel:

- The *headphone jack* receptacle accepts a 3.5-mm diameter stereo plug.
- The *volume control dial* is located to the right of the headphone jack. Use it to adjust the sound level of the drive.
- A *drive busy indicator LED* is located to the left of the eject button. When this LED is blinking, it indicates drive activity. The LED stays dark when no disc is loaded in the drive. See Figure B-4 for details on blink patterns and the status they indicate for the drive.
- The *eject button* is located at the right side of the front panel. It works *only* when the CD-ROM drive is powered on. The disc drawer (caddy) will not eject if the CD-ROM is in an active (busy) state. After pushing the eject button, two to three seconds will elapse before release occurs.
- An *emergency eject hole* is located at the far right of the drive. It is used to eject the CD when the normal procedure does not work. Insert the end of a large, straightened paper clip into the hole until the caddy drawer slides out.

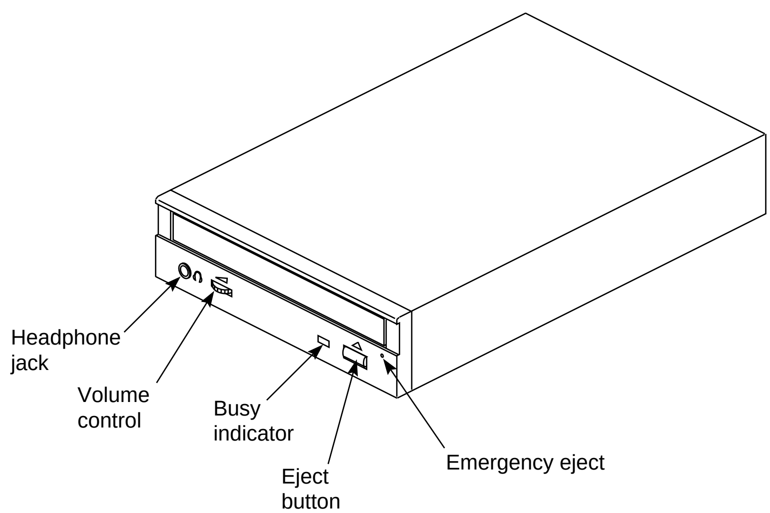

Figure B-3 CD-ROM Front Panel Features

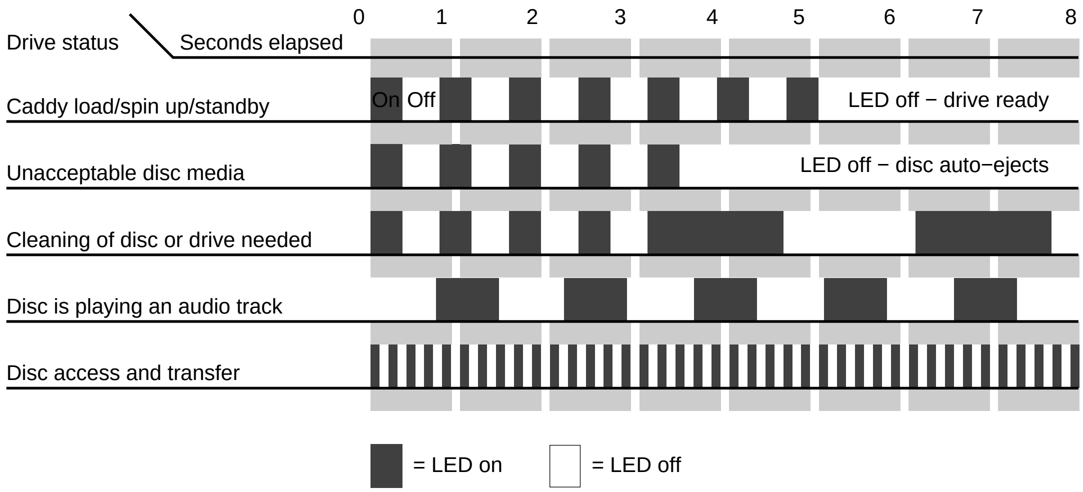

Figure B-4 CD-ROM Drive LED Status Indicators

Quarter-Inch Cartridge 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 functions.

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 tape head cleaning fluid and wipe the tape head (see Figure B-5).
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.

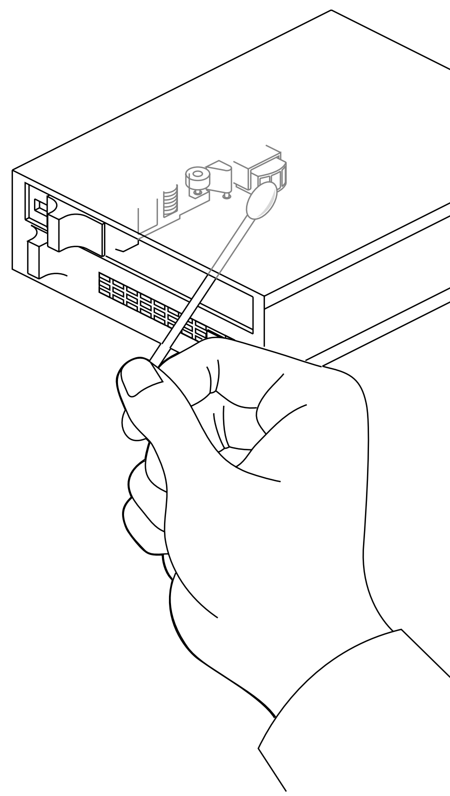

Figure B-5 Tape Head Cleaning

System Controller Error Messages

A complete list of all of the possible System Controller error messages is provided in Tables C-1 through C-4.

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 CPU board 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, reseat 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, reseat 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 CPU 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 CPU board.

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 reseat 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 OPCODE 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 first UART experienced a failure.
XMITTER 2 TIMEOUT	The System Controller's second UART experienced a failure.

Onyx IO4 PROM, Mezzanine and Troubleshooting

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

PROM Graphical User Interface

The IO4 PROM presents the user with a graphical interface when the *console* environment variable is set to "g." In all cases, the keyboard can be used instead of the mouse, and in most cases the keystrokes required to perform a particular task are identical to those in previous IRIX releases.

For example, the main five-item panel that is displayed when the system first starts up is identical to the five-item menu found on previous systems. To select an option from the panel, you may use the mouse to click one of the five buttons on the left side of the panel, or you can press the corresponding number key. The top item ("Start System") is option number one, and the last item ("Enter Command Monitor") is option number five.

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 the "Environment Variables" section 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 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 Mode

In the unlikely event of an extreme hardware failure, the system may drop down into a low-level diagnostic environment known as the power-on diagnostics (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 PROM Command Monitor by first selecting the "Stop for System Maintenance" option during the system startup. When the System Maintenance menu is displayed, enter the PROM Command Monitor by typing **5**.

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

Selecting the Console Device

The system can be configured to use a terminal connected to serial port tty_1 as the console by setting the *console* variable to “d” as follows:

```
setenv console d
```

To change the console back to the graphics screen, set the variable to “g”:

```
setenv console g
```

After setting the console variable, type `init` then press `<Enter>` to reinitialize the system and cause it to switch to the selected console device.

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, enter 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, enter 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, enter the following:

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

Starting the System Automatically

Each time that the system is powered up, the PROM waits for a brief period of time 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 will stop and generate 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 Bugs

The following subsections describe all of the known IO4 PROM bugs. Since the IO4 PROM is software-writable, these bugs will be fixed by PROM updates in future releases of the operating system.

A Spurious CD-ROM Medium Is Displayed During Startup

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 drawer (caddy) is empty when the system is booted. This message can be ignored.

The Graphical User Interface Handles Unexpected Warning Messages Poorly

If an unexpected status or warning message is printed, the graphical user interface (GUI) will switch over to a text port to display the message. The PROM will continue to execute, but additional information will be displayed textually instead of graphically. This bug is usually seen if an informational message is displayed while the miniroot is loading during the install process.

Mezzanine Board Configurations

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

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

```
% hinv <Enter>
4 250 MHZ IP19 Processors
CPU: MIPS R4400 Processor Chip Revision: 3.0
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: 64 Mbytes, 1-way interleaved
I/O board, Ebus slot 11: IO4 revision 1
Integral IO4 serial ports: 4
Integral Ethernet controller: et0, Ebus slot 3
Integral SCSI controller 1: Version WD33C95A
Integral SCSI controller 0: Version WD33C95A
Disk drive: unit 1 on SCSI controller 0
Graphics board GU1-InfiniteReality
VME bus: adapter 0 mapped to adapter 45
VME bus: adapter 45
Integral IO4 parallel port: Ebus slot 11
```

Each Onyx system is slightly different, but each has at least one IO4 installed. This determines the number of HIO mezzanine option boards it can support.

It also determines the type of mezzanine options you can order. The VCAM on the 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 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 Option Available With One IO4

Figure D-1 shows the configuration of the Onyx rackmount IO4. The IO4 uses a VCAM, and the IO4 may use up to two optional short mezzanine boards.

