POWER Indigo^2 and POWER CHALLENGE M Upgrade Instructions

Document Number 108-0130-001

Contributors

Written by Kameran Kashani
Illustrated by Dany Galgani
Edited by Christina Cary
Production by Lorrie Williams
Engineering contributions by Phillip Arellano, Frank Demcak, Jeff Evans, Bill Hare, Steve Perotin, Steve Schroder, Jeff Smith, Carl Strasen, Chris Wheaton

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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 his own expense.

Attention

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

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Chapter 1

Introduction

This document describes the procedures used to upgrade an existing Silicon Graphics® Indigo²™ or CHALLENGE™ M system to a POWER Indigo²™ or POWER CHALLENGE™ M system.

Caution: This upgrade requires a 64-bit operating system such as IRIX 6.0.1 or later. Part of the upgrade process includes installing a new version of IRIX.

1.1 POWER Indigo² and POWER CHALLENGE M Features

The POWER Indigo² and POWER CHALLENGE M systems feature an R8000 CPU module that contains a 75-MHz, 64-bit R8000 RISC chipset. This chipset provides fully separate floating point (FP) and integer units with supporting logic. These POWER systems also contain the IP26 system base board, which has been designed to work with the R8000 CPU module.

The R8000 CPU module has the following major functional elements:

- advanced superscalar architecture that supports four instructions per cycle with peak performances of 300 MFLOPs and 300 MIPs
- optimized floating point performance with a separate floating point (FP) chip, two FP units, and large load / store data queues
- true 64-bit microprocessor with 64-bit integer operations, floating-point operations, and registers
- on-chip memory management unit (MMU)
- primary 16 KB instruction and 16 KB data caches
- a global, 2-MB, 4-way set-associative cache

1.1.1 Environmental Considerations

The POWER Indigo2 and POWER CHALLENGE M systems consume almost exactly as much power and dissipate almost exactly as much heat as the Indigo² and CHALLENGE M systems. There are no additional site requirements for power and no additional site requirements for cooling.

All other environmental specifications, including humidity, altitude, temperature, and vibration are also unchanged.

1.2 New Operating System

The R8000 requires the 64-bit IRIX 6.0.1 (or later) operating system. This is installed as part of the upgrade.

1.2.1 Support for Option Boards

Be aware that some option boards may not yet be supported. Either you or the customer may wish to verify with Silicon Graphics whether or not a particular option board is supported.

1.3 New Power Supply

The new power supply (Rev S or later) is mechanically identical to previous revisions. However, the new power supply provides slightly higher nominal 3.3-volt power (3.45 volts). The increase is required for the R8000 processor as well as for the 200-MHz R4400, the 133-MHz R4600, and future graphics upgrades.

1.4 IP26 System Base Board

The layout of components on the IP26 system base board is largely unchanged from the IP22. The most significant update is a new memory controller (MC) chip that uses error correcting code (ECC) and provides increased memory (SIMM) capacity. See Section 1.6, “Maximum Memory (SIMM) Configurations,” for information on memory capacity.

There are five standoffs on the IP26 board to elevate the R8000 CPU module. Four of these are 40 mm long and one is 18 mm long. The standoffs are 6 mm x M3 and are attached to the IP26 from the bottom with 6 mm x M3 hex nuts. Figure 1-1 shows the locations and sizes of the standoffs.

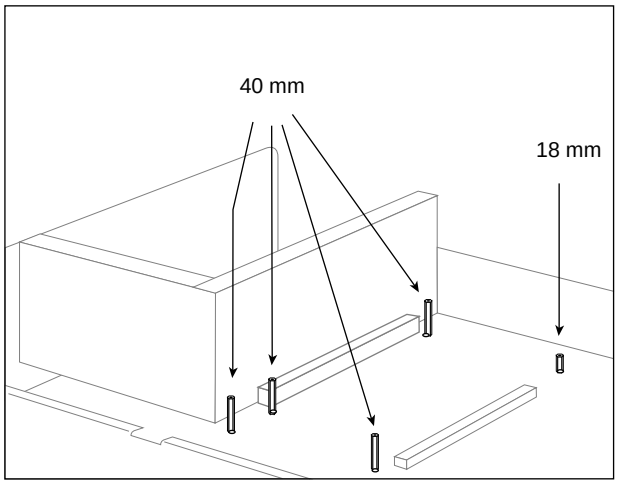


Figure 1-1 Location and Sizes of CPU Module Standoffs on the IP26 Base Board

1.5 R8000 CPU Board Components

Figure 1-2 shows the component layout of the R8000 CPU board. The R8000 IU and FPU chips are concealed by a heat sink.

