

M160 Internet Router

Hardware Guide

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About This Guide

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- List of Technical Publications on page xxi
- Documentation Feedback on page xxiii
- Requesting Support on page xxiii

Objectives

This manual describes hardware installation and basic troubleshooting procedures for the Juniper Networks M160 Internet router. It explains how to prepare your site for router installation, unpack and install the hardware, power on the router, perform initial software configuration, and perform routine maintenance. After completing the installation and basic configuration procedures covered in this manual, refer to the JUNOS Internet software configuration guides for information about further JUNOS software configuration.



NOTE: For additional information about Juniper Networks Internet routers and the Physical Interface Cards (PICs) they support—either corrections to or information that might have been omitted from this guide—see the hardware release notes at <http://www.juniper.net/>.

Audience

This guide is designed for network administrators who are installing and maintaining a Juniper Networks router or preparing a site for router installation. To use this guide, you need a broad understanding of networks in general, the Internet in particular, networking principles, and network configuration. Any detailed discussion of these concepts is beyond the scope of this guide.

Documentation Conventions

Table 1 defines the notice icons used in this guide.

Table 1: Notice Icons




Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.

Table 2 defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold sans serif typeface	Represents text that you type.	To enter configuration mode, type the configure command: user@host> configure
Fixed-width typeface	Represents output that appears on the terminal screen.	user@host> show chassis alarms No alarms currently active
<i>Italic typeface</i>	<ul style="list-style-type: none"> Introduces important new terms. Identifies book names. Identifies RFC and Internet draft titles. 	<ul style="list-style-type: none"> A policy <i>term</i> is a named structure that defines match conditions and actions. <i>JUNOS System Basics Configuration Guide</i> RFC 1997, <i>BGP Communities Attribute</i>
<i>Italic sans serif typeface</i>	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# set system domain-name domain-name
Sans serif typeface	Represents names of configuration statements, commands, files, and directories; IP addresses; configuration hierarchy levels; or labels on routing platform components.	<ul style="list-style-type: none"> To configure a stub area, include the stub statement at the [edit protocols ospf area area-id] hierarchy level. The console port is labeled CONSOLE.
< > (angle brackets)	Enclose optional keywords or variables.	stub <default-metric metric >;
(pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	broadcast multicast (string1 string2 string3)

Convention	Description	Examples
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	rsvp { # Required for dynamic MPLS only
[] (square brackets)	Enclose a variable for which you can substitute one or more values.	community name members [community-ids]
Indentation and braces ({ })	Identify a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop address ; retain; } } }
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
J-Web GUI Conventions		
Bold typeface	Represents J-Web graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none">■ In the Logical Interfaces box, select All Interfaces.■ To cancel the configuration, click Cancel.
> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select Protocols > Ospf .

List of Technical Publications

Table 3 lists the software and hardware guides and release notes for Juniper Networks routing platforms that use the JUNOS Internet software and describes the contents of each book.

Table 3: Juniper Networks Technical Documentation

Book	Description
JUNOS for J-series, M-series, and T-series Routing Platforms Configuration Guides	
<i>Feature Guide</i>	Provides a detailed explanation and configuration examples for several of the most complex features in the JUNOS software.
<i>System Basics</i>	Provides an overview of the JUNOS software and describes how to install and upgrade the software. This manual also describes how to configure system management functions and how to configure the chassis, including user accounts, passwords, and redundancy.
<i>Network Interfaces and Class of Service</i>	Provides an overview of the network interface and class-of-service functions of the JUNOS software and describes how to configure the network interfaces on the router.
<i>MPLS Applications</i>	Provides an overview of traffic engineering concepts and describes how to configure traffic engineering protocols.

Book	Description
<i>Multicast Protocols</i>	Provides an overview of multicast concepts and describes how to configure multicast routing protocols.
<i>Network Management</i>	Provides an overview of network management concepts and describes how to configure various network management features, such as SNMP, accounting options, and cflowd.
<i>Policy Framework</i>	Provides an overview of policy concepts and describes how to configure routing policy, firewall filters, and forwarding options.
<i>Routing Protocols</i>	Provides an overview of routing concepts and describes how to configure routing, routing instances, and unicast routing protocols.
<i>Services Interfaces</i>	Provides an overview of the services interfaces functions of the JUNOS software and describes how to configure the services interfaces on the router.
<i>VPNs</i>	Provides an overview and describes how to configure Layer 2 and Layer 3 virtual private networks (VPNs), virtual private LAN service (VPLS), and Layer 2 circuits. Provides configuration examples.
JUNOS References	
<i>Network and Services Interfaces Command Reference</i>	Describes the JUNOS Internet software operational mode commands you use to monitor and troubleshoot network and services interfaces on Juniper Networks routing platforms.
<i>Protocols, Class of Service, and System Basics Command Reference</i>	Describes the JUNOS Internet software operational mode commands you use to monitor and troubleshoot most aspects of Juniper Networks routing platforms.
<i>System Log Messages Reference</i>	Describes how to access and interpret system log messages generated by JUNOS software modules and provides a reference page for each message.
JUNOScript API Documentation	
<i>JUNOScript API Guide</i>	Describes how to use the JUNOScript application programming interface (API) to monitor and configure Juniper Networks routers.
<i>JUNOScript API Configuration Reference</i>	Provides reference pages for the configuration tags in the JUNOScript API.
<i>JUNOScript API Operational Reference</i>	Provides reference pages for the operational tags in the JUNOScript API.
JUNOS Comprehensive Index and Glossary	
<i>Comprehensive Index and Glossary</i>	Provides a complete index of all JUNOS Internet software books and the <i>JUNOScript API Guide</i> . Also provides a comprehensive glossary.
Hardware Documentation	
<i>Hardware Guide</i>	Describes how to install, maintain, and troubleshoot routers and router components. Each platform has its own hardware guide.
<i>PIC Guide</i>	Describes the router Physical Interface Cards (PICs). Each router platform has its own PIC guide.
JUNOScope Documentation	
<i>JUNOScope Software User Guide</i>	Describes the JUNOScope software graphical user interface (GUI), how to install and administer the software, and how to use the software to manage router configuration files and monitor router operations.

Book	Description
J-series Services Router Documentation	
<i>J-series Services Router User Guide</i>	Contains instructions for installing, configuring, and managing a J-series Services Router. The guide explains how to prepare your site for installation, unpack and install the hardware, power on the router, configure secure routing, monitor network operations, and perform routine maintenance.
Release Notes	
<i>JUNOS Internet Software Release Notes</i>	Provide a summary of new features for a particular software release. Software release notes also contain corrections and updates to published JUNOS and JUNOScript manuals, provide information that might have been omitted from the manuals, and describe upgrade and downgrade procedures.
<i>Hardware Release Notes</i>	Describe the available documentation for the router platform and summarize known problems with the hardware and accompanying software. Each platform has its own release notes.
<i>JUNOScope Software Release Notes</i>	Contain corrections and updates to the published JUNOScope manual, provide information that might have been omitted from the manual, and describe upgrade and downgrade procedures.
<i>J-series Services Router Release Notes</i>	Briefly describe Services Router features, identify known hardware problems, and provide upgrade and downgrade instructions

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. You can send your comments to techpubs-comments@juniper.net, or fill out the documentation feedback form at <http://www.juniper.net/techpubs/docbug/docbugreport.html>. If you are using e-mail, be sure to include the following information with your comments:

- Document name
- Document part number
- Page number
- Software release version

Requesting Support

For technical support, open a support case using the Case Manager link at <http://www.juniper.net/support/> or call 1-888-314-JTAC (within the United States) or 1-408-745-9500 (outside the United States).

Part 1

Product Overview

- System Overview on page 3
- Hardware Component Overview on page 7
- JUNOS Internet Software Overview on page 43
- System Architecture Overview on page 51

Chapter 1

System Overview

This chapter provides an overview of the Juniper Networks M160 Internet router, discussing the following topics:

- System Description on page 3
- Field-Replaceable Units (FRUs) on page 4
- System Redundancy on page 4
- Safety Requirements, Warnings, and Guidelines on page 5

System Description

The M160 Internet router is a complete routing system that provides SONET/SDH, ATM, Ethernet, and channelized interfaces for large networks and network applications, such as those supported by Internet service providers (ISPs). Application-specific integrated circuits (ASICs), a definitive part of the router design, enable the router to forward data at the high speeds demanded by current network media.

The router accommodates up to eight Flexible PIC Concentrators (FPCs), which can each be configured with a variety of network media types, altogether providing up to 32 OC-12/STM-4, 32 OC-48/STM-16, or eight OC-192/STM-64 ports per system. The router height of 35 in. (89 cm) enables stacked installation of two M160 systems in a single floor-to-ceiling rack, for increased port density per unit of floor space.

The router's maximum aggregate throughput is 160 gigabits per second (Gbps) simplex or 80 Gbps full duplex. The router provides very high throughput for any combination of Physical Interface Cards (PICs) that does not exceed 3 Gbps on an FPC1 or 10 Gbps on an FPC2. A combination that exceeds these numbers is supported, but constitutes oversubscription.

The router architecture cleanly separates control operations from packet forwarding operations, which helps to eliminate processing and traffic bottlenecks. Control operations in the router are performed by the Routing Engine, which runs JUNOS Internet software to handle routing protocols, traffic engineering, policy, policing, monitoring, and configuration management. Forwarding operations in the router are performed by the Packet Forwarding Engine, which consists of hardware, including ASICs, designed by Juniper Networks.

Field-Replaceable Units (FRUs)

Field-replaceable units (FRUs) are router components that can be replaced at the customer site. Replacing most FRUs requires minimal router downtime. The router uses the following types of FRUs:

- Hot-removable and hot-insertable FRUs—You can remove and replace these components without powering down the router or disrupting the routing functions.
- Hot-pluggable FRUs—You can remove and replace these components without powering down the router, but the routing functions of the system are interrupted when the component is removed.

Table 4 lists the FRUs for the M160 router.

Table 4: Field-Replaceable Units

Hot-Removable and Hot-Insertable FRUs	Hot-Pluggable FRUs	FRUs That Require Powering Down the Router
Air filter Fan tray (located behind the cable management system) Flexible PIC Concentrator (FPC) Physical Interface Card (PIC) Power supply Small form factor pluggable (SFP)	Miscellaneous Control Subsystem (MCS) Packet Forwarding Engine Clock Generator (PCG) Routing Engine Switching and Forwarding Module (SFM)	Circuit breaker box Connector Interface Panel (CIP)

For FRU replacement instructions, see “Replacing Hardware Components” on page 139.

System Redundancy

The router is designed so that no single point of failure can cause the entire system to fail. The following hardware components contribute to system redundancy:

- Cooling system—When the temperature inside the router is below the acceptable maximum, the cooling system’s components function at less than full speed. If the temperature becomes excessive—for example, because a cooling system component is removed—the MCS automatically increases the speed of the remaining components to reduce the temperature. The cooling

system can function at the higher speed indefinitely. For more information, see Cooling System on page 39.

- Host module (Routing Engine and MCS functioning together)—The router can have one or two host modules. If two host modules are installed, one (the master) is active and the other is in standby mode. If the master host module (or either of its components) is removed from the chassis, the standby host module becomes active. The Routing Engine and MCS must reside in adjacent slots and be fully operational for the host module to function. For more information, see Host Module on page 22.
- PCG—The router has two PCGs. Both PCGs send their clock signals to the other Packet Forwarding Engine components, along with a signal that indicates which clock is the master. If one PCG fails, the other PCG becomes the master system clock. For more information, see “Packet Forwarding Engine Clock Generators (PCGs)” on page 18.
- Power supply—The router has two load-sharing, fully redundant power supplies to distribute DC power to the other components. If one power supply fails, the second power supply can provide full power to the router’s components indefinitely. For more information, see Power System on page 35.
- SFM—The router can have up to four interconnected SFMs. If one SFM fails, the switching and forwarding functions of the failed module are distributed among the remaining SFMs. Total bandwidth is reduced by $1/n$, where n is the total number of SFMs installed in the router. For example, in a system with four SFMs, each SFM provides one-fourth of the forwarding capacity. For more information, see “Switching and Forwarding Module (SFM)” on page 19.

In the base configuration, the router has one host module and multiple SFMs, PCGs, power supplies, and cooling system components.

Safety Requirements, Warnings, and Guidelines

To avoid harm to yourself or the router as you install and maintain it, you need to follow the guidelines for working with and near electrical equipment, as well as the safety procedures for working with Internet routers. For a discussion of how to make the installation site a safe environment, see “Preparing for Router Installation” on page 59. For a list of safety warnings, see “Safety and Regulatory Compliance Information” on page 221 and particularly “Electrical Safety Guidelines and Warnings” on page 227. However, providing an exhaustive set of guidelines for working with electrical equipment is beyond the scope of this manual.

Chapter 2

Hardware Component Overview

This chapter provides an overview of the hardware components on the M160 Internet router:

- Chassis on page 7
- Packet Forwarding Engine on page 11
- Host Module on page 22
- Craft Interface on page 27
- Connector Interface Panel (CIP) on page 32
- Power System on page 35
- Cooling System on page 39
- Cable Management System on page 41

Chassis

The router chassis is a rigid sheet metal structure that houses the other hardware components. The chassis is 17.5 in. (44.5 cm) wide and 29 in. (73.6 cm) deep. The chassis height of 35 in. (89 cm) enables stacked installation of two M160 routers in a single floor-to-ceiling rack. For more information, see Rack Requirements on page 59.

The two front support posts and center-mounting brackets (one on each side) extend the chassis width to 19 in. (48.3 cm) and enable installation into either a front-mount or a center-mount rack.

Figure 1, Figure 2, and Figure 3 show three views of the router chassis.

Figure 1: Front of Chassis

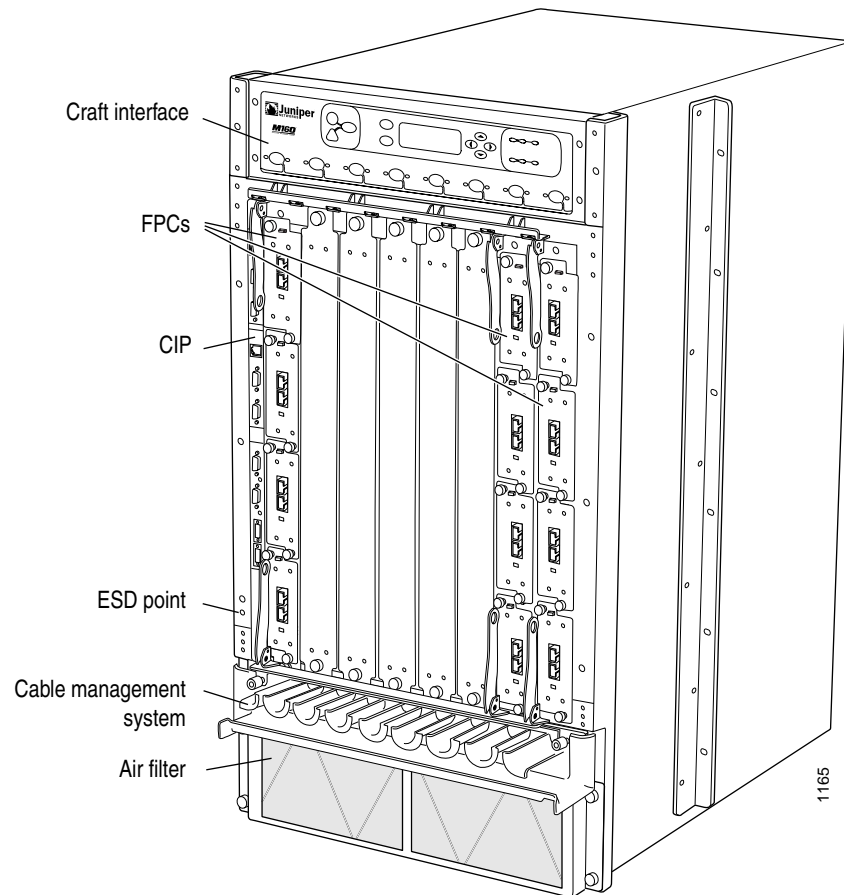


Figure 2: Rear of Chassis with Component Cover in Place

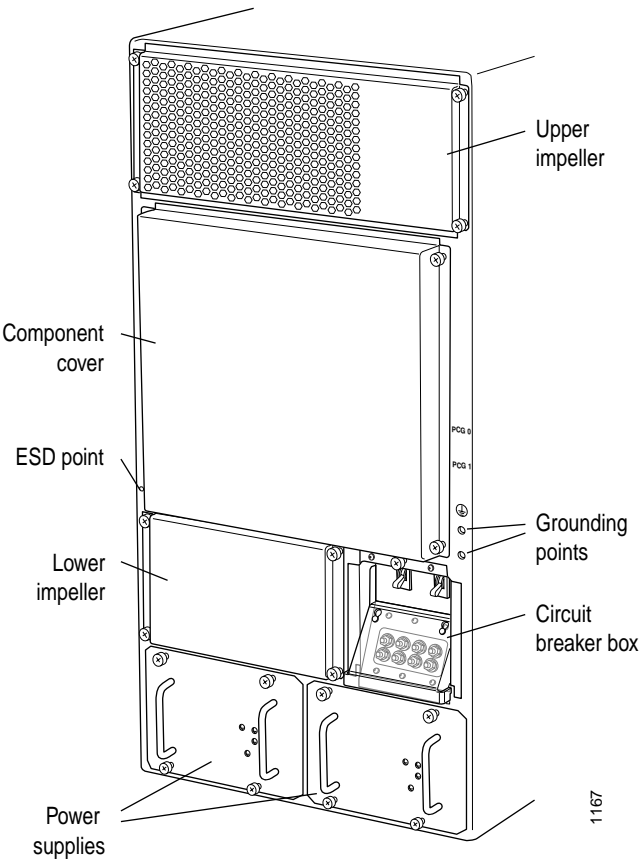
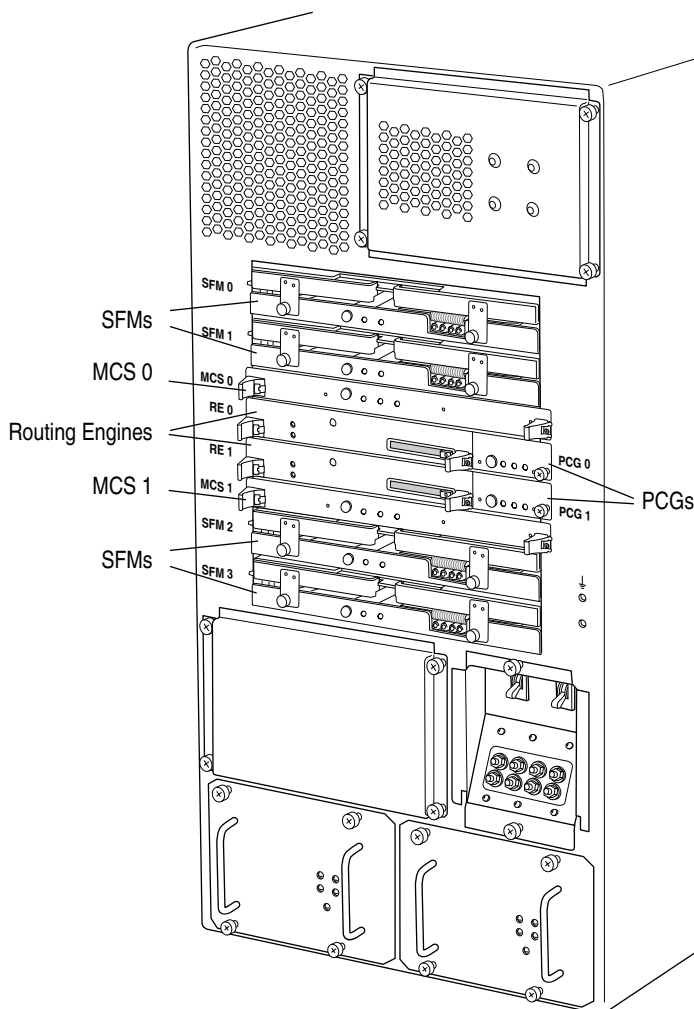


Figure 3: Rear of Chassis with Component Cover Removed

The chassis includes the following electrical safety components:

- Two electrostatic discharge (ESD) points (banana plug receptacles), one front and one rear, as shown in Figure 1 and Figure 2
- Two internally threaded grounding points, as shown in Figure 2



WARNING: Before removing or installing components of a functioning router, attach an ESD strap to an ESD point and place the other end of the strap around your bare wrist. Failure to use an ESD strap could result in damage to the router.