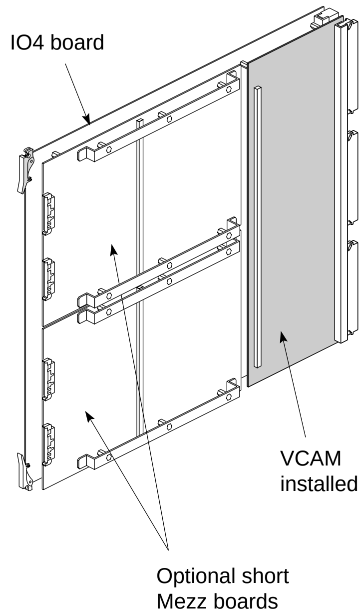

Figure D-1 IO4 with VCAM

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.

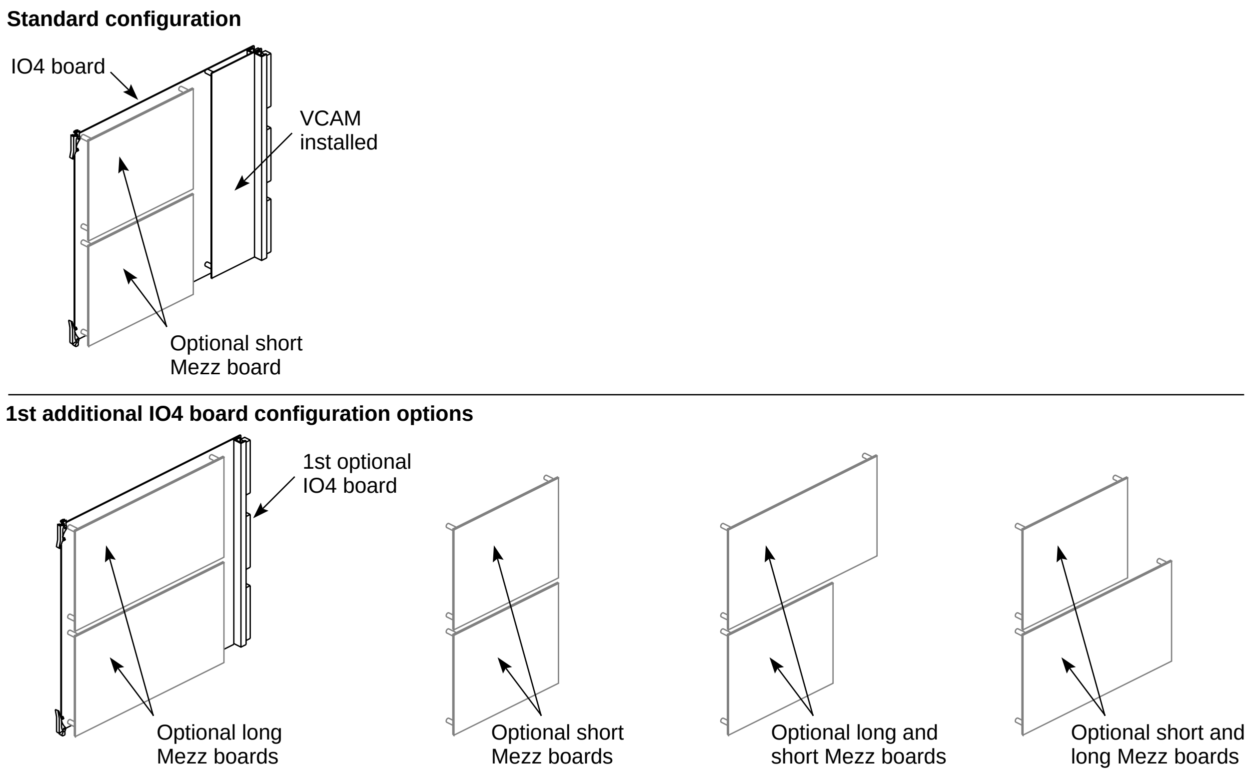

Figure D-2 Mezzanine Types Available With Optional Second IO4

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.

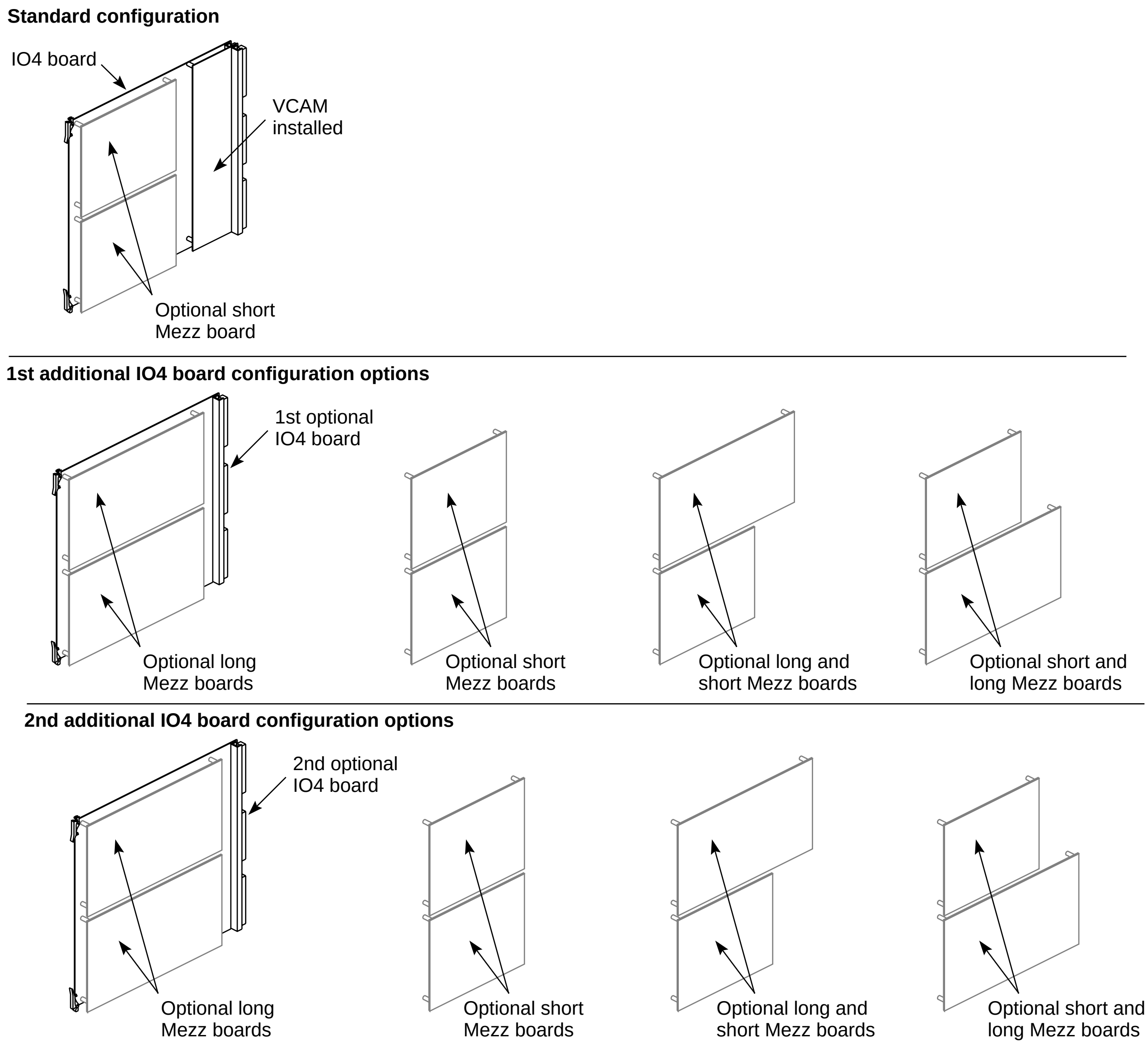

Figure D-3 Optional Second and Third IO4 Configuration

IO4 Troubleshooting

There are a number of troubleshooting steps you can use to determine if the IO4 is the cause of system-level faults.

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.

VMEbus Implementation

This appendix provides information to help users integrate third-party VME boards into the Onyx, Onyx R10000, and POWER Onyx rackmount systems. Hereinafter, the term Onyx is used to refer to all Onyx systems unless it is necessary to refer to a specific system type. The following information is divided into three major sections:

- "VMEbus Architecture Interface," provides a detailed discussion of the VMEbus architecture in the Onyx 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 pins assignments, the VME slots, and VME backplane jumpering.
- "VMEbus Boards 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*).

General Information

The VME (versa modular European) interface in the Onyx and POWER Onyx rack systems 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 Onyx system does not support VSBbus mode.

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

VMEbus Architecture Interface

The VMEbus interface circuitry for the Onyx and POWER Onyx 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 card cage (see Figure E-1). The VCAM is located on the master IO4 (in slot 12) and provides the VME connection for card cage 2.

