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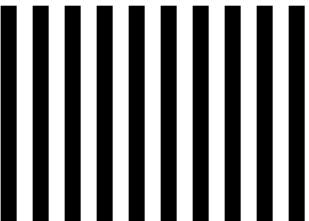Country _____ Phone (   ) _____ Extension _____

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CISCO SYSTEMS

Cisco 12016, Cisco 12416, and Cisco 12816 Router Installation and Configuration Guide

About This Guide

Audience

The *Cisco 12016, Cisco 12416, and Cisco 12816 Router Installation and Configuration Guide* is written for hardware installers and system administrators of Cisco routers.

This publication assumes that the user has a substantial background in installing and configuring router and switch-based hardware. The reader should also be familiar with electronic circuitry and wiring practices, and have experience as an electronic or electromechanical technician.

Purpose

This installation and configuration guide contains procedures for installing the router hardware, creating a basic startup configuration file, and powering on the router for the first time.

Document Organization

This installation and configuration guide is organized into the following chapters and appendixes:

- Chapter 1, "Product Overview,"provides an introduction to the major components of the Cisco 12016, Cisco 12416, and Cisco 12816 series routers.

- Chapter 2, "Preparing for Installation," describes safety considerations, required tools and equipment, an overview of the installation, and procedures to perform before the installation.

- Chapter 3, "Installing the Router," provides instructions for installing the hardware and connecting external network interface cables.

- Chapter 4, "System Startup and Basic Configuration," provides simple procedures for completing a basic system configuration, and for checking and saving the configuration to system memory.

- Chapter 5, "Troubleshooting the Installation," provides guidelines for troubleshooting the router hardware installation.

- Chapter 6, "Router Field Diagnostics," describes how to load and run router field diagnostics.

- Chapter 7, "Maintaining the Router,"provides removal and replacement procedures for primary router components or field-replaceable units (FRUs).

- Appendix A, "Technical Specifications," provides a summary of physical, electrical, and environmental specifications for the router.

- Appendix B, "Site Log,"provides a sample site log that can be used to record actions relevant to the operation and maintenance of the router.

- Index

Document Conventions

This publication uses the following conventions:

- **Ctrl** represents the key labeled *Control*. For example, the key combination **Ctrl-Z** means hold down the **Control** key while you press the **z** key.

Command descriptions use these conventions:

- Examples that contain system prompts denote interactive sessions, indicating the commands that you should enter at the prompt. The system prompt indicates the current level of the EXEC command interpreter.

  For example, the prompt `router>` indicates that you should be at the *user* level, and the prompt `router#` indicates that you should be at the *privileged* level. Access to the privileged level usually requires a password. Refer to the related software configuration and reference documentation for additional information.

- Commands and keywords are in **bold** font.

- Arguments for which you supply values are in *italic* font.

- Elements in square brackets ([ ]) are optional.

- Alternative but required keywords are grouped in braces ({ }) and separated by vertical bars (|).

Examples use these conventions:

- Terminal sessions and sample console screen displays are in `screen` font.

- Information you enter is in **`bold`** font.

- Nonprinting characters, such as passwords, are in angle brackets (< >).

- Default responses to system prompts are in square brackets ([ ]).

- Exclamation points (!) at the beginning of a line indicate a comment line.

⚠️

Caution   Means *reader be careful*. You are capable of doing something that might result in equipment damage or loss of data.

✎

Note   Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Timesaver Means *the described action saves time*. You can save time by performing the action described in the paragraph.

Warning **This warning symbol means *danger*. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. To see translations of the warnings that appear in this publication, refer to the *Regulatory Compliance and Safety Information* document that accompanied this device.**

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- 1 877 228-7302
- 1 408 525-6532

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Submitting a Service Request

Using the online TAC Service Request Tool is the fastest way to open S3 and S4 service requests. (S3 and S4 service requests are those in which your network is minimally impaired or for which you require product information.) After you describe your situation, the TAC Service Request Tool provides recommended solutions. If your issue is not resolved using the recommended resources, your service request is assigned to a Cisco engineer. The TAC Service Request Tool is located at this URL:

http://www.cisco.com/techsupport/servicerequest

For S1 or S2 service requests or if you do not have Internet access, contact the Cisco TAC by telephone. (S1 or S2 service requests are those in which your production network is down or severely degraded.) Cisco engineers are assigned immediately to S1 and S2 service requests to help keep your business operations running smoothly.

To open a service request by telephone, use one of the following numbers:

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EMEA: +32 2 704 55 55
USA: 1 800 553-2447

For a complete list of Cisco TAC contacts, go to this URL:

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Definitions of Service Request Severity

To ensure that all service requests are reported in a standard format, Cisco has established severity definitions.

Severity 1 (S1)—Your network is "down," or there is a critical impact to your business operations. You and Cisco will commit all necessary resources around the clock to resolve the situation.

Severity 2 (S2)—Operation of an existing network is severely degraded, or significant aspects of your business operation are negatively affected by inadequate performance of Cisco products. You and Cisco will commit full-time resources during normal business hours to resolve the situation.

Severity 3 (S3)—Operational performance of your network is impaired, but most business operations remain functional. You and Cisco will commit resources during normal business hours to restore service to satisfactory levels.

Severity 4 (S4)—You require information or assistance with Cisco product capabilities, installation, or configuration. There is little or no effect on your business operations.

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CONTENTS

Cisco 12016, Cisco 12416, and Cisco 12816 Router Installation and Configuration Guide

CHAPTER 5 **Troubleshooting the Installation**   **5-1**

Product Overview

This chapter provides an overview of the Cisco 12016, Cisco 12416, and Cisco 12816 series routers. It contains physical descriptions of the router hardware and major components, as well as functional descriptions of the hardware-related features.

Introduction

The routers described in this guide are part of the Cisco 12016, Cisco 12416, and Cisco 12816 series routers and include:

- The original Cisco 12016, Cisco 12416, and Cisco 12816 series routers.

- The newer Cisco 12016, Cisco 12416, and Cisco 12816 enhanced series routers. The enhanced series of routers use higher capacity power supplies, more powerful blower modules, and have newly designed front doors.

The capacity of the router switch fabric differentiates each model:

- Cisco 12016 Router—2.5-Gbps switch fabric

- Cisco 12416 Route—10-Gbps switch fabric

- Cisco 12816 Router—40-Gbps switch fabric

Other than their various capacities, these routers are nearly identical. Differences between each router are described where necessary, and unless otherwise noted, the information in this publication applies to all routers.

Physical and Functional Description of Router

The Cisco 12000 series router chassis is a sheet-metal enclosure that houses router components. The major components consist of three power supplies, upper and lower line card cages, a switch fabric card cage, and upper and lower blower modules. Power is distributed to these components over the chassis backplane.

All router models contain the following major components (Figure 1-1):

- Power shelf and power supplies—Three AC or DC power entry modules (PEMs) provide power to the router. See the "AC and DC Power Subsystems" section on page 1-4 for additional information.

- Upper blower module—Supplies cooling air to the upper half of the router so it does not overheat. See the "Blower Module" section on page 1-44 for additional information.

- Upper and lower cable management brackets—Used to neatly route line card cables. See the "Upper and Lower Cable Management Brackets" section on page 1-43 for additional information.

- Upper Line card and Route Processor card cage—Has 8 user-configurable slots that support a combination of line cards, a route processor (RP), and an alarm card. See the "Alarm Card, Line Card, and Rout Processor Overview" section on page 1-21 for additional information.

- Switch fabric card cage—Located behind the air filter door, this card cage contains 5 slots for the switch fabric card set. The switch fabric card set is made up of 3 switch fabric cards (SFCs) and 2 clock scheduler cards (CSCs). See the "Switch Fabric Overview" section on page 1-19 for additional information.

- Lower Line card and Route Processor card cage—Has 8 user-configurable slots that support a combination of line cards, a redundant route processor (RP), and an alarm card. See the "Alarm Card, Line Card, and Rout Processor Overview" section on page 1-21 for additional information.

- Lower blower module—Supplies cooling air to the lower half of the router so it does not overheat. See the "Blower Module" section on page 1-44 for additional information.

- Chassis backplane (not shown)—Distributes power to card cages and to the blower modules.

Figure 1-1   Cisco 12016 Series Router Components—Front View

Power shelf and power supplies

Upper blower module

Upper cable management bracket

RP

Alarm card

Upper card cage

Air filter door

Switch fabric card cage (behind filter door)

Alarm card

Lower card cage

Lower cable management bracket

Lower blower module

26194
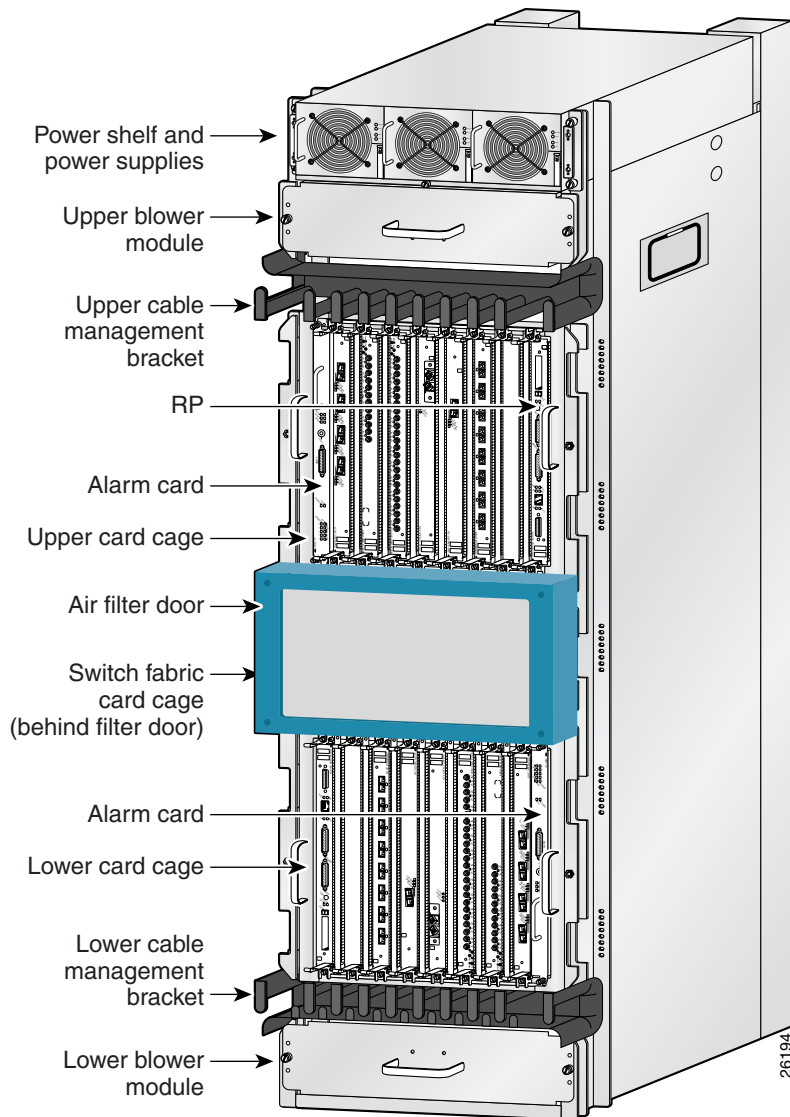
AC and DC Power Subsystems

A router ships with either an AC or DC powered system. Source power connects to the power shelf at the back of the chassis which route power to the power supplies, also referred to as power entry modules (PEMs).

Standard AC Power Shelf

The standard AC-input power subsystem consists of a single-level AC-input power shelf that house three (2000 W original series or 2400 W enhanced series) AC power supplies which supply full redundant power to the router. Figure 1-2 shows the standard power shelf housing original series 2000 W power supplies.

The power supplies participate in an N+1 redundant current-sharing scheme that is divided among all three power supplies. If one power supply fails, the system can continue to operate temporarily, (depending on your system configuration) with the remaining two power supplies. Failed power supplies should be replaced as soon as possible to ensure full redundancy.

⚠

Caution   To ensure that the chassis configuration complies with the required power budgets, use the on-line power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails. Contact your local sales representative for assistance.

Figure 1-2   Standard AC-Input Power Subsystem —2000 W

⚠
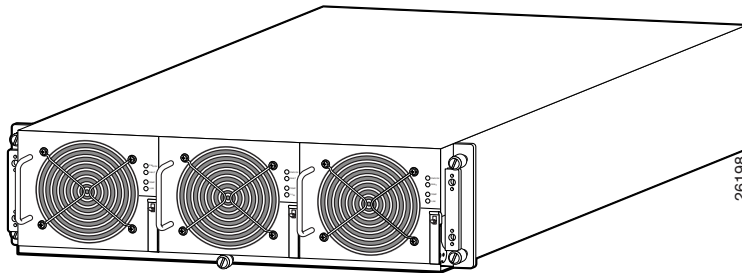
Caution   A router equipped with the standard AC power subsystem must be operated with three power supplies installed in the power shelf at all times for electromagnetic compatibility (EMC).

AC power to the router is provided through power cords connected from AC power outlets to connectors on back of the power shelf as shown in Figure 1-3.

Figure 1-3   Standard Power Shelf AC-Input Connections
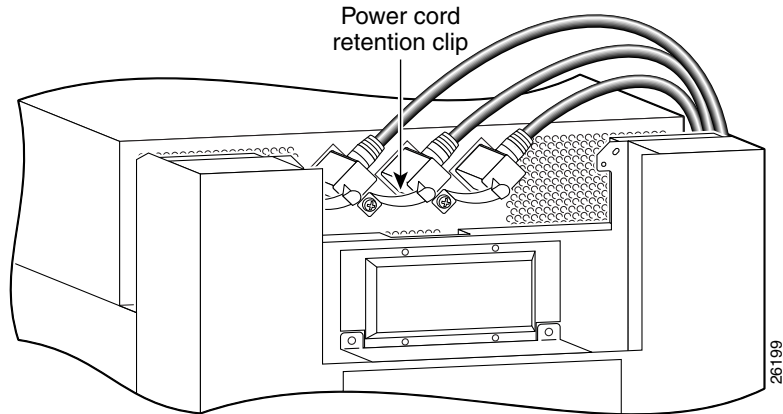
Optional AC Power Shelf

The power subsystem consists of a double-level AC-input power shelf with bays for 4 AC-input power supplies. Figure 1-4 shows the optional power shelf housing original series 2000 W power supplies. It attaches to the top of the router chassis and is secured to the chassis the same way as the standard AC-input power shelf.

Note A router equipped with the optional AC-input power subsystem stands 77.5 inches (196.85 cm) tall and does not fit in a standard 7-foot (2.1 m) rack.

The 4 power supplies in the optional power shelf participate in an N+2 redundant current-sharing scheme in which current sharing is divided among all 4 power supplies. Up to two power supplies can fail and the system can continue to operate temporarily, (depending on your system configuration) using the remaining two power supplies. Failed supplies should be replaced as soon as possible to ensure full redundancy.

Caution To ensure that the chassis configuration complies with the required power budgets, use the on-line power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails. Contact your local sales representative for assistance.

Figure 1-4   Optional AC-Input Power Subsystem—2000 W

⚠️
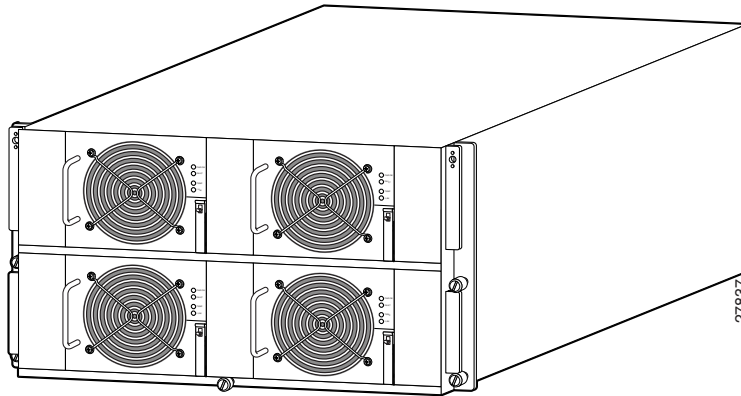
Caution   A router equipped with the optional AC power subsystem must be operated with 4 power supplies installed in the power shelf at all times for electromagnetic compatibility (EMC).

AC power to the router is provided through power cords connected from AC power outlets to the connectors on the back of the power shelf as shown in Figure 1-5.

Figure 1-5   Optional Power Shelf AC-Input Connections
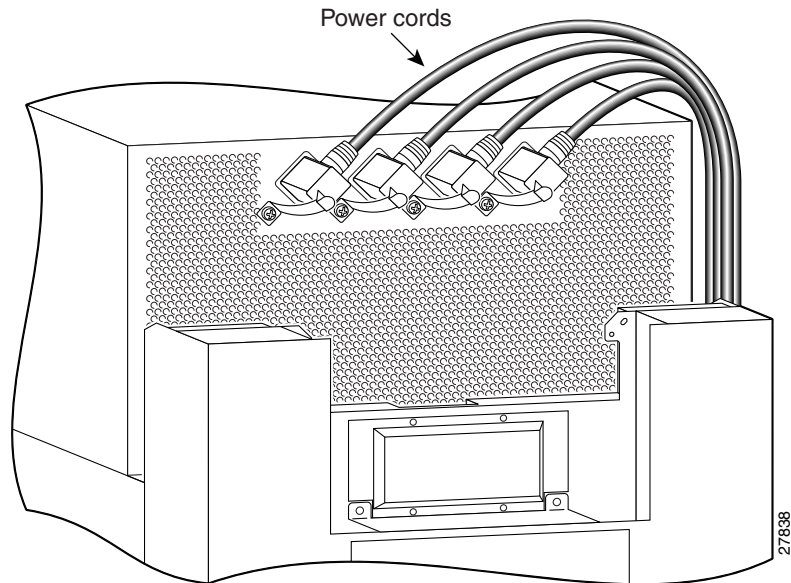
AC Power Supplies

Each AC PEM converts 200 to 240 VAC into -48 VDC, which is distributed through the chassis backplane to all cards, RPs, and the blower modules.

Figure 1-6 identifies the components of a 2000 W AC power supply.

Figure 1-6   2000 W AC Power Supply Components
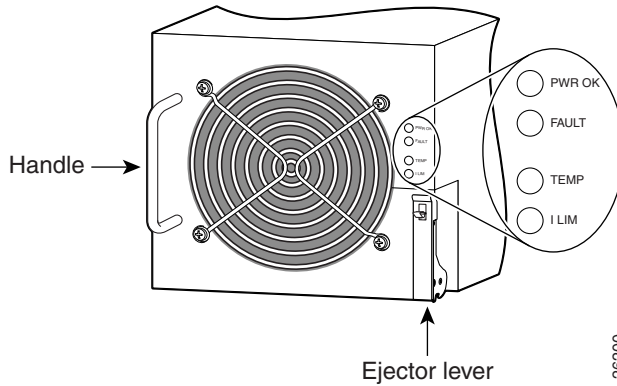
Figure 1-7 identifies the components of a 2500 W AC power supply.

Figure 1-7   2500 W AC Power Supply Components
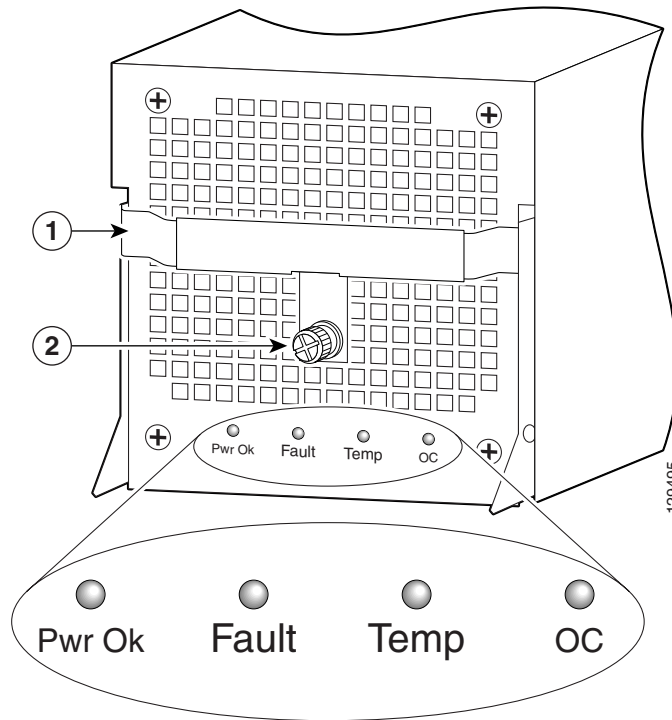
1	Ejector handle	**2**	Captive screw

The status LEDs on an AC PEM provide information about the current operational status of the power supply:

- PWR OK (green)—Indicates that the power supply module is operating normally.

- FAULT (yellow)—Indicates that a fault is detected within the PEM.

- TEMP (yellow)—Indicates the PEM is in an overtemperature condition and shutdown has occurred.

- ILMI (yellow)—Indicates the PEM is operating in a current-limiting condition.

For additional information about troubleshooting AC PEMs, see the "Troubleshooting the AC-Input Power Subsystem" section on page 5-6.

DC Power Shelf

A DC-input power subsystem consists of a DC-input power shelf that houses 4 (2000 W or 2400 W) DC PEMs that provide full redundant power to the router. Figure 1-8 shows a DC-input power shelf housing original series 2000 W power supplies.

The Cisco 12416 and 12816 DC powered systems (part numbers GSR16/320-DC and GSR16/320-DC) are equipped with 4 PEMs. The chassis is electrically divided between the PEMS. These sections are referred to as power zones and are labeled accordingly:

- Two PEMs power the upper card cage (Zone 1)
- Two PEMs power the lower card cage (Zone 2)

Each zone provides power to one blower, one alarm card, line cards and route processor cards.

Zone 2 also supplies power to all switch fabric cards. The result is that there is less power available for line cards in Zone 2, limiting the number of high-powered line cards that can be configured in the lower cage.

⚠
Caution   To ensure that the chassis configuration complies with the required power budgets, contact your sales representative to provide you with the required power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails.

Contact your local sales representative for assistance.

In the DC-input power configuration:

- Modules A1 and B1 provide redundant power for system load zone 1 (the upper blower module and the upper card cage).
- Modules A2 and B2 provide redundant power for system load zone 2 (the switch fabric card cage, the lower card cage, and the lower blower module).

Figure 1-8   DC-Input Power Shelf—2000 Watts

⚠️
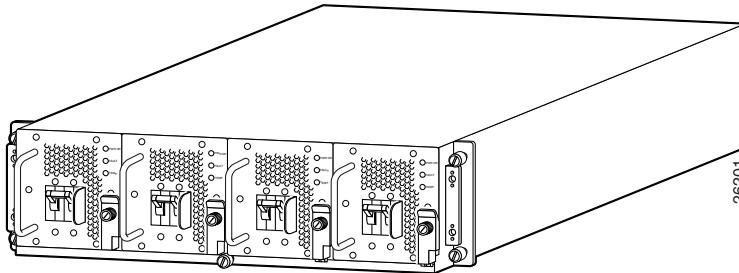
Caution   A router configured for source DC operation must be operated with 4 DC-input PEMs installed at all times for electromagnetic compatibility (EMC).

✎

Note   DC PEMs support online insertion and removal (OIR) which means that you can remove and replace one PEM in each load zone (A1 or B1; A2 or B2) while the system remains powered on.

DC power to the router is provided from cables from a DC power source that are connected to threaded terminal studs on the back of the DC-input power shelf as shown in Figure 1-9.

Figure 1-9   DC-Input Power Shelf Connections

Cover with slotted screw hole;
fastens to standoff in middle of
cable connection area
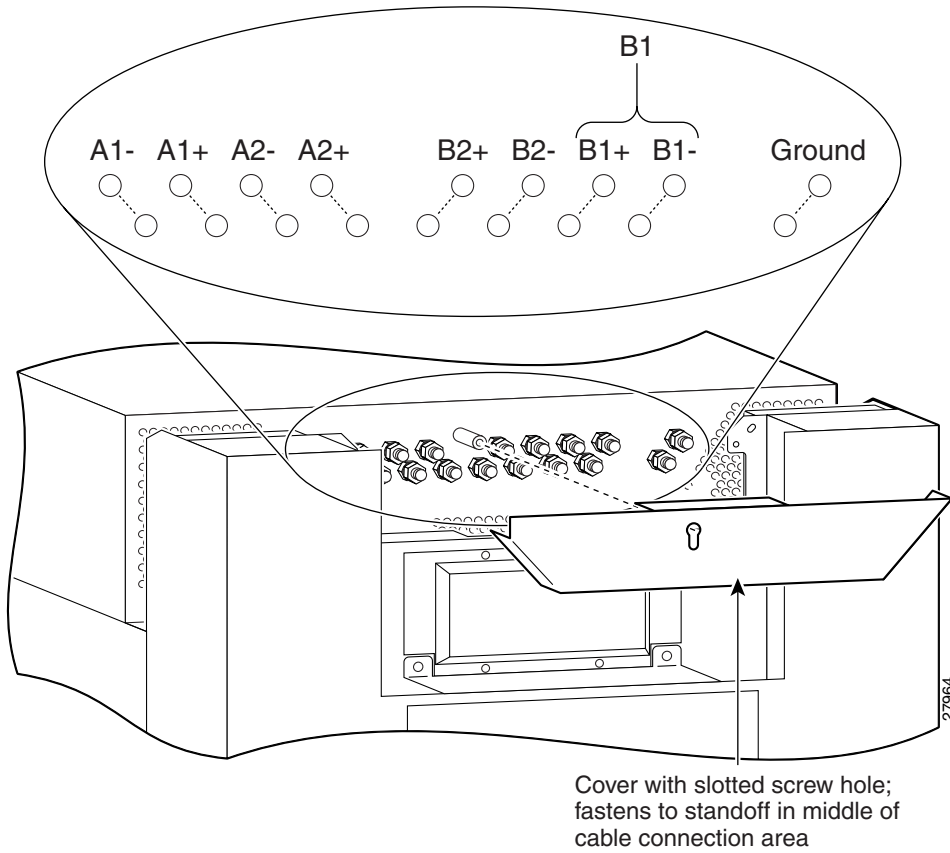
DC Power Supplies

Each DC PEM operates from a nominal source DC voltage of –48 to –60 VDC and requires a dedicated 60 amp service.

Figure 1-10 identifies the components of a 2000 W DC power supply.

Figure 1-10   2000 W DC Power Supply Components
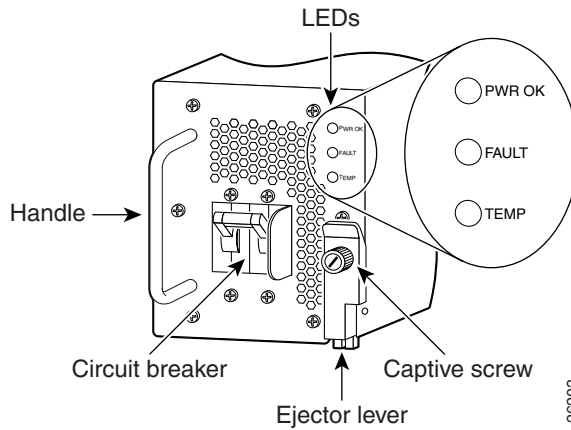
Figure 1-11 identifies the components of a 2400 W DC power supply.

Figure 1-11   2400 W DC Power Supply Components
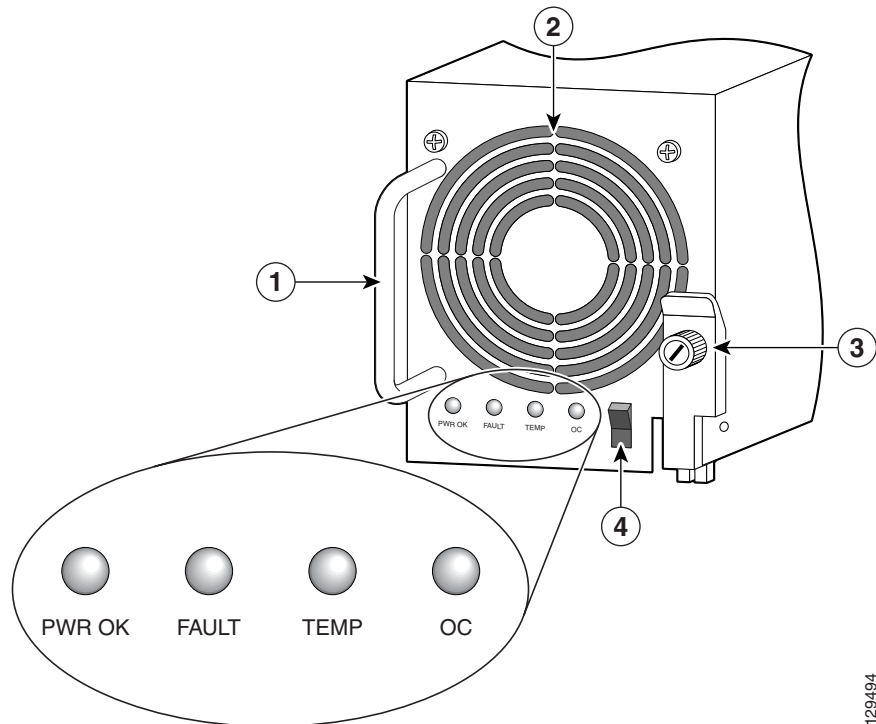
1	Handle	**3**	Ejector lever
2	Fan	**4**	Power switch

The status LEDs on a DC PEM provide information about the current operational status of the power supply:

- PWR OK (green)—Indicates that the power supply module is operating normally.

- FAULT (yellow)—Indicates that a fault is detected within the PEM.

- TEMP (yellow)—Indicates the PEM is in an overtemperature condition and shutdown has occurred.

For additional information about troubleshooting DC PEMs, see the "Troubleshooting the DC-Input Power Subsystem" section on page 5-10.

Chassis Card Cages

There are three integral card cages in the chassis: the upper card cage, the lower card cage, and the switch fabric card cage (see Figure 1-1).

Upper Card Cage

The upper card cage has eight user-configurable slots that support a combination of line cards, an alarm card, and an RP.

- Alarm—The far *left* slot is a dedicated slot for an alarm card.
- Slots 0 through 6—Can be populated with any line cards supported by the router.
- Slot 7—The far *right* slot is reserved for the RP.

Lower Card Cage

The lower card cage also has eight user-configurable slots that support additional line cards, an alarm card, and an optional, redundant RP.

✎
Note   The lower card cage is an inverted, or *head-down,* copy of the upper card cage, which means that cards are installed in an inverted or head-down orientation. The orientation of the slots is opposite that of the upper card cage.

- Slot 8—The far *left* slot is reserved for an optional redundant RP.

    ✎
    Note   This slot may be used for a line card if you are not using an redundant RP.

- Slots 9 through 15—Can be populated with any line cards supported by the router.
- Alarm—The far *right* slot is a dedicated slot for an alarm card.

Switch Fabric Card Cage

The router ships from the factory with 2 CSCs and 3 SFCs installed in five of the eight slots in the switch fabric card cage.

- The 2 CSCs are installed in slot 0 (CSC0) or slot 1 (CSC1)
- The 3 SFCs are installed in slot 2 (SFC0), slot 3 (SFC1), and slot 4 (SFC2).
- Three non-working slots with no backplane connectors. These non-working slots are not labeled, but there is a blank filler panel installed in the far left slot to help maintain proper air flow through the chassis.

⚠
Caution   Do not remove the blank filler panel unless instructed to do so by a Cisco support representative.

Switch Fabric Overview

The switch fabric provides synchronized gigabit-speed connections between line cards and the RP. The switch fabric card cage is located behind the air filter door and consists of 2 clock and scheduler cards (CSCs) and 3 switch fabric cards (SFCs). One CSC and the 3 SFCs are the active switch fabric; the second CSC provides redundancy for the other 4 cards.

Note 10-Gbps and 40-Gbps switch fabrics do not operate in 1/4-bandwidth mode as they did in some earlier models of the Cisco 12000 series routers. You must have at least one CSC and three SFCs for the system to function. You can add an additional CSC for redundancy.

The combination of CSCs and SFCs make up the 2.5-Gbps, 10-Gbps, or 40-Gbps per-slot switch fabric. Routers are identified by the switch fabrics they use:

- Cisco 12010: 2.5-Gbps switch fabric
- Cisco 12410: 10-Gbps switch fabric
- Cisco 12810: 40-Gbps switch fabric

Each SFC or CSC provides a 2.5-Gbps, 10-Gbps, or 40-Gbps full-duplex connection to each line card in the system. For example, in a Cisco 12416 router with 16 line cards, each with 2 x 10 Gbps capacity (full duplex), the system switching bandwidth is 16x 20 Gbps = 320 Gbps.

Note The Cisco 12000 series router supports online insertion and removal (OIR), allowing you to remove and replace a card while the router remains powered on.

Switch Fabric Card Functionality

The core of the router is a crossbar switch fabric that provides synchronized connections between the line cards and the RP. The switch fabric consists of 2 clock scheduler cards (CSCs) and 3 switch fabric cards (SFCs) installed in the switch fabric card cage. One CSC and the three SFCs are the active switch fabric; the second CSC provides redundancy for the other 4 cards.

The router also ships with a blank switch fabric card installed in the far left (non-working) slot of the switch fabric card cage. The blank filler panel balances the air flow through the switch fabric card cage which helps maintain proper air flow through the chassis.

⚠️
Caution Do not remove the blank filler panel unless instructed to do so by a Cisco support representative.

Clock Scheduler Cards

Clock scheduler cards provide the following functionality:

- Scheduler—Handles all scheduling requests from the line cards for access to the switch fabric.

- System clock—Supplies the synchronizing signal to all SFCs, line cards, and the RP. The system clock synchronizes data transfers between line cards or between line cards and the RP through the switch fabric.

- Switch fabric—Carries the user traffic between line cards or between the RP and a line card. The switch fabric on the CSC is identical to the switch fabric on the SFC.

The second CSC provides redundancy for the data path, scheduler, and reference clock. Traffic between the line cards and the switch fabric is monitored constantly. If the system detects a loss of synchronization (LOS), it automatically activates the data paths on the redundant CSC so data flows across the redundant paths. The switch to the redundant CSC occurs within The switch to the redundant CSC occurs within sub-seconds (the actual switch time depends on your configuration and its scale).

Switch Fabric Cards

The switch fabric cards augment the traffic capacity of the router. SFCs contain switch fabric circuitry that can only carry user traffic between line cards or between the RP and the line cards. SFCs receive all scheduling information and the system clock signal from the CSCs.

Alarm Card, Line Card, and Rout Processor Overview

This section provides general information about alarm cards, line cards and types of route processors installed in the router.

Note   The Cisco 12000 series router supports online insertion and removal (OIR), allowing you to remove and replace a card while the router remains powered on.

Alarm Cards

The router is equipped with 2 alarm cards:

- One alarm card occupies the dedicated far left slot of the upper card cage.
- The other alarm card occupies the dedicated far right slot of the lower card cage.

The alarm card slots differ from the rest of the card cage slots in that it is labeled as an "alarm" card slot, is physically narrower than the other slots, and has a different backplane connector.

Some of the functions that the alarm cards provide are:

- Supplies +5 VDC to the MBus modules on router components (see AC and DC Power Subsystems, page 1-4).

- Displays alarm severity levels (critical, major, and minor) detected by the system through the MBus.

- Provides connections for an external alarm system.

- Displays the status of the alarm cards, clock scheduler cards, and switch fabric cards.

The following components and LEDs are on the front panel of the alarm card (Figure 1-12):

- Critical, Major, and Minor LEDs that identify system level alarm conditions.

- A switch to shut off an audio alarm.

- Cable connection for an external alarm (labeled Alarm)

- Alarm card LEDs:

    – ENABLED (green)—The alarm card is operational and functioning properly.

    – FAIL (yellow)—The alarm card in that slot is faulty.

- A pair of status LEDs that correspond to each of the 5 card slots in the switch fabric card cage (2 CSCs and 3 SFCs):

    – ENABLED (green)
    On—The card installed in that slot is operational and functioning properly.
    Off—Either the slot is empty or the card installed in that slot is faulty.

    – FAIL (yellow)—The card in that slot is faulty.

Figure 1-12   Alarm Card Components and LEDs
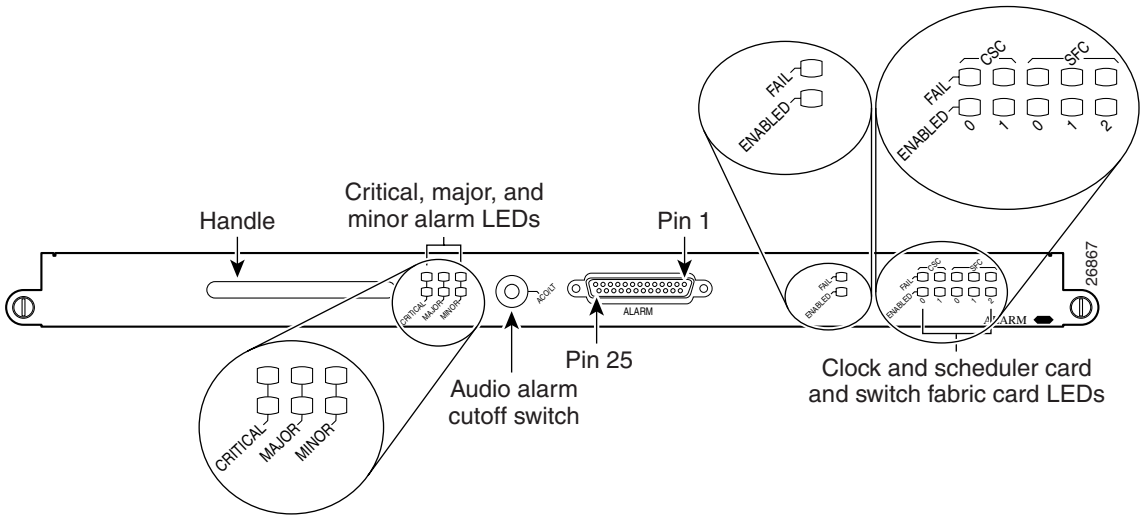
Line Cards

Up to 15 Cisco 12000 series line cards can be installed in the routers upper and lower card cages to support a variety of physical network media. Ports and connectors on the line card front panels provide interfaces for external connections. Line cards communicate with the RP and exchange packet data with each other through the switch fabric cards.

⚠️

Caution   Any unoccupied card slot in the upper and lower card cages must have a blank filler panel installed to meet electromagnetic compatibility (EMC) requirements and to ensure proper air flow through the chassis. Also, if the front panel of a line card does not completely fill the card slot opening, a narrow card filler panel must be installed to meet the EMC requirements.

A cable management bracket on the front panel of each line card helps to organize the interface cables connected to that line card.

Route Processor Selection

Two types of RPs are available: a Gigabit Route Processor (GRP) or a Performance Route Processor (PRP). The GRP is the route processor that shipped with earlier Cisco 12000 series routers; the PRP is the route processor shipping with all current Cisco 12000 series routers. You cannot mix GRPs with PRPs. If you install a redundant RP, it must be the same type as the primary RP.

Note   This publication uses the term route processor (RP) to indicate either a Gigabit Route Processor (GRP) or a Performance Route Processor (PRP) unless otherwise specified.

Each system includes at least one RP that performs a variety of functions including the following:

- Downloads the Cisco IOS software to all installed line cards at power-on.

- Processes the network routing protocols and distributes updates to Cisco Express Forwarding (CEF) tables on the line cards.

- Communicates with the line cards, either through the switch fabric or the maintenance bus (MBus):

  - The switch fabric connection is the main data path for distributing routing tables, as well as packets passed between the RP and the line cards.

  - The MBus connection allows the RP to download a system bootstrap image, collect or load diagnostic information, and perform general, internal system maintenance operations.

Gigabit Route Processor Overview

The GRP uses an IDT R5000 Reduced Instruction Set Computing (RISC) CPU that runs at an external bus clock speed of 100 MHz and has an internal clock speed of 200 MHz.

Figure 1-13 identifies the connectors and LEDs on the GRP front panel.

Figure 1-13   Gigabit Route Processor Front Panel
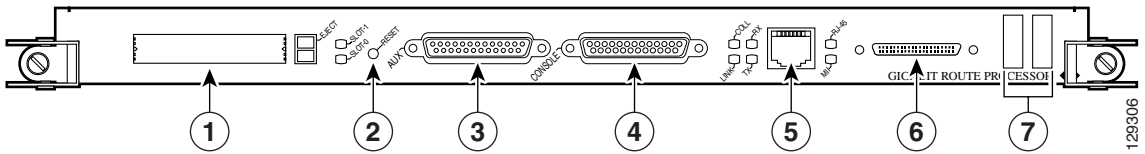
1	PCMCIA flash card slots, eject buttons, and slot LEDs	**5**	RJ-45 Ethernet port and data status LEDs
2	Reset button	**6**	MII Ethernet connection
3	Auxiliary serial port	**7**	Alphanumeric message displays
4	Console serial port		

GRP PCMCIA Card Slots and Status LEDs

Two PCMCIA card slots (slot 0 and slot 1) provide the GRP with additional flash memory capacity or other input/output (I/O) device capability.

⚠

Caution   The GRP only supports +5.2 VDC Type I and Type II devices. It does not support +3.3 VDC PCMCIA devices.

Status LEDs (Slot-0/Slot-1) indicate when the flash memory card or I/O device in that slot is accessed. Each slot has an eject button to remove the card from the slot (Figure 1-14).

Figure 1-14   Slot Activity LEDs—Front Panel
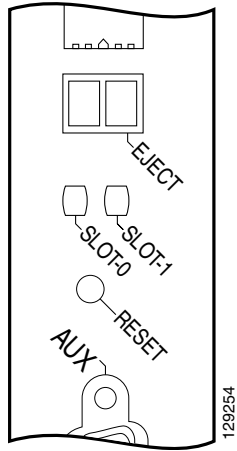
GRP Reset Switch

Access to the (soft) reset switch is through a small opening in the GRP front panel. To press the switch, insert a paper clip or similar small pointed object into the opening (see Figure 1-13 on page 1-25).

⚠

Caution   The reset switch is *not* a mechanism for resetting the GRP and reloading the Cisco IOS image. It is intended for software development use only. To prevent system problems or loss of data, use the reset switch only on the advice of Cisco service personnel.

Pressing the reset switch causes a nonmaskable interrupt (NMI) and places the GRP in ROM monitor mode. When the GRP enters ROM monitor mode, its behavior depends on the setting of the GRP software configuration register. For example, if the boot field of the software configuration register is set to:

- 0x0—The GRP remains at the ROM monitor prompt (rommon>) and waits for a user command to boot the system manually.

- 0x1—The system automatically boots the first Cisco IOS image found in flash memory on the GRP.

For more information on the software configuration register, see the "Configuring the Software Configuration Register" section on page 4-31.

GRP Auxiliary and Console Ports

The auxiliary and console ports on the GRP are EIA/TIA-232 (also known as RS-232) asynchronous serial ports. These ports connect external devices to monitor and manage the system.

- The auxiliary port—A (male) plug that provides a data terminal equipment (DTE) interface. The auxiliary port supports flow control and is often used to connect a modem, a channel service unit (CSU), or other optional equipment for Telnet management.

- The console port—A (female) receptacle that provides a data circuit-terminating equipment (DCE) interface for connecting a console terminal.

⚠️
Caution   To maintain Class B EMI compliance, use shielded cables when you connect to the auxiliary and console ports of original GRPs (Part Numbers GRP= and GRP-B=). An updated version of the GRP-B= board (Rev. F0) does not require shielded cables for Class B compliance.

GRP Ethernet Ports and Status LEDs

The GRP has two types of Ethernet connections for Telnet use:

- RJ-45 port—An 8-pin media-dependent interface (MDI) RJ-45 port for either IEEE 802.3 10BASE-T (10 Mbps) or IEEE 802.3u 100BASE-TX (100 Mbps) Ethernet connections.

- MII connector—A 40-pin media-independent interface (MII) that provides additional flexibility for Ethernet connections. The pinout of this standard 40-pin interface is defined by the IEEE 802.3u standard.

✏️
Note   The RJ-45 and MII interfaces on the GRP represent two physical connection options for one Ethernet interface; therefore, you can use *either* the RJ-45 connection or the MII connection, but not both simultaneously.

The transmission speed of the Ethernet port is not user-configurable. You set the speed through an autosensing scheme on the GRP which is determined by the network that the Ethernet port is connected to. However, even at an autosensed data transmission rate of 100 Mbps, the Ethernet port can only provide a usable bandwidth of substantially less than 100 Mbps. You can expect a maximum usable bandwidth of approximately 20 Mbps when using either the MII or RJ-45 connection.

The following LEDs on the front panel indicate traffic status and port selection (Figure 1-15):

- LINK, COLL, TX, RX—Indicate link activity (LINK), collision detection (COLL), data transmission (TX), and data reception (RX).

> **Note**   These LEDs are only used by the RJ-45 Ethernet connector and are disabled when the MII Ethernet port is in use.

- MII/RJ-45—Indicates which Ethernet port is selected.

Figure 1-15   Port Activity LEDs—Front Panel
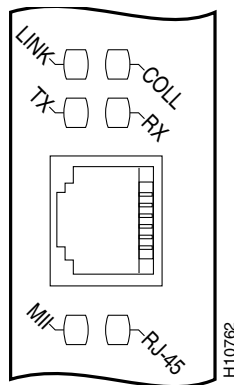
GRP Alphanumeric Message Displays

The alphanumeric message displays are organized in two rows of four LED characters (Figure 1-16).

Figure 1-16   Alphanumeric Message Displays—Front Panel
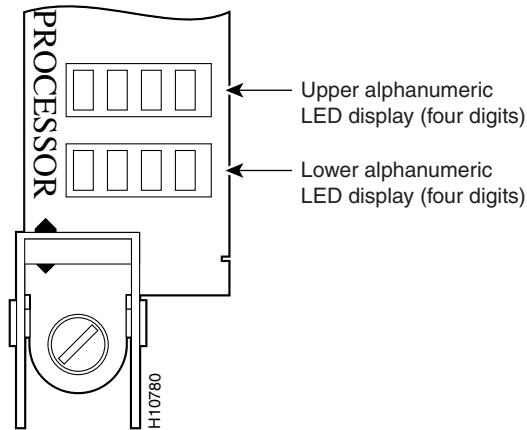
The alphanumeric message displays show router status messages during the boot process, and after the boot process is complete.

- During the boot process, the message displays are controlled directly by the MBus module.

- After the boot process, the message displays are controlled by Cisco IOS software (through the MBus).

The alphanumeric message displays also provide information about different levels of system operation, including the status of the GRP, router error messages, and user-defined status and error messages

Note   A complete, descriptive list of all system and error messages appears in the *Cisco IOS System Error Messages* publication.

GRP Memory Components

This section describes various types of memory used on the GRP to support router functions. Table 1-1 provides a quick reference of the different types of memory, and Figure 1-17 shows the location on the GRP board.

Table 1-1   GRP Memory Components

Type	Size	Quantity	Description	Location
DRAM	128[1] or 256 MB	1 or 2	Uses 64 MB or 128 MB DIMMs (based on DRAM configuration) for main Cisco IOS software functions	U39 (bank 1) U42 (bank 2)
SRAM	512 KB (fixed)	—	Secondary CPU cache memory functions	—
NVRAM	512 KB (fixed)	—	System configuration files, register settings, and logs	—
Flash memory	8 MB SIMM	1	Cisco IOS software images and other user-defined files	U17
Flash memory card PCMCIA[2]	20 MB[1]	1 or 2	Cisco IOS software images, system configuration files, and other user-defined files on one or two flash memory cards	Slots 0 and 1
Flash boot ROM	512 KB	1	Flash EPROM for the ROM monitor program boot image	—

1. Default shipping configuration.

2. Type I or Type II PCMCIA cards can be used in either slot.

Figure 1-17   GRP Memory Locations
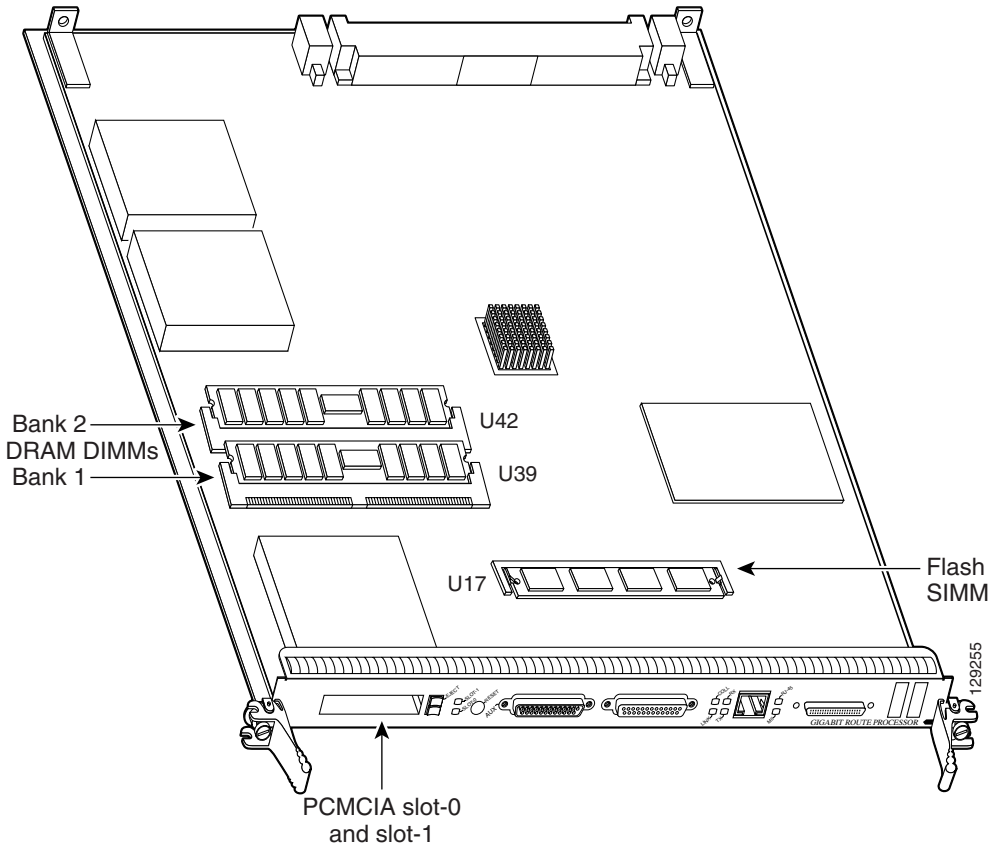
GRP DRAM

The GRP uses Extended Data-Out (EDO) Dynamic Random Access Memory (DRAM) to store routing tables, protocols, network accounting applications, and to run Cisco IOS software.

Table 1-2 lists the DRAM configurations for the GRP.

Table 1-2   GRP DRAM Configurations

Total DRAM	Part Number	DRAM Sockets	Number of DIMMs
128 MB[1]	MEM-GRP/LC-64(=)	U39 (bank 1) U42 (bank 2)	Two 64 MB
128 MB	MEM-GRP/LC-128(=)	U39 (bank 1)	One 128 MB
256 MB	MEM-GRP/LC-256(=)	U39 (bank 1) U42 (bank 2)	Two 128 MB

1. Default shipping configuration.

⚠
Caution   DRAM DIMMs must be 3.3-volt, 60-nanosecond devices only. Do not attempt to install other devices in the DIMM sockets. To prevent memory problems, use the Cisco approved memory products listed in Table 1-2.

GRP SRAM

Static Random Access Memory (SRAM) provides 512 KB of secondary CPU cache memory. Its principal function is to act as a staging area for routing table updates, and for information sent to and received from the line cards. SRAM is *not* user-configurable and cannot be upgraded in the field.

GRP NVRAM

Nonvolatile Random Access Memory (NVRAM) provides 512 KB of memory for system configuration files, software register settings, and environmental monitoring logs. Built-in lithium batteries retain the contents of NVRAM for a minimum of 5 years. NVRAM is *not* user configurable and cannot be upgraded in the field.

GRP Flash Memory

Use flash memory to store multiple Cisco IOS software and microcode images that you can use to operate the router. You can download new images to flash memory over the network (or from a local server) to replace an existing image, or to add it as an additional image. The router can be booted (manually or automatically) from any of the stored images in flash memory.

Flash memory also functions as a Trivial File Transfer Protocol (TFTP) server that allows other servers to boot remotely from the stored images, or to copy them into their own flash memory.

The system uses two types of flash memory:

- Onboard flash memory (called *bootflash)* —Contains the Cisco IOS boot image.
- 20 MB Type II PCMCIA flash memory cards (MEM-GRP-FL20=)—Contain the Cisco IOS software images.

Performance Route Processor Overview

The performance route processor (PRP) uses a Motorola PowerPC 7450 CPU that runs at an external bus clock speed of 133 MHz and has an internal clock speed of 667 MHz.

Figure 1-18 identifies the slots, ports, and LEDs on the PRP front panel.

Figure 1-18   Performance Route Processor Front Panel
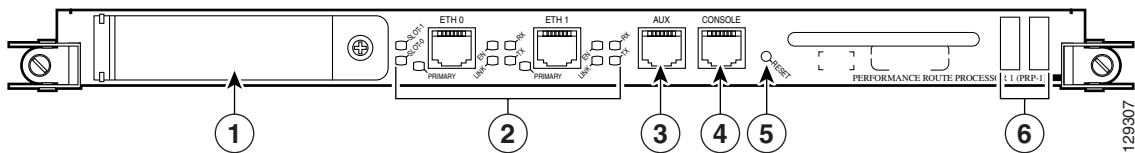
1	PCMCIA flash disk slots (shown with cover in place) and slot LEDs	4	Console serial port
2	RJ-45 Ethernet ports and data status LEDs	5	Reset button
3	Auxiliary serial port	6	Alphanumeric message displays

PRP PCMCIA Card Slots and Status LEDs

Two PCMCIA card slots (slot 0 and slot 1) provide the PRP with additional flash memory capacity. All combinations of different flash devices are supported by the PRP. You can use ATA flash disks, Type 1 or Type 2 linear flash memory cards, or a combination of the two.

Note   The PRP only supports +5.2 VDC flash memory devices. It does *not* support +3.3 VDC PCMCIA devices.

Status LEDs (Slot-0 / Slot-1) indicate when the flash memory card in that slot is accessed (see Figure 1-18). Each slot has an eject button (located behind the cover) to remove a flash card from the slot.

PRP Ethernet Ports and Status LEDs

The PRP has two 8-pin media-dependent interface (MDI) RJ-45 ports for either IEEE 802.3 10BASE-T (10 Mbps) or IEEE 802.3u 100BASE-TX (100 Mbps) Ethernet connections. These ports are labeled ETH 0 and ETH 1.

The transmission speed of the Ethernet port is not user-configurable. You set the speed through an autosensing scheme on the PRP which is determined by the network that the Ethernet port is connected to. However, even at an autosensed data transmission rate of 100 Mbps, the Ethernet port can only provide a usable bandwidth of substantially less than 100 Mbps. You can expect a maximum usable bandwidth of approximately 20 Mbps when using an Ethernet connection.

The following LEDs on the front panel indicate traffic status and port selection (Figure 1-19):

- LINK, EN, TX, RX—Indicate link activity (LINK), port enabled (EN), data transmission (TX), and data reception (RX).

- PRIMARY—Indicates which Ethernet port is selected (ETH 0 or ETH 1).

Note Because both ports are supported on the PRP, ETH 0 is always on. ETH 1 lights when it is selected.

Figure 1-19   Port Activity LEDs—Partial Front Panel
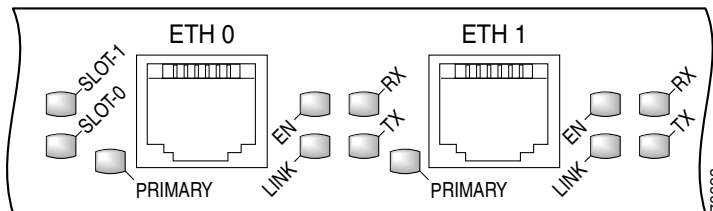
PRP Auxiliary and Console Ports

The auxiliary and console ports on the PRP are EIA/TIA-232 (also known as RS-232) asynchronous serial ports. These ports connect external devices to monitor and manage the system.

- The auxiliary port—A (male) plug that provides a data terminal equipment (DTE) interface. The auxiliary port supports flow control and is often used to connect a modem, a channel service unit (CSU), or other optional equipment for Telnet management.

- The console port—A (female) receptacle that provides a data circuit-terminating equipment (DCE) interface for connecting a console terminal.

PRP Reset Switch

Access to the (soft) reset switch is through a small opening in the PRP front panel (see Figure 1-18). To press the switch, insert a paper clip or similar small pointed object into the opening.

⚠️

Caution   The reset switch is *not* a mechanism for resetting the PRP and reloading the Cisco IOS image. It is intended for software development use only. To prevent system problems or loss of data, use the reset switch only on the advice of Cisco service personnel.

Pressing the reset switch causes a nonmaskable interrupt (NMI) and places the PRP in ROM monitor mode. When the PRP enters ROM monitor mode, its behavior depends on the setting of the PRP software configuration register. For example, if the boot field of the software configuration register is set to:

- 0x0—The PRP remains at the ROM monitor prompt (rommon>) and waits for a user command to boot the system manually.

- 0x1—The system automatically boots the first Cisco IOS image found in flash memory on the PRP.

For more information on the software configuration register, see the "Configuring the Software Configuration Register" section on page 4-31.

PRP Alphanumeric Message Displays

The alphanumeric message displays are organized in two rows of four LED characters each (Figure 1-20).

Figure 1-20   Alphanumeric Message Displays—Partial Front Panel
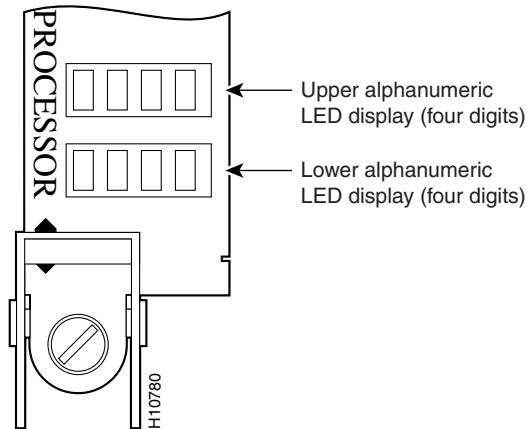
The alphanumeric message displays show router status messages during the boot process, and after the boot process is complete.

- During the boot process, the message displays are controlled directly by the MBus module.

- After the boot process, the message displays are controlled by Cisco IOS software (through the MBus).

The alphanumeric message displays also provide information about different levels of system operation, including the status of the GRP, router error messages, and user-defined status and error messages

Note   A complete, descriptive list of all system and error messages appears in the *Cisco IOS System Error Messages* publication.

PRP Memory Components

This section describes various types of memory used on the PRP to support router functions. Table 1-3 provides a quick reference of the different types of memory, and Figure 1-21 shows the location on the PRP board.

Table 1-3   PRP Memory Components

Type	Size	Quantity	Description	Location
SDRAM	512 MB[1], 1 GB, or 2 GB	1 or 2	Uses 512 MB or 1 GB DIMMs (based on SDRAM configuration) for main Cisco IOS software functions	U15 (bank 1) U18 (bank 2)
SRAM	2 MB (fixed)	—	Secondary CPU cache memory functions	—
NVRAM	2 MB (fixed)	—	System configuration files, register settings, and logs	—
Flash memory	64 MB SIMM	1	Cisco IOS boot image (bootflash), crash information, and other user-defined files	P3
Flash disk (PCMCIA)	64 MB[1]	1 or 2	Cisco IOS software images, system configuration files, and other user-defined files on one or two Flash memory cards	Flash memory card slot 0 and slot 1
Flash boot ROM	512 KB	1	Flash EPROM for the ROM monitor program boot image	—

1.   Default shipping configuration.

Figure 1-21   PRP Memory Locations
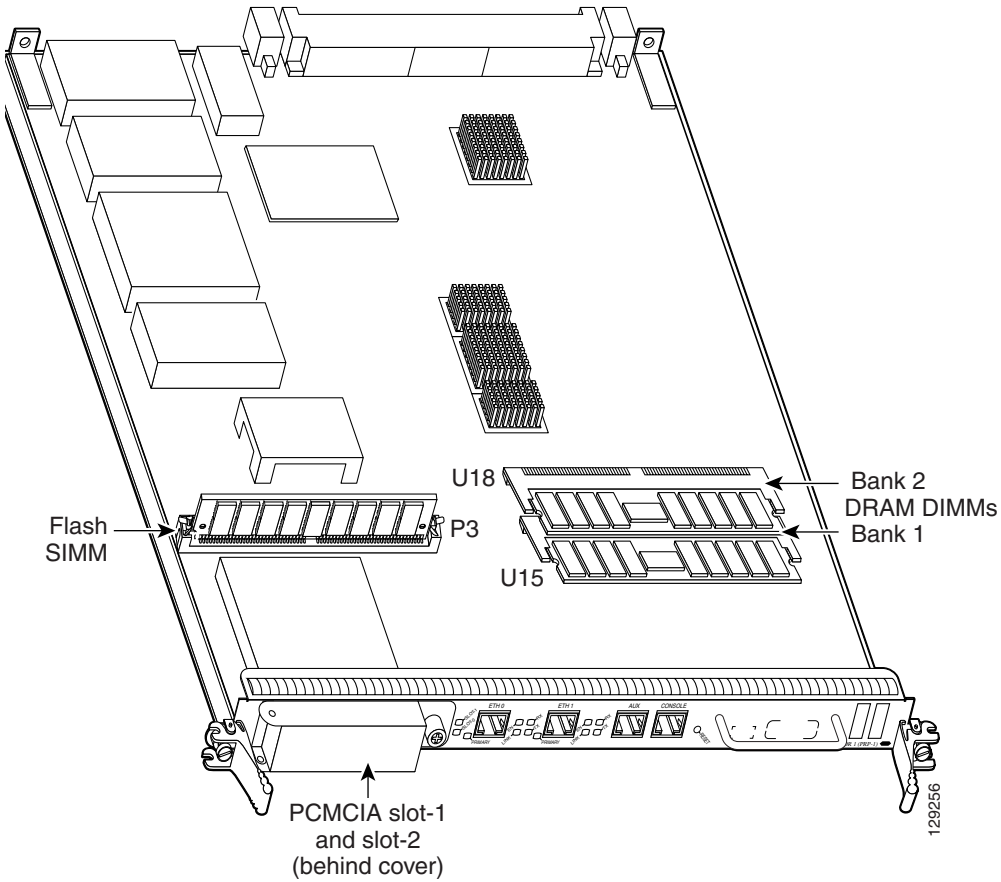
PRP SDRAM

The PRP uses Error Checking and Correction (ECC) Synchronized Dynamic Random Access Memory (SDRAM) to store routing tables, protocols, network accounting applications, and to run Cisco IOS software.

Table 1-4 lists the DRAM configurations for the PRP. If you are using:

- One DIMM—Bank 1 (U15) must be populated first.
- Two DIMMs—You cannot mix memory sizes; both banks must contain the same size DIMM.

Table 1-4   PRP DRAM Configurations

Total SDRAM	Part Number	SDRAM Sockets	Number of DIMMs
512 MB[1]	???(=)	U15 (bank 1) U18 (bank 2)	One 512 MB DIMM or Two 256 MB DIMMs
1 GB	???(=)	U15 (bank 1) U18 (bank 2)	One 1 GB DIMM or Two 512 MB DIMMs
2 GB	???(=)	U15 (bank 1) U18 (bank 2)	Two 1 GB DIMMs

1. Default shipping configuration.

⚠️
Caution   DRAM DIMMs must be 3.3-volt, 60-nanosecond devices only. Do not attempt to install other devices in the DIMM sockets. To prevent memory problems, use the Cisco approved memory products listed in Table 1-4.

PRP SRAM

Static Random Access Memory (SRAM) provides 2 MB of secondary CPU cache memory. Its principal function is to act as a staging area for routing table updates, and for information sent to and received from the line cards. SRAM is *not* user-configurable and cannot be upgraded in the field.

PRP NVRAM

Non-volatile Random Access Memory (NVRAM) provides 2 MB of memory for system configuration files, software register settings, and environmental monitoring logs. Built-in lithium batteries retain the contents of NVRAM for a minimum of 5 years. NVRAM is *not* user configurable and cannot be upgraded in the field.

PRP Flash Memory

Use flash memory to store multiple Cisco IOS software and microcode images that you can use to operate the router. You can download new images to flash memory over the network (or from a local server) to replace an existing image, or to add it as an additional image. The router can be booted (manually or automatically) from any of the stored images in flash memory.

Flash memory also functions as a Trivial File Transfer Protocol (TFTP) server to allow other servers to boot remotely from the stored images, or to copy them into their own flash memory.

The system uses two types of flash memory:

- Onboard flash memory (called *bootflash)*—Contains the Cisco IOS boot image

- Flash memory disks (or cards)—Contain the Cisco IOS software image

Table 1-5 lists supported flash disk sizes and Cisco part numbers.

Table 1-5   Supported Flash Disk Sizes

Flash Disk Size[1]	Part Number
64 MB[2]	MEM-12KRP-FD64=
128 MB	MEM-12KRP-FD128=
1 GB	MEM-12KRP-FD1G=

1. Standard Type 1 and Type 2 linear flash memory cards also are supported, although they may not have the capacity to meet the configuration requirements of your system.

2. Default shipping configuration.

Upper and Lower Cable Management Brackets

Cisco 12010, Cisco 12410, and Cisco 12810 series routers include upper and lower cable management brackets that work together with individual line card cable management brackets to organize interface cables entering and exiting the router (see Figure 1-1).

Network interface cables to the line cards are fed across the brackets, and then through the openings to the individual line card cable management bracket. This system keeps cables out of the way and free of sharp bends.

⚠️

Caution   Excessive bending of interface cables can damage the cables.

Blower Module

The router has two blower modules to distribute air within the chassis. One blower module is located above the upper card cage; the second blower module is located below the lower card cage (see Figure 1-1).

Each blower module contains three variable speed fans and a controller card. The two front cover LEDs provide a visual indication of blower module status (Figure 1-22):

Figure 1-22   Blower Module
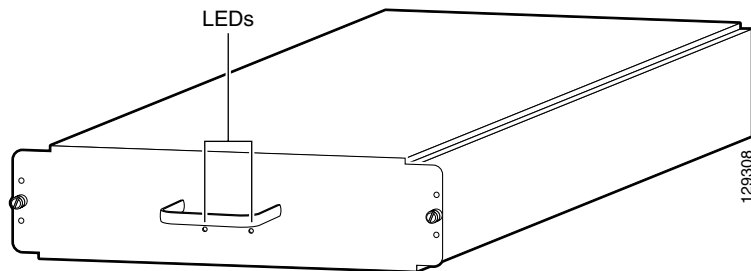
- OK (green)—All three fans are operating normally.

- FAIL (red)—The system has detected a fan failure or other fault in the blower module. The fault can be caused by any of the following:

    - One or more fans are not operating

    - One or more fans are running below speed

    - A controller card fault

The blower modules maintain acceptable operating temperatures for the internal components by drawing cool air through a replaceable air filter into the switch fabric card cage and then through the upper and lower card cages. Figure 1-23 illustrates the air flow path through the chassis.