The router must be connected to earth ground during normal operation.

For further safety information, see “Safety and Regulatory Compliance Information” on page 221.

Table 5 summarizes physical specifications for the router chassis.

Table 5: Chassis Physical Specifications

Description	Value
Chassis height	35 in. (89 cm)
Chassis width	17.5 in. (44.5 cm) for sides of chassis 19 in. (48.3 cm) with front support posts and center-mounting brackets
Chassis depth	29 in. (73.6 cm)
Weight, maximum configuration	370.5 lb (168 kg)
Weight, minimum configuration	190 lb (86 kg)
Thermal output	9400 BTU/hour

Packet Forwarding Engine

The Packet Forwarding Engine is a multicomponent system that uses application-specific integrated circuits (ASICs) to perform Layer 2 and Layer 3 packet switching, route lookups, and packet forwarding. The ASICs include the Distributed Buffer Manager ASIC, Internet Processor II ASIC, I/O Manager ASIC, Packet Director ASIC, and media-specific controller ASICs.

The Packet Forwarding Engine has the following components:

- Midplane—Physically separates front and rear cavities inside the chassis, distributes power from the power supplies, and transfers packets and signals between router components, which plug into it.
- Physical Interface Card (PIC)—Physically connects the router to network media such as OC-12/STM-4, OC-48/STM-16, Ethernet, and channelized interfaces. PICs are housed in Flexible PIC Concentrators (FPCs). (Quad-wide PICs, such as the OC-192/STM-64 SONET/SDH PIC, are exceptions. Such PICs occupy

an entire FPC slot in the chassis and insert directly into the slot rather than into an FPC card carrier.)

- Flexible PIC Concentrator (FPC)—Processes incoming and outgoing packets. Up to eight FPCs plug into the midplane from the front of the chassis. Each FPC accommodates up to four PICs.
- Packet Forwarding Engine Clock Generator (PCG)—Sends clock signals to the other Packet Forwarding Engine components. Two PCGs plug into the midplane from the rear of the chassis.
- Switching and Forwarding Module (SFM)—Performs route lookup, filtering, and switching. Up to four SFMs plug into the midplane from the rear of the chassis.

For information about Packet Forwarding Engine components, see the following sections:

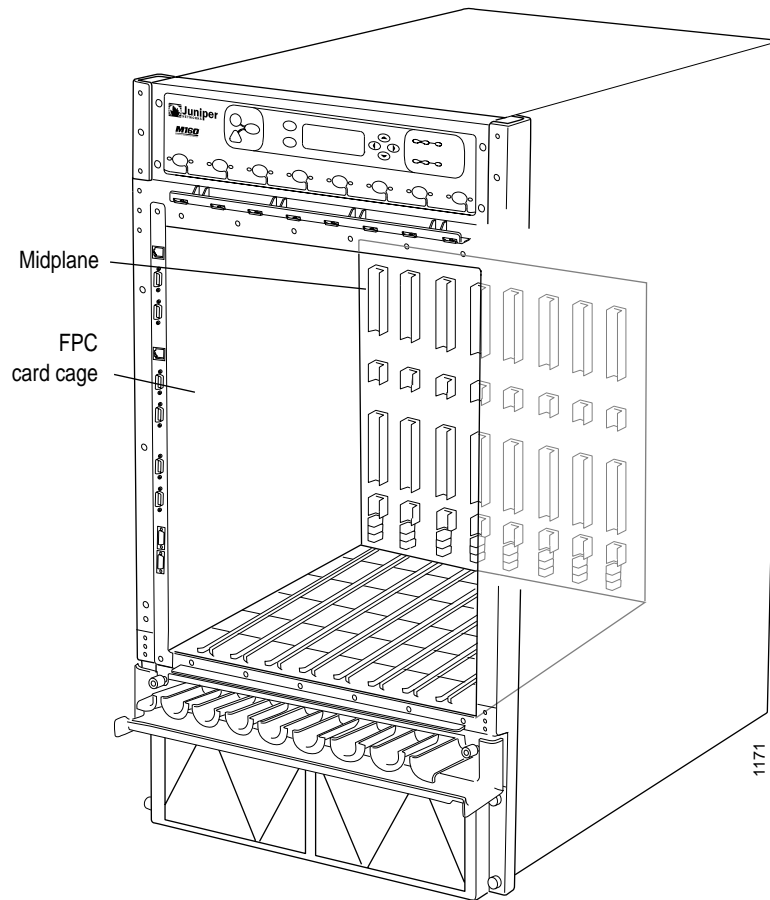
- Midplane on page 12
- Physical Interface Cards (PICs) on page 13
- Flexible PIC Concentrators (FPCs) on page 14
- Packet Forwarding Engine Clock Generators (PCGs) on page 18
- Switching and Forwarding Module (SFM) on page 19

Midplane

The midplane is a panel located in the center of the chassis, running from side to side and forming the rear of the FPC card cage (see Figure 4). All router components other than PICs plug directly into the midplane. The midplane contains an EEPROM that stores the serial number and revision level of the midplane.

The midplane performs the following functions:

- Transfer of packets—The midplane accepts an incoming packet after it is processed by an FPC, and transmits it to an SFM. The SFM performs switching and forwarding functions and transfers outgoing packets back across the midplane to the FPCs for transmission to the network.
- Power distribution—The midplane distributes power to all router components from the power supplies attached to it.
- Signal connectivity—The midplane transports the signals exchanged by system components for monitoring and control purposes.

Figure 4: Midplane

Physical Interface Cards (PICs)

Physical Interface Cards (PICs) physically connect the router to network media. They are housed in Flexible PIC Concentrators (FPCs); for more information about FPCs, see “Flexible PIC Concentrators (FPCs)” on page 14. (Quad-wide PICs, such as the OC-192/STM-64 SONET/SDH PIC, are exceptions. Such PICs occupy an entire FPC slot in the chassis and insert directly into the slot rather than into an FPC card carrier.)

PICs receive incoming packets from the network and transmit outgoing packets to the network, performing framing and line-speed signaling for their media type as required. PICs also encapsulate outgoing packets received from the FPCs before transmitting them. The controller ASIC on each PIC performs additional control functions specific to the PIC media type.

The router supports various PICs, including ATM, Channelized, Gigabit Ethernet, IP Services, and SONET/SDH interfaces. For complete PIC specifications, see the *M160 Internet Router PIC Guide*.

Some PICs, such as selected Gigabit Ethernet PICs, accept small form factor pluggables (SFPs), which are fiber-optic transceivers that can be removed from the PIC. Various SFPs have different reach characteristics. You can mix them in a single PIC and change the combination dynamically. SFPs are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. For SFP replacement instructions, see “Replace an SFP” on page 190. For information about PICs that use SFPs, see the *M160 Internet Router PIC Guide*.

You can install up to four PICs in an FPC. The number of ports on a PIC depends on the type of PIC. PICs are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. For PIC replacement instructions, see “Replacing a PIC” on page 179.

PIC Components

Most PICs supported on the M160 router have the following components. For complete specifications, see the *M160 Internet Router PIC Guide*. For information about pinouts for PIC cable connectors, see “Cable Connector Pinouts” on page 269.

- One or more cable connector ports—Accept a network media connector.
- LEDs—Indicate PIC and port status. Most PICs have an LED labeled **STATUS** on the PIC faceplate. Some PICs have additional LEDs, often one per port. The meaning of the LED states differs for various PICs. For more information, see the *M160 Internet Router PIC Guide*.
- Offline button—Prepares the PIC for removal from the FPC when pressed. For the PICs that install on an FPC1, the offline button for each PIC is next to it on the FPC card carrier. For the PICs that install on an FPC2, the offline button is on the PIC faceplate. See Figure 6.

Flexible PIC Concentrators (FPCs)

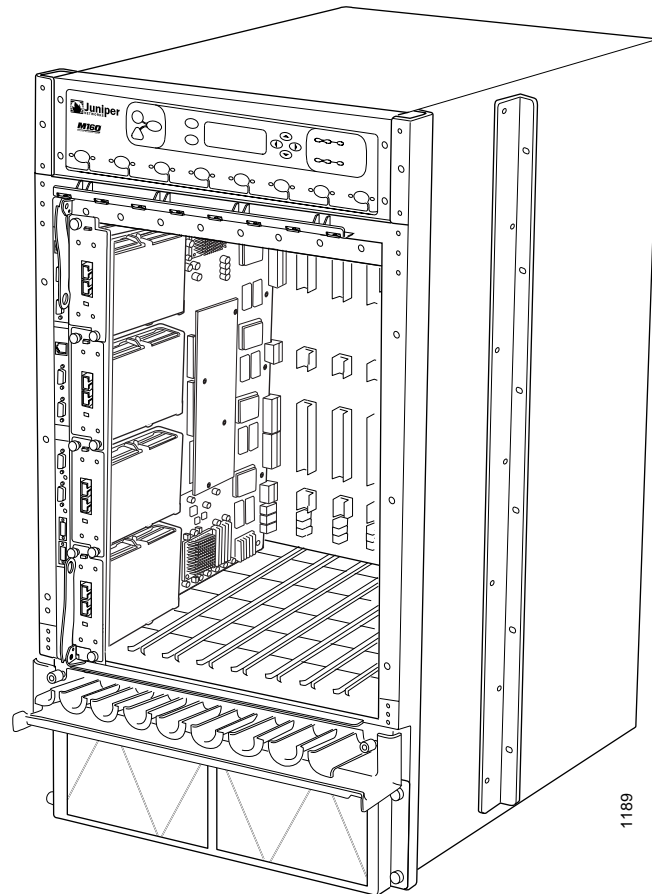
Flexible PIC Concentrators (FPCs) house the PICs that connect the router to network media (for information about PICs, see “Physical Interface Cards (PICs)” on page 13). The main function of an FPC is to connect the PICs installed in it to the other router components. An I/O Manager ASIC on the FPC divides each incoming data packet into 64-byte cells and passes the cells through the midplane to the SFM, where another ASIC decides how to distribute them among the memory buffers located on and shared by all installed FPCs. After the SFM decides how to forward a packet, an I/O Manager ASIC on the FPC reassembles the corresponding data cells back into network-packet form and passes the packet to the appropriate PIC for transmission to the network. For more information, see “Data Flow through the Packet Forwarding Engine” on page 52.

Up to eight FPCs install vertically into the midplane from the front of the chassis. The FPC slots are numbered from **FPC0** to **FPC7**, left to right. Each FPC accommodates up to four PICs. The PIC slots in each FPC are numbered from 0 (zero) through 3, top to bottom. An FPC can be installed into any FPC slot, regardless of the PICs it contains, and any combination of slots can be used. If a

slot is empty, you must install a blank FPC panel to shield it, so that cooling air can circulate properly throughout the card cage.

Figure 5, which shows a chassis with an FPC in slot FPC0, omits the blank FPC panels to show the position of the FPC in the card cage.

Figure 5: Front of Chassis with Four-PIC FPC Installed in Slot FPC0



For information about FPC components and types, see the following sections:

- FPC Components on page 16
- FPC Types on page 17

FPC Components

An FPC has the following components:

- FPC card carrier—Houses the ASICs, connectors, and processor subsystem.
- Four I/O Manager ASICs—Parse Layer 2 and Layer 3 data and perform encapsulation and segmentation. The I/O Manager ASICs divide incoming packets into 64-byte data cells for easier processing, and reassemble the cells for each packet after the forwarding decision is made for it. Enhanced FPCs have I/O Manager ASICs capable of enhanced quality of service.
- Two Packet Director ASICs—Transfer packets between the PICs and the I/O Manager ASICs: one directs incoming packets from the PICs to the I/O Manager ASICs, while the second directs outgoing packets from the I/O Manager ASICs to the PICs.
- Eight identical synchronous DRAM (SDRAM) dual inline memory modules (DIMMs)—Form the memory pool shared with the other FPCs installed in the router.
- Parity-protected synchronous SRAM (SSRAM)—Stores data structures used by the I/O Manager ASICs.
- Processor subsystem—Manages packet handling in the FPC and communication with the SFM. It is a PowerPC 603e-based CPU with parity-protected DRAM.
- EEPROM—Stores the serial number and revision level of the FPC.
- Two LEDs—Indicate FPC status. The LED labeled **OK** is green and the one labeled **FAIL** is red. The LEDs for each FPC are located on the router craft interface. For more information, see “FPC LEDs and Offline Button” on page 31.
- Offline button—Prepares the FPC for removal from the router when pressed. Like the LEDs, an offline button is located on the craft interface. For more information, see “FPC LEDs and Offline Button” on page 31.
- Four PIC offline buttons (on FPC1 only)—Prepare each corresponding PIC for removal from the FPC.
- Ejector levers—Control the locking system that secures the FPC in the card cage.



NOTE: For specific information about FPC components (for example, the amount of memory available), issue the `show chassis fpc` command.

FPC Types

The router supports two types of FPC, shown in Figure 6:

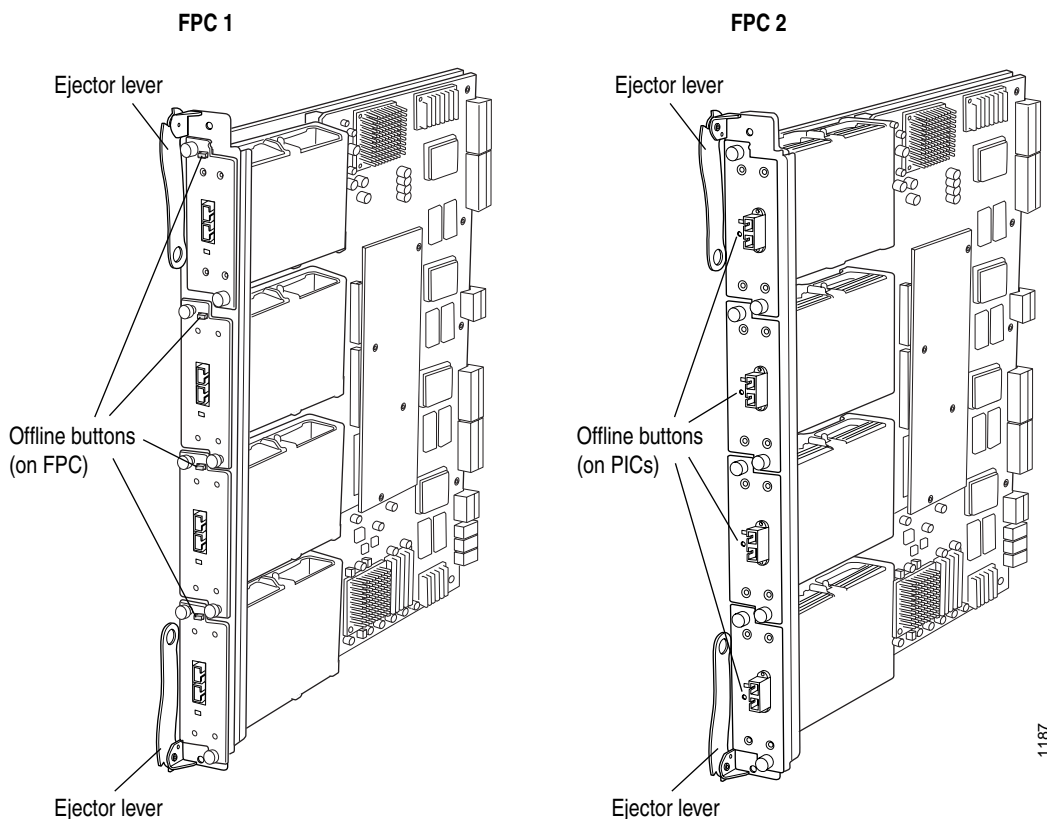
- FPC1 (standard or enhanced)—Supports PICs including single-port OC-12/STM-4 and Gigabit Ethernet.
- FPC2 (standard or enhanced)—Supports higher-speed PICs including OC-48/STM-16 and Tunnel services.

You can install any combination of FPC types together on the router.

FPCs are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. When you remove or install an FPC, packet forwarding halts for about 200 ms while the Packet Forwarding Engine adjusts to the change in the amount of memory available in the pool located on and shared by all FPCs. When you install an FPC into a functioning router, the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs housed on the FPC are enabled. Forwarding continues uninterrupted during this process. For FPC replacement instructions, see “Replacing an FPC” on page 169.

Enhanced FPCs have I/O Manager ASICs capable of enhanced quality of service, and 2 MB of SSRAM. Enhanced FPCs can be identified through the CLI, or by a sticker on the faceplate.