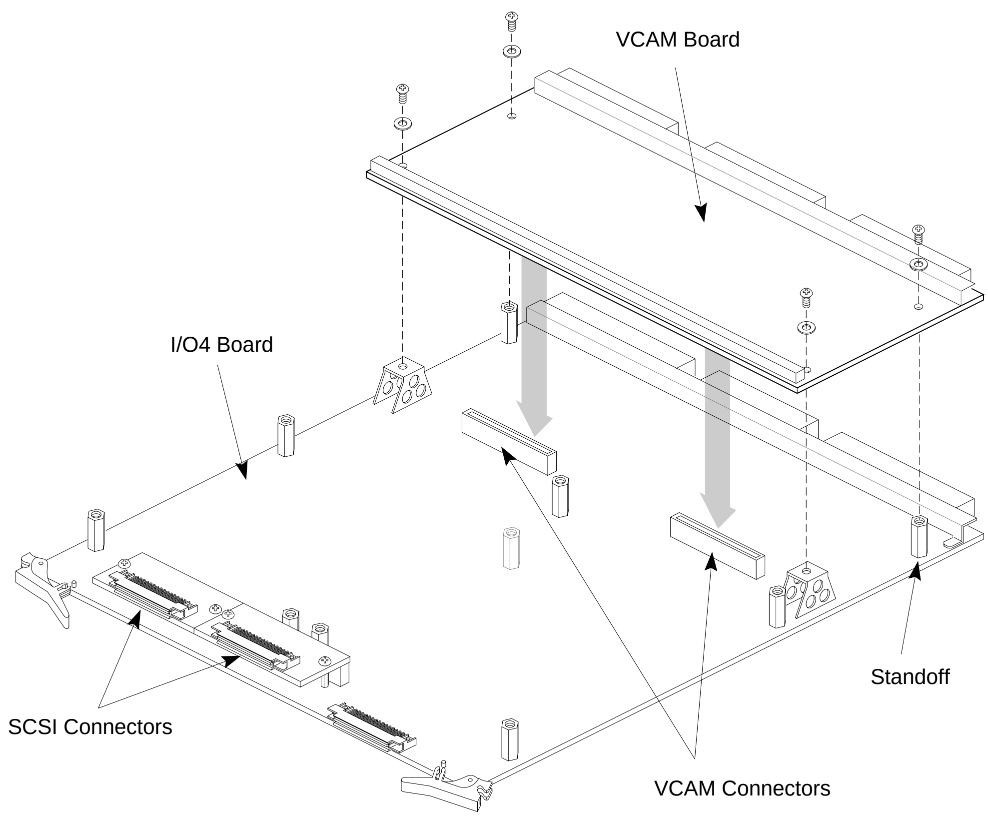

Figure E-1 Placement of the VCAM Board on the IO4 Board for CC2

The IO4 board is the heart of the I/O subsystem. The IO4 board 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 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). 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.

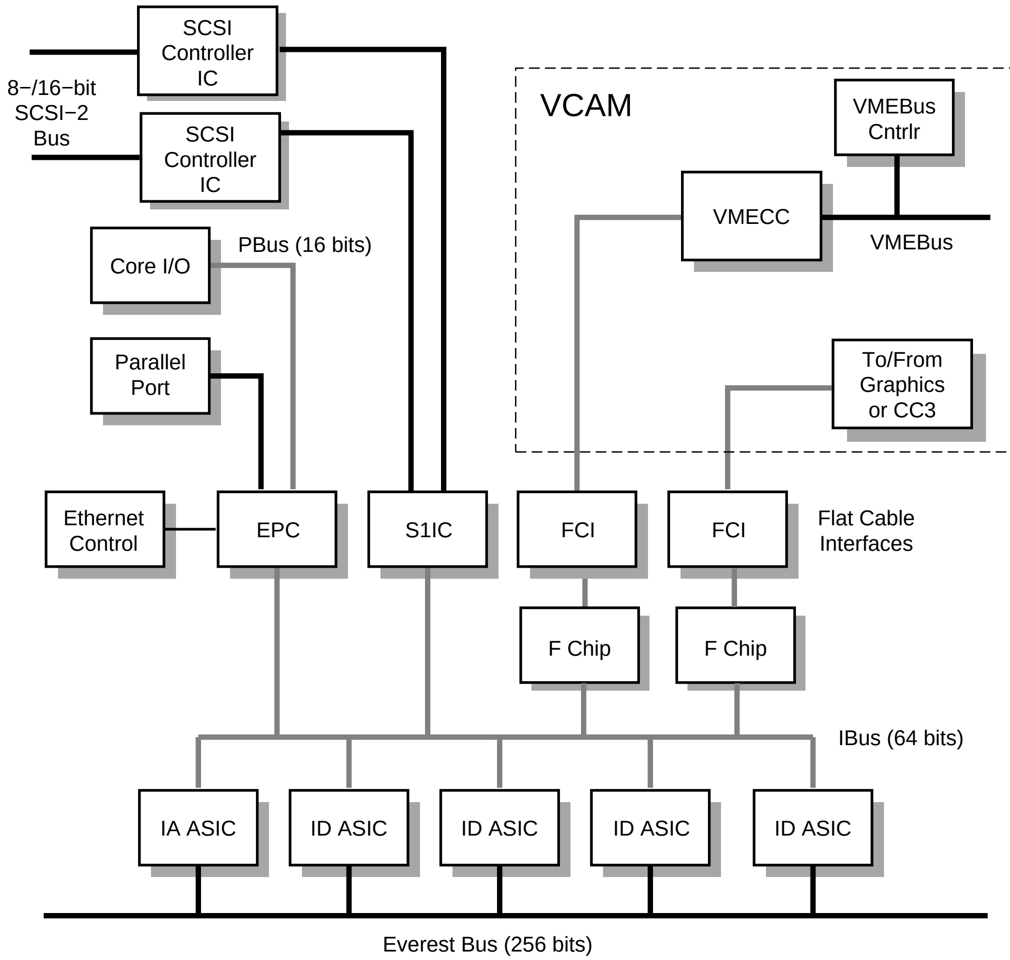

Figure E-2 IO4 Base Board Functional Block Diagram

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.

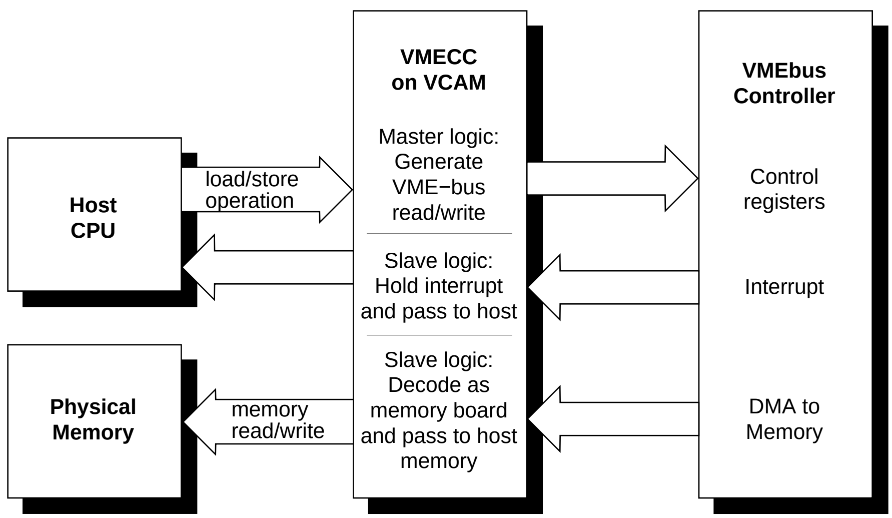

Figure E-3 VMECC, the VMEbus Adapter

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 VME bus from the host CPUs

- a built-in VME interrupt handler and built-in VME bus 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) takes 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 Onyx and POWER Onyx 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 and from main memory

The VME bus 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]

VME-bus Address Space

The VME bus 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 VME bus allows the master to broadcast addresses at any of these sizes. The VME bus 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 Onyx and POWER Onyx systems, a DMA address from a VME controller goes through a two-level translation to generate an acceptable physical address. 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.

Note: The second level mapping requires system memory to be reserved for the mapping tables. The current 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 1K mapping entries for the R4400 for each page and 8K mapping entries in the R8000. In the R4400, if you divide the amount of memory allocated for the map tables (64 KB) by the pointer size (4 B) and then multiply it by the

[1] Transfers of 64-bit data, 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.

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.

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 VMEbusses. 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 two of the thirteen 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 nine bits select an entry or element within the table. A 00 (two zeros) are appended to form a 40-bit address into the main memory table.

The main memory table then generates 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*).