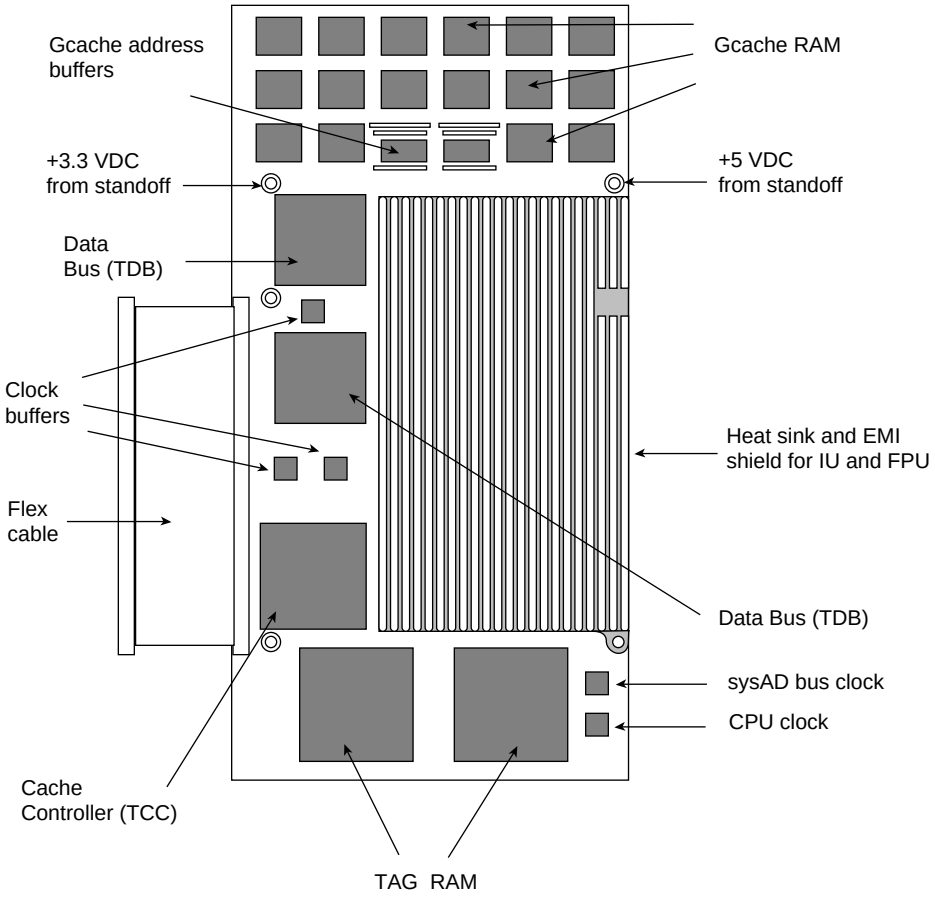


Figure 1-2 R8000 CPU Board Component Layout

1.5.1 POWER Indigo^2 and POWER CHALLENGE M Logic Diagram

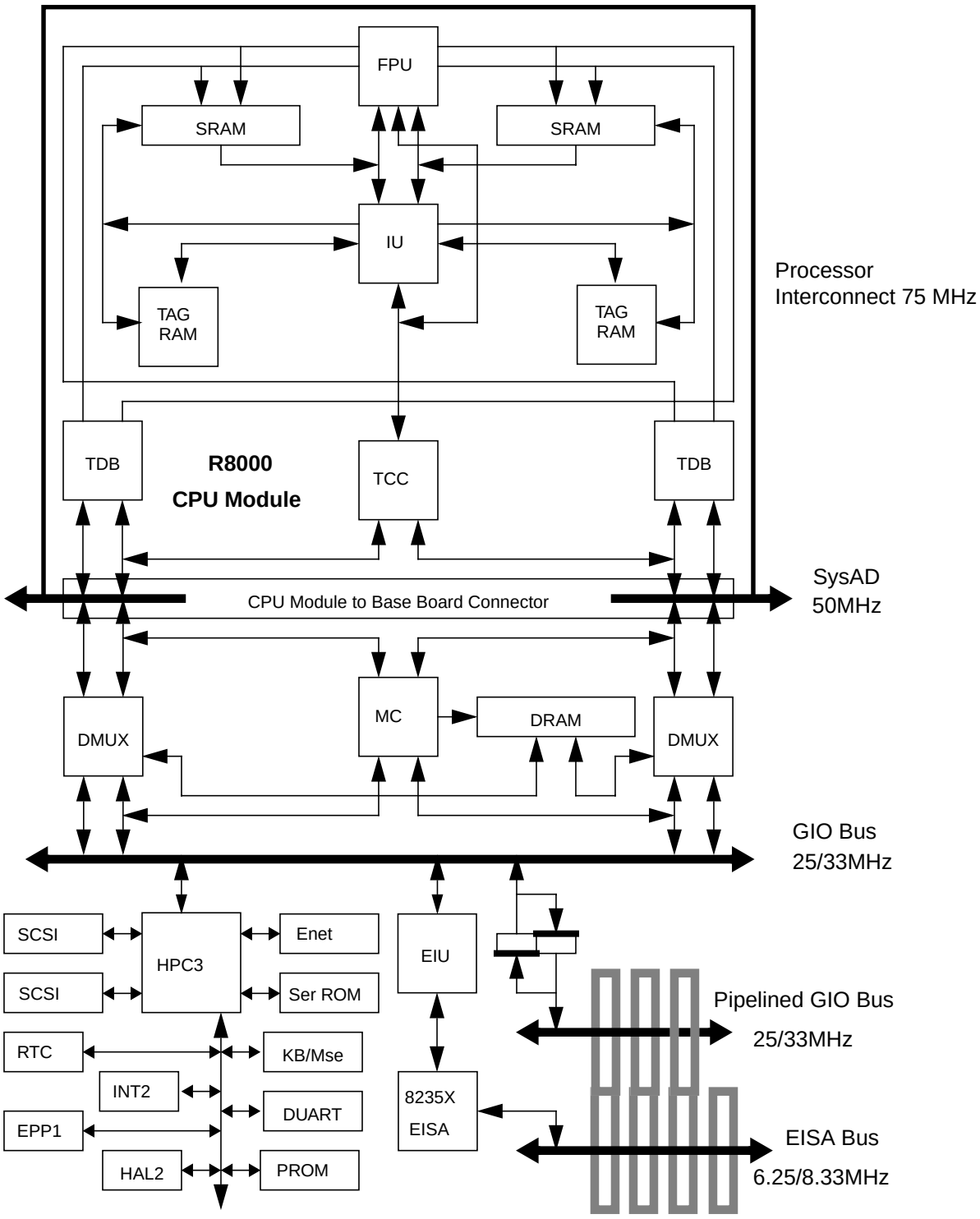
Figure 1-3 provides a logic diagram for both the R8000 CPU module and the IP26 base board. The flex cable noted in Figure 1-2 is the same as the “CPU Module to Base Board Connector” in Figure 1-3.

Figure 1-3 POWER Indigo^2 and POWER CHALLENGE M Block Diagram

1.5.2 R8000 Chipset

The R8000 has a separate floating point unit (FPU) and integer unit (IU). This is different from the single-chip R4400 processor.

The major advantage of the two-chip implementation of the R8000 is that the main processor (the IU) is no longer tied up performing both integer and floating point



operations. Floating point tasks are now executed by a separate FPU in the R8000. The IU and FPU also have dedicated support busing and logic so that their operations can take

place simultaneously for maximized CPU board throughput: 300 MFLOPs compared to 40 MFLOPs in the R4400.

Note: The R8000 has two dedicated load and store data buses, while single-chip processors such the R4000 have only one load and store data bus.

Other differences between the R8000 and R4400 systems are highlighted in Table 1-1.

The major internal bus of the R8000 chipset is the 80-bit, 75-MHz Tbus, which connects the IU, FPU, and the cache controller. Ownership of the Tbus changes depending on the operation being performed.

Table 1-1 Differences Between IP22-Based Systems and IP26-Based Systems

Features	IP22 and R4000/R4400	IP26 and R8000
Primary cache	R4000: 8 KB instruction, 8 KB data R4400: 16 KB instruction, 16 KB data	16 KB instruction, 16 KB data
L2 Cache	1 MB	2 MB, 4-way associative
Maximum Memory	384 MB	640 MB
Processor Speed	100 MHz / 150 MHz / 200 MHz	75 MHz
Issue Rate	1 per clock	up to 4 per clock
Peak MFLOPs	~ 40	300
Memory References per Clock	1	2
Data Path to Memory	64 bits @ 50 MHz	128 bits @ 75 MHz
Kernel Operation Modes	32 bits	64 bits
User Operation Modes	32 bits	32 or 64 bits

1.5.3 Memory Management

The R8000 integer unit (IU) provides a memory management unit (MMU) that uses an on-chip translation lookaside buffer (TLB) to translate virtual address to physical addresses.

The TLB is dual-ported and can get two virtual addresses and come up with two real addresses each cycle. The R8000 TLB is larger than previous TLBs used in previous Silicon Graphics systems. The TLB supports 384 entries and is three-way associative.

In addition, two tag RAMs store address information for even and odd data banks of the interleaved 2-MB streaming cache with dedicated bussing logic.

1.6 Maximum Memory (SIMM) Configurations

The maximum memory that can be installed in a POWER Indigo^2 and POWER CHALLENGE M system depends upon the density of the SIMMs, as shown in Table 1-2.

Table 1-2 Maximum Memory Configurations for POWER Indigo^2 / CHALLENGE M

SIMM Density	Maximum Memory
4 MB	48 MB
8 MB	96 MB
16 MB	192 MB
32 MB	384 MB
64 MB	640 MB[a]

a. Only two of the three SIMM banks can be used with 64 MB memory. Any two banks may contain the 64 MB SIMMs, but the remaining bank must have 32 MB or smaller SIMMs.

Within each bank (Bank A, Bank B, and Bank C), SIMMs must be of the same density. Also, be aware that SIMMs in Bank C and SIMM slot S7 (the last slot in Bank B) cannot be taller than 1.27" (approximately 32 mm). See Section 2.1.2, "SIMM Height Limitation."

Chapter 2

Installation

This chapter describes the procedure for upgrading an existing Indigo^2 or CHALLENGE M to a POWER Indigo^2 or POWER CHALLENGE M.

2.1 Overview

The basic steps to upgrade the system are:

- Verify that the customer's system has been backed up.
- Verify that you have all of the required components before proceeding with the installation. See Section 2.2, "Checking the Kit Contents."
- Power off the system, move the customer's SIMMs from the old IP22 board to the new IP26 board, then remove the power supply, CPU module, and IP22 base board. (For Indigo^2 systems, you also remove the audio subsystem from the IP22 base board and install it on the new, IP26 base board.) See Section 2.3, "Removing the Old Components."
- Install the upgrade components (power supply, R8000 CPU module, and IP26 base board). See Section 2.4, "Installing the New Components."
- Power on the system, enter the Command Monitor, and verify the new configuration using the *hinv* command. See Section 2.5, "Testing the Installation."
- Boot the IRIX 6.0.1 miniroot from CD-ROM and install IRIX. See Section 2.6, "Software Installation."
- Attach the upgrade "Power" emblem to the front of the system and the upgrade identification label to the back of the system. See Section 2.7, "Completing the Installation."
- Pack and return the old components. See Chapter 3, "Returning the Old Components."

2.1.1 Safety

Be sure to read the safety guidelines outlined in this section before proceeding with the installation procedures.

Warning: **This equipment is extremely sensitive and is susceptible to damage caused by electrostatic discharge (ESD). ESD is an electrical discharge (spark) caused by the buildup of electrical potential on clothing and other materials. Because of the design of the R8000, you must use proper ESD-preventive measures.**

Follow these ESD-preventive measures:

- Connect a ground strap to your wrist when installing and removing peripherals.
- Be sure that you and all of the electrical equipment that you handle during this installation remain at a ground potential of zero to avoid damage from ESD.
- Remove a component from its antistatic bag only when you are properly grounded with a ground strap, and only when you are working on the board or installing it.
- Do not use an ohmmeter on the R8000 CPU module.