The PICs that install on both types of FPC are also hot-removable and hot-insertable. For more information, see “Physical Interface Cards (PICs)” on page 13.

Figure 6: FPC1 and FPC2

Packet Forwarding Engine Clock Generators (PCGs)

The router has two Packet Forwarding Engine Clock Generators (PCGs) installed in the slots at the rear of the chassis that are labeled **PCG 0** and **PCG 1**, as shown in Figure 3. The PCGs generate a 125-MHz clock signal used to gate packet processing. During startup, the active Routing Engine determines which PCG is master and which is backup, and the MCS relays the decision to the PCGs and to the modules and ASICs in the Packet Forwarding Engine that use the clock signal. The modules and ASICs then use only the signal from the master source.

PCGs are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. Removal or failure of the backup PCG does not affect router function. When the master PCG fails or is removed from the chassis, however, the Packet Forwarding Engine resets so that the components start using the signal from the other PCG (which becomes the master). Packet forwarding halts while there is no clock signal, because the Packet Forwarding Engine does not accept incoming packets. For PCG replacement instructions, see “Replacing a PCG” on page 176.

PCG Components

Each PCG (shown in Figure 7) has the following components:

- Signal generator—Provides a 125-MHz system clock signal.
- EEPROM—Stores the serial number and revision level of the PCG.
- Three LEDs—Indicate PCG status. There is a blue one labeled **MASTER**, a green one labeled **OK**, and an amber one labeled **FAIL**. Table 6 describes the LED states.
- Offline button—Prepares the PCG for removal from the router when pressed.

Figure 7: Packet Forwarding Engine Clock Generator

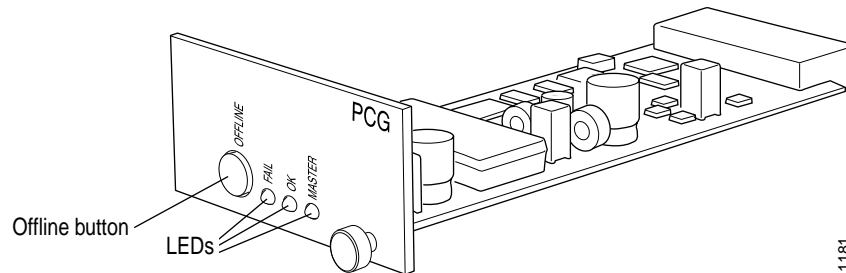


Table 6: States for PCG LEDs

Label	Color	State	Description
MASTER	Blue	On steadily	PCG is master.
OK	Green	On steadily	PCG is functioning normally.
		Blinking	PCG is starting up.
FAIL	Amber	On steadily	PCG has failed.

Switching and Forwarding Module (SFM)

The Switching and Forwarding Module (SFM) performs route lookup, filtering, and switching on incoming data packets, then directs outbound packets to the appropriate FPC for transmission to the network. It can process 40 million packets per second (Mpps).

Up to four SFMs can be installed in the router, processing a total of 160 Mpps. The SFMs are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. Removing or inserting an SFM causes a brief interruption in forwarding performance (about 500 ms) as the Packet Forwarding Engine reconfigures the distribution of packets across the remaining SFMs.

For SFM replacement instructions, see “Replacing an SFM” on page 188.

The SFM communicates with the Routing Engine using a dedicated 100-Mbps Fast Ethernet link that transfers routing table data from the Routing Engine to the forwarding table in the Internet Processor II ASIC. The link is also used to transfer from the SFM to the Routing Engine routing link-state updates and other packets destined for the router that have been received through the router interfaces.

The ASICs and other components on the SFM provide the following functions:

- Route lookups—The Internet Processor II ASIC on each SFM performs route lookups using the forwarding table stored in SSRAM.
- Management of shared memory on the FPCs—One Distributed Buffer Manager ASIC receives the 64-byte data cells into which the I/O Manager ASICs on each FPC divide incoming packets, and uniformly allocates them throughout the shared memory buffers located on the FPCs.
- Transfer of outgoing data packets—The second Distributed Buffer Manager ASIC passes notification of the forwarding decision for each packet to an I/O Manager ASIC so that data cells for the outgoing packet can be reassembled for transmission to the network.
- Transfer of exception and control packets—The Internet Processor II ASIC passes exception packets to the microprocessor on the SFM, which processes almost all of them. The SFM sends any remaining exception packets to the Routing Engine for further processing. When the SFM detects an error originating in the Packet Forwarding Engine, it sends it to the Routing Engine using system logging (syslog) messages.

SFM Components

Each SFM is a two-board system, as shown in Figure 8. It has the following components:

- Two Distributed Buffer Manager ASICs—Process incoming and outgoing packets: one distributes data cells (which the I/O Manager ASIC on each FPC derives from incoming packets) to the shared memory buffers on the

FPCs, while the second forwards notification of routing decisions to the I/O Manager ASICs.

- One Internet Processor II ASIC—Performs route lookups and makes routing decisions.
- Parity-protected SSRAM—Stores the forwarding table.
- Processor subsystem—Manages SFM functions and handles exception packets. The processor has the following components:
 - One PowerPC 603e processor
 - Parity-protected Level 2 cache
 - Parity-protected DRAM
- EEPROM—Stores the serial number and revision level.
- Offline button—Prepares the SFM for removal from the router when pressed.
- Two LEDs—Indicate SFM status. There is a green one labeled OK and an amber one labeled FAIL. Table 7 describes the LED states.
- Ejector handles and locking tabs—Control the locking system that secures the SFM in the chassis.



NOTE: For specific information about SFM components (for example, the amount of SSRAM and DRAM), issue the `show chassis sfm detail` command.

Figure 8: Switching and Forwarding Module

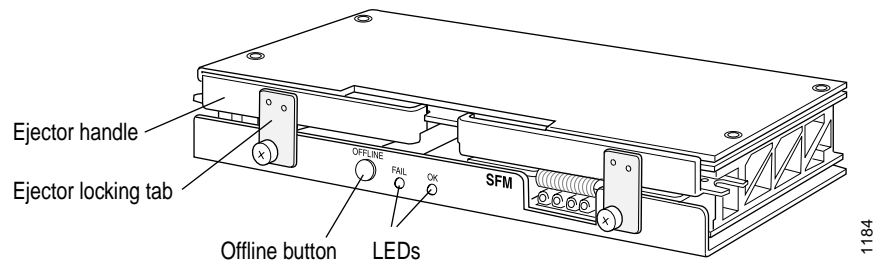


Table 7: States for SFM LEDs

Label	Color	State	Description
OK	Green	On steadily	SFM is functioning normally.
		Blinking	SFM is starting up.
FAIL	Amber	On steadily	SFM has failed.

Host Module

The host module constructs routing tables, performs system management functions, and generates the SONET/SDH clock signal for SONET/SDH interfaces. It consists of a paired Routing Engine and Miscellaneous Control Subsystem (MCS).

For a host module to function, both of its components—Routing Engine and MCS—must be installed and operational. One or two host modules can be installed into the midplane from the rear of the chassis, as shown in Figure 3: the Routing Engine slot labeled **RE 0** is below the MCS slot labeled **MCS 0** and the **RE 1** slot is above the **MCS 1** slot.

If two host modules are installed, both are powered on, but only one is active (the master); the second host module is in standby mode and performs no functions. By default, the master host module is the one with components installed in the **RE 0** and **MCS 0** slots. To change the default master Routing Engine, include the appropriate `[edit chassis redundancy routing-engine]` statement in the configuration, as described in the section about Routing Engine redundancy in the *JUNOS Internet Software Configuration Guide: Getting Started*.

The host module components are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. Removal or failure of one or both components in the standby host module does not affect router function. If one or both components in the master host module is removed from the chassis, the effect depends on whether two host modules are installed:

- If there is only one host module, packet forwarding halts until both the Routing Engine and MCS are reinstalled and functioning normally.
- If there are two host modules, the effect depends on the software configuration:
 - If the Routing Engines are running JUNOS Release 6.0 or later and are configured for graceful switchover, the standby Routing Engine automatically assumes mastership without interruption of forwarding performance. For information about configuring graceful switchover, see the section about Routing Engine redundancy in *JUNOS Internet Software Configuration Guide: Getting Started*.
 - Otherwise, forwarding halts while standby host module becomes the master and the new master Routing Engine resets the Packet Forwarding Engine.

For host module replacement instructions, see “Replacing an MCS” on page 159 and “Replacing a Routing Engine” on page 165.

Note that the effect of a hardware or software failure on one or both components in the master host module differs from the effect of removing a component that belongs to the master host module:

- With the default router configuration, in case of failure you must correct the problem manually. You can issue the appropriate `request chassis routing-engine master` command to switch mastership to the other Routing Engine, for example. For information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.
- On routers with two installed Routing Engines running JUNOS Release 6.0 or later, you can configure graceful switchover of Routing Engines, as previously described for the case of Routing Engine removal. When the standby Routing Engine stops receiving keepalive signals from the master Routing Engine, it automatically assumes mastership without interruption of forwarding performance.
- On routers with two installed Routing Engines running any JUNOS release, you can configure automatic Routing Engine mastership failover. When the standby Routing Engine stops receiving keepalive signals from the master Routing Engine, it automatically assumes mastership. Packet forwarding halts while the Packet Forwarding Engine components reset and connect to the new master Routing Engine.

For information about configuring graceful switchover or automatic mastership failover, see the section about Routing Engine redundancy in the *JUNOS Internet Software Configuration Guide: Getting Started*.

For more information about host module components, see the following sections:

- Routing Engine on page 23
- Miscellaneous Control Subsystem (MCS) on page 25

Routing Engine

The Routing Engine is an Intel-based PCI platform that runs JUNOS Internet software. Software processes that run on the Routing Engine maintain the routing tables, manage the routing protocols used on the router, control the router’s interfaces, control some chassis components, and provide the interface for system management and user access to the router.

For a description of the Routing Engine’s role in router architecture, see Routing Engine Architecture on page 53.

One or two host modules (paired Routing Engine and MCS) can be installed into the midplane from the rear of the chassis, as shown in Figure 3. If two host modules are installed, the Routing Engines together determine which is

the master and which is in standby mode (and so performs no functions). By default, the Routing Engine in the slot labeled RE0 is the master. The master Routing Engine also determines which of the two PCGs is the master.

The Routing Engine is hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. For information about the effect of removing a Routing Engine, see Host Module on page 22. For replacement instructions, see “Replacing a Routing Engine” on page 165.

Routing Engine Components

The Routing Engine (shown in Figure 9) is a two-board system with the following components:

- CPU—Runs JUNOS Internet software to maintain the router’s routing tables and routing protocols. It has a Pentium-class processor.
- SDRAM—Provides storage for the routing and forwarding tables and for other Routing Engine processes.
- Compact flash drive—Provides primary storage for software images, configuration files, and microcode. The drive is fixed and inaccessible from outside the router.
- Hard disk—Provides secondary storage for log files, memory dumps, and rebooting the system if the flash drive fails.
- PC card slots—Accept removable PC cards, which store software images for system upgrades.
- LED—Indicates disk activity for the internal IDE interface. It does not necessarily indicate routing-related activity.
- Interfaces for out-of-band management access—Provide information about Routing Engine status to devices (console, laptop, or terminal server) that can be attached to access ports located on the Connector Interface Panel (CIP).
- EEPROM—Stores the serial number of the Routing Engine.
- Reset button—Reboots the Routing Engine when pressed.



NOTE: The LEDs that report host module status (and by implication Routing Engine status) are on the craft interface rather than the Routing Engine faceplate. For more information, see “Host Module LEDs” on page 31.



NOTE: The appearance and position of electronic components or the PC card slot on your Routing Engine might differ from Figure 9 and other figures in this

document that depict the Routing Engine. These differences do not affect Routing Engine installation and removal or functionality.

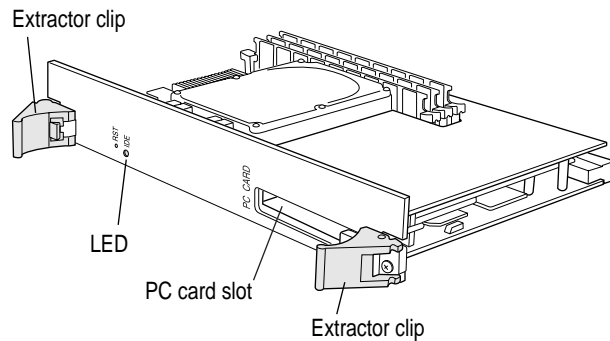
For specific information about Routing Engine components (for example, the amount of SDRAM), issue the `show chassis routing-engine` command.



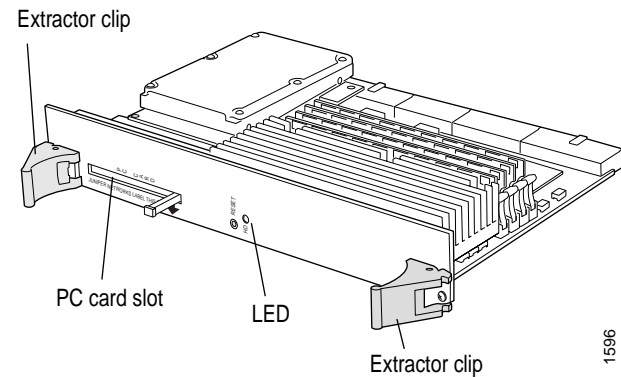
NOTE: If two Routing Engines are installed, they must both be the same version.

Figure 9: Routing Engine

Routing Engine 333



Routing Engine 600



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Miscellaneous Control Subsystem (MCS)

The Miscellaneous Control Subsystem (MCS) works with its companion Routing Engine to provide control and monitoring functions for router components. It also generates a clock signal for the SONET/SDH interfaces on the router.

One or two host modules (paired MCS and Routing Engine) can be installed into the midplane from the rear of the chassis, as shown in Figure 3. Only one host module is active at a time, with the optional second host module in standby mode. For more information about host module interdependence and redundancy, see Host Module on page 22.

The MCS performs the following functions:

- Monitoring and control of router components—The MCS collects statistics from all sensors in the system. When it detects a failure or alarm condition, it sends a signal to the Routing Engine, which generates control messages

or sets an alarm. The MCS also relays control messages from the Routing Engine to the router components.

- Controlling component power-up and power-down—The MCS controls the power-up sequence of router components as they start, and powers down components when their offline buttons are pressed.
- Signaling of mastership—In a router with more than one host module, the MCS signals to all router components which host module is the master and which is the standby. It relays the mastership signal for the two PCGs as well.
- Providing SONET/SDH clock source—The MCS generates a 19.44-MHz SONET/SDH clock signal, along with a signal that indicates which MCS is the master SONET/SDH clock generator (if two MCSs are installed).
- Clock monitoring—The MCS monitors the PCG system clock and its SONET/SDH clock to verify that they are providing the expected signal. It generates an alarm if a clock signal is incorrect.
- Control of FPC resets—If the MCS detects errors in an FPC, it attempts to reset the FPC. After three unsuccessful reset attempts, the MCS takes the FPC offline and informs the Routing Engine. Other FPCs are unaffected, and system operation continues.

MCS Components

Each MCS (shown in Figure 10) has the following components:

- PCI interface—Connects the MCS to the Routing Engine.
- 100-Mbps Ethernet switch—Carries signals and monitoring data between router components.
- 19.44-MHz stratum 3 reference clock—Generates clock signal for SONET/SDH PICs.
- I²C controller—Monitors the status of router components.
- Three LEDs—Indicate MCS status. There is a blue one labeled **MASTER**, a green one labeled **OK**, and an amber one labeled **FAIL**. Table 8 describes the LED states.
- Offline button—Prepares the MCS for removal from the router when pressed.
- Extractor clips—Control the locking system that secures the MCS in the chassis.

Figure 10: Miscellaneous Control Subsystem

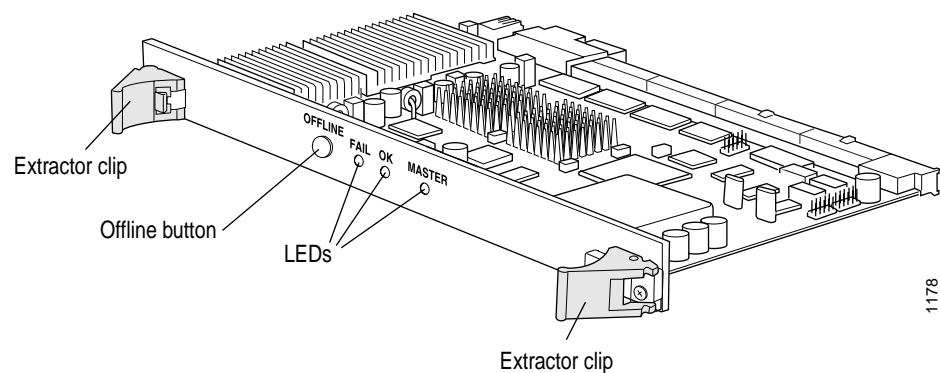
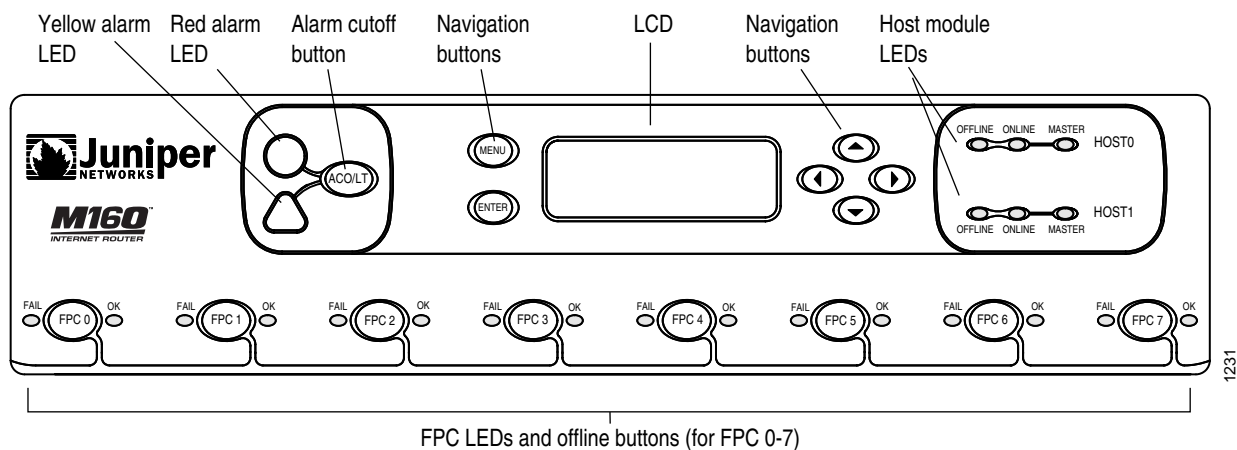


Table 8: States for MCS LEDs

Label	Color	State	Description
MASTER	Blue	On steadily	MCS is master.
OK	Green	On steadily	MCS is functioning normally.
		Blinking	MCS is starting up.
FAIL	Amber	On steadily	MCS has failed.