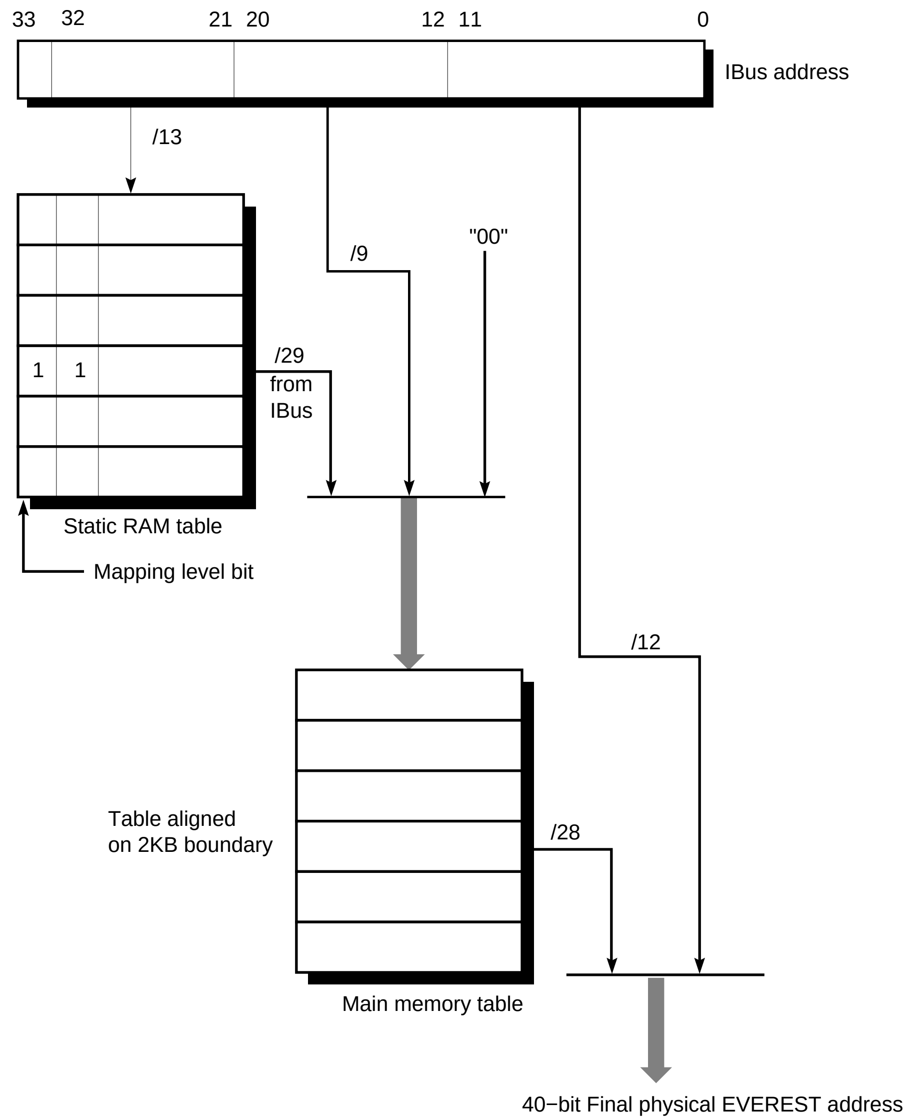

Figure E-4 I/O Address to System Address Mapping

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 VME bus 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 VME buses, adapter 0 has the highest priority; other adapters are prioritized in ascending order (after 0).

No device can interrupt the VME bus at the same level as an interrupt currently being serviced by the CPU because the register associated with that level is busy. A device that tries to post a VME-bus interrupt at the same VME-bus 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 and Figure E-5 outline how a VMEbus interrupt is generated.

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 bussed 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.

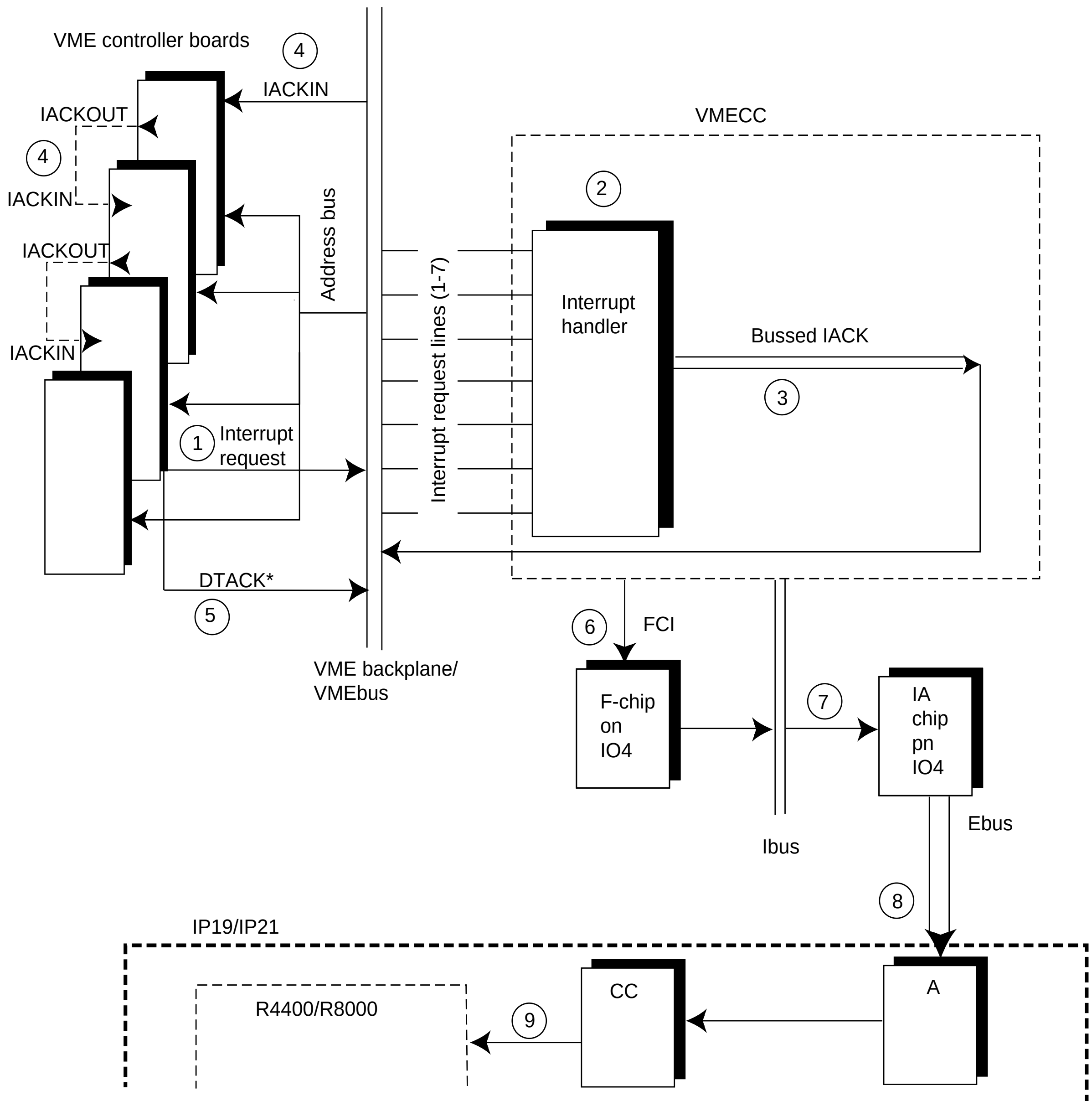

Figure E-5 VMEbus Interrupt Generation

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 an 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 I-bus 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 CPU board.
9. The CC chip interrupts the CPU, 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 the 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

The following outlines VME interrupt problems that could 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 expectant response to the IACK takes place. This lack of a response from a VME board results in a time out, 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 levels 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 also provides VMEbus slot-specific information for the Onyx and POWER Onyx systems.

VME Board Dimensions

The Onyx 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 203, for further information.

Card Cage 1 and 2 VME Issues

Card cage 2 has three available VME slots and supplies approximately 40 watts of +5-V power per VME slot (nominally) and also receives approximately 200 to 250 linear feet per minute (LFM) of air flow.

When using an InfiniteReality rackmount system with large numbers of processor, memory, graphics, and I/O boards; system power availability may limit the number of VME boards you can install. Table E-3 gives examples of the number of VME boards usable in CC1 and CC2 maximum configuration InfiniteReality systems.

Note: There are no VME slots in the card cage 1 in Onyx rackmount systems.

Table E-3 CC1 and CC2 InfiniteReality Maximum Configuration Examples

CPU Bds.	Memory Bds.	IO4 Bds.	RM Bds.	VO2 Bds.[a]	VME Bds.
6	2	1	4	2	1
6	4	1	2	2	1
6	4	1	4	1	0
5	3	2	4	2	1
5	2	3	4	2	1
5	4	1	4	2	1
4	2	4	4	2	1

a. The Sirius (VO2) board installs in a VME slot and uses VME power.

Note: Reducing the configuration by removing one memory board and one IO4 board allocates power for one additional CPU board. Removing one VO2 board from the configuration allows installation of two additional VME boards.

InfiniteReality Card Cage 3 and System VME Guidelines

The InfiniteReality card cage 3 (CC3), uses different power boards and has different limitations than the RE^2 CC3 version. Use the information in Table E-4 when installing a fully configured CC3 (2 pipes with 4 RMs each).

Note that with only 250 total watts of (+5 V) VME power available, you can install a very limited (or 0) number of VME boards in a fully loaded CC3.

Table E-4 InfiniteReality CC3 VME Power Availability

CC3 Power Boards	+5V VME Power Available	+12V VME Power Available
Five 303s and one 512T	50 amps (250 watts)	15 amps (180 watts)

Because the high-performance graphics of the InfinteReality system consume more power than RealityEngine^2 graphics; some maximum configurations preclude the installation of any VME boards.