Warning: **Use extreme care when handling the R8000 CPU module and attached flex cable. Do not set the board down roughly onto a hard surface (such as a desktop or filing cabinet) and be careful not to scrape the underside of the board against parts of the system chassis. The CPU module has several capacitors mounted on the back side that help control various internal clocks, and if any one of these capacitors is damaged the CPU module will not function properly.**

2.1.2 SIMM Height Limitation

Because of the size of the R8000 CPU module, SIMMs in Bank C (SIMMs S8 through S12) and the last SIMM in Bank B (SIMM S7) on the IP26 base board *cannot be taller than* 1.27 inches (approximately 32 mm). Figure 2-1 shows the SIMM sockets that are affected by this height limitation

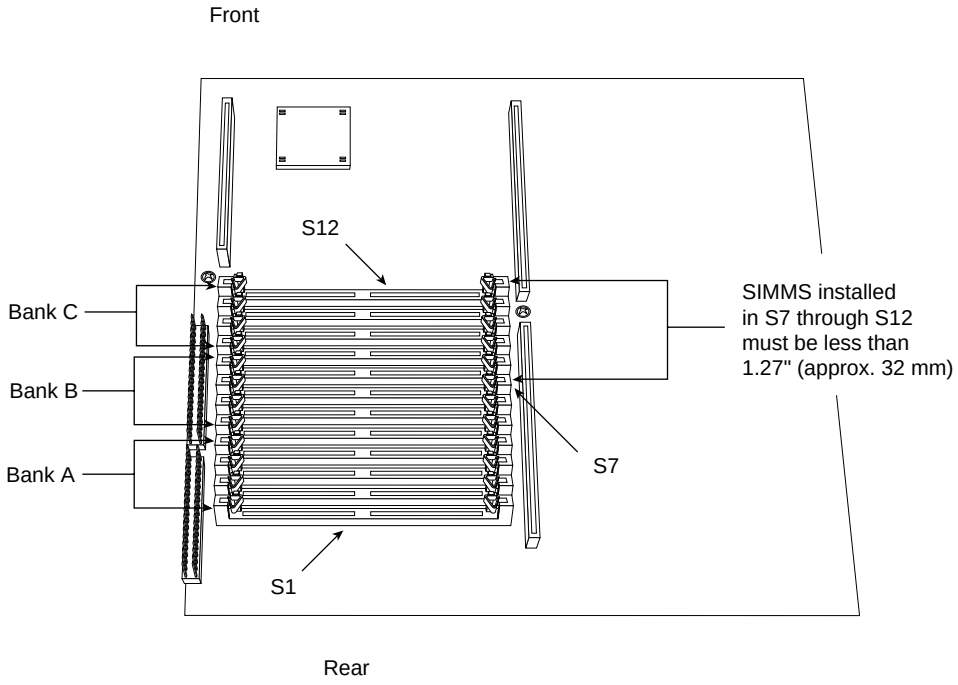


Figure 2-1 SIMM Banks on the IP26 Affected by a Height Limitation

SIMMs in Bank A and SIMMS in sockets SS5 through S6 in Bank B can be taller than 1.27 inches (approximately 32 mm).

Warning: **Never install a SIMM in Bank C or in the last socket of Bank B (S7) if it is taller than 1.27 inches (approximately 32 mm). SIMMs that are too tall can damage the R8000 CPU module if they are installed in these particular sockets.**

For more information about memory in the POWER Indigo^2 and POWER CHALLENGE M, see Section 1.6, “Maximum Memory (SIMM) Configurations.”

2.2 Checking the Kit Contents

This section lists the major contents of the upgrade kit:

- IP26 board (system base board)
- R8000 CPU module with attached flex cable
- power supply (Rev S or later; marked on side of power supply)
- screws (Phillips), four 8 mm (M3 thread) and one 30 mm (M3 thread)
- insulating sheet (for the R8000 CPU module)
- SIMM removal tool
- IRIX 6.0.1 (or later) CD-ROM

- POWER upgrade badge
- upgrade label (to attach to the back of the system)
- shipping box in which to pack the old components
- RMA labels for old components

2.2.1 Tools You Need

You need the following tools:

- #2 Phillips screwdriver
- SIMM tool (provided in upgrade kit)
- wrist strap

You should also make sure that a CD-ROM drive is available, preferably one that is attached directly to the system (either internally or externally).

2.2.2 Optional Tools and Documentation

You may need the following tools:

- 6 mm hex wrench or nut driver
- flat-bladed screwdriver

If you are not familiar with booting the IRIX miniroot and using the software installation tool *inst*, you should refer to the *IRIS Software Installation Guide*.

2.3 Removing the Old Components

Remove the old components from the customer's Indigo^2 and CHALLENGE M as follows:

1. Shut down the system and turn the power switch off.
2. Disconnect all external cables from the system, including the power cable.
3. Open the top cover, as shown in Figure 2-2.

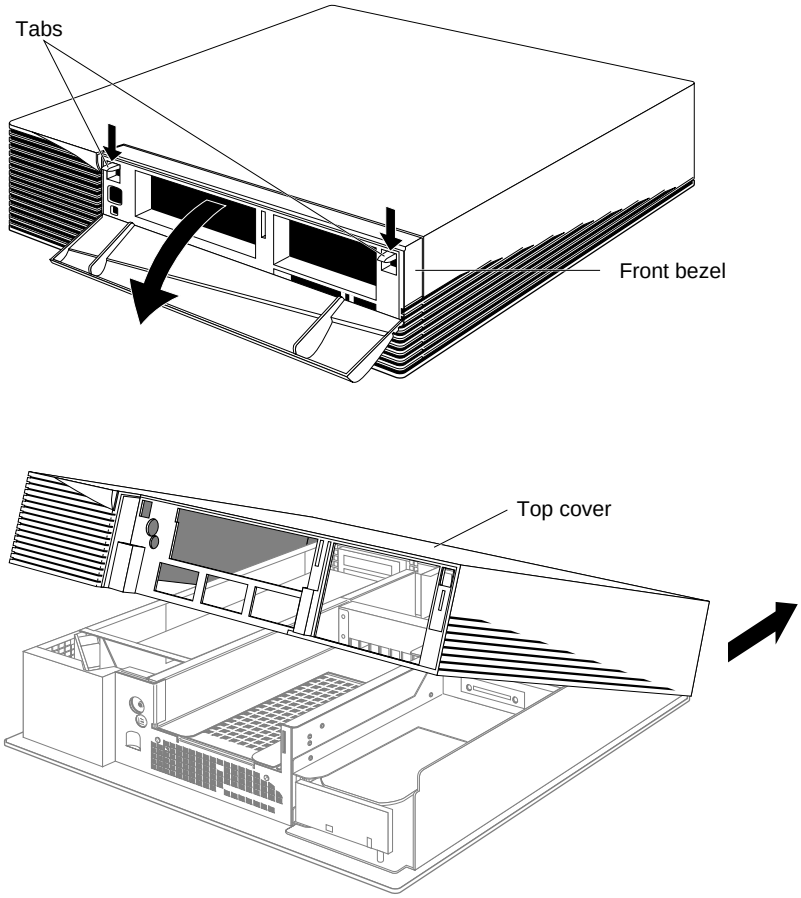


Figure 2-2 Opening and Removing the Top Cover

4. If there is a peripheral installed in the 5-1/4 inch drive tray, remove it now. As a precaution, you may wish to remove any peripherals from the 3-1/2 inch drive bay to prevent damage from shock and vibration while you perform the upgrade. However, this is not strictly required.

5. Disconnect the flex cable from the 5-1/4 inch drive tray, then loosen the captive screws at the front of the system and remove the drive tray. Slide the tray back to unlatch it, then lift it from the system, as shown in Figure 2-3.