Craft Interface

The craft interface provides status and troubleshooting information at a glance and has buttons for deactivating alarms and preparing FPCs for removal. The craft interface is located on the front of the chassis above the FPC card cage, as shown in Figure 1. It includes the elements shown in Figure 11.

Figure 11: Craft Interface

NOTE: The LEDs for some router components are located on the component faceplate, rather than on the craft interface. For information about those LEDs, see the following sections:

- “PCG Components” on page 19
- “SFM Components” on page 20
- “MCS Components” on page 26
- Power System on page 35

For information about the elements on the craft interface, see the following sections:

- Alarm LEDs and Alarm Cutoff/Lamp Test Button on page 28
- LCD and Navigation Buttons on page 29
- Host Module LEDs on page 31
- FPC LEDs and Offline Button on page 31

Alarm LEDs and Alarm Cutoff/Lamp Test Button

Two large alarm LEDs are located at the upper left of the craft interface (see Figure 11). The circular red LED lights to indicate a critical condition that can result in a system shutdown. The triangular yellow LED lights to indicate a less severe condition that requires monitoring or maintenance. Both LEDs can be lit simultaneously.




A condition that causes an LED to light also activates the corresponding alarm relay contact on the connector interface panel (CIP), as described in “Alarm

Relay Contacts” on page 34. The LCD on the craft interface reports the cause of the alarm, as described in “LCD Alarm Mode” on page 30.

To deactivate red and yellow alarms, press the button labeled ACO/LT (for “alarm cutoff/lamp test”), which is located to the left of the alarm LEDs. Deactivating an alarm turns off both LEDs and deactivates the device attached to the corresponding alarm relay contact on the CIP. However, the LCD continues to report the alarm message until you clear the condition that caused the alarm.

Table 9 describes the alarm LEDs and alarm cutoff button in more detail.

Table 9: Alarm LEDs and Alarm Cutoff/Lamp Test Button

Shape	Color	State	Description
	Red	On steadily	Critical alarm LED—Indicates a critical condition that can cause the router to stop functioning. Possible causes include component removal, failure, or overheating.
	Yellow	On steadily	Warning alarm LED—Indicates a serious but nonfatal error condition, such as a maintenance alert or a significant increase in component temperature.
	—	—	Alarm cutoff/lamp test button—Deactivates red and yellow alarms. Causes all LEDs on the craft interface to light (for testing purposes), when pressed and held.

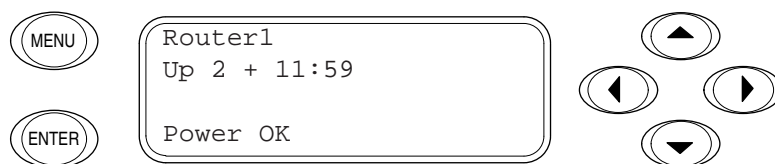
LCD and Navigation Buttons

A four-line LCD is located in the craft interface, along with six navigation buttons. The LCD operates in two modes, as described in the following sections:

- LCD Idle Mode on page 29
- LCD Alarm Mode on page 30

LCD Idle Mode

During normal operation, the LCD operates in idle mode and reports current status information, as shown in Figure 12.

Figure 12: LCD in Idle Mode

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The lines in the display report the following information:

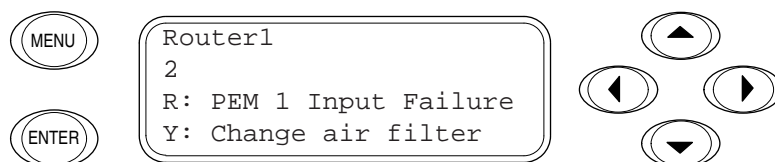
- First line—Routing node name.
- Second line—Length of time the router has been running, reported in the following form:

Up *days* + *hours* : *minutes*
- Third and fourth lines—Status messages, which rotate at two-second intervals. Some conditions, such as removal or insertion of a system component, can interrupt the messages.

To add a message that alternates every 2 seconds with the default status messages, use the `set chassis display message` command. For more information, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

LCD Alarm Mode

When a red or yellow alarm occurs, the LCD switches to alarm mode and reports about the alarm condition, as shown in Figure 13.

Figure 13: LCD in Alarm Mode

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The lines in the display report the following information:

- First line—Routing node name.
- Second line—Number of active alarms.
- Third and fourth lines—Individual alarm messages, with the most severe condition shown first. The prefix on each line indicates whether the alarm is a red (R) or yellow (Y) alarm.

For a list of alarm messages that can appear on the LCD, see “Chassis and Interface Alarm Messages” on page 209.

Host Module LEDs

At the upper right corner of the craft interface (see Figure 11) are two sets of LEDs that indicate host module status: the set labeled HOST0 reports the status of the Routing Engine in slot RE 0 and MCS in slot MCS 0, and the set labeled HOST1 reports the status of the Routing Engine in slot RE 1 and the MCS in slot MCS 1. Each set includes three LEDs—a green one labeled MASTER, another green one labeled ONLINE, and a red one labeled OFFLINE. Table 10 describes the LED states.

Table 10: States for Host Module LEDs

Label	Color	State	Description
MASTER	Green	On steadily	Host module is functioning as master.
ONLINE	Green	On steadily	Host module components (Routing Engine and MCS) are installed and functioning normally.
		Blinking	Host module is starting up.
OFFLINE	Red	On steadily	One or both host module components are not installed or have failed.

FPC LEDs and Offline Button

The LEDs and offline button for each FPC are located directly above it on the craft interface, as shown in Figure 11. The red LED labeled FAIL and the green LED labeled OK indicate FPC status, as described in Table 11.

The offline button, labeled with the FPC slot number (for example, FPC2), prepares the FPC for removal from the router when pressed.

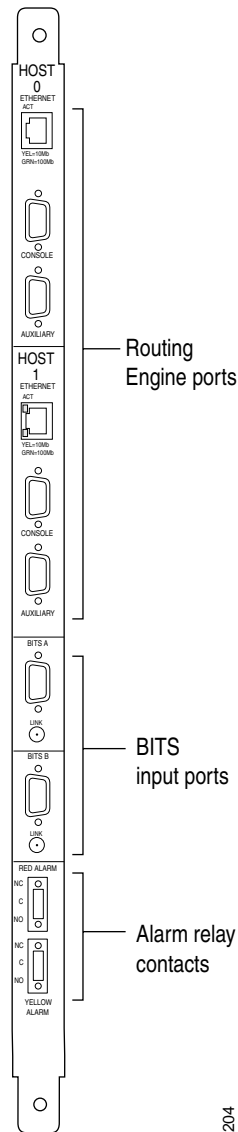
Table 11: States for FPC LEDs

Label	Color	State	Description
OK	Green	On steadily	FPC is functioning normally.
		Blinking	FPC is starting up or going offline.
		Off	FPC is offline or not installed.
FAIL	Red	On steadily	FPC has failed.

Connector Interface Panel (CIP)

The Connector Interface Panel (CIP) is located at the left side of the FPC card cage, as shown in Figure 1. It houses Routing Engine management ports and alarm relay contacts, as shown in Figure 14 and described in the following sections:

- Routing Engine Management Ports on page 33
- BITS Input Ports on page 34
- Alarm Relay Contacts on page 34

Figure 14: Connector Interface Panel

Routing Engine Management Ports

On the upper half of the CIP are two sets of ports for connecting the Routing Engines to one or more external devices on which system administrators can issue JUNOS command-line interface (CLI) commands to manage the router. The set of ports labeled HOST0 connects to the Routing Engine in the slot labeled RE 0, and the set labeled HOST1 connects to the Routing Engine in the slot labeled RE 1.

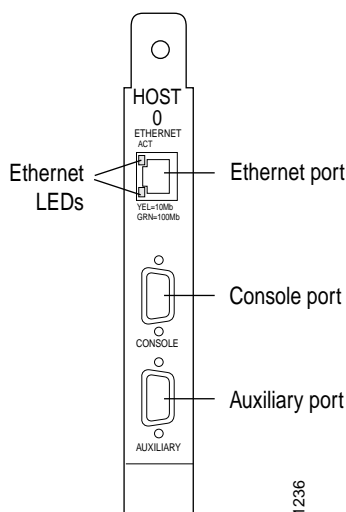
The ports with the indicated label in each set function as follows:

- **ETHERNET**—Connects the Routing Engine through an Ethernet connection to a management LAN (or any other device that plugs into an Ethernet connection) for out-of-band management. The port uses an autosensing RJ-45 connector to support both 10- and 100-Mbps connections. Two small LEDs on the left edge of the port indicate the connection in use: the LED labeled **ETHERNET** lights yellow or green for a 10-Mbps or 100-Mbps connection, and the LED labeled **ACT** lights green when traffic is passing through the port.
- **CONSOLE**—Connects the Routing Engine to a system console through an RS-232 (EIA-232) serial cable.
- **AUXILIARY**— Connects the Routing Engine to a laptop, modem, or other auxiliary device through an RS-232 (EIA-232) serial cable.

For information about the pinouts for the connectors, see “Cable Connector Pinouts” on page 269.

Figure 15 shows the ports that connect to the Routing Engine installed in slot RE 0. The arrangement of ports for the Routing Engine installed in slot RE 1 is the same.

Figure 15: Routing Engine Interface Ports for Host Module 0



BITS Input Ports

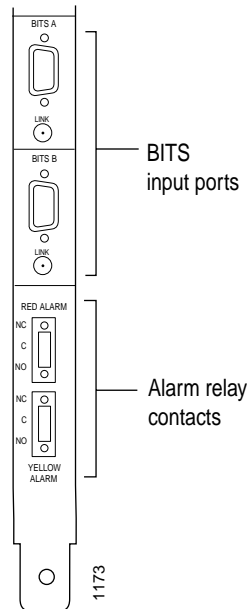
In the center of the CIP are two ports labeled BITS A and BITS B (see Figure 16). The router does not support BITS input, so these ports do not function.

Alarm Relay Contacts

At the bottom of the CIP are two relay contacts for connecting the router to external alarm-reporting devices, the upper labeled **RED ALARM** and the lower

YELLOW ALARM (see Figure 16). A system condition that causes the red or yellow alarm LED to light on the craft interface also activates the corresponding alarm relay contact. For instructions for attaching a device to the alarm relay contacts, see “Connecting to an External Alarm-Reporting Device” on page 115.

Figure 16: Alarm Relay Contacts and BITS Input Ports



Power System

The router uses DC power. There are two load-sharing, pass-through power supplies located at the bottom rear of the chassis, as shown in Figure 2. The power supplies connect to the midplane, which distributes power to router components according to their individual voltage requirements. When the power supplies are installed and operational, they automatically share the electrical load. If a power supply stops functioning for any reason, the remaining power supplies instantly begin providing all the power the router needs for normal functioning and can provide full power indefinitely.

Power supplies are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. To avoid electrical injury, carefully follow the instructions in “Replacing a Power Supply” on page 197.



NOTE: After powering off a power supply, wait at least 60 seconds before turning it back on. After powering on a power supply, wait at least 60 seconds before turning it off.

If the router is completely powered down when you power on the power supply, the Routing Engine boots as the power supply completes its startup sequence. If

the Routing Engine finishes booting and you need to power down the router again, first issue the CLI `request system halt` command. For more information, see “Disconnecting Power from the Router” on page 200.

After a power supply is powered on, it can take up to 60 seconds for status indicators—such as LEDs on the power supply, `show chassis` commands, and messages on the craft interface LCD—to indicate that the power supply is functioning normally. Ignore error indicators that appear during the first 60 seconds.

See the following sections for further information:

- Power Supply on page 36
- Circuit Breaker Box on page 38
- Fuses on page 39

Power Supply

The router has two load-sharing, pass-through power supplies, located at the bottom rear of the chassis, as shown in Figure 2. For information about power supply redundancy and replaceability, see Power System on page 35.

Each power supply has the following components (see Figure 17 and Figure 18):

- LEDs—Indicate power supply status. There is a green one labeled **CB ON**, a blue one labeled **OUTPUT OK**, and an amber one labeled **CB OFF**. The original power supply also has an amber LED labeled **NO AIRFLOW**. Table 12 describes the LED states.

In addition, power supply failure triggers the red alarm LED on the craft interface and the **RED ALARM** relay contact on the CIP. See “Alarm LEDs and Alarm Cutoff/Lamp Test Button” on page 28.

- Self-test button—Tests the power supply. Do not press this button; it is for use by qualified service personnel only.

Figure 17: Original Power Supply

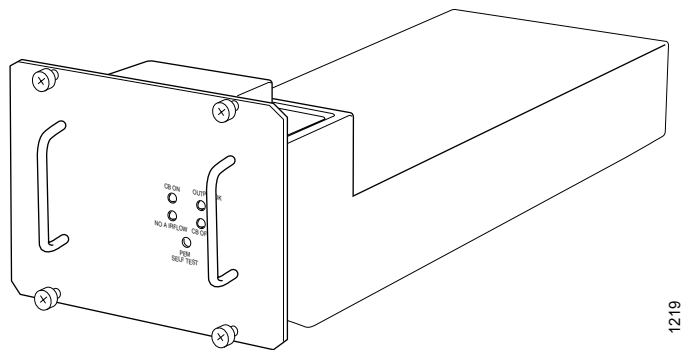


Figure 18: Enhanced Power Supply

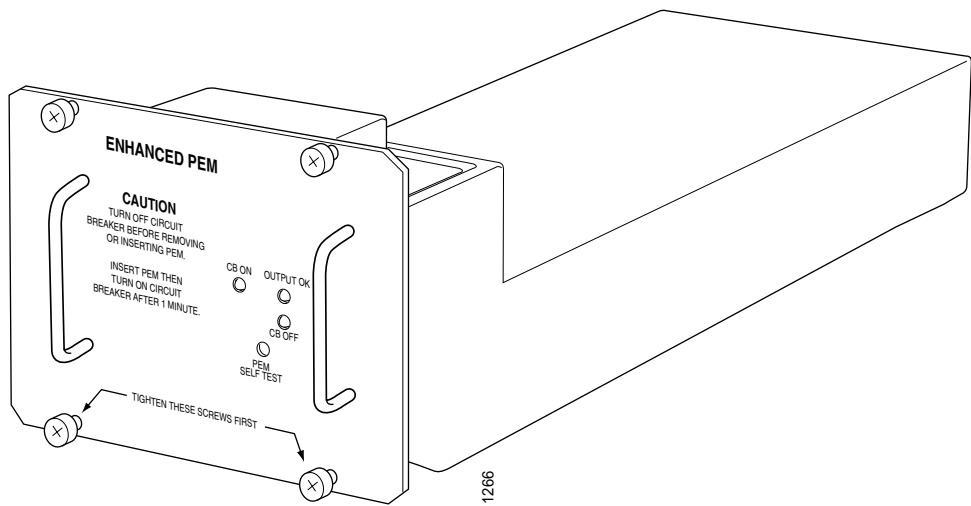


Table 12: States for Power Supply LEDs

Label	Color	State	Description
CB ON	Green	On steadily	Power supply is inserted correctly and is receiving power. Circuit breaker is on.
OUTPUT OK	Blue	On steadily	Power supply is inserted and is functioning normally.
		Blinking	Power supply is not functioning, is starting up, or is not properly inserted, or airflow is not sufficient.

Label	Color	State	Description
NO AIRFLOW (original power supply only)	Amber	On steadily	Power supply is inserted, but airflow around the power supply is not sufficient.
CB OFF	Amber	On steadily	Power supply is functioning, but the circuit breaker is off.

Table 13 lists electrical specifications for the power supply.

Table 13: Electrical Specifications for Power Supply

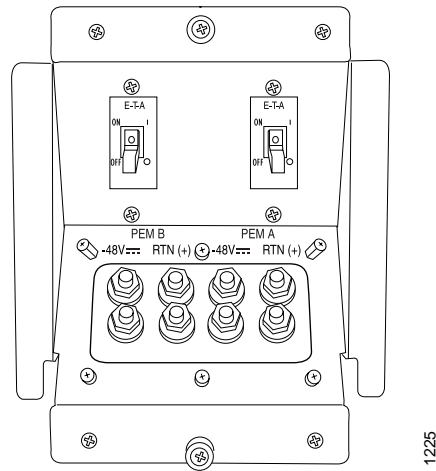
Description	Specification
Maximum power output	Original power supply: 2400 W; nonisolated Enhanced power supply: 3000 W; nonisolated
DC input voltage	Nominal: -48 VDC, -60 VDC Operating range: -42 to -72 VDC
DC input current rating	80 A @ -48 V
Output voltages	+ 48 V @ 8.3 A (cooling system), + 8.3 V @ 6 A (bias), -48 V to -60 V @ 75 A

Circuit Breaker Box

The circuit breaker box is located on the rear of the chassis, above the right power supply, as shown in Figure 2.

The circuit breaker box houses two circuit breakers and sets of terminal studs, corresponding positionally to the two power supplies, as shown in Figure 19. For proper router operation and power load sharing, connect a different external DC power source to each set of terminal studs.

In addition, a grounding cable attaches to separate grounding points located above the circuit breaker box, as shown in Figure 2. For more information, see “Power, Connection, and Cable Specifications” on page 67.

Figure 19: Circuit Breaker Box

Fuses

The router uses fuses from the Cooper Bussman brand GMT series for the FPCs, MCSs, PCGs, and SFMs. The fuses are located in a fuse box on the rear of the midplane. When the fuse for a component blows, the component stops functioning even though it is installed correctly and the power supplies are providing power to the router. For more information, see “Blown Fuse Indicators” on page 211. For fuse replacement instructions, see “Replacing a Fuse” on page 204.

Cooling System

The cooling system includes a fan tray and several impellers that draw room air into the chassis to keep its internal temperature below a maximum acceptable level. When the temperature is below the maximum, the fans and impellers function at less than full speed. If the MCS detects that the temperature of a component has exceeded the acceptable maximum—for example, because an impeller is removed—it automatically increases the speed of the remaining impellers and fans to reduce the temperature. The fans and impellers can function at the higher speed indefinitely.