Note: The following four tables provide examples of maximum configurations of VME and all other types of boards supported in the rack system. In the case of a maximum system configuration, installation of additional boards in any card cage must be balanced by removal of a board or boards requiring equal power. For example:

- one memory board and one IO4 board = one CPU board
- one VO2 (Sirius) board = two VME boards

Table E-7 shows the limits of a fully configured InfiniteReality system using three graphics pipes with four RM6s in each pipe.

Table E-5 System Maximum (12 RM6s) Board Configuration

CPU Bds.	Memory Bds.	IO4 Bds.	RM Bds.	VO2 Bds.	VME Bds.
4	4	3	12	0	0
3	4	3	12	1	0
3	2	3	12	2	1
2	2	3	12	3	0

Table E-7 shows the limits of an InfiniteReality system using three graphics pipes, with four RM6s in two pipes, and two RM6s in the third pipe.

Table E-6 System Maximum (10 RM6s) Board Configuration

CPU Bds.	Memory Bds.	IO4 Bds.	RM Bds.	VO2 Bds.	VME Bds.
6	2	3	10	4	2
5	2	3	10	3	0
4	1	3	10	4	2

Table E-7 shows the limits of an InfiniteReality system using three graphics pipes, with four RM6s in one pipe, and two RM6s in the second and third pipes. Note that the configurations shown in Table E-7 may require a power board upgrade in CC3 to successfully support the large numbers of VO2 and VME boards listed in the example. Check with your Onyx service provider.

Table E-7 System Maximum (8 RM6s) Board Configuration

CPU Bds.	Memory Bds.	IO4 Bds.	RM Bds.	VO2 Bds.	VME Bds.
6	2	3	8	4	2
5	2	3	8	5	2
4	2	3	8	6	2

Table E-7 shows the limits of an InfiniteReality system using two graphics pipes, with four RM6s in each pipe.

Table E-8 Two-Pipe System Maximum (8 RM6s) Board Configuration

CPU Bds.	Memory Bds.	IO4 Bds.	RM Bds.	VO2 Bds.	VME Bds.
6	2	3	8	4	3
5	4	2	8	4	4

RealityEngine^2 Card Cage 3 System VME Guidelines

The card cage 3 (CC3), which is optional on the Onyx rackmount system, supplies up to 6 additional VME slots. The CC3 provides approximately 70 watts of +5-V power per VME slot. This assumes the presence of the proper power boards in the CC3 backplane. The power boards are included with the optional RE^2 CC3 upgrade. The card cage 3 also receives approximately 200 to 250 linear feet per minute (LFM) of air flow through the chassis.

Onyx Slot Assignments

As mentioned earlier, card cage 1 has no available VME slots. Figure E-6 shows the card cage 1 and 2 slot assignments for the Onyx InfiniteReality rackmount system. Figure E-7 provides the optional CC3 slot assignments for InfiniteReality.

See Figure E-8 for an example of the power board locations in a rackmount Onyx system. Figure E-9 shows the location of the VME slots in card cage 2 in RealityEngine^2 systems. See Figure E-10 for the optional card cage 3 slot assignments for RealityEngine^2 systems.