Figure 1-23   Cooling Air Flow

Power supply shelf

Top blower module →

Air exhaust

(Plenum)

Upper card cage

Air filter

Room air

Middle card cage

Lower card cage

(Plenum)

Bottom blower module →

Air exhaust

Front   Rear

26204
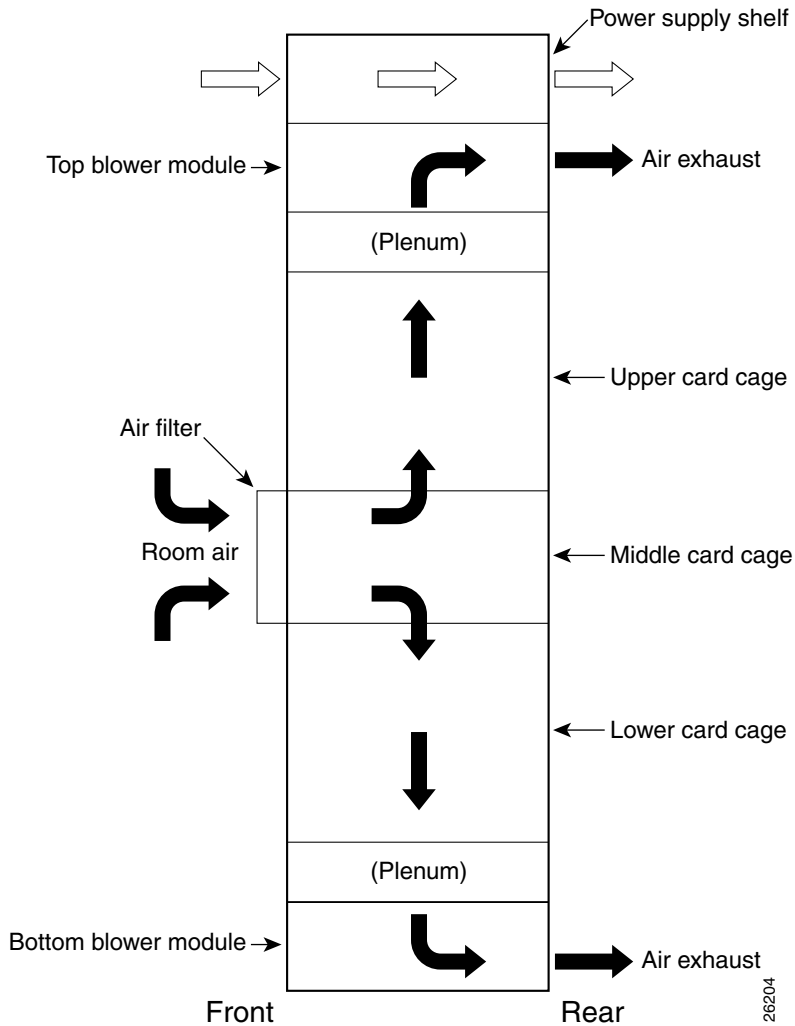
To ensure that there is adequate air flow to prevent overheating inside the card cages keep the front and back of the router unobstructed. We recommend at least 6 inches (15.24 cm) of clearance.

⚠

Caution   You should inspect and clean the air filter one time per month (more often in dusty environments). Do not operate the router without an air filter installed.

The blower module controller card monitors and controls operation of three variable-speed fans in the blower modules. The variable-speed feature allows quieter operation by running the fans at below maximum speed, while still providing adequate cooling to maintain an acceptable operating temperature inside the card cages.

Two temperature sensors on each line card monitor the internal air temperature in the card cages:

- When the ambient air temperature is within the normal operating range, the fans operate at their lowest speed, which is 55 percent of the maximum speed.

- If the air temperature rises inside the card cages the fan speed increases to provide additional cool air to the cards.

- If the air temperature continues to rise beyond the specified threshold, the system environmental monitor shuts down all internal power to prevent equipment damage due to excessive heat.

- If the system detects that one of the three fans within a blower module has failed, it displays a warning message on the console window. In addition, the two remaining fans go to full speed to compensate for the loss of the one fan. If another fan fails, the system shuts down to prevent equipment damage.

For additional troubleshooting information, see the "Blower Module Operation" section on page 5-38.

Preparing for Installation

Before installing your router, consider power and cabling requirements that must be in place at your installation site, special equipment for installing the router, and the environmental conditions your installation site must meet to maintain normal operation. This chapter guides you through the process of preparing for router installation.

The shipping package for the router is engineered to reduce the chances of product damage associated with routine material handling experienced during shipment.

- The router should always be transported or stored in its shipping package in the upright position.
- Keep the router in the shipping container until you have determined the installation site.

Use the *Cisco 12016, Cisco 12416, and Cisco 12816 Router Unpacking Instructions* included with the router to unpack it and inspect all items for shipping damage. If an item appears damaged, contact a Cisco customer service representative immediately.

This chapter contains the following installation topics:

Safety Guidelines

Before you perform any procedure in this publication, review the safety guidelines in this section to avoid injuring yourself or damaging the equipment. In addition, be sure to review the safety warnings listed in the *Regulatory Compliance and Safety Information for Cisco 12000 Series Internet Routers* publication that accompanied your router before you begin router installation.

Note that the information in this section are *guidelines* and do not include every potentially hazardous situation. When you install a router, always use common sense and caution.

Safety with Equipment

- Cisco equipment operates safely when used in accordance with its specifications and product-usage instructions.

- Never install equipment that appears damaged.

- Do not perform any action that creates a potential hazard to people or makes the equipment unsafe.

- Never attempt to lift an object that might be too heavy for you to lift by yourself.

- Do not wear loose clothing, jewelry, or other items that could get caught in the router.

- Keep tools and assembly components away from walk areas.

- Do not work alone if potentially hazardous conditions exist.

- Keep the work area clear and dust-free during and after installation. Do not allow dirt or debris to enter into any laser-based components.

Safety with Electricity

- The installation shall be in compliance with national and local electrical codes: in the United States, National Fire Protection Association (NFPA) 70, United States National Electrical Code; in Canada, Canadian Electrical Code, part I, CSA C22.1; in other countries, International Electrotechnical Commission (IEC) 60364, part 1 through part 7.

- Before you begin any procedures requiring access to the interior of the router, locate the emergency power-off switch for the room in which you are working.

- Disconnect all power source cables before installing or removing a router.

- Never assume that power has been disconnected from a circuit; always check.

- Carefully examine your work area for possible hazards such as moist floors, ungrounded power extension cables, and missing safety grounds.

- Only a DC power source that complies with the safety extra-low voltage (SELV) requirements in UL60950, CSA-C22.2 No. 60950, EN60950, ACATS001, AS/NZS 60950,and IEC60950 can be connected to the line card chassis DC-input power system.

- A line card chassis configured with the DC-input power system shall have a readily accessible two-poled disconnect device incorporated in the fixed wiring.

- The line card chassis requires short-circuit (overcurrent) protection to be provided as part of the building installation.

- If an electrical accident occurs, proceed as follows:

    - Use caution; do not become a victim. Disconnect power to the router.

    - If possible, send another person to get medical aid; otherwise, assess the condition of the victim and then call for help.

Preventing Electrostatic Discharge Damage

Many router components can be damaged by static electricity. Not exercising the proper electrostatic discharge (ESD) precautions can result in intermittent or complete component failures. To minimize the potential for ESD damage, always use an ESD-preventive antistatic wrist strap (or ankle strap) and ensure that it makes good skin contact.

Note   Check the resistance value of the ESD-preventive strap periodically. The measurement should be between 1 and 10 megohms.

Before you perform any of the procedures in this guide, attach an ESD-preventive strap to your wrist and connect the leash to the chassis or to another grounded, bare metal surface as shown in Figure 2-1.

Figure 2-1   Connecting an ESD-Preventive Strap to the Router Chassis

ESD
connection
socket

26208
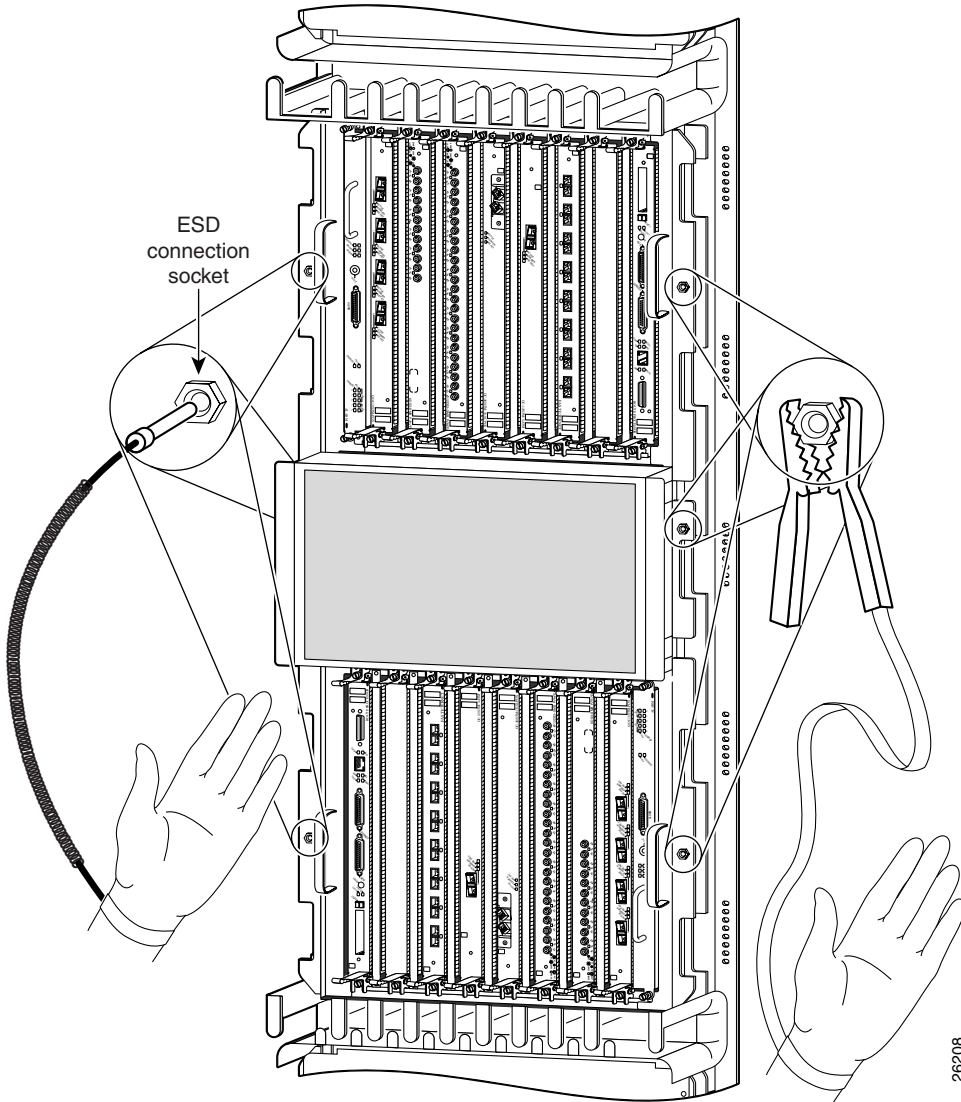
Lifting Guidelines

A fully configured router can weigh as much as 275 pounds (lb) (124.74 kilograms (kg)), while an empty chassis weighs 125 lb (56.7 kg). These systems are not intended to be moved frequently. Before you install the router, ensure that your site is properly prepared so you can avoid having to move the router later to accommodate power sources and network connections.

Use the following lifting guidelines to avoid injury to yourself or damage to the equipment:

- Do not lift equipment alone; have another person help you to lift heavy equipment.
- Ensure that your footing is solid; balance the weight of the object between your feet.
- Lift the equipment slowly; never move suddenly or twist your body as you lift.
- Keep your back straight and lift with your legs, not your back. When bending down to lift equipment, bend at the knees (not at the waist), to reduce the strain on your lower back muscles.

⚠

Caution   To prevent equipment damage, never attempt to lift or tilt the router chassis using the handles on the blower module or on line cards. These handles do not support the weight of the chassis.

Compliance and Safety Information

The Cisco 12016, Cisco 2416 and Cisco 12816 routers are designed to meet the regulatory compliance and safety approval requirements. Refer to the *Regulatory Compliance and Safety Information for the Cisco 12000 Series Router* (Document Number 78-4347-xx) if you require additional compliance information (see "Cisco Technical Support & Documentation Website" section on page -xx for site information).

Laser Safety

Some line cards are equipped with ports that can emit hazardous laser radiation from the aperture when there is no cable connected to the port. This invisible radiation can cause eye injury if you stare into the port.

Warning   **To avoid eye injury, never stare into open line card ports.**

Site Requirement Guidelines

This section provides the following site requirement guidelines that you must consider before installing the router:

Rack-Mounting Guidelines

The router can be mounted in most 2-post, 4-post, or telco-type 19-inch equipment racks that comply with the Electronics Industries Association (EIA) standard for equipment racks (EIA-310-D). The rack must have at least two posts with mounting flanges to mount the router chassis. The distance between the center lines of the mounting holes on the two mounting posts must be 18.31 inches ± 0.06 inch (46.50 cm ± 0.15 cm). The rack-mounting hardware included with the router is suitable for most 19-inch equipment racks or telco-style frames.

Figure 2-2 shows examples of typical 2-post, 4-post, and telco-type equipment racks.

Figure 2-2   Equipment Rack Types
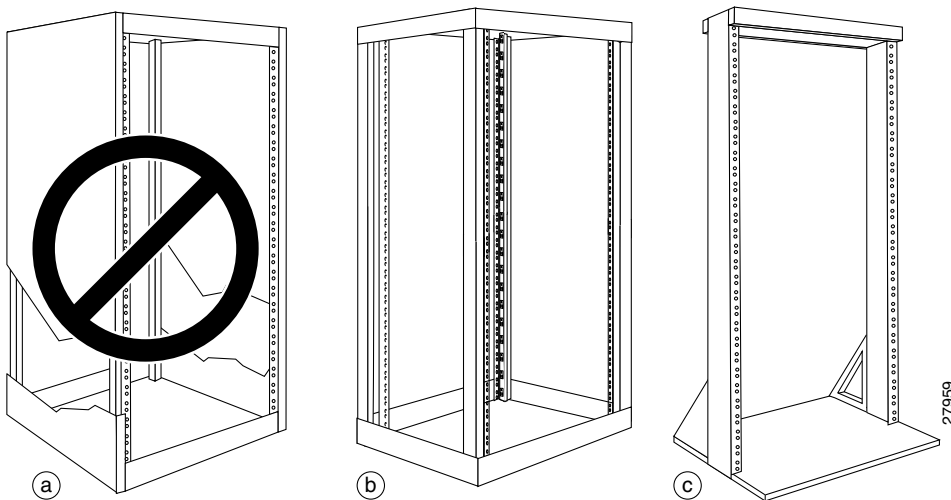
Enclosed Rack

Figure 2-2**a** shows a free-standing, enclosed rack with two mounting posts in the front. The router should *not* be installed in this type of enclosed rack, because the router requires an unobstructed flow of cooling air to maintain acceptable operating temperatures for its internal components. Installing the router in any type of enclosed rack—*even with the front and back doors removed*—could disrupt the air flow, trap heat next to the chassis, and cause an overtemperature condition inside the router.

Open Rack

Figure 2-2**b** shows a free-standing, 4-post open rack with two mounting posts in the front and two mounting posts in the back. The mounting posts in this type of rack are often adjustable so that you can position the rack-mounted unit within the depth of the rack rather than flush-mount with the front of the rack.

Telco Rack

Figure 2-2**c** shows a telco-type rack. The telco-type rack is an open frame consisting of two posts tied together by a cross-bar at the top and a floor stand at the bottom.

This type of rack is usually secured to the floor and sometimes to an overhead structure or wall for additional stability. The router chassis can be installed in the telco-type rack either in a front-mounted position or a center-mounted position (Figure 2-3).

- In the front-mounted position, you secure the chassis rack-mounting brackets directly to the rack posts.

- In the center-mounted position, you secure a set of optional center-mount brackets to the rack posts. The chassis rack-mounting flanges are then secured to the center-mount brackets. The center-mounted position moves the center of gravity of the chassis closer to the vertical axis of the rack posts, which adds to the stability of the rack installation.

Figure 2-3   Front-Mounted and Center-Mounted Installation in a Telco Rack

Front-mount rail

Cisco 12016 chassis

Center-mount bracket

Front-mounted chassis
in telco rack

Center-mounted chassis
in telco rack
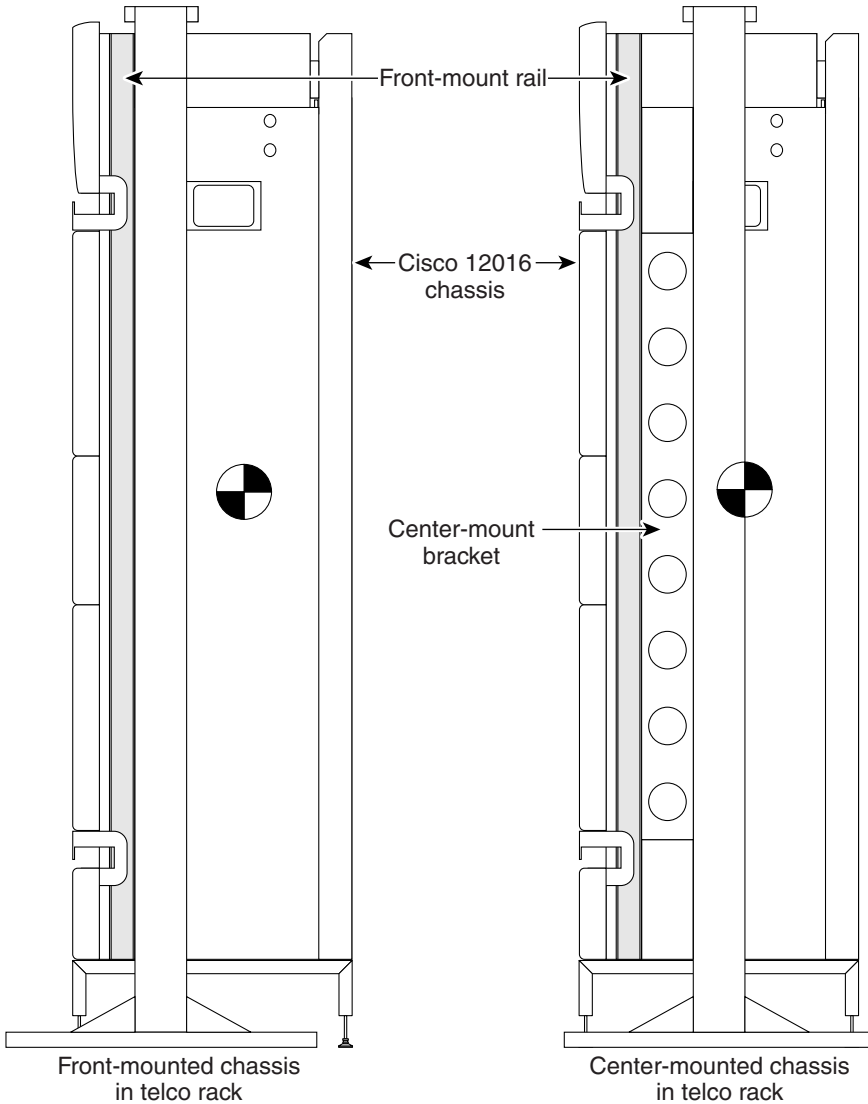
27958

Site Layout and Equipment Dimensions

To help maintain trouble-free operation, adhere to the following precautions when planning your rack installation:

- Ensure the site of the rack includes provisions for source AC or DC power, grounding, and network interface cables.

- Allow sufficient space to work around the rack during the installation. You need:

  - At least 3 feet adjacent to the rack to move, align, and insert the chassis.

  - At least 2 feet in front of the power shelf to insert power entry modules.

- Maintain at least 24 inches (61 cm) of clearance in front of and behind the chassis for maintenance after installation.

- To mount the router between two posts or rails, the usable aperture (the width between the *inner* edges of the two mounting flanges) must be at least 17.7 inches (45.0 cm).

- When fully populated with cards, the router can weigh as much as 440 lb (200 kg). Mount the router so that the bottom of the router chassis is no higher than 10 inches (25.4 cm) from the floor to keep the center of gravity of the rack as low as possible. To maintain equipment rack stability and to ensure your safety, make sure you install any stabilizing devices provided before you install the router.

- If you use a telco-style rack, the weight of the chassis is cantilevered off of the two rack posts. Make sure that:

  - The weight of the router does not make the frame unstable.

  - The frame is bolted to the floor and is secured to the building structure using either wall brackets or overhead brackets.

- When mounting the router in a telco-type rack or 4-post rack, be sure to use all of the screws provided to secure the chassis to the rack posts.

- For the enhanced models of the Cisco 12016 series routers, the mounting rails on a 4-post rack must be recessed no more than 1.5 inches for the front door to fully open and close and to provide adequate room for cable routing.

- Install the cable-management brackets included with the router to keep cables organized. Be sure to:

  - Use appropriate strain-relief methods to protect cables and equipment connections.

  - Make sure that cables from other equipment installed in the rack do not restrict access to the card cages.

- To avoid noise interference in network interface cables, do not route them directly across or along power cables.

Figure 2-4 shows the footprint and outer dimensions of the original series router chassis.

Figure 2-4   Router Chassis Footprint and Dimensions—Top View)
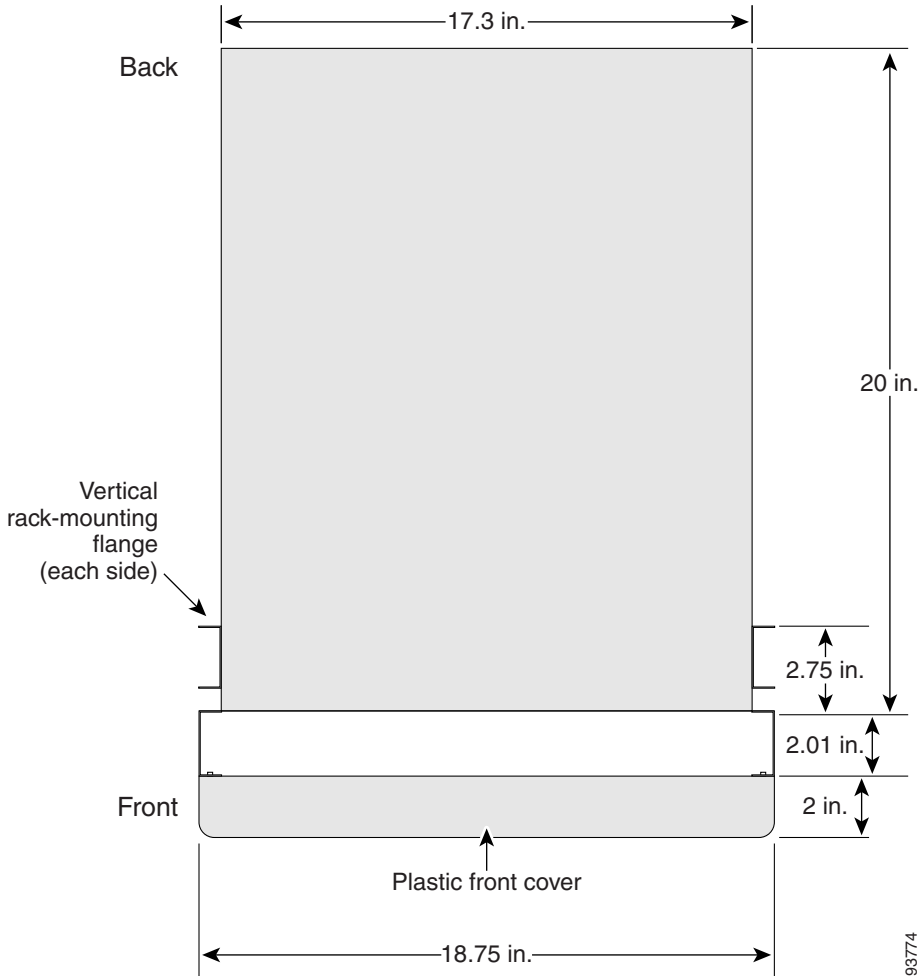
Figure 2-5 shows the footprint and outer dimensions of the enhanced version of router chassis.

Figure 2-5   Enhanced Router Chassis Footprint and Dimensions—Top View
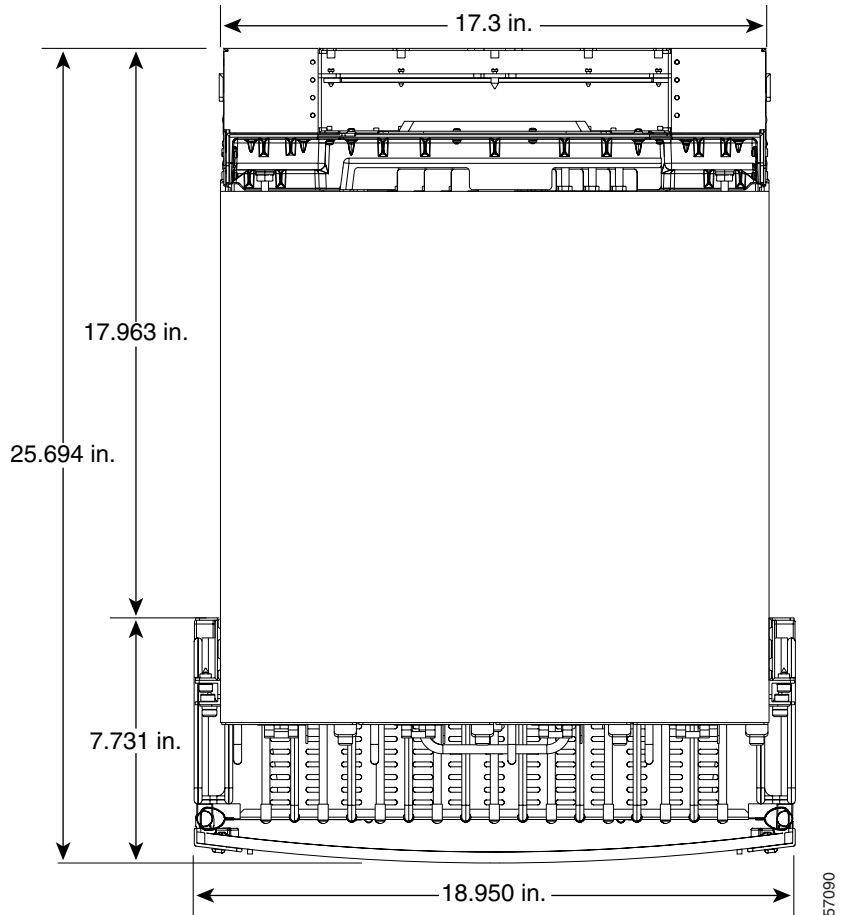
Air Flow Guidelines

Cool air is circulated through the router chassis by two blower modules. The blower modules maintain acceptable operating temperatures for the internal components by drawing in cool air through the air filter in front of the switch fabric card cage (middle), and circulating the air through both card cages (Figure 2-6).

Each power supply is also equipped with a fan that draws cooler air into the front of the power supply and forces warmer air out of the back of the chassis.

When selecting a site to install the router, observe the following guidelines:

- Dust free area—The site should be as dust free as possible. Dusty environments can clog the air filter or power supply intake vents, reducing the cooling air flow through the router. Clogged filters and vents can cause an overtemperature condition in the router.

- Unrestricted air flow—Allow sufficient air flow by maintaining a minimum of 6 inches (15.24 cm) of clearance at both the inlet and exhaust openings on the chassis and the power modules. If the air flow is blocked or restricted, or if the inlet air is too warm, an overtemperature condition can occur within the router. Under extreme conditions, the environmental monitoring system will power off the router to protect the components.

Figure 2-6   Air Flow Path through the Router - Side View

Power supply shelf

Top blower module →

Air exhaust

(Plenum)

Upper card cage

Air filter

Room air

Middle card cage

Lower card cage

(Plenum)

Bottom blower module →

Air exhaust

Front   Rear

26204
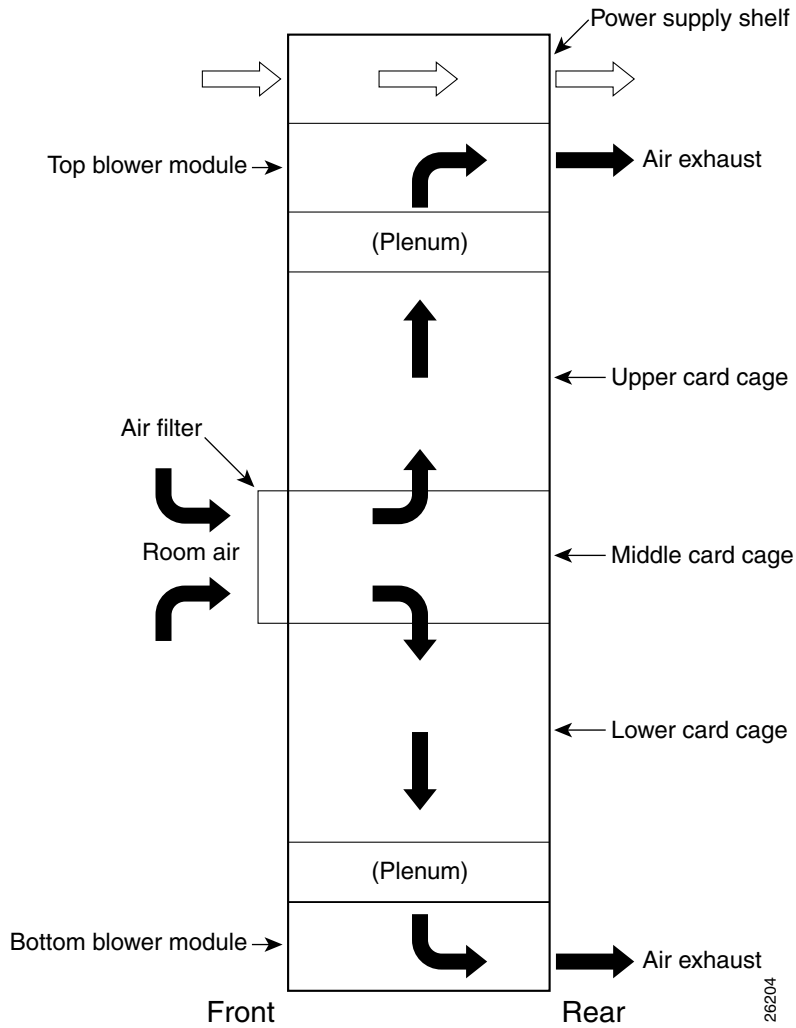
Temperature and Humidity Guidelines

The operating and nonoperating environmental site requirements are listed in Table A-4 on page A-4. The router normally operates within the ranges listed in Table A-4, however, if a temperature measurement is approaching a minimum or maximum parameter it indicates a potential problem. Maintain normal operation by anticipating and correcting environmental anomalies before they approach critical values by properly planning and preparing your site before you install the router.

Power Connection Guidelines

You can configure the router with either an AC-input or DC-input power subsystem, so the site power source requirements differ depending on the power subsystem in your router. Ensure all power connection wiring conforms to the rules and regulations in the National Electrical Code (NEC), as well as local codes.

⚠️

Caution   Proper grounding is necessary to avoid damage from lightning and power surges. See the "Router Bonding and Grounding Receptacles—Top Rear" section on page 2-23 for grounding requirements.

AC-Powered Routers

AC PEMs operate in the nominal range of 200 VAC to 240 VAC and require a minimum service of:

- 20 A for operation in North America

- 16 A for international operation

- 13 A for operation in the UK

Each of the AC power inputs requires separate dedicated branch circuit. For a list of the nominal and acceptable value ranges for source AC power, refer to Table A-2 on page A-3.

Figure 2-7 shows different styles of AC power cords used to connect to the local AC power source that are available for North America and various locales.

Figure 2-7   AC Power Cord Plugs and Appliance Coupler
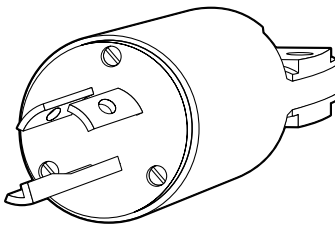
North America
Rewirable twist-lock plug
NEMA L6-20P (20A)
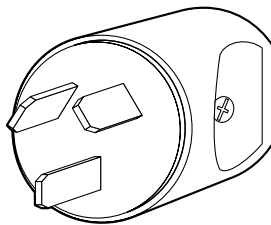
Australia, New Zealand
SAA/3 plug
AS/NZZS 3112-1993 (15A)

Europe, Argentine, Brazil
VIIG plug
CEE (7) VII (16A)
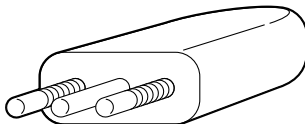
Italy
1/3/16 plug
CEI 23-16 (16A)
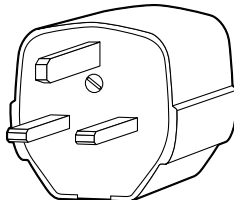
United Kingdom
BS89/13
BS 1363/A
(13A; replaceable fuse)
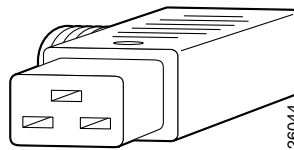
Appliance coupler
C19W coupler
Hot EN60320/C19 (20A)

26044

Table 2-1 lists power cord options. All AC-input power supply power cords measure 14 feet (4.3 m).

Table 2-1   AC Power Cord International Options

Label	Description	Part Number
North America	20 A, 250 VAC	CAB-GSR16-US=
Australia, New Zealand	15 A, 250 VAC	CAB-GSR16-AU=
Europe, Argentina, Brazil	16 A, 250 VAC	CAB-GSR16-EU=
Italy	16 A, 250 VAC	CAB-GSR16-IT=
United Kingdom	13 A, 250 VAC (13 A replaceable fuse)	CAB-GSR16-UK=

DC-Powered Routers

Connections to DC PEMs are rated at 60 amps maximum. A dedicated, commensurately rated DC power source is required for each PEM connection.

For DC power cables, we recommend that you use a commensurately rated, high-strand-count copper wire cable. Connection to the DC power shelf requires one earth ground cable and two cable leads; a source DC (–) and source DC return (+) for each PEM. The length of the cables depends on your router location from the source power.

Note   DC power cables are not available from Cisco, but are available from any commercial cable vendor.

You must terminate DC power cables using cable lugs at the power shelf end. Ensure the lugs are dual-hole and that they are able to fit over M6 terminal studs at 0.625-inch (15.88-mm) centers (for example, Panduit Part Number LCD8-14A-L or equivalent).

Figure 2-8 shows the type of lug required for the DC-input cable connections.

Figure 2-8   DC Power Cable Lug
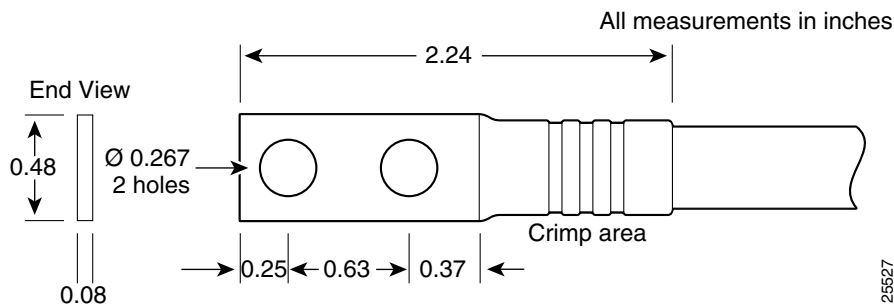
Figure 2-9 shows a source DC power distribution scheme for a DC-input power shelf.

It shows two power cables attached to the DC-input power lugs for power shelf bay B1 (far right bay of the DC-input power shelf when looking at the back panel).

The color coding of the source DC power cable leads depends on the color coding of the site DC power source. Typically, green or green and yellow indicate that the cable is a ground cable. Because there is no color code standard for the source DC wiring, be sure that the power cables are connected to the DC-input power shelf terminal studs using the proper positive (+) and negative (–) polarity.

• In some cases, the source DC cable leads might have a positive (+) or a negative (–) label. This is a relatively safe indication of the polarity, but you must verify the polarity by measuring the voltage between the DC cable leads. When making the measurement, the positive (+) lead and the negative (–) lead must always match the (+) and (–) labels on the power shelf.

• A green (or green and yellow) cable typically indicate that it is a ground cable.

Figure 2-9   Typical Source DC Power Cabling Scheme for Power Shelf Bay B1

⚠
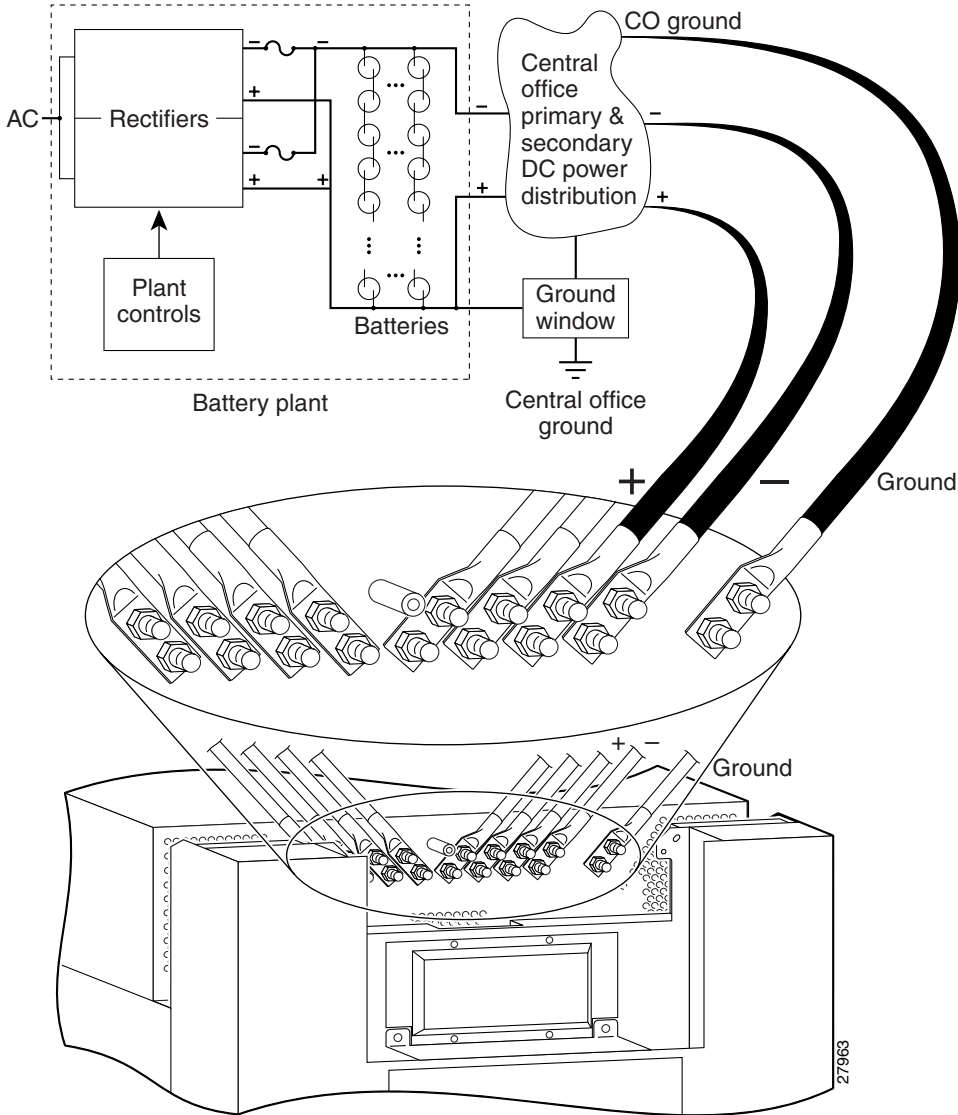
Caution   DC PEMs contains circuitry to trip the breaker on the PEM if the PEM detects a reverse polarity condition. No damage should occur from reverse polarity, but you should correct a reverse polarity condition immediately.

For a list of the nominal and acceptable value ranges for source DC power, refer to Table A-3 on page A-3.

NEBS Supplemental Unit Bonding and Grounding Guidelines

Although the router chassis requires a safety earth ground connection as part of the power cabling to the power shelf, we also recommend that you connect the central office ground system or interior equipment grounding system to the supplemental bonding and grounding connections.

Supplemental connections are located at the top of the power interface panel on the back of the chassis (Figure 2-10), and near the lower corners of the switch fabric card cage on the front flanges of the chassis (Figure 2-11). The DC return of this system should remain isolated from the system frame and chassis (DC-I).

This grounding points are also referred to as the network equipment building system (NEBS) bonding and grounding connections.

✎

Note   These bonding and grounding connections satisfy the Telcordia NEBS requirements for supplemental bonding and grounding connections. If you are not installing the router in a NEBS environment, you can choose to bypass these guidelines and rely on the safety earth ground connections to the AC and DC power shelves.

Figure 2-10   Router Bonding and Grounding Receptacles—Top Rear

Supplemental
bonding and
grounding
receptacle

29183
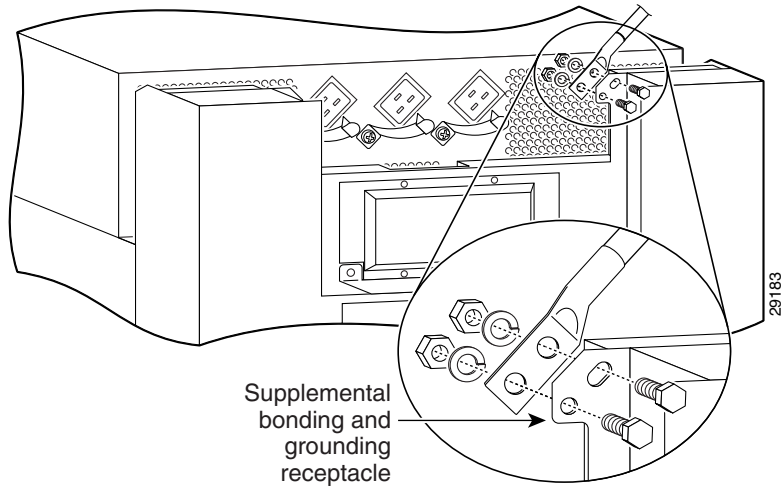
Figure 2-11   Router Bonding and Grounding Receptacles—Front

NEBS
supplemental
earth ground
receptacle

Air filter door

28022
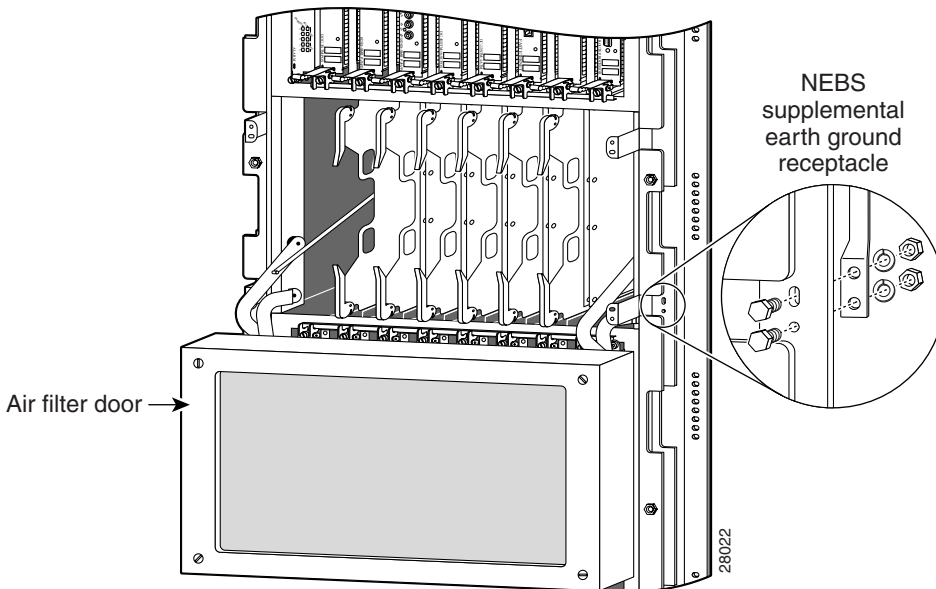
To ensure a satisfactory supplemental ground connection to the router, use the following parts:

Note   These parts are not available from Cisco, but are available from commercial vendors.

- Two grounding lugs, which have two M6 bolt holes with 0.625 to 0.75-inch (15.86 to 19.05-mm) spacing between them, and a wire receptacle large enough to accept a 6-AWG or larger, multistrand copper wire. This lug is similar to those used for the DC-input power supply leads (see Figure 2-8).
- Two M6 hex-head nuts and locking washers (nickel-plated brass is ideal).
- Two grounding wires. Although we recommend at least 6-AWG multistrand copper wire, the wire diameter and length depend on your router location and site environment.

Site Wiring Guidelines

When planning the location of the router, consider distance limitations for signaling, electromagnetic interference (EMI), and connector compatibility. If the wiring is run for any significant distance in an electromagnetic field, interference can occur between the field and the signals on the wires. Poor wiring can cause:

- Radio interference emanating from the wires.
- Strong EMI, especially when caused by lightning or radio transmitters. EMI can destroy the signal drivers and receivers in the router, and can even create an electrical hazard by conducting power surges through lines and into equipment.

Note   To predict and remedy strong EMI, you may need to consult with experts in radio frequency interference (RFI).

Site wiring is unlikely to emit radio interference if you use twisted-pair cable with a good distribution of grounding conductors. Use a high-quality twisted-pair cable with one ground conductor for each data signal, when applicable.

Give special consideration to the effect of a lightning strike in your vicinity, especially if the wiring exceeds the recommended distances, or if it passes between buildings. The electromagnetic pulse (EMP) caused by lightning or other high-energy phenomena can easily induce enough energy into unshielded conductors to destroy electronic devices. If you have experienced EMP problems in the past, you may want to consult experts in electrical surge suppression and shielding.

Most data centers cannot resolve the infrequent but potentially catastrophic problems without pulse meters and other special equipment. In addition, these problems can take a great deal of time to identify and resolve. We recommend that you take the necessary precautions to avoid these problems by providing a properly grounded and shielded environment, with special attention to issues of electrical surge suppression.

GRP Port Connection Guidelines

This section contains detailed cabling and signal information for all interface and port connections to the GRP. It also provides information for Ethernet routing and equipment.

⚠️

Caution   Ports labeled Ethernet, 10BASE-T, Token Ring, Console, and AUX are safety extra-low voltage (SELV) circuits. Only connect SELV circuits to other SELV circuits.

- GRP Auxiliary and Console Port Connections, page 2-26
- GRP Ethernet Port Connections, page 2-29
- PRP Auxiliary and Console Port Connection Guidelines, page 2-36
- PRP Ethernet Connections, page 2-40

GRP Auxiliary and Console Port Connections

The GRP has two EIA/TIA-232 ports (Figure 2-12):

- Auxiliary port— DB-25 plug, DTE-mode port for connecting a modem or other DCE device (such as a CSU/DSU or another router) to the GRP.

- Console port—DB-25 receptacle, DCE-mode port for connecting a data terminal to perform the initial configuration of the router.

✎
Note   The auxiliary and console ports are asynchronous serial ports. Devices connected to these ports must be capable of asynchronous transmission.

Figure 2-12   GRP Auxiliary and Console Port Connections
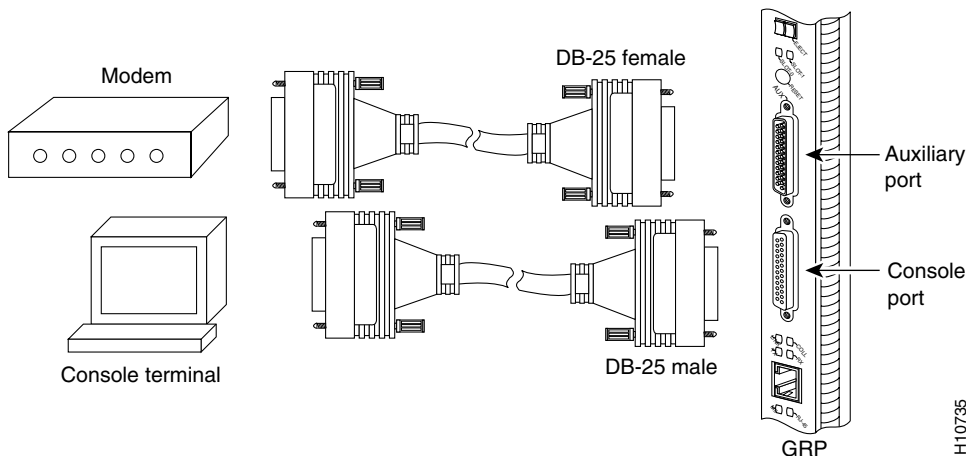
Because the connectors on some standard cables are large enough to interfere with the front covers installed on the card cages, a lower-profile cable adapter is included that permits you to connect a flat cable with modular RJ-45 plugs to the GRP console port.

✎
Note   EIA/TIA-232 cables are not available from Cisco, but are available from any commercial cable vendor.

⚠️

Caution   To maintain Class B EMI compliance, you must use shielded cables when connecting to the auxiliary and console ports of original GRPs (part numbers GRP= and GRP-B=). An updated version of the GRP-B= board (Rev. F0) does not require shielded cables for Class B compliance.

GRP Auxiliary Port Signals

The GRP auxiliary port is a DB-25 DTE port for connecting a modem or other DCE device to the router. The auxiliary port supports hardware flow control and modem control.

Table 2-2 lists the signals used on the auxiliary port.

Table 2-2   GRP Auxiliary Port Signals

Pin	Signal	Direction	Description
1	GND	—	Shield ground
2	TxD	Output	Transmit data (to DCE)
3	RxD	Input	Receive data (from DCE)
4	RTS	Output	Request to send (used for hardware flow control)
5	CTS	Input	Clear to send (used for hardware flow control)
6	DSR	Input	Data set ready
7	GND	—	Signal ground
8	DCD	Input	Carrier detect (used for modem control)
20	DTR	Output	Data terminal ready (used for modem control only)
22	RING	Input	Ring

GRP Console Port Signals

The GRP console port is a DB-25 DCE interface for connecting a DTE terminal device to the router. Both Data Set Ready (DSR) and Data Carrier Detect (DCD) signals are active when the router is powered on. The console port does not support modem control or hardware flow control and requires a straight-through EIA/TIA-232 cable.

Before you connect a terminal to the console port, check the terminal setting for the data transmission rate, in bits per second (bps). The terminal transmission rate setting must match the default rate of the GRP console port, which is 9600 bps. Set the terminal to these operational values: 9600 bps, 8 data bits, no parity, 2 stop bits (9600 8N2).

Table 2-3 lists the signals used on the console port.

Table 2-3   GRP Console Port Signals

Pin	Signal	Direction	Description
1	GND	—	Shield ground
2	TxD	Output	Transmit data (from DTE)
3	RxD	Input	Receive data (to DTE)
6	DSR	Input	Data set ready (always on)
7	GND	—	Signal ground
8	DCD	Input	Data carrier detect (always on)
20	DTR	Output	Data terminal ready

GRP Ethernet Port Connections

The GRP has the following two types of Ethernet connections (Figure 2-13):

- RJ-45 media-dependent interface (MDI)

- 40-pin, D-shell type media-independent interface (MII)

Figure 2-13   GRP RJ-45 and MII Ethernet Connections
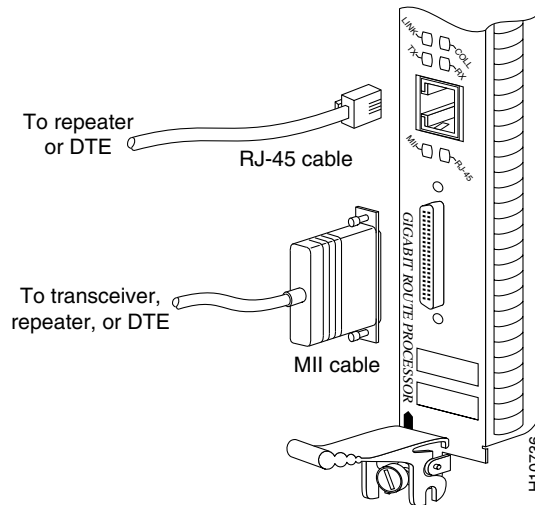
You can use either Ethernet connection, but not both at the same time. Two LEDs on the GRP front panel indicate which Ethernet port is active. Each connection supports IEEE 802.3 and IEEE 802.3u interfaces compliant with the 10BASE-T and 100BASE-TX standards.

Note   The Ethernet port can use either unshielded twisted-pair (UTP) or shielded twisted-pair (STP) cables. Shielded twisted-pair cables are recommended for sites at which extremely high immunity to noise is required.

The GRP Ethernet port does not provide external routing functions. Its primary roles are to act as a Telnet port into the router, and to boot or access Cisco IOS software images over a network to which the GRP Ethernet port is directly connected.

⚠️

Caution   Cisco Express Forwarding (CEF) functions on these ports are switched off by default for security reasons. Cisco strongly cautions you to consider the security implications of switching on CEF routing functions on these ports.

Figure 2-14 shows:

- You cannot access Network 2.0.0.0 from Ethernet port (E0) on the GRP in Router A. You can only access Host A, Host B, and Router C, which are in Network 1.0.0.0 (see dotted-line arrows).

- To access Network 2.0.0.0 from Router A, you must use an interface port on one of the line cards (a POS line card in this example) in Router A. Data from Router A is routed through Router B and Router C, to reach Network 2.0.0.0 (see solid-line arrows).

Figure 2-14   Using the Ethernet Port on the GRP
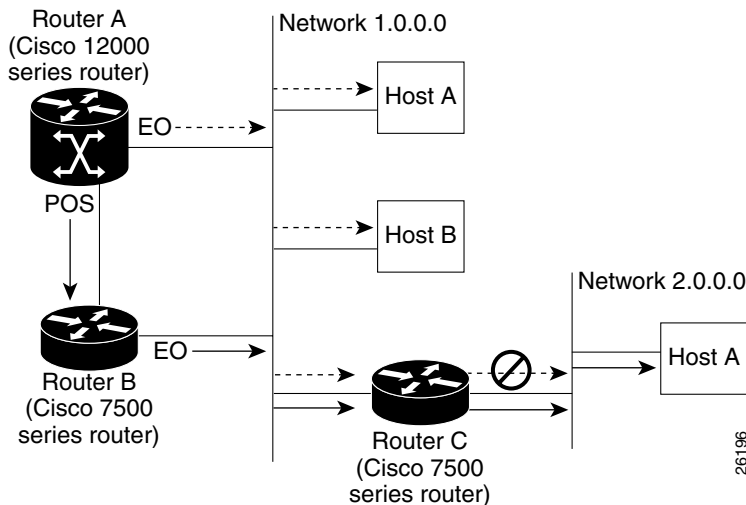
GRP RJ-45 Ethernet Connections

The RJ-45 Ethernet connection does not require an external transceiver. Figure 2-15 shows the pin orientation of the RJ-45 Ethernet port and the modular cable plug it accepts.

Figure 2-15   GRP RJ-45 Ethernet Receptacle and Modular Plug

87654321

RJ-45 connector

H2936
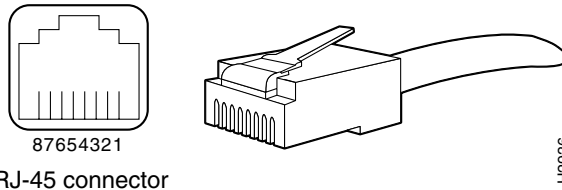
Table 2-4 lists the RJ-45 pin signals used on the connector.

Table 2-4   GRP RJ-45 Ethernet Receptacle Pinout

Ethernet Port Pin	Signal	Description
1	TxD+	Transmit data +
2	TxD–	Transmit data –
3	RxD+	Receive data +
4	Termination network	No connection
5	Termination network	No connection
6	RxD–	Receive data –
7	Termination network	No connection
8	Termination network	No connection

When connecting the RJ-45 port to a hub or repeater, use the straight-through cable pinout shown in Figure 2-16.

Figure 2-16   Straight-Through Ethernet Cable Pinout

MDI wiring   MDI-X wiring

  1 TxD+ ——————— 1 RxD+

  2 TxD– ——————— 2 RxD–

  3 RxD+ ——————— 3 TxD+

  6 RxD– ——————— 6 TxD–
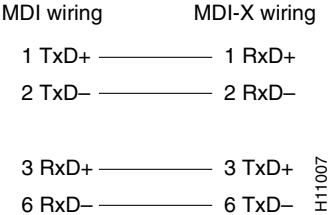
When connecting two GRPs back-to-back, use the crossover cable pinout shown in Figure 2-17.

Figure 2-17   Crossover Ethernet Cable Pinout

 GRP   GRP

1 TxD+ —   — 1 TxD+

2 TxD– —   — 2 TxD–

3 RxD+ —   — 3 RxD+

6 RxD– —   — 6 RxD–
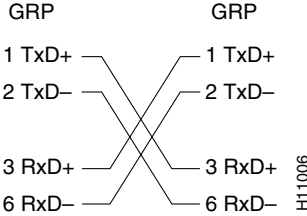
GRP MII Ethernet Connections

The GRP MII Ethernet connection requires an external physical sublayer (PHY) and an external transceiver that permits connection to multimode fiber for 100BASE-FX or 100BASE-T4 physical media. Depending on the type of media between the MII receptacle and the switch or hub, the network side of your 100-Mbps transceiver should be appropriately equipped with fiber-optic SC-type or ST-type connectors, coaxial cable BNC connectors, or other appropriate hardware.

Figure 2-18 shows the pin orientation of the female MII connector on the GRP. The MII connector uses 2-56 screw-type locks, called *jackscrews*, to secure the cable or transceiver to the MII port. MII cables and transceivers have knurled thumbscrews that you fasten to the jackscrews on the MII connector to provide strain relief for your MII cable.

Figure 2-18   GRP MII Ethernet Connector
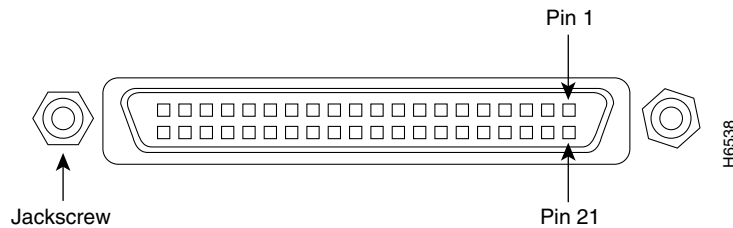
Table 2-5 lists the signals used on the MII connector.

Table 2-5   GRP MII Ethernet Pinout

Pin[1]	In	Out	Input/ Output	Description
14–17	–	Yes	–	Transmit data (TxD)
12	Yes	–	–	Transmit clock (Tx_CLK)[2]
11	–	Yes	–	Transmit error (Tx_ER)
13	–	Yes	–	Transmit enable (Tx_EN)
3	–	Yes	–	MII data clock (MDC)
4–7	Yes	–	–	Receive data (RxD)
9	Yes	–	–	Receive clock (Rx_CLK)
10	Yes	–	–	Receive error (Rx_ER)
8	Yes	–	–	Receive data valid (Rx_DV)
18	Yes	–	–	Collision (COL)
19	Yes	–	–	Carrier sense (CRS)
2	–	–	Yes	MII data input/output (MDIO)
22–39	–	–	–	Common (ground)
1, 20, 21, 40	–	–	–	+5 V

1. Pins not listed in the table are not used.

2. Tx_CLK and Rx_CLK are provided by the external transceiver.

Table 2-6 lists the cabling specifications for 100-Mbps transmission over unshielded twisted-pair (UTP) cables.

Table 2-6   Specifications and Connection Limits for 100-Mbps Transmission

Parameter	RJ-45	MII
Cable specification	Category 5[1] UTP, 22 - 24 AWG[2]	Category 3, 4, or 5, 150-ohm UTP or STP, or multimode optical fiber
Cable length (max)	—	1.64 ft (0.5 m) (MII-to-MII cable[3])
Segment length (max)	328 ft (100 m) for 100BASE-TX	3.28 ft (1 m)[4] or 1,312 ft (400 m) for 100BASE-FX
Network length (max)	656 ft (200 m)[4] with 1 repeater	—

1. EIA/TIA-568 or EIA-TIA-568 TSB-36 compliant. Not supplied by Cisco.

2. AWG = American Wire Gauge. This gauge is specified by the EIA/TIA-568 standard.

3. The cable between the MII port on the GRP and the appropriate transceiver.

4. Specifically, the length between any two stations on a repeated segment.

Table 2-7 lists IEEE 802.3u physical characteristics for 100BASE-TX cabling.

Table 2-7   IEEE 802.3u Physical Characteristics

Parameter	100BASE-TX
Data rate (Mbps)	100
Signaling method	Baseband
Segment length (max meters)	100 m between DTE and repeaters
Media	Category 5 UTP (for RJ-45) or MII
Topology	Star/hub

PRP Port Connection Guidelines

This section contains detailed cabling and signal information for all interface and port connections to the PRP. It also provides information for Ethernet routing and equipment.

⚠️

Caution   Ports labeled Ethernet, 10BASE-T, Token Ring, Console, and AUX are safety extra-low voltage (SELV) circuits. Only connect SELV circuits to other SELV circuits.

PRP Auxiliary and Console Port Connection Guidelines

The PRP has two RJ-45 connection ports:

- Auxiliary port— DTE RJ-45 interface for connecting a modem or other DCE device (such as a CSU/DSU or another router) to the PRP.

- Console port—DCE RJ-45 interface for connecting a data terminal device to the router, which you need to perform the initial configuration of the router.

✎

Note   The auxiliary and console ports are asynchronous serial ports. Ensure that devices connected to these ports are capable of asynchronous transmission.

Figure 2-19 shows the auxiliary and console port connections from the PRP to the associated devices.

Figure 2-19   PRP Auxiliary and Console Port Connections
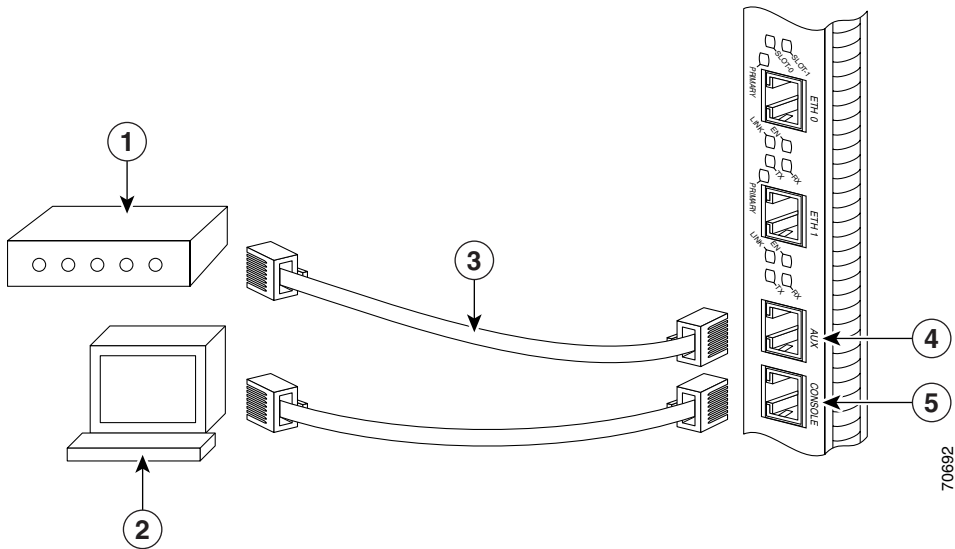
1	Modem	**4**	Auxiliary port
2	Console terminal	**5**	Console port
3	RJ-45 cables		

PRP Auxiliary Port Signals

The PRP auxiliary port is a DTE, RJ-45 interface for connecting a modem or other DCE device (such as a CSU/DSU or another router) to the PRP. The auxiliary port supports hardware flow control and modem control.

Table 2-8 lists the signals used on the auxiliary port.

Table 2-8   PRP Auxiliary Port Signals

Auxiliary Port Pin	Signal	Input/Output	Description
1	RTS	Output	Request to send
2	DTR	Output	Data terminal ready
3	TxD	Output	Transmit data
4	GND	—	Signal ground
5	GND	—	Signal ground
6	RxD	Input	Receive data
7	DSR	Input	Data set ready
8	CTS	Input	Clear to send

PRP Console Port Signals

The PRP console port is a DCE RJ-45 interface for connecting a terminal to the router. The console port does not support modem control or hardware flow control and requires a roll-over RJ-45 cable.

Before connecting a terminal to the console port, check the terminal setting for the data transmission rate, in bits per second (bps). The terminal transmission rate setting must match the default rate of the PRP console port, which is 9600 bps. Set the terminal to these operational values: 9600 bps, 8 data bits, no parity, 2 stop bits (9600 8N2).

Table 2-9 lists the signals used on the console port.

Table 2-9   PRP Console Port Signals (with RJ45 roll-over cable)

Console Port Pin	Signal	Input/Output	Description
1[1]	—	—	—
2	DTR	Output	Data terminal ready
3	TxD	Output	Transmit data
4	GND	—	Signal ground
5	GND	—	Signal ground
6	RxD	Input	Receive data
7	DSR	Input	Data set ready
8[1]	—	—	—

1.   These pins are not connected.

PRP Ethernet Connections

The PRP has two RJ-45 MDI Ethernet ports; ETH0 and ETH1 (Figure 2-20).

Figure 2-20   PRP Ethernet Connections
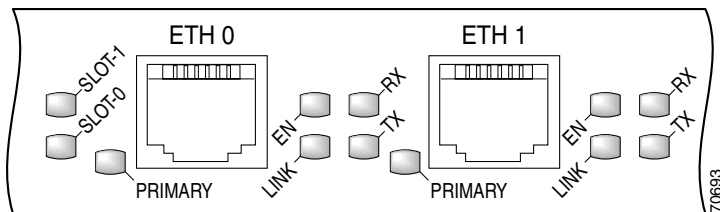
These connections support IEEE 802.3 and IEEE 802.3u interfaces compliant with 10BASE-T and 100BASE-TX standards. The transmission speed of the Ethernet ports is autosensing by default and is user configurable.

The PRP Ethernet port does not provide external routing functions. Its primary roles are to act as a Telnet port into the router, and to boot or access Cisco IOS software images over a network to which the PRP Ethernet port is directly connected.

⚠

Caution   Cisco Express Forwarding (CEF) functions on these ports are switched off by default for security reasons. We strongly caution you to consider the security implications of switching on CEF routing functions on these ports.

Figure 2-21 shows:

- You cannot access Network 2.0.0.0 from Ethernet port (E0) on the GRP in Router A. You can only access Host A, Host B, and Router C, which are in Network 1.0.0.0 (see dotted-line arrows).

- To access Network 2.0.0.0 from Router A, you must use an interface port on one of the line cards (a POS line card in this example) in Router A. Data from Router A is routed through Router B and Router C, to reach Network 2.0.0.0 (see solid-line arrows).

Figure 2-21   Using the Ethernet Port on the PRP
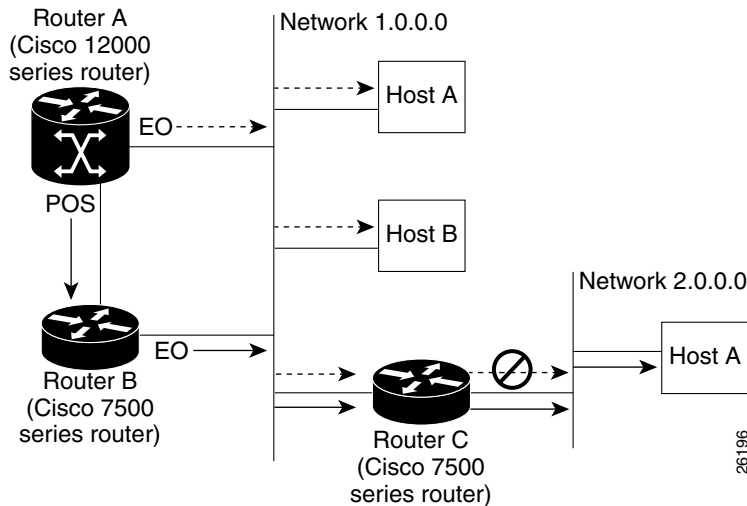
PRP RJ-45 Ethernet Connections

The RJ-45 Ethernet connection does not require an external transceiver. Figure 2-22 shows the pin orientation of the RJ-45 Ethernet port and the modular cable plug it accepts.

Figure 2-22   RJ-45 Receptacle and Plug

87654321

RJ-45 connector

210222
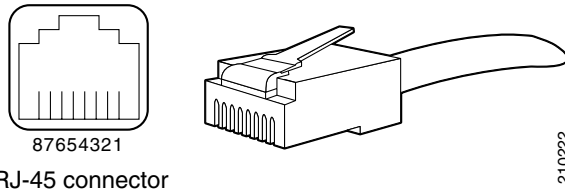
Table 2-10 lists the RJ-45 pin signals used on the connector.

Table 2-10   PRP RJ-45 Ethernet Receptacle Pinout

Ethernet Port Pin	Signal	Description
1	TxD+	Transmit data +
2	TxD–	Transmit data –
3	RxD+	Receive data +
4	Termination network	No connection
5	Termination network	No connection
6	RxD–	Receive data –
7	Termination network	No connection
8	Termination network	No connection

When connecting the RJ-45 port to a hub or repeater, use the straight-through cable pinout shown in Figure 2-23.