For more information about the cooling system, see the following sections:

- Cooling System Components on page 40
- Airflow through the Chassis on page 40

Cooling System Components

The cooling system has the following components. All are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4.

- Air intake vent, air filter, and intake cover—Provide an opening for room air to enter the router. They are located at the bottom of the chassis front, below the cable management system, as shown in Figure 1. The air filter is removable and covers the air intake vent, preventing dust and other particles from entering the cooling system. For maintenance and replacement instructions, see “Maintaining the Air Filter” on page 128. The nonremovable air intake cover is located behind the air filter and provides EMC shielding.

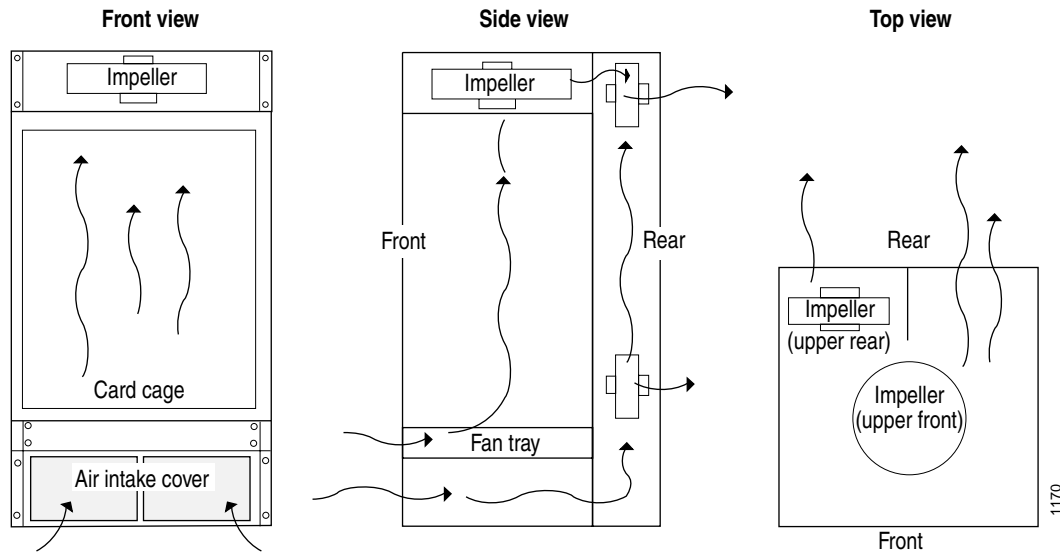


CAUTION: Do not remove the air filter for more than a few minutes while the router is operating. The fans and impellers are powerful enough to draw in foreign material, such as bits of wire, through the unfiltered air intake, which could damage router components.

- Front cooling subsystem—Cools the FPCs, PICs, and midplane. It includes a fan tray located behind the cable management system and a large, central impeller behind the craft interface. For replacement instructions, see “Replacing the Fan Tray” on page 148 and “Replacing the Front Impeller Assembly” on page 150.
- Rear cooling subsystem—Cools the SFMs, host module, PCGs, and power supplies. It includes one impeller located at the upper right of the chassis rear and another at the lower left, as shown in Figure 2. The upper and lower impellers are not interchangeable. For replacement instructions, see “Replacing the Rear Lower Impeller Assembly” on page 154 and “Replacing the Rear Upper Impeller Assembly” on page 156.

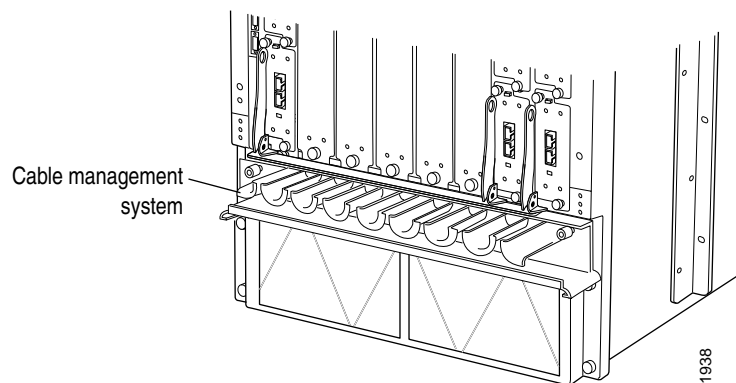
Airflow through the Chassis

Figure 20 shows airflow through the chassis and the location of the impellers and fan tray.

Figure 20: Airflow through the Chassis

Cable Management System

The cable management system (see Figure 21) consists of a row of nine semicircular plastic bobbins mounted on the front of the router below the FPC card cage. The PIC cables pass between the bobbins and into the tray, keeping the cables organized and securely in place. The curvature of the bobbins also helps maintain the proper bend radius for optical PIC cables.

Figure 21: Cable Management System

Chapter 3

JUNOS Internet Software Overview

The JUNOS Internet software is especially designed for the large production networks typically supported by Internet Service Providers (ISPs). It incorporates Internet Protocol (IP) routing software and software for management of interfaces, networks, and the router chassis.

The JUNOS Internet software runs on the Routing Engine. The software consists of processes that support Internet routing protocols, control the router's interfaces and the router chassis itself, and provide an interface for system management. The processes run on top of a kernel that coordinates the communication among processes and has a direct link to the Packet Forwarding Engine software.

Use the JUNOS Internet software to configure the routing protocols that run on the router and the properties of router interfaces. After you have activated a software configuration, use the JUNOS Internet software to monitor the protocol traffic passing through the router and to troubleshoot protocol and network connectivity problems.

For additional information about the JUNOS Internet software, including its security features and a list of the industry standards it supports, see the *JUNOS System Basics Configuration Guide*. For complete information about configuring the software, including examples, see the JUNOS Internet software configuration guides.

This chapter discusses the following topics:

- Routing Engine Software Components on page 43
- Tools for Accessing and Configuring the Software on page 50
- Tools for Monitoring the Software on page 50
- Software Upgrades on page 50

Routing Engine Software Components

The Routing Engine software consists of several software processes that control router functions and a kernel that coordinates communication among the processes, as described in the following sections:

- Routing Protocol Process on page 44

- VPNs on page 48
- Interface Process on page 49
- Chassis Process on page 49
- SNMP and MIB II Processes on page 49
- Management Process on page 49
- Routing Engine Kernel on page 49

Routing Protocol Process

The JUNOS software routing protocol process controls the routing protocols that run on the router. The routing protocol process starts all configured routing protocols and handles all routing messages. It consolidates the routing information learned from all routing protocols into common routing tables. From this routing information, the routing protocol process determines the active routes to network destinations and installs these routes into the Routing Engine's forwarding table. Finally, the routing protocol process implements the routing policies you specify, which determine how routing information is transferred between the routing protocols and the routing table.

This section discusses the following topics:

- IPv4 Routing Protocols on page 44
- IPv6 Routing Protocols on page 46
- Routing and Forwarding Tables on page 47
- Routing Policy on page 47

For complete information about routing concepts, see the JUNOS Internet software configuration guides.

IPv4 Routing Protocols

The JUNOS Internet software implements full IP routing functionality, providing support for IP version 4 (IPv4). The routing protocols are fully interoperable with existing IP routing protocols and provide the scale and control necessary for the Internet core. The software provides support for the following routing and traffic engineering protocols:

- Unicast routing protocols
 - BGP—Border Gateway Protocol, version 4, is an Exterior Gateway Protocol (EGP) that guarantees loop-free exchange of routing information between routing domains (also called autonomous systems). BGP, in conjunction

with JUNOS routing policy, provides a system of administrative checks and balances that can be used to implement peering and transit agreements.

- ICMP—Internet Control Message Protocol router discovery is a method that hosts can use to discover the addresses of operational routers on a subnet.
- IS-IS—Intermediate System-to-Intermediate System is a link-state interior gateway protocol (IGP) for IP networks that uses the shortest-path-first algorithm (SPF algorithm, also called the Dijkstra algorithm) to determine routes.
- OSPF—Open Shortest Path First, version 2, is an IGP developed for IP networks by the Internet Engineering Task Force (IETF). OSPF is a link-state protocol that makes routing decisions based on the SPF algorithm.
- RIP—Routing Information Protocol, version 2, is an IGP for IP networks based on the Bellman-Ford algorithm. RIP is a distance-vector protocol. RIP dynamically routes packets between a subscriber and a service provider without the subscriber having to configure BGP or to participate in the service provider's IGP discovery process.
- Multicast routing protocols
 - DVMRP—Distance Vector Multicast Routing Protocol is a dense-mode (flood-and-prune) multicast routing protocol.
 - IGMP—Internet Group Management Protocol, versions 1 and 2, is used to manage membership in multicast groups.
 - MSDP—Multicast Source Discovery Protocol enables multiple PIM sparse mode domains to be joined. A rendezvous point (RP) in a PIM sparse mode domain has a peering relationship with an RP in another domain, thereby discovering multicast sources from other domains.
 - PIM sparse mode and dense mode—Protocol-Independent Multicast is a multicast routing protocol used to route traffic to multicast groups that might span wide-area and interdomain internetworks. In PIM sparse mode, routers explicitly join and leave multicast groups. PIM dense mode is a flood-and-prune protocol.
 - SAP/SDP—Session Announcement Protocol and Session Description Protocol handle conference session announcements.
- MPLS application protocols
 - LDP—Label Distribution Protocol provides a mechanism for distributing labels in nontraffic-engineered applications. LDP allows routers to establish label-switched paths (LSPs) through a network by mapping network-layer routing information directly to data-link layer switched

paths. LSPs created by LDP can also traverse LSPs created by Resource Reservation Protocol (RSVP).

- MPLS—Multiprotocol Label Switching enables you to configure LSPs through a network either manually or dynamically. You can control how traffic traverses the network by directing it through particular paths, rather than relying on an IGP's least-cost algorithm to choose a path.
- RSVP—Resource Reservation Protocol, version 1, provides a mechanism for engineering network traffic patterns that is independent of the shortest path determined by a routing protocol. RSVP itself is not a routing protocol, but is designed to operate with current and future unicast and multicast routing protocols. JUNOS RSVP software supports dynamic signaling for MPLS LSPs.

IPv6 Routing Protocols

The JUNOS Internet software implements full IP routing functionality, providing support for IP version 6 (IPv6). The routing protocols are fully interoperable with existing IP routing protocols and provide the scale and control necessary for the Internet core. The software provides support for the following unicast routing protocols:

- BGP—Border Gateway Protocol, version 4, is an EGP that guarantees loop-free exchange of routing information between routing domains (also called autonomous systems). BGP, in conjunction with JUNOS routing policy, provides a system of administrative checks and balances that can be used to implement peering and transit agreements.
- ICMP—Internet Control Message Protocol router discovery is a method that hosts can use to discover the addresses of operational routers on a subnet.
- IS-IS—Intermediate System-to-Intermediate System is a link-state interior gateway protocol (IGP) for IP networks that uses the shortest-path-first algorithm (SPF algorithm, also called the Dijkstra algorithm) to determine routes.
- OSPF—Open Shortest Path First, version 3 (OSPFv3), supports version 6 of the Internet Protocol (IPv6). The fundamental mechanisms of OSPF such as flooding, Designated Router (DR) election, area based topologies and the Shortest Path First (SPF) calculations remain unchanged. Some differences exist either due to changes in protocol semantics between IPv4 and IPv6, or to handle the increased address size of IPv6.
- RIP—Routing Information Protocol, version 2, is an IGP for IP networks based on the Bellman-Ford algorithm. RIP is a distance-vector protocol. RIP dynamically routes packets between a subscriber and a service provider without the subscriber having to configure BGP or to participate in the service provider's IGP discovery process.

Routing and Forwarding Tables

The primary function of the JUNOS routing protocol process is maintaining routing tables and using the information in them to determine active routes to network destinations. It copies information about the active routes into the Routing Engine's forwarding table, which the JUNOS kernel copies to the Packet Forwarding Engine.

By default, the routing protocol process maintains the following routing tables and uses the information in each table to determine active routes to network destinations:

- Unicast routing table—Stores routing information for all unicast protocols running on the router, including BGP, IS-IS, OSPF, and RIP. You can also configure additional routes, such as static routes, for inclusion in the routing table. The unicast routing protocols use the routes in this table when advertising routing information to their neighbors.

In the unicast routing table, the routing protocol process designates routes with the lowest preference values as active. By default, a route's preference value is simply a function of how the routing protocol process learned about the route. You can modify the default preference value by setting routing policies and configuring other software parameters. See "Routing Policy" on page 47.

- Multicast routing table (cache)—Stores routing information for all multicast protocols running on the router, including DVMRP and PIM. You can configure additional routes for inclusion in the routing table.

In the multicast routing table, the routing protocol process uses traffic flow and other parameters specified by the multicast routing protocol algorithms to select active routes.

- MPLS routing table—Stores MPLS label information.

For unicast routes, the routing protocol process determines active routes by choosing the most preferred route, which is the route with the lowest preference value. By default, the route's preference value is simply a function of how the routing protocol process learned about the route. You can modify the default preference value using routing policy and with software configuration parameters.

For multicast traffic, the routing protocol process determines active routes based on traffic flow and other parameters specified by the multicast routing protocol algorithms. The routing protocol process then installs one or more active routes to each network destination into the Routing Engine's forwarding table.

You can configure additional routing tables to meet your requirements, as described in the *JUNOS Routing Protocols Configuration Guide*.

Routing Policy

By default, all routing protocols place their routes into the routing table. When advertising routes, the routing protocols, by default, advertise only a limited set of routes from the routing table. Specifically, each routing protocol exports only the active routes that were learned by that protocol.

In addition, IGPs (IS-IS, OSPF, and RIP) export the direct (interface) routes for the interfaces on which the protocol is explicitly configured.

For each routing table, you can affect the routes that a protocol places into the table and the routes from the table that the protocol advertises by defining one or more routing policies and then applying them to the specific routing protocol.

Routing policies applied when the routing protocol places routes into the routing table are called *import policies* because the routes are being imported into the routing table. Policies applied when the routing protocol is advertising routes that are in the routing table are called *export policies* because the routes are being exported from the routing table. In other words, the terms import and export are used with respect to the routing table.

Routing policy enables you to control (filter) which routes are imported into the routing table and which routes are exported from the routing table. Routing policy also allows you to set the information associated with a route as it is being imported into or exported from the routing table. Routing policies applied to imported routes control the routes used to determine active routes, whereas policies applied to exported routes control which routes a protocol advertises to its neighbors.

You implement routing policy by defining policies. A policy specifies the conditions to use to match a route and the action to perform on the route when a match occurs. For example, when a routing table imports routing information from a routing protocol, a routing policy might modify the route's preference, mark the route with a color to identify it for later manipulation, or prevent the route from even being installed in a routing table. When a routing table exports routes to a routing protocol, a policy might assign metric values, modify the BGP community information, tag the route with additional information, or prevent the route from being exported altogether. You also can define policies for redistributing the routes learned from one protocol into another protocol.

VPNs

The JUNOS software supports several types of VPNs:

- **Layer 2 VPNs**—A Layer 2 VPN links a set of sites sharing common routing information, and whose connectivity is controlled by a collection of policies. A Layer 2 VPN is not aware of routes within a customer's network. It simply provides private links between a customer's sites over the service provider's existing public Internet backbone.
- **Layer 3 VPNs**—A Layer 3 VPN links a set of sites that share common routing information, and whose connectivity is controlled by a collection of policies. A Layer 3 VPN is aware of routes within a customer's network, requiring more configuration on the part of the service provider than a Layer 2 VPN. The sites that make up a Layer 3 VPN are connected over a service provider's existing public Internet backbone.
- **Interprovider VPNs**—An interprovider VPN supplies connectivity between two VPNs in separate autonomous systems (ASs). This functionality could be used

by a VPN customer with connections to several various ISPs, or different connections to the same ISP in various geographic regions.

- Carrier-of-Carrier VPNs—Carrier-of-carrier VPNs allow a VPN service provider to supply VPN service to a customer who is also a service provider. The latter service provider supplies Internet or VPN service to an end customer.

Interface Process

The JUNOS interface process manages the physical interface devices and logical interfaces on the router. It implements the JUNOS command-line interface (CLI) commands and configuration statements that you use to specify interface properties such as location (FPC location in the FPC card cage and PIC location on an FPC), the interface type (such as SONET/SDH or ATM), encapsulation, and interface-specific properties. You can configure both interfaces that are currently active and interfaces that might be installed later.

The JUNOS interface process communicates with the interface process in the Packet Forwarding Engine through the JUNOS kernel, enabling the JUNOS Internet software to track the status and condition of router interfaces.

Chassis Process

The JUNOS chassis process allows you to configure and control the properties of the router, including conditions that trigger alarms and clock sources. The chassis process communicates directly with a chassis process in the JUNOS kernel.

SNMP and MIB II Processes

The JUNOS Internet software supports the Simple Network Management Protocol (SNMP), versions 1, 2, and 3, which provides a mechanism for monitoring the state of the router. This software is controlled by the JUNOS SNMP and Management Information Base (MIB) II processes, which consist of an SNMP master agent and a MIB II agent.

Management Process

The management process starts all the other JUNOS software processes and the CLI when the router boots. It monitors the running JUNOS processes and makes all reasonable attempts to restart any process that terminates.

Routing Engine Kernel

The Routing Engine kernel provides the underlying infrastructure for all JUNOS software processes. It also provides the link between the routing tables maintained by the routing protocol process and the forwarding table maintained by the Routing Engine. Additionally, it coordinates communication with the Packet Forwarding Engine, which primarily involves synchronizing the Packet Forwarding Engine's forwarding table with the master forwarding table maintained by the Routing Engine.

Tools for Accessing and Configuring the Software

The JUNOS CLI is the primary tool for accessing and controlling the JUNOS Internet software. You use it when accessing the router through the console or a connection to an out-of-band management network. The CLI includes commands for configuring router hardware, the JUNOS Internet software, and network connectivity.

The JUNOS CLI is a straightforward command interface. You type commands on a single line and enter the commands by pressing the Enter key. The CLI provides command help and command completion, as well as Emacs-style keyboard sequences for moving around on a command line and scrolling through a buffer that contains recently executed commands. For more information about the CLI, see the *JUNOS System Basics Configuration Guide*.

Tools for Monitoring the Software

In addition to commands for configuring router hardware and software, the CLI includes commands for monitoring and troubleshooting hardware, software, routing protocols, and network connectivity. CLI commands display information from routing tables, information specific to routing protocols, and information about network connectivity derived from the `ping` and `traceroute` utilities.