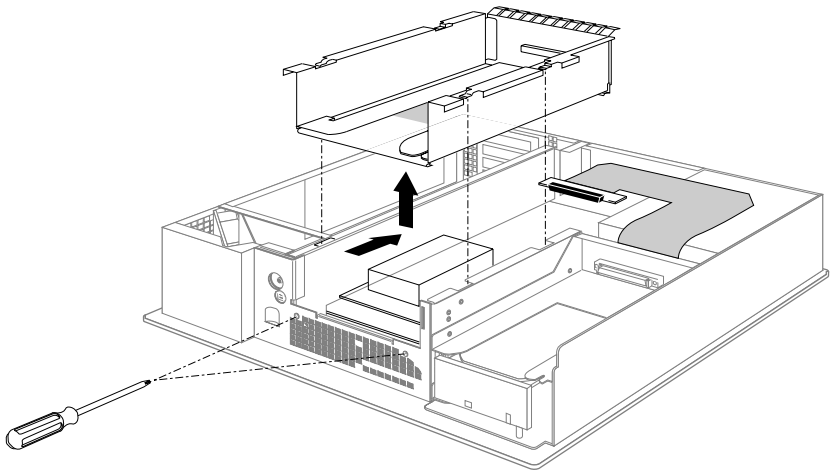


Figure 2-3 Removing the 5-1/4 Inch Drive Tray

6. Remove the new IP26 system base board from its anti-static packaging and place it on a flat, antistatic surface.

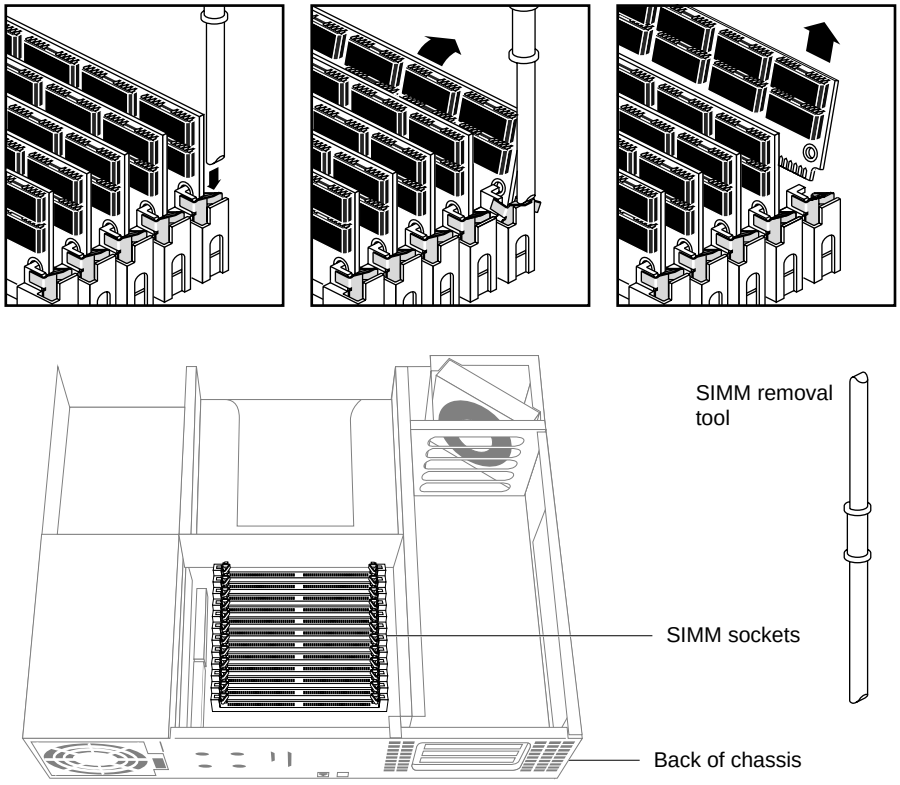
7. Remove all of the customer's SIMMs from the system and reinstall them on the new IP26 board.

   We recommend that you start populating the SIMM sockets on the IP26 board at Bank C (closest to the front of the system). This bank will be covered by the new R8000 CPU module and it will be difficult for the customer to install new memory into this bank in the future. Also, see Section 2.1.2, "SIMM Height Limitation" for a description of the maximum height for SIMMs in various banks on the IP26 board.

   Figure 2-4 shows how to use the SIMM removal tool to unlatch a SIMM from its socket. Tilt the SIMM backwards, then lift it out of the socket. To install a SIMM, set it into the socket at the same angle at which you removed it. Press firmly to seat the SIMM, then tilt the SIMM upright until it latches.

   Some high-capacity SIMMs may extend over the top of the SIMM release latches. In this case, you must unlatch the SIMMs using the front part of the SIMM release latches. Figure 2-4 shows both methods. Also, you must start at the rear-most SIMM socket (lowest SIMM socket number) at the back of the chassis and work towards the front of the system (highest SIMM socket number), removing the SIMMs sequentially.

For normal width SIMMs, release the latch from the top.



For extra wide SIMMs, release the latch from the front of the socket.

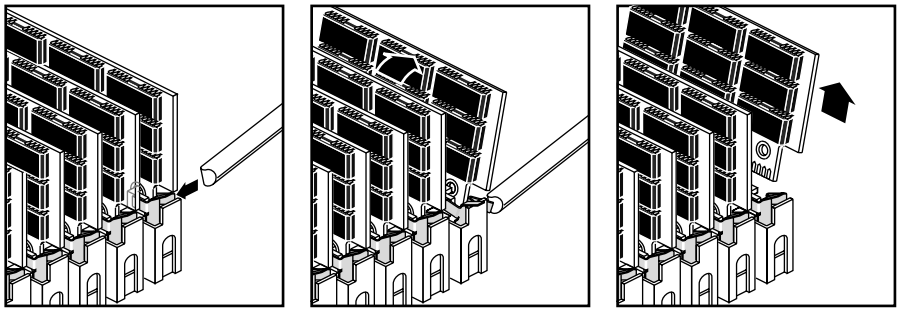


Figure 2-4 Removing a SIMM

8. Lower the metal door that covers the GIO and EISA expansion slots, then unfasten the screws that hold the graphics boards in place (for an Indigo^2) and remove the boards. If there are any EISA boards installed, remove them also. Figure 2-5 shows how to remove the graphics boards; EISA boards are removed in a similar manner.

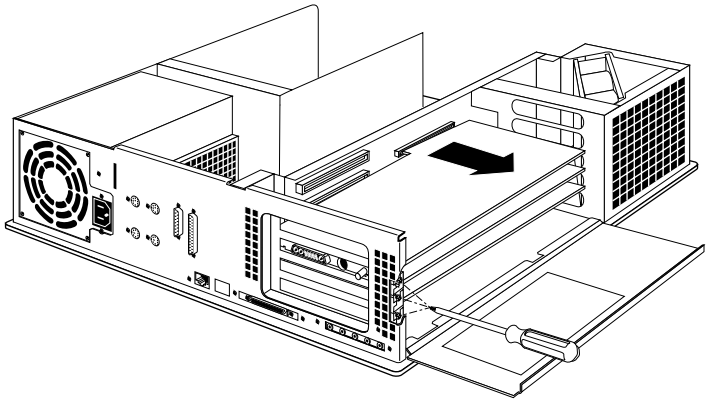


Figure 2-5 Removing Graphics and EISA Boards

9. Unfasten the four screws that hold the power supply in place. Two are located on the back of the system and the other two are located on the side of the system, as shown in Figure 2-6.