Figure 2-23   Straight-Through Cable Pinout to Hub or Repeater

MDI wiring   MDI-X wiring

  1 TxD+ ——————— 1 RxD+

  2 TxD– ——————— 2 RxD–

  3 RxD+ ——————— 3 TxD+

  6 RxD– ——————— 6 TxD–
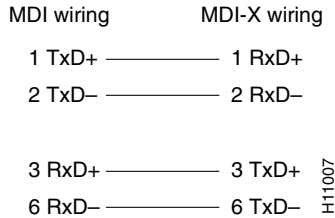
When connecting two PRPs back-to-back, use the crossover cable pinout shown in Figure 2-24.

Figure 2-24   Crossover Cable Pinout Between PRPs

PRP   PRP

1 TxD+   1 TxD+

2 TxD–   2 TxD–

3 RxD+   3 RxD+

6 RxD–   6 RxD–
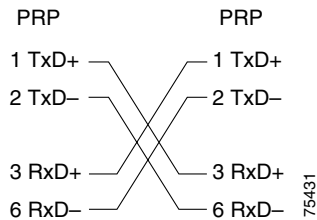
Table 2-11 lists the cabling specifications for 100-Mbps transmission over unshielded twisted-pair (UTP) cables.

Note The transmission speed of the Ethernet ports is autosensing by default and is user configurable.

Table 2-11   Specifications and Connection Limits for 100-Mbps Transmission

Parameter	RJ-45
Cable specification	Category 5[1] UTP, 22 to 24 AWG[2]
Cable length (max)	—
Segment length (max)	328 feet (100 m) for 100BASE-TX
Network length (max)	656 feet (200 m)[3] with 1 repeater

1. EIA/TIA-568 or EIA-TIA-568 TSB-36 compliant. Not supplied by Cisco.

2. AWG = American Wire Gauge. This gauge is specified by the EIA/TIA-568 standard.

3. Specifically, the length between any two stations on a repeated segment.

Table 2-12 lists IEEE 802.3u physical characteristics for 100BASE-TX.

Table 2-12   IEEE 802.3u Physical Characteristics

Parameter	100BASE-TX
Data rate (Mbps)	100
Signaling method	Baseband
Maximum segment length	100 m between DTE and repeaters
Media	Category 5 UTP
Topology	Star/Hub

Alarm Card Connection Guidelines

The router is equipped with two alarm cards:

- One alarm card occupies the dedicated far *left* slot in the upper card cage

- The second alarm card occupies the dedicated far *right* slot in the lower card cage

Each alarm card has one 25-pin D-subconnector (ALARM) on the front panel that connects the router to an external site alarm maintenance system (Figure 2-25). When a critical, major, or minor alarm is generated, it energizes the alarm relays on the alarm card to activate the external site alarm.

Figure 2-25   Alarm Card Connector Location
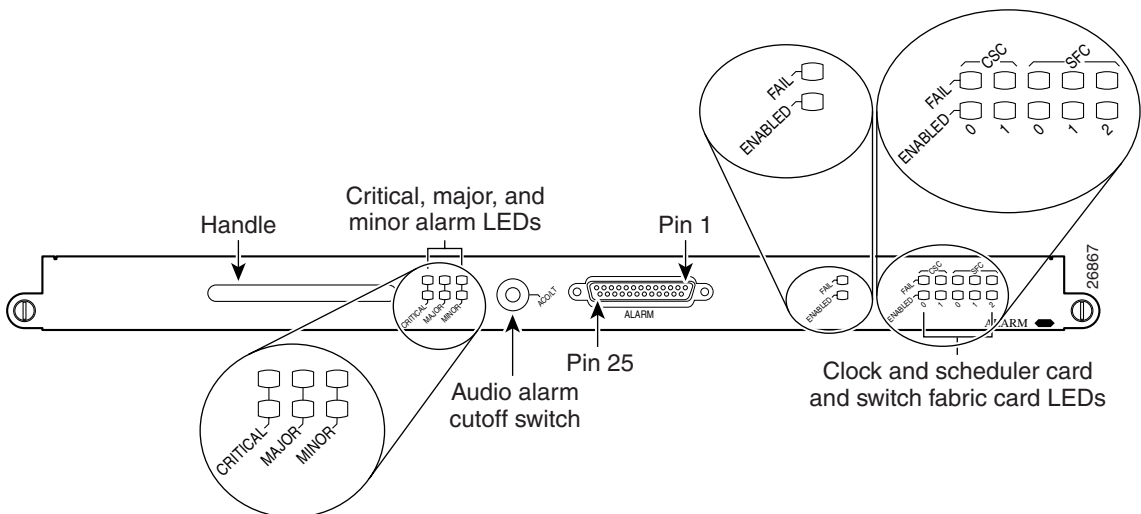
The alarm relay contacts on the alarm card consist of standard *common*, *normally open*, and *normally closed* relay contacts that are wired to the pins on the connectors.

⚠

Caution   Only safety extra-low voltage (SELV) circuits can be connected to the alarm connector. Maximum rating for the alarm circuit is 2 A, 50 VA.

Note   To comply with the intrabuilding lightning surge requirements of GR-1089-CORE, Issue II, Revision 01, February 1999, you must use a shielded cable when connecting to the external alarm ports on the alarm card. The shielded cable is terminated by shielded connectors on both ends, with the cable shield material tied to both connectors.

Table 2-13 lists the pin-to-signal correspondence between the cable connector pins and the alarm card relay contacts.

Table 2-13   Alarm Connector Pinout

Pin Group	Common	Normally Open	Normally Closed
Critical audible alarm	2	1	14
Major audible alarm	16	3	15
Minor audible alarm	5	4	17
Critical visual alarm	19	6	18
Major visual alarm	8	7	20
Minor visual alarm	22	9	21
Alarm input	13	25	—

Installing the Router

This chapter contains the procedures to install the router in a rack. The installation is presented in the following sections:

Pre-Installation Considerations and Requirements

Before you perform any procedures in this chapter, review the following sections in Chapter 2, "Preparing for Installation":

- Safety Guidelines, page 2-2
- Site Requirement Guidelines, page 2-7

In particular, observe the guidelines for preventing electrostatic discharge (ESD) damage described in the Preventing Electrostatic Discharge Damage, page 2-4 and use Figure 2-1 on page 2-5 as a reference in locating and using the ESD sockets on the front of the router chassis.

A fully equipped router with an optional two-level AC-input power shelf can weigh as much as 440 pounds (200 kg). The router ships on a scissor-jack platform that enables two people to install a fully loaded router into a rack without removing any of the components from the chassis.

Warning **This router is not designed to be installed as a shelf-mounted or a free-standing router. The router must be installed in a rack that is secured to the building structure. You must install the router in either a telco-style frame or a four-post equipment rack.**

For additional safety and compliance information, refer to the *Regulatory Compliance and Safety Information for Cisco 12000 Series Internet Routers* publication that accompanied your router.

Required Tools and Equipment

Before you begin the rack-mount installation, you must read and understand the information in the "Rack-Mounting Guidelines" section on page 2-7 and have the following tools and equipment:

- ESD-preventive wrist strap

- Number 1 and number 2 Phillips screwdrivers

- 1/4-inch (6.35-mm) and 3/16-inch (4.5-mm) flat-blade screwdrivers

- Tape measure

- Level (optional)

- 3/8-inch (10-mm) nutdriver (for systems equipped with the DC-input power shelf)

- 9/16-inch (14-mm) wrench (for chassis hold-down bolts and pallet hold-down bracket bolts)

- 3/4-inch (19-mm) socket and ratchet wrench

Unpacking and Positioning the Router

Follow the unpacking instructions that came with the router and use a safety hand truck to move the router to the location where it is being installed in a rack.

Save the packaging materials in case the router has to be repackaged to be shipped again.

Removing the Front Covers from Cisco 12016 Original Series Routers

The chassis front covers for the power shelf and upper blower module, upper card cage, lower card cage, and lower blower module are fastened to the chassis by ball studs on the front of the chassis (Figure 3-1).

> **Note** The power shelf and upper blower module front cover is packaged in the accessory kit to permit the foam shipping cap to fit securely on the top of the router, and to protect the router without damaging the front cover.

To remove a cover, grasp the outside edges of the cover and pull it straight out to detach it from the front of the chassis.

Figure 3-1   Router Chassis Front Covers
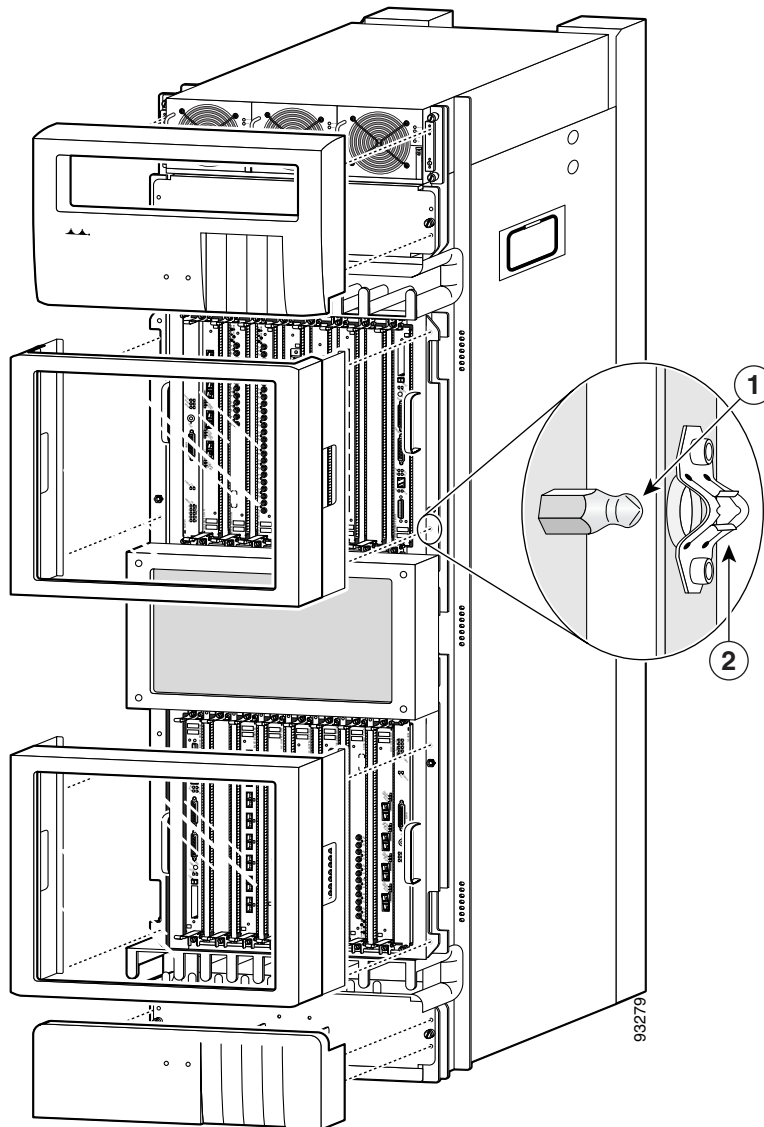
1	Ball stud	2	Ball stud clip

Removing the Front Cover from Cisco 12016 Enhanced Series Routers

The new cover on the Cisco enhanced series of routers has a two-piece front cover. The covers have release buttons on both sides that give you the flexibility to open it from either the left side or from the right side.

To remove each front cover, grasp the sides of the cover and press both release buttons simultaneously to release the door from the chassis (Figure 3-2).

Figure 3-2   Removing the Front Covers
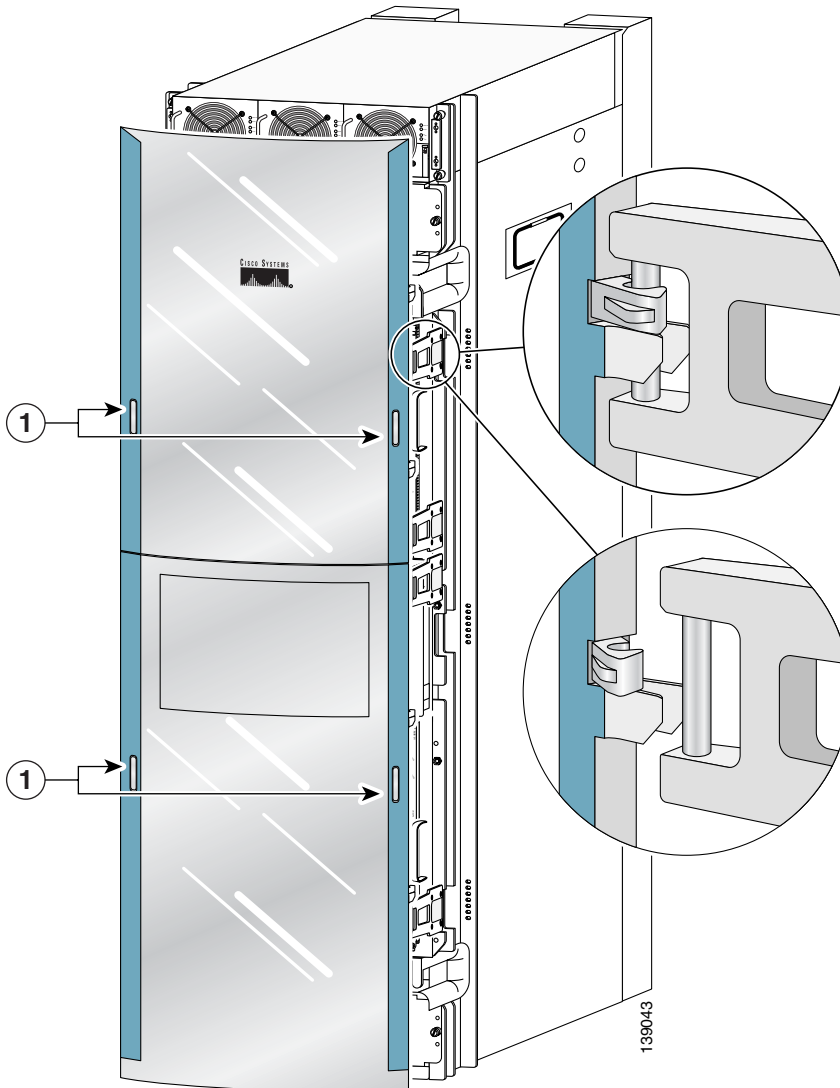
1	Release buttons

Rack-Mounting the Router Chassis

The router chassis can be installed in either a front-mounted position or a center-mounted position.

- In a front-mounted position, the chassis rack-mounting flanges are secured directly to the rack posts.
- In a center-mounted position, an optional set of center-mount brackets are secured to the rack posts and the chassis rack-mounting flanges are then secured to the center-mount brackets. The center-mounted position moves the center of gravity of the chassis closer to the vertical axis of the rack posts, which adds to the security and stability of the rack installation.

⚠

Warning   **The chassis should be mounted on a rack that is permanently affixed to the building**

Verifying Rack Dimensions

Before you install the chassis, measure the space between the vertical mounting flanges (rails) on your equipment rack to verify that the rack conforms to the measurements shown in Figure 3-3.

Step 1   Mark and measure the distance between two holes on the left and right mounting rails.

- The distance should measure 18.31 inches ± 0.06 inches (46.5 cm ± 0.15 cm).

✎

Note   Measure for pairs of holes near the bottom, middle and top of the equipment rack to ensure that the rack posts are parallel.

Step 2   Measure the space between the inner edges of the left front and right front mounting flanges on the equipment rack.

- The space must be at least 17.7 inches (45 cm) to accommodate the chassis which is 17.25 inches (43.8 cm) wide and fits between the mounting posts on the rack.

Figure 3-3   Verifying Equipment Rack Dimensions
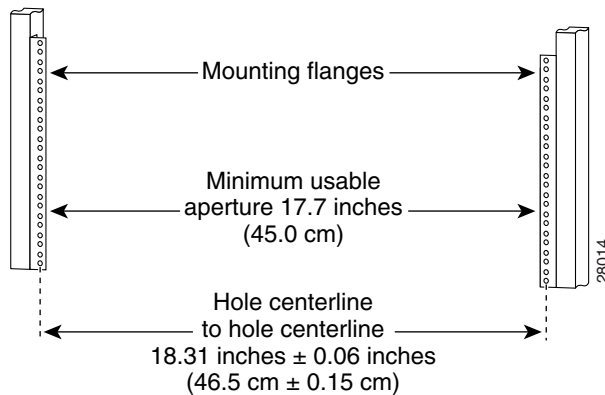
Installing Center-Mount Brackets—Optional

If you plan to install the router in the center-mount position, you must install the center-mount brackets to the rack rails first. If you do not plan to use the optional center-mount brackets, proceed directly to the "Installing the Chassis Rack-Mounting Platform" section on page 3-13.

The optional center-mount bracket installation kit ships in the accessories box included with the router and contains the following:

- Two center-mount brackets.
- 10 (minimum) Phillips binderhead screws (usually provided with the bracket kit) to secure the brackets to the mounting flanges (also called *rails*) in the rack. Five screws should be installed on each bracket.

Contact a Cisco service representative for assistance if any parts are missing.

> **Note**   Make sure you have performed the measurements described in "Verifying Rack Dimensions" section on page 3-8 before installing the center-mount brackets.

Use the following procedure to install the center-mount brackets to the rack rails.

Step 1   Determine the location in which you want to position the chassis in the rack, and mark holes at the same height on both the left and right rack rails.

Step 2   Identify the orientation of the left and right center-mount brackets (Figure 3-4).

Figure 3-4   Center-Mount Brackets

Threaded holes to chassis

Open holes to rack

28451

Left bracket   Right bracket
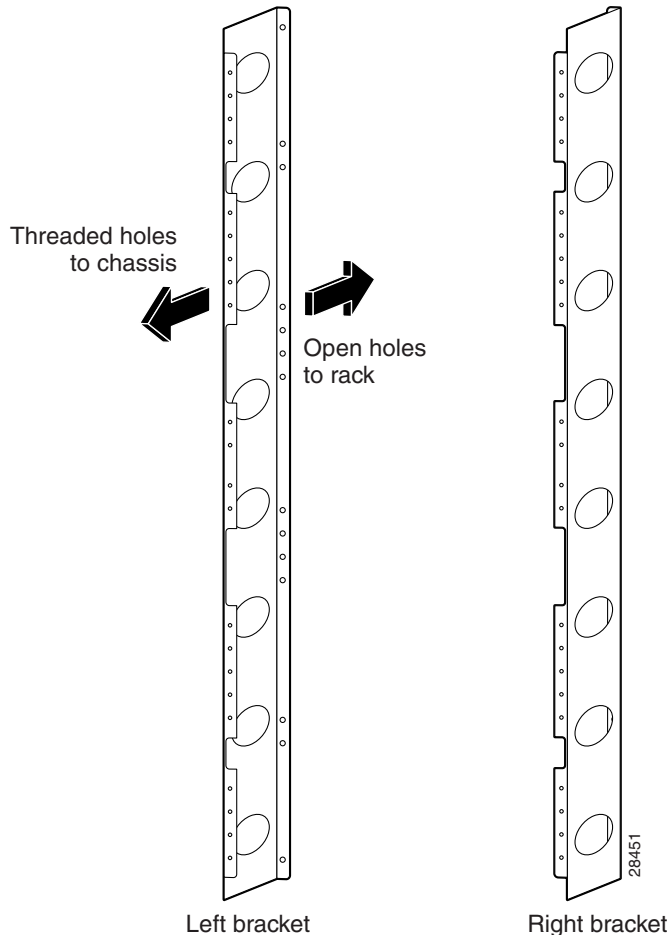
Step 3   Install the right center-mount bracket (Figure 3-5).

a.   Align the bottom screw hole of the bracket with the marked screw hole at the bottom of the rack and finger tighten a screw in that hole.

      b. Finger-tighten a second screw in the top hole of the bracket.

      c. Finger-tighten three more screws in the middle of in the bracket.

      d. Use a screwdriver to tighten all five screws securely.

Step 4   Repeat Step 3 for the left center-mount bracket.

Step 5   Use a level to verify that the tops of the two brackets are level, or use a measuring tape to verify that both brackets are the same distance from the top of the rack rails.

Figure 3-5   Installing a Center-Mount Rack-Mounting Bracket

Chassis

Rack

Bracket

Chassis
rack-mounting
rail

Bracket

Rack

Threaded hole
(chassis secured
by screw)

Open hole
(screw inserted
through)

28450
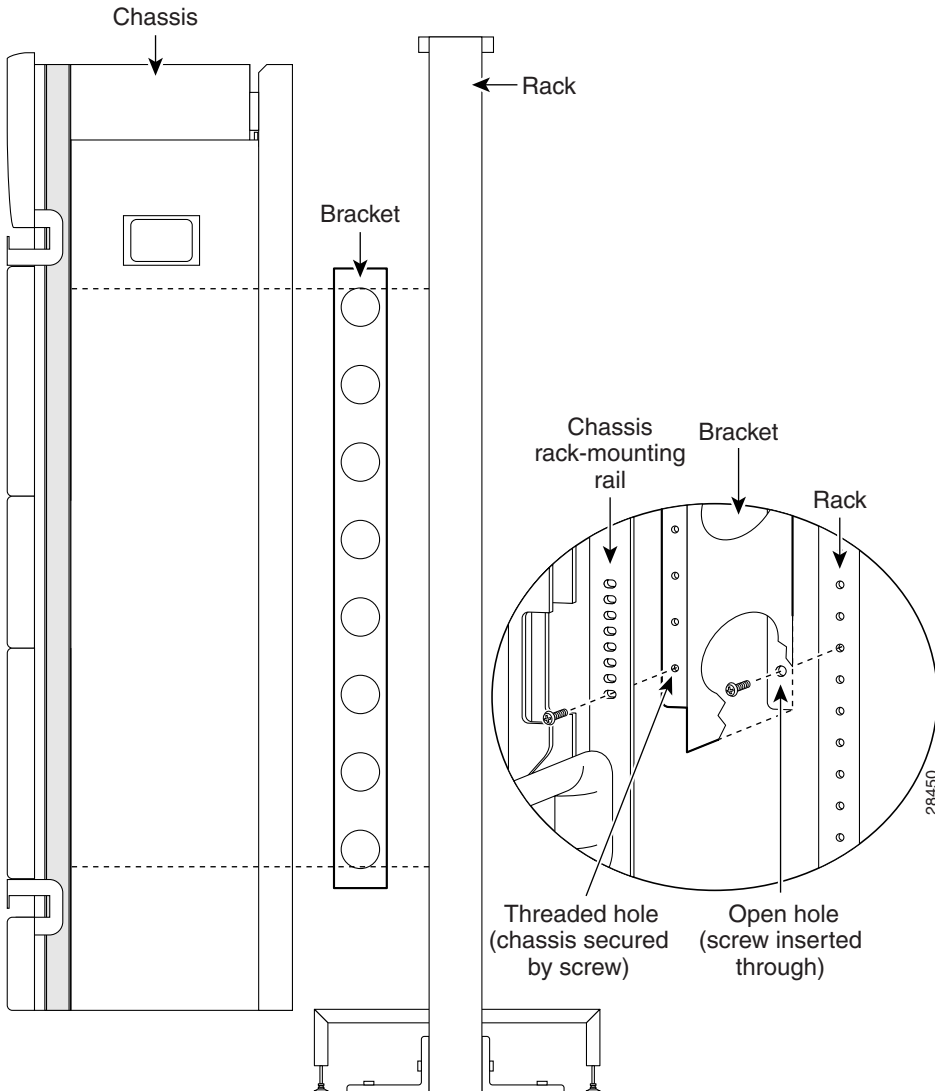
Installing the Chassis Rack-Mounting Platform

The rack-mounting platform is installed at the bottom of an empty rack and acts as a permanent support platform for the chassis. It can be installed in either the front-mounted position or the center-mounted position, to match the installed position of the chassis.

The platform is adjustable from a minimum height of 5.25 inches (13.34 cm) to a maximum height of 8.00 inches (20.32 cm). For telco-style racks, the bottom edge of the platform can be raised to approximately 6.00 inches (15.24 cm) to clear the cross-members at the bottom of the rack.

⚠

Warning   **The chassis should be mounted on a rack that is permanently affixed to the building**

Use the following procedure to install the rack-mounting platform.

Step 1   Remove the platform from the accessory box.

Step 2   Adjust the height of the platform to match the required rack-mounting height for the chassis:

   a.   Turn each of the adjustable feet to approximately the required platform height (Figure 3-6).

   b.   Place the platform in the rack making sure that it clears any rack cross-members.

   c.   Use a level to be sure the platform is level from side to side and front to back.

   d.   Adjust the feet until the platform clears any obstacles and is level at the required platform height.

Step 3   Determine whether the platform is to be installed in the front-mounted position or in the center-mounted position, and adjust the positioning brackets on the platform:

   a.   Locate the hole on the side of the platform that corresponds with the front-mounted or center-mounted position of the table.

   b.   Align the side of the bracket with the round hole over the hole on the side of the platform, insert a screw, and use your fingers to loosely tighten it (see blow-out in Figure 3-6).

Repeat these steps to attach a bracket in the same position on the other side of the platform.

Step 4 Align the platform between the rack posts and set it in position so that the sides of the positioning brackets with the oblong holes are flush against the rack-mounting flanges.

Step 5 Secure the platform to the rack:

a. Locate an open screw hole through the oblong hole in the bracket, then insert a screw and use your fingers to loosely tighten it (see blow-out in Figure 3-6).

b. Repeat step a. for the other side of the platform.

c. Verify that the platform is level and seated squarely against the rack, then tighten all four screws.

Figure 3-6   The Chassis Rack-Mounting Platform
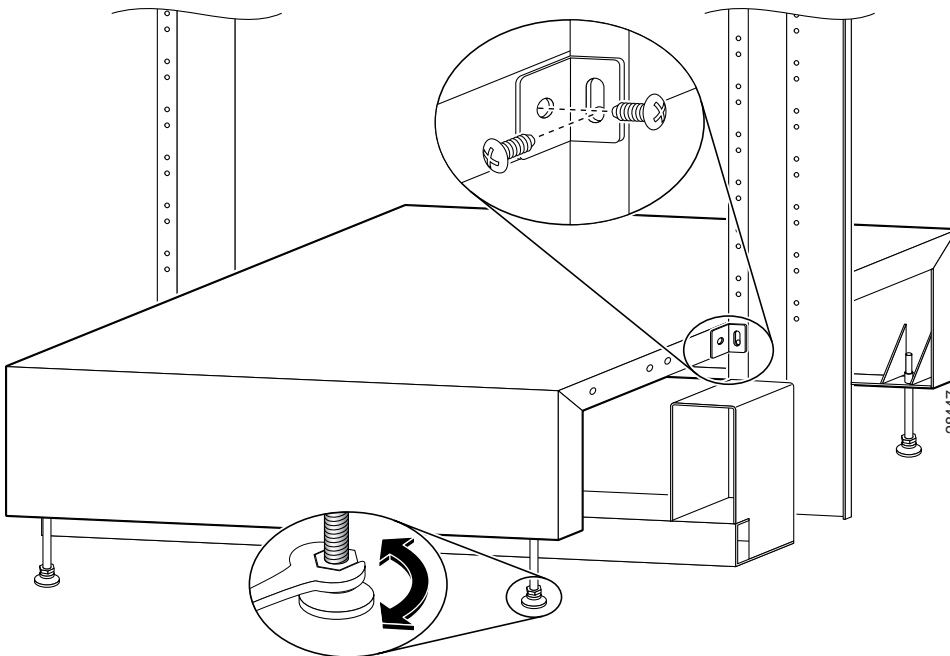
Unpack and Position the Router

Unpack the router following the instructions in the *Cisco 12016, Cisco 12416, and Cisco 12816 Router Unpacking Instructions* that came with the router. Use a safety hand truck to move the router to the location where it is being installed and position it in front of the rack so that the back panel of the chassis faces the rack opening (Figure 3-7).

Figure 3-7   Positioning the Router for Insertion into the Rack
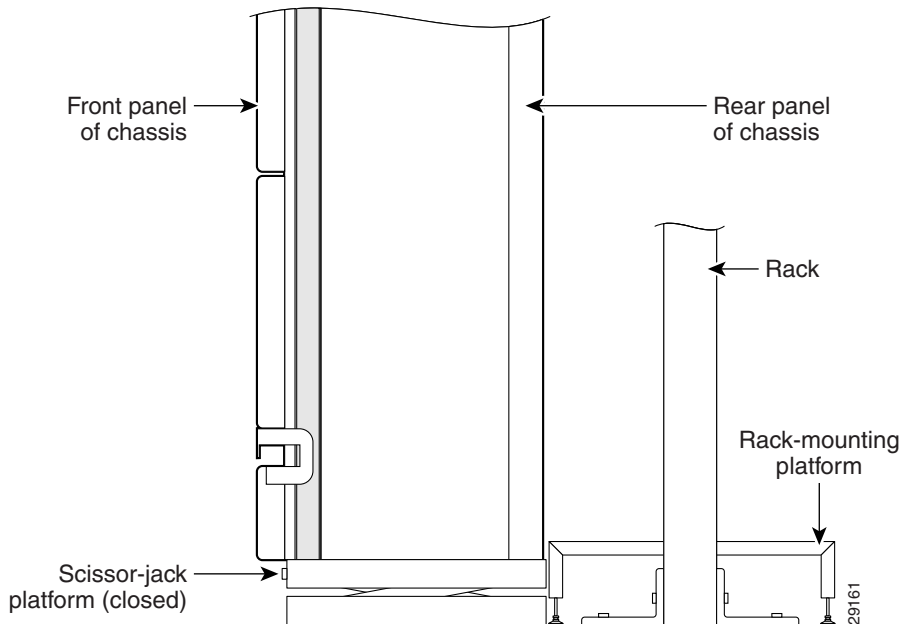
Installing the Chassis into the Rack

Use the following procedure to install the chassis in the rack.

Step 1 Rotate the scissor-jack screw counterclockwise slowly and expand the scissor-jack platform to raise the chassis to the required installation height (Figure 3-8).

⚠

Warning **A second person should be holding the chassis to prevent it from tipping while the platform is raised.**

Figure 3-8   Raising the Chassis to the Installation Height
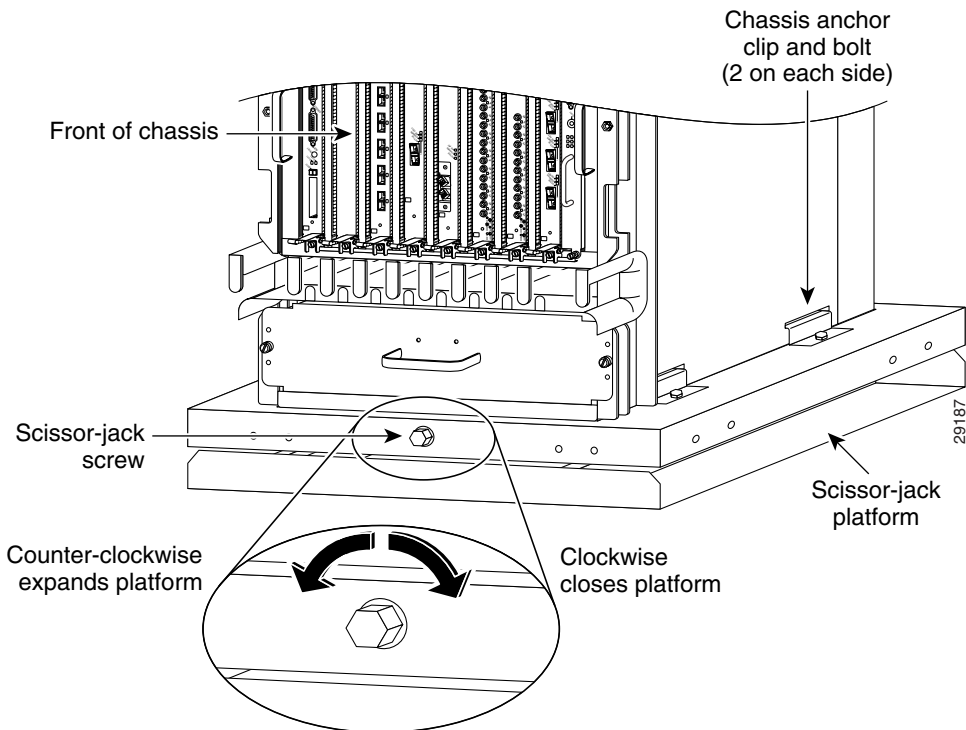
Step 2   Remove the four bolts and chassis anchor clips that secure the base of the chassis to the scissor-jack platform (Figure 3-9).

Figure 3-9   Removing the Chassis Anchor Clips
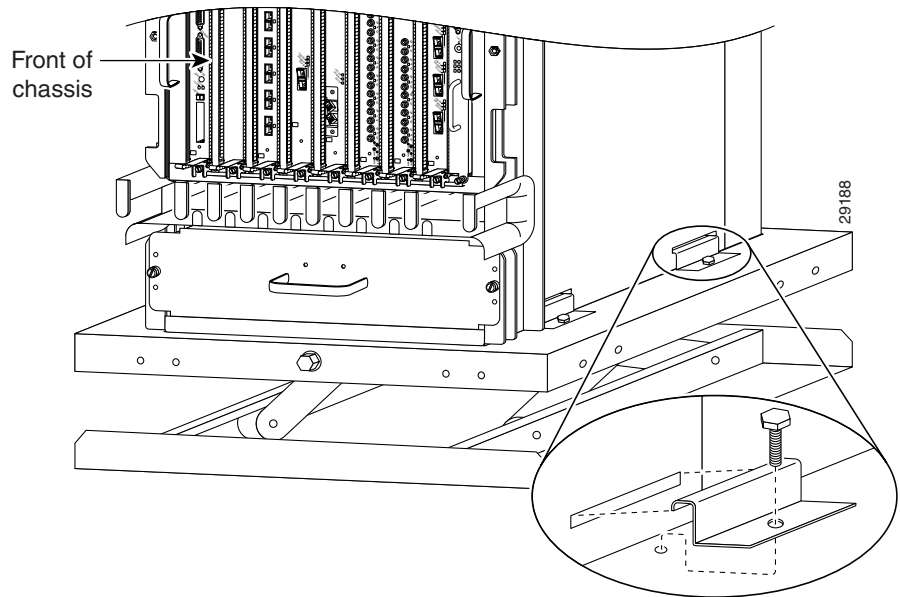
Step 3   Grasp the handle on the back panel of the chassis to carefully pull the chassis off of the scissor-jack platform and onto the rack-mounting platform while a second person pushes from the front of the chassis. (See Figure 3-10.)

Figure 3-10   Inserting the Router into the Rack

⚠
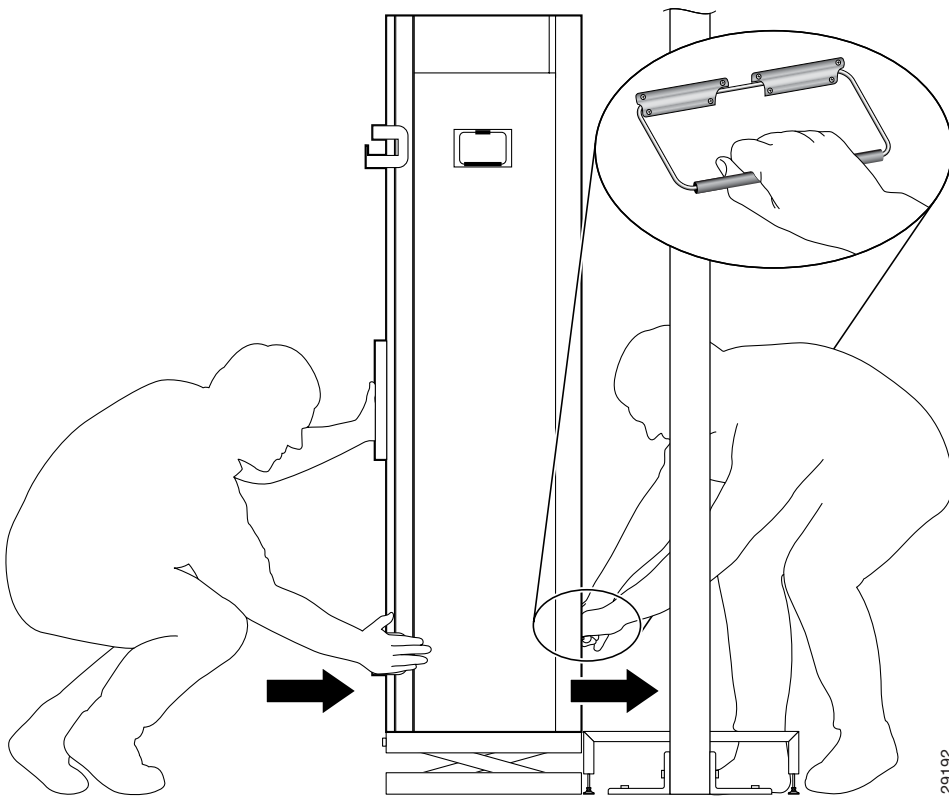
Warning   **Do not attempt to lift the chassis with the handles on the back and sides of the chassis. These handles are not designed to support the weight of the chassis, and should be used only to steady and guide the chassis while it is being inserted into or removed from an equipment rack. To reduce the risk of damage to the chassis and serious bodily injury, do not use these handles to lift or support the chassis.**

Step 4   Insert the chassis into the rack until the chassis rack-mounting flanges are flush against the mounting flanges on the rack (or the optional center-mount brackets, if installed).

- The weight of the chassis is now supported by the rack-mounting platform. Remove the scissor-jack platform and set it safely aside.

> ✎
> **Note**   Save and reassemble all parts of the shipping package in case it becomes necessary to transport the router to another location or return it to Cisco. Do not discard or destroy any of the shipping materials.

Step 5   Secure the chassis to the rack beginning (Figure 3-11):

   a.   Identify one of the holes in group A that aligns with a mounting hole on the mounting flanges of the rack.

   b.   Hold the chassis in position against the mounting flanges on the rack and have a second person insert and loosely tighten one of the mounting screws provided.

   c.   Repeat step b. for the mounting hole on the other side of the chassis.

Step 6   Repeat Step 5 for each group of chassis mounting holes (groups b through e).

Step 7   Tighten all mounting screws (five on each side of the chassis) securely.

Figure 3-11   Chassis Rack-Mounting Hole Groups

Chassis mounting holes group E

Chassis mounting holes group D

Chassis mounting holes group C

Chassis mounting holes group B

Chassis mounting holes group A

26864
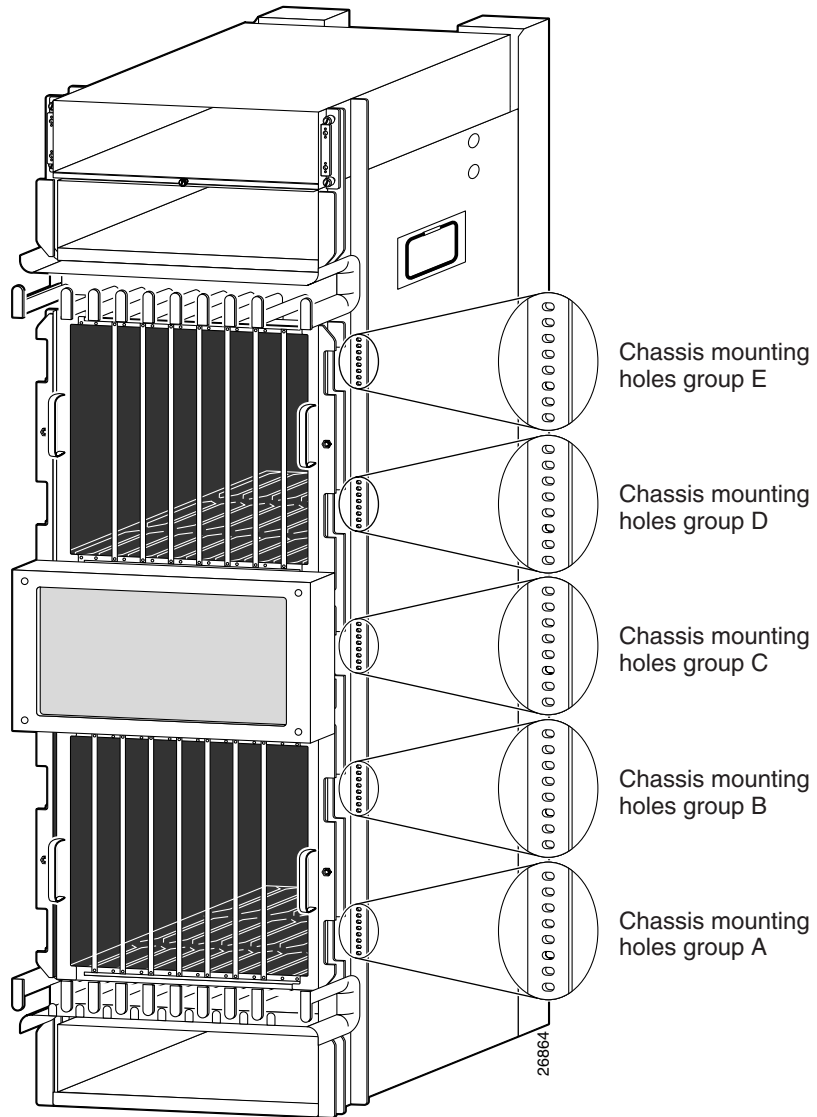
Supplemental Bonding and Grounding Connections

Before you connect power to the router, or power on the router for the first time, we recommend that you connect the central office ground system or new equipment building system (NEBS) to the supplemental bonding and grounding points on the router. For more information on supplemental bonding and grounding cable requirements, see the "Router Bonding and Grounding Receptacles—Top Rear" section on page 2-23.

There are two earth ground receptacles that you can use to connect a supplemental grounding cable to the chassis; one is on the front of the chassis behind the air filter door, and the other is located at the top rear of the chassis.

Use one of the following procedures to connect a grounding cable lug to the chassis:

- Connecting to the Front Grounding Receptacle, page 3-22
- Connecting to the Top Rear Receptacle, page 3-24

Connecting to the Front Grounding Receptacle

Use the following procedure to connect the supplemental grounding cable to front grounding receptacle.

Step 1   Loosen the two captive screws on each side of the air filter door and pivot the door open (Figure 3-12).

Figure 3-12   Opening the Air Filter Door

Switch fabric
card cage
(behind filter door)

Air filter door

Air filter

Captive screws
(2 on each side)
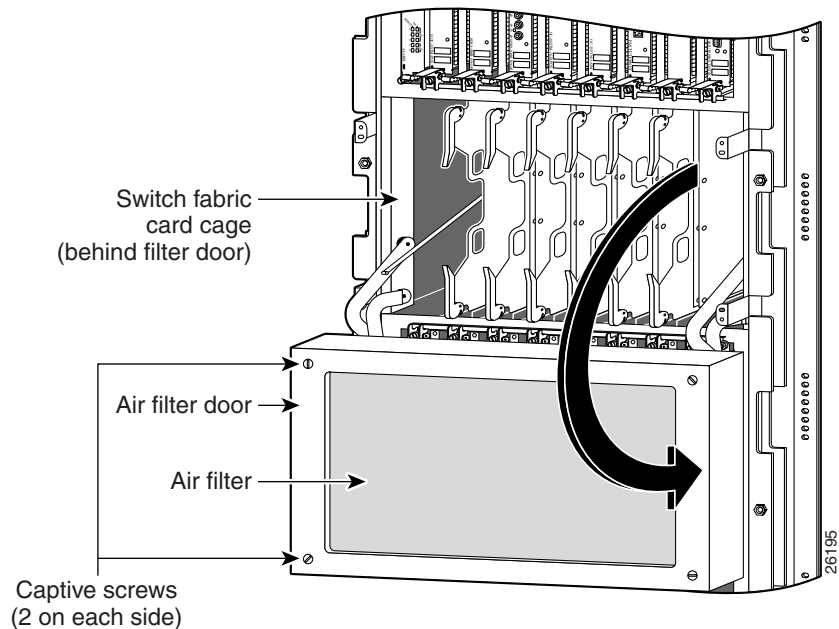
Step 2   Attach the grounding cable to the chassis (Figure 3-13):

    a.   Insert two M6 bolts through the grounding holes in the chassis.

    b.   Place the cable lug over the bolts and secure with the locking washers and nuts.

Figure 3-13   Router Front Bonding and Grounding Receptacles
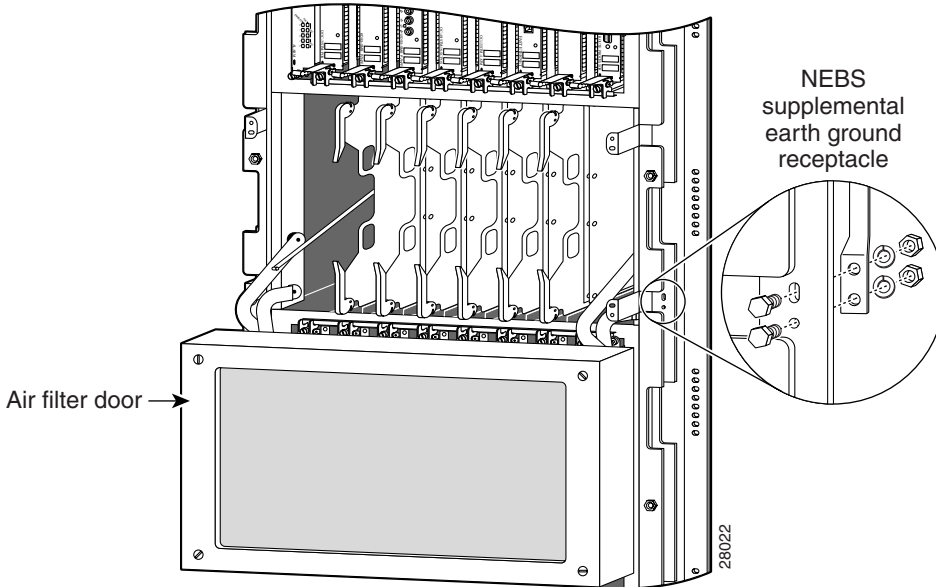
Step 3   Prepare the other end of the grounding wire and connect it to the appropriate grounding point at your site to ensure an adequate earth ground.

Connecting to the Top Rear Receptacle

Use the following procedure to connect the supplemental grounding cable to top rear grounding receptacle.

Step 1 Attach the grounding cable to the chassis (Figure 3-14):

a. Insert two M6 bolts through the grounding holes in the chassis.

b. Place the cable lug over the bolts and secure with the locking washers and nuts.

Figure 3-14   Router Top Bonding and Grounding Receptacles

Supplemental bonding and grounding receptacle
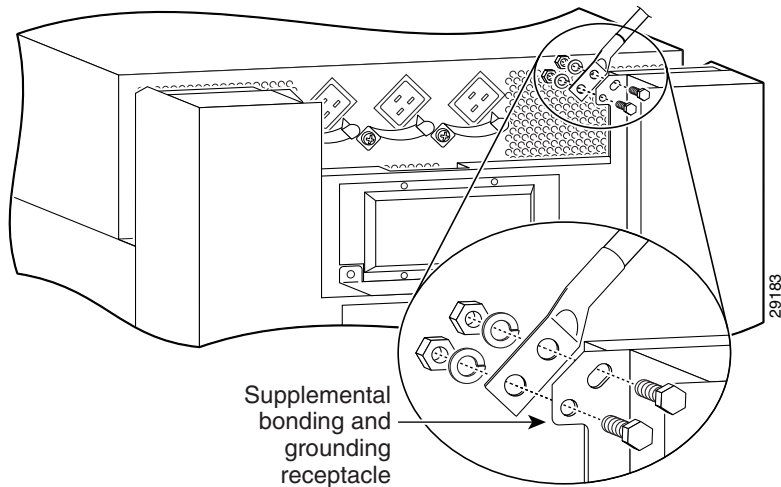
Step 2 Prepare the other end of the grounding wire and connect it to the appropriate grounding point at your site to ensure an adequate earth ground.

Attaching the Vertical Cable-Management Trough

Refer to Figure 3-15 and use the following procedure to attach the vertical cable-management trough.

Step 1   Position the trough so that the access gate opens toward the front of the chassis.

Step 2   Align the top screw holes on the inside panel of the trough with the chassis standoffs.

Step 3   Hand tighten two screws into the holes to hold the trough in place.

Step 4   Repeat Step 2 and Step 3 for the middle two standoffs and the bottom two standoffs.

Step 5   Tighten all six screws with a Phillips screwdriver to secure the trough to the chassis.

Figure 3-15   Attaching the Vertical Cable-Management Troughs
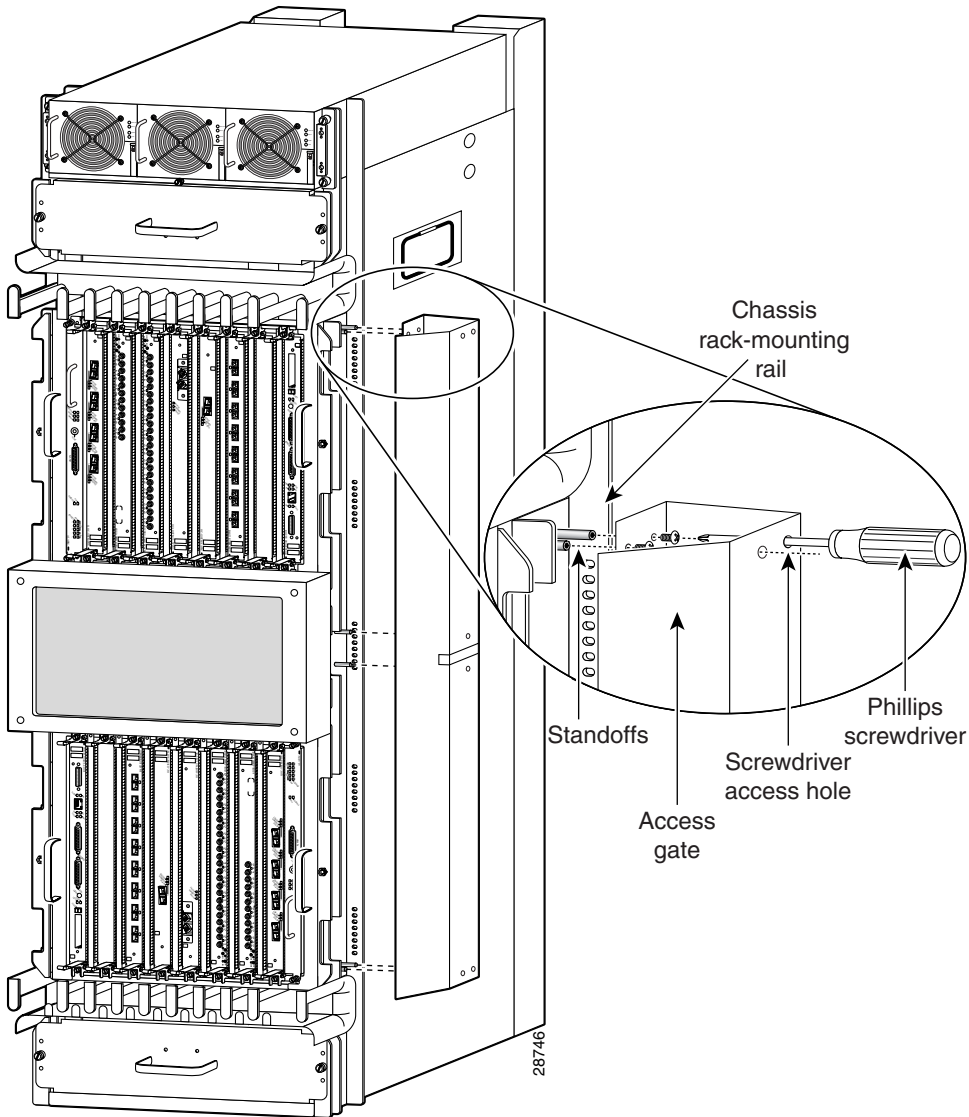
Connecting Line Card Network Interface Cables

This section describes how to route the network interface cables through the router cable-management system and attach the network interface cables to the line card ports.

This procedure uses an 8-port fiber-optic Fast Ethernet card as an *example* to describe how to attach a network interface cable to a line card port and route the cable through the cable-management system. Depending on which line cards are installed in your system, your cable connection procedure might differ slightly from this example. For cable connection information for your specific line card, refer to the installation and configuration note for that line card.

> **Note** You can access the most current Cisco line card documentation on the World Wide Web at: http://www.cisco.com.

Use the following procedure as an example to route the network interface cables through the cable-management system and connect them to the line card.

Step 1 Route an interface cable across the horizontal cable-management tray, through the cable tray opening to connect it to the line card:

- For legacy fiber-optic line cards, go to Step 2.

- For current fiber-optic line cards, go to Step 6.

Step 2 Install a plastic bend-radius clip on the strain-relief ferrule on the connector (see blow-out in Figure 3-16).

> **Note** The bag of bend-radius clips (Part Number 800-06119-01) in the accessories box that shipped with your router contains two sizes of bend-radius clips. The clip size is determined by the diameter of the strain-relief ferrule on the cable connectors. Use the size that provides the most secure fit on the strain-relief ferrule on the cable connectors in use at your site.

Step 3 Insert the cable connector into its assigned port.

Step 4 Route the cable up the cable-management bracket and carefully press the cable into the channel so it is held in place by the cable clips (Figure 3-16b).

Step 5   Repeat Steps 3 through 5 for each additional cable connection to that line card.

Figure 3-16   Connecting a Network Interface Cable to a Legacy Line Card
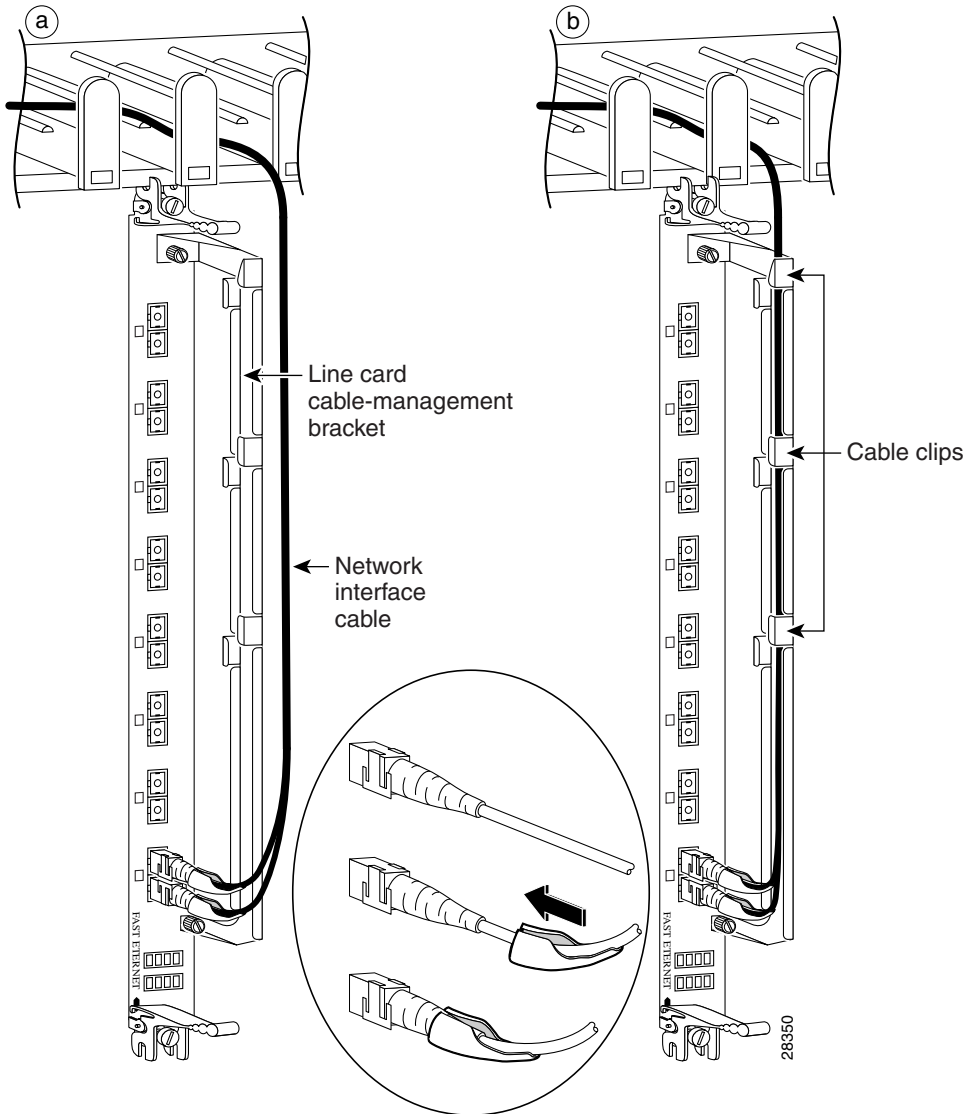
Step 6   Insert all cables into their assigned ports.

Step 7   Place several evenly spaced velcro straps through slots on the cable-management bracket (Figure 3-17a).

Step 8   Route the cables alongside the cable-management bracket and secure them with the velcro straps as appropriate (Figure 3-17b).

⚠

Caution   Make sure the interface cables do not have any kinks or sharp bends which can destroy or degrade the ability of the optical fiber to propagate the signal-encoded beam of light accurately from one end of the cable to the other. Always allow adequate strain relief in the interface cable.

Figure 3-17   Current Style Cable Management Bracket

Line card
cable-management
bracket

Network
interface
cable

Velcro
strap

53228
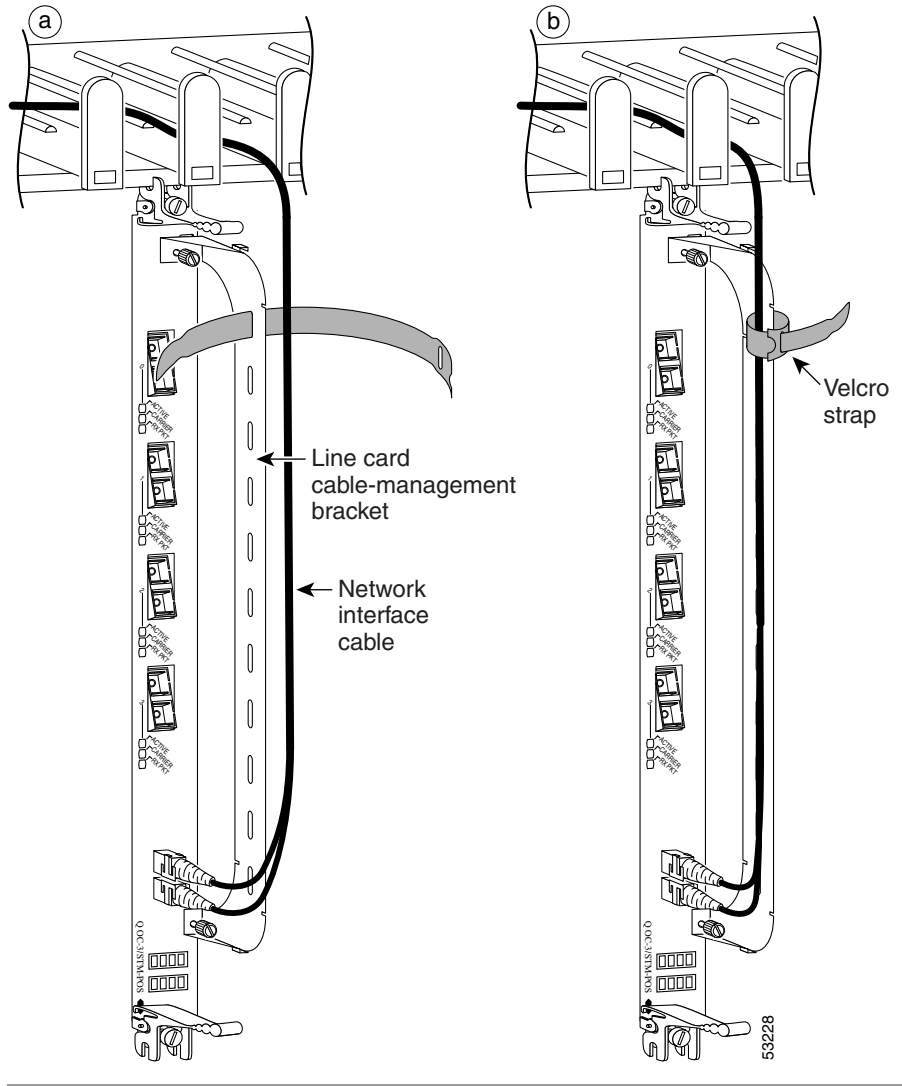
Connecting GRP Route Processor Cables

This section describes how to connect cables to the console, auxiliary, and Ethernet ports on the GRP. The console and auxiliary ports are both asynchronous serial ports; any devices connected to these ports must be capable of asynchronous transmission. For example, most modems are asynchronous devices.

Figure 3-18 shows an example of a data terminal and modem connections.

Figure 3-18   GRP Console and Auxiliary Port Connections
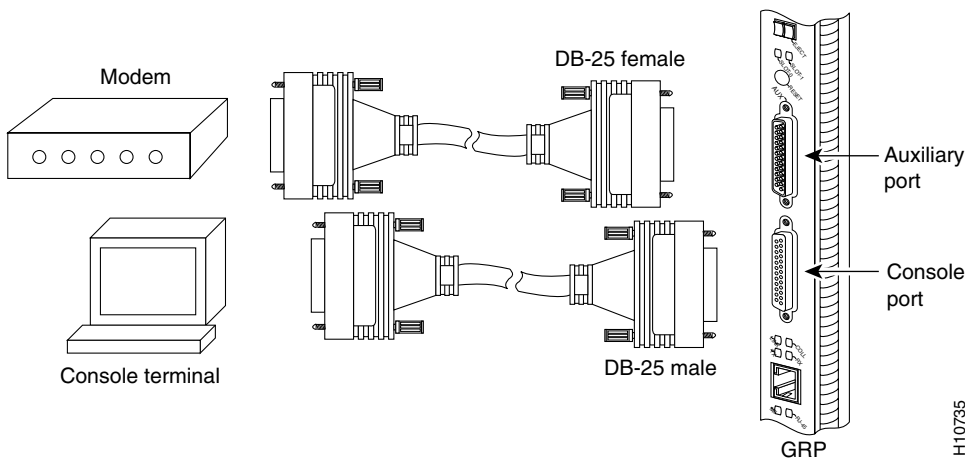
⚠️

Caution   The ports labeled Ethernet, 10BASE-T, Token Ring, Console, and AUX are safety extra-low voltage (SELV) circuits. SELV circuits should only be connected to other SELV circuits.

✎

Note   RP cables are not available from Cisco, but are available from any commercial cable vendor.

Note   To comply with Telcordia GR-1089 NEBS standard for electromagnetic compatibility and safety, connect all console, auxiliary, and Ethernet interfaces only to intrabuilding or nonexposed wiring or cabling. The intrabuilding cable must be shielded and the shield must be grounded at both ends.

Connecting to the GRP Console Port

The system console port on the GRP is an EIA/TIA-232 DCE DB-25 receptacle for connecting a data terminal to perform the initial configuration of the router. The console port requires a straight-through RJ-45 cable.

See "GRP Auxiliary and Console Port Connections" section on page 2-26 for additional information about the GRP console port.

Use the following procedure to connect a data terminal to the GRP console port.

Step 1   Set your terminal to these operational values: 9600 bps, 8 data bits, no parity, 2 stop bits (9600 8N2).

Step 2   Power off the data terminal.

Step 3   Attach the terminal end of the cable to the interface port on the data terminal.

Step 4   Attach the other end of the cable to the GRP console port.

Step 5   Power on the data terminal.

Connecting to the GRP Auxiliary Port

The auxiliary port on the GRP is an EIA/TIA-232 DTE DB-25 plug for connecting a modem or other DCE device (such as a channel service unit/data service unit (CSU/DSU) or another router) to this router.

See the "GRP Auxiliary and Console Port Connections" section on page 2-26 for more information.

Use the following procedure to connect an asynchronous serial device to the GRP auxiliary port.

Step 1   Power off the asynchronous serial device.

Step 2   Attach the device end of the cable to the interface port on the asynchronous serial device.

Step 3   Attach the other end of the cable to the GRP auxiliary port.

Step 4   Power on the asynchronous serial device.

Connecting to the GRP Ethernet Port

The Ethernet port on the GRP supports two types of Ethernet ports as shown in (Figure 3-19):

- A media-independent interface (MII), 40-pin, D-type receptacle.
- A media-dependent interface (MDI) RJ-45 receptacle.

The RJ-45 and MII receptacles on the GRP represent two physical connection options for only *one* Ethernet interface; therefore, you can use *either* the RJ-45 connection or the MII connection, but not both simultaneously.

⚠
Caution   The GRP can support only one Ethernet connection at a time. To prevent router and network problems, do not connect both RJ-45 *and* MII cables to the Ethernet receptacles at the same time, and use cables that comply with EIA/TIA-568 standards.

LEDs on the front panel indicate which Ethernet receptacle is active when the GRP is operating.

See "GRP Ethernet Port Connections" section on page 2-29 for additional information about GRP Ethernet ports.

⚠️

Caution   Ethernet ports are primarily used as a Telnet port into the Cisco 12000 series router, and for booting or accessing Cisco IOS software images over a network to which an Ethernet port is directly connected. Cisco Express Forwarding (CEF) functions are switched off by default for security reasons. We strongly caution you to consider the security implications of switching on CEF routing functions on these ports.

Figure 3-19   GRP RJ-45 and MII Ethernet Connections
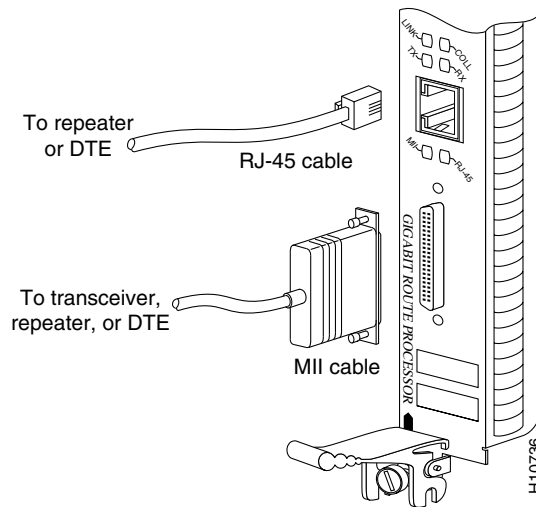
RJ-45 Connection

Use the following procedure to connect an Ethernet cable to the RJ-45 receptacle.

Step 1   Plug the cable directly into the RJ-45 receptacle.

Step 2   Connect the network end of your RJ-45 cable to your transceiver, switch, hub, repeater, DTE, or other external equipment.

> ✎
>
> **Note**   The Ethernet interfaces on the GRP are endstation devices only, not repeaters.

MII Connection

The MII receptacle requires an external transceiver that permits connection to multimode fiber for 100BASE-FX or 100BASE-T4 physical media. Depending on the type of media you use between the MII receptacle and your switch or hub, the network side of your 100-Mbps transceiver should be appropriately equipped with ST-type connectors (for fiber-optic cables), BNC connectors, and so forth.

Use the following procedure to connect a cable to the MII Ethernet receptacle on the GRP.

Step 1   Connect the cable directly to the MII receptacle, or attach a 100BASE-T transceiver (with the media appropriate to your application) to the MII receptacle.

Step 2   Connect the network end of your MII cable to your transceiver, switch, hub, repeater, DTE, or other external equipment.

> ✎
>
> **Note**   The Ethernet interfaces on the GRP are endstation devices only, not repeaters.

Connecting PRP Route Processor Cables

This section describes how to connect cables to the console, auxiliary, and Ethernet ports on the PRP. The console and auxiliary ports are both asynchronous serial ports; any devices connected to these ports must be capable of asynchronous transmission. For example, most modems are asynchronous devices.

Figure 3-20 shows an example of a data terminal and modem connections.