You can also use the JUNOS Internet software implementation of SNMP to monitor routers. The SNMP software consists of an SNMP master agent and a MIB II agent. It provides full support for MIB II SNMP version 1 traps and version 2 notifications, SNMP version 1 `Get` and `GetNext` requests, and version 2 `GetBulk` requests. For more information about SNMP, see the *JUNOS Network Management Configuration Guide*.

The software also supports tracing and logging operations, which you can use to track normal router operations, error conditions, and the packets that the router generates or forwards. Logging operations use a syslog-like mechanism to record systemwide, high-level events such as interfaces going up or down and user logins on the router. Tracing operations record more detailed information about the operation of routing protocols, such as the various types of routing protocol packets sent and received, and routing policy actions.

Software Upgrades

The router is delivered with the JUNOS Internet software preinstalled. To upgrade the software, you use CLI commands to copy a set of software images over the network to memory storage on the Routing Engine. The JUNOS Internet software set consists of several images provided in individual packages or as a bundle. You normally upgrade all packages simultaneously. For information about installing and upgrading JUNOS software, see the *JUNOS System Basics Configuration Guide*.

Chapter 4

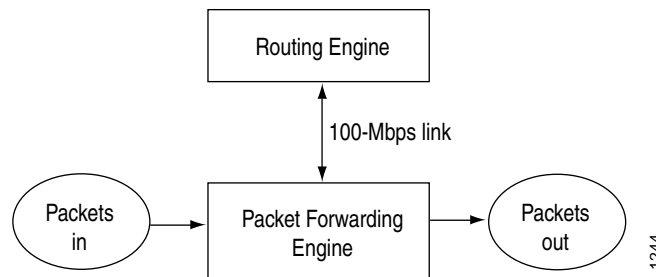
System Architecture Overview

The router architecture consists of two major components:

- Packet Forwarding Engine—Performs Layer 2 and Layer 3 packet switching, route lookups, and packet forwarding.
- Routing Engine—Provides Layer 3 routing services and network management.

The Packet Forwarding Engine and the Routing Engine perform independently but communicate constantly through a 100-Mbps internal link. This arrangement provides streamlined forwarding and routing control and the ability to run Internet-scale networks at high speeds. Figure 22 illustrates the relationship between the Packet Forwarding Engine and the Routing Engine.

Figure 22: System Architecture



For a discussion of the architectural components, see the following sections:

- Packet Forwarding Engine Architecture on page 51
- Routing Engine Architecture on page 53

Packet Forwarding Engine Architecture

The Packet Forwarding Engine performs Layer 2 and Layer 3 packet switching. It can forward up to 160 for all packet sizes. The aggregate throughput for the router is 160 gigabits per second (Gbps) simplex or 80 Gbps full duplex. The Packet Forwarding Engine is implemented in application-specific integrated circuits (ASICs). It uses a centralized route lookup engine and shared memory.

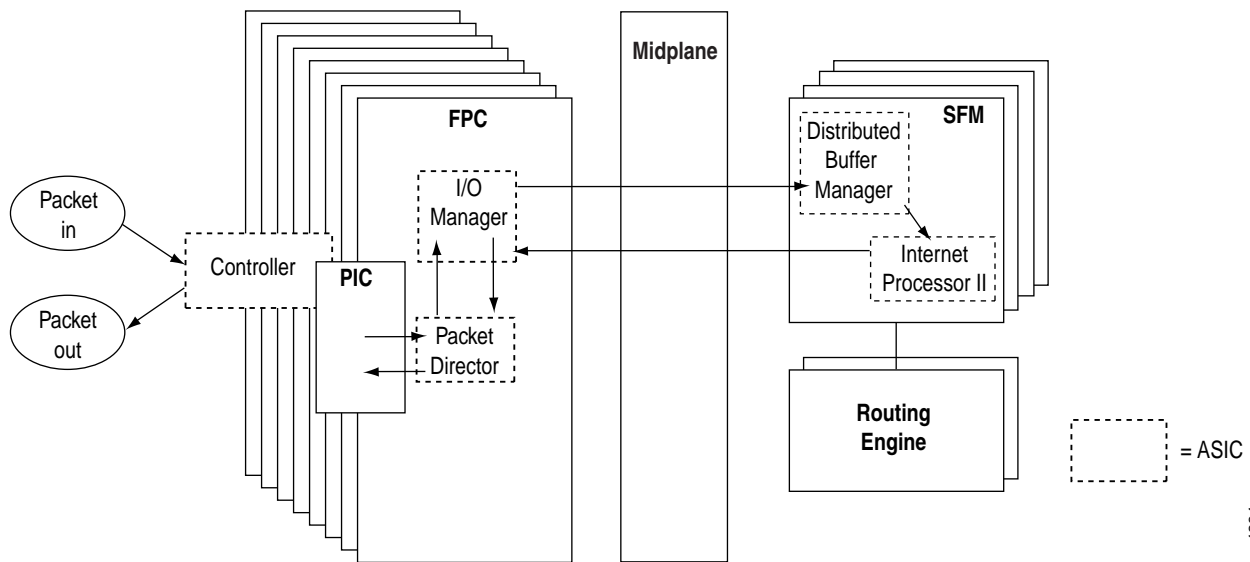
The Packet Forwarding Engine architecture includes the following components:

- Midplane—Transports packets, notifications, and other signals between the FPCs and the Packet Forwarding Engine (as well as other system components).
- Physical Interface Card (PIC)—Physically connects the router to fiber-optic or digital network media. A controller ASIC in each PIC performs control functions specific to the PIC media type.
- Flexible PIC Concentrator (FPC)—Houses PICs and provides shared memory for processing incoming and outgoing packets. Each FPC hosts four I/O Manager ASICs, which divide incoming data packets into memory blocks (cells) before passing them to the SFMs, and reassembles cells into data packets when the packets are ready for transmission. The FPC also hosts two Packet Director ASICs—one distributes incoming packets among the I/O Manager ASICs, and the other distributes outgoing packets to the appropriate PICs on the FPC.
- Switching and Forwarding Module (SFM)—Hosts an Internet Processor II ASIC, which makes forwarding decisions, and two Distributed Buffer Manager ASICs: one distributes data cells to the shared memory buffers on the FPCs and the other notifies the FPCs of forwarding decisions for outgoing packets.

Data Flow through the Packet Forwarding Engine

Use of ASICs promotes efficient movement of data packets through the system. Packets flow through the Packet Forwarding Engine in the following sequence (see Figure 23):

1. Packets arrive at an incoming PIC interface.
2. The PIC passes the packets to the FPC, where the Packet Director ASIC distributes them among the I/O Manager ASICs.
3. The I/O Manager ASICs process the packet headers, divide the packets into 64-byte data cells, and pass the cells through the midplane to the SFMs.
4. The Distributed Buffer Manager ASICs on the SFMs distribute the data cells throughout memory buffers located on and shared by all the FPCs.
5. For each packet, an Internet Processor II ASIC on an SFM performs a route lookup and decides how to forward the packet.
6. The Internet Processor II ASIC notifies a Distributed Buffer Manager ASIC of the forwarding decision, and the Distributed Buffer Manager ASIC forwards the notification to the FPC that hosts the appropriate outbound interface.
7. The I/O Manager ASIC on the FPC reassembles data cells in shared memory into data packets as they are ready for transmission and passes them through the Packet Director ASIC to the outbound PIC.
8. The outbound PIC transmits the data packets.

Figure 23: Packet Forwarding Engine Components and Data Flow

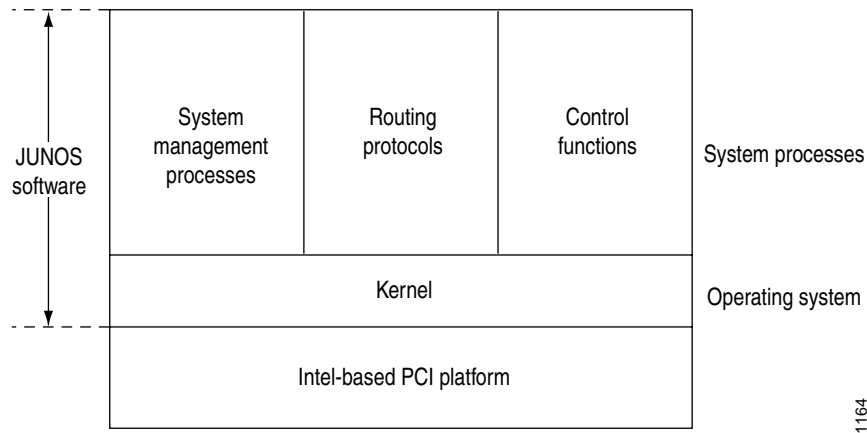
1234

Routing Engine Architecture

The Routing Engine is an Intel-based PCI platform running the JUNOS Internet software, which Juniper Networks has developed and optimized to handle large numbers of network interfaces and routes. The software consists of a set of system processes running in protected memory modules on top of an independent operating system. The JUNOS kernel supports JUNOS system processes, which handle system management processes, routing protocols, and control functions (see Figure 24).

The Routing Engine has a dedicated 100-Mbps internal connection to the Packet Forwarding Engine.

Figure 24: Routing Engine Architecture



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Routing Engine Functions

The Routing Engine handles all routing protocol processes, as well as the software processes that control the router’s interfaces, the chassis components, system management, and user access to the router. These routing and software processes run on top of a kernel that interacts with the Packet Forwarding Engine. For more information about the processes, see Routing Engine Software Components on page 43.

The Routing Engine includes the following functions and features:

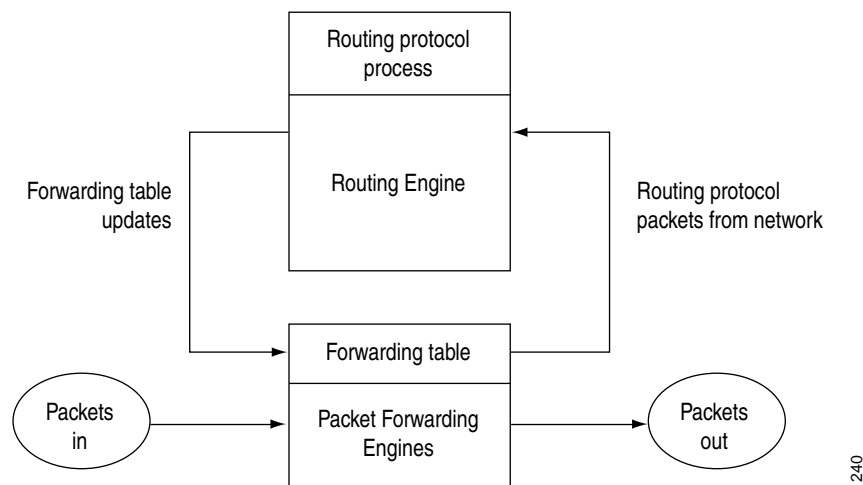
- Processing of routing protocol packets—The Routing Engine handles all packets that concern routing protocols, freeing the Packet Forwarding Engine to handle only packets that represent Internet traffic.
- Software modularity—Because each software process is devoted to a different function and uses a separate process space, the failure of one process has little or no effect on the others.
- In-depth Internet functionality—Each routing protocol is implemented with a complete set of Internet features and provides full flexibility for advertising, filtering, and modifying routes. Routing policies are set according to route parameters (for example, prefix, prefix lengths, and Border Gateway Protocol [BGP] attributes).
- Scalability—The JUNOS routing tables have been designed to hold all the routes in current networks with ample capacity for expansion. Additionally, the

JUNOS Internet software can efficiently support large numbers of interfaces and virtual circuits.

- Management interface—Different levels of system management tools are provided, including the JUNOS command-line interface (CLI), the JUNOScript application programming interface, the craft interface, and SNMP.
- Storage and change management—Configuration files, system images, and microcode can be held and maintained in primary and secondary storage systems, permitting local or remote upgrades.
- Monitoring efficiency and flexibility—The router supports functions such as alarm handling and packet counting on every port, without degrading packet-forwarding performance.

The Routing Engine constructs and maintains one or more routing tables (see Figure 25). From the routing tables, the Routing Engine derives a table of active routes, called the forwarding table, which is then copied into the Packet Forwarding Engine. The design of the ASICs allow the forwarding table in the Packet Forwarding Engine to be updated without interrupting forwarding performance.

Figure 25: Control Packet Handling for Routing and Forwarding Table Updates



Part 2

Initial Installation

- Preparing for Router Installation on page 59
- Unpacking the Router on page 77
- Installing the Router Using a Mechanical Lift on page 81
- Installing the Router without a Mechanical Lift on page 83
- Connecting the Router and Performing Initial Configuration on page 111

Chapter 5

Preparing for Router Installation

This chapter describes how to prepare your site for installation of the M160 Internet router. It discusses the following topics:

- Rack Requirements on page 59
- Clearance Requirements for Airflow and Hardware Maintenance on page 62
- Routing Node Environmental Specifications on page 62
- Fire Safety Requirements on page 63
- Power Guidelines, Requirements, and Specifications on page 64
- Network Cable Specifications and Guidelines on page 70
- Routing Engine Interface Cable and Wire Specifications on page 74
- Site Preparation Checklist on page 75

Rack Requirements

The router must be installed in a rack. Many types of racks are acceptable, including front-mount racks, 4-post (telco) racks, and center-mount racks. An example of a center-mount rack appears in Figure 26.

The following sections describe rack requirements:

- Rack Size and Strength on page 60
- Spacing of Mounting Holes on page 61
- Connection to Building Structure on page 62

Rack Size and Strength

The router is designed for installation in a rack that complies with either of the following standards:

- A 19-in. rack as defined in *Cabinets, Racks, Panels, and Associated Equipment* (document number EIA-310-D) published by the Electronics Industry Association (<http://www.eia.org>).
- A 600-mm rack as defined in the four-part *Equipment Engineering (EE); European telecommunications standard for equipment practice* (document numbers ETS 300 119-1 through 119-4) published by the European Telecommunications Standards Institute (<http://www.etsi.org>).

The horizontal spacing between the rails in a rack that complies with this standard is usually wider than the router's front support posts and center-mounting brackets, which measure 19 in. (48.3 cm) from outer edge to outer edge. Use approved wing devices to narrow the opening between the rails as required.

The rack rails must be spaced widely enough to accommodate the router chassis's external dimensions: 35 in. (89 cm) high, 29 in. (73.6 cm) deep, and 17.5 in. (44.5 cm) wide. The outer edges of the front support posts and center-mounting brackets extend the width to 19 in. (48.3 cm). The spacing of rails and adjacent racks must also allow for the clearances around the router and rack that are specified in Clearance Requirements for Airflow and Hardware Maintenance on page 62.



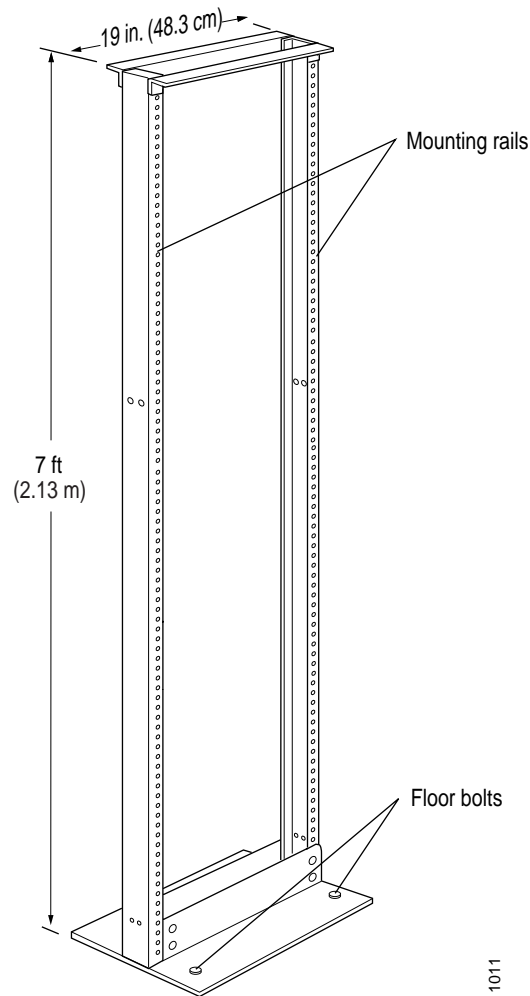
NOTE: The router might not fit into an 800-mm-deep cabinet, even if you adjust the front-to-back position of the front mounting rails inside the cabinet.

If you mount the router in a cabinet, be sure that ventilation is sufficient to prevent overheating.

In general, a center-mount rack is preferable to a front-mount rack because the more even distribution of weight in the center-mount rack provides greater stability. If a front-mount rack is used, we recommend supporting the back of the router with a shelf or other structure.

The chassis height of 35 in. (89 cm) is approximately 20 U. A U is the standard rack unit defined in *Cabinets, Racks, Panels, and Associated Equipment* (document number EIA-310-D) published by the Electronics Industry Association. You can stack eight M160 routers in a rack that has at least 40 U (70 in. or 1.78 m) of usable vertical space.

The rack must be strong enough to support the weight of the fully configured router, up to about 370.5 lb (168 kg). If you stack eight routers in one rack, it must be capable of supporting about 740 lb (336 kg).

Figure 26: Typical Center-Mount Rack

Spacing of Mounting Holes

Table 14 specifies the spacing between mounting holes in the chassis's front support posts and center-mounting brackets. The mounting holes in a front-mount rack's rails must align with the holes in the front support posts, and the mounting holes in a center-mount rack's rails must align with the holes in the center-mounting brackets.