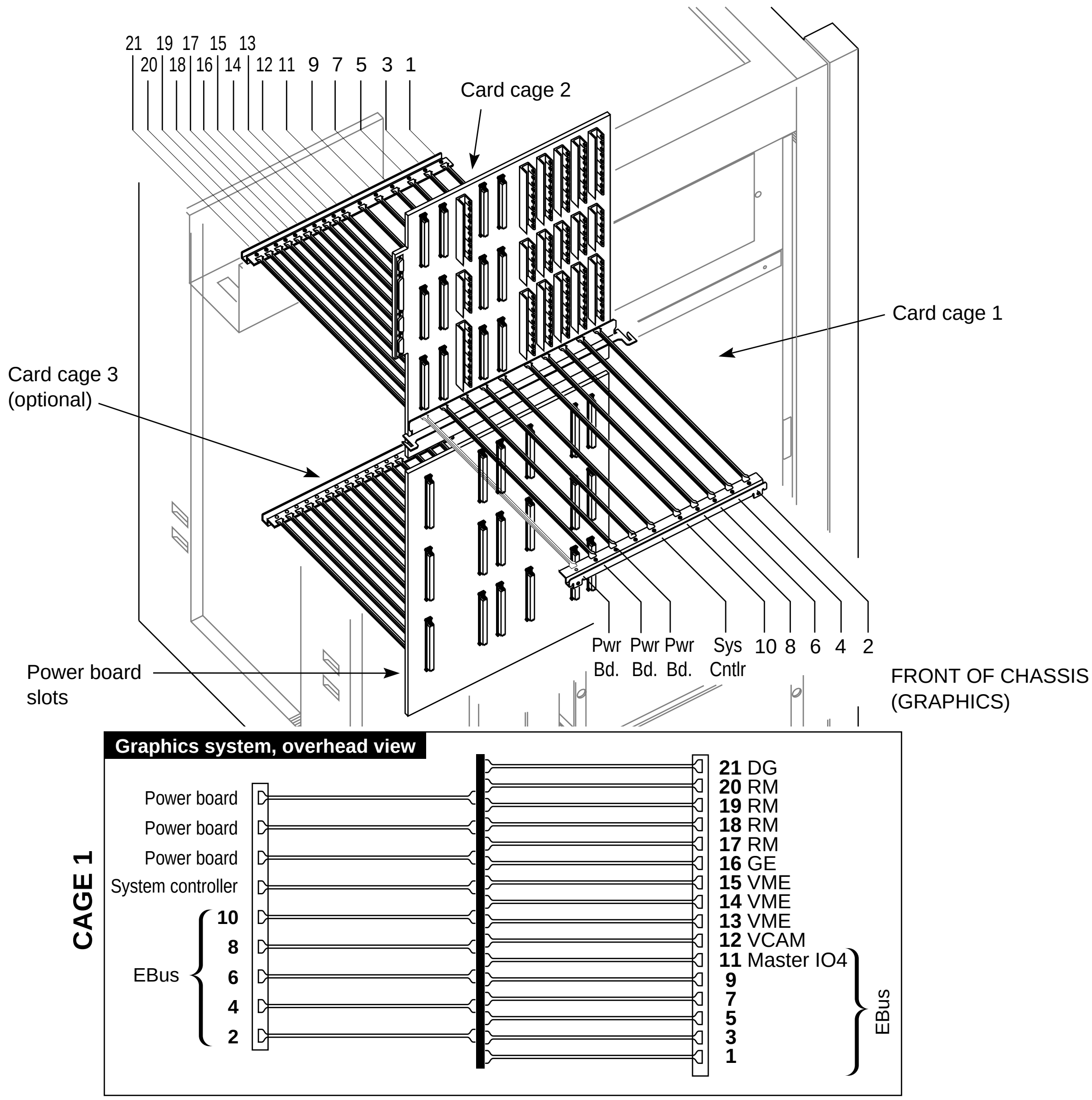

Figure E-6 InfiniteReality Card Cage 1 and 2 Slot Assignments

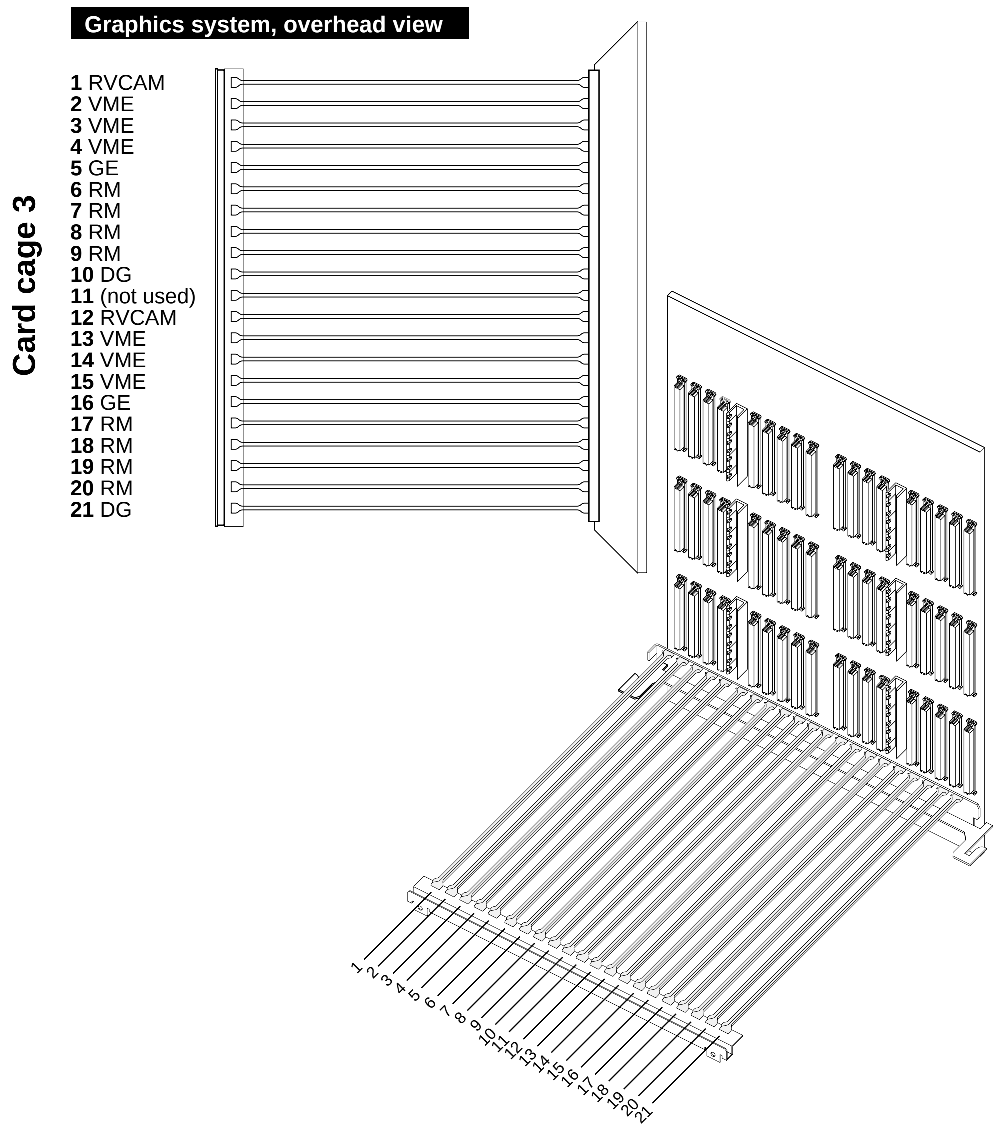

Figure E-7 InfiniteReality CC3 Slot Assignments

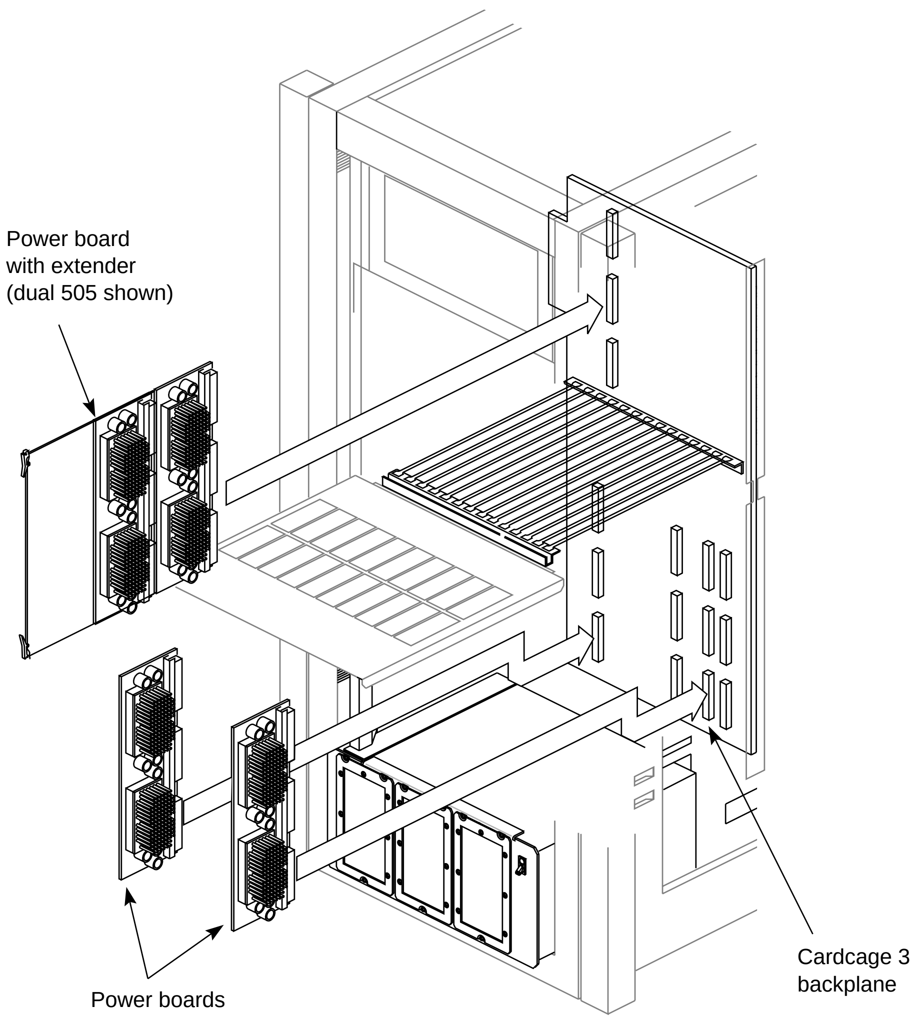

Figure E-8 Power Board Locations in the Rackmount Onyx

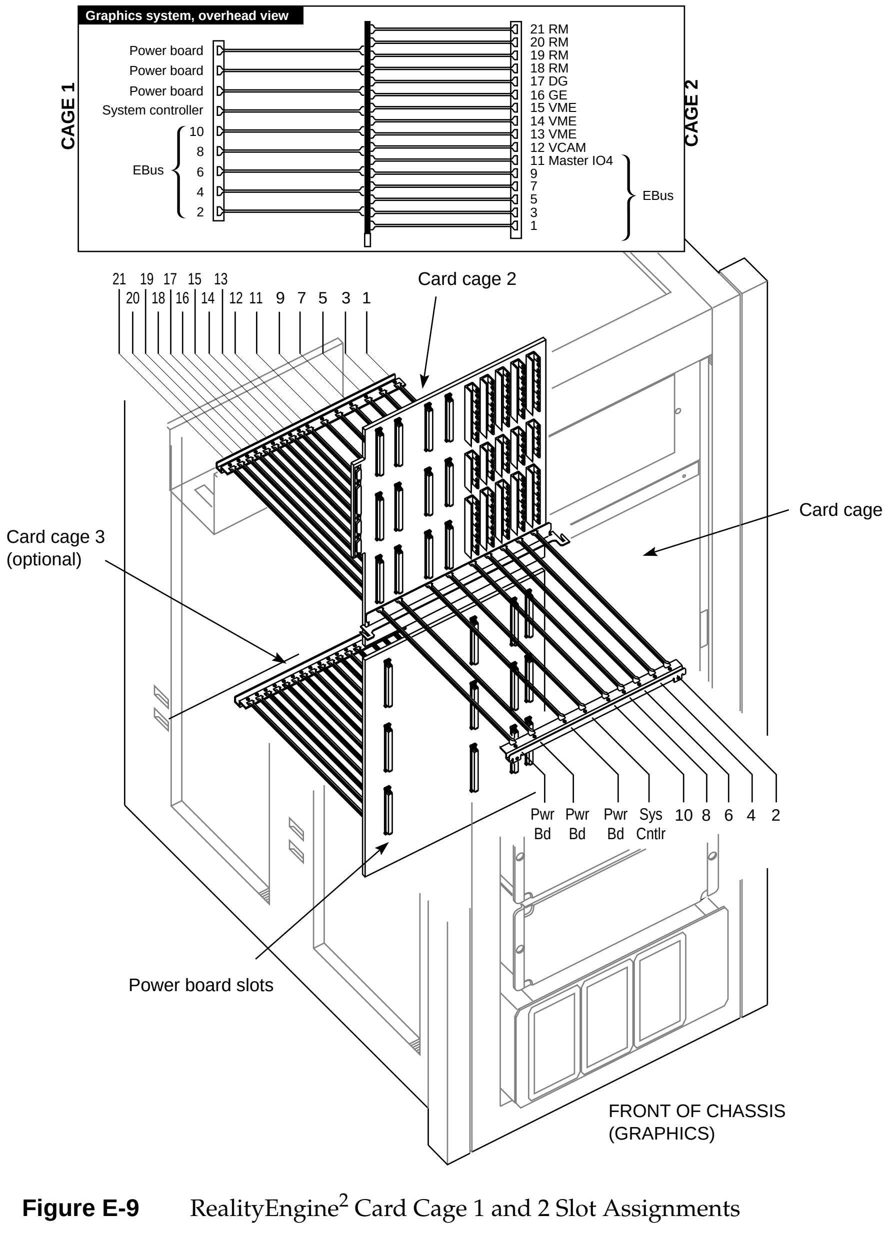

Figure E-9 RealityEngine^2 Card Cage 1 and 2 Slot Assignments

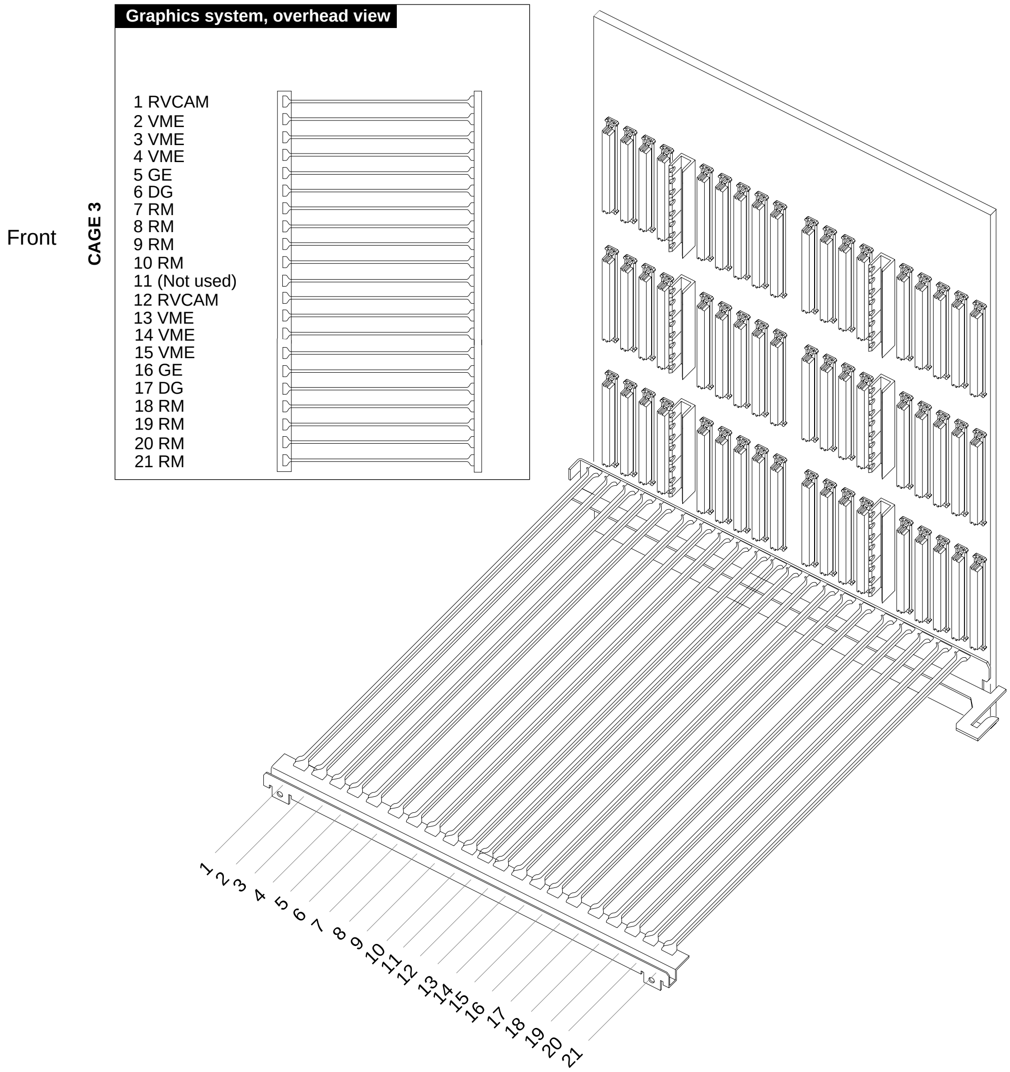

Figure E-10 Rackmount RealityEngine^2 Card Cage 3 Slot Assignments

Exceeding the Normal VME Power Rating Per Slot

If a VME board requires more than the normal slot power allotment (approximately 40 watts of +5 V power per slot in CC2 or approximately 70 watts in a card cage 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-9 through Table E-11) 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.

In card cage 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 card cage 2, providing the remaining VME slots are also not used.

In the VME version of card cage 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-8). However, as a result, the remaining VME slots cannot then be used.

VME Pin Information

Table E-9 through Table E-11 list the pin assignments of the VME P1, P2, and P3 connectors. Table E-12 describes the pin signals.

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

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

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

Caution: The Onyx system does not support VSBbus boards.