Figure 3-20   PRP Console and Auxiliary Port Connections
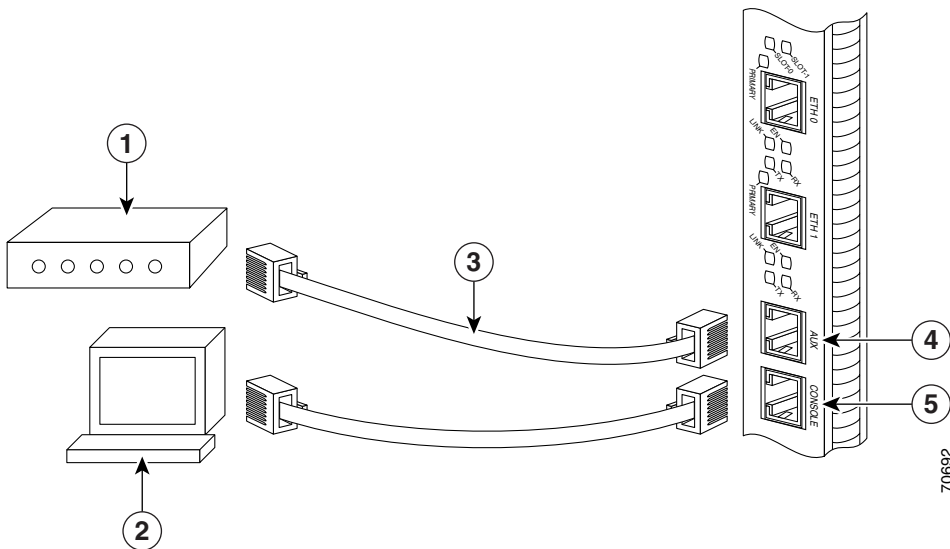
1	Modem	**4**	Auxiliary port
2	Console terminal	**5**	Console port
3	RJ-45 Ethernet cables		—

⚠

Caution   The ports labeled Ethernet, 10BASE-T, Token Ring, Console, and AUX are safety extra-low voltage (SELV) circuits. SELV circuits should only be connected to other SELV circuits.

> **Note** RP cables are not available from Cisco, but are available from any commercial cable vendor.

> **Note** To comply with Telcordia GR-1089 NEBS standard for electromagnetic compatibility and safety, connect all console, auxiliary, Ethernet, and BITS (PRP2) interfaces only to intrabuilding or nonexposed wiring or cabling. The intrabuilding cable must be shielded and the shield must be grounded at both ends.

Connecting to the PRP Console Port

The system console port on the PRP is a DCE RJ-45 receptacle for connecting a data terminal to perform the initial configuration of the router. The console port requires an RJ-45 rollover cable.

See the "PRP Auxiliary and Console Port Connection Guidelines" section on page 2-36 for additional information about the console port.

Refer to Figure 3-20 and use the following procedure to connect a data terminal to the PRP console port.

Step 1 Set your terminal to these operational values: 9600 bps, 8 data bits, no parity, 2 stop bits (9600 8N2).

Step 2 Power off the data terminal.

Step 3 Attach the terminal end of the cable to the interface port on the data terminal.

Step 4 Attach the other end of the cable to the GRP console port.

Step 5 Power on the data terminal.

Connecting to the PRP Auxiliary Port

The auxiliary port on the PRP is a DTE, RJ-45 receptacle for connecting a modem or other DCE device (such as a CSU/DSU or another router) to the router. The asynchronous auxiliary port supports hardware flow control and modem control.

See the "PRP Auxiliary and Console Port Connection Guidelines" section on page 2-36 for additional information about the auxiliary port.

Refer to Figure 3-20 and use the following procedure to connect an asynchronous serial device to the PRP auxiliary port.

Step 1   Power off the asynchronous serial device.

Step 2   Attach the device end of the cable to the interface port on the asynchronous serial device.

Step 3   Attach the other end of the cable to the PRP auxiliary port.

Step 4   Power on the asynchronous serial device.

Connecting to the PRP Ethernet Ports

Two RJ-45 Ethernet interface receptacles on the PRP provide media-dependent interface (MDI) Ethernet ports. These connections support IEEE 802.3 and IEEE 802.3u interfaces compliant with 10BASE-T and 100BASE-TX standards. The transmission speed of the Ethernet ports is autosensing by default and is user-configurable.

The RJ-45 receptacles on the PRP provide two physical connection options for Ethernet interfaces. To connect cables to the PRP Ethernet interfaces (ports labeled ETH0 and ETH1), attach the Category 5 UTP cable directly to a RJ-45 receptacle on the PRP.

See the "PRP Ethernet Connections" section on page 2-40 for additional information.

Note RJ-45 cables are not available from Cisco Systems; they are available from outside commercial cable vendors. Use cables that comply with EIA/TIA-568 standards.

Caution Ethernet ports are primarily used as a Telnet port into the Cisco 12000 series router, and for booting or accessing Cisco IOS software images over a network to which an Ethernet port is directly connected. Cisco Express Forwarding (CEF) functions are switched off by default for security reasons. We strongly caution you to consider the security implications of switching on CEF routing functions on these ports.

Use the following procedure to connect an Ethernet cable to the PRP RJ-45 Ethernet receptacle.

Step 1 Plug the cable directly into the RJ-45 receptacle.

Step 2 Connect the network end of your RJ-45 cable to a switch, hub, repeater, DTE, or other external equipment.

Note The Ethernet interfaces on the PRP are endstation devices only, not repeaters.

Connecting an Alarm Card Cable

Each router alarm card has one 25-pin Dsub connector, labeled Alarm
(Figure 3-21).

Figure 3-21   Alarm Card Cable Connection
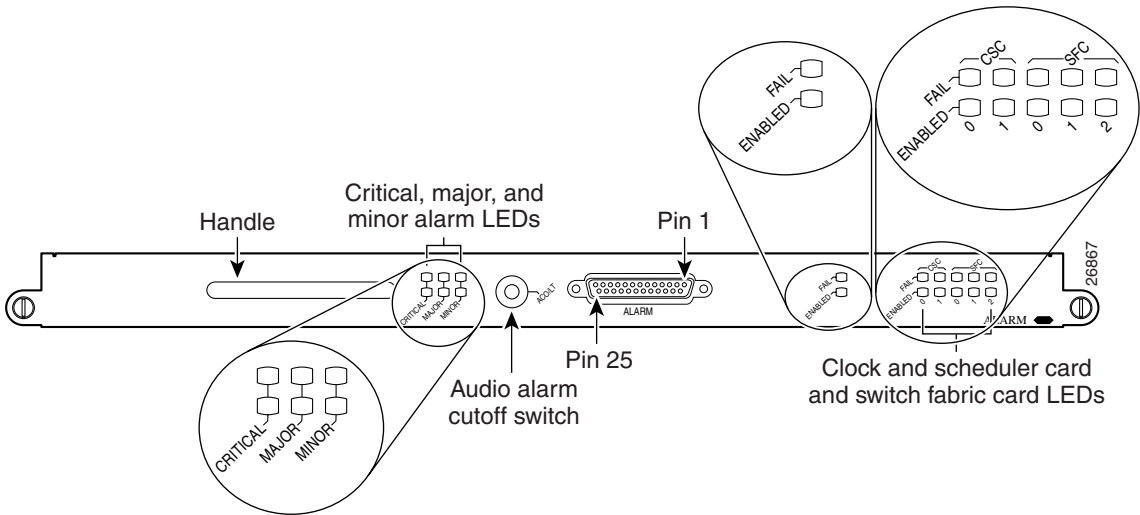
Alarm subconnectors can be used to connect the router to an external site alarm
maintenance system. Any critical, major, and minor alarms generated by the
router also energize alarm relays on the alarm card and activate the external site
alarm. The alarm relay contacts on the alarm card consist of standard *common*,
normally open, and *normally closed* relay contacts that are wired to the alarm
connector pins.

Table 2-13 lists the pin-to-signal correspondence between the connector pins and
the alarm card relay contacts. Because alarm contact cables are entirely dependent
on installation site circumstances, alarm connector cables are not available from
Cisco. For information about alarm connector wiring requirements and the
pinouts for the alarm connector interface, see the "Alarm Card Connection
Guidelines" section on page 2-45.

⚠

Caution   Only safety extra-low voltage (SELV) circuits can be connected to the alarm connector. Maximum rating for the alarm circuit is 2 A, 50 VA.

✎

Note   To comply with Telcordia GR-1089 NEBS standard for electromagnetic compatibility and safety, you must use a shielded cable when connecting to the external alarm ports on the alarm card. The shielded cable is terminated by shielded connectors on both ends, with the cable shield material tied to both connectors.

Connecting Power to the Power Shelf

Use the one of the following procedures to connect power to your router.

- Connecting Power to the AC-Input Power Shelf, page 3-41
- Connecting Power to the DC-Input Power Shelf, page 3-42

⚠

Caution   A router must be operated with all its power modules installed at all times for electromagnetic compatibility (EMC).

Connecting Power to the AC-Input Power Shelf

Use the following procedure to connect the AC power cords to the power shelf.

✎

Note   Connect each AC power supply to a dedicated power source (branch circuit). Each AC-input power supply operates between 200 and 240 VAC and requires at least a 20 A service for North American use, or a 13 A service for international use. For more information on AC power cords, see the "Power Connection Guidelines" section on page 2-17.

Step 1   Connect each AC power cord to the back panel of the power shelf and secure them in place with their retention clips (Figure 3-22).

Figure 3-22   Connecting AC Power Cords
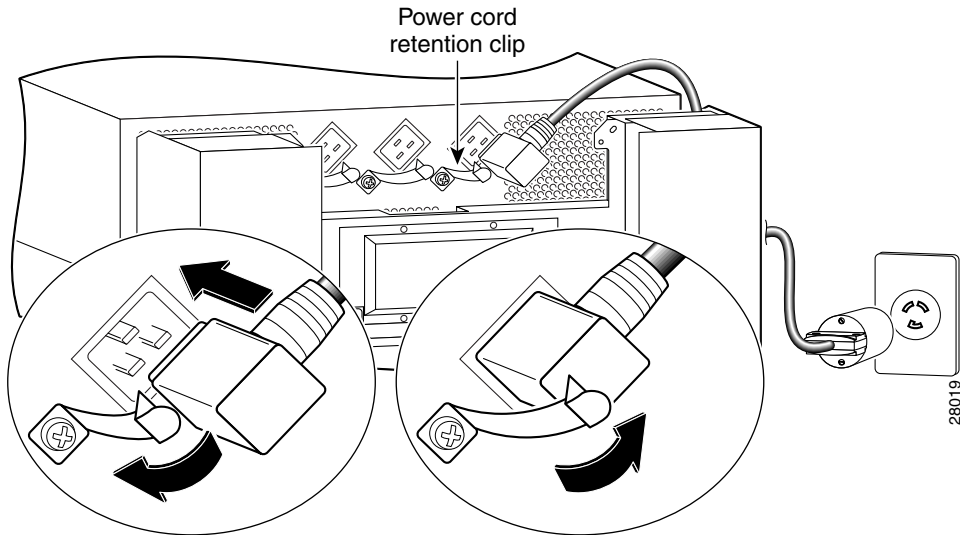
Step 2   Plug each power supply cable into its AC outlet.

Connecting Power to the DC-Input Power Shelf

This section contains the procedures to connect the DC source power cables to a DC-powered router.

The color coding of source DC power cable leads depends on the color coding of the site DC power source.

Because there is no color code standard for source DC wiring, you must be sure that power source cables are connected to the power shelf with the proper positive (+) and negative (–) polarity:

- In some cases, the source DC cable leads might have a positive (+) or a negative (–) label. This is a relatively safe indication of the polarity, *but you must verify the polarity by measuring the voltage between the DC cable leads*. Be sure that the positive (+) and negative (–) cable leads match the positive (+) and negative (–) labels on the power shelf when making the measurement.

- A green (or green and yellow) cable typically indicate that it is a ground cable.

⚠️

Caution   DC PEMs contain circuitry to trip the breaker on the PEM if the PEM detects a reverse polarity condition. No damage should occur from reverse polarity, but you should correct a reverse polarity condition immediately.

✎

Note   The length of the cables depends on the location of your router in relation to the source of DC power. These cables and the cable lugs used to attach the cables to the router chassis are not available from Cisco Systems. They are available from any commercial cable vendor. For more information on site power and source DC cable requirements, see the "Power Connection Guidelines" section on page 2-17.

⚠️

Warning   **To ensure that power remains off while you are performing this procedure, tape the DC circuit breaker switch in the off (0) position.**

Use the following procedure to connect DC power cables to the power shelf.

Step 1   Remove the cover over the cable terminal studs on the back panel of the power shelf (Figure 3-23):

- **a.** Loosen (but do not remove) the screw that secures the cover.
- **b.** Slide the cover down then pull the cover over the screw head and away from the PEM shelf.

Figure 3-23   DC-Input Terminal Connections on the DC-Input Power Shelf

Cover with slotted screw hole;
fastens to standoff in middle of
cable connection area
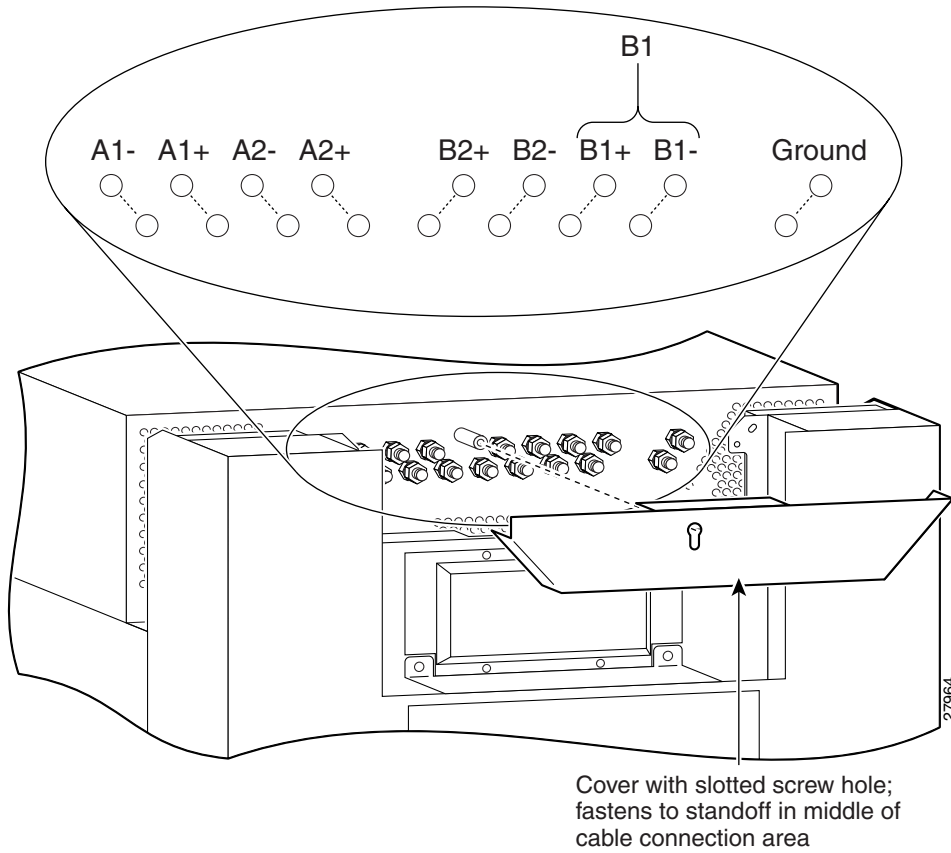
Step 2   Connect the ground and each pair of power cables to the DC-input terminal studs as follows (Figure 3-24):

⚠️

Warning   **When reconnecting source DC power cables, always connect the ground cable first.**

   a.   Connect the ground cable to the ground terminal studs.

   Beginning with terminal studs B2:

   b.   Connect the positive cable to the positive (+) terminal studs. For example: B2+.

   c.   Connect the negative cable to the negative (–) terminal studs. For example: B2-.

   Repeat steps **b** and **c** for the remaining pairs of terminal studs.

Figure 3-24   Reconnecting the Source DC Power Cables to the Power Shelf

Positive (+)
cable lug

Ground (⏚)
cable lug

Negative (–)
cable lug

26866
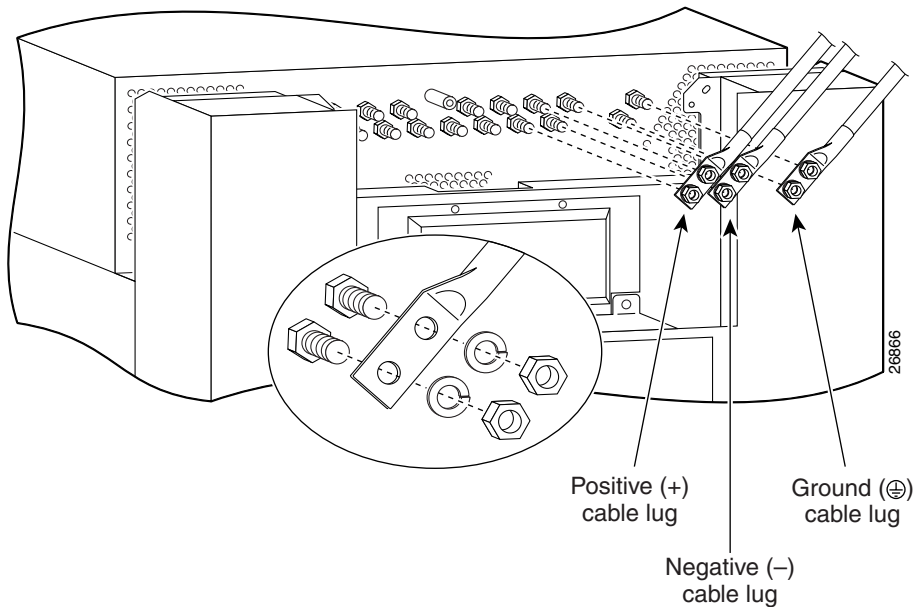
Step 3   Reinstall the power cable cover (Figure 3-25).

Figure 3-25   Reinstalling the Source DC Power Cable Cover
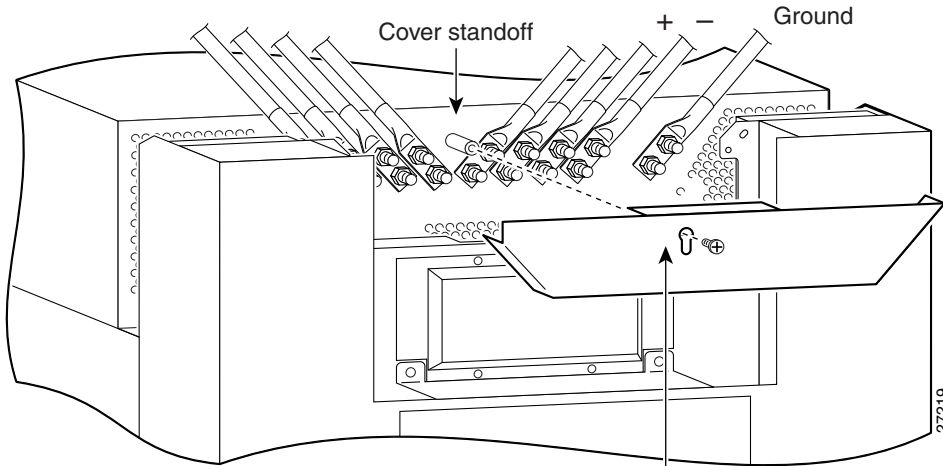
Installing the Front Covers of Cisco 12016 Original Series Routers

The chassis front covers for the power shelf and upper blower module, upper card cage, lower card cage, and lower blower module are fastened to the chassis by ball studs on the front of the chassis (Figure 3-26).

Note   The front cover for power shelf and upper blower module is packaged in the accessory kit to permit the foam shipping cap to fit securely on the top of the router and protect the router without damaging the front cover.

Step 1   Hold the front cover by its outside edges and align the ball studs with the ball stud clips on the front of the chassis.

Step 2   Push the front cover into the ball stud clips and the front cover is flush with the front of the chassis.

Step 3   Repeat Step 1 and Step 2 for the remaining front covers.

Figure 3-26   Router Chassis Front Covers
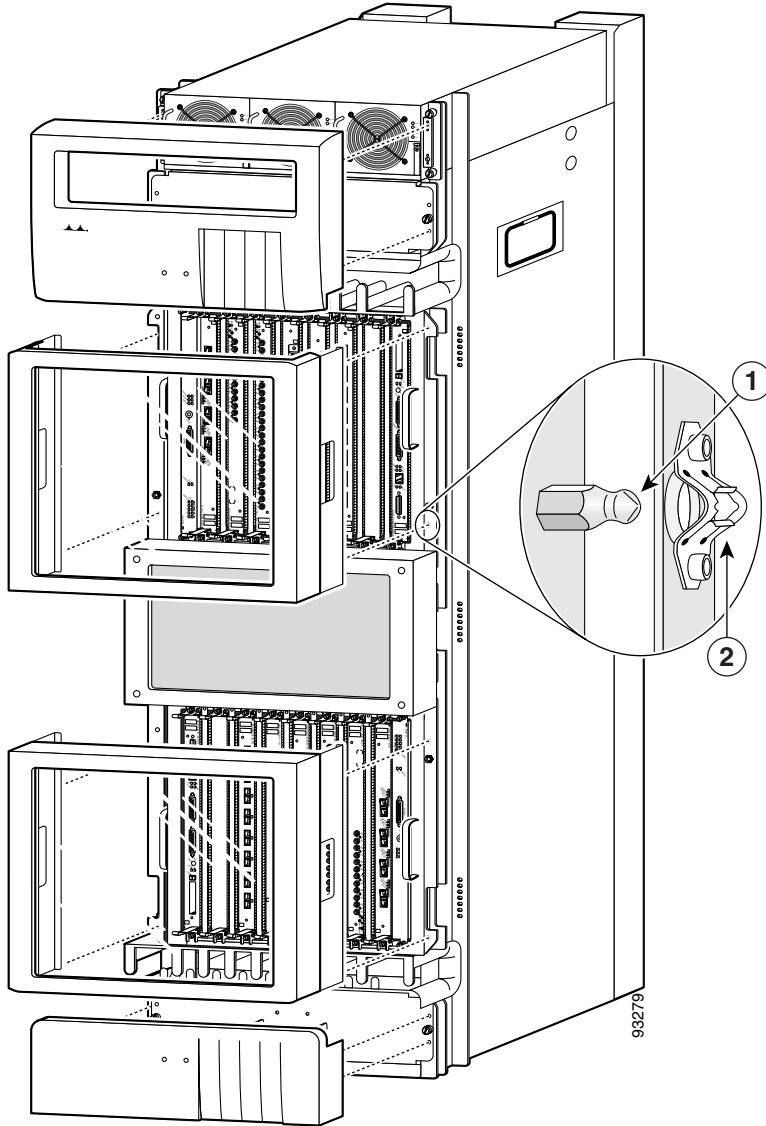
1	Ball stud	2	Ball stud clip

Installing the Front Cover of Cisco 12010 Enhanced Series Routers

Refer to Figure 3-27 and use the following procedure to install the front cover for the Cisco 12010 enhanced series routers.

Step 1   Align the hinges on each side of the cover with the hinge connectors on each side of the chassis (see blowout in Figure 3-27).

Step 2   Push the front cover until the hinges snap into place.

Step 3   Repeat Step 1 and Step 2 for the remaining front cover.

Figure 3-27   Attaching the Front Covers
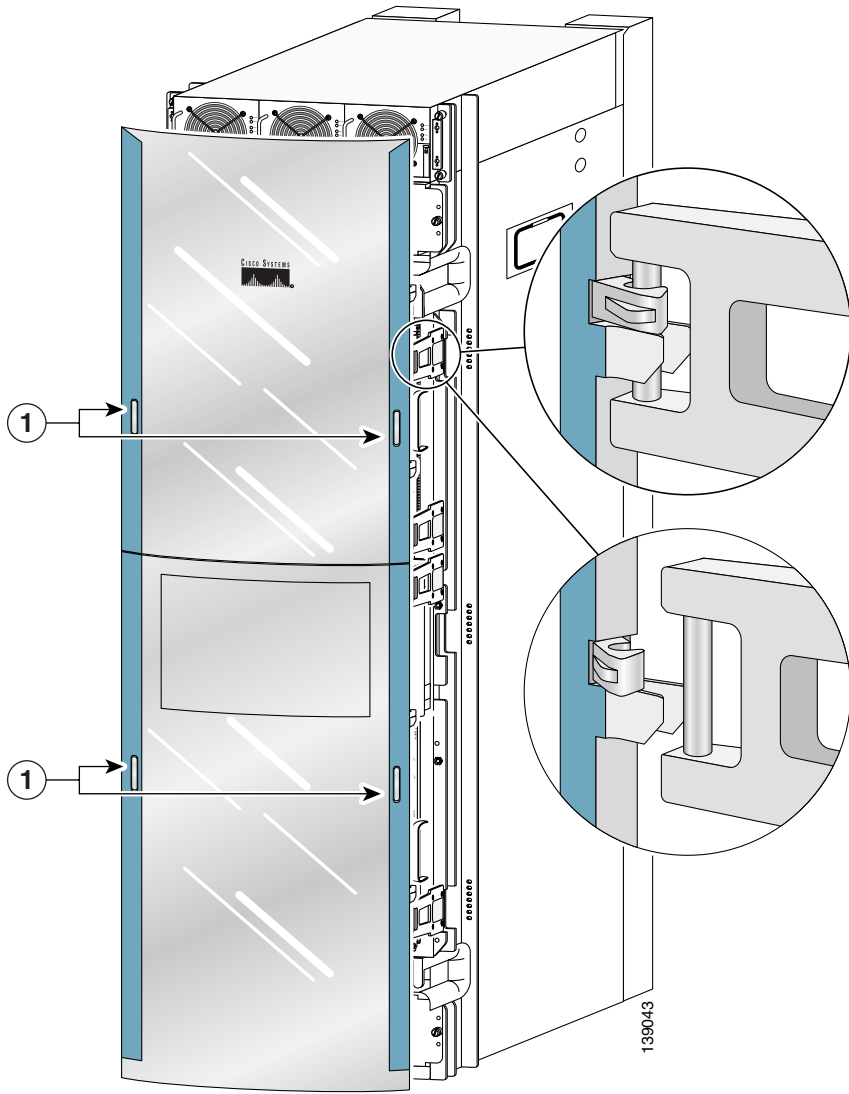
1	Release buttons

This completes the hardware installation procedures for Cisco 12016, Cisco 12416, and Cisco 12816 routers. Proceed to the next chapter to perform the initial router startup and basic configuration.

■ **Installing the Front Cover of Cisco 12010 Enhanced Series Routers**

System Startup and Basic Configuration

The system startup process and a procedure for performing a basic configuration of your Cisco 12016, Cisco 12416, or Cisco 12816 router is presented in the following sections:

This chapter provides you with the information to configure your system so that it can access the network or enable other hosts in the network to access your system remotely by means of a Telnet connection. Detailed configuration procedures are beyond the scope of this document, but you can find more information in the "Post-Installation Procedures" section on page 4-63.

Sources of Cisco IOS Software

A default Cisco IOS software image for your system is available through any of the following internal or external sources:

- Onboard flash memory on the Route Processor (RP)—The latest Cisco IOS software image is preloaded into the flash memory, and it is a single inline memory module (SIMM). Flash memory is also referred to as nonvolatile random access memory (NVRAM). NVRAM retains its contents when you power off the system.

- Flash memory card—A flash memory card (sometimes referred to as a flash disk) inserted in a PCMCIA slot on the RP can serve as an external storage medium for a default Cisco IOS software image.

- TFTP server—A Trivial File Transfer Protocol (TFTP) server in the network can also function as an external source of a default Cisco IOS software image. You can download a valid Cisco IOS software image from such a remote host using a Telnet connection.

Preconfiguration Requirements

Before you configure your system, confirm the following:

- All cards are securely installed.

- All interface cable connections are secure and use cable strain relief where provided.

- All source power cables are securely fastened to the PDUs, and are connected to the appropriate power source.

- A terminal device is connected to the console port on the RP, powered on, and configured for 9600 bps, 8 data bits, no parity, and 2 stop bits (9600, 8N2).

> ✎
>
> **Note**   You must connect a terminal to the RP to perform the initial configuration of the router.

- The flash memory card that shipped with your router is installed in slot 0 of the RP. The software configuration register is set to 0x0102 (default), causing the system to boot automatically from the Cisco IOS software image stored on the flash memory card.

After you complete the above, proceed to the following section to start the router.

Boot Process Overview

The following sequence summarizes a typical boot process.

1. Power on the router.

2. The RP MBus module receives +5 VDC voltage and starts executing MBus software.

3. The RP determines the router configuration by sending a message over the MBus requesting all installed devices to identify themselves. Their responses provide the RP with slot numbers, card, and component types.

4. The RP, line cards, switch fabric cards (CSCs and SFCs), and alarm card are then powered on.

5. The power-on-reset logic of the RP is delayed to allow power for both local and CSC clocks to stabilize.

6. After the power-on reset logic is released, the RP begins to execute the ROM monitor software.

   – If the ROM monitor is configured to autoboot, the system automatically loads and boots the Cisco IOS software.

   – If the ROM monitor is *not* configured to autoboot, you must boot the Cisco IOS software manually.

7. When the Cisco IOS software boots, it polls all other cards in the system, powers them on, and loads the Cisco IOS software they require.

8. The RP waits for all other cards to finish their boot processes.

Powering On the Router and Observing the Boot Process

The first time you start the router, observe the following conditions:

Step 1   Switch on all the circuit breakers that control power to the router.

Step 2   Observe the power entry module LEDs:

- AC PEMs—The green PWR OK LED should be on and the power supply fan operating.

- DC PEMs—The green PWR OK LED should be on and the power supply fan operating.

Step 3   Check the blower module:

- Ensure that the green OK LED is on.

- Listen for the blowers in the blower modules; you should hear them operating immediately. In a noisy environment, the blowers may be difficult to hear. You can place your hand in front of the exhaust vents near the top rear of the chassis to verify that the blower is operating.

Step 4   Observe the RP alphanumeric LED displays during the RP boot process
(Figure 4-1).

Figure 4-1   RP Alphanumeric LED Displays
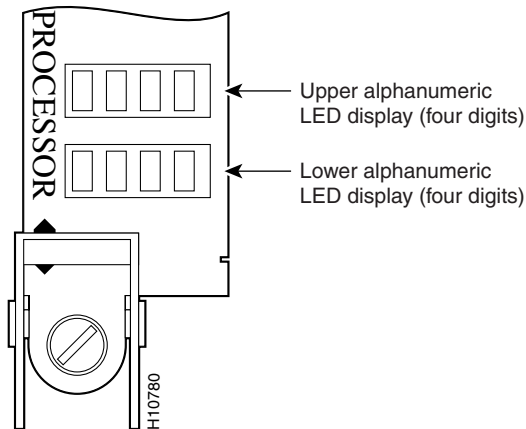
Each 4-digit display shows part of a 2-line system message. During the RP boot
process, the LED displays present a sequence of messages similar to that shown
in Table 4-1.

Table 4-1   RP Alphanumeric LED Display Sequence Examples

LED Display[1]	Meaning	Source
MROM *nnnn*	The MBus microcode begins to execute; *nnnn* is the microcode version number. For example, microcode Version 1.17 appears as 0117[2].	MBus controller
LMEM TEST	Low memory on the RP is being tested.	RP ROM monitor
MEM INIT	The size of main memory on the RP is being discovered.	RP ROM monitor
RP RDY	The system is operational and ready to execute basic Cisco IOS software commands at the ROM monitor prompt (rommon>).	RP ROM monitor
RP UP	A valid Cisco IOS image is running.	RP Cisco IOS software

Table 4-1   RP Alphanumeric LED Display Sequence Examples (continued)

LED Display[1]	Meaning	Source
PRI RP	The RP is enabled and is recognized as the system primary RP. A valid Cisco IOS image is running.	RP Cisco IOS software
SEC RP	The RP is enabled and is recognized as the system secondary RP. A valid Cisco IOS image is running.	RP Cisco IOS software

1. Some LED sequences may occur too quickly to view.

2. The version of MBus microcode running on your system might be different.

Step 5   Observe the status of the RP interfaces (see Figure 4-2 for the GRP and Figure 4-3 for the PRP).

The LEDs on the RP show system status, the active flash memory card slot, the Ethernet connection in use, and the status of the Ethernet interface.

- PCMCIA flash memory card slot LEDs (labeled Slot-0 and Slot-1) are on when the slot is accessed.

- PRP—RJ-45 Ethernet port LEDs show the port activity:

  - LINK: Link activity

  - EN: port enabled

  - TX: data transmission

  - RX: data reception

- GRP—RJ-45 and MII Ethernet LEDs identify which of the two Ethernet connections is selected (only one port can be operational at a time). RJ-45 LEDs show port activity.

  - LINK: Link activity

  - COLL: Collision detection

  - TX: data transmission

  - RX: data reception

Figure 4-2   GRP LEDs—Partial Front Panel View
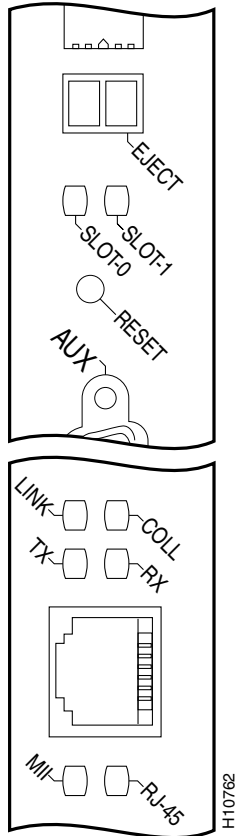
Figure 4-3   PRP Ethernet Ports and LEDs—Partial Front Panel View
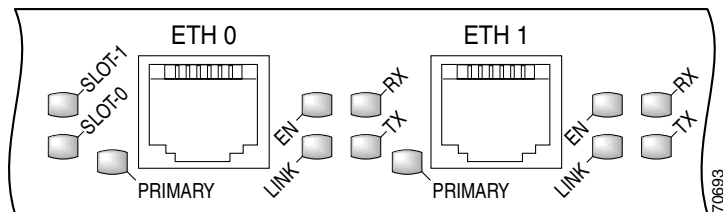
Step 6   During the line card boot process, observe the alphanumeric LED displays on each line card (Figure 4-4).

✎
Note   The line card boot process occurs immediately after the RP boot process.

The system attempts to boot identical line cards in parallel. Further, the system boots line cards as soon as they are powered on and become available. Each line card displays a sequence similar to those shown in Table 4-2.

Figure 4-4   Line Card Alphanumeric LED Displays—Partial View Shown

Table 4-2   Line Card Alphanumeric LED Display Sequence Examples

LED Display[1]	Meaning	Source
MROM *nnnn*	The MBus microcode begins to execute; *nnnn* is the microcode version number. For example, microcode Version 1.17 appears as 0117[2].	MBus controller
LMEM TEST	Low memory on the line card is being tested.	Line card ROM monitor
MEM INIT	The size of main memory on the line card is being discovered.	Line card ROM monitor

Table 4-2   Line Card Alphanumeric LED Display Sequence Examples (continued)

LED Display[1]	Meaning	Source
ROMI GET	The ROM image is being loaded into line card memory.	RP Cisco IOS software
FABL WAIT	The line card is waiting for the fabric downloader to load.[3]	RP Cisco IOS software
FABL DNLD	The fabric downloader is being loaded into line card memory.	RP Cisco IOS software
FABL STRT	The fabric downloader is being launched.	RP Cisco IOS software
FABL RUN	The fabric downloader is launched and running.	RP Cisco IOS software
IOS DNLD	Cisco IOS software is being downloaded into line card memory.	RP Cisco IOS software
IOS STRT	Cisco IOS software is being launched.	RP Cisco IOS software
IOS UP	Cisco IOS software is running.	RP Cisco IOS software
IOS RUN	The line card is enabled and ready for use.	RP Cisco IOS software

1. Some LED sequences may occur too quickly to view. Sequence are shown in this tabular form as a baseline to represent line card functionality at startup.

2. The version of MBus microcode running on your system might be different.

3. The fabric downloader loads the Cisco IOS software image onto the line card.

Step 7 The router automatically boots using the default image (if a flash memory card containing a valid Cisco IOS software image is inserted in slot 0 and the software configuration register is set to 0x0102).

As the router boots the Cisco IOS software image, a system banner similar to the following appears:

```
Cisco Internetwork Operating System Software
IOS (tm) GS Software (GSR-P-M), Experimental Version
12.0(20010120:204554) [gha]
Copyright (c) 1986-2001 by cisco Systems, Inc.
Compiled Sat 20-Jan-01 18:34 by ghall
```

✎

Note The system banner depends on the image version of the Cisco IOS software that the system is running. Your system banner might be different than the examples throughout this chapter.

- If the ROM monitor prompt (rommon>) displays, the router did not find a valid system image or the boot sequence is interrupted, and the system entered read-only memory (ROM) monitor mode.

  In this case, you must boot a Cisco IOS software image manually by issuing the **boot** command.

  – For information on locating a valid Cisco IOS software image, refer to the "Locating a Valid Cisco IOS Software Image" section on page 4-12.

  – For information on using one of the various forms of the **boot** command, refer to the "Booting from the Cisco IOS Software Image" section on page 4-12.

- After manually booting the router, continue to Step 8.

Step 8 When you start an unconfigured system for the first time, the system automatically starts the system configuration dialog. The interactive script prompts you through the steps to create a router configuration file defining basic system operation parameters.

```
          --- System Configuration Dialog ---

Continue with configuration dialog? [yes/no]:
```

The router uses the system configuration file to activate network connections to the RP so the router can be administered from a remote location, or to activate the line card network interfaces. After the initial configuration, the RP and line cards can communicate with external networks.

You do not need to configure the network interfaces immediately, but you cannot connect to a network until you configure the interfaces for operation in your network environment. For configuration information, see the "Configuring the Router" section on page 4-14.

Note   The interface-specific LEDs on the line cards may not power on until you configure the line card interfaces. To verify correct operation of each line card interface, complete the first-time setup procedure and configuration, then check the status of the interfaces against the descriptions in the documentation for each line card.

If the system does not complete each of the preceding steps, go to the "Troubleshooting the Installation" chapter for troubleshooting recommendations and procedures.

Manually Booting the System

If your router does not find a valid system image, or if you interrupt the boot sequence, the system enters ROM monitor mode and displays the ROM monitor prompt (rommon>). From ROM monitor mode, you have access to commands which locate and boot a valid system image.

Locating a Valid Cisco IOS Software Image

Use the following procedure to locate a Cisco IOS software image to manually boot the router from the ROM monitor prompt (rommon>).

Step 1   Enter the ROM monitor mode **dir bootflash** command to examine the contents of the onboard flash memory in NVRAM on the RP.

```
rommon 1> dir bootflash:
   File size               Checksum       File name
   3277967 bytes (0x32048f)  0x6b331e30     gsr-p-mz.120-7.4.5
rommon 2>
```

- If the memory contains the desired Cisco IOS boot image, proceed to the "Booting from the Cisco IOS Software Image" section on page 4-12.

- If the onboard flash memory does not contain the desired Cisco IOS boot image, proceed to the next step.

Step 2   Enter the **dir slot*n*:** command, where *n* represents either slot 0 (0) or slot 1(1) to find a valid image by examining the contents of the flash memory card.

The following example shows the contents of the flash memory card in slot 0:

```
rommon 2> dir slot0:
   File size               Checksum       File name
   3277967 bytes (0x32048f)  0x6b331e30     gsr-p-mz.120-7.4.5
rommon 3>
```

After you locate a valid boot image, proceed to the "Booting from the Cisco IOS Software Image" section on page 4-12.

Booting from the Cisco IOS Software Image

To boot an image manually, issue the appropriate ROM monitor mode **boot** command after locating a valid Cisco IOS software image. Boot the image using one of the **boot** commands shown in Table 4-3.

⚠

Caution   Use the **boot flash** command with care. Make sure that the flash memory card inserted in slot 0 contains a valid Cisco IOS software image; otherwise, you could instruct the system to boot an invalid image from the flash memory card. Before entering a boot command, always enter the **dir slot***n***:** command to examine the contents of a flash memory card.

Table 4-3   Boot Commands

Command	Purpose
boot	(No argument.) Boots the default image in NVRAM. This image is loaded into memory at the factory.
boot bootflash: *filename*	Boots the router using the specified file in NVRAM.
boot disk0: *filename*	Boots the file *filename* from the flash disk in slot 0.
boot disk1: *filename*	Boots the file *filename* from the flash disk in slot 1.
boot flash	(Does not specify a particular PCMCIA slot.) Attempts to boot the router using the first file from the flash memory card in slot 0.
boot slot0: *filename*	Boots the specified file from the linear flash memory card in slot 0.
boot slot1: *filename*	Boots the specified file from the linear flash memory card in slot 1.
boot tftp: *filename* [*host*] or **boot** [*host*] *filename*	Boots the router using the specified file and host name from a TFTP server in the network.

Note   If you did not change the configuration register setting, the next reload will revert to the default configuration register setting (0x0102). This setting causes the system to boot Cisco IOS software from a flash memory card inserted in slot 0 the next time you boot the router. See the "Configuring the Software Configuration Register" section on page 4-31 for additional information.

Configuring the Router

You can perform a basic configuration for your router by using one of the following methods:

- Method 1—Using the setup facility or the **setup** command.

    During the initial startup of an unconfigured router, the system automatically runs the setup facility, which enables you to begin configuring your router manually. The setup facility presents a structured, interactive script that guides you through the process.

    You can also invoke the setup facility at any time to alter previously entered configuration information by issuing the **setup** command at the privileged EXEC mode prompt (`Milo#`).

    This method is described in the "Using Setup for Configuration Changes" section on page 4-18.

- Method 2—Using global configuration mode through the Cisco IOS command line user interface.

    If you prefer not to use the interactive script of the setup facility to configure the router, you can configure it manually in global configuration mode. This method requires you to enter configuration commands on a line-by-line basis at the console without being prompted by a configuration script. This method is described in the "Using Global Configuration Mode" section on page 4-27.

You can use the method that suits your operating style and your knowledge of network configuration requirements.

Whether you use the **setup** command facility or global configuration mode to configure the router to operate in your networking environment, be sure you know the:

- Interfaces the router has.

- Protocols the router is routing.

- Network addresses for the protocols being configured.

- Password scheme for your environment.

Cisco IOS User Interface

Cisco IOS software provides a command line interface that allows you to configure and manage your router. If you are not familiar with the Cisco IOS command line interface, you should read the "Using the Command Line Interface" chapter in the *Configuration Fundamentals Configuration Guide*. This section discusses the different command modes, context-sensitive help, and editing features of the interface.

Cisco IOS User Interface Command Modes

The Cisco IOS user interface is organized into several different modes. The available commands depend on which mode you are currently in. Entering a question mark (?) at the system prompt displays a list of commands available for the current command mode.

When you start a session on the router, you begin in user EXEC mode. Only a limited subset of the commands are available in EXEC mode. In order to have access to all of the commands, you must enter privileged EXEC mode which normally requires a password. From privileged EXEC mode, you can enter any EXEC command or enter global configuration mode. Most of the EXEC commands are 1-time commands, such as **show** commands, that show the current configuration status, and **clear** commands, that clear counters or interfaces. The EXEC commands are not saved across reboots of the router.

The configuration modes allow you to make changes to the running configuration file. If you save the configuration, the commands are stored and persist across router reboots. In order to access the various configuration modes, you must start from global configuration mode. From global configuration mode, you can enter interface configuration mode, subinterface configuration mode, and a variety of protocol-specific modes.

ROM monitor mode, described earlier in this chapter, is a separate mode used when the router cannot boot properly. If your router does not find a valid system image when it is booting, or if its configuration file is corrupted at startup, the system typically enters ROM monitor mode.

User EXEC Mode

After the system boots successfully and loads the Cisco IOS software, the user EXEC mode prompt appears on the system console. The user EXEC mode prompt consists of the router host name followed by the right angle bracket (>). The following example shows the user EXEC mode prompt for a router with the factory default name Router.

```
Router>
```

Note   The default host name is `Router` unless it was changed during initial configuration using the **setup** command facility.

Privileged EXEC Mode

To enter privileged EXEC mode, enter the **enable** command at the user EXEC mode prompt. If the enable secret password is set and saved in memory, the system prompts you to enter the enable secret password. The password does not appear on the window and is case sensitive. When the system accepts the password, the prompt changes to the privileged EXEC mode prompt, which consists of the router host name followed by the pound sign (#).

Note   Because many of the privileged commands set operating parameters, privileged access should be password-protected to prevent unauthorized use.

The following example shows the change from user EXEC mode to privileged
EXEC mode.

```
Router> enable
password: <password>
Router#
```

For information about using passwords, see the "Configuring Passwords" section
on page 4-23.

Global Configuration Mode

Global configuration commands:

- Apply to features that affect the system as a whole, rather than just one
  protocol or interface.

- Use the **configure terminal** command to enter global configuration mode.
  From global configuration mode, you can access a number of other command
  modes.

- Enable particular routing or bridging functions.

For information on protocol-specific global configuration commands, refer to the
appropriate configuration guide in the Cisco IOS software documentation.

Interface Configuration Mode

Use interface configuration commands to modify the operation of an interface
such as Ethernet, FDDI, or a serial port. Interface configuration commands always
follow an **interface** global configuration command, which defines the interface
type.

For details on interface configuration commands that affect general interface
parameters such as bandwidth and clock rate, refer to the "Interface Commands"
chapter in the *Configuration Fundamentals Command Reference*. For
protocol-specific commands, refer to the appropriate Cisco IOS software
command reference guide.

Subinterface Configuration Mode

Use subinterface configuration mode to configure multiple virtual interfaces (called subinterfaces) on a single physical interface. Subinterfaces appear to be distinct physical interfaces to the various protocols. For detailed information on how to configure subinterfaces, refer to the appropriate module for a specific protocol in the Cisco IOS software documentation.

ROM Monitor Mode

If the router cannot locate a valid system image, or if the boot sequence is interrupted, the system may enter ROM monitor mode. You can then boot the system manually or perform diagnostic tests.

You can also enter ROM monitor mode by entering the **reload** command from the privileged EXEC mode prompt and then pressing the Break key during the first 60 seconds of startup.

Using Setup for Configuration Changes

Use the **setup** command facility to perform first-time configuration and other basic configuration procedures on your router. This facility is based on a script that prompts you to enter basic configuration information to start a router quickly and uneventfully.

During the first-time startup of an unconfigured router, the system automatically starts the **setup** command facility and displays an interactive dialog called the system configuration dialog. The system configuration dialog guides you through the configuration process by prompting you for global (system-wide) parameters and interface (line card) parameters.

To use the setup command to change a configuration:

1. You must toggle through each system configuration dialog prompt until you come to the item that you intend to change.

   – To accept default settings for items that you do not want to change, press the **Return** key.

   – To return to the privileged EXEC prompt without making changes and toggling through each system configuration dialog prompt, press **Ctrl-C**.

The setup command facility also provides help text for any prompt. To access help text, press the question mark (?) at a prompt.

2. When you complete your changes, the setup command facility displays the configuration command script that was created as a result of the changes you entered during the **setup** session. It also prompts you to use this configuration. There is no default for this prompt; you must answer either Yes or No.

• If you answer **Yes**, the configuration is saved to NVRAM.

• If you answer **No**, the configuration is not saved and the process begins again.

The following example shows typical output of a setup session automatically invoked during the initial startup of the router. The system banner appears, and then the system configuration dialog begins.

Note The output shown in this section are *examples.* Your configuration dialog might be different depending on which image of the Cisco IOS software you are using and how your router is equipped.

```
Cisco Internetwork Operating System Software
.
.
.
        --- System Configuration Dialog ---

Continue with configuration dialog? [yes/no]: Yes

At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.

Basic setup only configures enough connectivity
for management of the system, extended setup will ask you
```

```
to configure each interface of the system.
Would you like to enter basic management setup? [yes/no]: Yes
Configuring global parameters:

  Enter host name [Router]: Milo

  The enable secret is a password used to protect access to
  privileged EXEC and configuration modes. This password, after
  entered, becomes encrypted in the configuration.
  Enter enable secret [<Use current secret>]: barney

  The enable password is used when you do not specify an
  enable secret password, with some older software versions, and
  some boot images.
  Enter enable password: wilma

  The virtual terminal password is used to protect
  access to the router over a network interface.
  Enter virtual terminal password: bambam
  Configure SNMP Network Management? [no]:

Current interface summary
Interface   IP-Address      OK? Method Status                Protocol
Ethernet0   unassigned      YES unset  administratively down down
POS1/0      unassigned      YES unset  administratively down down
SDCC1/0     unassigned      YES unset  administratively down down
POS2/0      unassigned      YES unset  administratively down down
SDCC1/0     unassigned      YES unset  administratively down down
.
.
.
POS15/0     unassigned      YES unset  administratively down down
SDCC15/0    unassigned      YES unset  administratively down down

Enter interface name used to connect to the
management network from the above interface summary: Ethernet0

Configuring interface Ethernet0:
Configure IP on this interface? Yes
  IP address for this interface: 172.16.72.2
  Subnet mask for this interface: 255.0.0.0
Class B network is 172.16.0.0, 8 subnet bits; mask is /24

The following configuration command script was created:

hostname Milo
enable secret 5 $1$krIg$emfYm/1OwHVspDuS8Gy0K1
enable password wilma
```

```
line vty 0 4
password bambam
no snmp server
!
no ip routing
!
interface Ethernet0
no shutdown
ip address 172.16.72.2 255.255.255.0
!
interface POS1/0
shutdown
no ip address
!
interface SDCC1/0
shutdown
no ip address
.
.
.
interface POS15/0
shutdown
no ip address
!
interface SDCC15/0
shutdown
no ip address
!
end
[0] Go to the IOS command prompt without saving this script.
[1] Return back to the setup without saving this config.
[2] Save this configuration to nvram and exit.

Enter your selection [2]:

Building configuration ...

Use the enabled mode 'configure' command to modify this configuration.

Milo#
```

You can set configuration parameters using the setup command facility, or you can enter the **setup** command at any time at the privileged EXEC prompt to activate the setup facility. When you enter setup using the **setup** command, the script displays any existing (previously entered) system configuration settings within square brackets [ ].

For example, during the configuration of a POS interface, (using the setup facility initial router startup), the script appears as the following example as you respond to queries:

```
Configuring interface POS1/0:
  Is this interface in use?: yes
  Configure IP on this interface?: yes
```

In this example, the script does not display default or current parameters in square brackets [ ], because you entered the setup facility automatically at startup and there is no prior configuration information.

Conversely, when you enter the **setup** command at the privileged EXEC mode prompt (assuming that the POS interface has been configured previously), the script displays those settings in square brackets [ ].

```
Configuring interface POS1/0:
  Is this interface in use?[yes]:
  Configure IP on this interface?[yes]:
```

When a system prompt contains an existing value in square brackets, press **Return** to accept the value, or type an alternate value and press **Return**.

Configuring Global Parameters Using the Setup Facility

When you first enter the setup facility or enter the **setup** command, the system prompts you to configure global parameters for your router. Global parameters control system-wide settings, including the following:

- Host name for the router.

- Passwords for the enable, enable secret, and virtual terminal security parameters.

- Protocols used by the router.

Configuring Host Name

The host name you configure your router with must:

- Follow the rules for ARPANET host names.

- Start with a letter, end with a letter or digit, and have as interior characters only letters, digits, and hyphens.

- Consist of 63 or fewer characters.

For more information, refer to RFC 1035, "Domain Names—Implementation and Specifications."

Uppercase and lowercase characters look the same to many internet software applications, so do not expect case to be preserved. It may seem appropriate to capitalize a name the same way you might do when writing, but names must appear as all lowercase. For more information, see RFC 1178, "Choosing a Name for Your Computer."

Configuring Passwords

The commands available at the user EXEC level are a subset of those available at the privileged EXEC level. Because many privileged EXEC commands are used to set system parameters, you should password-protect these commands to prevent their unauthorized use. For information on how to establish password protection or configure privilege levels, refer to the "Configuring Passwords and Privileges" chapter in the *Security Configuration Guide.*

The enable secret password functionality is available for Cisco 12000 series Gigabit switch routers. To gain access to privileged-level commands, you must enter the correct password. Depending on your boot ROM level, you can use enable password while in ROM monitor mode.

For maximum security, enable secret and enable password settings should be different. If you use the same password during the setup process, the system accepts it but issues a warning to enter a different password.

- An enable secret password can contain from 1 to 25 uppercase and lowercase alphanumeric characters.

- An enable password can contain any number of uppercase and lowercase alphanumeric characters.

In either case, you cannot use a number as the first character. Spaces, however, are valid password characters. For example, *two words* is a valid password. Leading spaces are ignored, but trailing spaces are recognized.

Note   Make a note of all passwords you set and store that information in a secure location for future reference.

Configuring Protocols

For complete information on protocol configuration for your router, refer to the appropriate software configuration publications, which are listed in the "The Cisco IOS software running your router contains extensive features and functionality. For information on Cisco IOS software and general installation and maintenance information for your router, use the following resources:" section on page 4-63.

Configuring Network Interfaces

This section summarizes network interface configuration for the RP and the installed line cards using the setup facility or **setup** command. After the RP and line cards are configured, they can communicate with external networks.

To configure the interface parameters for the RP and installed line cards, you must have the following information available:

- Interface network addresses
- Subnet mask values
- Protocols to be configured

You may need to consult your network administrator to obtain this information. For additional interface configuration information for the RP and line cards installed in your router, refer to the documentation for each card.

Configuring RP Ethernet Interfaces

The RJ-45 and MII receptacles on the GRP and PRP are IEEE 802.3u-compliant interfaces that provide connectivity to Ethernet networks. You can use one interface or the other, but not both at the same time.

The following configuration dialog example shows how to configure the system for an Ethernet interface that uses the IP network layer protocol.

Note The Ethernet interface does not support external routing functions.

```
Configuring interface Ethernet0:
Is this interface in use?: yes
  Configure IP on this interface?: yes
    IP address for this interface: 3.3.1.1
    Number of bits in subnet field: 8
    Class A network is 3.0.0.0, 8 subnet bits; mask is 255.255.0.0
  Configure CLNS on this interface?: yes
```

Configuring Line Card Interfaces

This section contains several brief examples to show how the setup facility manages line card interface configurations. Because of the wide variety of line cards supported by the router, refer to the documentation for your particular line card for detailed information.

The following example shows a system configuration dialog session for a Quad OC-3c POS line card.

```
Configuring interface POS3/0:
  Is this interface in use?: yes
  Configure IP on this interface?: yes
  Configure IP unnumbered on this interface?: no
    IP address for this interface: 2.1.1.1
    Number of bits in subnet field: 0
    Class A network is 2.0.0.0, 0 subnet bits; mask is 255.0.0.0
Configure CLNS on this interface?: yes
```

The following sample shows how to configure the same Quad OC-3c POS line card interface for IP unnumbered.

```
Configuring interface POS3/0:
  Is this interface in use?: yes
  Configure IP on this interface?: yes
  Configure IP unnumbered on this interface?: yes
    Assign to which interface: ethernet0
  Configure CLNS on this interface?: yes
```

The following example shows how to configure an ATM line card to use IP.

```
Configuring interface parameters:

Configuring interface ATM1/0:
  Is this interface in use?: yes
  Configure IP on this interface?: yes
    IP address for this interface: 1.1.1.2
    Number of bits in subnet field: 0
    Class A network is 1.0.0.0, 0 subnet bits; mask is 255.0.0.0
```

After you have manually configured the network interface parameters, the RP and line card interfaces are available for limited use.

- To modify the currently saved configuration information, you can enter the **setup** command at the privileged EXEC mode prompt (`Milo#`) at any time to start another system configuration dialog session.

- To perform more complex configuration tasks, you can enter the **configure terminal** command at the privileged EXEC mode prompt (`Milo#`), which invokes global configuration mode [`Milo(config)#`]. See the "Using Global Configuration Mode" section on page 4-27 for more information.

Checking the Software Version Number and Installed Interfaces

The **show version** command displays the Cisco IOS software version number as well as other information, including the hardware installed in the system, the names and sources of system image files, and the contents of the software configuration register.

The following example shows the type of information generated by this command.

```
Milo# show version
Cisco Internetwork Operating System Software
IOS (tm) GS Software (GSR-P-M), Experimental Version
12.0(20010120:204554) [gha]
Copyright (c) 1986-2001 by cisco Systems, Inc.
Compiled Sat 20-Jan-01 18:34 by ghall
Image text-base: 0x60010950, data-base: 0x61C14000

ROM: System Bootstrap, Version 11.2(17)GS2, [htseng 180] EARLY
DEPLOYMENT RELEA)
BOOTFLASH: GS Software (GSR-BOOT-M), Version 11.2(18)GS4, EARLY
DEPLOYMENT RELE

Getty uptime is 22 hours, 15 minutes
System returned to ROM by reload
```

```
System image file is "tftp://xxx.xxx.xxx.xxx/directory/ghall/gsr-p-mz"

cisco 12410/GRP (R5000) processor (revision 0x05) with 262144K bytes
of memory.
R5000 CPU at 200Mhz, Implementation 35, Rev 2.1, 512KB L2 Cache
Last reset from power-on

1 Route Processor Card
2 Clock Scheduler Cards
5 Switch Fabric Cards
2 OC48 POS controllers (2 POS).
1 four-port OC48 POS controller (1 POS).
1 Ethernet/IEEE 802.3 interface(s)
6 Packet over SONET network interface(s)
507K bytes of non-volatile configuration memory.
8192K bytes of Flash internal SIMM (Sector size 256K).
Configuration register is 0x0
...
```

Using Global Configuration Mode

Global configuration mode enables you to enter configuration commands line–by–line from the console terminal. If you prefer not to use the interactive script of the setup facility, you can manually configure your router using global configuration mode.

To display a list of the configuration commands available to you, enter a question mark (**?**) at any prompt or press the designated **help** key on the terminal keyboard while in configuration mode.

Use the following procedure to configure your router using global configuration mode.

Step 1   When you are prompted to enter the system configuration dialog at bootup, answer **no**.

```
Would you like to enter the initial dialog? [yes]: no
Milo>
```

Step 2   Enter the **enable** command and password (if prompted).

```
Milo> enable
Password: <password>
Milo#
```

Step 3   Enter the **configure terminal** command to enter global configuration mode.

```
Milo# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Milo(config)#
```

Step 4   Enter the **interface** *type slot/port* command to enter interface configuration mode.

```
Milo(config)# interface type slot/port
Milo(config-if)#
```

Step 5   Enter the **copy running-config startup-config** command to save your configuration settings.

```
Milo# copy running-config startup-config
```

Your system is now minimally configured and able to boot using the configuration you entered.

Verifying Running Configuration File Settings

The **show running-config** command lets you check the settings in the running configuration file.

The following example displays the output for a Quad OC-3c/STM-1c POS interface installed in slot 1.

```
router# show running-config
Building configuration...

Current configuration:
!
version 12.0
no service pad
no service udp-small-servers
no service tcp-small-servers
!
hostname Milo
!
enable secret 5 $1$W6K5$W/p5Bq6IPLGJ/hS9VVP1g.
enable password twink

interface POS1/0
 ip address 10.1.1.1 255.255.255.0
 crc 32
```

```
 clock source internal
!
interface POS1/1
 no ip address
 no ip route-cache cef
 no ip route-cache
 shutdown
 crc 32
!
interface POS1/2
 no ip address
 no ip route-cache cef
 no ip route-cache
 shutdown
 crc 32
!
interface POS1/3
 no ip address
 no ip route-cache cef
 no ip route-cache
 shutdown
 crc 32
```

Saving the Running Configuration Settings to NVRAM

The **copy running-config startup-config** command saves the configuration settings that you created while in the global configuration mode to NVRAM. Be sure to enter this command any time you make changes to configuration settings.

```
Milo# copy running-config startup-config
```

Note   If you do not save the running configuration settings to NVRAM, they will be lost the next time you reload the system.

Viewing the Running Configuration Settings

You can use the **show startup-config** command to view the current configuration settings stored in NVRAM.

The following example shows the type of information generated by this command.

```
Milo# show startup-config
Using 5560 out of 520184 bytes
!
version 12.0
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Milo
!
enable secret 5 $1$/5HX$OOvyhG2JYhNaCbPa45Wmn/
enable password wilma
ip cef distributed switch
ip host biff 10.3.3.254
!
interface Ethernet0
 ip address 10.3.1.1 255.255.0.0
 no ip mroute-cache
!
interface POS1/0
 ip address 10.1.1.1 255.0.0.0
 no keepalive
 crc 16
 no cdp enable
.
.
.
interface ATM3/0
 ip address 10.0.0.15 255.0.0.0 secondary
 ip address 10.1.1.2 255.0.0.0
 atm pvc 1 0 64 aal5snap
 atm pvc 2 0 72 aal5mux ip 155000 155000 1
 atm pvc 3 1 90 aal5snap 312000 312000 1
 atm pvc 4 0 108 aal5snap
 atm pvc 10 0 144 aal5mux ip 155000 155000 1
 atm pvc 11 1 91 aal5snap 310000 310000 1
 map-group atm1
!
no ip classless
ip route 10.5.4.254 255.255.255.255 Ethernet0
```

```
!
map-list atm1
 ip 10.1.1.1 atm-vc 1
 ip 10.1.1.3 atm-vc 2
 ip 10.1.1.4 atm-vc 4
 ip 10.0.0.1 atm-vc 3
 ip 10.0.0.5 atm-vc 10
 ip 10.0.0.6 atm-vc 11
no logging trap
!
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 password bambam
 login
!
end
```

Configuring the Software Configuration Register

The software configuration register is a 16-bit register in NVRAM that defines specific system parameters. You can set or change the contents of this register to accomplish the following tasks:

- Define the boot sources for the default Cisco IOS software, assigning them in the following order of precedence:

  - Flash memory card inserted in PCMCIA slot 0

  - TFTP server on the network

  - Flash memory SIMM (NVRAM) on the route processor

  - Boot image stored within the operating environment

- Define a default boot filename.

- Enable or disable the Break function.

- Control broadcast addresses.

- Set the console terminal baud rate.

- Recover a lost password.

- Force an automatic boot using a boot image.

- Read **boot system** commands from the configuration file stored in NVRAM.

Table 4-4 defines software configuration register bits.

⚠
Caution   To avoid confusion and possibly halting the system, remember that valid software configuration register values may be combinations of settings, rather than the individual settings listed in Table 4-4. For example, the default value for the software configuration register (0x0102) is a combination of several settings (binary bit 8 = 0x0100 and binary bits 00 through 03 = 0x0002).

Table 4-4   Software Configuration Register Bits

Bit Number	Hexadecimal Value	Meaning/Function
00 to 03	0x0000 to 0x000F	Comprises the boot field for defining the source of a default Cisco IOS software image required to run the router (see Table 4-5)
06	0x0040	Causes the system software to ignore the contents of NVRAM
07	0x0080	Enables the OEM[1] bit
08	0x0100	Disables the break function
09	0x0200	Uses a secondary bootstrap
10	0x0400	Broadcasts Internet protocol (IP) with all zeros
11 and 12	0x0800 to 0x1000	Defines the console baud rate (default = 9600 bps)
13	0x2000	Boots the default flash memory software if the network boot fails
14	0x4000	Excludes network numbers from IP broadcasts
15	0x8000	Enables diagnostic messages and ignores the contents of NVRAM

1.   OEM = original equipment manufacturer.

The boot field (Table 4-5) defines a source for booting a default Cisco IOS software image required to run the router. The content of the boot field is specified as a binary number.

Table 4-5   Boot Field—Software Configuration Register

Boot Field	Meaning at Power-On
00	System remains at the ROM monitor prompt (`rommon>`), awaiting a user command to boot the system manually.
01	System automatically boots the first system image found in the onboard flash memory SIMM on the RP.
02 to 0F	System boots automatically from a default Cisco IOS software image stored on a TFTP server in the network. This boot field setting requires that the Ethernet port on the RP is configured and operational. This setting also enables **boot system** commands that override the default filename.

Note   A Cisco 12010, Cisco 12410, or Cisco 12810 router is shipped with a boot image in the boot flash, and a Cisco IOS image on a flash memory card.

Setting Software Configuration Settings

The four low-order bits of the software configuration register (bits 3, 2, 1, and 0) form a boot field that defines the source of a Cisco IOS software image for booting the router.

You can set or change the contents of the boot field by entering the **config-register** command at the global configuration mode prompt [`Milo(config)#`].

Note   The factory default configuration register setting for an RP is 0x0102.

Depending on the boot field setting, the system ignores boot instructions in the system configuration file and performs one of the following operations:

- When the boot field is set to 0—You must boot the operating system manually by entering the **boot** command at the ROM monitor prompt (`rommon>`). You can enter the **boot** command with or without arguments.

  If you enter the **boot** command:

  – Without an argument (that is, without specifying a file or any other boot instructions), the system automatically boots using the default image in the flash memory SIMM on the RP.

  – With arguments (that is, by instructing the system to boot from a specific source), you have the following options:

- You can instruct the system to boot from a:

  – Specific flash SIMM image (by entering the **boot bootflash:***filename* command)

  – Specific image stored on a PCMCIA flash memory card (by entering the **boot slot #:** *imagename* command).

  – Network TFTP server either by sending broadcast TFTP requests (by entering a **boot** *filename* command), or by sending a direct request to a specific network TFTP server (by entering a **boot** *filename ip-address* command).

- When the boot field is set to 1—The system automatically boots using the first image found in the onboard flash SIMM on the RP.

- When the boot field is set to a bit pattern other than 0 or 1—The router uses the software configuration register settings to compute the filename of a default system image stored on a network TFTP server. It then uses that system image to boot the router. However, if the configuration file contains boot instructions, the system uses those instructions to boot the system rather than using the filename it computed from the software configuration register settings.

  To form this filename, the system starts with *cisco* and links the octal equivalent of the boot field value and the processor type in the following format:

  cisco<*bootfieldvalue*>-<*processorname*>

For example, the filename formation process may yield a range of typical filenames like the following:

```
cisco2-grp

.
.
.

cisco17-grp
```

The system uses one of the filenames in this range to boot a default system image stored on a network TFTP server.

> ✎
>
> **Note**   If a bootable Cisco IOS software image exists in a flash memory card inserted in slot 0 or slot 1, the software configuration register boot field setting is overridden. The system boots from the image in the flash memory card, rather than from a network TFTP image (that is, from a computed filename in the range from *cisco2-grp* through *cisco17-grp* on the GRP and *cisco2-prp* through *cisco17-prp* on the PRP).

Changing Software Configuration Register Settings

Use the following procedure to change software configuration register settings while running system software.

Step 1   Enter the **enable** command and password (if prompted).

```
Milo> enable
Password: <password>
Milo#
```

Step 2   Enter the **configure terminal** command to enter global configuration mode.

```
Milo# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Milo(config)#
```

Step 3 Set the contents of the software configuration register by entering the **config-register** *value* command, where *value* is a hexadecimal number preceded by 0x.

```
Milo(config)# config-register 0xvalue
```

> ✎
>
> **Note** Consult the hexadecimal column in Table 4-4 on page 4-32 for the possible settings to enter as the 4-bit *value* parameter.

Step 4 Press **Ctrl-Z** to exit global configuration mode.

```
Milo(config)# config-register 0xvalue
Milo(config)# Ctrl-Z
Milo#
```

Step 5 Enter the **show version** command to verify the software configuration register value that is currently in effect, and the new value you entered (in Step 3) the next time the router reloads.

```
Milo# show version

.
.
.

Configuration register is 0x141 (will be 0x102 at next reload)
```

Step 6 Enter the **copy running-config startup-config** command to save the software configuration register settings to NVRAM.

```
Milo# copy running-config startup-config
```

Step 7 Reboot the system.

> ✎
>
> **Note** Configuration register changes take effect only after the system reboots (for example, when you enter a **reload** command from the console).

Low-Order Bits in the Software Configuration Register

This section provides detail about of the low-order bits in the software configuration register and how they interact during the router boot process.

As described in the "Setting Software Configuration Settings" section on page 4-33, the boot field setting determines the source of the Cisco IOS software image used to boot the router.

- If you set the boot field value to 0 (0x0000), you must boot the operating system manually by entering the **boot** command at the ROM monitor prompt (`rommon>`).

- If you set the boot field value to 0x2 through 0xF and a valid **boot system** command is stored in the configuration file, the router boots the Cisco IOS software image as directed by that value.

- If no **boot system** command is present in the configuration file, the router forms a default boot filename and attempts to acquire that file from a network TFTP server.

In the following example, the software configuration register is set to boot the router from the flash memory SIMM on the RP, and to ignore the Break function at the next reboot of the system (see Table 4-4):

```
Milo# configure terminal
Enter configuration commands, one per line. End with CTRL-Z.
Milo(config)# config-register 0x0102
Milo(config)# boot system flash filename
Ctrl-Z
Milo#
```

With the configuration register set to 0x0102, the system computes a default boot filename. In forming this filename, the system starts with *cisco* and appends the octal equivalent of the boot field number, a hyphen, and the processor type (*grp* or *prp*).