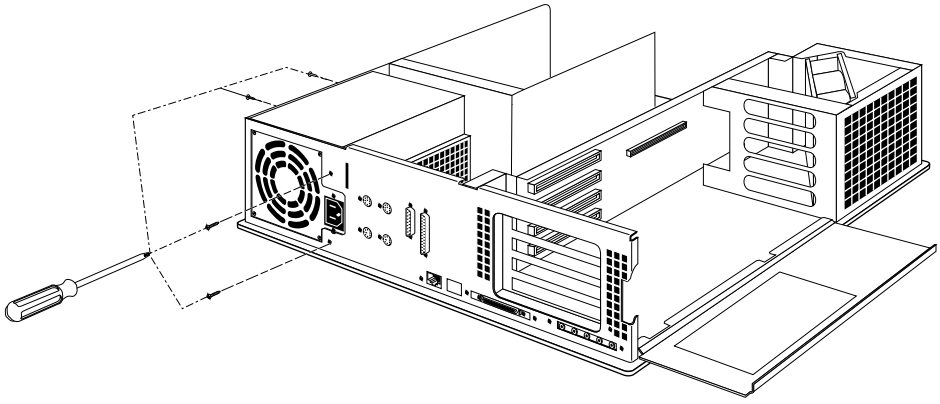


Figure 2-6 Removing the Power Supply Screws

10. Disconnect the power supply cables, as shown in Figure 2-7.

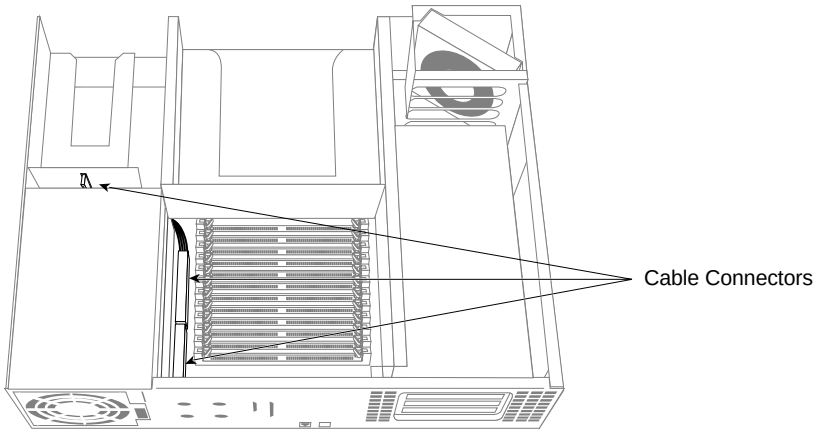


Figure 2-7 Disconnecting the Power Supply Cables

11. Slide the power supply forward about 1/4 inch (approximately 6 mm), then lift it out of the chassis, as shown in Figure 2-8.

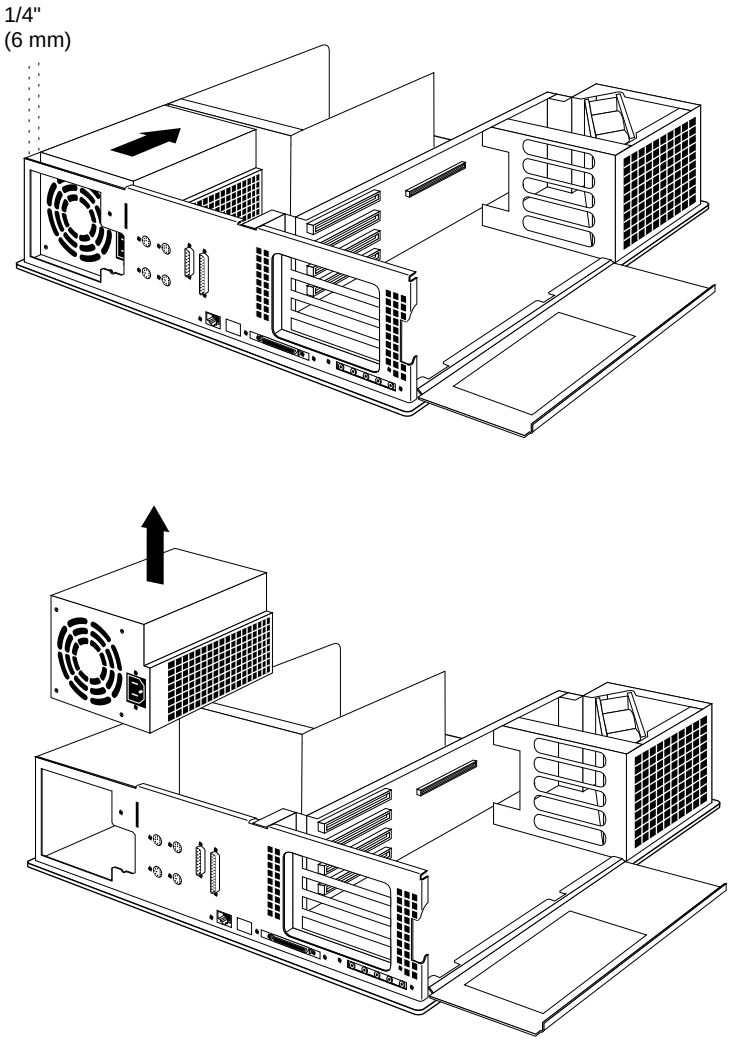


Figure 2-8 Unlatching and Removing the Power Supply

12. Remove the two screws that fasten the EISA / GIObus backplane to the chassis, as shown in Figure 2-9. Pull the backplane straight up out of the system. Pull on the metal tabs indicated in Figure 2-9.

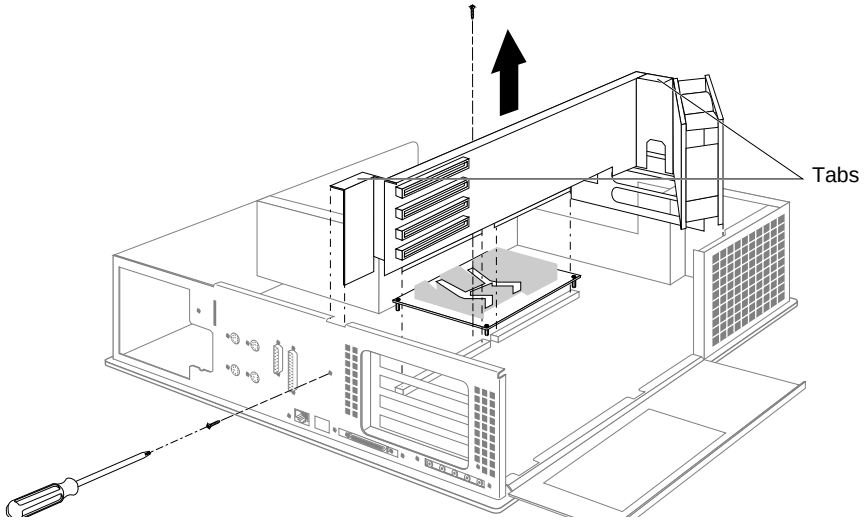


Figure 2-9 Removing the Backplane

Note: Some older chassis may not have screws fastening the backplane to the chassis.

13. Disconnect the speaker and power-switch wires, and the SCSI cable from the IP22 base board. See Figure 2-10.

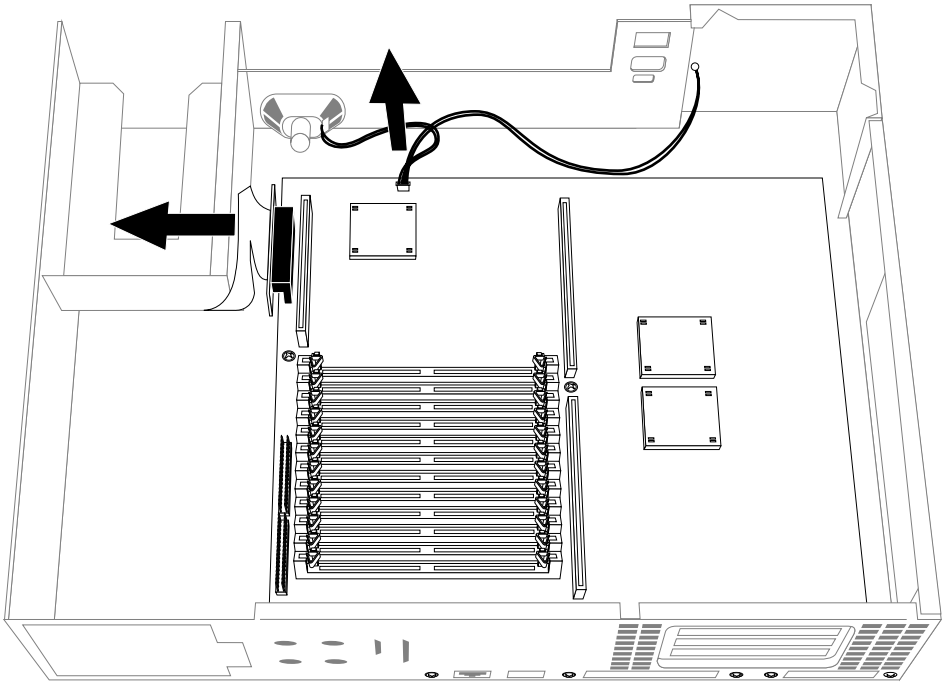


Figure 2-10 Disconnecting Cables From the IP22 System Base Board

14. Remove the screws that fasten the IP22 base board to the system chassis. There are five screws on the back of the chassis, and two screws on the base board, as shown in Figure 2-11.