Table E-9 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-9 (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-10 P2 VME Pin Assignments

Pin	Row A [a]	Row B	Row C[a]
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	
23		D24	

Table E-10 (continued) P2 VME Pin Assignments

Pin	Row A [a]	Row B	Row C[a]
24		D25	
25		D26	
26		D27	
27		D28	
28		D29	
29		D30	
30		D31	
31		GND	
32		+5V	

a. This row is user-defined.

Table E-11 P3 VME Pin Assignments

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

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

Table E-12 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 indicates 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 request 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-12 (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 VME bus.

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 into the jumper banks corresponding to the VME slot number that you are skipping (see Table E-13). For example, if you are skipping VME slot 13, you need to insert five jumpers into jumper bank 1 (see Figure E-11).

Table E-13 Correspondence of VME Jumpers to VME Slots

Jumper Bank	Cardcage 2 VME Slot
1	13
2	14
3	15

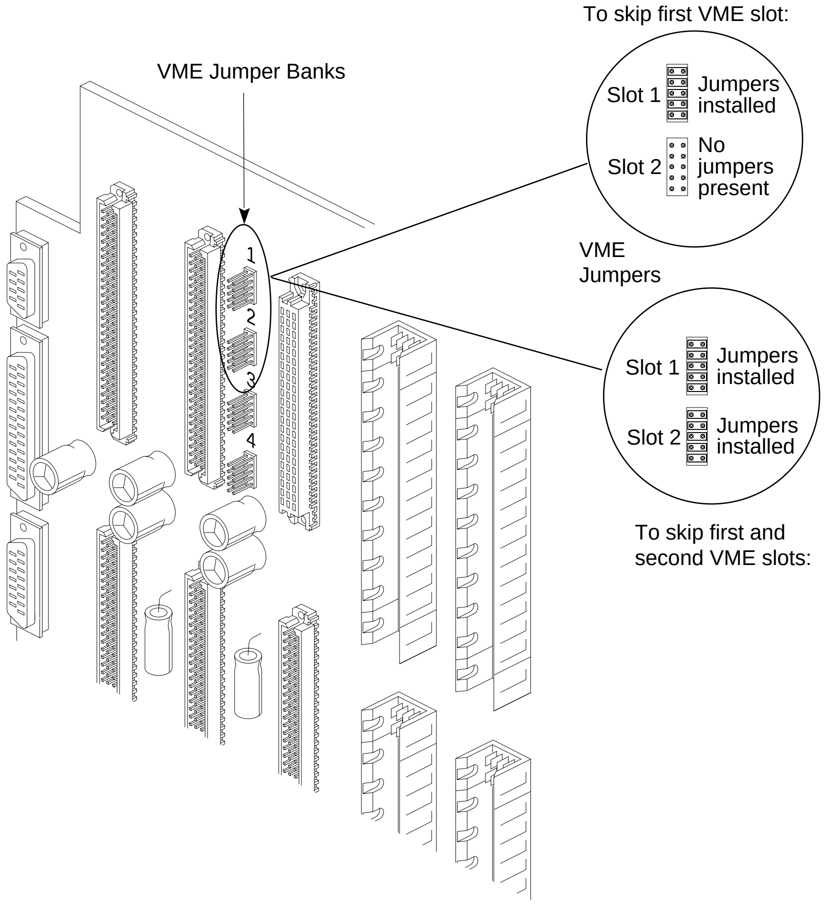

Figure E-11 VMEbus Midplane Jumpers

Card Cage 3 Jumpering

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

Caution: You must install this board *only* in the top VME connector, P1, or else 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 Onyx or POWER Onyx system (see Figure E-12).