Table 4-6 lists the range of possible computed default filenames for booting the system over the network. Note, however, that a valid **boot system** configuration command stored in the NVRAM configuration file overrides any computed default filename for booting over the network.

Note If a bootable Cisco IOS software image exists in a flash memory card installed in slot 0 or slot 1, the configuration register setting is overridden, and the bootable Cisco IOS software image is booted instead of the default TFTP-bootable Cisco IOS software image (cisco2-grp through cisco17-grp or cisco2-prp through cisco17-prp).

Table 4-6   Default Boot Filenames

Action/Filename	Bit 3	Bit 2	Bit 1	Bit 0
Bootstrap mode	0	0	0	0
Default software	0	0	0	1
cisco2-grp or cisco2-prp	0	0	1	0
cisco3-grp or cisco3-prp	0	0	1	1
cisco4-grp or cisco4-prp	0	1	0	0
cisco5-grp or cisco5-prp	0	1	0	1
cisco6-grp or cisco6-prp	0	1	1	0
cisco7-grp or cisco7-prp	0	1	1	1
cisco10-grp or cisco10-prp	1	0	0	0
cisco11-grp or cisco11-prp	1	0	0	1
cisco12-grp or cisco12-prp	1	0	1	0
cisco13-grp or cisco13-prp	1	0	1	1
cisco14-grp or cisco14-prp	1	1	0	0
cisco15-grp or cisco15-prp	1	1	0	1
cisco16-grp or cisco16-prp	1	1	1	0
cisco17-grp or cisco17-prp	1	1	1	1

High-Order Bits in the Software Configuration Register

This section describes the significance of high-order bits in the software configuration register.

- Bit 8 of the software configuration register controls the console Break key.

    – Setting bit 8 causes the system to ignore the console Break key (factory default).

    – Clearing bit 8 causes the system to interpret a Break keystroke as a command to halt normal system operation and force the system into ROM monitor mode.

> ✎
>
> **Note**   Pressing the Break key during the first 5 seconds of system bootup causes a return to the ROM monitor mode regardless of the setting of the Break enable bit in the software configuration register.

- Bit 9 is not used.
- Bit 10 of the software configuration register controls the host portion of the IP broadcast address.

    – Setting bit 10 causes the processor to use all zeros in the host portion of the IP broadcast address

    – Clearing bit 10 causes the processor to use all ones (factory default)

    Bit 10 interacts with bit 14, which controls the network and subnet portions of the IP broadcast address.

Table 4-7 shows the combined effect of bits 10 and 14.

Table 4-7   Configuration Register Settings for Broadcast Address Destination

Bit 14	Bit 10	Address (<net> <host>)
Off	Off	<ones> <ones>
Off	On	<zeros> <zeros>
On	On	<net> <zeros>
On	Off	<net> <ones>

- Bits 11 and 12 of the software configuration register determine the data transmission rate of the console terminal. Table 4-8 shows the bit settings for four data transmission rates.

Table 4-8   System Console Terminal Data Transmission Rate Settings

Bit 12	Bit 11	Data Transmission Rate (bps)
0	0	9600[1]
0	1	4800
1	0	1200
1	1	2400

1. Default.

- Bit 13 of the software configuration register determines the system response to a bootload failure.
  - Setting bit 13 causes the system to load Cisco IOS software from flash memory after five unsuccessful attempts to load a boot file from the network TFTP server.
  - Clearing bit 13 causes the system to continue attempting to load a boot file from the network TFTP server indefinitely (default).

Recovering a Lost Password

Use the following procedure to recover a lost password.

✎

Note   This procedure does not work for password recovery if the enable password is encrypted—you must reconfigure the system before attempting a reboot (see the "Configuring the Router" section on page 4-14).

Step 1   Enter the **show version** command at the privileged EXEC mode prompt to display the existing software configuration register value.

```
Milo# show version

.
.
.

Configuration register is 0x141
```

Write this value on paper for use in Step 10.

Step 2   Enter the **reload** command to boot the system and press the **Break** key within 5 seconds to display the ROM monitor prompt.

```
Milo# reload
rommon 1>
```

If the Break function is disabled, power off the power supplies, wait for at least 5 seconds, and then restore power. Press the **Break** key within 5 seconds of powering on the router.

Step 3   Enter the **config-register** command and answer **yes** to change the configuration settings and then to ignore the system configuration information.

```
rommon 1> config-register

Configuration Summary
enabled are:
console baud: 9600
boot: image specified by the boot system command
or default to: cisco2-prp

do you wish to change the configuration? y/n [n]: y
enable "diagnostic mode"? y/n [n]:
```

```
enable "use net in IP bcast address"? y/n [n]:
enable "load rom after netbootfails"? y/n [n]:
enable "use all zero broadcast"? y/n [n]:
enable "break/abort has effect?" y/n [n]:
enable "ignore system config info?" [n]: y
change console baud rate? y/n [n]:
change boot characteristics? y/n [n]

Configuration Summary
enabled are:
console baud: 9600
boot: image specified by the boot system command
or default to: cisco2-prp
do you wish to change the configuration? y/n [n]

You must reset or power cycle for the new config to take effect
rommon 1>
```

Step 4   Enter the **initialize** command to initialize the router.

```
rommon 1> initialize
```

After the router completes its power cycle, the software configuration register is set to ignore the configuration file. The router boots the system image and displays the system configuration dialog:

```
        --- System Configuration Dialog ---

.
.
.
```

Step 5   Enter **no** in response to the system configuration dialog prompts until the following instruction is displayed:

```
Press RETURN to get started!
```

Step 6   Press **Return**.

After some interface configuration information is displayed, the user EXEC mode prompt appears:

```
Milo>
```

Step 7 Enter the **enable** command and password (if prompted).

```
Milo> enable
Password: <password>
Milo#
```

Step 8 Enter the **show startup-config** command to display the enabled password in the configuration file.

```
Milo# show startup-config
.
.
.
password bambam
```

Step 9 Enter the **configure terminal** command to enter global configuration mode:

```
Milo# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Milo(config)#
```

Step 10 Enter the **config-register 0x***value* command to change the software configuration register value back to its original value which you noted in Step 1.

```
Milo(config)# config-register 0xvalue
Milo(config)#
```

Step 11 Press **Ctrl-Z** to exit global configuration mode.

```
Milo(config)# Ctrl-Z
Milo#
```

Step 12 Reboot the router and use the recovered password with the **enable** command to gain access to the router.

Using RP Flash Memory Cards

This section describes how to use RP flash memory cards and includes information on the following topics:

Installing and Removing a Flash Memory Card

The PCMCIA flash card slots are designated as slot 0 (left) and slot 1 (right). Both flash memory card slots can be used at the same time.

If there are dual GRPs, the slots in the primary GRP are designated slot 0 and slot 1. The slots in the secondary GRP are designated sec-slot 0 and sec-slot 1.

Note   The following procedures can be used for a flash memory card in either slot position.

Refer to Figure 4-5 and the following procedure to install a flash memory card.

Step 1   Remove the flash memory slot cover by loosening its captive screw (illustration is shown without the cover for clarity).

Step 2   Hold the flash memory card with the connector end of the card toward the slot and the label facing right (see Figure 4-5a).

Step 3   Insert the card into the appropriate slot until the card completely seats in the connector and the ejector button pops out (see Figure 4-5b).

⚠

Caution   The flash memory card is keyed for proper insertion. The ejector button does not pop out unless the card is inserted correctly. Part of the card remains outside of the slot even when the card is properly seated. *Do not attempt to force the card deeper into the slot after the ejector button pops out.*

Step 4   Replace the flash memory card slot cover.

Use the following procedure to remove a flash memory card.

Step 1   Remove the flash memory slot cover by loosening its captive screw (illustration is shown without the cover for clarity).

Step 2   Press the appropriate ejector button to eject the card from the connector at the back of the slot (see Figure 4-5c).

Step 3   Pull the card from the slot and place it in an antistatic bag to protect it from ESD damage.

Step 4   Replace the flash memory card slot cover.

Figure 4-5   Installing and Removing a Flash Memory Card
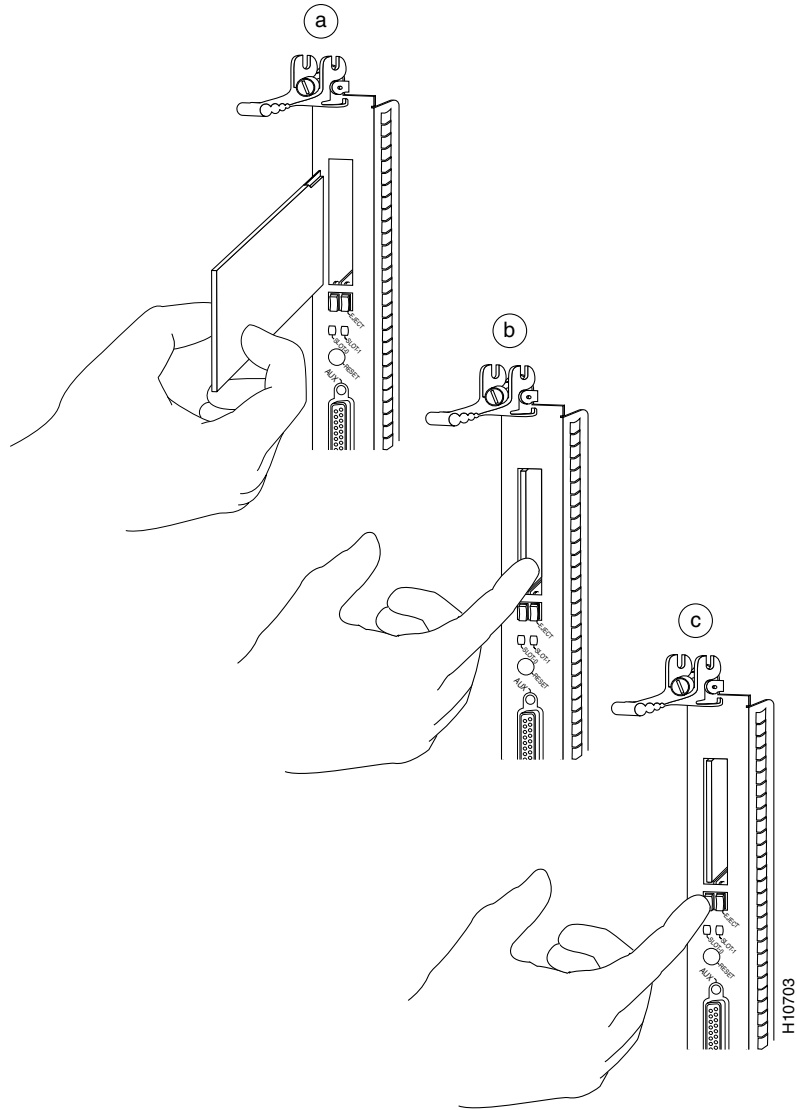
Formatting a New Flash Memory Card

The flash memory card that shipped with your router contains the default Cisco IOS software image you need to boot your router.

If you require a new flash memory card to copy images or backup configuration files, you must first format the card.

Note   Use only Type I or Type II flash memory cards.

Use the following procedure to format a new flash memory card.

Step 1   Insert the flash memory card into slot 0 or slot 1.

Step 2   Enter the **format slot0:** (or **format slot1:**) command at the privileged EXEC mode prompt:

```
Milo# format slot0:
All sectors will be erased, proceed? [confirm]
Enter volume id (up to 30 characters): MyNewCard
Formatting sector n
Format device slot0 completed
Milo#
```

When the console displays the "Formatting sector *n*" line, the format routine begins to count backward from the number of sectors on the flash memory card. For example, on a 20MB there are 160 sectors. When the count reaches 1, the formatting process is complete. The new flash memory card is now formatted and ready to use.

For command descriptions and configuration information, refer to the *Configuration Fundamentals Command Reference* and the *Configuration Fundamentals Configuration Guide* in the Cisco IOS documentation set.

Specifying a Cisco IOS Software Image to Boot the System

Use the procedure in this section to identify a specific Cisco IOS software image (*new.image* in this example) that you want to make bootable from a flash memory card.

The software configuration register must be set to 0x2102 to boot the image from the flash memory card. Therefore, the **config-register** command must be included in the command sequence, as shown in the following example.

```
Milo# configure terminal
Milo(config)# no boot system
Milo(config)# boot system flash slot0:new.image
Milo(config)# config-register 0x2102
Ctrl-Z
Milo# copy running-config startup-config
Milo# reload
```

When you enter the **reload** command, the system uses the specified file (*new.image*) on the flash memory card in slot 0 to boot the system.

If one of the following software configuration register settings is specified in the preceding example, the system would follow those instructions accordingly:

- 0x2000—If the network boot fails, the system boots a default Cisco IOS software image from a flash memory card.

- 0x0100—The system ignores the Break function.

- 0x0101—The system boots the default image (the first image found) from the onboard flash memory SIMM on the RP. This setting also tells the system that it should *not* reset the Break disable function, nor should it check for a default filename for booting over the network.

- 0x0002—The system looks in the flash memory SIMM on the RP for a default Cisco IOS software image.

- 0x0102—The system disables the Break function and checks for a default TFTP server filename. If the network boot operation fails, the system boots from a flash memory card.

Flash Memory Commands

This section describes console commands that you can use to access the different types of flash memories. Enter these commands from the privileged EXEC mode prompt.

pwd Command

To determine whether the present device you are accessing is the onboard flash SIMM on the RP or a PCMCIA flash memory card, use the **pwd** command.

This example shows how to access a flash memory card in slot 0 of the RP.

```
Milo# pwd
slot0:
Milo#
```

cd Command

To change access from one type of flash memory device to another, enter the **cd** *device-name* command.

Where *device-name* can be **slot0:**, **slot1:**, or **bootflash:**.

The following example shows the **cd** command changing access to different devices.

```
Milo# cd slot1:
Milo# pwd
slot1:/
Milo# cd slot0:
Milo# pwd
slot0:/
Milo# cd bootflash:
Milo# pwd
bootflash:/
Milo#
```

dir Command

To list the directory contents of the flash memory in use, enter the
dir [*device-name*] command.

Where *device-name* can be **slot0:**, **slot1:**, or **bootflash:**.

The following example shows the contents of the flash memory card in slot 0.

```
Milo# dir slot0
Directory of slot0:/

  1  -rw-     122015    Sep 30 1999 15:03:55 myfile1
  2  -rw-    2054979    Sep 30 1999 15:17:33 gsr-diag-mz.RELEASE28
  3  -rw-    6670560    Sep 30 1999 15:22:49 gsr-p-mz.p7
  4  -rw-       5560    Oct 08 1999 16:54:53 fun1

20578304 bytes total (9661756 bytes free)
Milo#
```

delete Command

To delete a file from flash memory, use the **cd** command to select the flash
memory device and then enter the **delete** *filename* command.

• Where *filename* is any file within the selected flash memory media.

The following example shows how to delete the file named *fun1* from the current
flash memory card directory in slot 0.

```
Milo# cd slot0:
Milo# delete slot0:fun1
Milo# dir
Directory of slot0:/

  1  -rw-     122015    Sep 30 1999 15:03:55 myfile1
  2  -rw-    2054979    Sep 30 1999 15:17:33 gsr-diag-mz.RELEASE28
  3  -rw-    6670560    Sep 30 1999 15:22:49 gsr-p-mz.p7

20578304 bytes total (9661756 bytes free)
Milo#
```

Files that are deleted from the current flash memory directory are removed from
the directory list but are not erased (they still occupy space in memory). This
allows you to recover a deleted file at a later time using the **undelete** command.
To permanently remove deleted files use the squeeze command.

squeeze Command

The **squeeze** command permanently removes deleted files from flash memory and makes all other (undeleted) files contiguous to conserve storage space.

To permanently remove deleted files from a flash memory directory, but leave the other files intact, enter the **squeeze** *device-name* command.

- Where *device-name* can be **slot0:**, **slot1:**, or **bootflash:**.

```
Milo# squeeze slot0:
All deleted files will be removed, Continue? [confirm]y
Squeeze operation may take a while, Continue? [confirm]y
Squeeze of slot0 complete
Milo#
ebESZ
```

In this example the character:

- e in the last line indicates that the flash memory area is erased. This erase operation must be accomplished before any write operation to the flash memory area can begin.

- b indicates that the data about to be written to the flash memory area has been temporarily copied.

- E indicates that the sector temporarily occupied by the data is erased.

- S indicates that the data is written to its permanent location in flash memory.

- Z indicates that the log is erased following the successful **squeeze** operation.

To prevent loss of data from a sudden power loss, the "squeezed" data is temporarily saved to another flash memory area reserved specifically for system use.

Note   During a squeeze operation, the system maintains a log of executed squeeze functions, so that the system can return to the proper place and continue the operation in the event of a power failure.

Booting from Flash Memory

To boot from flash memory, the boot field in the software configuration register (bits 3 through 0) must be set to a value between 2 and 15 (see the "Configuring the Software Configuration Register" section on page 4-31).

Use the following command to enable booting from flash memory.

boot system flash *device:filename*

Where:

- **boot system flash** *device:* is **slot0:**, or **slot1:**

- *filename* is the name of the configuration file

```
Milo# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Milo(config)# boot system flash slot0:myfile1
```

Copying Image Files to or From Flash Memory

This section describes how to copy image files to the flash memory SIMM on the route processor, or to a flash memory card in slot 0 or slot 1.

⚠

Caution   You *cannot* copy a new Cisco IOS software image into the onboard flash memory SIMM (also referred to as *bootflash*) while the system is running from that onboard flash memory.

Use the following command to copy a file to flash memory.

```
Milo# copy tftp:filename [bootflash:|slot0:|slot1:] filename
```

Where:

- **tftp:***filename* specifies the source and name of the file to be copied.
- [**bootflash:** | **slot0:** | **slot1:**] *filename* specifies the destination flash device and name of the file.

    The destination flash device can be one of the following:

    – **bootflash:**—Specifies that the file is to be copied to the flash memory SIMM on the RP.

    – **slot0:**—Specifies that the file is to be copied to the flash memory card in slot 0.

    – **slot 1:**—Specifies that the file is to be copied to the flash memory card in slot 1.

The following is typical output generated using the **copy tftp:***filename* command.

```
Milo# copy tftp:myfile1 slot0:myfile1
20575008 bytes available on device slot0, proceed? [confirm]
Address or name of remote host [1.1.1.1]?
Loading new.image from 1.1.1.1 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!![OK - 7799951/15599616 bytes]
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC
Milo#
```

In this example:

- The exclamation points (!!!) appear as the source file is being downloaded to the destination device.

- The C characters indicate that a cyclic redundancy check (CRC) is being calculated during the downloading process. The CRC verifies that the file is correctly downloaded to the destination device (the flash memory card inserted in slot 0).

Copying a Cisco IOS Software Image into a Flash Memory Card

You can copy a Cisco IOS software image to a flash memory card at any time for later use.

Before you copy an image be sure that:

- You have a formatted flash memory card inserted in RP slot 0 or slot 1. See the "Formatting a New Flash Memory Card" section on page 4-47 if you need to format a flash memory card.

- You know the name of the file you want to copy to the flash memory card.

- You have a valid, bootable Cisco IOS software image stored in the onboard flash memory SIMM, enabling you to start the router.

- The bootable Cisco IOS software image that you want to copy to the flash memory card exists on a TFTP server somewhere in the network.

- You have access to the network TFTP server by means of a configured and fully functional network interface on your system.

✎

Note   To ensure access to the network TFTP server, you must configure a network interface using the **setup** command facility. See the "Using Setup for Configuration Changes" section on page 4-18 for information about the **setup** command facility. You can also refer to the *Configuration Fundamentals Configuration Guide*.

Use the following procedure to copy a bootable image into the flash memory card:

Step 1   Boot the router.

Step 2   Enter the **enable** command and password (if prompted).

```
Milo> enable
Password: <password>
Milo#
```

Step 3   Enter the **copy** command to copy the file (*new.image* in this example) from the server to the flash memory card in slot 0.

```
Milo# copy tftp:new.image slot0:new.image
20575008 bytes available on device slot0, proceed? [confirm]
Address or name of remote host [1.1.1.1]?
Loading new.image from 1.1.1.1 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 7799951/15599616 bytes]
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCC
Milo#
```

In this example:

• The exclamation points (!!!) appear as the source file is being downloaded (copied) to the destination device.

• The C characters indicate that a CRC is being calculated during the downloading process. The CRC verifies that the file is correctly copied to the destination device (the flash memory card in slot 0).

Copying Cisco IOS Software Images Between Flash Memory Cards

This procedure describes how to copy a later Cisco IOS software image from one flash memory card to another flash memory card containing an earlier Cisco IOS software image. In this example, the following filenames apply:

- *image.new*—The new image on the flash memory card located in slot 1.

- *image.old*—The old image on the flash memory card in slot 0.

- *image.boot*—The bootable Cisco IOS software image stored in the onboard flash memory SIMM. (This image is used by default to boot the system if no other bootable image is available.)

This procedure assumes there is sufficient space on the flash memory card in slot 0 for both images (the new Cisco IOS software image *and* the old image).

- If there is not enough space for both images on the card in slot 0, use the **delete** command to delete unnecessary files from the flash memory card, but *do not* delete the *image.old* file.

- After deleting the files, use the **squeeze** command to remove the deleted files from the flash memory card in slot 0 permanently.

  For additional information about the **delete** and **squeeze** commands, see the "Flash Memory Commands" section on page 4-49).

Use the following procedure to copy a bootable Cisco IOS software image from one flash memory card to another.

Step 1 Insert the flash memory card with the new image in slot 1.

Step 2 Enter the following command to copy the *image.new* file from the memory card in slot 1 to the memory card in slot 0:

```
Milo# copy slot1:image.new slot0:image.new
```

Step 3   Enter the following commands to designate the file named *image.new* in the
memory card in slot 0 as the new default system image for boot purposes:

```
Milo# configure terminal
Milo(config)# no boot system
Milo(config)# boot system flash slot0:image.new
Ctrl-Z
Milo# copy running-config startup-config
Milo# reload
```

When the system reloads, it boots the *image.new* file from the memory card in
slot 0.

Copying System Configuration Files Between RP Memory and a Flash Memory Card

If you do not have access to a TFTP server on which you can temporarily store
your system configuration file, you can copy the file from RP memory to a flash
memory card in slot 0 or slot 1. You can copy your startup configuration file (from
NVRAM) or your running configuration file (from DRAM) to the flash memory
card.

Use the procedures in the following sections to:

- Copy the configuration file from either NVRAM or DRAM to a flash memory
  card.

- Copy a configuration file from the flash memory card to NVRAM.

Note   You cannot copy files directly into DRAM.

Copying the Startup Configuration File from NVRAM to a Flash Memory Card

Use the following procedure to copy a configuration file from NVRAM to a flash memory card.

Step 1   Enter the **show bootvar** command to display the current setting for the environmental CONFIG_FILE variable.

✎
Note   The environmental CONFIG_FILE variable must point to NVRAM (system default).

```
Milo# show bootvar
.
.
.
CONFIG_FILE variable =
Current CONFIG_FILE variable =
.
.
.
Milo#
```

The absence of any notation following the CONFIG_FILE variable statement as shown in this example indicates that the environmental variable is pointing to NVRAM.

Step 2   Enter the **copy** command in the following form:

copy startup-config [**slot0:** | **slot1:**] *filename*

Where:

- **startup-config** is the source configuration file in NVRAM.
- [**slot0:** | **slot1:**] specifies the destination of the configuration file to be copied.
- *filename* is the name of the configuration file.

```
Milo# copy startup-config slot0:myfile2
20575008 bytes available on device slot0, proceed? [confirm]
Address or name of remote host [1.1.1.1]?
Loading new.image from 1.1.1.1 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 7799951/15599616 bytes]
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCC
Milo#
```

- The exclamation points (!!!) appear as the file is being copied.

- The C characters signify the calculation of the CRC, which verifies that the file is copied correctly.

Step 3   Enter the **dir** command to verify that the configuration file is copied correctly to the memory card in slot 0.

```
Milo# dir slot0:
-#- -length- -----date/time------ name
1   5200084  May 10 1997 19:24:12 gsr-p-mz.112-8
3   1215     May 10 1997 20:30:52 myfile1
4   6176844  May 10 1997 23:04:10 gsr-p-mz.112-8.1
5   1186     May 10 1997 16:56:50 myfile2

9197156 bytes available (11381148 bytes used)
Milo#
```

Copying the Running Configuration File from DRAM to a Flash Memory Card

Use the following procedure to copy the running configuration file from DRAM on the RP to a flash memory card.

Step 1   Enter the copy command in the following form:

copy running-config [**slot0:**|**slot1:**]*filename*

Where:

- **running-config** is the source configuration file in DRAM.
- [**slot0:** | **slot1:**] specifies the destination of the configuration file to be copied.
- *filename* is the name of the configuration file.

```
Milo# copy running-config slot0:myfile2
20575008 bytes available on device slot0, proceed? [confirm]
Address or name of remote host [1.1.1.1]?
Loading new.image from 1.1.1.1 (via Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!![OK - 7799951/15599616 bytes]
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
Milo#
```

- The exclamation points (!!!) appear as the file is being copied.
- The C characters signify the calculation of the CRC, which verifies that the file is copied correctly.

Step 2 Enter the **dir** command to further verify that the configuration file is copied correctly to the memory card in slot 0:

```
Milo# dir slot0:
-#- -length- -----date/time------ name
1   5200084  May 10 1997 19:24:12 gsr-p-mz.112-8
3   1215     May 10 1997 20:30:52 myfile1
4   6176844  May 10 1997 23:04:10 gsr-p-mz.112-8.1
5   1186     May 10 1997 16:56:50 myfile2

9197156 bytes available (11381148 bytes used)
Milo#
```

Copying a Startup Configuration File from a Flash Memory Card to RP NVRAM

Enter the **copy** command in the following form to copy a startup configuration file from a flash memory card to NVRA.M:

copy [**slot0:**|**slot1:**]*filename* **startup-config**

Where:

- [**slot0:** | **slot1:**] specifies the source of the configuration file to be copied.

- *filename* is the name of the configuration file to be copied.

- **startup-config** specifies the destination (NVRAM) of the file to be copied.

```
Milo# copy slot0:myfile startup-config
[ok]
Milo#
```

Copying a Configuration File from NVRAM to DRAM

Enter the following command to copy the startup configuration file from NVRAM to DRAM to designate it as the default running configuration file for the system:

```
Milo# copy startup-config running-config
Milo#
%SYS-5-CONFIG_I: Configured from memory by console
Milo#
```

Booting a New Cisco IOS Software Image from a Flash Memory Card

Use the following procedure to boot a new image from a flash memory card in slot 0 or slot 1 (this example uses slot 0).

Step 1   Insert the flash memory card with the new image in slot 0.

Step 2   Enter the following commands to designate the file named *image.new* as the new default system image for boot purposes:

```
Milo# configure terminal
Milo(config)# no boot system
Milo(config)# boot system flash slot0:image.new
Ctrl-Z
Milo# copy running-config startup-config
Milo# reload
```

When the system reloads, it boots the *image.new* file from the memory card in slot 0.

Recovering from Locked Blocks in Flash Memory Cards

When power is lost or the card is removed from its slot during a write or erase operation, a locked block in flash memory cards occurs.

When a block of flash memory is locked, you cannot write to it or erase it. The only way to recover from locked blocks is to reformat the flash memory card using the **format** command (see the "Formatting a New Flash Memory Card" section on page 4-47).

⚠

Caution   Formatting a flash memory card erases all existing data on the card.

Post-Installation Procedures

After you install the router hardware, check all external connections, turn on the system power, allow the system to boot up, and minimally configure the system, you may need to perform additional configuration tasks.

The Cisco IOS software running your router contains extensive features and functionality. For information on Cisco IOS software and general installation and maintenance information for your router, use the following resources:

- For Cisco IOS software configuration information and support, refer to the modular configuration and modular command reference publications. You can also refer to the Cisco IOS software release notes for the version of Cisco IOS software you are using on your router.

Note   To access Cisco IOS software documentation and hardware installation and maintenance documentation, go to http://www.cisco.com.

- For information on regulatory compliance and safety, refer to the *Regulatory Compliance and Safety Information for Cisco 12000 Series Internet Routers* publication.

- For additional line card information, refer to the installation and configuration note for your line card.

- For additional GRP information, refer to the configuration note *Gigabit Route Processor (GRP) Installation and Configuration Note*.

- For additional PRP information, refer to the *Performance Route Processor (PRP) Installation and Configuration Note*.

5

Troubleshooting the Installation

This chapter contains general troubleshooting information to help isolate the cause of difficulties you might encounter during the installation and initial startup of the system.

The procedures in this chapter assume that you are troubleshooting the initial startup of the router, as described in the Powering On the Router and Observing the Boot Process, page 4-4, and that the system is running the original configuration. If you altered the original hardware configuration or changed any default configuration settings, the recommendations in this chapter may not apply.

Although an overtemperature condition is unlikely at initial startup, environmental monitoring functions are included in this chapter because they also monitor internal voltages.

Troubleshooting the installation is presented in the following sections:

Troubleshooting Overview

This section describes the methods used in troubleshooting the router. The troubleshooting methods are organized according to the major subsystems in the router.

If you are unable to solve a problem on your own, you can contact a Cisco customer service representative for assistance. When you call, have the following information ready:

- Date you received the router and the chassis serial number (located on a label on the back of the chassis).
- Installed line cards.
  - Use the **show hardware** command to determine which line cards are installed if possible.
- Cisco IOS software release number.
  - Use the **show version** command to determine this information if possible.
- Brief description of the symptoms and steps you have taken to isolate and solve the issue.
- Maintenance agreement or warranty information.

Troubleshooting Using a Subsystem Approach

To solve a system problem, try to isolate the problem to a specific subsystem. Compare current router behavior with expected router behavior. Because a startup issue is usually attributable to one component, it is most efficient to examine each subsystem, rather than trying to troubleshoot each router component.

For troubleshooting purposes in this chapter, the router consists of the following subsystems:

- Power subsystem—Includes the following components:
  - AC-input or DC-input power supplies, also called power entry modules (PEMs). The router chassis is shipped with fully-redundant PEMs installed in the chassis.

- Chassis backplane power distribution. –48 VDC power from the power supplies is transferred to the chassis backplane. The –48 VDC is distributed to all of the cards through the backplane connectors. The blower module receives power from the chassis backplane through a wiring harness and passes MBus data back to the chassis backplane.

- Processor subsystem—Includes redundant RPs, line cards, switch fabrics, and two alarm cards. The RP and line cards are equipped with onboard processors. The RP downloads a copy of the Cisco IOS image to each line card processor. The system uses an alphanumeric display (on each line card and RP) to display status and error messages, which can help in troubleshooting.

- Cooling subsystem—Consists of 2 blower modules, which circulate air through the card cages to cool the cards, and fan in each of the power modules, which circulates cooling air through the power module.

Normal Router Startup Sequence

You can generally determine when and where the router failed during the startup sequence by checking the status LEDs on the power modules, and the alphanumeric displays on the RP and line cards.

In a normal router startup sequence, the following sequence of events and conditions occur:

1. The fans in the blower module receive power and begin drawing air through the chassis.

   The blower module OK indicator is on.

2. The fan in each PEM receives power and begins drawing air through the power supply.

   The power supply Pwr OK indicator is on.

3. As the power on and boot process progresses for the RP and each installed line card, the status of each card appears on the alphanumeric display on the front panel of the card:

   – The upper row of the display is powered by the DC-to-DC converter on the card.

   – The lower row of the display is powered by the +5 VDC provided through the backplane.

Identifying Startup Issues

Table 5-1 shows the contents of the alphanumeric displays on the RP and the line cards, as well as the normal LED states on the alarm card, the power modules (AC or DC), and the blower modules after a successful system startup.

Table 5-1   Alphanumeric Displays and LEDs at System Startup

Component	Type of Indicator	Display Contents/LED Status and Meaning
RP	Alphanumeric display	Upper row: MSTR Lower row: GRP or PRP The RP is enabled and recognized by the system; a valid Cisco IOS software image is running.
Line Cards	Alphanumeric display	Upper row: IOS Lower row: RUN The line card is enabled and ready for use.
Alarm Cards	Detected alarm severity	Critical: Off Major: Off Minor: Off
	Alarm card	Enabled: On Fail: Off
	CSC 0 and 1	Enabled: On Fail: Off
	SFC 0, 1, 2, and 3,	Enabled: On Fail: Off
2000 Watt AC Power Supplies	Power status	PWR OK: On FAULT: Off TEMP: Off ILIM: Off The correct power module voltages are present and no faults have been detected.

Table 5-1   Alphanumeric Displays and LEDs at System Startup (continued)

Component	Type of Indicator	Display Contents/LED Status and Meaning
2500 Watt AC Power Supplies	Power status	PWR OK: On FAULT: Off TEMP: Off OC: Off The correct power module voltages are present and no faults have been detected.
2000 Watt DC Power Supplies	Power status	PWR OK: On FAULT: Off TEMP: Off The correct power module voltages are present and no faults have been detected.
2400 Watt DC Power Supplies	Power status	PWR OK: On FAULT: Off TEMP: Off OC: Off The correct power module voltages are present and no faults have been detected.
Blower Modules	Blower status	OK: On FAIL: Off

Troubleshooting the Power Subsystem

This section contains information to troubleshoot the power subsystems:

- Troubleshooting the AC-Input Power Subsystem, page 5-6
- Troubleshooting the DC-Input Power Subsystem, page 5-10
- Troubleshooting the Power Distribution System, page 5-15

Troubleshooting the AC-Input Power Subsystem

AC-input power supplies are monitored for internal temperature, voltage, and current load by the MBus module on the alarm cards, and by the master MBus module on the RP. If the router detects an extreme condition, it generates an alarm on the alarm card and logs the appropriate warning messages on the console.

Cisco 12016, Cisco 12416, and Cisco 12816 series routers are available with either an original (2000 W) or enhanced (2500 W) capacity AC power supply:

Figure 5-1 identifies the components of a 2000 W AC power supply.

Figure 5-1   2000 W AC Power Supply Components
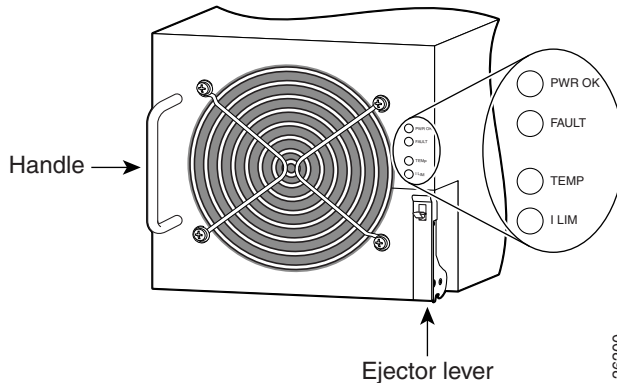
Figure 5-2 identifies the components of a 2500 W AC power supply.

Figure 5-2   2500 W AC Power Supply Components
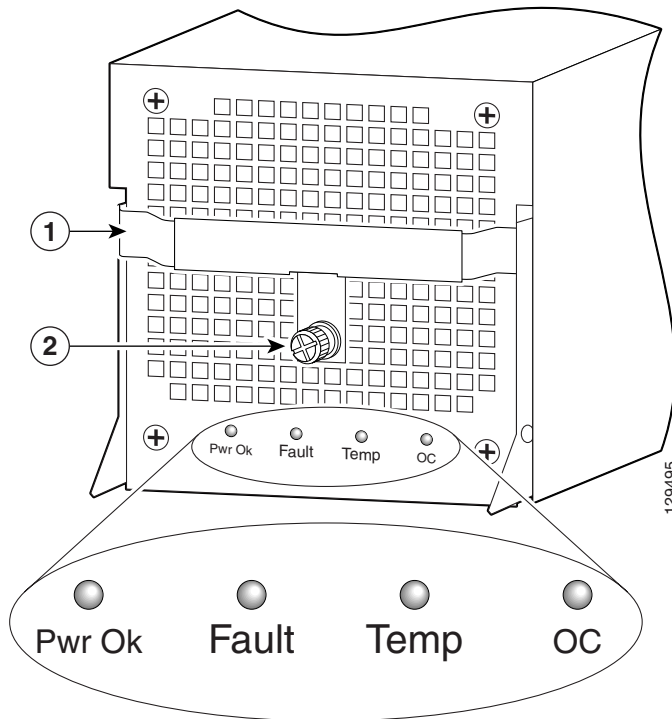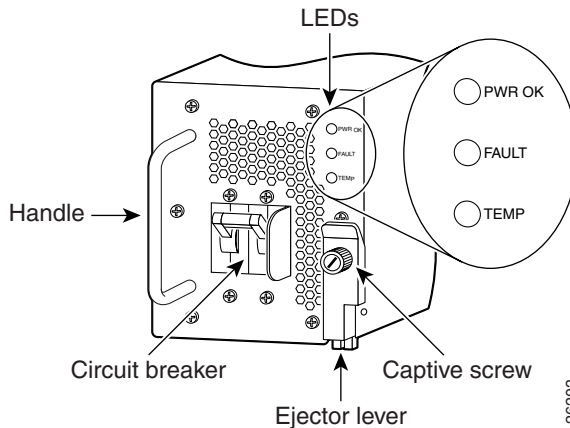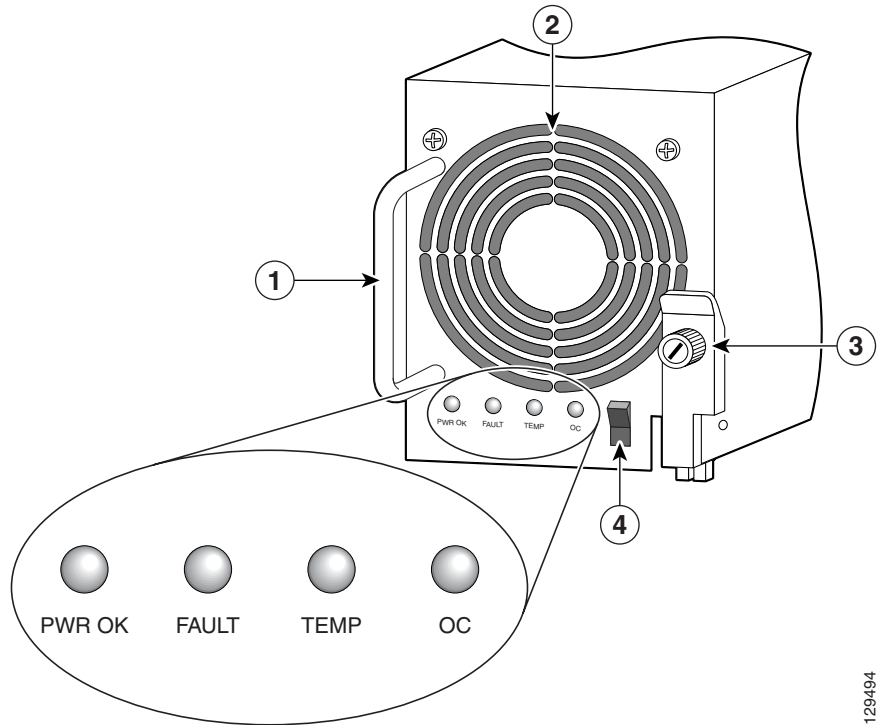

1	Ejector handle	**2**	Captive screw

Use the following procedure to troubleshoot the AC power supply if it is not operating properly after installation.

Step 1   Make sure the power supply is seated properly:

- Eject and reseat the PEM. Check that:
    - The ejector lever is locked into place by its spring clip (2000 W PEM), or the captive screw on the ejector lever is tightened securely (2500 W PEM).

Step 2   Make sure the router is powered on and that all power cords are connected properly:

- Power cords on the back panel of the power shelf are secured in place with their retention clips.

- Power cords at the power source end are securely plugged into their own AC power outlet.

- The source AC circuit breaker is switched on.

Step 3   Check the power supply status LED indicators:

- PWR OK (green)—Indicates the power supply is operating normally, and the source AC voltage is within the nominal operating range of 200 VAC to 240 VAC. This indicator lights when the power supply is properly seated in position.

- FAULT (yellow)—Indicates the system detected a fault within the power supply or the incoming voltage is too low. This indicator remains off during normal operation.

  If the indicator is on:

  - Check that the source voltage is within the correct range: 170 to 262 VAC

  - Remove and then apply power to the power supply by disconnecting its power cord. If the indicator remains on, replace the existing power supply with a spare.

  - If the spare power supply also fails, the problem could be a faulty power shelf backplane connector. Power off the router and contact a Cisco service representative for assistance.

- TEMP (yellow)—Indicates that the power supply is in an overtemperature condition, causing a shut-down to occur.

  ✎
  Note   If the temp indicator is on, the fault indicator is also on.

  - Verify that the power supply fan is operating properly.

  - Verify that the blower modules are operating properly.

  - If the power supply fan and blower modules are operating properly, replace the existing power supply with a spare.

- TEMP (flashing yellow—2500 W PEM only)—Indicates that a power supply fan is locked or malfunctioning.

    Note   If the temp indicator is flashing, the fault indicator also goes on.

    – Check to see if the fan is operating. Remove any obstructions to the fan.

    – If the fan is not operating, replace the power supply.

- ILIM (yellow—2000 W PEM only)—Indicates the power supply is operating in a current-limiting condition.

    – Make sure that each power cord is connected to a dedicated AC power source.

    – Each AC power supply operating in the nominal range of 200 to 240 VAC requires a minimum service of 20 A, North America (or 13 A, international).

- OC (2500 W PEM only) (steady, or flashing yellow after 10 seconds)—Indicates the output current of the power supply has exceeded its limit and that an overload or short has occurred.

    Note   If the OC indicator is on or flashing, the fault indicator also goes on.

    – Remove and then apply power to the power supply by disconnecting its power cord.

    – If the indicator remains on, try reseating the power supply.

    – If the indicator remains on, replace the power supply.

Because both the standard and optional AC-input power subsystems use redundant power supplies, a problem with the DC output voltage to the backplane from only one power supply should not affect router operation. Because the router is equipped with multiple AC power supplies, it powers on and operates even if one power supply fails.

Troubleshooting the DC-Input Power Subsystem

DC-input power supplies are monitored for internal temperature, voltage, and current load by the MBus module on the alarm cards, and by the master MBus module on the RP. If the router detects an extreme condition, it generates an alarm on the alarm card and logs the appropriate warning messages on the console.

Cisco 12016, Cisco 12416, and Cisco 12816 series routers are available with either original or enhanced capacity DC power supplies:

- Figure 5-3 identifies the components of a 2000 W DC power supply.

- Figure 5-4 identifies the components of a 2400 W DC power supply.

Figure 5-3   2000 W DC Power Supply Components

Figure 5-4   2400 W DC Power Supply Components

1	Handle	**3**	Ejector lever
2	Fan	**4**	Power switch

Use the following procedure to troubleshoot the DC PEM if it is not operating properly after installation.

Step 1   Make sure the PEM is seated properly:

- Eject and reseat the PEM. Make sure:

    - The captive screw on the ejector lever are tightened securely.

    - The power switch is in the on (1) position (2400 W only).

Step 2   Make sure the router is powered on and that all power cords are connected properly. Check that:

- Power cables are securely connected to their terminal studs on the back panel.

- Power cables are connected to a dedicated 60 A DC service.

- The source DC circuit breaker is switched on.

- The PEM circuit breaker is switched on (2000 W only).

    - If circuit breaker does not stay switched on, replace the PEM.

Step 3   Check the PEM status indicators:

- PWR OK (green) — Indicates that the PEM is operating normally, and the source DC voltage is within the nominal operating range of –48 to –60 VDC. This indicator should light when the PEM circuit breaker is switched on.

- FAULT (yellow) — Indicates that the system has detected a fault within the PEM or the incoming voltage is too low. This indicator remains off during normal operation.

    - Check that the source voltage is within the correct range: –40.5 to –75 VDC.

    - Toggle the PEM circuit breaker off and then on. If the indicator remains on after several attempts to power it on, replace the existing PEM with a spare.

    - If the spare PEM also fails, the problem could be a faulty power shelf backplane connector. Power off the router and contact a Cisco service representative for assistance.

- TEMP (yellow)—Indicates that the PEM is in an overtemperature condition causing a shut-down to occur.

  ✎
  Note   If the temp indicator is on, the fault indicator also goes on.

  - Verify that the power supply fan is operating properly.
  - Verify that the blower modules are operating properly.
  - If the power supply fan and the blower modules are operating properly, replace the existing PEM with a spare.

- TEMP (flashing yellow—2400 W PEM only)—Indicates that a power supply fan is locked or malfunctioning.

  ✎
  Note   If the temp indicator is flashing, the fault indicator is also on.

  - Check to see if the fan is operating. Remove any obstructions to the fan.
  - If the fan is not operational, replace the power supply.

- OC (2400 W PEM only) (steady, or flashing yellow after 10 seconds)—Indicates the output current of the power supply has exceeded its limit and that an overload or short circuit has occurred.

  ✎
  Note   If the OC indicator is on or flashing, the fault indicator also goes on.

  - Remove and then apply power to the power supply by disconnecting its power cord.
  - If the indicator remains on, try reseating the power supply.
  - If the indicator remains on, replace the power supply.

Because there are redundant power supplies, a problem with the DC output voltage to the backplane from only one PEM should not affect router operation. Because the router is equipped with multiple DC power supplies, it powers on and operates even if one power supply fails.

Additional Power Subsystem Troubleshooting Information

This section contains additional troubleshooting information to help you isolate the cause of a power problem.

The MBus modules powering the alphanumeric displays on the RP and line cards are powered by +5 VDC from the backplane. The blower modules use –48 VDC from the backplane. If both the RP and the blower modules are operating, all internal correct DC voltages are present.

Enter the **show environment** command at the user EXEC mode prompt to display temperature and voltage information for each installed card, blower module, and PEM as shown in this example:

```
router#show environment
Slot #  Hot Sensor      Inlet Sensor
        (deg C)         (deg C)

1        38.0            32.5
3        36.5            39.0
5        37.0            37.0
7        36.0            32.0
16       26.0            26.0
17       27.5            27.5
18       27.0            27.5
19        0.0      0.0
20       27.0            27.5
21       28.0            28.0
22       28.0            28.0
24       47.0            NA
29        NA             22.0


Slot #  PEM Over Temperature Sensors

24      PEM1    OK
        PEM2    OK
Slot #  Hot Sensor      Inlet Sensor
        (deg C)          (deg C)

29        NA              22.0

Slot #  3V      5V      MBUS 5V
        (mv)    (mv)    (mv)

1       3296    5016    5048
3       3284    4976    5000
5       3308    5008    5048
7       3296    5016    5000
```

```
16      3300    NA      5064
17      3308    NA      5064
18      3292    NA      5056
19      3300    NA      5072
20      3288    NA      5056
21      3296    NA      5072
22      3292    NA      5064
24      NA      NA      5096
29      NA      NA      4920

Slot #          48V     AMP_48
                (Volt)  (Amp)

24      PEM1    56      2
        PEM2    55      2
Slot #  Fan 0   Fan 1   Fan 2
        (RPM)   (RPM)   (RPM)

29      3021    3090    2997
```

Troubleshooting the Power Distribution System

The power distribution system consists of:

- AC or DC PEMs which supply –48 VDC to the backplane,

- The chassis backplane which carries voltage to chassis components.

- DC-to-DC converters which convert –48 VDC from the backplane to the correct voltages required by the line cards.

Use the following procedure to troubleshoot the power distribution system.

Step 1   Check each power supply to make sure that:

- The ejector lever is fully closed and properly secured by the its captive screw.
- The PWR OK indicator is on.
- The FAULT and TEMP indicators are both off.
- The ILIM is off (2000W AC only)
- The OC indicator is off (2500 W AC and 2400 W DC only)

    If the power supplies meet the above criteria, then the correct source power is present and within tolerance. The power supplies are functioning properly.

Step 2   Make sure the blower modules are operating.

- If the blower modules are functioning, then the –48 VDC from the chassis backplane and the cables from the backplane to the blower modules are functioning properly.
- If a blower module is not functioning, there may be a problem with either the blower module itself, or the –48 VDC power supplied to the blower module. Eject and reseat the blower module.
- If a blower module is still not operating there could be a problem with the blower module controller card or cable. Replace the blower module.

    Contact your Cisco representative if replacing the blower module does not fix the problem.

Troubleshooting the Processor Subsystem

The router processor subsystem consists of the RPs, line cards, and alarm cards. The RPs and line cards have two onboard processors; one serves as the main (or master processor), and the other serves as the MBus module processor. The MBus module processor monitors the environment and controls the onboard DC-to-DC converters.

Note   A minimally configured router must have an RP installed in slot 7 of the upper card cage. If the router is equipped with an optional, redundant RP, that RP must be installed in the far left slot in the lower card cage (slot 8).

This section contains information to troubleshooting the processor subsystem, including:

- Troubleshooting the RP, page 5-18
- Troubleshooting Line Cards, page 5-20
- Troubleshooting Using the Alarm Cards, page 5-27

Troubleshooting the RP

When the router is powered on, the alphanumeric display on the RP indicate the following (Figure 5-5):

- Upper row—Indicates which RP software component is running. At the end of a successful boot process, this display reads MSTR.

- Lower row—Indicates the current phase of the boot process. At the end of a successful boot process, this display reads GRP or PRP depending on the RP type.

Figure 5-5   RP Alphanumeric Display

Upper alphanumeric
LED display (four digits)

Lower alphanumeric
LED display (four digits)
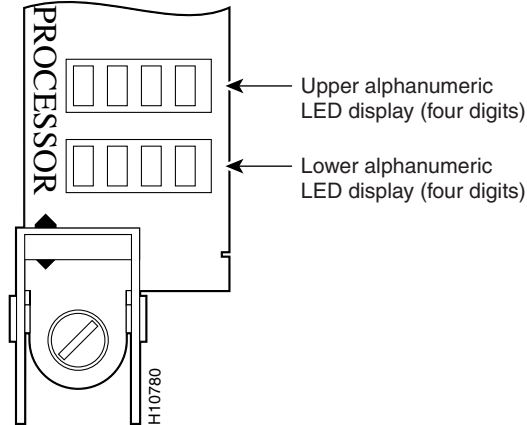
Troubleshooting Using the RP Alphanumeric Display

You can use the alphanumeric display to isolate a problem with the RP. The two rows on the alphanumeric display are powered separately:

- The upper row receives power from the DC-to-DC converters on the RP.

- The lower row is powered directly from the MBus on the RP through the chassis backplane.

  - If the lower row is not operating, the MBus module may be malfunctioning.

  - If the MBus module is operating, the lower row could be on even if the RP failed to powered on.

- If neither the upper nor the lower row is on, but the power modules and the blower modules are operational, the RP may not be installed properly, or the +5 VDC output from the chassis backplane is faulty.

  - Make sure that the system is powered on.

  - Initialize the RP by ejecting it from the chassis backplane and then reseating it.

⚠
Caution   The soft reset (NMI) switch is *not* a mechanism for resetting the RP and reloading the Cisco IOS image. It is intended for software development use. To prevent system problems or loss of data, use the soft reset switch *only* when instructed by a Cisco certified service representative.

- If both the upper and the lower displays are operating, check the meaning of the messages (see Table 5-2).

  When the DC-to-DC converters are powered-on by the MBus module, the RP processor begins the boot process and displays various status messages. Some messages appear briefly; while others appear for several seconds. If the messages appear to stop at a particular point, the boot process may be halted.

  - Make a note of the message.

  - Turn off power to the router, then turn on the power again to reset the router and start the boot process. If the router halts again, replace the RP (see "Removing and Replacing Cards from the Chassis" section on page 7-79).

Table 5-2   Troubleshooting Using the RP Alphanumeric Display Messages

Message	Description
LMEM TEST	Running low memory test
LCAH TEST	Initializing lower 15K cache
BSS INIT	Initializing main memory for ROM
NVRAM INIT	Initializing NVRAM
EXPT INIT	Initializing interrupt handlers
TLB INIT	Initializing TLB
CACH INIT	Initializing CPU data and instruction cache
CACH PARY	Enabling CPU cache parity
MEM INIT	Initializing main memory
NVRAM SIZE	Detecting the NVRAM size
PCMC INIT	Initializing the PCMCIA
EXIT INIT	Exiting the initialization sequence
IOS UP	Running Cisco IOS software

Troubleshooting Line Cards

When the line card is powered on, the display on the line card indicates the following (Figure 5-6):

- Upper row—Indicates which software component is running. At the end of a successful boot process, this display reads IOS.

- Lower row—Indicates the current phase of the boot process. At the end of a successful boot process, this display reads RUN.

Figure 5-6   Line Card Alphanumeric Display

Upper alphanumeric
LED display (four digits)

Lower alphanumeric
LED display (four digits)

H11344
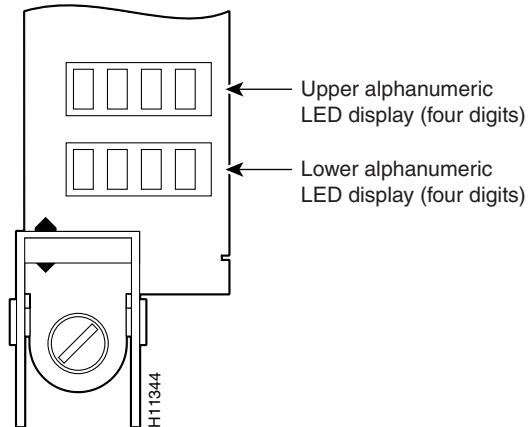
Troubleshooting Using the Line Card Alphanumeric Display

You can analyze the alphanumeric displays to isolate a problem with the line card. The two rows of the alphanumeric display are powered separately:

- The upper row receives power from the DC-to-DC converters on the line card.

- The lower row is powered directly from the MBus on the line card through the chassis backplane.

    - If the lower row is not operating the MBus module may be malfunctioning.

    - If the MBus module is operating, the lower row could be on even if the RP failed to powered on.

- If neither the upper or lower row is on, but the power modules and the blower modules are operational, the line card may not be installed properly, or the +5 VDC output from the chassis backplane is faulty.

    - Make sure that the system is powered on.

    - Initialize the line card by ejecting it from the chassis backplane and then reseating it.

- If both the upper and lower rows are operating, check the status messages (see Table 5-3).

When the DC-to-DC converters are powered-on by the MBus module, the line card processor begins the boot process and displays various status messages. Some messages appear briefly; while others appear for several seconds.

Table 5-3   Troubleshooting Using Alphanumeric Display Messages

Display[1]	Meaning	Source
MROM *nnnn*	MBus microcode executing; where *nnnn* is the microcode version number.	MBus controller
LMEM TEST	Low memory on the line card is being tested.	Line card ROM monitor
LROM RUN	Low memory test is complete.	Line card ROM monitor
BSS INIT	Main memory is being initialized.	Line card ROM monitor

Table 5-3   Troubleshooting Using Alphanumeric Display Messages (continued)

Display[1]	Meaning	Source
RST SAVE	Contents of the reset reason register are being saved.	Line card ROM monitor
IO RST	Reset I/O register is being accessed.	Line card ROM monitor
EXPT INIT	Interrupt handlers are being initialized.	Line card ROM monitor
TLB INIT	TLB is being initialized.	Line card ROM monitor
CACH INIT	CPU data and instruction cache is being initialized.	Line card ROM monitor
MEM INIT	Size of the main memory on the line card is being discovered.	Line card ROM monitor
LROM RDY	ROM is ready for a software download attempt.	Line card ROM monitor
ROMI GET	ROM image is being loaded into line card memory.	RP IOS software
ROM VGET[3]	ROM image is receiving a response.	RP IOS software
FABI WAIT	Line card is waiting for the fabric downloader.[2]	RP IOS software
FABM WAIT[3]	Line card is waiting for the Fabric Manager to report that the fabric is usable.	RP IOS software
FABL DNLD	Fabric downloader is being loaded into line card memory.	RP IOS software
FABL STRT	Fabric downloader is being launched.	RP IOS software
FABL RUN	Fabric downloader is launched and running.	RP IOS software
IOS DNLD	Cisco IOS software is being downloaded into line card memory.	RP IOS software

Table 5-3   Troubleshooting Using Alphanumeric Display Messages (continued)

Display[1]	Meaning	Source
IOS FABW[3]	Cisco IOS software is waiting for the fabric to be ready.	RP IOS software
IOS VGET[3]	Line card is obtaining the Cisco IOS release.	RP IOS software
IOS RUN	Line card is enabled and ready for use.	RP IOS software
IOS STRT	Cisco IOS software is being launched.	RP IOS software
IOS TRAN	Cisco IOS software is transitioning to active.	RP IOS software
IOS UP	Cisco IOS software is running.	RP IOS software

1. The LED initialization sequence shown in Table 5-3 may occur too quickly for you to read; therefore, the sequence is provided in this tabular form as a baseline for how a line card should function at startup.

2. The fabric downloader loads the Cisco IOS software image onto the line card.

3. This LED sequence only appears in Cisco IOS Release 12.0(24)S or later.

Table 5-4   Troubleshooting Using Other Alphanumeric Display Messages

Display	Meaning	Source
MAL FUNC	Line card malfunction reported by field diagnostics.	RP
MISM ATCH[1]	Line card type mismatch in paired slots.	RP
PWR STRT[1]	Line card is newly powered on.	RP
PWR ON	Line card is powered on.	RP
IN RSET	System is resetting.	RP

Table 5-4   Troubleshooting Using Other Alphanumeric Display Messages (continued)

Display	Meaning	Source
RSET DONE	System reset complete.	RP
MBUS DNLD	MBus agent is downloading.	RP
MBUS DONE	MBus agent download complete.	RP
ROMI DONE	Acquisition of ROM image complete.	RP
MSTR WAIT	Waiting for mastership determination.	RP
CLOK WAIT	Waiting for slot clock configuration.	RP
CLOK DONE	Slot clock configuration complete.	RP
FABL LOAD	Load of fabric downloader[2] complete.	RP
IOS LOAD	Downloading of Cisco IOS software is complete.	RP
BMA ERR	Cisco IOS software BMA error.	RP
FIA ERR	Cisco IOS fabric interface ASIC configuration error.	RP
CARV ERR	Buffer carving failure.	RP
DUMP REQ	Line card requesting a core dump.	RP
DUMP RUN	Line card dumping core.	RP
DUMP DONE	Line card core dump complete.	RP

Table 5-4   Troubleshooting Using Other Alphanumeric Display Messages (continued)

Display	Meaning	Source
DIAG MODE	Diagnostic mode.	RP
DIAG LOAD	Downloading field diagnostics over the MBus.	RP
DIAG F_LD	Downloading field diagnostics over the fabric.	RP
DIAG STRT	Launching field diagnostics.	RP
DIAG HALT	Cancel field diagnostics.	RP
DIAG TEST	Running field diagnostics tests.	RP
DIAG PASS[1]	Field diagnostics completed successfully.	RP
POST STRT	Launching power-on self-test (POST).	RP
UNKN STAT	Unknown state.	RP
ADMN DOWN	Line card is administratively down.	RP
SCFG PRES[1]	Incorrect **hw-module slot srp** command entered.	RP
SCFG[1] REDQ	Required **hw-module slot srp** command not entered.	RP

1. This LED sequence only appears in Cisco IOS Release 12.0(24)S or later.

2. The fabric downloader loads the Cisco IOS software image onto the line card.

Troubleshooting Using the Alarm Cards

The router is equipped with two alarm cards:

- One card occupies the dedicated far left slot of the upper card cage.

- A second alarm card occupies the dedicated far right slot of the lower card cage.

In both card cages, the alarm card slot differs from the rest of the card cage slots in that it is labeled to identify it as an alarm card slot, it is physically narrower, and has a different backplane connector.

The following components and indicators are on the front panel of the alarm cards (Figure 5-7):

- Critical (red), Major (red), and Minor (yellow) indicators that identify system level alarm conditions detected by the system through the MBus.

    - These indicators are normally off.

- Audio alarm cutoff switch.

- 25-pin cable connection to an external alarm.

- Alarm card indicators:

    - ENABLED (green)—the alarm card is operational and functioning properly.

    - FAIL (yellow)—the alarm card in that slot is faulty.

- A pair of status LEDs that correspond to each of the CFC and SFC card slots in the switch fabric and clock scheduler card cage:

    - ENABLED (green)
      On—the card installed in that slot is operational and functioning properly.
      Off—either the slot is empty or the card installed in that slot is faulty.

    - FAIL (yellow)—the card in that slot is faulty.

Figure 5-7   Status LEDs on the Alarm Card
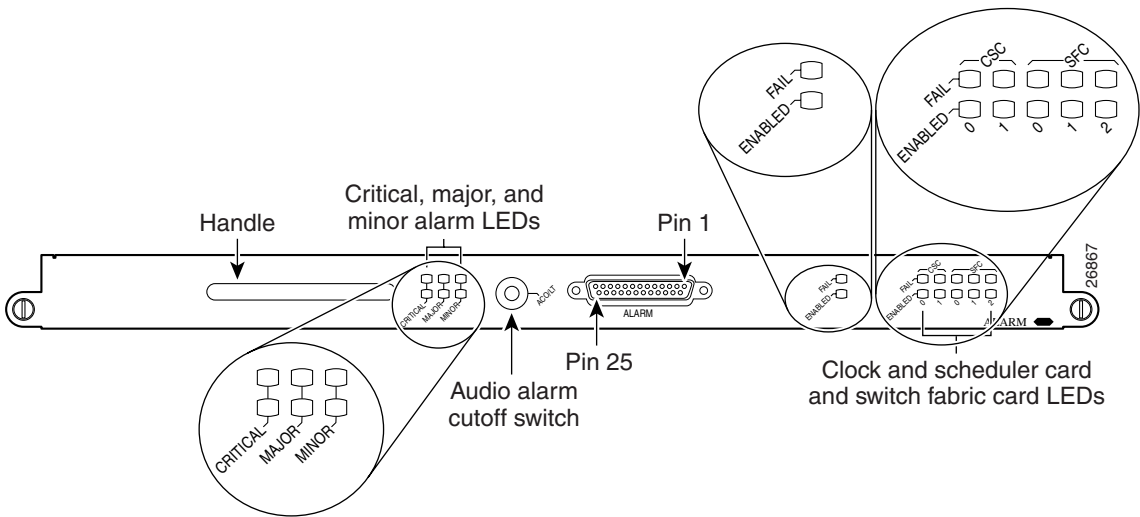
Monitoring Critical, Major, and Minor Alarm Status

The alarms can warn of an overtemperature condition:

- On a component in the card cage

- A fan failure in a blower module

- An overcurrent condition in a power supply

- An out-of-tolerance voltage on one of the cards

The alarm LEDs are controlled by MBus software, which sets the threshold levels for triggering the different stages of alarms.

The RP continuously polls the system for temperature, voltage, current, and fan speed values. If a threshold value is exceeded, the RP sets the appropriate alarm severity level on the alarm card which lights the corresponding LED, and energizes the appropriate alarm display relays to activate any external audible or visual alarms wired to the alarm display. The RP also logs a message about the threshold violation on the system console.

Note   You can use the audio alarm cutoff switch to visually check that the alarm card indicators are operating properly. If no audible alarm is active, pressing the audio alarm cutoff switch temporarily lights all of the indicators on the alarm card front panel. If an indicator does not light it means that LED is faulty.

Troubleshooting the Switch Fabric

This section describes the procedures needed to troubleshoot problems with the switch fabric. The RP and the line cards connect through the crossbar switch fabric, which provides a high-speed physical path for most inter-card communication. Among the messages passed between the RP and the line cards over the switch fabric are, actual packets being routed and received, forwarding information, traffic statistics, and most management and control information. This information is useful in diagnosing hardware-related failures.

Note   This section is recommended only for advanced Cisco IOS software operators and system administration personnel. Refer to the appropriate Cisco IOS software publications for detailed Cisco IOS information.

Use the following procedure to collect the needed data from the RPs and line cards in order to troubleshoot the switch fabric.

Step 1   Enter the **show controllers fia** command for the primary and secondary RPs and save the output.

Step 2   Enter the **attach** *<slot #>* command to access a line card.

Note   Use the **attach** command when you connect to the line card. The **execute-on** command is dependent upon the inter-process communication (IPC) which operates over the switch fabric. If you are having problems with IPC, the commands that run remotely through the switch fabric can time out. The **attach** *<slot #>* command travels over the MBus and not the IPC.

Step 3 Enter the **show controllers fia** command for all installed line cards and save the output from each.

Step 4 Proceed to the next section, Analyzing the Data.

Analyzing the Data

Switch fabric problems can occur due to failures in any of the following components:

- RPs
- Line card hardware
- The backplane
- CSCs/SFCs

When troubleshooting switch fabric errors, look for patterns with regard to which components are reporting errors. For example, if you combine the **show controllers fia** output from all RPs and line cards, you can determine if there is an error pattern. The following subsections discuss the values within the output that can help you determine any error patterns.

crc16 Output

The crc16 data line from the **show controllers fia** command is an important indicator of hardware problems. If one line card or one CSC/SFC has been on line, inserted and removed, you can expect to see some crc16 error data. However, this number should not continue to increase. If the number is increasing, you may need to replace a faulty hardware component. It is very important to correlate the data from both the primary RP and the secondary RP and all installed line cards. The example output below shows the status of the primary RP. The crc16 data line is underlined and is showing errors from sfc1.

```
Router#show controllers fia
Fabric configuration: Full bandwidth, redundant fabric
Master Scheduler: Slot 17  Backup Scheduler: Slot 16
From Fabric FIA Errors
----------------------
redund fifo parity 0    redund overflow 0      cell drops 0
crc32 lkup parity  0    cell parity      0     crc32       0
Switch cards present    0x001F   Slots  16 17 18 19 20
Switch cards monitored  0x001F   Slots  16 17 18 19 20
Slot:    16         17         18         19         20
Name:    csc0       csc1       sfc0       sfc1       sfc2
         --------   --------   --------   --------   --------
los     0          0          0          0          0
state   Off        Off        Off        Off        Off
crc16   0          0          0          1345       0
To Fabric FIA Errors
----------------------
sca not pres 0        req error    0        uni FIFO overflow 0
grant parity 0        multi req    0        uni FIFO undrflow 0
cntrl parity 0        uni req      0        crc32 lkup parity 0
multi FIFO   0        empty dst req 0       handshake error   0
cell parity  0
```

In the example output below, you can see the status of the line card in slot 2. The crc16 data line is underlined and is showing errors from sfc1.

```
Router#attach 2
Entering Console for 4 port ATM Over SONET OC-3c/STM-1 in Slot: 2
Type "exit" to end this session
Press RETURN to get started!
LC-Slot2>
LC-Slot2>enable
LC-Slot2#show controllers fia
From Fabric FIA Errors
----------------------
redund FIFO parity 0        redund overflow 0        cell drops 0
crc32 lkup parity  0        cell parity      0       crc32       0
Switch cards present    0x001F   Slots  16 17 18 19 20
Switch cards monitored  0x001F   Slots  16 17 18 19 20
Slot:    16         17         18         19         20
Name:    csc0       csc1       sfc0       sfc1       sfc2
         --------   --------   --------   --------   --------
Los     0          0          0          0          0
state   Off        Off        Off        Off        Off
crc16   0          0          0          1345       0
```

```
To Fabric FIA Errors
-----------------------
sca not pres 0        req error    0       uni fifo overflow 0
grant parity 0        multi req    0       uni fifo undrflow 0
cntrl parity 0        uni req      0       crc32 lkup parity 0
multi fifo   0        empty DST req 0       handshake error   0
cell parity  0
LC-Slot2#exit
Disconnecting from slot 2.
Connection Duration: 00:00:21
Router#
```

After you have gathered the **show controllers fia** command data from the RPs and line cards, you can create a table similar to Table 5-5.

Table 5-5   Error Data Collection Table

Card Slot	CSC 0	CSC 1	SFC 0	SFC 1	SFC 2	SFC 3	SFC 4
0				ERROR			
1							
2				ERROR			
3				ERROR			
4							
5				ERROR			
6							
7				ERROR			
8							

Table 5-5 indicates that more than one line card is reporting errors coming from SFC 1. Therefore, the first step to correcting this problem is to check or replace SFC 1. Whenever a replacement is recommended, first verify that the card is correctly seated (see the "Properly Seating Switch Fabric Cards" section on page 5-35).

✎
Note   Always reseat the corresponding card as the first line of troubleshooting to be sure it is correctly seated. If, after reseating the card, the crc errors are still increasing, then replace the part.

The common failure patterns and recommended actions for crc16 errors are as follows (one step at a time until the problem goes away):

1. Errors indicated on more than one line card from the same switch fabric card:

   a. Replace the switch fabric card in the slot corresponding to the errors.

   b. Replace all switch fabric cards.

   c. Replace the backplane.