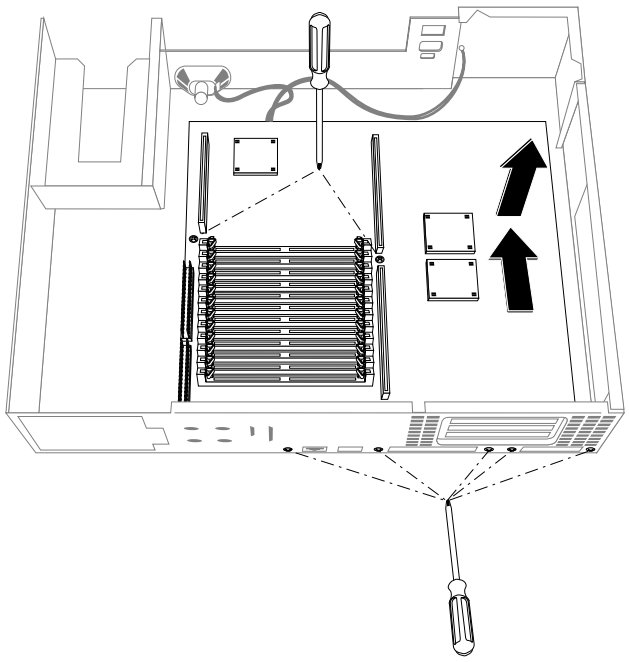


Figure 2-11 Removing the IP22 System Base Board

15. If there is an audio subsystem board attached to the IP22 base board, remove it and attach it to the new IP26 base board.

You are finished removing the old components of the system. Proceed with Section 2.4, “Installing the New Components.”

2.4 Installing the New Components

Install the new components as follows.

1. Install the IP26 base board. Place the board over the slot pins and slide the board down onto them. You may need to hold up the connectors at the back of the chassis in order to slide the board into position.

   Slide the board back as far as it will go. Check to make sure all the screw holes line up, then insert and tighten all the screws, as shown in Figure 2-12.

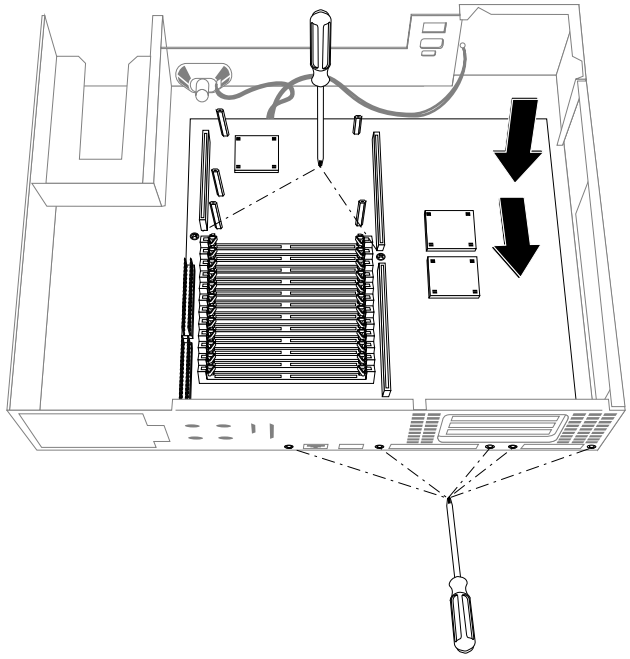


Figure 2-12 Installing the IP26 System Base Board

2. Connect the SCSI cable and the speaker and power-switch wires to the IP26 base board, as shown in Figure 2-13.

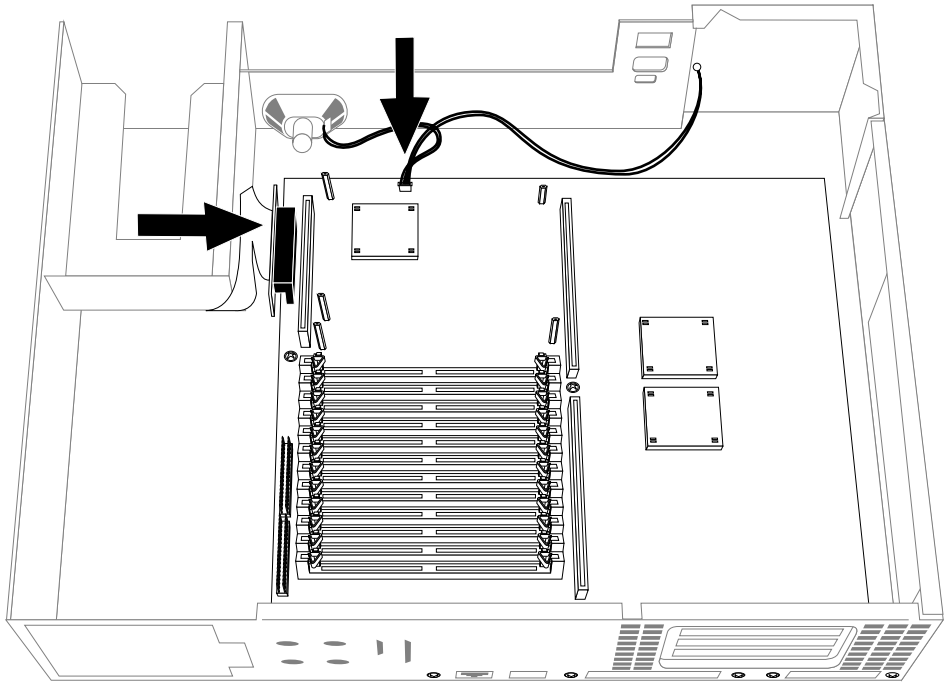


Figure 2-13 Reconnecting Cables to the IP26 System Base Board

3. Install the new power supply and connect the power supply cables. Lower it into place, then slide it towards the back of the chassis. Align the screw holes on the power supply with the appropriate holes on the chassis, then install and tighten the screws. See Figure 2-14.

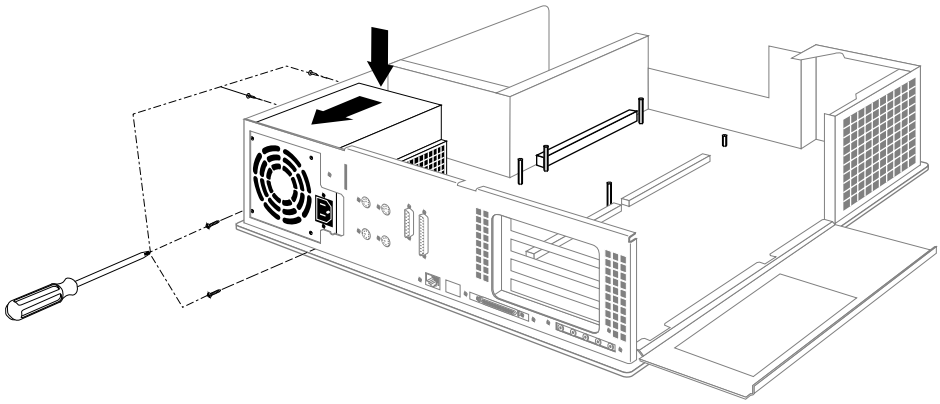


Figure 2-14 Installing the Power Supply

Note: With some older models of the Indigo^2 and CHALLENGE M, you may have difficulty sliding the power supply into position. If this happens, remove the power supply and examine the bottom of the unit. Locate the two tabs on the bottom of the power supply that attach the unit to the **U**-shaped slots on the bottom of the system chassis. Using a flat-bladed screwdriver, bend the two tabs outward slightly (approximately two to three millimeters) so that they protrude further from the bottom of the power supply. This allows the tabs to slide into the **U**-shaped slots.