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

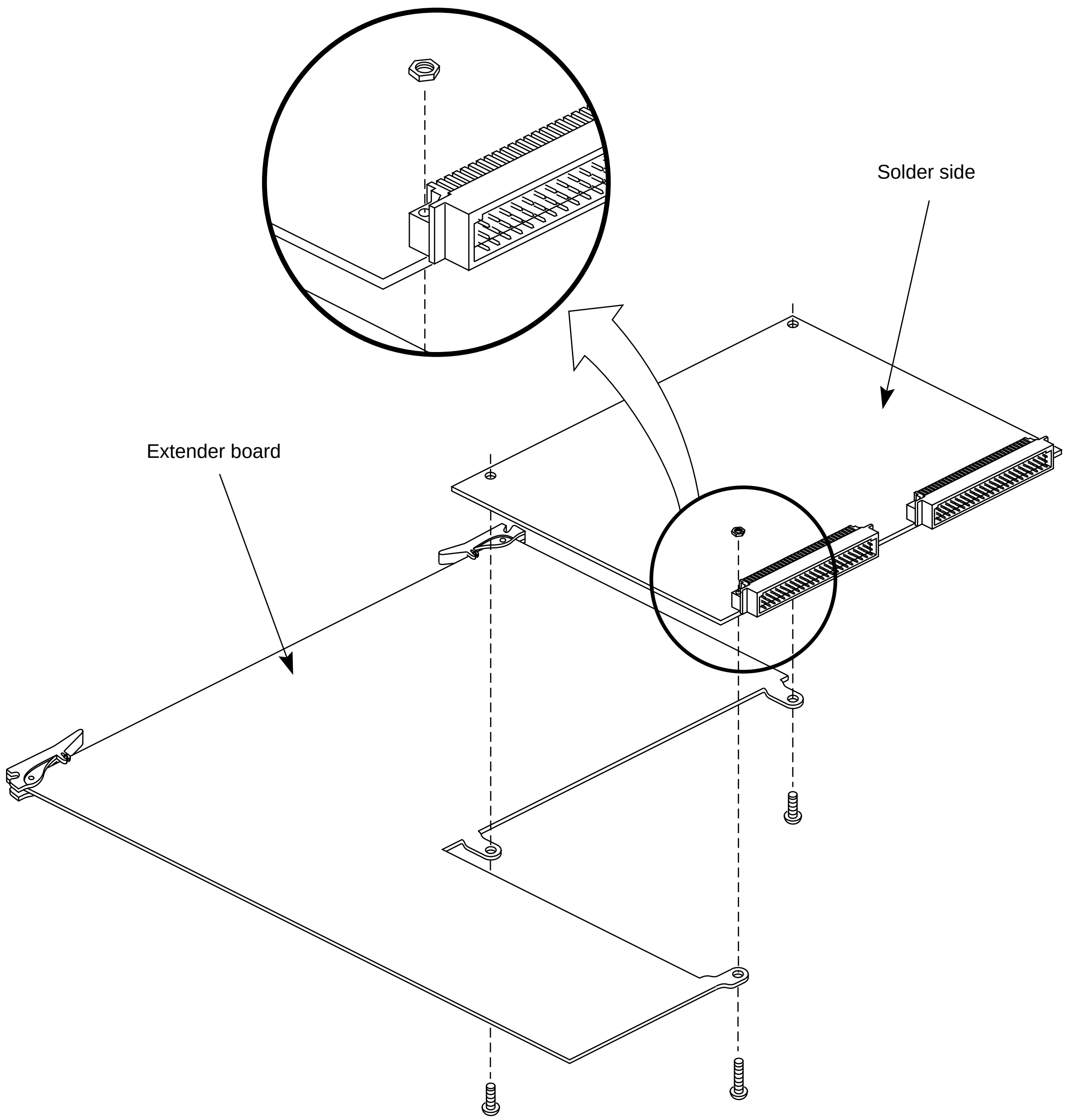

Figure E-12 A Silicon Graphics 6U Converter Board

VMEbus Boards 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 Onyx system.
- Devices in Slave mode must not require address modifiers, other than Supervisory/Nonprivileged data access.
- While in VME Master mode, devices must access the system memory using Nonprivileged data access or Nonprivileged block transfers only.
- Devices must have the ability to be configured so that their address range does not conflict with those used by the Onyx 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 Onyx system does not support VSBbus boards. In addition, there are not 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. Otherwise, this will break the interrupt acknowledge and bus arbitration schemes.
- 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 Onyx 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 VME bus master for the Onyx and POWER Onyx systems.

- The first word of a read is delivered to the master in 3 to 8 microseconds.
- The first word of a write is retrieved from the master in 1 to 3 microseconds.
- The VME spec has a burst length of 265 bytes in D08, D16, and D32 modes and 2 KB in D64.

The Onyx 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-13 illustrates the VME handshake.

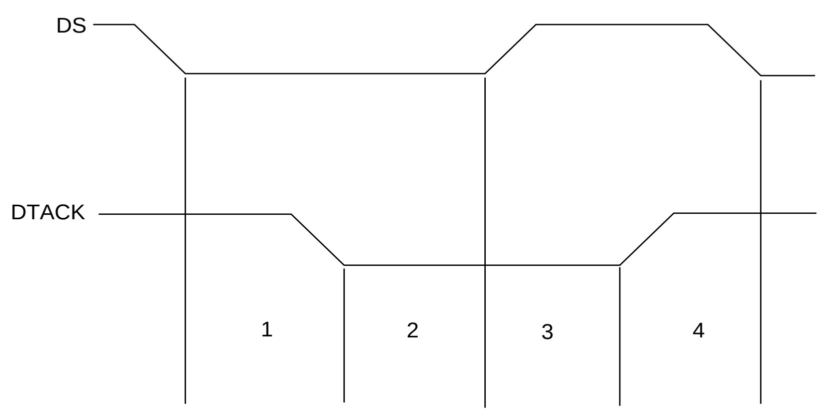

Figure E-13 VME Handshake

Parts 1 and 3 are controlled by the slave, the Onyx system hardware. Parts 2 and 4 are controlled by the master, and the VME controller board.

Note: Part 1 is approximately 40 ns and Part 3 is about 20 to 25 ns. The total Onyx or POWER Onyx system 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 VME bus specifications, it is recommended that you place a field in a control register on your VME board that enables or disables this feature. This allows you to put the board in standard mode so it can be used on other VME systems.

Configuring a Multipipe Onyx System

The Onyx rackmount system can be configured with up to three graphics subsystems, called *pipes*.

Additional information on multipipe software configuration is found in the *IRIS Performer Programming Guide*, (P/N 007-1680-0x0). You may also wish to reference the *OpenGL Programming Guide* (P/N 860-0151-00x); or the *OpenGL Porting Guide* (P/N 007-1797-0x0).

Hardware Configurations

The first graphics pipe in the Onyx rackmount is in the upper cardcage (cardcage 2), which also contains many other boards, such as the CPU boards and IO4 boards. Each graphics system includes an IO4 board, which connects graphics pipes to each other, and a Geometry Engine board.

The second and third pipes are located in a separate optional cardcage (cardcage 3), in the bottom section of the rackmount chassis.

IO4 Considerations

Each IO4 supporting InfiniteReality graphics pipes must have the Rev C (F3) ASIC installed. Note that each InfiniteReality pipe requires its own F3-based IO4.

Note: Use of an F2 ASIC with InfiniteReality graphics results in warning messages being written to the */usr/adm/SYSLOG* file upon startup. The InfiniteReality graphics does *not* work properly with an F2-based IO4.

The system's IO4 F chip should always be at Rev C (F3) for proper operation of InfiniteReality based graphics pipes. Specifically, it is required for **sproc()** graphics, even if only one thread is doing the graphics.

F2-equipped IO4s used for non-graphics ports, such as VME, do not need to be upgraded to F3. All current releases of the IO4 board have F3 chips where they are required for graphics.

Caution: Using InfiniteReality graphics and Reality Engine^2 graphics pipes in the same rack is not supported.

Wiring the Genlock and Swap Ready Cables

This section explains the synchronization process for a three-pipe system. To configure a two-pipe system, omit the third pipe in the process as described.

Assuming pipe 0 is the master, the following cables and connections should be in place:

- syncout(0) connects to syncin(1)
- loopthru(1) connects to syncin(2)
- loopthru(2) is terminated
- swapready(0) connects to swapready(1) and swapready(2)

Use a T-connector and normal BNC coax.

Note: Do not use any termination on the swap ready signal.

Software Installation and Configuration

Do not use any version of IRIX prior to 6.2. Systems using older versions should be upgraded.

The IO4 board and GE board each have a PROM—the IO4 PROM and the GE PROM, respectively. All PROMs must be at the correct revision for the particular IRIX software release.

Directing Graphics to a Particular Pipe

To direct graphics to a particular pipe, use the DISPLAY environment variable.

Set it to

- :0.0 for pipe 0
- :0.1 for pipe 1
- :0.2 for pipe 2

Using sproc

Since **sproc(2)** shares the data segment, it doesn't make sense to have separate sproc threads controlling separate graphics pipes. Use **fork(2)** to control separate pipes. If multiple sproc threads are used to draw to one pipe, you must call **gflush()** (or **glFlush()**), when switching threads.

Using mswapbuffers()

To modify an Iris GL application to use **mswapbuffers()** instead of **swapbuffers()**, replace **swapbuffers()** with **mswapbuffers(NORMALDRAW | GANGDRAW)**.

Note that GANGDRAW was named DUALDRAW prior to the release of IRIX 5.1. Also note that OpenGL does not have an equivalent for mswapbuffers().

Note: Only one program should be running on each pipe. For information on directing graphics to a particular pipe, see “Genlocking the Pipes,” earlier in this section.

Synchronizing Swap Buffers on Multiple Pipes

Synchronizing swap buffers on multiple pipes consists of:

- wiring the genlock and swap ready signals
- genlocking the pipes
- using *mswapbuffers*

Genlocking the Pipes

Follow these steps to genlock the pipes:

1. All pipes must be running the same video output format (VOF). The additional pipes need to be genlocked to the master, pipe 0.
2. For a 1280 x 1024, 60 Hz VOF set the following

   ```
   setmon -g -n 1280x1024_60
   ```

   on these additional pipes, and simply

   ```
   setmon -n 1280x1024_60
   ```

   on the master, pipe 0.

   Omit `-n 1280x1024_60` if this VOF is already running on the particular pipe.

Also note at this point that with normal software (not using mswapbuffers), the pipes should be running properly.

Alternatly, InfiniteReality users can build the VOF settings using the Combiner utility. See the Section , “InfiniteReality Combiner Programming Overview,” in Chapter 3 for an introduction to this utility.

RE^2 users can avoid using **setmonitor()** calls by using */usr/gfx/setmon* instead.

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