2. Errors indicated on one line card from more than one switch fabric card:

   a. Replace the line card.

   b. If errors are incrementing, replace the current master CSC.

   c. If errors are not incrementing and the current master is CSC0, replace CSC1.

Grant Parity and Request Errors

Another troubleshooting indicator are the console logs or the output of the **show log** command, in the form of grant parity and request errors. Look for the following type of message that indicates a grant parity error:

```
%FABRIC-3-PARITYERR: To Fabric parity error was detected.
Grant parity error Data = 0x2.
SLOT 1:%FABRIC-3-PARITYERR: To Fabric parity error was detected.
Grant parity error Data = 0x1
```

You can also use the output from the **show controllers fia** command. Important information is underlined:

```
Router#show controllers fia
Fabric configuration: Full bandwidth, redundant fabric
Master Scheduler: Slot 17      Backup Scheduler: Slot 16

From Fabric FIA Errors
----------------------
redund FIFO parity 0   redund overflow 0   cell drops 76


crc32 lkup parity  0    cell parity 0   crc32 0
Switch cards present    0x001F    Slots  16 17 18 19 20
Switch cards monitored  0x001F    Slots  16 17 18 19 20
Slot:     16        17        18        19         20
Name:   csc0      csc1      sfc0      sfc1       sfc2
```

```
        --------  --------  --------  --------  --------
Los     0         0         0         0         0
state   Off       Off       Off       Off       Off
crc16   876       257       876       876       876


To Fabric FIA Errors
----------------------
sca not pres 0          req error     1          uni fifo overflow 0
grant parity 1          multi req     0          uni fifo undrflow 0


cntrl parity 0          uni req       0          crc32 lkup parity 0
multi fifo   0          empty DST req 0          handshake error   0
cell parity  0
```

The common failure patterns and recommended actions for grant parity and request errors are as follows (one step at a time until the problem goes away):

1. Grant errors on more than one line card:

   a. Replace the CSC (see the note below to know which one should be swapped).

   b. Replace the backplane.

2. Grant errors on one line card:

   a. Replace the line card.

   b. Replace the CSC (see the note below to know which one should be swapped).

   c. Replace the backplane.

> **Note** If multiple line cards are reporting grant parity or request errors and the router is still functioning, then a CSC switchover has occurred. The failed CSC is the one that is currently the backup CSC (not the one listed as Master Scheduler in the **show controllers fia** output). If Halted is next to the heading From Fabric FIA Errors or To Fabric FIA Errors, or if the router is no longer forwarding traffic, then a CSC switchover has not occurred and the failing CSC is the one listed as Master Scheduler. By default, the CSC in slot 17 is the primary and the CSC in slot 16 is the backup.

Properly Seating Switch Fabric Cards

The switch fabric cards in the router can be challenging to insert, and may require a small amount of force to seat correctly. If either of the CSCs are not seated properly, you may see the following error message:

```
%MBUS-0-NOCSC: Must have at least 1 CSC card in slot 16 or 17
%MBUS-0-FABINIT: Failed to initialize switch fabric infrastructure
```

Note You may also get this error message if there are only enough CSCs and SFCs seated for quarter bandwidth configurations. Quarter bandwidth configurations are no longer supported on Cisco 12000 series routers.

When dealing with switch fabric and line card booting problems, it is important to verify that all CSCs and SFCs are correctly seated and powered on. The output from the **show version** and **show controllers fia** commands tells you which hardware configuration is currently running on the box. Important data is underlined.

```
Router#show version
Cisco Internetwork Operating System Software
IOS (tm) GS Software (GSR-P-M), Experimental Version
12.0(20010505:112551)
Copyright (c) 1986-2001 by cisco Systems, Inc.
Compiled Mon 14-May-01 19:25 by tmcclure
Image text-base: 0x60010950, data-base: 0x61BE6000

ROM: System Bootstrap, Version 11.2(17)GS2, [htseng 180]
EARLY DEPLOYMENT RELEASE SOFTWARE (fc1)
BOOTFLASH: GS Software (GSR-BOOT-M), Version 12.0(15.6)S,
EARLY DEPLOYMENT MAINTENANCE INTERIM SOFTWARE

Router uptime is 17 hours, 53 minutes
System returned to ROM by reload at 23:59:40 MET Mon Jul 2 2001
System restarted at 00:01:30 MET Tue Jul 3 2001
System image file is
"tftp://172.17.247.195/gsr-p-mz.15S2plus-FT-14-May-2001"

cisco 12016/GRP (R5000) processor (revision 0x01) with 262144K bytes
of memory.
R5000 CPU at 200Mhz, Implementation 35, Rev 2.1, 512KB L2 Cache
Last reset from power-on

2 Route Processor Cards
```

```
1 Clock Scheduler Card
3 Switch Fabric Cards
1 8-port OC3 POS controller (8 POs).
1 OC12 POS controller (1 POs).
1 OC48 POS E.D. controller (1 POs).
7 OC48 POS controllers (7 POs).
1 Ethernet/IEEE 802.3 interface(s)
17 Packet over SONET network interface(s)
507K bytes of non-volatile configuration memory.

20480K bytes of Flash PCMCIA card at slot 0 (Sector size 128K).
8192K bytes of Flash internal SIMM (Sector size 256K).


Router#show controller fia
Fabric configuration: Full bandwidth nonredundant
Master Scheduler: Slot 17
```

Troubleshooting the Cooling Subsystem

The cooling subsystem of the router consists of an upper and lower blower module in the chassis and a fan in each of the power supplies. The blower modules and the power supply fans circulate air to maintain acceptable operating temperatures within the router (Figure 5-8).

This section contains information to troubleshooting the cooling subsystem and includes:

- Blower Module Operation, page 5-38
- Power Supply Operation, page 5-38
- Overtemperature Conditions, page 5-39
- Isolating Cooling Subsystem Problems, page 5-39

Figure 5-8   Cooling Air Flow
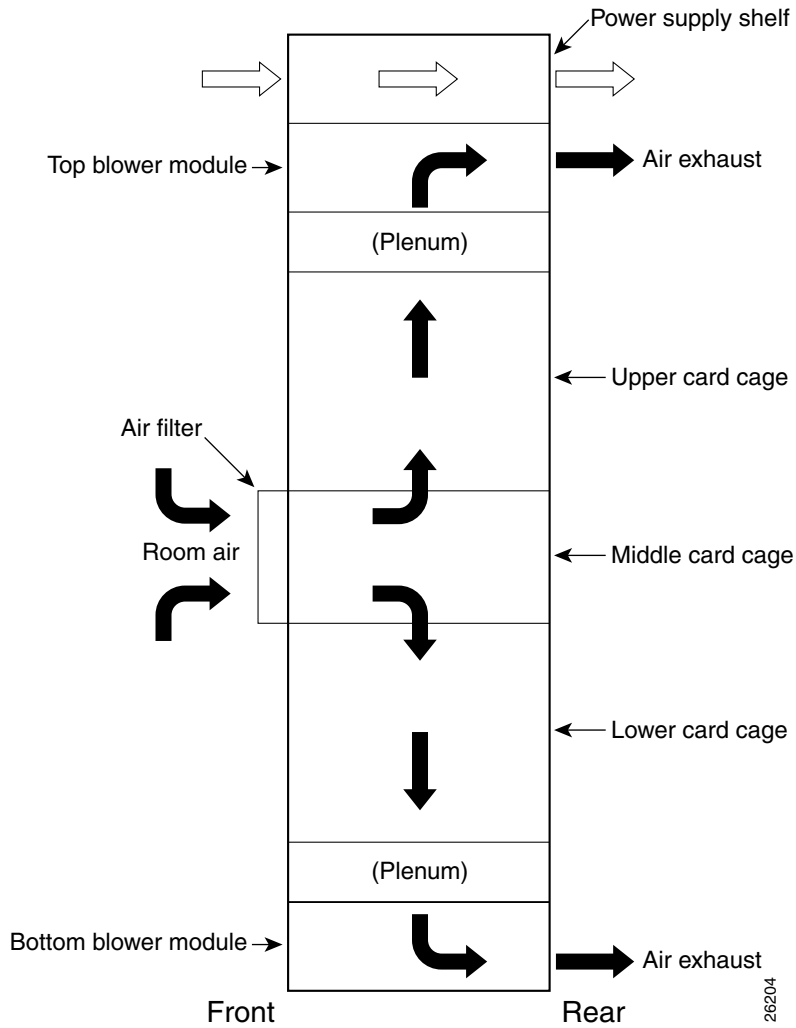
Blower Module Operation

The blower modules maintain acceptable operating temperatures for the internal components by drawing cooling air through a replaceable air filter into the card cages. The blowers occupy a bay near the top and at the bottom of the router.

Each blower module contains three fans, a controller card, and two front panel status LEDs. A snap-on plastic front cover fits over the front panel, but the LEDs are visible through the front covers.

- **–** Green—The blower module is functioning properly.

- **–** Red—There is a fault detected in the blower module.

- **•** If the air temperature inside the chassis rises, blower speed increases to provide additional cooling air to the internal components.

- **•** If the internal air temperature continues to rise beyond the specified threshold, the system environmental monitor shuts down all internal power to prevent equipment damage due to excessive heat.

- **•** If the system detects that one or more of the fans in a blower module has failed, it displays a warning message on the system console and displays a blower failure message on the RP alphanumeric display. In addition, the remaining fans go to full speed to compensate for the loss of the failed fan.

Power Supply Operation

Each AC or DC power supply is equipped with a fan that draws cooler air in through the front of the power module and forces warmer out the back of the power shelf.

- **•** If the power source is within the required range, the power supply fan remains on.

- **•** If the fan fails:

  - **–** Power supply detects an internal overtemperature condition

  - **–** Fault and Temp indicators light

  - **–** Power supply sends an overtemperature warning to the system and then shuts down the system.

For additional power supply troubleshooting information, see the

Overtemperature Conditions

The following console error message indicates that the system has detected an overtemperature condition or out-of-tolerance power value inside the system:

```
Queued messages:
%ENVM-1-SHUTDOWN: Environmental Monitor initiated shutdown
```

The preceding message could also indicate a faulty component or temperature sensor. Enter the **show environment** command or the **show environment all** command at the user EXEC prompt to display information about the internal system environment. The information generated by these commands include:

- Voltage measurements on each card from the DC-to-DC converter
- The +5 VDC for the MBus module
- The operating voltage for the blower module.
- Temperature measurements received by two sensors on each card (one for inlet air temperature and one for the card's hot-spot temperature), as well as temperature measurements from sensors located in each power supply.

If an environmental shutdown results from an overtemperature or out-of-tolerance condition, the Fault indicator on the power supply lights before the system shuts down.

Although an overtemperature condition is unlikely at initial system startup, make sure that:

- Heated exhaust air from other equipment in the immediate environment is not entering the chassis card cage vents.
- You allow sufficient air flow by maintaining a minimum of 6 inches (15.24 cm) of clearance at both the inlet and exhaust openings on the chassis and the power modules to allow cool air to enter freely and hot air to be expelled from the chassis.

Isolating Cooling Subsystem Problems

Use the following procedure to isolate a problem with the chassis cooling system if you have an overtemperature condition.

Step 1   Make sure the blower modules are operating properly when you power on the system.

- To determine if a blower module is operating, check the two LED indicators on the blower module front panel:

    - OK (green)—The blower module is functioning properly and receiving –48 VDC power, indicating that the cables from the chassis backplane to the blower module are good.

    - Fail (red)—A fault is detected in the blower module. Replace the blower module.

    - If neither indicator is on and the blower is not operating, there may be a problem with either the blower module or the –48 VDC power supplied to the blower module. Go to Step 2.

Step 2   Eject and reseat the blower module making sure the captive screws are securely tightened.

If the blower module still does not function, go to Step 3.

Step 3   Check for –48 VDC power by looking at the LED indicators on each power supply:

- If the Pwr OK indicator is on and the Fault indicator is off on each power supply, it indicates that the blower is receiving –48 VDC.

    - If the blower module is still not functioning, there could be a problem with the blower module controller card or an undetected problem in the blower module cable. Replace the blower module.

    - If the new blower module does not function, contact a Cisco customer service representative for assistance.

- If the Fault indicator is on, the power supply is faulty. Replace the power supply.

- If the Temp and Fault indicators are on, an overtemperature condition exists.

    - Verify that the power supply fan is operating properly.

    - If the fan is not operating, replace the power supply.

        Contact your Cisco representative if replacing the power supply does not fix the problem.

■   **Troubleshooting the Cooling Subsystem**

Router Field Diagnostics

This chapter describes the diagnostic commands you can use to troubleshoot line cards, Route Processor cards (PRP and GRP), Switch Fabric Cards (SFC), and Clock Scheduler Cards (CSC) installed in Cisco 12016, Cisco 12416, and Cisco 12816 routers.

You can run field diagnostics to help isolate a faulty line card without disrupting the operation of the system. Field diagnostics are not designed to identify specific components within the router. They simply determine whether a particular card is operational or defective.

> **Note** Starting with Cisco IOS Release 12.0(22)S, the line card field diagnostics image is not bundled with the main Cisco IOS image. Line card field diagnostics are now stored and maintained as a separate image that must be available on a flash memory card or TFTP boot server before you enter the diagnostic commands. Route processor and switch fabric card field diagnostics continue to be bundled with the main Cisco IOS image and do not need to be launched from a separate image.

Unbundled field diagnostics provide the following benefits:

- In-service testing—Field diagnostics can be run on an in-service router running Cisco IOS and only take the card being tested out of service. The tested card is returned to normal operation if the diagnostic tests pass. If there is a hardware fault, the card remains out of service after the testing is completed.

- Smaller Cisco IOS image—The smaller IOS image helps accommodate customers with 20 MB flash memory cards.

- Easy access to the most current diagnostics software—Because the field diagnostic software is now maintained as a separate image, the most recent version is always available on Cisco.com, without regard to the Cisco IOS software release currently in use.

This chapter describes the following topics:

Diagnostics Overview

More than 100 diagnostic operations for each router line card exist, in addition to diagnostics for the switch fabric and route processor cards. These operations include the following:

- Processor tests
- Memory tests
- Component tests
- Major data path tests
- Field-programmable gate array (FPGA) image updates (on some line cards)

Note When using Cisco IOS Release 12.0(21)S or 12.0(21)ST or later, the default download method changes from the MBus to the switch fabric to make the process faster. It takes about 1 minute to obtain test results from the switch fabric compared to 15 minutes from the MBus.

While diagnostics are running, the line card being tested is taken offline and is controlled by the diagnostic software. The diagnostics affect only the line card being tested; the other line cards remain online and continue to pass traffic normally. Diagnostics do not affect system performance.

Diagnostic testing stops when all of the tests are completed, are terminated by the user, or by default if an error is encountered. If multiple cards are specified for the test cycle, the diagnostics stop testing a card when it fails a test, but then continues testing the remaining cards.

When testing is finished, a pass or fail message appears on the console, and on the alphanumeric LED display on the card being tested.

Downloading the Diagnostic Image

Before you can use the diagnostic commands, you must download a valid diagnostic image to a flash memory card installed in the router or to an TFTP boot server.

Field diagnostic images are 10 to 18 MB in size, and Cisco IOS images are slightly larger. One 64 MB flash memory card can store both images, or the images can be stored individually on two 20 MB memory cards.

The name of the field diagnostic image is **c12k-fdiagsbflc-mz** and the latest version is always available on Cisco.com. The image name is combined with the Cisco IOS release number, for example: **c12k-fdiagsbflc-mz** 120-25.S

In this example, 120-25.S is the release number of the image that corresponds to the Cisco IOS image: Cisco IOS Release 12.0(25)S.

Note   All Cisco field diagnostic images available on Cisco.com are compatible with Cisco IOS Release 12.0(22)S and later. We recommend that you use the latest available diagnostic image for testing and verifying line cards.

Field-Programmable Gate Array Overview

Some Cisco 12000 series line cards store hardware information as software code in the form of a field-programmable gate array, or FPGA. This code is permanently placed in flash memory on the line card. Occasionally, this flash memory code must be updated with new FPGA code containing feature enhancements or code improvements.

Some FPGA images are bundled within the Cisco IOS image and are updated along with a new release. These type of FPGA images do not require flash memory storage and are developed and expanded within Cisco IOS feature sets. FPGA images stored in flash memory on the line card receive updates occasionally. When the line card boots, Cisco IOS software may use an FPGA image bundled within itself, or it may use the FPGA image stored in flash memory on the line card.

Cisco IOS checks the revision of the FPGA code in flash memory during the boot process and informs you if an upgrade is necessary.

The following example of Cisco IOS software boot text shows an FPGA upgrade message (see underlined section):

```
*Aug 19 14:51:06 UTC: %MBUS-6-FABCONFIG: Switch Cards 0x1F (bitmask)
    Primary Clock is CSC_1
    Fabric Clock is Redundant
    Bandwidth Mode : Full Bandwidth
    *Aug 19 14:51:23 UTC: %MBUS-6-NO_FPGA_IMG: FPGA image is not
appropriate or corrupted for slot 0. Please run Field Diagnostics
image on slot 0 to upgrade the FPGA image.
    *Aug 19 14:51:31 UTC: %GRPGE-6-SYNC_LOSS: Interface
GigabitEthernet2/0: Loss of Sync
    *Aug 19 14:51:31 UTC: %GRPGE-6-RX_LOS: Interface
GigabitEthernet2/0: Detected RX Loss of Signal
    SLOT 2:00:00:12: %SYS-5-RESTART: System restarted --
    Cisco Internetwork Operating System Software
    IOS (tm) GS Software (GLC1-LC-M), Experimental Version
12.0(20030605:093502) [mliflian-25-thr-work-nog-lke 115]
    Copyright (c) 1986-2003 by cisco Systems, Inc.
    Compiled Tue 19-Aug-03 17:33 by mliflian
```

If an upgrade message appears, you can run the field diagnostics to update the image in flash memory. No actual tests are initiated when using field diagnostics to update the FPGA; it only performs the update to the FPGA code. See the

When field diagnostics run, the target line card stops passing traffic and goes offline (the rest of the router continues passing traffic normally). The line card is loaded with the field diagnostics program, the FPG update is run, and if successful, the card reboots to Cisco IOS. The entire process takes approximately 2 minutes and must be done one line card at a time.

> ✎
>
> **Note**   Before updating the next line card, wait about 30 seconds after the
> Cisco IOS software reloads on the line card to give the router a chance to
> synchronize all of its internal functions.

Upgrading an FPGA Image on a Line Card

When the Cisco IOS image boots, it verifies that a compatible FPGA image is
running on the router. The major version number of the FPGA image must be the
same as that expected by the Cisco IOS image; the minor version number on the
FPGA image must be the same as or greater than the minor version number
expected by the Cisco IOS image.

For example, if the Cisco IOS image expects a minimum FPGA image of 03.02,
the software verifies that the actual major version number of the FPGA image in
the line card bootflash is 03, and that the minor version number is 02 or above.

If a line card does not boot and an error message indicates that there is a problem
with the FPGA image, or if the line card alphanumeric LED display remains stuck
in the IOS STRT stage, you must upgrade the FPGA image using the **diag**
command.

Use the following procedure to upgrade the FPGA image on a line card.

Step 1   Enter the **enable** command and password (if prompted).

```
Milo> enable
Password: <password>
Milo#
```

Step 2   Enter the **diag** *slot-number* **update-fpga source** {**tftp** | **flash**} *source-path* command to update the flash memory.

Where:

- *slot-number* is the slot number of the line card you are upgrading.

- *source-path* is the path to the diagnostic image.

    – For flash memory cards, the source path is typically:
      slot0:c12k-fdiagsbflc-mz.*120-25.S* or
      slot1:c12k-fdiagsbflc-mz.*120-25.S*.

    – For TFTP boot servers, the source path is typically:
      tftp://*tftp_server_ip_address/my_directory***/c12k-fdiagsbflc-mz.***120-25
      .S*.

⚠

Caution   Do not unplug the line card or terminate the field diagnostics session during this test.

The following example shows the output of a line card with the **update-fpga** option specified.

```
Router# diag 7 verbose source tftp
tftp://223.255.254.254/c12k-fdiagsbflc-mz.120-25.S update-fpga
Running DIAG config check
Fabric Download for Field Diags chosen: If timeout occurs, try 'mbus'
option.
Verbose mode: Test progress and errors will be displayed
UUT will update FPGA's flash
Runnning Diags will halt ALL activity on the requested slot.
[confirm]
Router#
PID of f_diag_run is 121, set test_pid[3]
gdb slot is 0
Launching a Field Diagnostic for slot 7
Loading c12k-fdiagsbflc-mz.new_fpga from 223.255.254.254 (via
Ethernet0):
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Calling enable_slot_and_type_on_fabric(DISABLE) for slot 7
Calling enable_slot_and_type_on_fabric(ENABLE) for slot 7
FD 3> ****************************************************
FD 3> GSR Field Diagnostics V6.9
```

```
FD 3> Compiled by ckhuong on Fri Jan 17 15:51:36 PST 2003
FD 3> view: ckhuong-conn_isp.inti4
FD 3> ****************************************************
Diagnostics have been downloaded to slot 7
Executing all diagnostic tests in slot 7
(total/indiv. timeout set to 2000/600 sec.)
FD 3> BFR_CARD_TYPE_4P_GE_E48 testing...
FD 3> Available test types 2
FD 3>                       1
FD 3>                       3
FD 3>                       11
FD 3> Completed f_diags_board_discovery() (0x32)
FD 3> Verbosity now (0x00000011) TESTSDISP FATL
FD 3> Test list selection received: Test ID 3, Device 0
FD 3> running in slot 7 (1 tests from test list ID 3)
FD 3> Just into idle state
FDIAG_STAT_IN_PROGRESS(3): test #1 Tetra Flash Mem Upgrading
FD 3> Upgraded FPGA image in Flash from version 0xcc53 to 0xcc54
Calling enable_slot_and_type_on_fabric(DISABLE) for slot 7
Calling enable_slot_and_type_on_fabric(ENABLE) for slot 7
FDIAG_STAT_DONE(3)


FD 3> Changed current_status to FDIAG_STAT_IDLE
COMPLETED Field Diags: pid 121, status 6, test_num 1, error_code 0


Field Diagnostic ****PASSED**** for slot 7


Field Diag results from eeprom before updating slot 7, run# 0x10 were
0x0
previous field diag eeprom values: run 16 fail mode 0 (PASS)
   last test failed was 0, error code 0
Field Diag eeprom values: run 17 fail mode 0 (PASS) slot 7
   last test failed was 0, error code 0
Shutting down diags in slot 7


Board will reload
Router#
```

Using the diag Command

You can use the **diag** command to run field diagnostics on a line card, Route Processor card (PRP and GRP), Switch Fabric Card (SFC), or Clock and Scheduler Card (CSC) in Cisco 12016, Cisco 12416, and Cisco 12816 Routerrouters.

⚠️

Caution   Performing field diagnostics on a line card stops all activity on the line card. Before the **diag** command begins running diagnostics, you are prompted to confirm the request to perform field diagnostics on the line card.

⚠️

Caution   Some line cards include components that are unable to isolate internal line card testing traffic from customer premise connections. You are warned to disconnect any connections to these line cards before testing to achieve the most reliable results and minimize traffic disruption.

Refer to Table 6-1 for a description of the command variables.

Diagnostic Commands for Cisco 12016, Cisco 12416, and Cisco 12816 RouterLine Cards

The following diagnostic commands apply to line cards.

diag *slot-number* **source** {**tftp** | **flash**} *source-path* [**verbose**] [**wait**] [**full**] [**coe**]
[**dl-timeout-plus** *<1-2000>*] [**device**] [**messaging**]

diag *slot-number* **previous**

diag *slot-number* **halt**

diag *slot-number* **update-fpga source** {**tftp** | **flash**} *source-path*
[**dl-timeout-plus** *<1-2000>*]

Diagnostic Commands for Cisco 12000 Series Rout Processors

The following diagnostic commands apply to GRP and PRP route processors.

diag *slot-number* [**verbose**] [**wait**] [**full**] [**coe**]

diag *slot-number* **previous**

diag *slot-number* **halt**

Diagnostic Commands for Cisco 12000 Series Switch Fabric Cards and Clock Scheduler Cards

The following diagnostic command applies to SFC and CSC fabric cards.

diag *slot-number* [**verbose**]

Diagnostic Command Reference Table

Table 6-1 lists the diag command keywords, options, variables, and their descriptions.

Table 6-1   diag Command Reference

Command	Description
slot-number	Specifies the slot number of the card you want to test.
source	Specifies the source path of the line card diagnostic image. The **source** keyword must be followed by either the **tftp** or **flash** keyword.
tftp	Specifies that a TFTP server is the source of the diagnostic image. The **tftp** keyword must be followed by the *source-path* variable. To manipulate the download time for slow TFTP connections, see the **dl-timeout-plus** option.
flash	Specifies that a flash memory card is the source of the diagnostic image. The **flash** keyword must be followed by the *source-path* variable.

Table 6-1   diag Command Reference (continued)

source-path	Specifies the path to the diagnostic image file **c12k-fdiagsbflc-mz.***IOS Release*
	Where *IOS Release* corresponds to the Cisco IOS release number. For example:
	c12k-fdiagsbflc-mz.*120-25.S*
	In this example *120-25.S* corresponds to Cisco IOS Release 12.0(25)S.
	The following are examples of the source path for flash cards:
	• **slot0:c12k-fdiagsbflc-mz.***120-25.S*
	• **slot1:c12k-fdiagsbflc-mz.***120-25.S*.
	The following is an example of the source path for a TFTP server:
	• **tftp://***tftp_server_ip_address/my_directory***/c12k-fdiags bflc-mz.***120-25.S*.
halt	(Optional) Stops diagnostic testing on the line card.
	If you stop the field diagnostic test using the **diag halt** command, the line card remains down (in an unbooted state). Generally, you stop testing to remove or replace the line card. If this is not the case, and you need to bring the line card back up (online), use the microcode **reload slot** global configuration command, or power cycle the line card by removing and replacing it in its slot.
previous	(Optional) Displays previous test results (if any) for the card.

Table 6-1   diag Command Reference (continued)

verbose	(Optional) Enables progress and error messages to be displayed on the console.
	By default, only the minimum status messages appear on the console, along with the final result. Use the **verbose** option to view all of the tests performed.
	Due to the comprehensive nature of the diagnostics, testing *without* the verbose option can cause a delay of up to 15 minutes before any results are displayed. We recommend that you specify the **verbose** option to capture results when communicating with Cisco TAC.
wait	(Optional) Stops the automatic reloading of the Cisco IOS software on the line card after the successful completion of diagnostic testing.
	If you use the **wait** keyword, you must use the microcode **reload slot** global configuration command to reload the Cisco IOS software image to the line card, or you can manually remove and insert the line card in the slot (to initialize it) so the RP recognizes the line card.
coe	(Optional) Continue On Error.
	Normally the field diagnostics stop immediately upon failing any one test during a test session. **coe** forces the testing to continue to the end of the internal test list, even if a failure occurs.
	⚠
	Caution If you use this option and a cascade of failures is found, it *may* require that you reload the router, affecting all RPs and line cards.
full	(Optional) Forces a line card or RP to complete the most extensive set of tests.
	The default set of diagnostics emphasize memory and data path tests. Use the **full** option to run the complete set of tests.

Table 6-1   diag Command Reference (continued)

dl-timeout-plus <1-2000 seconds>	(Optional) Manipulates the download timeout value for users with slow TFTP boot paths.
	300 seconds is the baseline value. Any value from 1 to 2000 adds that value to 300. For example, a **dl-timeout-plus** value of 12 makes the total value 312 seconds.
update-fpga	(Optional) Updates flash memory with FPGA images from the current field diagnostics download image.
	This option limits the field diagnostics session to one task; updating the FPGA images in flash memory on the line card. No other testing is performed during this session. This process is non-selective in cases where a line card contains multiple FPGA images.
	⚠ **Caution** Do not unplug the line card or terminate the field diagnostics session during an FPGA upgrade.
messaging	Provides additional troubleshooting information.

After all diagnostic tests are completed on a line card, a PASSED or TEST FAILURE message appears on the console.

- If the line card passes, the Cisco IOS software image on the line card is automatically reloaded (unless the **wait** keyword is specified).

- If the line card fails, the Cisco IOS software image on the line card is not automatically reloaded.

If the line card fails the test, the line card is defective and must be replaced. Under certain circumstances, TAC engineers may direct you to replace field-replaceable memory modules and then retest. For example, if the DRAM test fails, you might only need to replace the DRAM on the line card. However, this should only be performed under the guidance of a TAC engineer and only when observing tightly controlled static-sensitive device handling procedures.

⚠

Caution   Do not replace memory components without properly grounding both the board and yourself.

diag Command Output Examples

This section contains output examples using diag commands.

⚠

Caution   Performing field diagnostics on a line card stops all activity on the line card. Before the **diag** command begins running diagnostics, you are prompted to confirm the request to perform field diagnostics on the line card.

Testing Without the verbose Option

The following example shows the output of diagnostic testing performed on a line card in slot 7 *without* the **verbose** option specified. After the line card passes all field diagnostic tests, Cisco IOS software automatically reloads on the card.

Note that the *total/indiv. timeout set to 2000/600 sec.* message indicates that 2000 seconds are allowed to perform all field diagnostics tests, and that no one test should exceed 600 seconds to complete.

```
Router# diag 7 source tftp
tftp://192.164.5.4/images/c12k-fdiagsbflc-mz.120-25.S
Running DIAG config check
Fabric Download for Field Diags chosen: If timeout occurs, try 'mbus'
option.
Running Diags will halt ALL activity on the requested slot.  [confirm]
award-rp-slot0#
Launching a Field Diagnostic for slot 7
Downloading diagnostic tests to slot 7 via fabric (timeout set to 300
sec.)
5d20h: %GRP-4-RSTSLOT: Resetting the card in the slot: 7,Event:
EV_ADMIN_FDIAG
Loading images/award/c12k-fdiagsbflc-mz from 192.164.1.1 (via
Ethernet0):    !!!!!
5d20h: Downloading diags from tftp file
tftp://192.164.1.1/images/award/c12k-fdiagsbflc-mz
!!!!![OK - 13976524 bytes]
```

```
FD 7> *****************************************************
FD 7> GSR Field Diagnostics V6.05
FD 7> Compiled by award on Tue Jul 30 13:00:41 PDT 2002
FD 7> view: award-conn_isp.FieldDiagRelease
FD 7> *****************************************************
Executing all diagnostic tests in slot 7
(total/indiv. timeout set to 2000/600 sec.)
FD 7> BFR_CARD_TYPE_OC12_4P_POS testing...
FD 7> Available test types 2
FD 7>                          1
FD 7> Completed f_diags_board_discovery() (0x1)
FD 7> Test list selection received: Test ID 1, Device 0
FD 7> running in slot 7 (30 tests from test list ID 1)
FD 7> Skipping MBUS_FDIAG command from slot 2
FD 7> Just into idle state
Field Diagnostic ****PASSED**** for slot 7
Shutting down diags in slot 7
Board will reload
5d20h: %GRP-4-RSTSLOT: Resetting the card in the slot: 7,Event:
EV_ADMIN_FDIAG
SLOT 7:00:00:09: %SYS-5-RESTART: System restarted --
Cisco Internetwork Operating System Software
IOS (tm) GS Software (GLC1-LC-M), Experimental Version
12.0(20020509:045149)    [award-conn_isp.f_diag_new 337]
Copyright (c) 1986-2002 by cisco Systems, Inc.
Compiled Tue 25-Jun-02 15:51 by award
```

Testing Using the verbose Option

The following example shows the output of diagnostic testing performed on a line card in slot 7 *with* the **verbose** option specified (recommended).

```
Router# diag 7 verbose tftp
tftp://192.164.1.1/images/award/c12k-fdiagsbflc-mz.120-25.S
Running DIAG config check
Fabric Download for Field Diags chosen: If timeout occurs, try 'mbus'
option.
Verbose mode: Test progress and errors will be displayed
Runnning Diags will halt ALL activity on the requested slot.
[confirm]
Router#
Launching a Field Diagnostic for slot 7
Downloading diagnostic tests to slot 7 via fabric (timeout set to 300
sec.)
00:07:41: %GRP-4-RSTSLOT: Resetting the card in the slot: 7,Event:
EV_ADMIN_FDIAG
```

```
Loading images/award/c12k-fdiagsbflc-mz from 192.164.1.1 (via
Ethernet0):      !!!!!! (...)
00:08:24: Downloading diags from tftp file
tftp://192.164.1.1/images/award/c12k-fdiagsbflc-mz
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!
[OK - 13976524 bytes]
FD 7> *****************************************************
FD 7> GSR Field Diagnostics V6.05
FD 7> Compiled by award on Tue Jul 30 13:00:41 PDT 2002
FD 7> view: award-conn_isp.FieldDiagRelease
FD 7> *****************************************************
Executing all diagnostic tests in slot 7
(total/indiv. timeout set to 2000/600 sec.)
FD 7> BFR_CARD_TYPE_OC12_4P_POS testing...
FD 7> Available test types 2
FD 7>                      1
FD 7> Completed f_diags_board_discovery() (0x1)
FD 7> Verbosity now (0x00000011) TESTSDISP FATL
FD 7> Test list selection received: Test ID 1, Device 0
FD 7> running in slot 7 (30 tests from test list ID 1)
FD 7> Just into idle state
FDIAG_STAT_IN_PROGRESS(7): test #1 Dram Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #2 Dram Datapins
FDIAG_STAT_IN_PROGRESS(7): test #3 Dram Busfloat
FDIAG_STAT_IN_PROGRESS(7): test #4 RBM SDRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #5 RBM SDRAM Datapins
FDIAG_STAT_IN_PROGRESS(7): test #6 RBM SSRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #7 RBM SSRAM Datapins Memory
FDIAG_STAT_IN_PROGRESS(7): test #8 TBM SDRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #9 TBM SDRAM Datapins
FDIAG_STAT_IN_PROGRESS(7): test #10 TBM SSRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #11 TBM SSRAM Datapins Memory
FDIAG_STAT_IN_PROGRESS(7): test #12 PSA TLU SDRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #13 PSA TLU SDRAM Datapins
FDIAG_STAT_IN_PROGRESS(7): test #14 PSA PLU SDRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #15 PSA PLU SDRAM Datapins
FDIAG_STAT_IN_PROGRESS(7): test #16 PSA SRAM Marching Pattern
FDIAG_STAT_IN_PROGRESS(7): test #17 PSA SRAM Datapins
FDIAG_STAT_IN_PROGRESS(7): test #18 To Fabric SOP FIFO SRAM Memory
FDIAG_STAT_IN_PROGRESS(7): test #19 From Fabric SOP FIFO SRAM Memory
FDIAG_STAT_IN_PROGRESS(7): test #20 RBM to SALSA Packet
FDIAG_STAT_IN_PROGRESS(7): test #21 TBM to SALSA Packet
FDIAG_STAT_IN_PROGRESS(7): test #22 RBM to TBM SLI Packet Loopback
FDIAG_STAT_IN_PROGRESS(7): test #23 TBM to PSA Packet - Framer
Loopback
FDIAG_STAT_IN_PROGRESS(7): test #24 TBM to TX SOP Packet
```

```
FDIAG_STAT_IN_PROGRESS(7): test #25 TBM to RX SOP Packet - 4302
Terminal Loopback
FDIAG_STAT_IN_PROGRESS(7): test #26 TBM to RX SOP Packet - Framer
System Bus Loop
FDIAG_STAT_IN_PROGRESS(7): test #27 RBM to TBM Fabric Packet Loopback
FDIAG_STAT_IN_PROGRESS(7): test #28 TBM to RBM Packet, RBM page
crossing
FDIAG_STAT_IN_PROGRESS(7): test #29 TBM to TX SOP Packet Simultaneous
FDIAG_STAT_IN_PROGRESS(7): test #30 TBM to PSA Multicast Packets -
Framer Loopbac
FDIAG_STAT_DONE(7)
FD 7> Changed current_status to FDIAG_STAT_IDLE
Field Diagnostic ****PASSED**** for slot 7
Field Diag eeprom values: run 62 fail mode 0 (PASS) slot 7
last test failed was 0, error code 0
Shutting down diags in slot 7
Board will reload
```

Displaying Previous Test Results

The following example shows the previous test results of a line card in slot 7. Diagnostics had been run 64 times on this line card. Because the board PASSED the last field diagnostics session, the fail mode was 0, and the last test that failed was 0.

```
Router # diag 7 prev
Field Diag eeprom values: run 64 fail mode 0 (PASS) slot 7
   last test failed was 0, error code 0
```

Maintaining the Router

Your router is equipped as ordered and is ready for installation and startup when it is shipped. As your networking requirements change, you may need to upgrade the system by adding or changing components. This chapter describes how to maintain router components.

Procedures for maintaining the router are described in the following sections:

Prerequisites and Preparation

Before you perform any of the procedures in this chapter, be sure that you:

- Review the "Safety Guidelines" section on page 2-2.
- Read the safety and ESD-prevention guidelines described in the "Preventing Electrostatic Discharge Damage" section on page 2-4.
- Ensure that you have all of the necessary tools and equipment before beginning the procedure.
- Have access to the following documents during the installation:
  - *Regulatory Compliance and Safety Information for Cisco 12000 Series Routers* publication that shipped with the router (PN 78-4347-xx)

Powering Off the Router

Most Cisco 12016, Cisco 12416, and Cisco 12816 Router field-replaceable units (FRUs) can be removed and replaced with the power on and the system operating. This is known as online insertion and removal (OIR). Power supplies, line cards, the RP, CSCs, SFCs, and alarm cards all support OIR. Unless otherwise noted, the maintenance tasks described in this chapter can be performed while the router remains powered on.

In some cases it may be necessary to power off the router, for example, to upgrade power supplies or to replace a power shelf. Use the following procedure to power off the router.

Step 1 Set the power switch on each power supply to the off (0) position.

Step 2 Power off all circuit breakers for the source power lines connected to the power supplies.

Step 3   Verify that the PWR OK indicator on each power supply is off.

Step 4   Verify that the OK indicator on each blower module is off.

Removing and Installing the Front Covers and Bezel Extenders on Original Cisco 12000 Series Routers

The chassis front covers for the power shelf and upper blower module, upper card cage, lower card cage, and lower blower module are fastened to the chassis by ball studs that insert into ball stud clips on the front of the chassis (Figure 7-1).

The partial front cover on the air filter door is fastened to the air filter door by four screws inserted from the back side of the air filter door. This partial front cover is referred to as the air filter door front cover.

Note   Recently released routers have bezel extenders installed on the front covers (bezels) for the upper and lower card cages to bring the covers out an additional 2 inches (50.8 mm) to allow more room for cables. If your chassis does not have these extenders and you want to purchase them, contact Cisco sales. (See the "Attaching Bezel Extenders to the Front Cover" section on page 7-6 if you are installing the bezel extenders.)

Removing the Front Covers

The front covers are held in place by ball studs that snap into clips on the chassis. Refer to Figure 7-1 and use the following procedure to remove the snap-on front covers.

Step 1   Grasp the outside edges of the upper blower module front cover and pull it straight out to detach the front cover from the chassis.

Step 2   Repeat Step 1 for the remaining front covers.

Installing the Front Covers

Refer to Figure 7-1 and use the following procedure to install the front covers.

Step 1   Hold the upper blower module front cover by its outside edges and align the ball studs with the ball stud clips on the front of the chassis.

Step 2   Push the front cover into the ball stud clips and the front cover is flush with the front of the chassis.

Step 3   Repeat Step 1 and Step 2 for the remaining front covers.

Figure 7-1   Router Chassis Front Covers
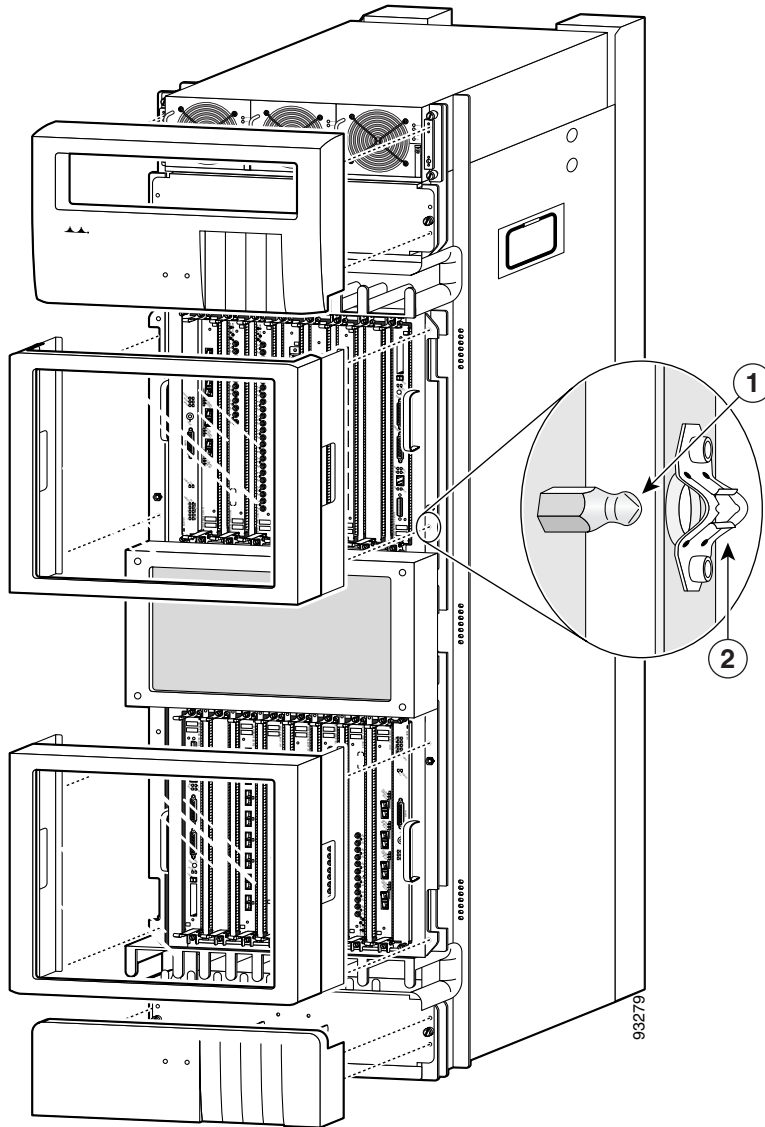
1	Ball stud	2	Ball stud clip

Attaching Bezel Extenders to the Front Cover

Use the following procedure to attach the bezel extenders to the card cage front cover.

Step 1 Remove the front covers from the chassis as described in the "Removing the Front Covers" section on page 7-3.

Step 2 Remove the four ball studs from the front cover.

Step 3 Screw the four ball studs into the threaded holes on the bezel extenders (two ball studs for each bezel extender) using a wrench to secure them (Figure 7-2, item 3).

⚠
Caution Do not overtighten the ball studs. Overtightening the ball studs could damage the threaded hole on the bezel extender.

Step 4 Attach the bezel extenders to the front cover:

a. Facing the inside of the front cover, align the screw holes in the left side bezel extender with the mounting screw holes in the front cover (Figure 7-2, item 4).

✎
Note If you cannot align both screw holes on the front cover inserts, you have the incorrect bezel extender. Try the other bezel extender on this side.

b. Fasten the bezel extender to the front cover with the mounting screws (Figure 7-2, item 2).

⚠
Caution Do not overtighten the screws. Overtightening the screws could damage the threaded holes in the front cover.

c. Repeat Steps **a** and **b** to fasten the right side bezel extender to the other side of the front cover (Figure 7-2, item 4).

Figure 7-2   Attaching the Bezel Extenders to a Card Cage Front Cover
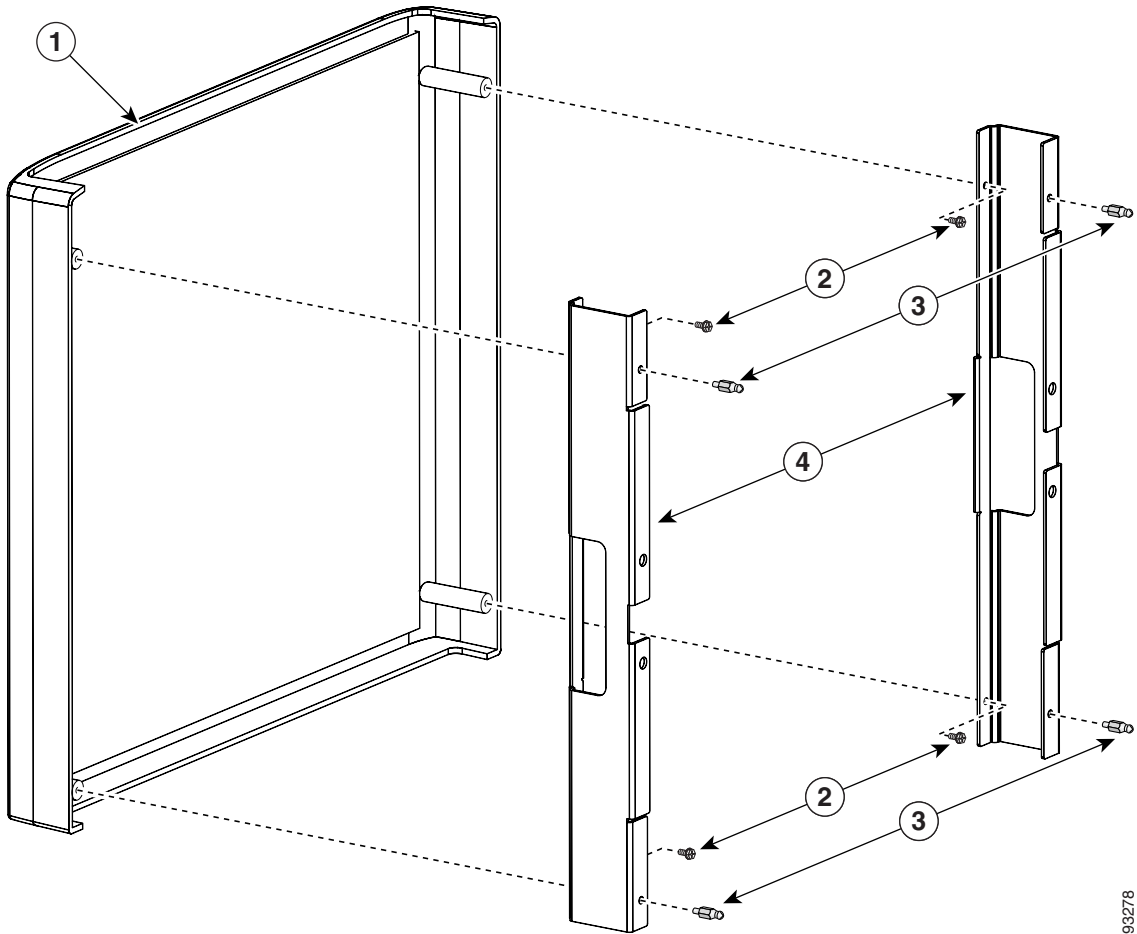
1	Line card and RP card cage front cover (bezel)	3	Ball studs
2	Mounting screws	4	Right and left side bezel extender

> **Step 5**   Hold the card cage front cover by its outside edges and align the ball studs with the ball stud clips on the front of the chassis (Figure 7-3).

Figure 7-3   Attaching the Front Covers Using Bezel Extenders
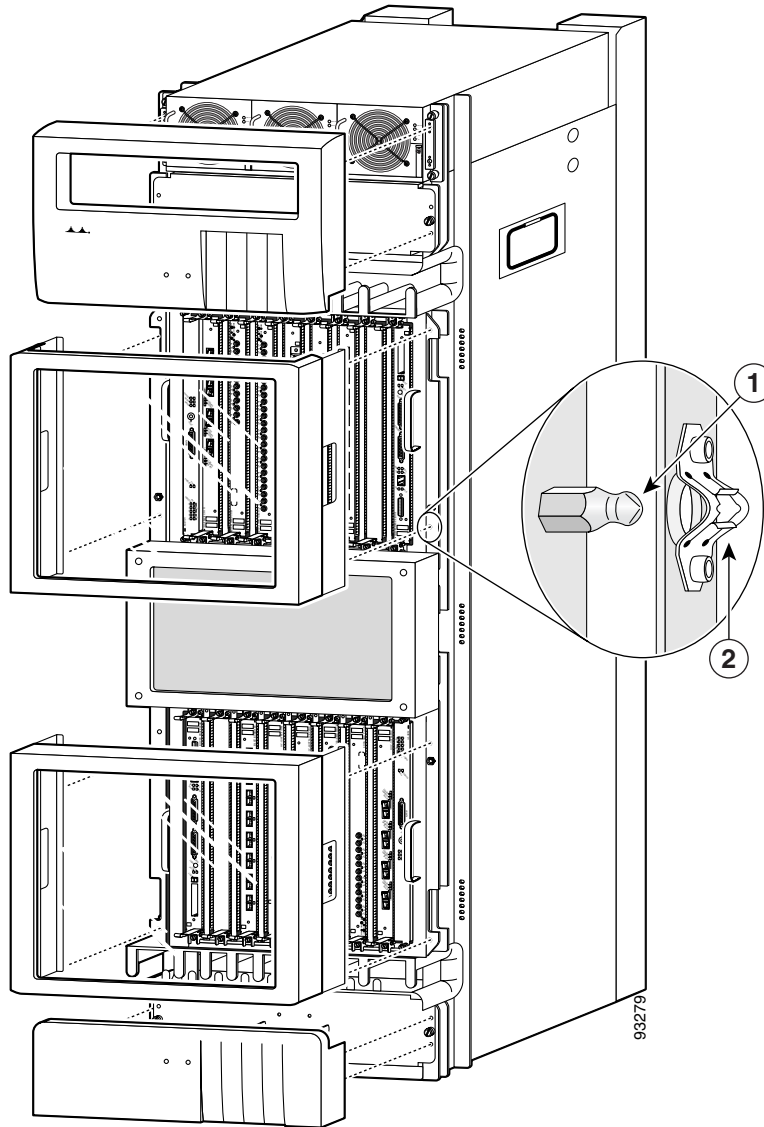
| **1** | Ball stud | **2** | Ball stud clip |

Step 6 Push the front cover into the ball stud clips so that the front cover is flush with the front of the chassis.

Removing and Replacing the Air Filter Door Front Cover

Use the following procedure to remove and replace the air filter door front cover.

Step 1 Loosen the captive screws on the air filter door and pivot the door open (Figure 7-4).

⚠

Caution If the router uses an extended front cover bezel, the air filter door does not have enough space to open completely. Before you open the air filter door, you must remove the extended front cover.

Figure 7-4   Opening the Chassis Air Filter Door
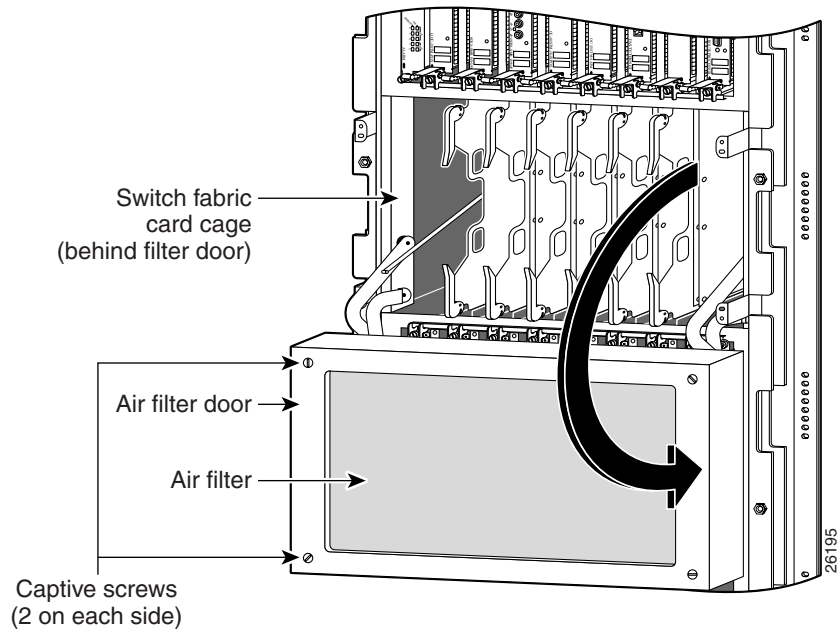
Caution Be especially careful not to damage the honeycomb screen on the back of the air filter door and on the inside of the switch fabric card cage. Damaging the honeycomb screen can restrict the air flow and cause overheating in the router. It can also diminish EMI protection.

Step 2   Remove the (4) screws from each corner that fasten the partial front cover to the air filter door (Figure 7-5).

- Set aside the screws; you will need them to install the replacement front cover.

Figure 7-5   Removing the Air Filter Door Front Cover
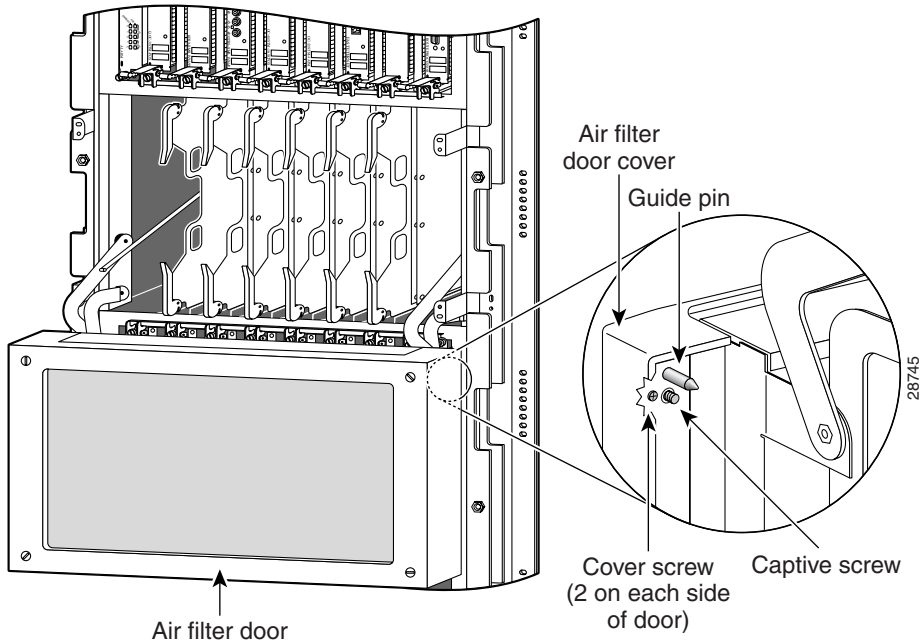
Step 3   Hold the replacement front cover by its outside edges and align the screw holes in the front cover with the holes on the air filter door.

Step 4   Secure the front cover to the air filter door using the (4) screws that you removed in Step 2.

⚠
Caution   Do not overtighten the screws. Overtightening the screws can damage the threaded holes in the air filter door.

Step 5   Close the air filter door and tighten the captive screws (Figure 7-6).

Figure 7-6   Closing the Air Filter Door
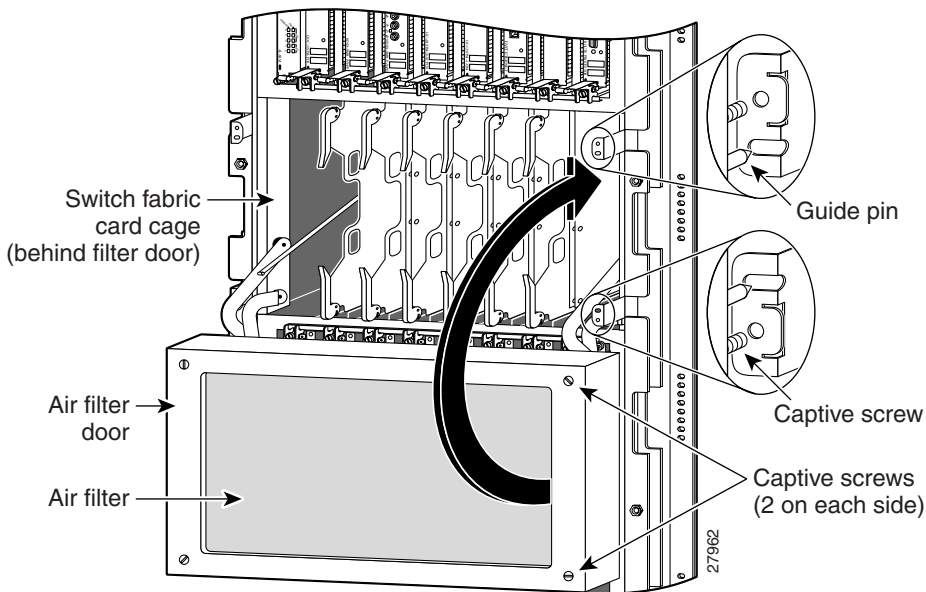
⚠
Caution   Align and seat the door carefully to avoid damaging the EMI-preventive gaskets on the door. The air filter door must be closed and secured at all times to maintain correct EMI performance.

Removing and Installing Front Doors on Cisco 12016 Enhanced Series Routers

The Cisco 12016 enhanced series routers have new front doors. The router ships with the door hinges mounted on the left side of the chassis so that they open from right-to-left. This section describes how to change the front doors to open from left-to-right by installing the hinges on the opposite side.

Use the following procedure to change the location of the hinges.

Note   The illustrations in this procedure show the top front door, but the procedure is the same for either the top or bottom door.

Step 1   Open the top front door by pressing the right latch button (Figure 7-7).

Figure 7-7   Opening the Front Door
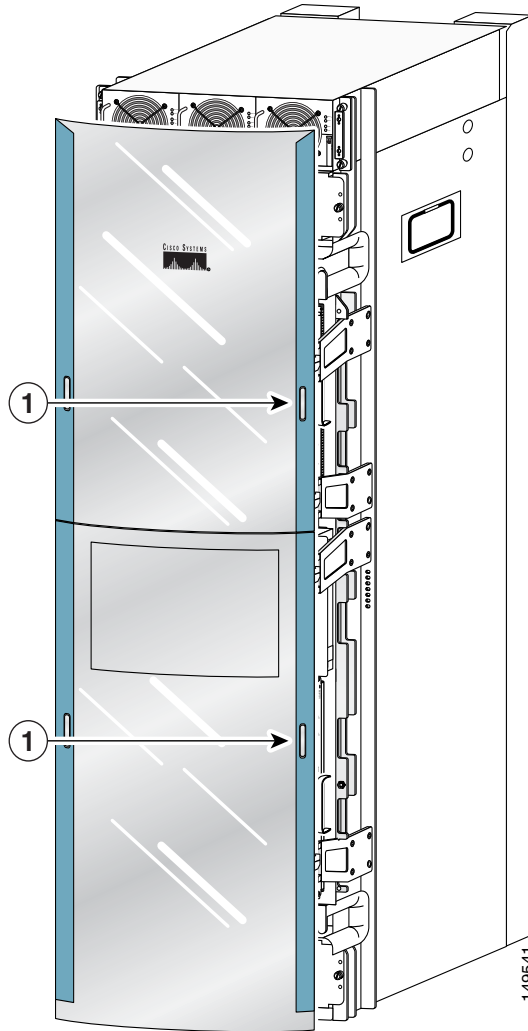
1	Front door latches

Step 2   Remove the front door by lifting the (top and bottom) hinge pins to free the door from the chassis (Figure 7-8).

⚠

Caution   Make sure you are holding the front door securely so it does not drop when you release it from the chassis.

Figure 7-8   ***Removing or Installing Hinge Pins***
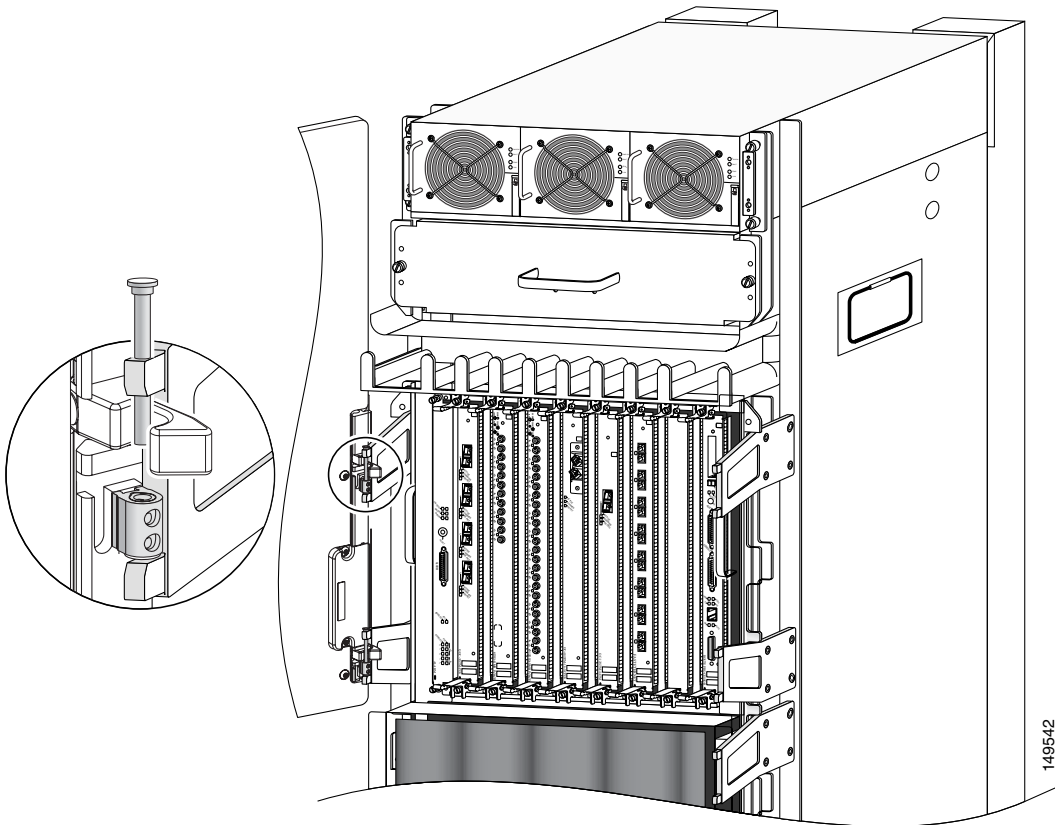
Reinstall the hinge pins into the chassis hinge brackets

Step 3 Remove the bumpers and pivot blocks from the door as shown in Figure 7-9.

Figure 7-9   Removing the Bumpers and Pivot Blocks

| 1 | Bumpers | 2 | Pivot blocks |
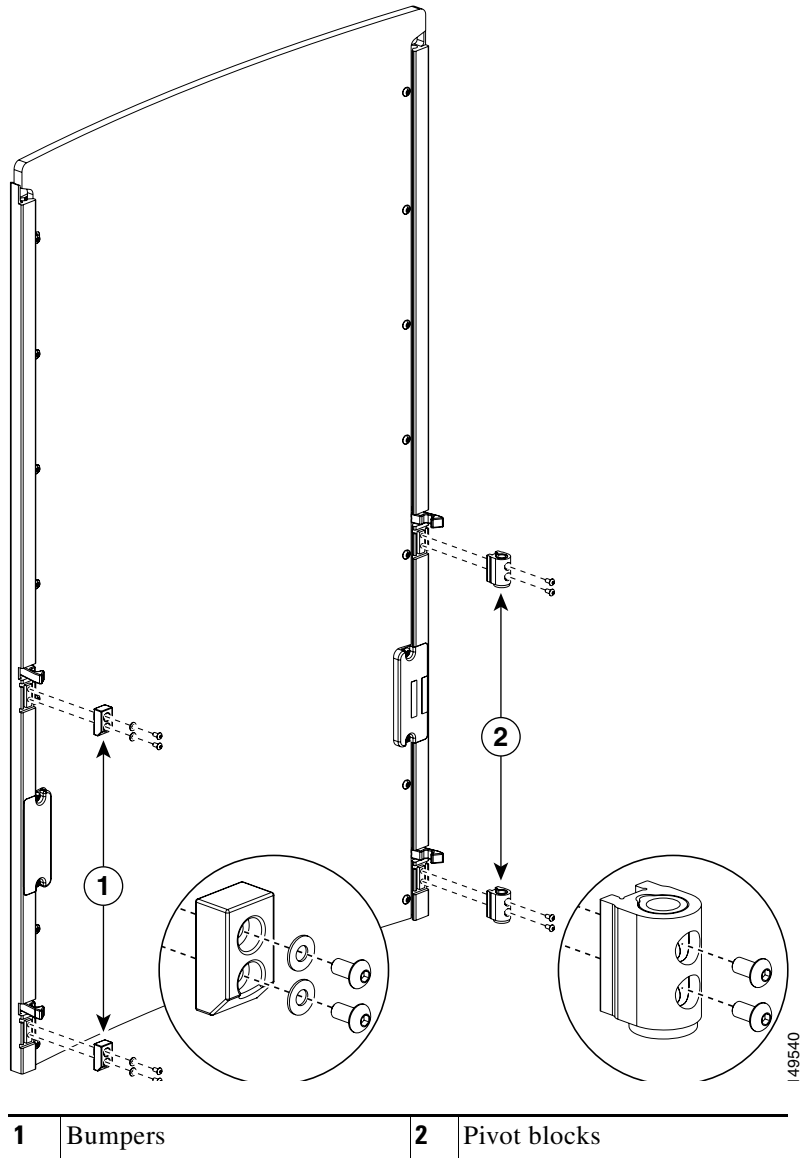
Step 4   Reinstall the hardware to the opposite sides of the front door:

    a. Mount pivot blocks to the left side and tighten the screws until snug.

    b. Mount the bumpers to the right side and tighten the screws until snug.

Step 5   Attach the front door to the chassis:

    a. Remove the hinge pins from the hinges on the right side of the chassis.

    b. Align the pivot blocks on the front door with the hinges on the right side of the chassis and install the hinge pins to hold the door in place (see Figure 7-8).

    c. Close the front door by pressing the latch button, allowing the door latch to engage with the hinge pins on the chassis.

Step 6   Repeat Step 1 through Step 5 for the bottom door.

Cleaning or Replacing the Chassis Air Filter

The Cisco 12016 series routers are equipped a user-serviceable air filter that removes dust drawn into the router. One time per month (or more often in dusty environments), examine the air filter for damage and cleanliness.

⚠

Caution   Damage to the air filter can restrict the airflow, cause overheating in the router, and degrade EMI performance. Be careful when cleaning and replacing the filter.

The following procedures describe how to replace the air filter on original series routers and enhanced series routers.

- Cleaning or Replacing the Chassis Air Filter on Cisco 12016 Original Series Routers, page 7-18
- Cleaning or Replacing the Chassis Air Filter on Cisco 12016 Enhanced Series Routers, page 7-22

Cleaning or Replacing the Chassis Air Filter on Cisco 12016 Original Series Routers

Use the following procedure to clean or replace an original series air filter.

Step 1 Loosen the captive screws on the air filter door and pivot open the door (Figure 7-10).

⚠️

Caution If the router uses an extended front cover bezel, the air filter door does not have enough space to open completely. Before you open the air filter door, you must remove the extended front cover.

Figure 7-10   Opening the Chassis Air Filter Door

Switch fabric
card cage
(behind filter door)

Air filter door

Air filter

Captive screws
(2 on each side)

26195
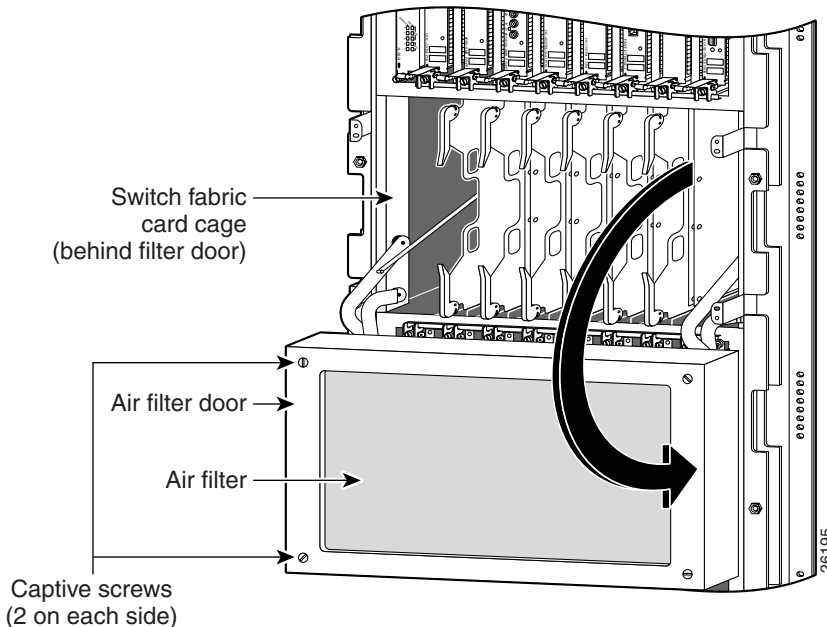
Step 2   Lift up the air filter and carefully slide it out the door (Figure 7-11).