Table 14: Spacing of Holes on Front Support Post and Center-Mounting Bracket

Router Mounting Rail	Hole Spacing
Front support post	4 U (7 in. or 17.78 cm)
Center-mounting bracket	3 U (5.25 in. or 13.33 cm)

Connection to Building Structure

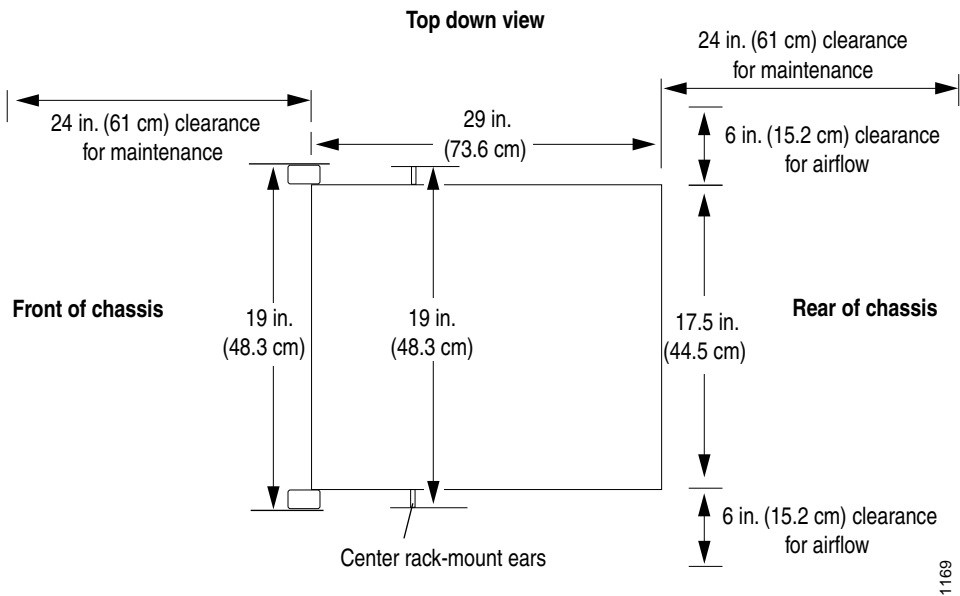
Always secure the rack to the structure of the building. If your geographical area is subject to earthquakes, bolt the rack to the floor. For maximum stability, also secure the rack to ceiling brackets. For more information, see “Rack-Mounting Requirements and Warnings” on page 240.

Clearance Requirements for Airflow and Hardware Maintenance

When planning the installation site, you need to allow sufficient clearance around the rack (see Figure 27):

- For the cooling system to function properly, the airflow around the chassis must be unrestricted. Figure 20 depicts the airflow in the router.
- For service personnel to remove and install hardware components, there must be adequate space at the front and back of the router. Allow at least 24 in. (61 cm) both in front of the router and behind it.

Figure 27: Chassis Dimensions and Clearance Requirements



Routing Node Environmental Specifications

Table 15 specifies the environmental specifications required for normal router operation. In addition, the site should be as dust-free as possible. Dust can clog air intake vents, reducing cooling system efficiency. Check the vents frequently, cleaning them as necessary. For more information, see “Maintaining Hardware Components” on page 127.

Table 15: Routing Node Environmental Specifications

Description	Value
Altitude	No performance degradation to 10,000 ft (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5 % to 90 %, noncondensing
Temperature	Normal operation ensured in temperature range of 32°F (0°C) to 104°F (40°C) Non-operating storage temperature in shipping crate: –40°F (–40°C) to 158°F (70°C)
Seismic	Tested to meet Telcordia Technologies Zone 4 earthquake requirements
Maximum thermal output	9400 BTU/hour



NOTE: Install the router only in restricted areas, such as dedicated equipment rooms and equipment closets, in accordance with Articles 110-16, 110-17, and 110-18 of the National Electrical Code, ANSI/NFPA 70.

For additional safety guidelines and requirements, see “Safety and Regulatory Compliance Information” on page 221.

Fire Safety Requirements

In the event of a fire emergency involving routers and other network equipment, the safety of people is the primary concern. You should establish procedures for protecting people in the event of a fire emergency, provide safety training, and properly provision fire-control equipment and fire extinguishers.

In addition, you should establish procedures to protect your equipment in the event of a fire emergency. Juniper Networks products should be installed in an environment suitable for electronic equipment. We recommend that fire suppression equipment be available in the event of a fire in the vicinity of the equipment, and that all local fire, safety, and electrical codes and ordinances be observed when installing and operating your equipment.

Fire Suppression

In the event of an electrical hazard or an electrical fire, you should first turn power off to the equipment at the source. Then use a Type C fire extinguisher, which uses noncorrosive fire retardants, to extinguish the fire. For more information about fire extinguishers, see “Fire Suppression Equipment” on page 64.

Fire Suppression Equipment

Type C fire extinguishers, which use noncorrosive fire retardants such as carbon dioxide (CO₂) and Halotron™, are most effective for suppressing electrical fires. Type C fire extinguishers displace the oxygen from the point of combustion to eliminate the fire. For extinguishing fire on or around equipment that draws air from the environment for cooling, you should use this type of inert oxygen displacement extinguisher instead of an extinguisher that leave residues on equipment.

Do not use multipurpose Type ABC chemical fire extinguishers (dry chemical fire extinguishers) near Juniper Networks equipment. The primary ingredient in these fire extinguishers is monoammonium phosphate, which is very sticky and difficult to clean. In addition, in minute amounts of moisture, monoammonium phosphate can become highly corrosive and corrodes most metals.

Any equipment in a room in which a chemical fire extinguisher has been discharged is subject to premature failure and unreliable operation. The equipment is considered to be irreparably damaged.



NOTE: To keep warranties effective, do not use a dry chemical fire extinguisher to control a fire at or near a Juniper Networks router. If a dry chemical fire extinguisher is used, the unit is no longer eligible for coverage under a service agreement.

We recommend that you dispose of any irreparably damaged equipment in an environmentally responsible manner.

Power Guidelines, Requirements, and Specifications

The router uses DC power. There are two load-sharing, pass-through power supplies located at the bottom rear of the chassis, as shown in Figure 2. The power supplies connect to the midplane, which distributes power to router components according to their individual voltage requirements. When the power supplies are installed and operational, they automatically share the electrical load. If a power supply stops functioning for any reason, the remaining power supplies instantly begin providing all the power the router needs for normal functioning and can provide full power indefinitely.

For site wiring and power system guidelines, requirements, and specifications, see the following sections:

- Site Electrical Wiring Guidelines on page 65
- Router Power Requirements on page 65
- Chassis Grounding on page 67
- Power, Connection, and Cable Specifications on page 67

Site Electrical Wiring Guidelines

When planning the electrical wiring at your site, consider the factors discussed in the following sections.

Distance Limitations for Signaling

Improperly installed wires can emit radio interference. In addition, the potential for damage from lightning strikes increases if wires exceed recommended distances, or if wires pass between buildings. The electromagnetic pulse (EMP) caused by lightning can damage unshielded conductors and destroy electronic devices. If your site has previously experienced such problems, you might want to consult experts in electrical surge suppression and shielding.

Radio Frequency Interference

You can reduce or eliminate the emission of radio frequency interference (RFI) from your site wiring by using twisted-pair cable with a good distribution of grounding conductors. If you must exceed the recommended distances, use a high-quality twisted-pair cable with one ground conductor for each data signal when applicable.

Electromagnetic Compatibility

If your site is susceptible to problems with electromagnetic compatibility (EMC), particularly from lightning or radio transmitters, you might want to seek expert advice. Strong sources of electromagnetic interference (EMI) can destroy the signal drivers and receivers in the router and conduct power surges over the lines into the equipment, resulting in an electrical hazard. It is particularly important to provide a properly grounded and shielded environment and to use electrical surge-suppression devices.



CAUTION: To comply with intrabuilding lightning/surge requirements, intrabuilding wiring must be shielded, and the shield for the wiring must be grounded at both ends.

Router Power Requirements

Table 16 lists the power requirements for various hardware components when the router is operating under typical voltage conditions. For PIC power requirements, see the *M160 Internet Router PIC Guide*.

Table 16: Component Power Requirements

Component	Power Requirement (Amps)
Base system (cooling system, power supplies, and craft interface)	7-10 A/48 V
Host module (Routing Engine and MCS)	1.3 A/48 V
FPC	2.4 A/48 V
PCG	0.2 A/48 V
SFM	1.3 A/48 V

You can use the information in Table 16 and the *M160 Internet Router PIC Guide* to calculate power consumption for various hardware configurations, input current from a different source voltage, and thermal output, as shown in the following examples. (For an added safety margin, the examples use a generalized value for PICs of 0.625 A/48 V each.)

■ Power consumption for minimum configuration:

$$\begin{aligned} &\text{Base system} + 1 \text{ FPC} + 1 \text{ SFM} + 1 \text{ host module} + 2 \text{ PCGs} + 4 \text{ PICs} = \\ &7 \text{ A} + 2.4 \text{ A} + 1.3 \text{ A} + 1.3 \text{ A} + 2(0.2 \text{ A}) + 4(0.625 \text{ A}) = \\ &7 \text{ A} + 2.4 \text{ A} + 1.3 \text{ A} + 1.3 \text{ A} + 0.4 \text{ A} + 2.5 \text{ A} = 14.9 \text{ A @ } 48 \text{ V} = 715 \text{ W DC} \end{aligned}$$

■ Power consumption for maximum configuration:

$$\begin{aligned} &\text{Base system} + 8 \text{ FPCs} + 4 \text{ SFMs} + 2 \text{ host modules} + 2 \text{ PCGs} + 32 \text{ PICs} = \\ &10 \text{ A} + 8(2.4 \text{ A}) + 4(1.3 \text{ A}) + 2(1.3 \text{ A}) + 2(0.2 \text{ A}) + 32(0.625 \text{ A}) = \\ &10 \text{ A} + 19.2 \text{ A} + 5.2 \text{ A} + 2.6 \text{ A} + 0.4 \text{ A} + 20 \text{ A} = 57.4 \text{ A @ } 48 \text{ V} = 2755 \text{ W DC} \end{aligned}$$

■ Input current from a DC source other than 48 V (based on maximum configuration):

$$\begin{aligned} &(54 \text{ VDC input}) \times (\text{input current X}) = (48 \text{ VDC input}) \times (\text{input current Y}) \\ &54 \times X = 48 \times 57.4 \text{ A} \\ &X = 48 \times 57.4 \text{ A} / 54 = 51.0 \text{ A} \end{aligned}$$

■ System thermal output for maximally configured router:

$$\begin{aligned} &105\% \text{ of Watts DC} / 0.293 = \text{BTU/hr} \\ &1.05 \times 2755 / 0.293 = 9873 \text{ BTU/hr} \end{aligned}$$



NOTE: If you plan to operate a maximally configured router, we recommend that you provision at least 70 A @ 48 VDC and use a facility circuit breaker rated for 70 A minimum. Doing so enables you to operate the router in any configuration without upgrading the power infrastructure, and allows the router to function at full capacity using one power supply.

If you plan to operate the router at less than the maximum configuration and do not provision a 70 A circuit breaker, we recommend that you provision a circuit breaker rated for at least 125 % of the continuous current that the system draws at 48 V.

Chassis Grounding

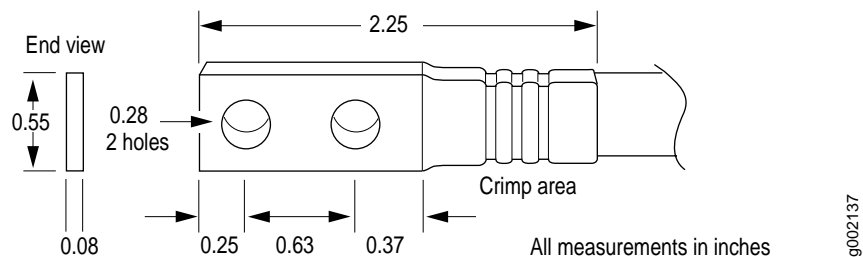
To meet safety and electromagnetic interference (EMI) requirements and to ensure proper operation, the router must be adequately grounded before power is connected. A pair of threaded inserts (PEM nuts) are provided on the right rear of the chassis for connecting the router to earth ground.



CAUTION: Before router installation begins, a licensed electrician must attach a cable lug to the grounding and power cables that you supply. A cable with an incorrectly attached lug can damage the router (for example, by causing a short circuit).

To ground the router, connect a grounding cable to earth ground and then attach it to the chassis grounding points. The grounding points are spaced at 0.625-in. (15.86-mm) centers. The accessory box shipped with the router includes the cable lug that attaches to the grounding cable (see Figure 28) and the UNC 1/4–20 screws (American) used to secure the grounding cable to the grounding points. (The cable lug shown in Figure 28 is also used for the DC power cables.) The grounding cable must be able to handle up to 82 A.

Figure 28: Power and Grounding Cable Lug



The grounding cable must be 8-AWG (8.4 m²) wire, minimum, or as permitted by the local code.

Power, Connection, and Cable Specifications

To supply power to the router, connect power cables to a separate, dedicated power source for each power supply and attach the cables to the terminal studs on the circuit breaker box. Most sites distribute power through a main conduit that leads to frame-mounted power distribution panels, one of which might be located at the top of the rack that houses the router. A pair of cables (one input and one return) connects each set of terminal studs to the power distribution panel.

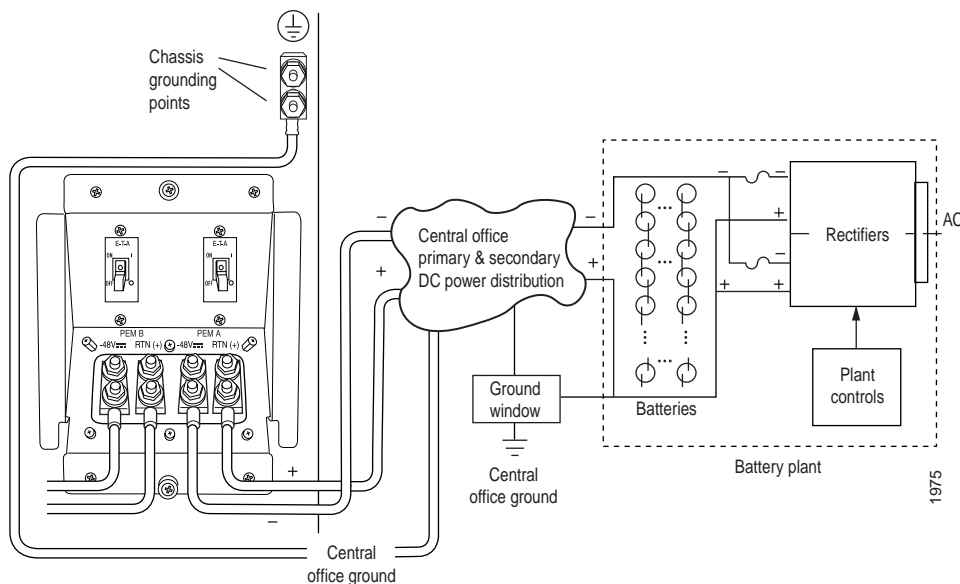


CAUTION: There is no standard color coding for DC power cables. The color coding used by the external DC power source at your site determines the color coding for the leads on the power cables that attach to the terminal studs on the circuit

breaker box. You must ensure that power connections maintain the proper polarity. The power source cables might be labeled (+) and (–) to indicate their polarity.

Figure 29 shows a typical source cabling arrangement.

Figure 29: Typical Source Cabling to the Router



WARNING: Power plant ground and chassis ground must be connected to the same building ground.

Table 17 summarizes the specifications for the grounding and power cables, which you supply. The accessory box shipped with the router includes the cable lugs that attach to the terminal studs of the circuit breaker box (see Figure 28). (The cable lug shown in Figure 28 is also used for the grounding the chassis.)



CAUTION: Before router installation begins, a licensed electrician must attach a cable lug to the grounding and power cables that you supply. A cable with an incorrectly attached lug can damage the router (for example, by causing a short circuit).

Table 17: DC Power and Grounding Cable Specifications

Cable Type	Quantity and Specification	Maximum Equal Length
Power	Eight 4-AWG (16 mm ²) wires, minimum, or as permitted by the local code	None
Grounding	One 8-AWG (8.4 mm ²) wire, minimum, or as permitted by the local code	None



WARNING: For field-wiring connections, use copper conductors only.

For other electrical safety information, see “Electrical Safety Guidelines and Warnings” on page 227.



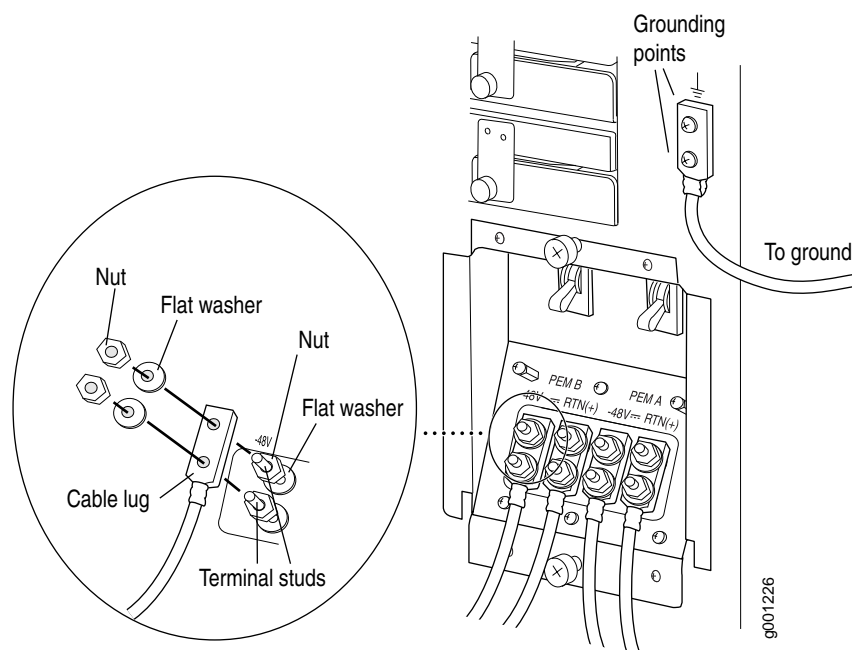
CAUTION: Power cords and cables must not block access to router components or drape where people could trip on them.

Figure 30 shows how to attach the power cables. The power cables attach to the 1/4–20 UNC terminal studs located on the circuit breaker box—the input set of studs is labeled –48V and the return set is labeled RTN(+). The nuts and locking washers used to secure the power cable lugs on the terminal studs are preinstalled on the studs.

The tool for loosening or tightening the nuts on the terminal studs is a 7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a minimum of 30 lb-in. (3.5 Nm) tightening torque.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

Figure 30: Power and Grounding Cable Connections

For information about the DC power supply, including electrical specifications and a description of components, see “Power Supply” on page 36. For instructions on connecting the DC power and grounding cables during initial installation, see “Connecting Power to the Router” on page 117. For instructions on replacing a DC power cable, see “Disconnecting and Connecting Power” on page 200.