4. Remove the R8000 CPU module from its anti-static bag and position it as shown in Figure 2-15.

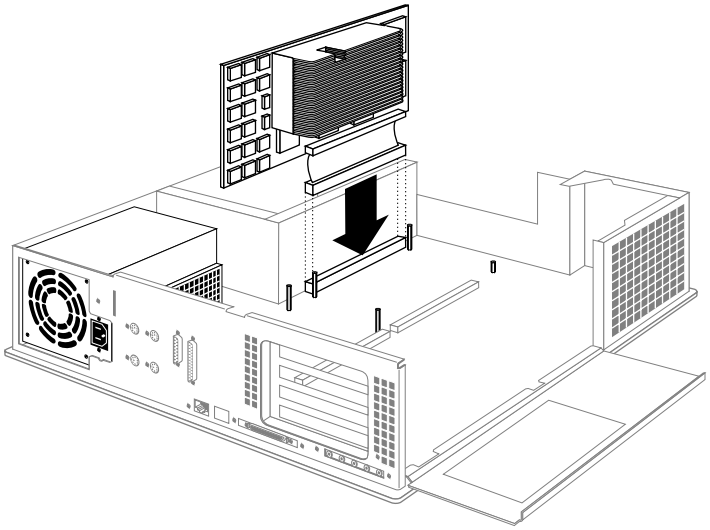


Figure 2-15 Positioning the R8000 CPU Module

5. Hold the R8000 CPU module in one hand and use your other hand to seat the flex-cable connector, as shown in Figure 2-16. Apply firm, even pressure to the flex-cable connector using your fingers.

   Do not place too much weight on the flex cable and do not twist or rock the CPU module on the flex cable. Bending and twisting the flex cable can damage it.

   Also, be careful not to scrape or hit the R8000 CPU module against the 3-1/2 inch drive bay. There are several critical capacitors on the back of the CPU module.

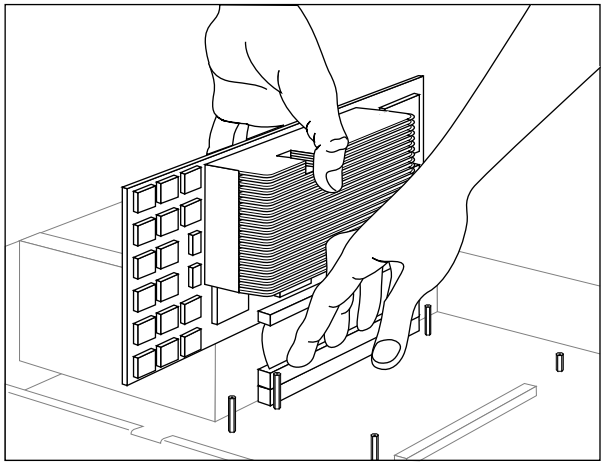


Figure 2-16 Seating the R8000 CPU Module Flex Cable

6. When the flex-cable connector is properly seated on the IP26 base board, prepare to lower the R8000 CPU module. Shift your hands to the front and back sides of the CPU module. Figure 2-17 shows the right hand already in position at the front of the module.

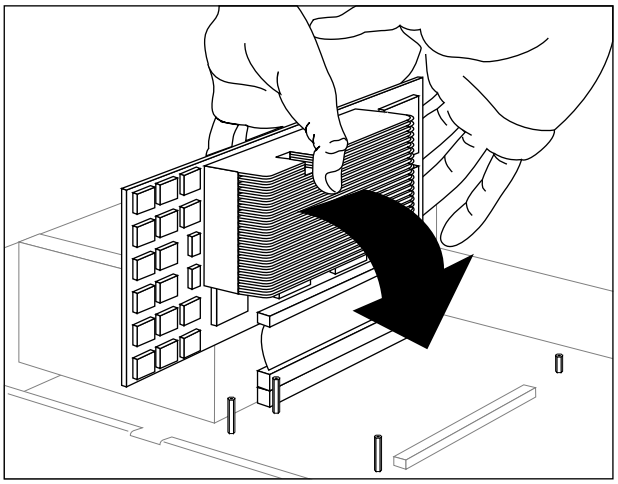


Figure 2-17 Preparing to Lower the R8000 CPU Module Into Place

7. When both hands are in position, lower the module onto the standoffs, as shown in Figure 2-18. This hand position is the best to use for raising and lowering the CPU module, as it places the minimum stress on the flex cable.

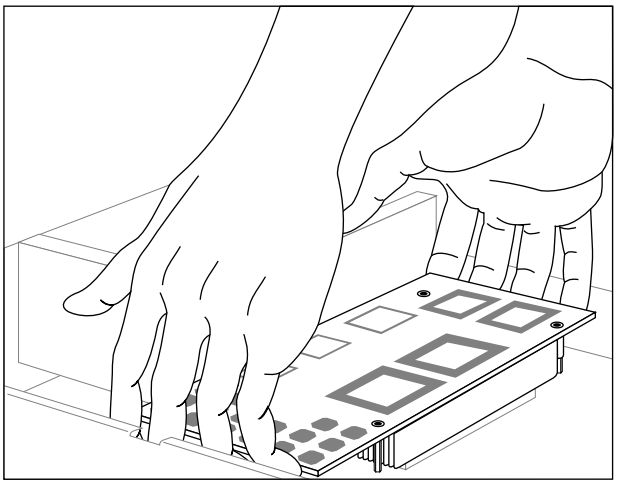


Figure 2-18 R8000 CPU Module Lowered Into Place

8. Place the insulating sheet on the R8000 CPU module as indicated in Figure 2-19. Position the sheet along the rear edge of the CPU module, and align it with the rear-most two screw holes.

9. Install the five Phillips screws that attach the R8000 CPU module to the standoffs, as shown in Figure 2-19. Note the location of the long, 30 mm screw. Finger-tighten the screws first, then tighten them snugly using the screwdriver.

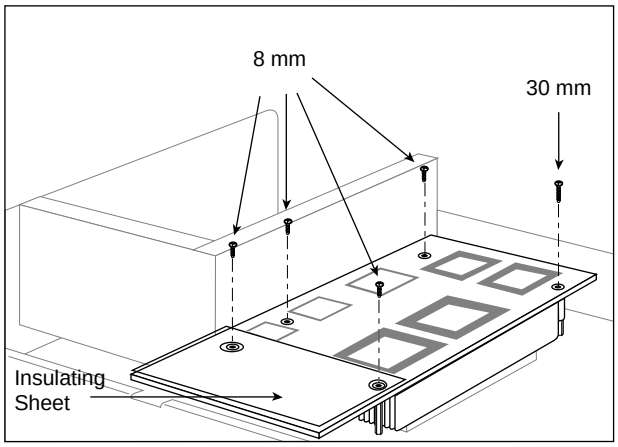


Figure 2-19 Installing the R8000 CPU Module Screws and Insulating Sheet

10. Install the backplane. Lower it into position, and press firmly to seat the backplane connectors in the slots on the IP26 base board. See Figure 2-20.

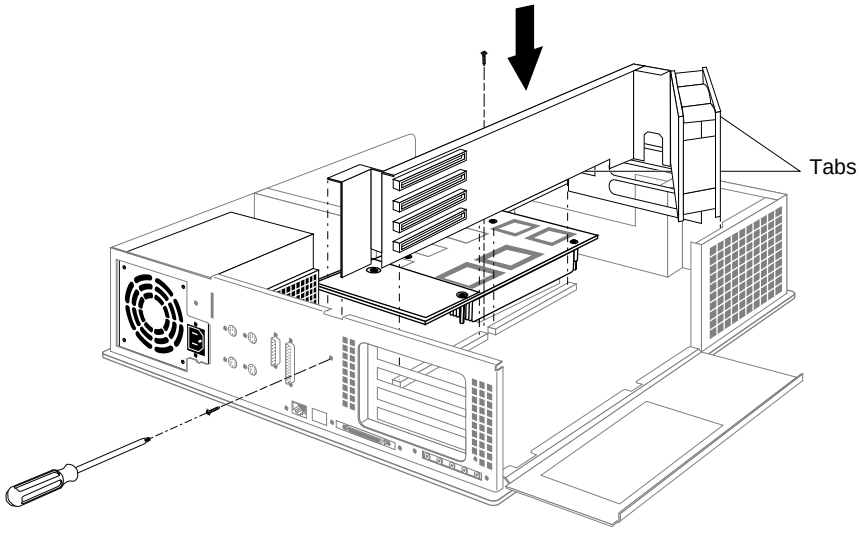


Figure 2-20 Installing the Backplane

11. Install the graphics boards (Indigo^2 only) and any EISA boards that you removed from the system. See Figure 2-21.

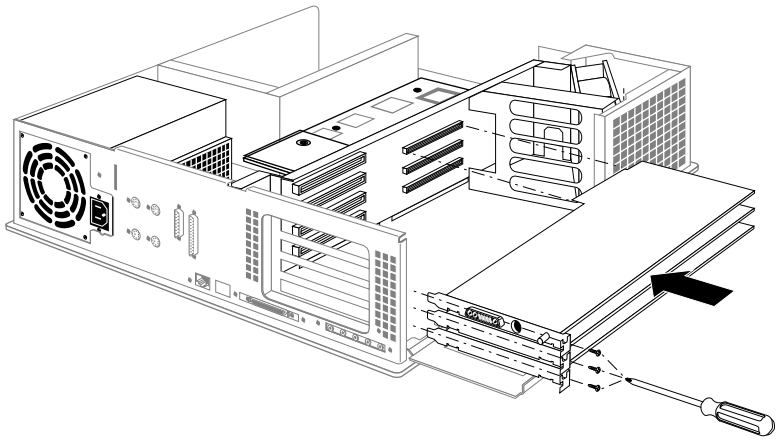


Figure 2-21 Installing Graphics Boards

12. Install the 5-1/4 inch drive tray and attach the flat SCSI cable. When lowering the tray, keep it level, as shown in Figure 2-22, to avoid hitting the CPU module with a corner of the drive tray.