⚠

Caution   Be careful not to damage the honeycomb screens on the back of the
air filter door and in the fabric card cage. Damage to the honeycomb
screens can restrict airflow, cause overheating, and affect EMI
performance.

Figure 7-11   Removing the Chassis Air Filter
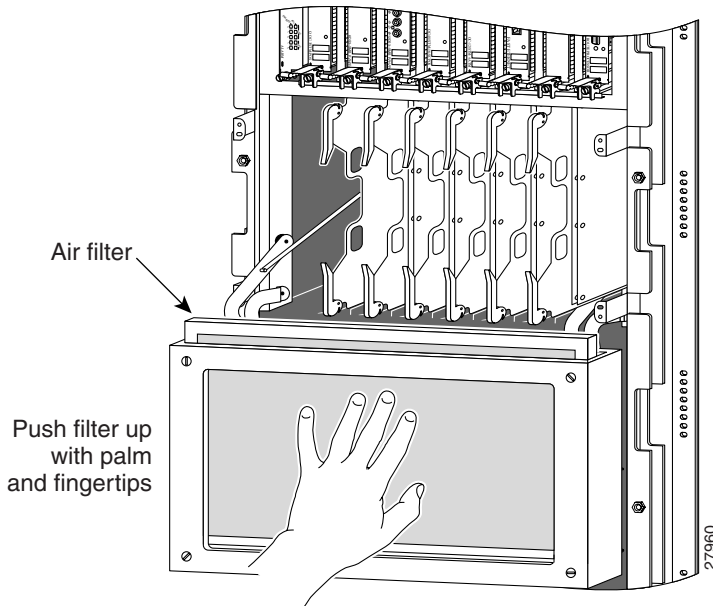
Air filter

Push filter up
with palm
and fingertips

27960

Step 3   Visually check the condition of the air filter to determine whether to clean it or install a new replacement.

- Dirty—You can vacuum or replace the filter.

⚠️
Caution   Do not vacuum the air filter while it is installed in the chassis. You must remove the air filter completely before you clean it to prevent contaminants from being drawn into the bays or cage.

- Worn or torn—If the filter appears worn or torn, dispose of it in a responsible manner and install a replacement air filter (ACS-GSR16-FLTR=).

Step 4   Position the metal braces on the back of the air filter to face toward the switch fabric and alarm card cage. Slide the new or cleaned air filter into the air filter door (Figure 7-12).

Figure 7-12   Installing the Chassis Air Filter

Air filter
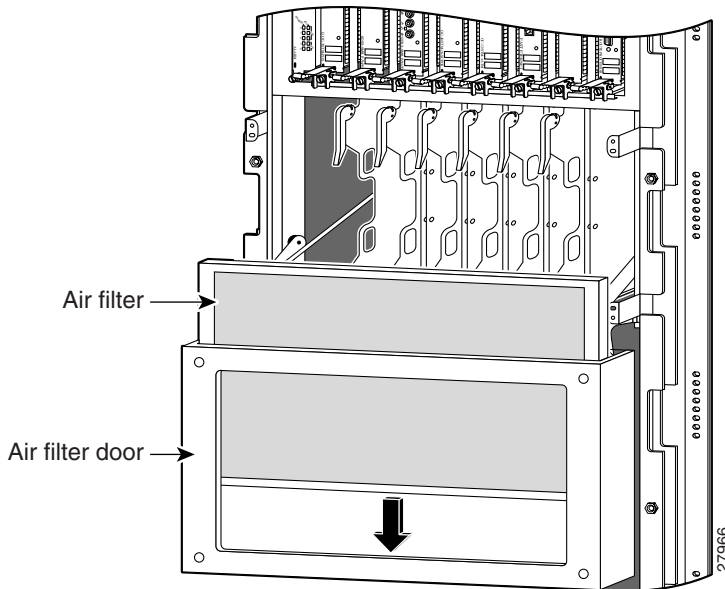
Air filter door

Step 5   Lift up the air filter door so that the four guide pins are inserted in the corresponding holes on each side of the switch fabric card cage (Figure 7-13).

⚠
Caution   Align and seat the door carefully to avoid damaging the EMI-preventive gasket contacts on the door.

Figure 7-13   Closing the Chassis Air Filter Door
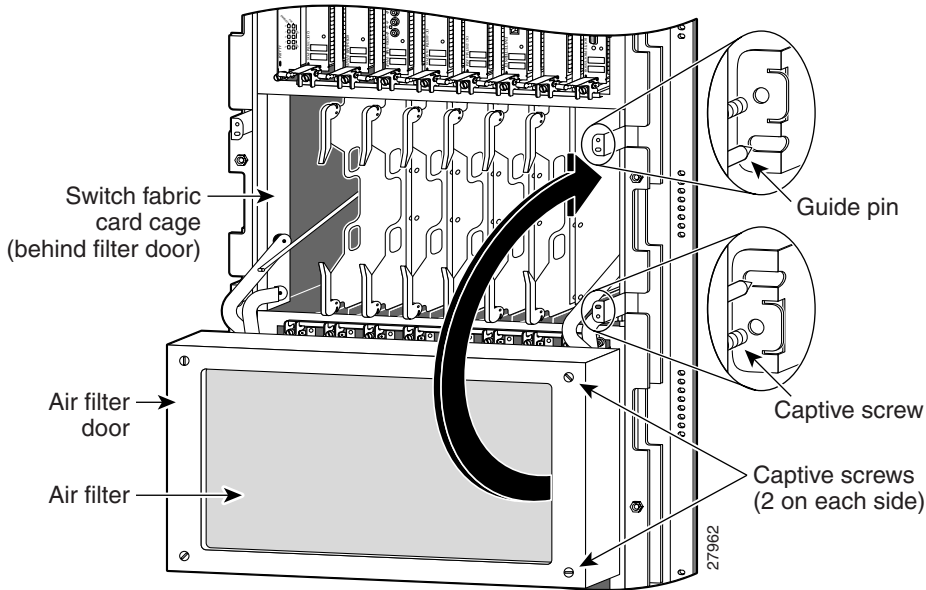
Step 6   Tighten the captive screws to secure the door to the chassis.

⚠
Caution   The air filter door must be closed and secured at all times to maintain correct EMI performance.

Cleaning or Replacing the Chassis Air Filter on Cisco 12016 Enhanced Series Routers

Use the following procedure to clean or replace the enhanced series air filter.

Step 1   Loosen the 4 captive screws on the air filter door and pivot the door open (Figure 7-10).

Figure 7-14   Opening the Chassis Air Filter Door
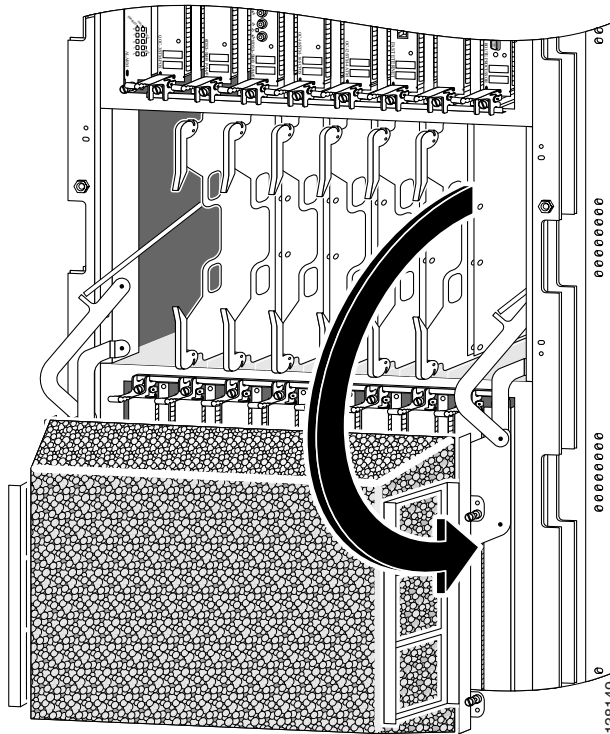
Step 2   Lift up the air filter and carefully slide it out of the door (Figure 7-11).

⚠️

Caution   Be careful not to damage the honeycomb screens on the back of the
air filter door and in the fabric card cage. Damage to the honeycomb
screens can restrict airflow, cause overheating, and affect EMI
performance.

Figure 7-15   Removing the Chassis Air Filter
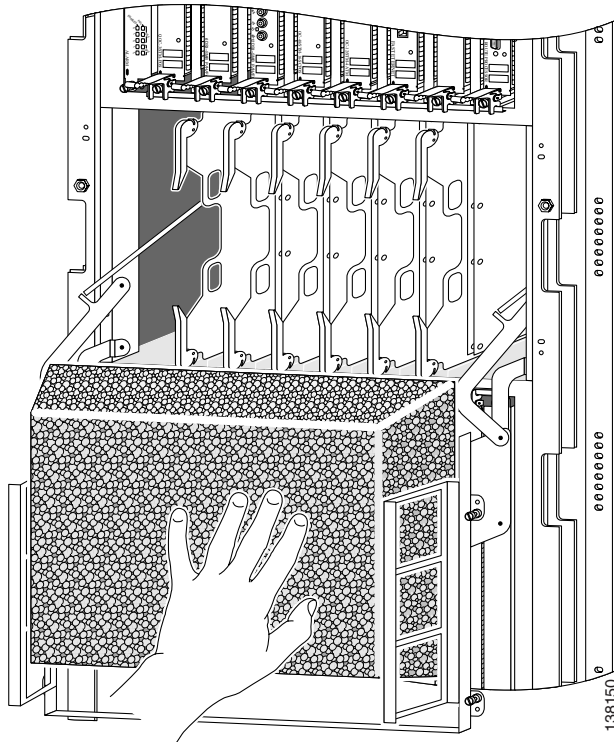
138150

Step 3   Visually check the condition of the air filter to determine whether to clean it or install a new replacement.

- Dirty—You can vacuum or replace the filter.

⚠️

Caution   Do not vacuum the air filter while it is installed in the chassis. You must remove the air filter completely before you clean it to prevent contaminants from being drawn into the bays or cage.

- Worn or torn—If the filter appears worn or torn, dispose of it in a responsible manner and install a replacement air filter (12000/16-FILTER=).

Step 4   Slide the new or cleaned air filter into the air filter door.

Step 5   Close the air filter door and tighten the 4 captive screws.

⚠️

Caution   Align and seat the door carefully to avoid damaging the EMI-preventive gasket contacts on the door. The air filter door must be closed and secured at all times to maintain correct EMI performance.

Removing and Replacing Blower Modules

The illustrations in this procedure represent both the original and newer enhanced capacity blower modules for Cisco 12016 series routers. Depending on your system, these components may not look *exactly* like those in your chassis, but the removal and replacement procedures are essentially the same.

There are currently two types of blower modules in use for the Cisco 12016 series routers; blowers that shipped with original systems, and enhanced capacity blowers that ship with current systems.

If you are replacing an:

- Original blower module (GSR16-BLOWER=)—Use an original blower module *or* enhanced capacity blower modules as replacements.

- Enhanced capacity blower module (12000/10/16-BLWER=)—Use an enhanced capacity blower module as a replacement.

✎

Note If you upgraded your router with a power supply upgrade kit (2500 W AC or 2400 W DC PEMs) and your system is required to meet NEBS extended temperature range requirements, you must install the enhanced capacity blower module (12000/10/16-BLWER=) to meet those requirements.

⚠

Caution You cannot mix original and enhanced capacity blower modules in the same chassis. Both the upper and lower blower modules must be identical.

The blower modules support online insertion and removal (OIR), so you can remove and install a blower module while the system remains powered on without presenting an electrical hazard or damage to the system. You can replace a blower module while the system maintains all routing information and ensures session preservation.

⚠

Caution Although the blower module supports OIR and can be replaced without interruption to system operation, the system should not operate without a blower module for more than 3 minutes to prevent overheating.

Upper and Lower Blower Module Orientation

Illustrations in this procedure show the removal and replacement of the upper blower module. The procedure to replace the lower blower module is the same *except for the orientation of the blower module*.

- Heads-up orientation—Install the blower module in the upper bay in the "heads-up" orientation with the three fan air intake openings face down.

- Heads-down orientation—Install the blower module in the lower blower module bay in the "heads-down" orientation with the three fan air intake openings face up.

Use the following procedure to remove and replace the blower modules.

Step 1   Remove the blower module from the chassis (Figure 7-16):

a. Loosen the captive screw on each side of the blower module.

b. Pull out the blower module halfway from the module bay.

c. Slide out the blower module completely from the module bay while supporting it with your other hand.

⚠️
Warning   **The blower module weighs approximately 20 pounds (9 kg). Use two hands when handling the blower module.**

Figure 7-16   Removing the Upper Blower Module
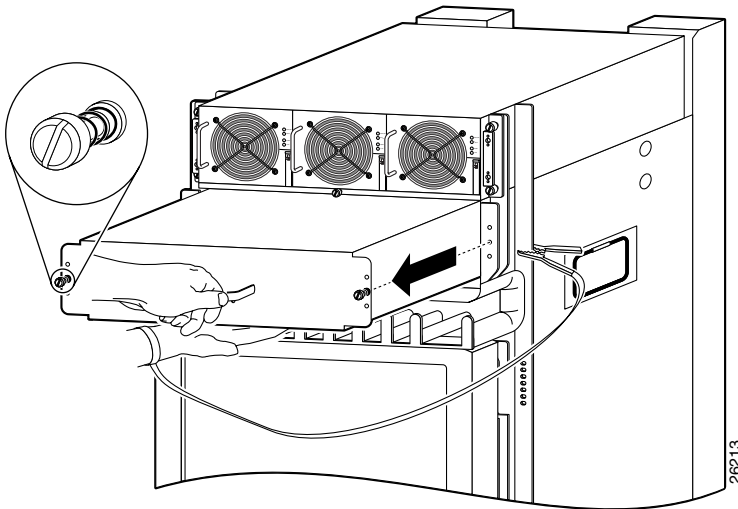
Step 2   Install the new blower module into the chassis (Figure 7-17):

    a.   Lift the blower module (with two hands) and slide it halfway into the module bay.

    b.   Slowly push the blower module into the chassis until it mates with the backplane connector at the back of the module bay.

⚠

Caution   To prevent damage to the connectors, do not use excessive force when inserting the blower module into the chassis.

    c.   Tighten the captive screws on the blower module to secure it to the chassis.

    •   The (green) OK status indicator on the front of the blower module should light. If the OK indicator does not light, see the "Troubleshooting the Blower Installation" section on page 7-28.

Figure 7-17   Installing the Upper Blower Module
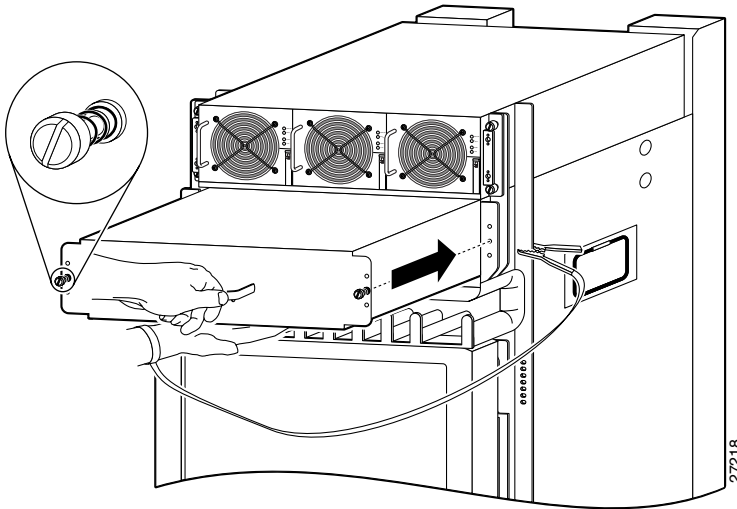
Troubleshooting the Blower Installation

Use the following procedure to troubleshoot a blower module if it is not operating properly after installation.

Step 1   Be sure the router is powered on and that all power cords are connected properly.

Step 2   Loosen the captive screws and reseat the blower module to the chassis.

- Retighten the captive screws to ensure the blower module is properly seated to the backplane connector.

Step 3   Check the blower module status indicators:

- OK (green)—Indicates that the blower module is operating normally. This indicator should light as soon as the blower module is installed and receives power from the backplane connector.

    - If this indicator remains on, and the blower module fans fail to operate after several attempts to reseat the blower module, replace it with a spare.

    - If the spare blower module also fails, power off the router and contact a Cisco service representative for assistance.

- FAIL (red)—During normal operation, this indicator remains off. If this indicator is on, the system has detected a fan failure or other fault in the blower module.

    - If this indicator remains on, and the blower module fans fail to operate after several attempts to reseat the blower module, replace it with a spare.

    - If the spare blower module also fails, power off the router and contact a Cisco service representative for assistance.

Removing and Replacing AC and DC Power Subsystem Components

This section contains removal and replacement procedures for the AC and DC power systems used with the Cisco 12016, Cisco 12416, and Cisco 12816 series routers. If you ordered an upgrade kit, you can use these same procedures to upgrade all of the power system components.

The illustrations in this procedure represent both original and upgraded power supplies and power shelves shipping with the Cisco 12016 series routers. Depending on your system, these components may not look *exactly* like those in your chassis, but the removal and replacement procedures are essentially the same. Multiple illustrations are presented to represent original and new models where appropriate.

The following tools and equipment are required to remove and install power equipment:

- Number 1 Phillips screwdriver
- 3/16-inch flat-blade screwdriver
- An ESD-preventive wrist strap

Installation Guidelines

The Cisco 12016 series routers support online insertion and removal (OIR). If you are replacing a redundant power supply, you can remove and install the power supply while the system remains powered on without causing an electrical hazard or damage to the system. This feature enables you replace a power supply while the system maintains all routing information and ensures session preservation.

However, to maintain operational redundancy, proper cooling, and meet EMI compliance standards, you must have all three (standard) or four (optional) working power supplies installed. When you remove a failed power supply with the router in operation, perform the replacement as quickly as possible. Make sure you have the tools and the replacement power supply ready before beginning the removal and installation procedure.

Power Supply and Power Shelf Compatibility

Cisco 12016 series routers are available with either an AC or a DC power supply system. Two types of power supplies are available for these systems:

- Original power supplies (rated at 2000 W)—Shipped with original systems

- Upgraded replacement power supplies (rated at 2500 W AC or 2400 W DC)—Ships currently

Removal and replacement procedures are the same for either type of power supply, but because of their capacity and physical differences, you cannot mix different types of power supplies within the same power shelf.

⚠️
Caution   Newer power supplies (AC and DC) require upgraded power shelves. You cannot install a new power supply using the original power shelf. If you are replacing an older power supply with a new unit, you must replace *all* of the power supplies *and* the power shelf.

Before you attempt to install or replace them, be sure you know the power supplies and associated power shelf your system has (Table 7-1).

Table 7-1   Original and Replacement Components

Original Component	Replacement Component
AC Power Shelf (PWR-GSR16-AC-SH=)	**AC Power Shelf (12000/16-AC-SHELF=)**
Compatible only with 2000 W AC power supplies. Do not use with newer, 2500 W power supplies.	Compatible only with newer, 2500 W AC power supplies. Do not use with older, 2000 W power supplies.
Optional AC Power Shelf (PWR-GSR16-AC4-SH=)	**Optional AC Power Shelf (12000/16-AC4-SHLF=)**
Compatible only with 2000 W AC power supplies. Do not use with newer, 2500 W power supplies.	Compatible only with newer, 2500 W AC power supplies. Do not use with older, 2000 W power supplies.

Table 7-1   Original and Replacement Components

Original Component	Replacement Component
AC Power Supply (PWR-GSR16-AC=)	**AC Power Supply (12000/16-AC-PWR=)**
Use to replace original 2000 W AC power supplies only. All power supplies in the power shelf must be 2000 W. Do not mix with newer, 2500 W power supplies.	Used to replace existing AC power supplies. All power supplies in the power shelf must be 2500 W. Do not mix with older, 2000 W power supplies. **Caution:** 2500 W AC power supplies require new power shelves (GSR16-SHLF-AC= or GSR16-SHLF-AC4=).
DC Power Shelf (PWR-GSR16-DC-SH=)	**DC Power Shelf (12000/16-DC-SHELF=)**
Compatible only with 2000 W DC PEMs. Do not use with newer, 2400 W PEMs.	Compatible only with newer, 2400 W DC PEMs. Do not use with older, 2000 W PEMs.
DC Power Supply (PWR-GSR16-DC=)	**DC Power Supply (12000/16-DC-PWR=)**
Use to replace original 2000W DC PEMs only. All PEMs in the power shelf must be 2000 W. Do not mix with newer, 2400 W PEMs.	Used to replace existing DC power supplies. All PEMs must be 2400 W. Do not mix with older, 2000W PEMs. **Caution:** 2400 W DC PEMs require new power shelves (GSR16-SHLF-DC=).

Installing Upgrade Kits

When installing a power system upgrade kit, you replace the following components:

- AC power upgrades (12000/16-AC-UP=, 12000/16-AC4-UP=):
    - Power supplies (Removing and Replacing an AC Power Supply, page 7-33).
    - Standard power shelf (Removing and Replacing the Standard AC-Input Power Shelf, page 7-44) or optional power shelf (Removing and Replacing the Optional 2-Level AC-Input Power Shelf, page 7-51)

- DC power upgrade (12000/10-DC-UP=):
    - Power supplies (Removing and Replacing a DC PEM, page 7-60)
    - Power shelf (Removing and Replacing the DC-Input Power Shelf, page 7-68)

⬧

Note   A blower upgrade (not included in the power upgrade kit) is also required to meet NEBS extended temperature range requirements. To order the blower upgrade (12000/10/16-BLWER=), contact your Cisco representative.

Removing and Replacing an AC Power Supply

This section provides the procedure to remove an AC power supply from the standard single-level AC power shelf. The procedure to remove an AC-input power supply from the optional double-level AC-input power shelf are identical to these; only the slot locations for AC-input power supplies are different. Figure 7-18 shows AC power shelves housing original series 2000 W power supplies.

Figure 7-18   Standard and Optional AC Power Shelves
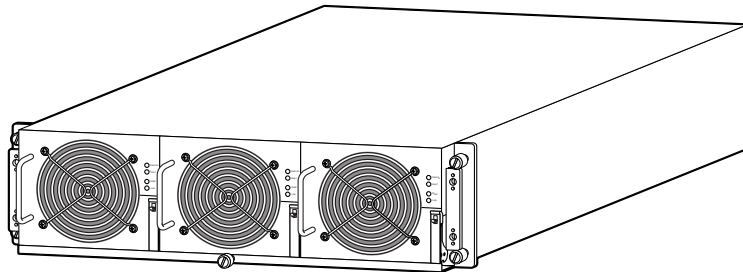
(a) Standard AC-input power shelf
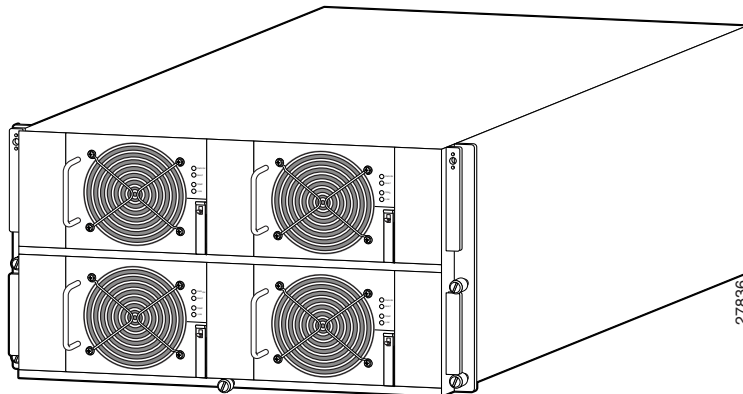
(b) Optional AC-input power shelf

Figure 7-19 identifies the components of a 2000 W AC power supply.

Figure 7-19   2000 W AC Power Supply Components
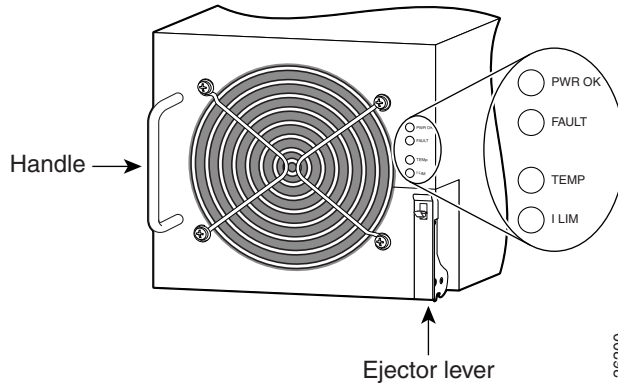
Figure 7-20 identifies the components of a 2500 W AC power supply.

Figure 7-20   2500 W AC Power Supply Components
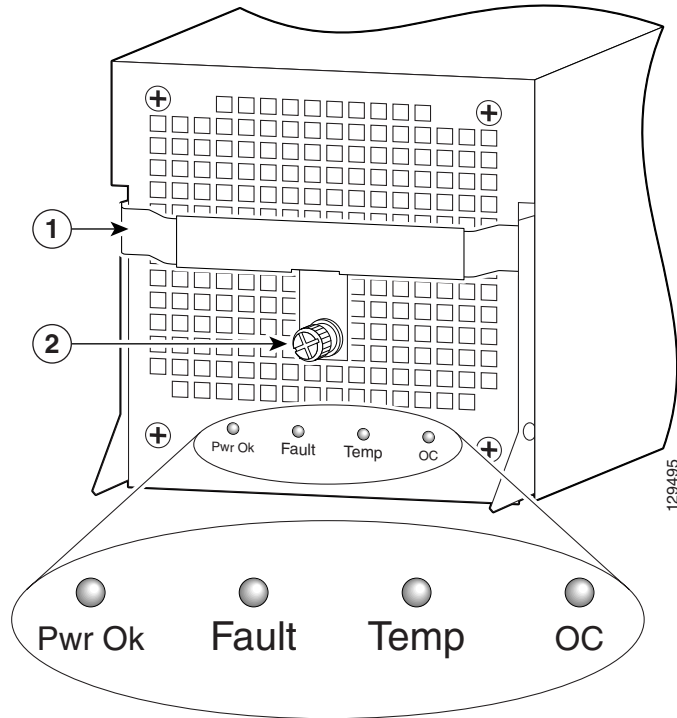
| **1** | Ejector handle | **2** | Captive screw |

To remove and replace an AC power supply, use the following procedure.

⚠️

Caution   You cannot mix power supply types within the chassis. If you plan to replace a 2000 W power supply from an original system with a newer, 2500 W power supply, you must replace all of the power supplies and the power shelf (see Table 7-1 on page 7-30). You must shut down the router to perform the upgrade. Be sure to notify the appropriate personnel that all routing traffic will stop while the upgrade takes place.

Step 1   Unplug the power supply cord from its AC outlet.

Step 2   Power off the circuit breaker assigned to that AC outlet.

⚠️

Warning   **To ensure that power remains off while you are performing this procedure, tape the circuit breaker switch in the off (0) position.**

Step 3   Remove the power supply from the power shelf.

- For 2000 W PEM—Go to Step 4.
- For 2500 W PEM—Go to Step 5.

Step 4 Remove the 2000 W PEM (Figure 7-21):

    a. Release the ejector lever by lifting the spring clip.

    b. Pivot the lever down to eject the power supply from its backplane connector.

    c. Slide the power supply out of its bay while supporting it with your other hand.

⚠

Caution   The power supply weighs approximately 12 pounds (5.4 kg). Use two hands when handling the power supply.

Figure 7-21   Removing a 2000 W AC Power Supply
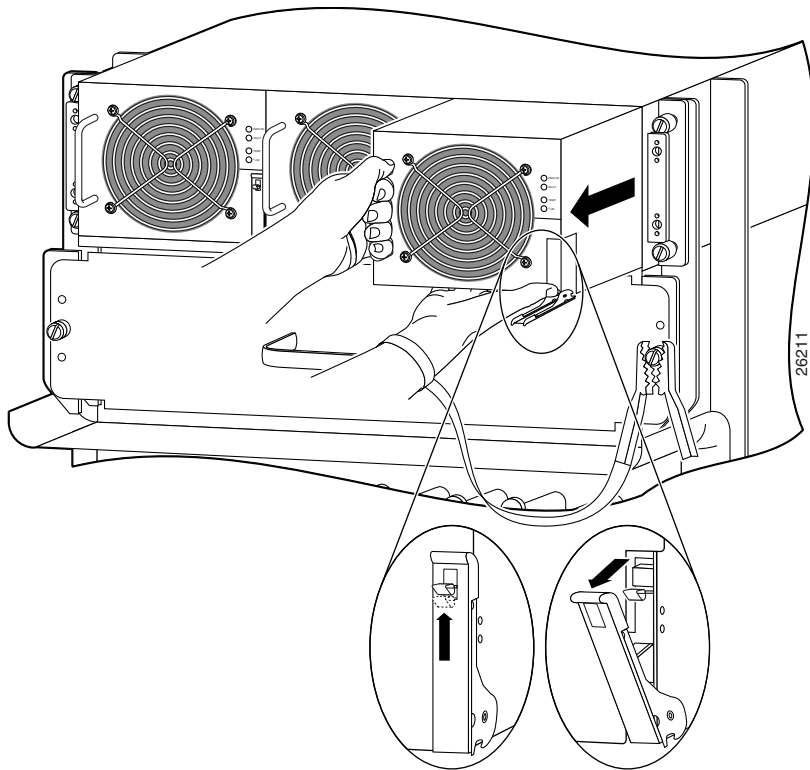
Step 5 Remove the 2500W PEM (Figure 7-22):

    a. Loosen the captive screw to release the ejector handle.

    b. Pivot the ejector handle down to eject the power supply from its backplane connector.

    c. Slide the power supply out of its bay while supporting it with your other hand.

Figure 7-22   Removing a 2500 W AC Power Supply
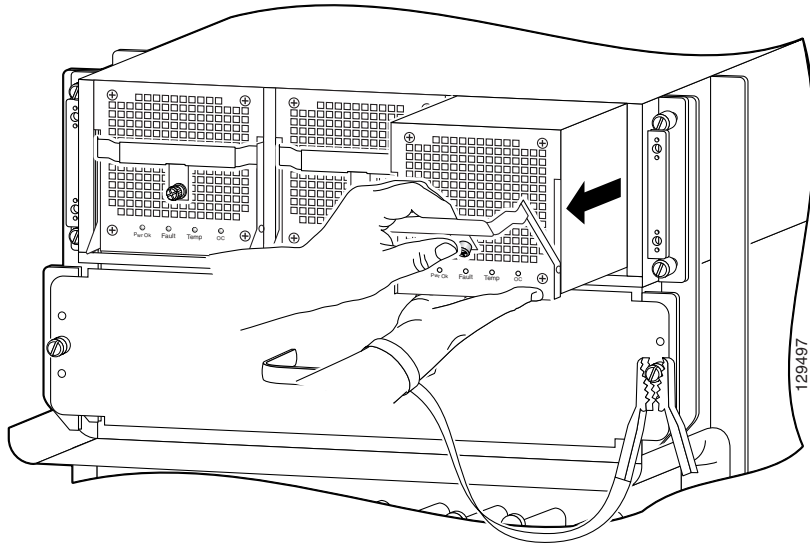
Step 6 Install the power supply:

    • For 2000 W PEM—Go to Step 7.

    • For 2500 W PEM—Go to Step 8.

Step 7 Install the 2000W PEM (Figure 7-23):

    a. Slide the power supply into the bay until it mates with its backplane connector.

⚠

Caution To prevent damage to the power shelf backplane connector, do not use excessive force when inserting the power supply into its power shelf bay.

    b. Lift up the ejector lever to hook it over the bottom edge of the power shelf.

    c. Pivot the ejector lever until it is flush with the power supply and the spring clip locks the lever in place.

⚠

Caution If the spring clip does not lock the lever in place, the power supply is not completely seated. Eject the power supply and push it in firmly to reseat it.

Figure 7-23   Installing a 2000 W AC Power Supply
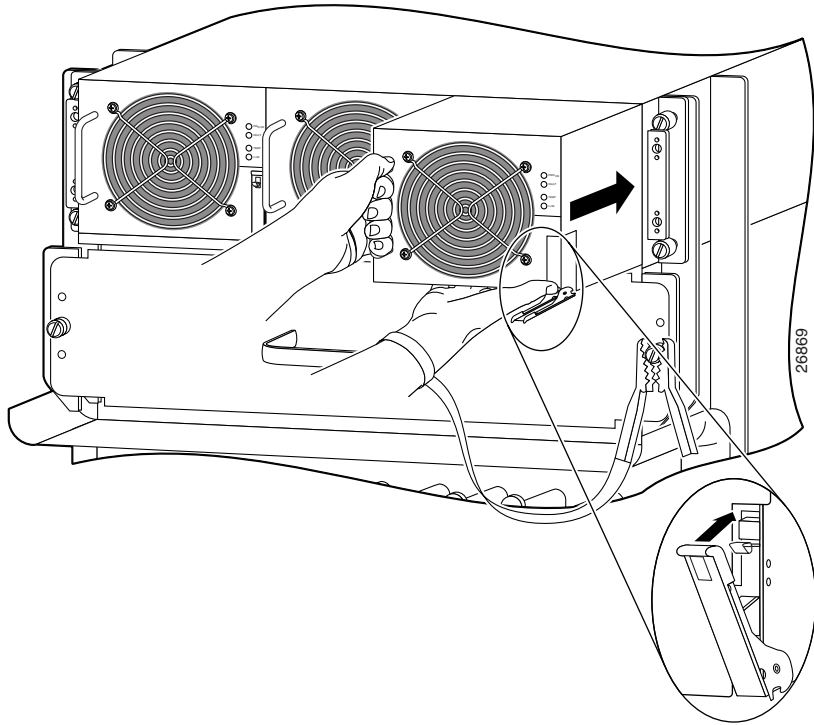
Step 8   Install the 2500 W power supply (Figure 7-24):

    a.   Slide the power supply into the bay until it mates with its backplane connector.

⚠

Caution   To prevent damage to the power shelf backplane connector, do not use excessive force when inserting the power supply into its power shelf bay.

    b.   Lift up the ejector handle to hook it over the bottom edge of the power shelf.

    c.   Tighten the captive screw to secure the power supply in the shelf.

Figure 7-24   Installing a 2500 W AC Power Supply
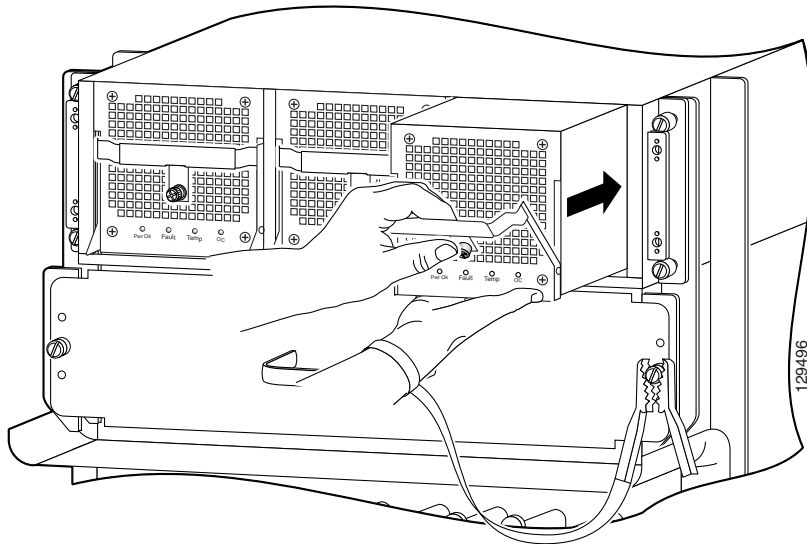
Step 9   Plug the power supply cable into its AC outlet.

Step 10   Power on the circuit breaker to that AC outlet.

After the power-on sequence completes, the (green) PWR OK indicator on the front of the power supply should light. If the indicator does not light, see the "Troubleshooting the AC Power Supply Installation" section on page 7-42.

Troubleshooting the AC Power Supply Installation

Use the following procedure to troubleshoot the AC power supply if it is not operating properly after installation.

Step 1   Make sure the power supply is seated properly as follows:

- Eject and reseat the PEM.
- The ejector lever is locked into place by its spring clip.

Step 2   Make sure the router is powered on and that all power cords are connected properly:

- Power cords on the back panel of the power shelf are secured in place with their retention clips.
- Power cords at the power source end are securely plugged into their own AC power outlet.
- The source AC circuit breaker is switched on.

Step 3   Check the power supply status indicators:

- PWR OK (green)—Indicates the power supply is operating normally, and the source AC voltage is within the nominal operating range of 200 VAC to 240 VAC. This indicator lights when the power supply is properly seated in position.
- FAULT (yellow)—Indicates the system detected a fault within the power supply or the incoming voltage is too low. During normal operation, this indicator remains off.

    If the indicator is on:

    – Check that the source voltage is within the correct range: 170 to 262 VAC
    – Remove and then apply power to the power supply by disconnecting its power cord. If the indicator remains on, replace the existing power supply with a spare.
    – If the spare power supply also fails, the problem could be a faulty power shelf backplane connector. Power off the router and contact a Cisco service representative for assistance.

- TEMP (yellow)—Indicates that the power supply is in an overtemperature condition, causing a shut-down to occur.

  Note If the temp indicator is on, the fault indicator also goes on.

  - Verify that the power supply fan is operating properly.
  - Verify that the blower modules are operating properly.
  - If the power supply fan and blower modules are operating properly, replace the existing power supply with a spare.

- TEMP (flashing yellow—2500 W PEM only)—Indicates that a power supply fan is locked or malfunctioning.

  Note If the temp indicator is flashing, the fault indicator also goes on.

  - Check to see if the fan is operating. Remove any obstructions to the fan.
  - If the fan is not operating, replace the power supply.

- ILIM (2000 W PEM only) (yellow)—Indicates the power supply is operating in a current-limiting condition.

  - Each power cord should be connected to a dedicated AC power source. Each AC power supply operating in the nominal range of 200 to 240 VAC requires a minimum service of 20 A, North America (or 13 A, international).

- OC (2500 W PEM only) (steady, or flashing yellow after 10 seconds)—Indicates the output current of the power supply has exceeded its limit and that an overload or short circuit has occurred.

✎
Note   If the OC indicator is on or flashing, the fault indicator also goes on.

   – Remove and then apply power to the power supply by disconnecting its power cord.
   – If the indicator remains on, try reseating the power supply.
   – If the indicator remains on, replace the power supply.

Removing and Replacing the Standard AC-Input Power Shelf

Use the following procedure to remove and replace the standard AC-input power shelf.

⚠
Caution   To remove and replace the power shelf, the system must be powered off. Be sure to notify the network administrator and other appropriate personnel that all routing traffic stops while the upgrade takes place.

⚠
Caution   If you are upgrading to a new power shelf, you cannot use old power supplies. You must upgrade to newer, 2500 W power supplies (see Table 7-1 on page 7-30).

Step 1   Remove all of the power supplies as described in "Removing and Replacing an AC Power Supply" section on page 7-33.

Step 2 Disconnect each of the AC power cords from the back panel of the power shelf by lifting the retention clip and unplugging the cord (Figure 7-25).

Figure 7-25   Disconnecting AC Power Cords
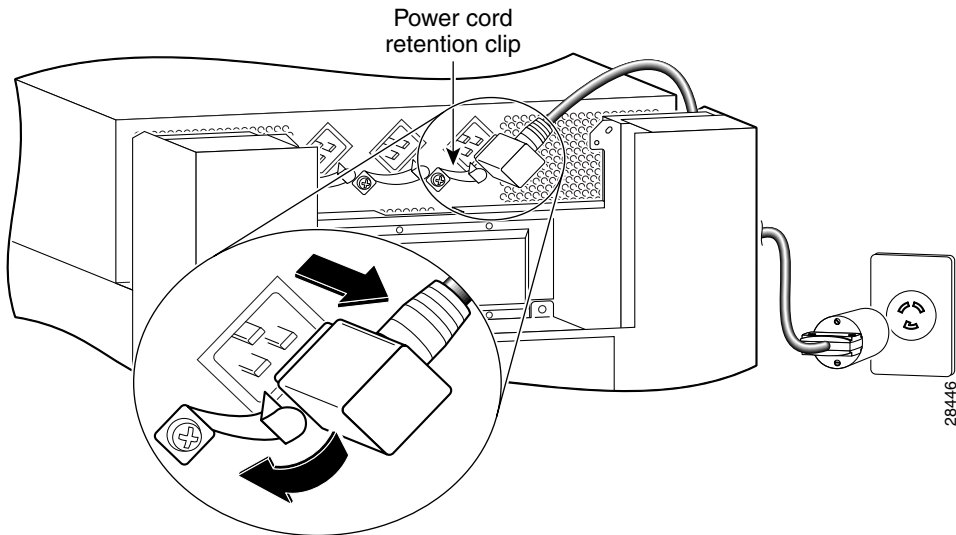
Step 3   Unseat the power shelf from the chassis (Figure 7-26):

    a.   Loosen the two captive screws on each side of the power shelf.

    b.   Loosen the ejector jackscrew to unseat the power shelf from the power interface panel connectors.

Figure 7-26   Unseating the Power Shelf
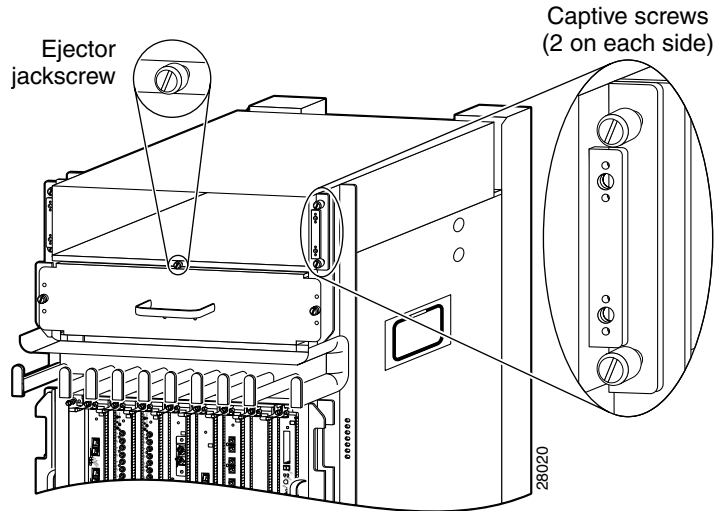
Step 4   Remove the power shelf by grasping the flanges on each side and slowly pulling the shelf along the chassis track to remove it (Figure 7-27):

⚠️

Warning   **The AC-input power shelf weighs approximately 21 pounds (9.5 kg). Use two hands to remove the power shelf.**

Figure 7-27   Removing the AC-Input Power Shelf

Track on chassis
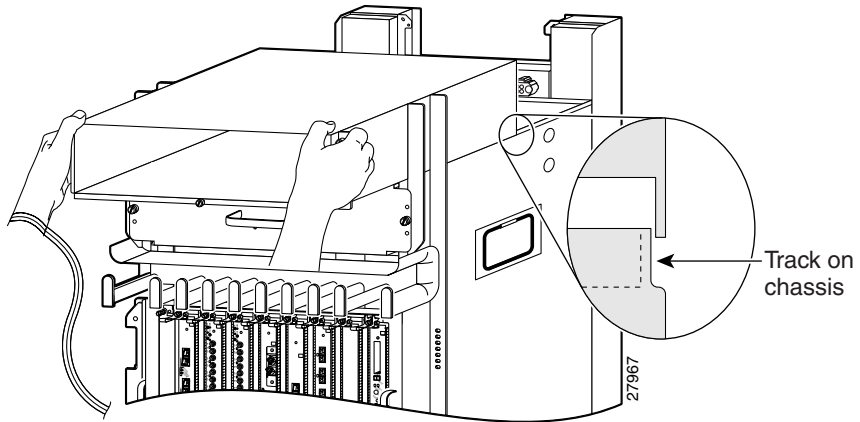
Step 5   Insert the new power shelf halfway into the chassis.

Step 6   Connect the power shelf to the chassis power interface panel connectors (Figure 7-28):

    a.   Be sure the holes on each side of the power shelf are aligned with the guide pins on each side of the chassis.

    b.   Carefully slide the power shelf into place until its two connectors just mate with the power interface panel connectors.

⚠

Caution   To prevent damage to the interface connectors, do not use excessive force when inserting the power shelf into the chassis.

Figure 7-28   Connecting the AC-Input Power Shelf
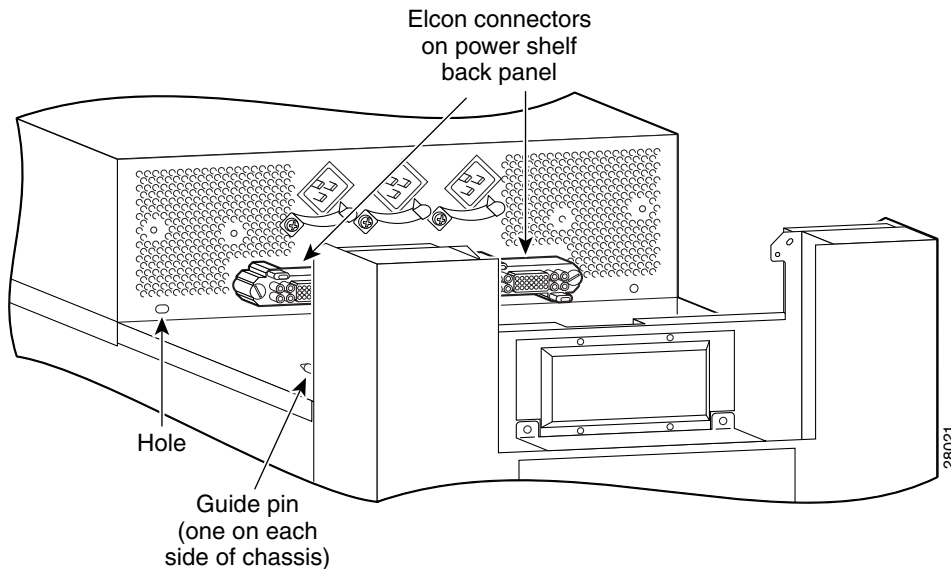
Step 7   Seat the power shelf to the chassis (Figure 7-29):

    a.   Tighten the ejector jackscrew.

    b.   Tighten the captive screws on each flange.

Figure 7-29   Seating the Power Shelf
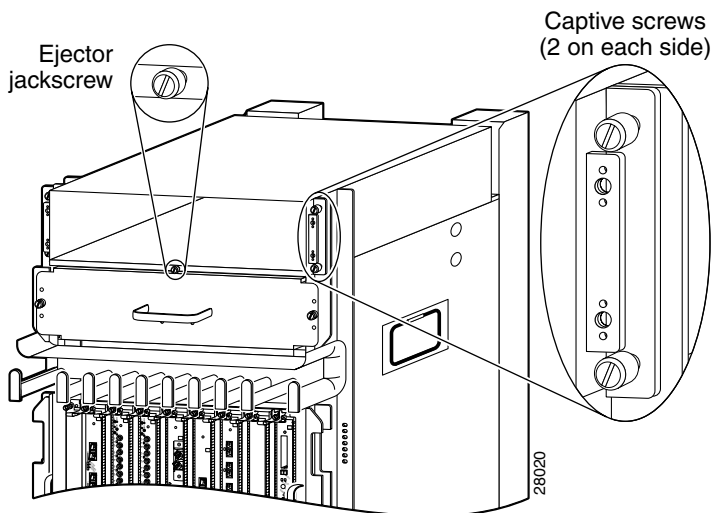
Step 8   Reconnect each of the AC power cords to the back panel of the power shelf and secure them in place with their retention clips (Figure 7-30).

Figure 7-30   Reconnecting AC Power Cords
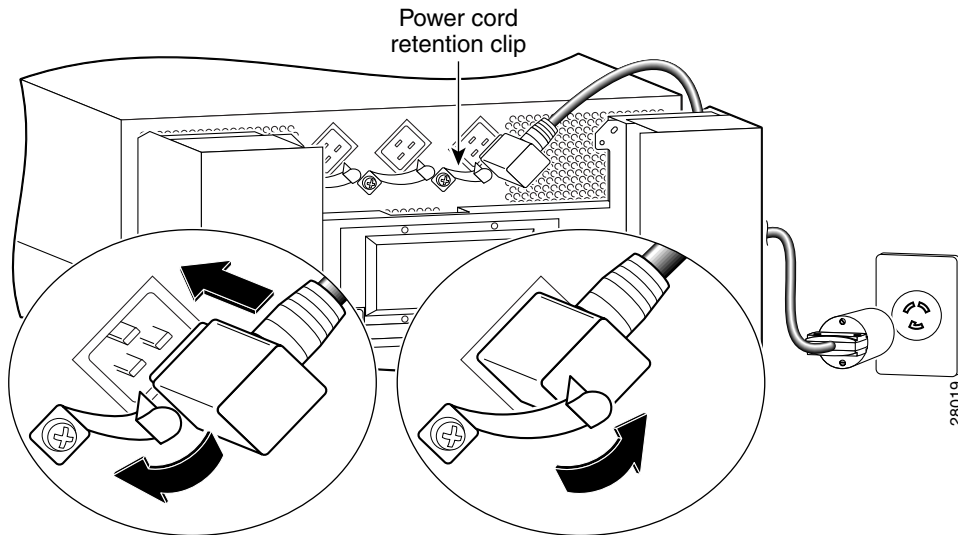
Step 9   Reinstall the power supplies as described in "Removing and Replacing an AC Power Supply" section on page 7-33.

Removing and Replacing the Optional 2-Level AC-Input Power Shelf

Use the following procedure to remove and replace the optional 2-level AC-input power shelf.

⚠

Caution   To remove and replace the power shelf, the system must be powered off. Notify the network administrator and other appropriate personnel that all routing traffic stops while the upgrade takes place.

⚠

Caution   If you are upgrading to a new power shelf, you cannot use original power supplies. You must upgrade to newer, 2500 W power supplies (see Table 7-1 on page 7-30).

Step 1   Remove all of the power supplies as described in Removing and Replacing an AC Power Supply, page 7-33.

Step 2   Disconnect each of the AC power cords from the back panel of the power shelf by lifting the retention clip and unplugging the cord (Figure 7-31).

Figure 7-31   Disconnecting the AC Power Cords
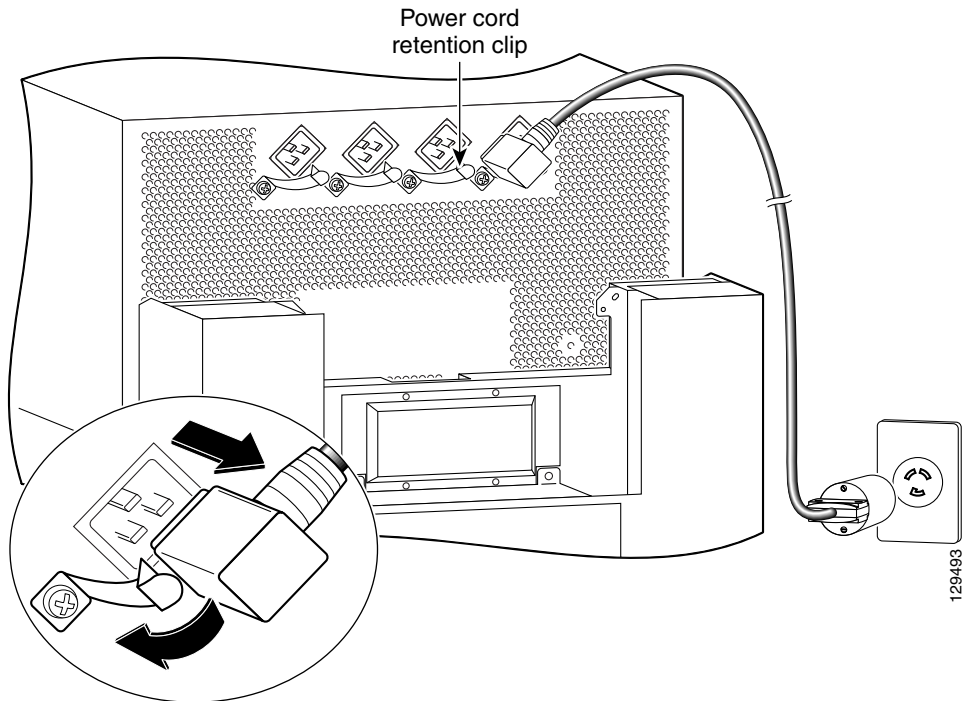
Step 3   Loosen the two captive screws on each side of the power shelf.

Step 4   Loosen the ejector jackscrew to unseat the power shelf from the connectors on the chassis power interface panel.

Step 5   Remove the power shelf by grasping the flanges on each side and slowly pulling the shelf along the chassis track to remove it (Figure 7-32).

⚠

Warning   **The AC-input power shelf weighs approximately 42 pounds (19.05 kg). Use two hands to remove the power shelf.**

Figure 7-32   Removing the AC-Input Power Shelf

Track on chassis

33450
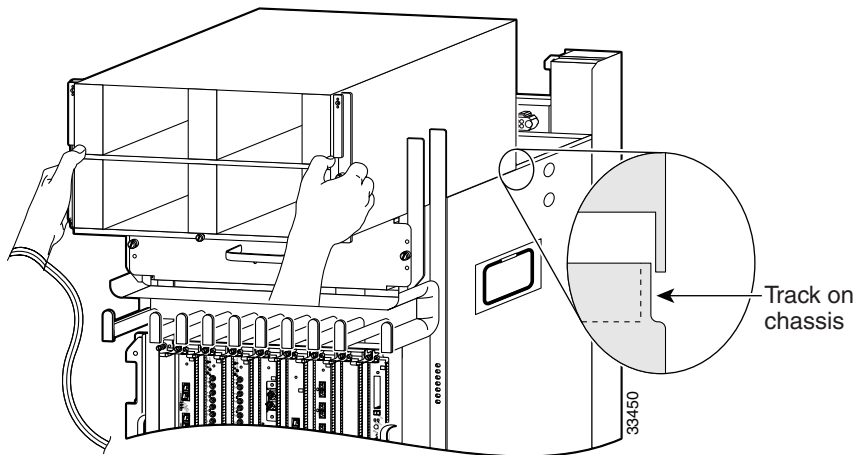
Step 6   Insert the new power shelf halfway into the chassis.

Step 7   Connect the power shelf to the chassis power interface panel connectors (Figure 7-33):

　　a.   Be sure the holes on each side of the power shelf are aligned with the guide pins on each side of the chassis.

　　b.   Carefully slide the power shelf into place until its two connectors just mate with the power interface panel connectors.

⚠

Caution   To prevent damage to the interface connectors, do not use excessive force when inserting the power shelf into the chassis.

Figure 7-33   Connecting the AC-Input Power Shelf

Elcon connectors on power shelf back panel

Hole

Guide pin (one on each side of chassis)
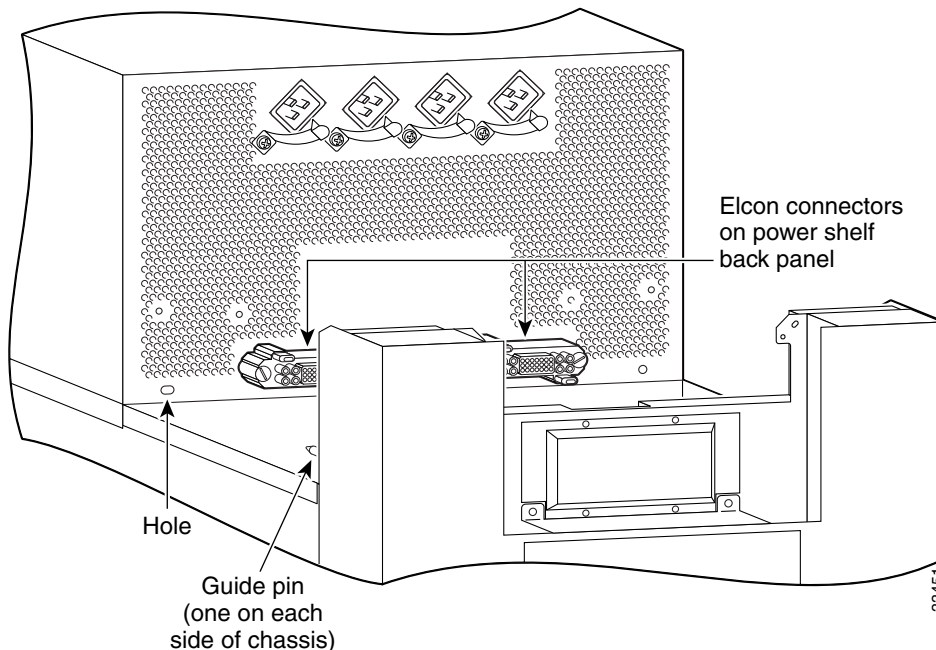
Step 8 Install the power shelf by grasping the flanges on each side and slowly sliding the shelf into the chassis along the track (Figure 7-34):

a. Tighten the ejector jackscrew.

b. Tighten the two captive screws on each flange.

Figure 7-34   Installing the AC-Input Power Shelf

Track on chassis
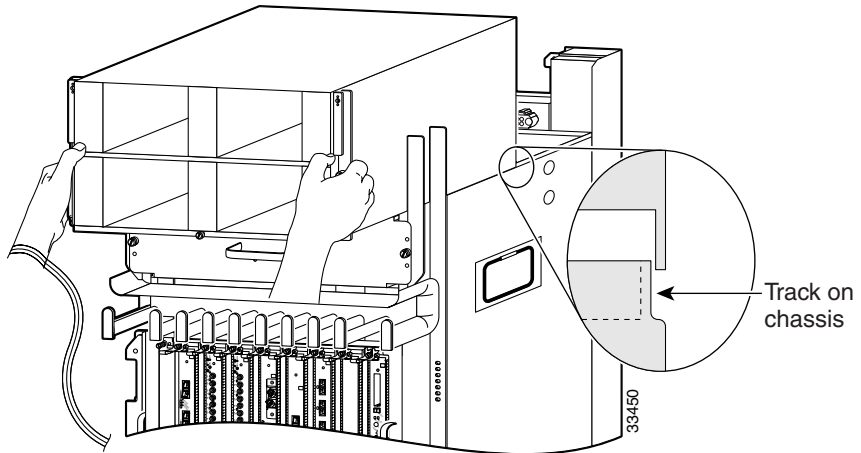
Step 9   Reconnect each of the AC power cords to the back panel of the power shelf and secure them in place with their retention clips (Figure 7-35).

Figure 7-35   Reconnecting AC Power Cords

Power cord
retention clip

33452
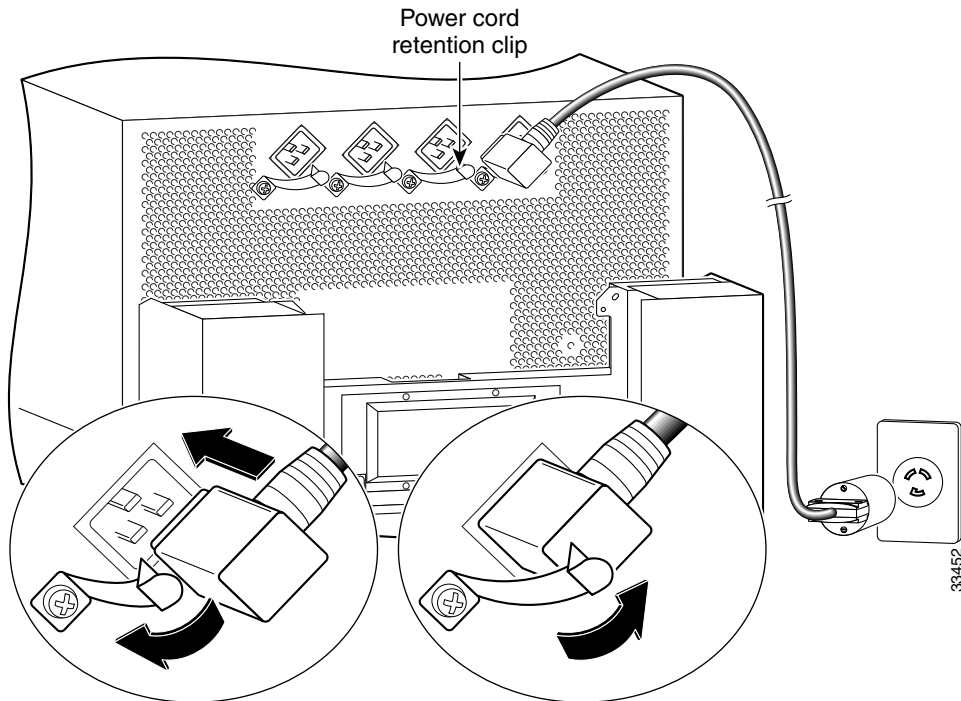
Step 10   Reinstall the power supplies as described in "Removing and Replacing an AC Power Supply" section on page 7-33 beginning with Step 6.

Troubleshooting the AC Power Shelf Installation

Use the following procedure to troubleshoot the AC power shelf if it does not operate properly after installation.

Step 1   Make sure that the power shelf is seated properly:

- The jackscrew is tightened securely.
- The captive screws on the flanges are tightened securely.

Step 2   Make sure each power supply is seated properly:

- The ejector lever is locked into place by its spring clip.

Step 3   Make sure the router is powered on and that all power cords are connected properly:

- Power cords on the back panel of the power shelf are secured in place with their retention clips.
- Power cords at the power source end are securely plugged into its own AC power outlet.
- Make sure the source AC circuit breaker is switched on.

Step 4   Check the power supply status indicators:

- PWR OK (green)—Indicates that the power supply is operating normally, and the source AC voltage is within the nominal operating range of 200 VAC to 240 VAC. When the power supply is properly seated, this indicator is on.
- FAULT (yellow)—Indicates that the system has detected a fault within the power supply or the incoming voltage is too low. During normal operation, this indicator remains off.

   If the indicator is on:

   – Check that the source voltage is within the correct range: 170 to 262 VAC

   – Remove and then apply power to the power supply by disconnecting its power cord. If the indicator remains on, replace the existing power supply with a spare.

   – If the spare power supply also fails, the problem could be a faulty power shelf backplane connector. Power off the router and contact a Cisco service representative for assistance.

- TEMP (yellow)—Indicates that the power supply is in an overtemperature condition, causing a shut-down to occur.

> **Note** If the temp indicator is on, the fault indicator also goes on.

  - Verify that the power supply fan is operating properly.
  - Verify that the blower modules are operating properly.
  - If the blower modules are operating properly, replace the existing power supply with a spare.

- TEMP (flashing yellow—2500 W PEM only)—Indicates that a power supply fan is locked or malfunctioning.

> **Note** If the temp indicator is flashing, the fault indicator also goes on.

  - Check to see if the fan is operating. Remove anything that may be obstructing the fan.
  - If the fan is not operating, replace the power supply.

- ILIM (2000 W PEM only) (yellow)—Indicates the power supply is operating in a current-limiting condition.

  - Each power cord should be connected to a dedicated AC power source. Each AC power supply operating in the nominal range of 200 to 240 VAC requires a minimum service of 20 A, North America (or 13 A, international).

- OC (2500 W PEM only) (steady, or flashing yellow after 10 seconds)—Indicates the output current of the power supply exceeded its limit and an overload or short circuit has occurred.

> **Note**   If the OC indicator is on or flashing, the fault indicator also goes on.

   – Remove and then apply power to the power supply by disconnecting its power cord.
   – If the indicator remains on, try reseating the power supply.
   – If the indicator remains on, replace the power supply.

Upgrading the AC-Input Power Shelf

Use the following procedure to upgrade your router from the standard, 1-level AC power shelf to an optional, 2-level AC power shelf.

> **Note**   A router with an optional, 2-level power shelf is 77.5 inches (196.85 cm) in height and does not fit into a standard 7-foot rack.

Step 1   Remove the standard one-level power shelf following the procedures in "Removing and Replacing the Standard AC-Input Power Shelf" section on page 7-44 through Step 4.

Step 2   Install the optional, 2-level power shelf following the procedures in "Removing and Replacing the Optional 2-Level AC-Input Power Shelf" section on page 7-51 beginning with Step 6.

Step 3   Replace the old cover with the new cover you received in the upgrade kit.

   a.   Hold the front cover by its outside edges and align the four ball studs on the back of the cover with the sockets on the front of the chassis.

   b.   Push in the front cover until all four ball studs snap into their sockets and the front cover is flush against the front of the chassis.

Removing and Replacing a DC PEM

This section contains the procedure to remove and replace an DC PEM from the chassis. *Before* you begin this procedure, read the "Installation Guidelines" section on page 7-29.

Figure 7-36 identifies the components of a 2000 W DC power supply.

Figure 7-36   2000 W DC Power Supply Components
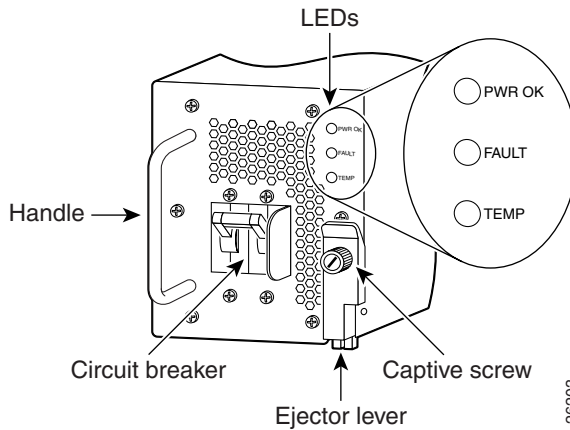
Figure 7-37 identifies the components of a 2400 W DC power supply.

Figure 7-37   2400 W DC Power Supply Components
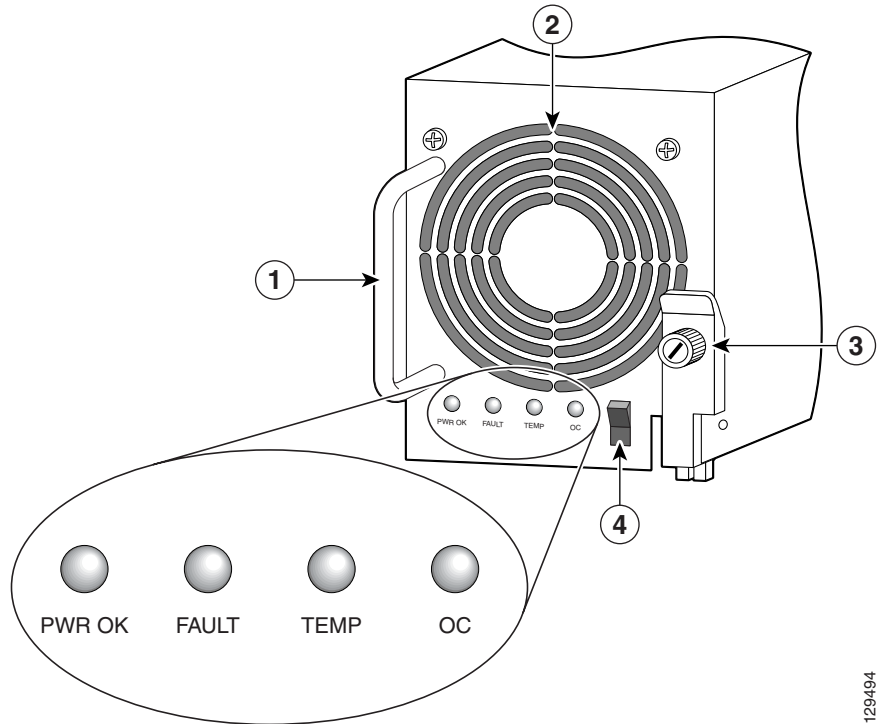
1	Handle	**3**	Ejector lever
2	Fan	**4**	Power switch

⚠

Caution   You cannot mix power supply types within the chassis. If you plan to replace a 2000 W PEM from an original system with a new 2400 W PEM, you must replace all of the older PEMs and the power shelf (see Table 7-1 on page 7-30). To perform the upgrade, you must shut down the router. Be sure to notify the system administrator and other appropriate personnel that all routing traffic stops while the upgrade takes place.