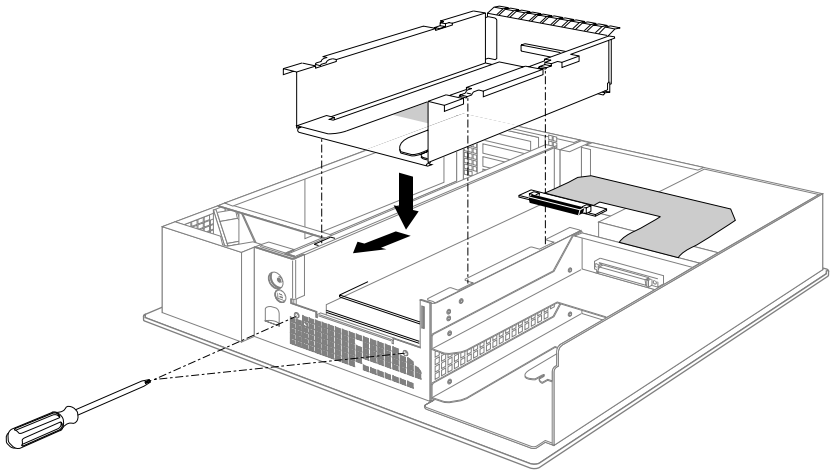


Figure 2-22 Reinstalling the 5-1/4 Inch Drive Tray

Warning: **Be very careful not to damage the R8000 CPU module when installing the 5-1/4 inch drive tray. The back side of the CPU module is very close to the underside of the drive tray. Before sliding the drive tray forward and locking it in place, visually inspect the clearance between the drive tray and the CPU module. (Look through the perforated metal at the bottom of the drive tray.)**

13. Replace the top cover, as shown in Figure 2-23.

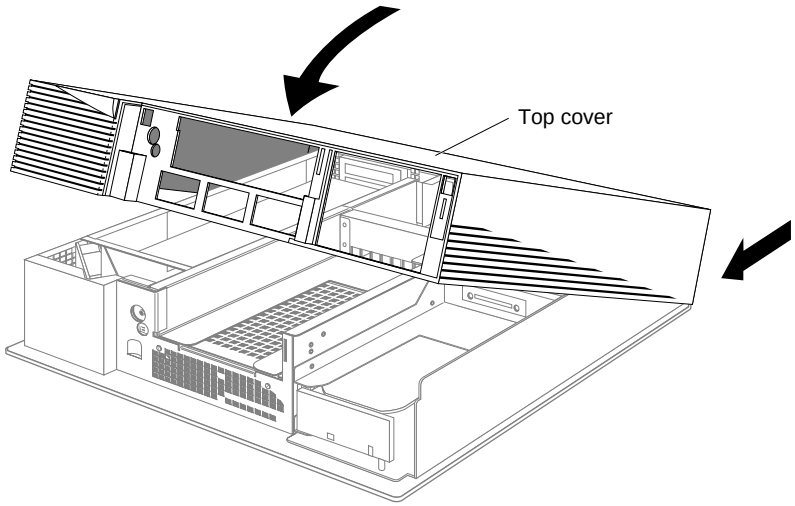


Figure 2-23 Replacing the Top Cover

14. Reinstall any peripherals and reattach any cables that you removed from the system.

At this point you should make sure that a CD-ROM drive is attached to the system so that you can reinstall IRIX. Although you can use a CD-ROM drive across the network, the procedure given in this chapter assumes the CD-ROM drive is directly connected to the system. It can be either an internal or external CD-ROM drive.

You are finished installing hardware. Turn to Section 2.5, “Testing the Installation.”

2.5 Testing the Installation

Follow this procedure to verify that you installed the upgrade correctly and that the components are working properly:

1. Power on the system.
2. *Indigo^2 only*: Press **<Esc>** to enter the System Maintenance Menu (CHALLENGE M stops automatically at this menu).
3. From the System Maintenance Menu, enter the Command Monitor.
4. At the Command Monitor prompt (>>), type

   hinv -v

   You should see a display similar to the following:

```
             System: IP26
          Processor: 75 Mhz R8000
Primary I-cache size: 16 Kbytes
Primary D-cache size: 16 Kbytes
Secondary cache size: 2 Mbytes
        Memory size: 64 Mbytes
```

```
SCSI Disk: scsi(0)disk(1)
```

5. After you are satisfied that the board is recognized by *hinv* and the system is running normally, type **exit** to quit the Command Monitor.
6. Do not allow the system to boot. Instead, reenter the System Maintenance Menu. (For Indigo^2 systems, press **<Esc>**.)

You are now ready to boot the miniroot and install IRIX 6.0.1. Turn to Section 2.6, "Software Installation."

2.6 Software Installation

The next step in the upgrade procedure is to install IRIX 6.0.1. You must perform this installation from the miniroot.

Follow these steps to boot the miniroot and install IRIX 6.0.1:

1. Make sure a CD-ROM drive is attached to the system (or is available on the network). This procedure assumes you have a CD-ROM drive attached directly to the system. If you have to use a CD-ROM drive across the network, see the *IRIS Software Installation Guide* for information on booting the miniroot from a remote CD-ROM.
2. Load the IRIX 6.0.1 CD into the CD-ROM drive.
3. At the System Maintenance Menu, select option **2**, Install System Software.
4. *Indigo^2 only*: You see a series of icons representing installation choices. Select the icon for the installation you are performing, for example Local CD-ROM. The miniroot begins to load. Proceed with the next step.

   CHALLENGE M only: You are prompted for an appropriate installation source, for example:

   ```
   Load software from local CD-ROM? (y/n) [y]
   ```

   Press <**Enter**> to boot the miniroot from the CD-ROM drive.
5. After a while, you see the *inst* prompt. A default set of subsystems is selected for installation. You may wish to add or delete subsystems depending upon your customer's needs.
6. After you have selected the appropriate subsystems, enter **go** at the *inst* prompt.
7. Once all the subsystems are installed, enter **quit** to exit from Inst.
8. Reboot the system to multiuser mode.
9. Log in and enter the following command to verify that the installation worked and that the operating system is IRIX 6.0.1:

   uname -a

   If *uname* reports that the system is running IRIX 6.0.1, the installation is successful.

You can now complete the installation. See the next section, Section 2.7, "Completing the Installation."

2.7 Completing the Installation

There are two final steps to complete the upgrade:

1. Attach the “POWER” badge to the front of the system. It snaps into the front grill.
2. Install the upgrade label that indicates the new Silicon Graphics model number of the system. Affix the label at the rear of the system, covering part of the old label.

You are now ready to pack the old components for return shipment to Silicon Graphics. Turn to Chapter 3, “Returning the Old Components.”

Chapter 3

Returning the Old Components

All components that have been replaced must be returned. This procedure is not optional. Shipping boxes are included in the upgrade kit.

3.1 Packing the Components

Pack the old components in the boxes and antistatic bags provided. Ensure that the IP22 base board and the CPU module are packed to withstand the rigors of surface and air freight transportation.

Caution: Boards must be shipped in antistatic bags.

3.2 Shipping Instructions

Shipping instructions are provided with the RMA kit.