Use the following procedure to remove and replace a DC PEM.

Step 1   Power off the PEM by switching its circuit breaker off.

Step 2   Power off the DC circuit breaker assigned to that PEM.

⚠

Warning   **To ensure that power remains off while you are performing this procedure, tape the circuit breaker switch in the off (0) position.**

Step 3   Loosen the captive screw on the ejector handle and pivot the lever down to eject the PEM from its bay (Figure 7-38).

Step 4   Remove the PEM from the power shelf (Figure 7-38):

   a.   Pull the PEM halfway out of its bay.

   b.   Slide the PEM out of its bay while supporting it with your other hand.

⚠

Warning   **The DC PEM weighs approximately 6 pounds (2.7 kg). Use two hands to remove the power supply.**

Figure 7-38   Removing a DC PEM

ⓐ Loosen captive screw
ⓑ Pivot ejector lever
ⓒ Pull module out of shelf
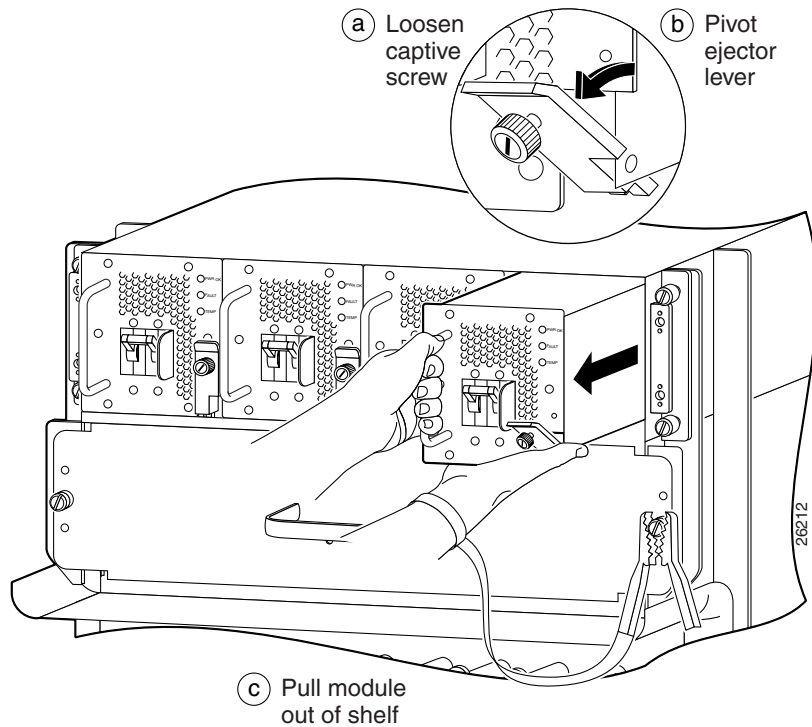
Step 5   Install the new DC PEM into the power shelf (Figure 7-39):

    a.   Slide the PEM halfway into the chassis.

    b.   Slowly push the power supply into the chassis until it mates with the backplane connector at the back of the bay.

    c.   Position the bottom of the ejector lever in the slot on the bottom of the power shelf and lift the ejector lever into place to seat the PEM to the backplane connector.

⚠

Caution   To prevent damage to the power shelf backplane connector, do not use excessive force when inserting the PEM into its power shelf bay.

    d.   Tighten the captive screw to secure the PEM in the power shelf.

⚑

Note   Because the PEM is powered redundantly by other PEMs in its power load zone, the fault indicator may go on. This can happen even if the circuit breaker for that PEM is switched off, or if there is no DC source power to the PEM. When power is supplied to the PEM and the circuit breaker is switched on, the fault indicator should go off and the PWR OK indicator should light.

Figure 7-39   Installing a DC PEM

ⓐ Loosen captive screw and pivot ejector lever

ⓑ Slide power module into power shelf bay

ⓒ Close ejector lever to seat power module

ⓓ Tighten captive screw
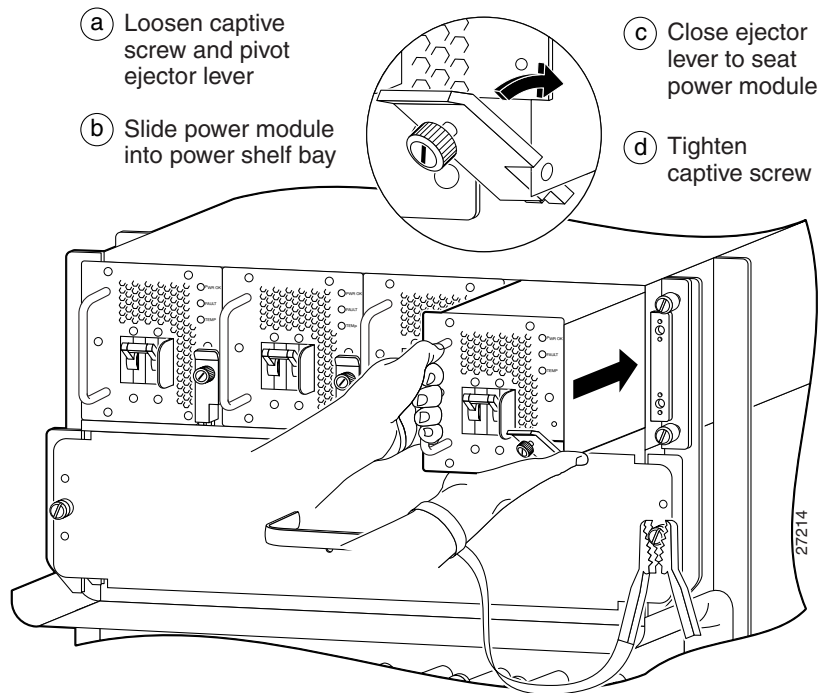
Step 6   Power on the DC circuit breaker assigned to that PEM.

Step 7   Power on the PEM by switching on its circuit breaker.

After the power-on sequence completes, the (green) PWR OK indicator on the front of the PEM should light. If the indicator does not light, see the "Troubleshooting the DC PEM Installation" section on page 7-66.

Troubleshooting the DC PEM Installation

Use the following procedure to troubleshoot the DC PEM if it is not operating properly after installation.

Step 1   Make sure the PEM is seated properly:

- Eject and reseat the PEM.
- The captive screw on the ejector lever are tightened securely.
- The power switch is in the on (1) position (2400 W only).

Step 2   Make sure the router is powered on and that all power cords are connected properly:

- All power cables are securely connected to their terminal studs on the back panel.
- Each pair of PEM power cables are connected to a dedicated 60 A DC service.
- The source DC circuit breaker is switched on.
- The PEM circuit breaker is switched on (2000 W only).
    - If circuit breaker does not stay switched on, replace the PEM.

Step 3   Check the PEM status indicators:

- PWR OK (green) — Indicates that the PEM is operating normally, and the source DC voltage is within the nominal operating range of –48 to –60 VDC. This indicator should light when the PEM circuit breaker is switched on.
- FAULT (yellow) — Indicates that the system has detected a fault within the PEM or the incoming voltage is too low. During normal operation, this indicator remains off.
    - Check that the source voltage is within the correct range: –40 to –72 VDC.
    - Toggle the PEM circuit breaker off and then on. If the indicator remains on after several attempts to power it on, replace the existing PEM with a spare.
    - If the spare PEM also fails, the problem could be a faulty power shelf backplane connector. Power off the router and contact a Cisco service representative for assistance.

- TEMP (yellow)—Indicates that the PEM is in an overtemperature condition causing a shut-down to occur.

> **Note** If the temp indicator is on, the fault indicator also goes on.

  – Verify that the power supply fan is operating properly.

  – Verify that the blower modules are operating properly.

  – If the power supply fan and the blower modules are operating properly, replace the existing PEM with a spare.

- TEMP (flashing yellow—2400 W PEM only)—Indicates that a power supply fan is locked or malfunctioning.

> **Note** If the temp indicator is flashing, the fault indicator also goes on.

  – Check to see if the fan is operating. Remove any obstructions to the fan.

  – If the fan is not operational, replace the power supply.

- OC (2400 W PEM only) (steady, or flashing yellow after 10 seconds)—Indicates the output current of the power supply has exceeded its limit and that an overload or short circuit has occurred.

> **Note** If the OC indicator is on or flashing, the fault indicator also goes on.

  – Remove and then apply power to the power supply by disconnecting its power cord.

  – If the indicator remains on, try reseating the power supply.

  – If the indicator remains on, replace the power supply.

Removing and Replacing the DC-Input Power Shelf

Use the following procedure to remove and replace the DC-input power shelf.

⚠
Caution   To remove and replace the power shelf, the system must be powered off. Notify the network administrator and other appropriate personnel that all routing traffic stops while the upgrade takes place.

⚠
Caution   If you are upgrading to a new power shelf, you cannot use old power supplies. You must upgrade to newer, 2400 W PEMs (see Table 7-1 on page 7-30).

Step 1   Remove all of the DC PEMs as described in the "Removing and Replacing a DC PEM" procedure on page 60 through Step 4.

Step 2   Remove the power cable cover by loosening its retaining screw (Figure 7-40).

Figure 7-40   Removing the Source DC Power Cable Cover

Cover with slotted screw hole; fastens to standoff in middle of cable connection area.
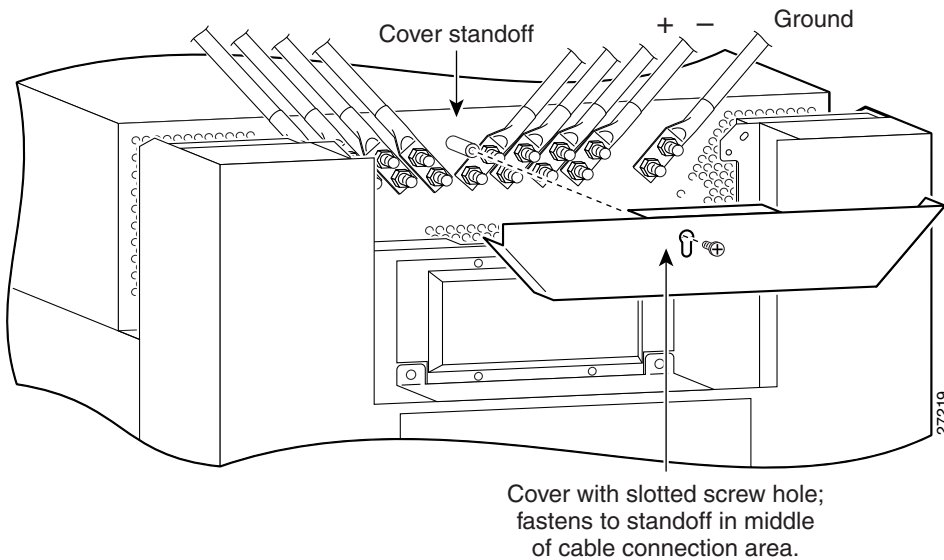
Step 3   Measure the voltage across each pair of positive (+) and negative (–) terminals of the power shelf to be sure they are not receiving power.

- All readings should be 0 VDC.

⚠

Warning   **Do not proceed if all readings are not 0 (zero) volts. Make sure that the router is powered off and that all source DC circuit breakers are switched off. Repeat Step 3 before continuing.**

Step 4   Disconnect each pair of power cables and the ground cable from the DC-input terminal studs as follows (Figure 7-41):

⚠

Caution   Before removing cables, be sure to note the color for each type of cable (positive, negative, and ground). Because there is no color code standard for source DC wiring, you must be sure which power cables are connected to the proper positive (+) and negative (–) terminal studs. Typically, green (or green and yellow) indicate a ground cable, while power cable leads may be labeled positive (+) or negative (–). Because this is not always the case, the safest way to indicate the polarity of a cable is to note its color and identify it as described in this procedure.

⚠

Warning   **When disconnecting source DC power cables, always disconnect the ground cable last.**

Beginning with terminal studs A1 (Figure 7-41):

a.   Remove the nut and washer from the negative (–) terminal studs and disconnect the cable.

- Label the cable. For example: A1-.

b.   Remove the nut and washer from the positive (+) terminal studs and disconnect the cable.

- Label the cable. For example: A1+.

   Repeat steps **a**. and **b.** for the remaining pairs of terminal studs.

c.   After all power cables are disconnected, remove the nut and washer from the ground terminal studs and disconnect the ground cable.

- Label the cable as "ground".

Figure 7-41   Disconnecting the Source DC Power Cables
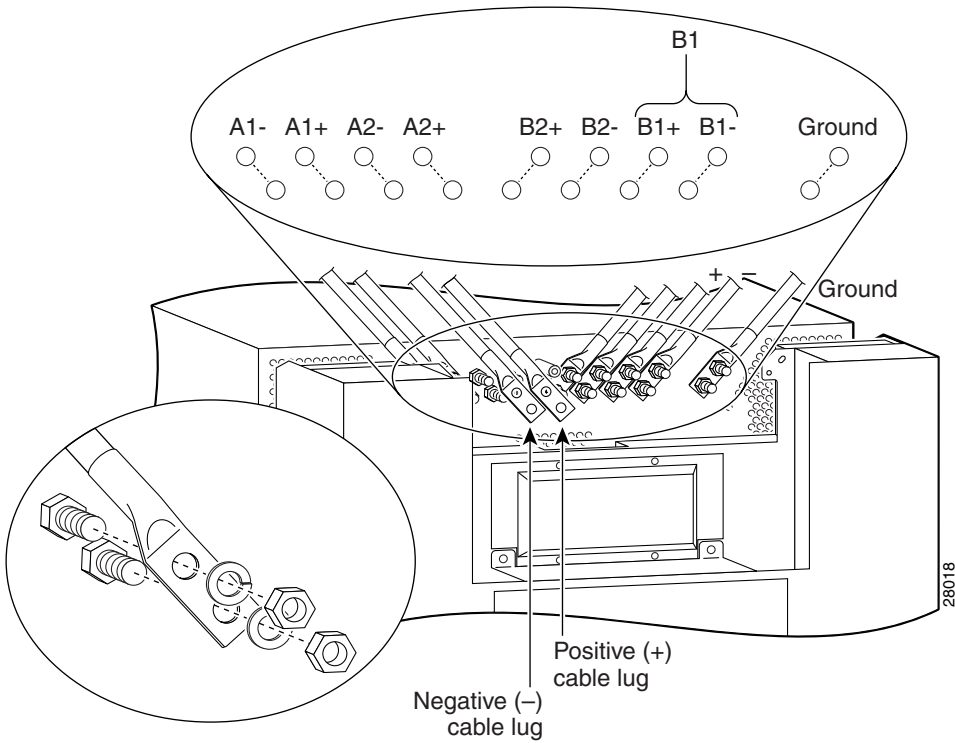
Step 5   Unseat the power shelf from the chassis (Figure 7-42):

    a.   Loosen the two captive screws on each side of the power shelf.

    b.   Loosen the ejector jackscrew to unseat the power shelf from the connectors on the chassis power interface panel.

![Warning icon]

Warning   **The DC-input power shelf weighs approximately 10.2 pounds (4.6 kg). Use two hands to remove the power shelf.**

Figure 7-42   Unseating the Power Shelf
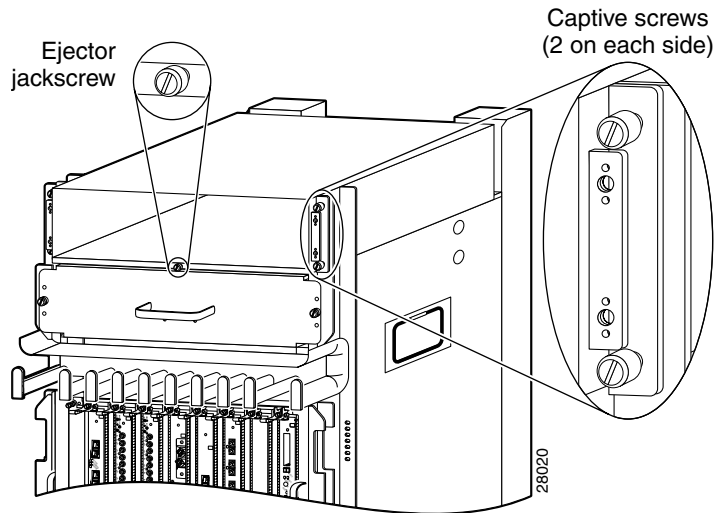
Step 6 Remove the power shelf by grasping the flanges on each side and slowly pulling the shelf along the chassis track to remove it (Figure 7-43):

Figure 7-43   Removing the DC-Input Power Shelf

Track on chassis

27967
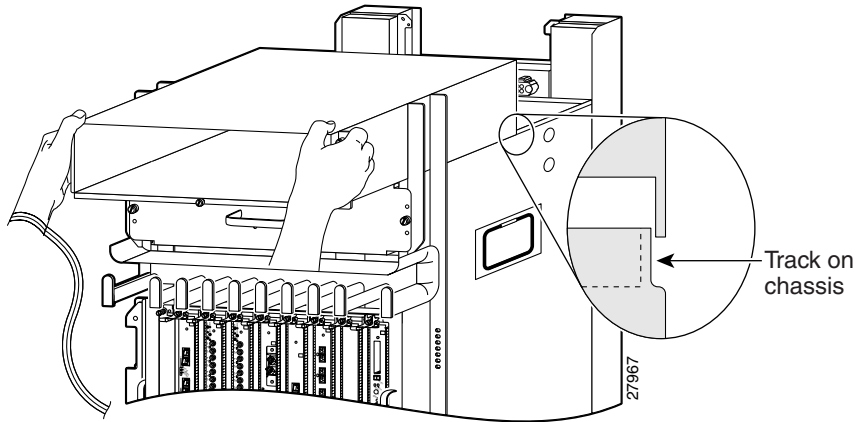
Step 7 Insert the new power shelf halfway into the chassis.

Step 8 Connect the power shelf to the chassis power interface panel connectors (Figure 7-44):

  a. Be sure the holes on each side of the power shelf are aligned with the guide pins on each side of the chassis.

  b. Carefully slide the power shelf into place until its two connectors just mate with the power interface panel connectors.

⚠

Caution To prevent damage to the interface connectors, do not use excessive force when inserting the power shelf into the chassis.

Figure 7-44   Connecting the DC-Input Power Shelf
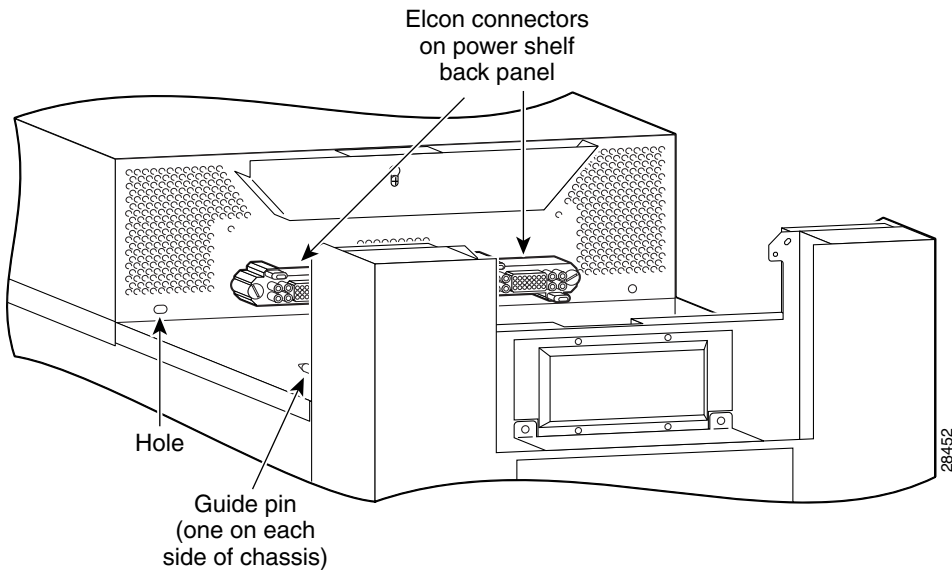
Step 9   Seat the power shelf to the chassis (Figure 7-45):

   a.   Tighten the ejector jackscrew.

   b.   Tighten the captive screws on each flange.

⚠

Warning   **The DC-input power shelf weighs approximately 10.2 pounds (4.6 kg). Use two hands to remove the power shelf.**

Figure 7-45   Seating the DC-Input Power Shelf
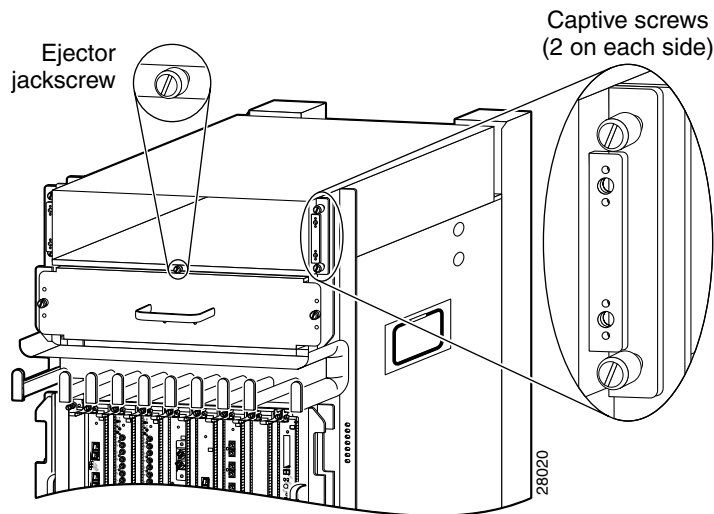
Step 10   Reconnect the ground and each pair of power cables to the DC-input terminal studs as follows (Figure 7-46):

⚠

Caution   Be sure to connect the cables according to the color coding notes and labels you made in Step 4.

⚠️

Warning   **When reconnecting source DC power cables, always connect the ground cable first.**

a. Reconnect the ground cable to the ground terminal studs.

Beginning with terminal studs B2:

b. Reconnect the positive cable to the positive (+) terminal studs. For example: B2+.

c. Reconnect the negative cable to the negative (–) terminal studs. For example: B2-.

Repeat steps **b** and **c** for the remaining pairs of terminal studs.

Figure 7-46   Reconnecting the Source DC Power Cables to the Power Shelf

Positive (+) cable lug

Ground (⏚) cable lug

Negative (–) cable lug
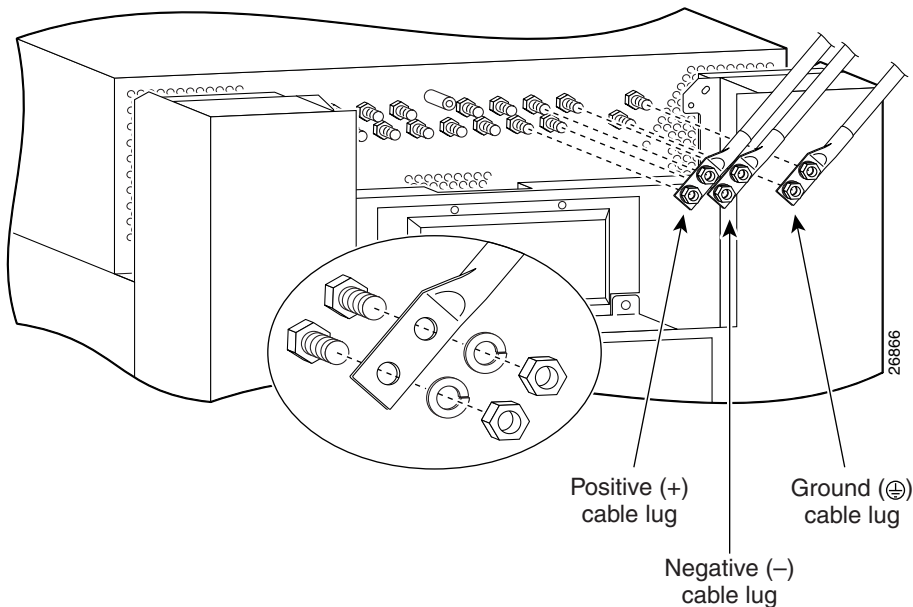
Step 11   Power on the source DC circuit breakers for the PEMs.

Step 12   Verify the polarity and voltage readings across the pairs of positive and negative terminal studs:

   • All voltage readings should be –48 to –60 VDC

⚠

Caution   If any of the voltage readings are not within the specified range, do not proceed. Check for correct polarity and DC source voltage.

Step 13   Reinstall the power cable cover (Figure 7-47).

Figure 7-47   Reinstalling the Source DC Power Cable Cover

Cover with slotted screw hole;
fastens to standoff in middle
of cable connection area.
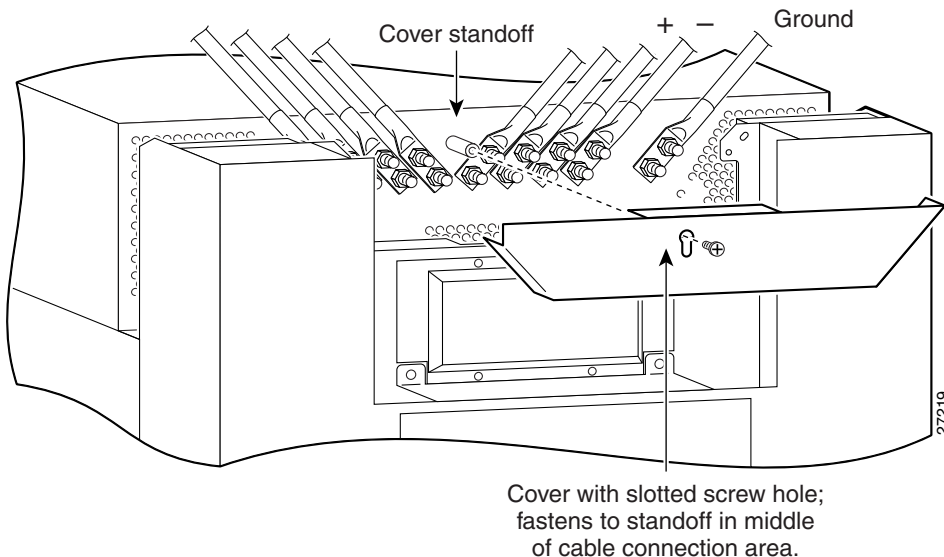
Step 14   Power off the source DC circuit breakers for the PEMs.

Step 15   Install all of the DC PEMs as described in the "Removing and Replacing a DC PEM" procedure on page 60 beginning with Step 5.

Troubleshooting the DC Power Shelf Installation

Use the following procedure to troubleshoot the DC power shelf if it is not operating properly after installation.

Step 1   Make sure that the power shelf is seated properly:

- The jackscrew is tightened securely.
- The captive screws on the flanges are tightened securely.

Step 2   Make sure each power supply is seated properly:

- Eject and reseat the PEM.
- The captive screw on the ejector lever is tightened securely.
- The power switch is in the on (1) position (2400 W only).

Step 3   Make sure the router is powered on and that all power cords are connected properly:

- All power cables are securely connected to their terminal studs on the back panel.
- Each pair of PEM power cables is connected to a dedicated 60 A DC service.
- The source DC circuit breaker is switched on.
- The PEM circuit breaker is switched on (2000 W only).
    - If the circuit breaker does not stay switched on, check the polarity of the power cables to the PEM.

✐
Note   A PEM trips its circuit breaker if it detects a reverse-polarity condition. This condition does not damage the PEM and it should operate properly after the polarity is corrected.

Step 4 Check the power supply status indicators:

- PWR OK (green)—Indicates that the PEM is operating normally, and the source DC voltage is within the nominal operating range of –48 to –60 VDC. When the PEM circuit breaker is switched on, this indicator lights.

- FAULT (yellow)—Indicates that the system detected a fault within the PEM or the incoming voltage is too low. During normal operation, this indicator remains off.

  If the indicator is on:

  – Check that the source voltage is within the correct range: –40 to –72 VDC.

  – Toggle the PEM circuit breaker off and then on. If the indicator remains on after several attempts to power it on, replace the existing PEM with a spare.

  – If the spare PEM also fails, the problem could be a faulty power shelf backplane connector. Power off the router and contact a Cisco service representative for assistance.

- TEMP (yellow)—Indicates that the PEM is in an overtemperature condition, causing a shut-down to occur.

  > **Note**   If the temp indicator is on, the fault indicator is also on.

  – Verify that the power supply fan is operating properly.

  – Verify that the blower modules are operating properly.

  – If the blower module is operating properly, replace the existing PEM with a spare.

- TEMP (flashing yellow—2400 W PEM only)—Indicates that a power supply fan is locked or malfunctioning.

  > **Note**   If the temp indicator is flashing, the fault indicator is also on.

  – Check to see if the fan is operating. Remove any obstructions to the fan.

  – If the fan does not operate, replace the power supply.

- OC (2400 W PEM only) (steady, or flashing yellow after 10 seconds)—Indicates the output current of the power supply exceeded its limit and an overload or short circuit has occurred.

✎

Note If the OC indicator is on or flashing, the fault indicator is also on.

  – Remove and then apply power to the power supply by disconnecting its power cord.

  – If the indicator remains on, try reseating the power supply.

  – If the indicator remains on, replace the power supply.

Removing and Replacing Cards from the Chassis

This section contains the procedures to remove cards from the card cages in the chassis. For additional information about specific types of cards, see Chapter 1, "Product Overview."

Removing and Replacing RP and Line Cards from the Upper and Lower Card Cages

This section describes the procedures for removing and installing a router processor (RP) card or a line card from the upper or lower card cage. The upper and lower card cages have 9 slots, and the lower card cage is a reverse image of the top card cage. Alarm cards can only be installed in their specific slots which are labeled as "Alarm Card". See the "Removing and Replacing an Alarm Card" section on page 7-81 for information about replacing an alarm card.

⚠

Caution If you are upgrading your router from a GRP to a PRP, you must power off the router to switch the RP cards. If you are replacing a nonredundant RP you should back up the running configuration file to a TFTP server or a flash disk so that you can retrieve it later. If the configuration file is not saved, you will have to reenter the entire configuration manually for the new RP.

⚠️

Caution   Handle all cards by the metal card carrier edges only; avoid touching the board or any connector pins. After removing a card, carefully place it in an antistatic bag or similar environment to protect it from ESD and dust in the optic ports (fiber-optic line cards).

Use the following procedure to remove and replace a line card or RP from the card cage:

Step 1   Disconnect any cables from the card.

Step 2   Remove the card:

  a.   Loosen the captive screws at the top and bottom of the front panel (Figure 7-48a).

  b.   Pivot the ejector levers to unseat the card from the backplane connector (Figure 7-48b.)

  c.   Slide the card out of the slot (Figure 7-48c) and place it directly into an antistatic bag or other ESD-preventive container.

Step 3   Replace the card by reversing the procedures in Steps 1 and 2.

Figure 7-48   Removing a Line Card from the Line Card and RP Card Cage

(a) Loosen captive screws

(b) Pivot ejector levers away from card to unseat card

(c) Grasp card carrier to slide card out of slot
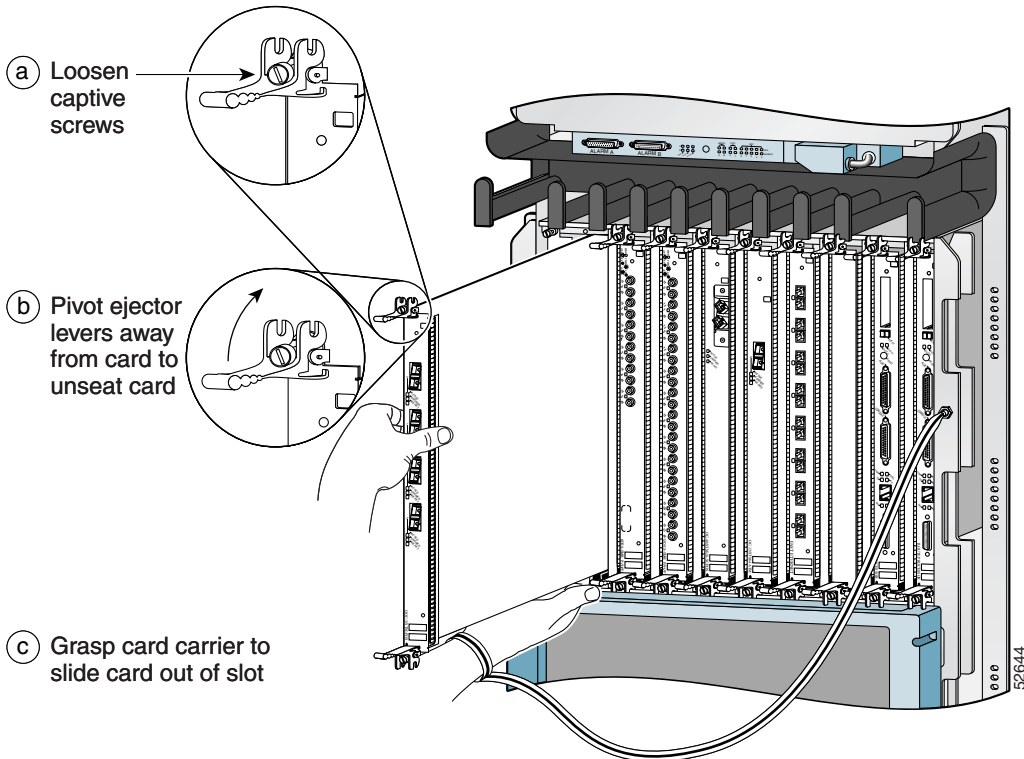
Removing and Replacing an Alarm Card

The router is equipped with two alarm cards. One card occupies the dedicated far left slot of the upper card cage; the second occupies the dedicated far right slot of the lower card cage (Figure 7-49). The alarm card slot differs from the rest of the card cage slots: it is physically narrower, has a different backplane connector, and is labeled as an "Alarm Card" slot. Alarm cards can only be installed in these two slots.

Figure 7-49   Alarm Card Locations in the Upper and Lower Card Cages

Use the following procedure to remove and replace an alarm card from either the top or bottom card cage.

⚠️

Caution   To ensure proper alarm card screw alignment, line card slots adjacent to the alarm cards must always be populated.

Step 1   Disconnect any cables from the alarm card.

Step 2   Remove the alarm card:

   a.   Loosen the captive screws at the top and bottom of the front panel (Figure 7-50a).

   b.   Pull the card out of the slot (Figure 7-50b) and place it directly into an antistatic bag or other ESD-preventive container.

Figure 7-50   Removing an Alarm Card from the Upper Card Cage

(a) Loosen captive screws

(b) Use handle to pull card out of slot

Step 3   Replace the card by reversing the procedures in Steps 1 and 2.

Removing and Replacing Switch Fabric Cards

The switch fabric card cage is located behind the air filter door on the front of the chassis. The card cage has five keyed, vertical card slots for the CSCs and SFCs. CSCs are installed in the left two card slots (labeled CSC 0 and 1); SFCs are installed in the right three card slots (labeled SFC 0, 1, and 2).

Use the following procedure to remove and replace switch fabric cards.

Step 1 Loosen the captive screws on the air filter door and pivot the door open (Figure 7-10).

⚠

Caution If the router uses an extended front cover bezel, the air filter door does not have enough space to open completely. Before you open the air filter door, you must remove the extended front cover.

Figure 7-51   Opening the Chassis Air Filter Door

Switch fabric card cage (behind filter door)

Air filter door →

Air filter →

Captive screws (2 on each side)

26195
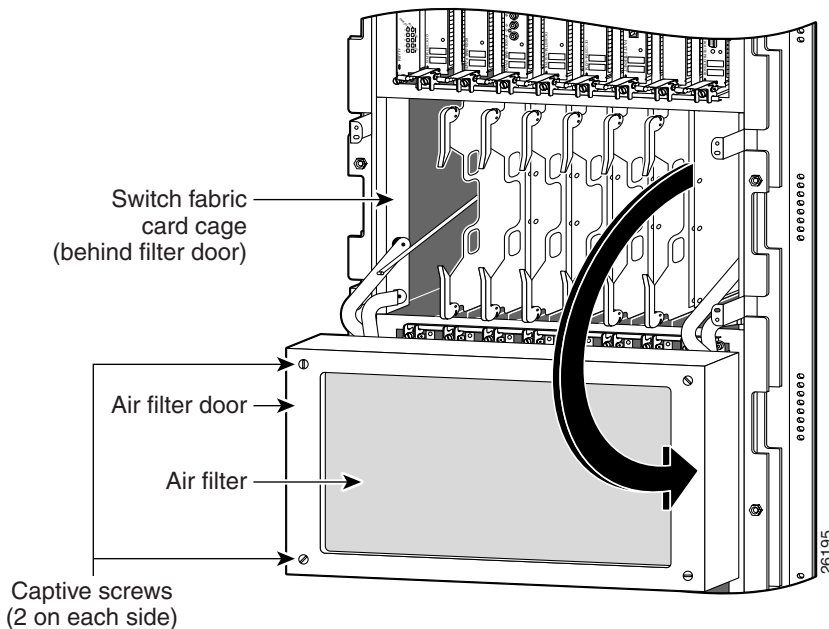
Step 2 Remove the card:

    a. Pivot the ejector levers to unseat the card from the backplane connector.

    b. Grasp the card by its metal card carrier and slide the card out of the slot (Figure 7-52).

        – Place the card directly into an antistatic bag or other ESD-preventive container.

Figure 7-52   Removing a Card from the Switch Fabric Card Cage
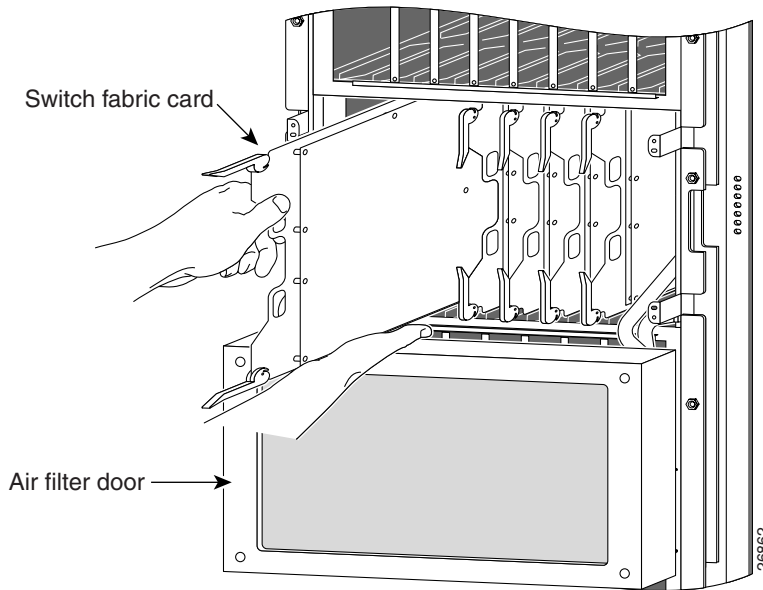
Step 3 To install the card, reverse the procedure in Step 2.

Step 4 Close the air filter door and tighten the captive screws.

Upgrading the Switch Fabric

The switch fabric on the Cisco 12016 and the Cisco 12416 routers can be upgraded in the field.

- Cisco 12016 Routers can be upgraded from a 2.5 Gbps switch fabric to a 10 Gbps or 40 Gbps switch fabric.

- Cisco 12416 Routers can be upgraded from a 10 Gbps switch fabric to a 40 Gbps switch fabric.

Table 7-2 lists the Cisco router model numbers, their corresponding switch fabric speed, and the available upgrade path for each router model.

Table 7-2   Switch Fabric Upgrade Paths

Router Model	Switch Fabric Speed	Upgrade Path
Cisco 12016 router	2.5 Gbps	- Cisco 12416 router or - Cisco 12816 router
Cisco 12416 router	10 Gbps	Cisco 12816 router
Cisco 12816 router	40 Gbps	NA

Upgrade Requirements

Review the following the following upgrade requirements before performing the switch fabric upgrade:

- You need a complete switch fabric card set. You cannot mix 2.5- Gbps 10 Gbps, and 40 Gbps CSCs and SFCs.

- When upgrading to a 10 Gbps switch fabric with a GRP installed, the flash memory card must be loaded with Cisco IOS Release 12.0(16)S or later.

- When upgrading to a 10 Gbps switch fabric with a PRP installed, the flash memory card must be loaded with Cisco IOS Release 12.0(22)S or later.

- When upgrading to a 40 Gbps switch fabric, a PRP must be installed and the flash memory card must be loaded with Cisco IOS Release 12.0(27)S or later.

Upgrade Procedures

To upgrade the switch fabric, follow these steps:

Step 1   Power off the router.

Step 2   Remove all CSCs and SFCs from the switch fabric card cage. See the "Removing and Replacing Switch Fabric Cards" section on page 7-84.

Step 3   Install the new CSCs and SFCs.

> ✎
> **Note**   Although they perform similar functions, you cannot intermix SFCs and CSCs. The switch fabric is a card *set*. You must use either the 10- or 40-Gbps switch fabric card set.

Step 4   Insert a flash memory card into the GRP or PRP, making sure that it is loaded with the appropriate Cisco IOS Release.

Step 5   Power on the router and wait for all installed line cards to boot completely before proceeding to the next step.

> ✎
> **Note**   Be sure the router returns to full operation before proceeding to the next step. This may take a considerable amount of time depending upon the configuration of the router.

Step 6   Enter the **configure terminal** command to enter global configuration mode.

Step 7   If you are using a Cisco IOS Release prior to 12.0(27)S, enter the **service upgrade all** command.

   –   Go to Step 10

If you are not using a Cisco IOS Release prior to 12.0(27)S, go to the next step.

Step 8   If you are using Cisco IOS Release 12.0(27)S or later, enter the **service upgrade mbus-agent-rom** command.

Step 9   Enter the **service upgrade fabric-downloader** command.

Step 10   After the commands have finished running, press **Ctrl-Z** to exit configuration mode.

Step 11   Run the **show gsr** command to verify that the new switch fabric cards are detected by the system.

✎

Note   The **show gsr** command output varies slightly between each switch fabric card set.

The switch fabric upgrade kit does not include a new label to identify the upgraded router model, so the label on the side of the chassis still identifies the chassis as a Cisco 12016 or Cisco 12416 router.

You can identify an upgraded router by:

- Reading the numbers on the switch fabric card labels.
- Using the **show gsr** command to generate the switch fabric card identification numbers. Table 7-3 lists the router model and the corresponding switch fabric card number on the identification label.

Table 7-3   Identifying Switch Fabric Cards

Router Model	Switch Fabric Card Identification Label
Cisco 12016 router	SFC-80 and CSC-80
Cisco 12416 router	SFC-320 and CSC-320
Cisco 12816 router	SFC-1280 and CSC-1280

Removing and Installing a Chassis

This section provides the procedures to remove and replace a chassis. You may need to perform this procedure to replace a defective chassis or move it to another location. These instructions include the steps directing you to removal and replacement instructions for individual components such as power supplies and line cards.

Because you are removing all the components (except the air filter) from the defective chassis and then reinstalling them in the replacement chassis, the procedures that follow are based on the following prerequisites:

- The replacement chassis, mounted on its own scissor-jack platform, is temporarily placed within reach of the rack in which the defective chassis is installed, and is temporarily connected to the same grounding system as the defective chassis.

- A spare scissor-jack platform with the anchor clips and bolts (that came with the original chassis) is available to remove the defective chassis from the equipment rack.

- Components are transferred from the defective chassis directly to the replacement chassis.

- The replacement chassis is installed in the equipment rack after all components are installed.

This approach has the advantage of protecting system components against damage by eliminating the need to store them, even temporarily, outside their card cages. It also helps ensure that the physical configuration of the router is maintained because each transferred component is installed in the same location in the replacement chassis that it occupied in the defective chassis.

Procedures for removing and installing the chassis are described in the following sections:

- Preparing the Replacement Chassis, page 7-90
- Preparing the Installed Chassis for Removal, page 7-90
- Removing and Installing System Components, page 7-91
- Removing and Installing System Components, page 7-91
- Removing the Chassis from the Equipment Rack, page 7-92
- Installing the Replacement Chassis, page 7-97

Preparing the Replacement Chassis

Before you can begin to install components in the replacement chassis, you need to temporarily connect the central office grounding system or interior equipment grounding system. You can make this connection when the replacement chassis and scissor-jack platform has been placed near the rack site.

See "NEBS Supplemental Unit Bonding and Grounding Guidelines" section on page 2-22 for information about making these connections.

Preparing the Installed Chassis for Removal

Use the following procedure to prepare the installed chassis for removal.

Step 1 Power off the router (see Powering Off the Router, page 7-2).

Step 2 Power off the circuit breakers to the power supplies.

Step 3 Disconnect the power cords from the power shelf:

- For a standard AC power shelf, see Step 2 of Removing and Replacing the Standard AC-Input Power Shelf, page 7-44.
- For an optional AC power shelf, see Step 2 of Removing and Replacing the Optional 2-Level AC-Input Power Shelf, page 7-51.
- For a CD power shelf, see Steps 2, 3, and 4 of Removing and Replacing the DC-Input Power Shelf, page 7-68.

Step 4 Remove the front covers (see Removing and Installing the Front Covers and Bezel Extenders on Original Cisco 12000 Series Routers, page 7-3, or Cleaning or Replacing the Chassis Air Filter, page 7-17).

Step 5 Disconnect RP cables connected to the console port, auxiliary port, or either of the Ethernet ports, RJ-45 or MII.

Label each of the RP cables before you disconnect the cables.

Step 6   Disconnect the cables from each alarm card.

Label each of the alarm card cables before you disconnect them.

Step 7   Disconnect the line card interface cables:

    a.   Identify the type of line card and its slot number. Write this information on a piece of paper before you disconnect the cables. You'll need this information when you reinstall the line cards.

    b.   Identify the line card cable and its port connection. Label the cable with this information.

    c.   Loosen the captive screw at each end of the line card cable-management bracket and pull the cable-management bracket away from the line card.

    d.   Carefully remove the cables from the cable tray and carefully place the cable bundle out of the way.

    e.   Repeat steps **a** through **d** for each line card.

Step 8   Remove the vertical cable-management troughs (see Attaching the Vertical Cable-Management Trough, page 3-25).

Removing and Installing System Components

Use the following procedure to remove and install system components from one chassis to another.

Step 1   Remove the blower modules and then install them into the replacement chassis. (see the "Removing and Replacing Blower Modules" section on page 7-24).

Step 2   Remove the power supplies and the power shelf and then install them into the replacement chassis (see "Removing and Replacing AC and DC Power Subsystem Components" section on page 7-29).

Step 3   Remove the cards from all three card cages and then install them into the replacement chassis (see "Removing and Replacing Cards from the Chassis" section on page 7-79).

Removing the Chassis from the Equipment Rack

Use the following procedure to remove the chassis from the equipment rack.

⚠

Warning   **Two people are required to remove the chassis from the equipment rack.**

Step 1   Remove all grounding connections to the chassis (See "NEBS Supplemental Unit Bonding and Grounding Guidelines" section on page 2-22).

Step 2   Position the scissor-jack platform from the original router shipping package in front of the rack-mounting platform in the rack (Figure 7-53).

Step 3   Turn the scissor-jack screw counterclockwise to slowly raise the top of the scissor-jack platform to the same height as the top of the rack-mounting platform. (See Figure 7-53.)

Figure 7-53   Positioning the Scissor-Jack Platform to Extract the Chassis
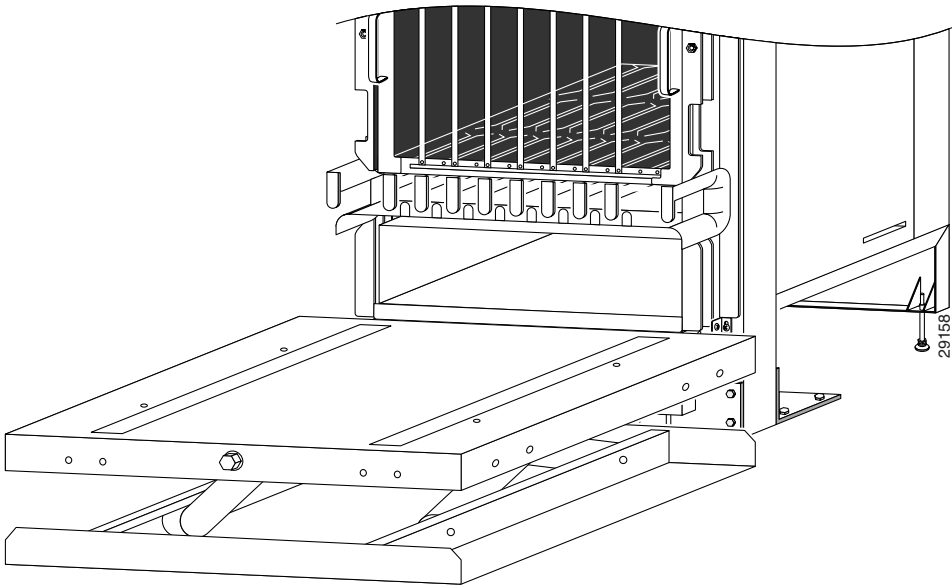
Step 4   Working from the top of the chassis down, remove the screws that secure the chassis to the mounting flanges on the rack (Figure 7-54).

• Set the screws aside for use to install the replacement chassis.

Warning   **The chassis is still supported by the rack-mounting platform installed in the bottom of the rack, but should be held to prevent the possibility of tipping out of the front of the rack.**

Figure 7-54   Removing the Mounting Screws

Chassis mounting holes group E

Chassis mounting holes group D

Chassis mounting holes group C

Chassis mounting holes group B

Chassis mounting holes group A
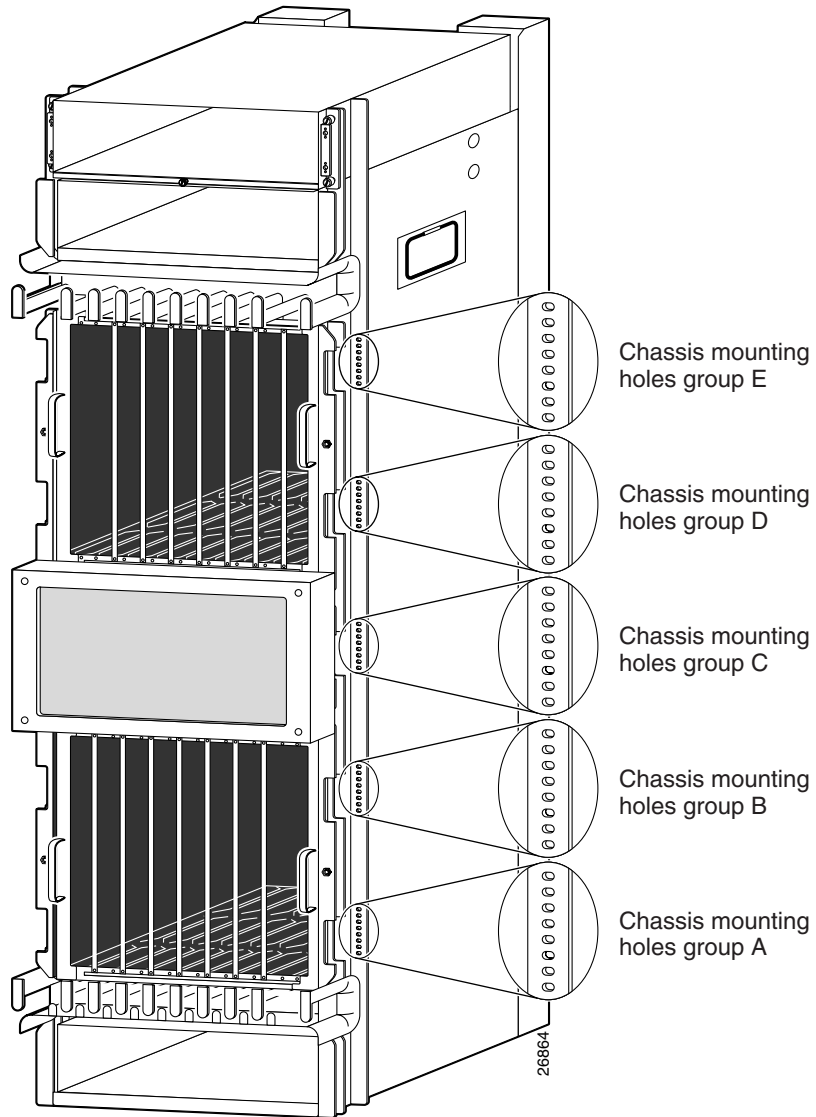
Step 5   Position one person in front of the chassis to support and guide it while the second person slowly pushes the chassis to slide it off the rack-mounting table and onto the scissor-jack platform.

Step 6   Install the four chassis anchor clips through the slots in the bottom of the chassis:

⚠️

Warning   **One person should be holding the side of the chassis to prevent it from tipping.**

    a.   Align the holes with the bolt holes in the platform.

    b.   Insert and tighten the four bolts to prevent the chassis from shifting on the scissor-jack platform (Figure 7-55).

Figure 7-55   Securing the Chassis to the Scissor-Jack Platform
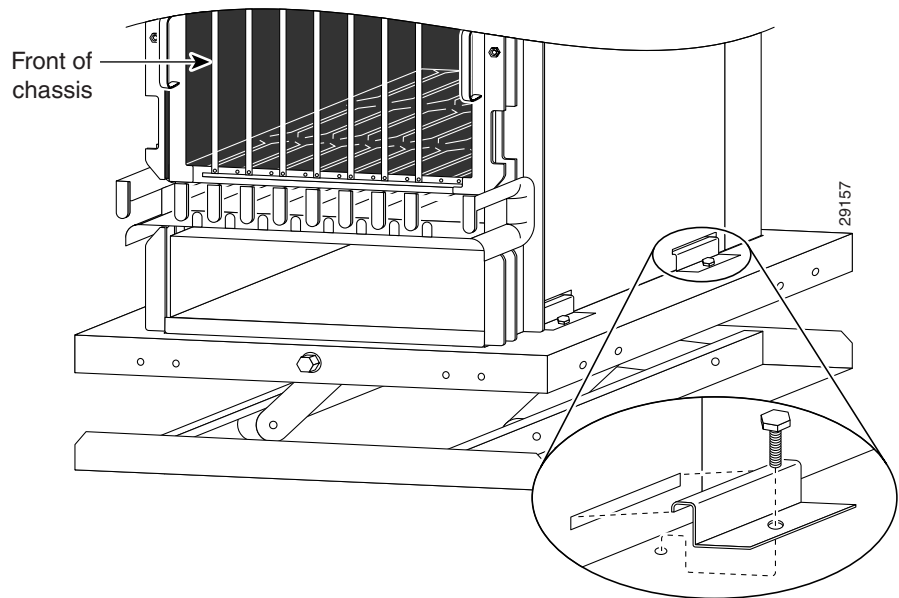
Front of chassis

Step 7   Turn the scissor-jack screw clockwise to slowly lower the scissor-jack platform (Figure 7-56).

Figure 7-56   Closing the Scissor-Jack Platform to Lower the Chassis
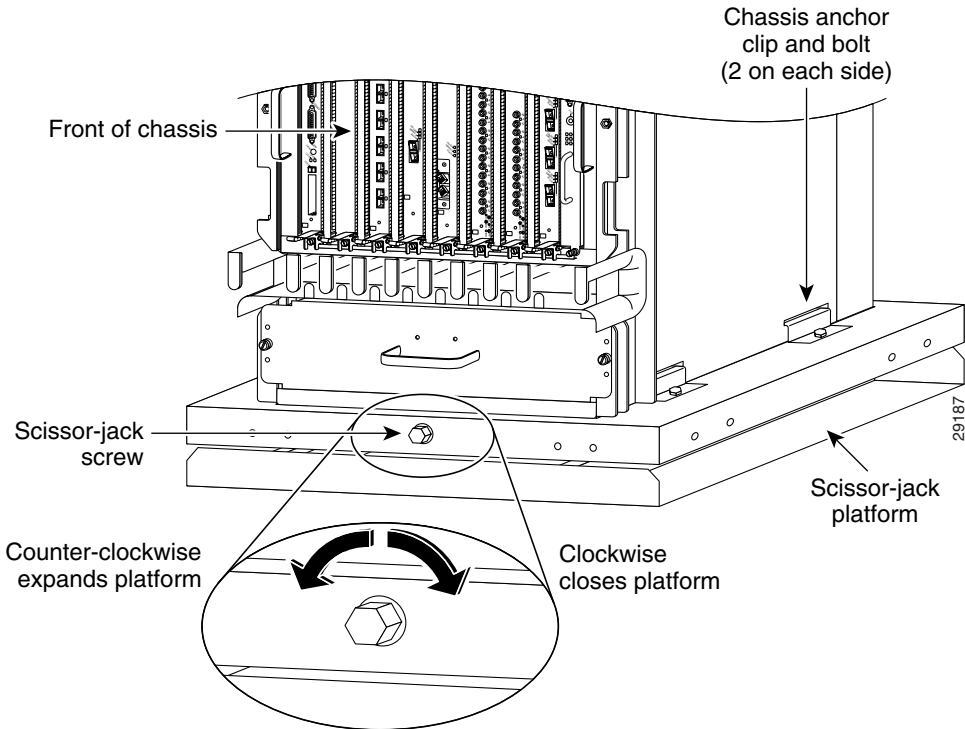
Step 8   Slide the chassis and scissor-jack platform onto a safety hand truck with outrigger wheels and secure it with the locking safety strap.

   –   Move the chassis to a level solid floor where the chassis can be repackaged for shipping.

   –   Use the packaging and unpacking instructions that came with the replacement chassis to repack and ship a defective chassis to the factory.

Installing the Replacement Chassis

Use the following procedure to install the replacement rack in the chassis.

Step 1 Disconnect the temporary ground connections to the replacement chassis.

Step 2 Install the chassis into the rack (see Rack-Mounting the Router Chassis, page 3-8).

Step 3 Connect all ground connections to the chassis (see Supplemental Bonding and Grounding Connections, page 3-21).

Step 4 Attach the vertical cable management troughs (see Attaching the Vertical Cable-Management Trough, page 3-25).

Step 5 Connect all line card interface cables using the notes and labeling you created when disconnecting them from the defective chassis.

Step 6 Connect power cables to the router (see Connecting Power to the Power Shelf, page 3-41).

Step 7 Power on the router (see Powering On the Router and Observing the Boot Process, page 4-4).

Removing and Replacing a Power Bus Board Fuse

There are two user-replaceable fuses on the power bus board inside the power interface panel:

- The fuse labeled F1 protects the MBus controller module.

- The fuse labeled F2 protects the 5.1 VDC bias voltage for the current monitoring (Imon) signal and the voltage monitoring (Vmon) signals on AC power subsystems.

Note Fuse F2 is used only in AC-input power shelves. It is not used in DC-input power shelves. Spane fuses can be ordered from Cisco as part number: PWR-2A/125V-FUSE=.

Use the following procedure to replace a fuse on the power bus board.

Step 1 Power off the router (see Powering Off the Router, page 7-2).

⚠

Warning **The router must be powered down before a fuse can be removed and replaced.**

Step 2 Remove the power bus board MBus access cover by loosening the four captive screws (Figure 7-57).

Figure 7-57   MBus Controller Access Cover

Back panel of chassis   MBus access cover

Captive screws
(2 on each side
of access cover)

28448
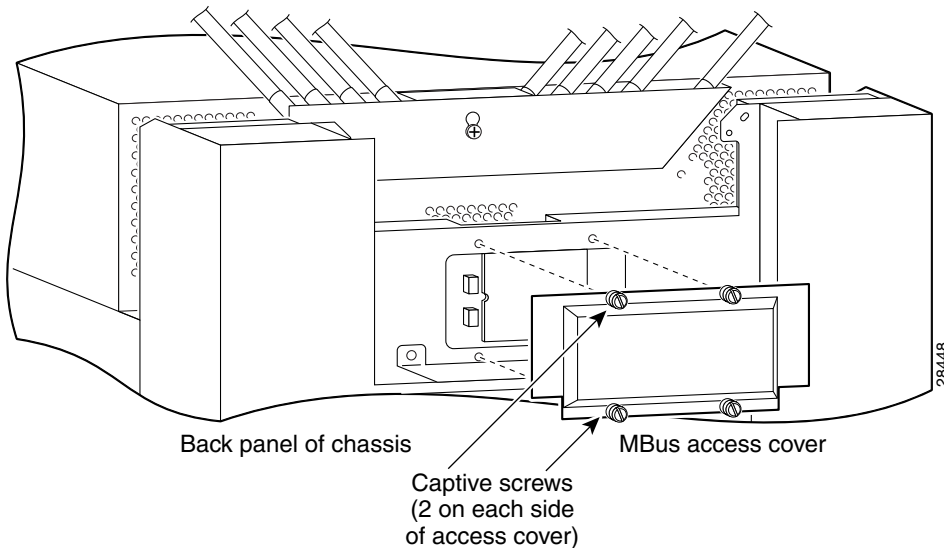
Step 3 Remove the fuse from the fuse holder using a non-conducting fuse extraction tool (Figure 7-58).

Step 4 Insert the replacement fuse using the fuse extraction tool to hold the replacement fuse, align the fuse with the opening in the fuse holder.

Step 5 Reinstall the MBus access cover.

Step 6 Power on the router and return it to service (see Powering On the Router and Observing the Boot Process, page 4-4).

Figure 7-58   Removing and Replacing a Power Bus Board Fuse

MBus module

Screw holes (4) ──▶

F2

F1

F1 - MBus
F2 - 5.1V bias
Fuse is 2A/125V

Fuse
pulling
tool

Fuse
holder

Fuse

28449
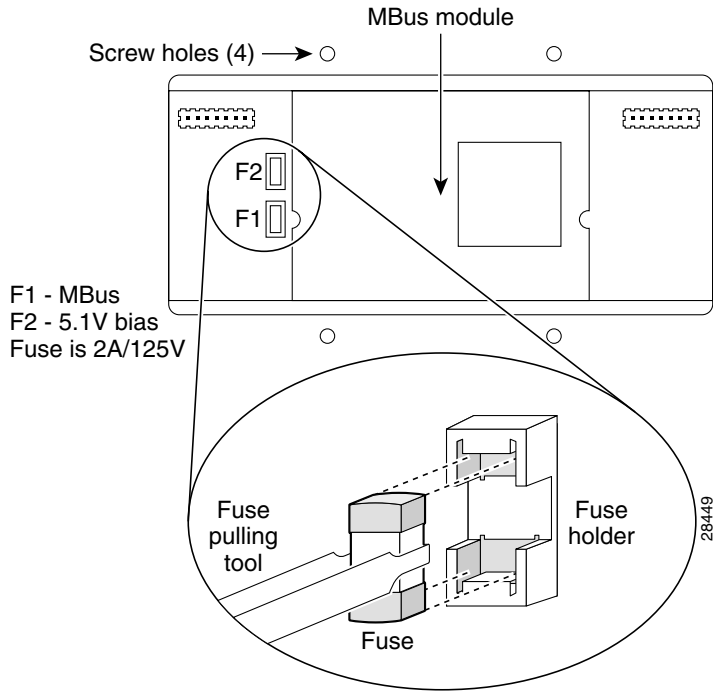
■ **Removing and Replacing a Power Bus Board Fuse**

APPENDIX A

Technical Specifications

This appendix includes the following sections:

- Router Specifications, page A-1
- Compliance and Safety Information, page A-5

Router Specifications

The Cisco 12016, Cisco 12416, and Cisco 12816 Router original series and enhanced series specifications are presented in four tables:

- Table A-1, "Physical Specifications for Cisco 12000 Series Routers"
- Table A-2, "AC Electrical Specifications"
- Table A-3, "DC Electrical Specifications"
- Table A-4, "Environmental Specifications"

Table A-1   Physical Specifications for Cisco 12000 Series Routers

Description	Value
Chassis height	
• With standard AC-input power shelf or DC-input power shelf	71.5 in. (181.6 cm); 72.5 in. (184.1 cm) with front covers installed
• With optional AC-input power shelf	77.63 in. (197.2 cm); 79.11 in. (200.9 cm) with front covers installed
Chassis width	17.25 in. (43.8 cm) 19.0 in. (48.3 cm) including chassis rack-mount flanges and front door width
Chassis depth	22.0 in. (55.9 cm) 26.25 in. (66.7 cm) including cable management system and front covers
Weight	
• Chassis only, standard power shelf	140 lb (64 kg)
• Chassis only, optional AC-input power shelf	160 lb (73 kg)
• Chassis fully configured, using all card slots, AC-input power shelf, and 3 AC-input power supplies	412 lb (187 kg)
• Chassis fully configured, using all card slots, AC-input power shelf, and 4 AC-input power supplies	440 lb (200 kg)

Table A-2   AC Electrical Specifications

Description	Value
Power	
• Standard subsystem (3 power supplies—original series)	4000 W maximum (for 3 AC-input power supplies—N+1 redundancy)
• Optional subsystem (4 power supplies—original series)	4000 W maximum (for 4 AC-input power supplies—N+2 redundancy)
• Standard subsystem (3 power supplies—enhanced series)	4800 W maximum (for 3 AC-input power supplies—N+1 redundancy)
• Optional subsystem (4 power supplies—enhanced series)	4800 W maximum (for 4 AC-input power supplies—N+2 redundancy)
Rated input voltage[1]	200 to 240 VAC nominal (range: 180 to 264 VAC)
Rated input line frequency[1]	50 to 60 Hz nominal (range: 47 to 63 Hz)
Input current rating[1]	13 A maximum @ 200 to 240 VRMS
Source AC service requirement[1]	20 A North America; 16 A international

1. For each power supply module (three in the standard shelf; four in the optional shelf).

⚠
Caution   To ensure that the chassis configuration complies with the required power budgets, use the on-line power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails. Contact your local sales representative for assistance.

Table A-3   DC Electrical Specifications

Description	Value
Power	4800 W maximum
Rated input voltage[1]	–48 VDC nominal in North America –60 VDC nominal in the European Community (range: –40.5 to –72 VDC (–75 VDC FOR 5mS))
	–40 VDC to –72 VDC steady-state input voltage

Table A-3   DC Electrical Specifications

Description	Value
Input current rating	60A maximum @ 40.5 VDC
Source DC service requirement	Sufficient to supply the rated input current. Local codes apply.

1. For each PEM.

⚠

Caution   To ensure that the chassis configuration complies with the required power budgets, use the on-line power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails. Contact your local sales representative for assistance.

Table A-4   Environmental Specifications

Description	Value
Temperature	Operating: 32° to 104°F (0° to 40°C)
	Nonoperating: –4° to 149°F (–20° to 65°C)
Humidity	Operating: 10 to 90% noncondensing
	Nonoperating: 5 to 95% noncondensing
Altitude	Operating: 0 to 10,000 ft (0 to 3,000 m)
	Nonoperating: 0 to 15,000 ft (0 to 4,570 m)
Heat dissipation	11,602 BTU/hr maximum (original series)
	16,378 BTU/hr maximum (enhanced series)
Acoustic noise	70 dBa maximum
Shock	Operating (halfsine): 21 in./sec (0.53 m/sec)
	Nonoperating (trapezoidal pulse): 20G[1], 52 in./sec (1.32 m/sec)
Vibration	Operating: 0.35 Grms[2] from 3 to 500 Hz
	Nonoperating: 1.0 Grms from 3 to 500 Hz

1. G is a value of acceleration, where 1G equals 32.17 ft/sec^2 (9.81 m/sec^2).

2. Grms is the root mean square value of acceleration.

Compliance and Safety Information

The Cisco 12016, Cisco 2416 and Cisco 12816 routers are designed to meet the regulatory compliance and safety approval requirements. Refer to the *Regulatory Compliance and Safety Information for the Cisco 12000 Series Router* (Document Number 78-4347-xx) if you require additional compliance information (see "Cisco Technical Support & Documentation Website" section on page -xx for site information).

■ **Compliance and Safety Information**

Site Log

The site log provides a historical record of all actions relevant to the operation and maintenance of the router. Keep your site log in a convenient place near the router where anyone who performs the maintenance has access to it.

Site log entries might include the following:

- Installation progress—Make entries in the site log to record installation progress. Note any difficulties and remedies during the installation process.

- Upgrades or removal and replacement procedures—Use the site log as a record of router maintenance and expansion history.

  Each time a procedure is performed on the router, update the site log to show the following:

  - Any FRU that is installed, removed, or replaced

  - Any router configuration changes

  - Software upgrades

  - Corrective or preventive maintenance procedures performed

  - Intermittent problems

  - Related comments

The following page shows a sample site log page. You can make copies of the sample or design your own site log page to meet the needs of your site and equipment.

Date	Action Performed or Symptoms Observed	Initials

INDEX

Numerics

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D

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