Network Cable Specifications and Guidelines

The various PICs supported on the router accept different kinds of network cable, including multimode and single-mode fiber-optic cable. For more information, see the following sections:

- Fiber Optic and Network Cable Specifications on page 71
- Signal Loss in Multimode and Single-Mode Fiber-Optic Cable on page 71
- Attenuation and Dispersion in Fiber-Optic Cable on page 71
- Calculating Power Budget for Fiber-Optic Cable on page 72
- Calculating Power Margin for Fiber-Optic Cable on page 73
- Attenuating to Prevent Saturation at SONET/SDH PICs on page 74

Fiber Optic and Network Cable Specifications

The router supports PICs that use various kinds of network cable, including multimode and single-mode fiber-optic cable. For information about the type of cable used by each PIC, see the *M160 Internet Router PIC Guide*.

Signal Loss in Multimode and Single-Mode Fiber-Optic Cable

Multimode fiber is large enough in diameter to allow rays of light to reflect internally (bounce off the walls of the fiber). Interfaces with multimode optics typically use LEDs as light sources. LEDs are not coherent sources, however. They spray varying wavelengths of light into the multimode fiber, which reflects the light at different angles. Light rays travel in jagged lines through a multimode fiber, causing signal dispersion. When light traveling in the fiber core radiates into the fiber cladding, higher-order mode loss (HOL) results. Together these factors limit the transmission distance of multimode fiber compared to single-mode fiber.

Single-mode fiber is so small in diameter that rays of light can reflect internally through one layer only. Interfaces with single-mode optics use lasers as light sources. Lasers generate a single wavelength of light, which travels in a straight line through the single-mode fiber. Compared with multimode fiber, single-mode fiber has higher bandwidth and can carry signals for longer distances. It is consequently more expensive.

For information about the maximum transmission distance and supported wavelength range for the types of single-mode and multimode fiber-optic cable used by PICs on the M160 router, see the *M160 Internet Router PIC Guide*. Exceeding the maximum transmission distances can result in significant signal loss, which causes unreliable transmission.

The router uses optical lasers for SONET/SDH PIC single-mode interfaces. These optics comply with IR-1 of Bellcore GR-253-CORE Issue 2, December 1995 and ANSI T1.105.06.

Attenuation and Dispersion in Fiber-Optic Cable

Correct functioning of an optical data link depends on modulated light reaching the receiver with enough power to be demodulated correctly. *Attenuation* is the reduction in power of the light signal as it is transmitted. Attenuation is caused by passive media components, such as cables, cable splices, and connectors. While attenuation is significantly lower for optical fiber than for other media, it still occurs in both multimode and single-mode transmission. An efficient optical data link must have enough light available to overcome attenuation.

Dispersion is the spreading of the signal in time. The following two types of dispersion can affect an optical data link:

- Chromatic dispersion—The spreading of the signal in time resulting from the different speeds of light rays.
- Modal dispersion—The spreading of the signal in time resulting from the different propagation modes in the fiber.

For multimode transmission, modal dispersion, rather than chromatic dispersion or attenuation, usually limits the maximum bit rate and link length. For single-mode transmission, modal dispersion is not a factor. However, at higher bit rates and over longer distances, chromatic dispersion rather than modal dispersion limits maximum link length.

An efficient optical data link must have enough light to exceed the minimum power that the receiver requires to operate within its specifications. In addition, the total dispersion must be less than the limits specified for the type of link in Telcordia Technologies document GR-253-CORE (Section 4.3) and International Telecommunications Union (ITU) document G.957.

When chromatic dispersion is at the maximum allowed, its effect can be considered as a power penalty in the power budget. The optical power budget must allow for the sum of component attenuation, power penalties (including those from dispersion), and a safety margin for unexpected losses. For more information about power budget, see “Calculating Power Budget for Fiber-Optic Cable” on page 72.

Calculating Power Budget for Fiber-Optic Cable

To ensure that fiber-optic connections have sufficient power for correct operation, you need to calculate the link’s power budget, which is the maximum amount of power it can transmit. When you calculate the power budget, you use a worst-case analysis to provide a margin of error, even though all the parts of an actual system do not operate at the worst-case levels. To calculate the worst-case estimate of power budget (P_B), you assume minimum transmitter power (P_T) and minimum receiver sensitivity (P_R):

$$P_B = P_T - P_R$$

The following hypothetical power budget equation uses values measured in decibels (dB) and decibels referred to one milliwatt (dBm):

$$P_B = P_T - P_R$$

$$P_B = -15 \text{ dBm} - (-28 \text{ dBm})$$

$$P_B = 13 \text{ dB}$$

Calculating Power Margin for Fiber-Optic Cable

After calculating a link's power budget (using the equation described in "Calculating Power Budget for Fiber-Optic Cable" on page 72), you can calculate the power margin (P_M), which represents the amount of power available after subtracting attenuation or link loss (LL) from the power budget (P_B). A worst-case estimate of P_M assumes maximum LL:

$$P_M = P_B - LL$$

A P_M greater than zero indicates that the power budget is sufficient to operate the receiver.

Factors that can cause link loss include higher-order mode losses, modal and chromatic dispersion, connectors, splices, and fiber attenuation. Table 18 lists an estimated amount of loss for the factors used in the following sample calculations. For information about the actual amount of signal loss caused by equipment and other factors, refer to vendor documentation.

Table 18: Estimated Values for Factors Causing Link Loss

Link-Loss Factor	Estimated Link-Loss Value
Higher-order mode losses	Single-mode—None Multimode—0.5 dB
Modal and chromatic dispersion	Single-mode—None Multimode—None, if product of bandwidth and distance is less than 500 MHz-km
Connector	0.5 dB
Splice	0.5 dB
Fiber attenuation	Single-mode—0.5 dB/km Multimode—1 dB/km

The following example uses the estimated values in Table 18 to calculate link loss (LL) for a 2 km-long multimode link with a power budget (P_B) of 13 dB:

- Fiber attenuation for 2 km @ 1.0 dB/km = 2 dB
- Loss for five connectors @ 0.5 dB per connector = 5(0.5 dB) = 2.5 dB
- Loss for two splices @ 0.5 dB per splice = 2(0.5 dB) = 1 dB
- Higher-order loss = 0.5 dB
- Clock recovery module = 1 dB

The power margin (P_M) is calculated as follows:

$$P_M = P_B - LL$$

$$P_M = 13 \text{ dB} - 2 \text{ km (1.0 dB/km)} - 5 (0.5 \text{ dB}) - 2 (0.5 \text{ dB}) - 0.5 \text{ dB [HOL]} - 1 \text{ dB [CRM]}$$

$$P_M = 13 \text{ dB} - 2 \text{ dB} - 2.5 \text{ dB} - 1 \text{ dB} - 0.5 \text{ dB} - 1 \text{ dB}$$

$$P_M = 6 \text{ dB}$$

The following sample calculation for an 8 km-long single-mode link with a power budget (P_B) of 13 dB uses the estimated values from Table 18 to calculate link loss (LL) as the sum of fiber attenuation (8 km @ 0.5 dB/km, or 4 dB) and loss for seven connectors (0.5 dB per connector, or 3.5 dB). The power margin (P_M) is calculated as follows:

$$P_M = P_B - LL$$

$$P_M = 13 \text{ dB} - 8 \text{ km (0.5 dB/km)} - 7 (0.5 \text{ dB})$$

$$P_M = 13 \text{ dB} - 4 \text{ dB} - 3.5 \text{ dB}$$

$$P_M = 5.5 \text{ dB}$$

In both examples, the calculated power margin is greater than zero, indicating that the link has sufficient power for transmission and does not exceed the maximum receiver input power.

Attenuating to Prevent Saturation at SONET/SDH PICs

SONET/SDH interfaces in the different reach classes—short reach (SR), intermediate reach (IR), and long reach (LR)—generate different output power levels and tolerate different input power levels. Interfaces that have a longer reach can transmit enough power to saturate the receivers on PICs that have a shorter reach. Specifically, LR interfaces can saturate IR PICs, and both IR and LR interfaces can saturate SR PICs. Interfaces in the same reach class can also saturate one another.

To prevent saturation, you might need to attenuate power at the PIC receiver, particularly if you know that it has a shorter reach than the interface that is sending the signal. Determine the amount of attenuation needed by measuring the power level at each receiver. Attenuate the power to bring it within the allowable range; for short lengths of fiber, with fiber and connector loss close to zero, an attenuator of 5 to 10 dB should be sufficient.

For specifications of minimum and maximum input level (receiver sensitivity and receiver saturation) and minimum and maximum output level (average launch power) for the SONET/SDH PICs supported on the M160 router, see the *M160 Internet Router PIC Guide*.

Routing Engine Interface Cable and Wire Specifications

For management and service operations, you connect the Routing Engine to an external console or management network through ports on the Connector

Interface Panel (CIP). You can also connect the router to external alarm-reporting devices through the alarm relay contacts on the CIP. (For more information, see Connector Interface Panel (CIP) on page 32.)

Table 19 lists the specifications for the cables that connect to management ports and the wires that connect to the alarm relay contacts.

Table 19: Cable and Wire Specifications for Routing Engine Management and Alarm Interfaces

Port	Cable Specification	Cable/Wire Supplied	Maximum Length	Router Receptacle
Routing Engine console or auxiliary interface	RS-232 (EIA-232) serial cable	One 6-ft (1.83-m) length with DB-9/DB-9 connectors	6 ft (1.83 m)	DB-9 male
Routing Engine Ethernet interface	Category 5 cable or equivalent suitable for 100BaseT operation	One 15-ft (4.57-m) length with RJ-45/RJ-45 connectors	328 ft (100 m)	RJ-45 autosensing
Alarm relay contacts	Wire with gauge between 24-AWG and 12-AWG (0.20 and 3.33 mm ²)	No	None	—

Site Preparation Checklist

The checklist in Table 20 summarizes the tasks you need to perform when preparing a site for router installation.

Table 20: Site Preparation Checklist

Item or Task	Performed By	Date	Notes
Verify that environmental factors such as temperature and humidity do not exceed router tolerances (see Routing Node Environmental Specifications on page 62).			
Measure distance between external power sources and router installation site.			
Select the type of rack or cabinet.			
Plan rack or cabinet location, including required space clearances.			
If a rack is used, secure rack to floor and building structure.			
Acquire cables and connectors.			

Item or Task	Performed By	Date	Notes
Locate sites for connection of system grounding.			
Calculate power budget and power margin.			

Chapter 6

Unpacking the Router

This chapter explains how to unpack the router and verify the parts received. Before beginning, prepare the installation site as described in “Preparing for Router Installation” on page 59 and review the safety information in “Safety and Regulatory Compliance Information” on page 221, especially “General Safety Guidelines and Warnings” on page 224 and “Installation Safety Guidelines and Warnings” on page 239. This chapter discusses the following topics:

- Tools and Parts Required on page 77
- Unpacking the Router on page 77

Tools and Parts Required

To unpack the router and prepare for installation, you need the following tools:

- Phillips (+) screwdriver, number 2
- 1/2-in. or 13-mm open-end or socket wrench to remove bracket bolts from the shipping pallet
- Blank panels to cover any slots not occupied by a component

Unpacking the Router

The router is shipped in a wooden crate and bolted to the pallet that forms the bottom of the crate. The crate also contains an accessory box, the handle used during manual router installation, and the *M160 Internet Router Installation Quick Start* poster.



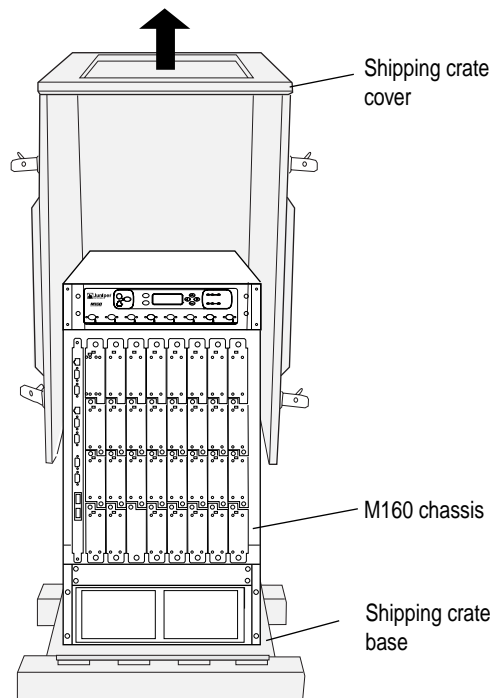
NOTE: The router is maximally protected inside the shipping crate. Do not unpack it until you are ready to begin installation.

To unpack the router, perform these steps:

1. Move the shipping crate to a staging area as close to the installation site as possible, but where you have enough room to remove the system components.

While the chassis is bolted to the pallet, you can use a forklift or pallet jack to move it.

2. Position the crate so that the arrows are pointing up.
3. Twist open the locking tabs that secure the crate to the pallet and the front panel to the side panels.
4. Remove the front panel from the crate, then lift the top and sides off the pallet as a unit. See Figure 31.
5. Remove the plastic cover, then the foam and Quick Start that are sitting on top of the chassis. The installation handle and accessory box are embedded in cutouts in the foam.
6. Open the accessory box and verify the contents against the parts inventory on the label attached to the box.
7. Verify the chassis components received against the packing list included with the router. A generic parts inventory appears in Table 21.
8. Use a 1/2-in. open-end or socket wrench to loosen and remove the bolts on the brackets that attach the chassis to the pallet. If a 1/2-in. tool is not available, use pliers or an adjustable wrench rather than a fixed-size metric wrench.
9. Use a Phillips screwdriver to loosen the screws that secure the brackets to the sides of the chassis, and remove the brackets. Store the brackets, screws, and bolts inside the accessory box.
10. Save the shipping crate, packing materials, and pallet in case you later need to move or ship the router.

Figure 31: Unpacking the Router**Table 21: Generic Inventory of Router Components Installed in Chassis**

Component	Quantity
Front impeller assembly with craft interface	1
FPC with one or more PICs installed	Up to 8
PIC	Up to 4 per FPC
CIP	1
Front fan tray with 4 fans and cable management system	1
Midplane	1
Rear upper impeller assembly	1
SFM	4
MCS	1 or 2
Routing Engine	1 or 2
PCG	2
Rear lower impeller assembly	1
Circuit breaker box	1
Power supply	2
Center-mounting brackets	2
Blank panels for slots without components	Varies depending on router configuration

Chapter 7

Installing the Router Using a Mechanical Lift

Because the router weighs between 190 lb (86 kg) and about 370.5 lb (168 kg) depending on configuration, using a mechanical lift to install it is recommended. This chapter provides instructions. If you do not use a lift, see “Installing the Router without a Mechanical Lift” on page 83. This chapter has the following sections:

- Tools and Parts Required on page 81
- Installing the Chassis Using a Mechanical Lift on page 81

Tools and Parts Required

To install the chassis into a rack using a mechanical lift, you need the following tools and parts:

- Mechanical lift
- 5/32-in. Allen (hexagonal) wrench for tightening the mounting screws provided in the accessory box; do not substitute a metric-size wrench
- Phillips (+) screwdrivers, numbers 1 and 2, if removing center-mounting brackets or installing rear support shelf

Installing the Chassis Using a Mechanical Lift

Using a mechanical lift to maneuver the router into the rack is recommended because of the router’s size and weight. The lift must be able to accommodate the router’s weight—between 190 lb (86 kg) and about 370.5 lb (168 kg) depending on configuration—and must fit between the support posts of the rack.



NOTE: If you are installing multiple routers in a rack, install the lowest one first and proceed upward.

First, perform the following prerequisite procedures:

- Verify that the router site meets the requirements described in “Preparing for Router Installation” on page 59.
- Place the rack in its permanent location, allowing adequate clearance for airflow and maintenance, and secure it to the building structure. For details, see Rack Requirements on page 59.
- Read the information in “Installation Safety Guidelines and Warnings” on page 239, with particular attention to “Chassis Lifting Guidelines” on page 239.
- Remove the router from the shipping carton, as described in “Unpacking the Router” on page 77.

Then, perform the following procedures to install the router:

1. If you are front-mounting the router, remove the center-mounting ear from each side of the chassis. (Also, we recommend installing a shelf or other support for the rear of the chassis.)
2. Load the router onto the lift, making sure it rests securely on the lift platform.
3. Use the lift to position the router at the correct height in the rack.
4. Align the bottom hole in both front support posts or center-mounting brackets with a hole in each rack rail, making sure the chassis is level.
5. Install one of the mounting screws provided into each of the two aligned holes. Use a 5/32-in. Allen wrench to tighten the screws.
6. Moving up each post or ear, install a screw in every mounting hole.
7. Verify that all the mounting screws on one side of the rack are aligned with the mounting screws on the opposite side and that the router is level.
8. Move the lift away from the rack.
9. To continue the installation, proceed to “Connecting the Router and Performing Initial Configuration” on page 111.

Chapter 8

Installing the Router without a Mechanical Lift

You can install the router into a rack either with or without the help of a mechanical lift. Because the router weighs between 190 lb (86 kg) and about 370.5 lb (168 kg) depending on configuration, using a mechanical lift is recommended; for instructions, see “Installing the Router Using a Mechanical Lift” on page 81.

If you do not use a mechanical lift, you must remove components from the chassis to reduce its weight before lifting it into the rack. The reduced chassis weight is approximately 115 lb (52 kg), so installing it safely still requires three people to lift and another person to insert the mounting screws.

Table 22 lists the weight of the chassis and major components.

Table 22: Router Component Weights

Component	Approximate Weight (lb)	Approximate Weight (kg)
Air filter	2	0.9
Cable management system	1	0.5
Chassis (with midplane, CIP, and circuit breaker box or panel)	113.5	51.5
DC power supply	13	5.9
Fan tray	13	5.9
FPC with 4 installed PICs	15	6.8
Front impeller assembly with craft interface	14.5	6.6
MCS	2.5	1.1
PCG	0.75	0.34
Rear lower impeller assembly	5	2.3
Rear upper impeller assembly	4	1.8
Routing Engine	1.5	0.7
SFM	5	2.3

Before installing the chassis, perform the following prerequisite procedures:

- Verify that the router site meets the requirements described in “Preparing for Router Installation” on page 59.
- Place the rack in its permanent location, allowing adequate clearance for airflow and maintenance, and secure it to the building structure. For details, see Rack Requirements on page 59.
- Read the information in “Installation Safety Guidelines and Warnings” on page 239, with particular attention to “Chassis Lifting Guidelines” on page 239.
- Remove the router from the shipping carton, as described in “Unpacking the Router” on page 77.

Then install the router by performing the procedures in the following sections:

- Tools and Parts Required on page 84
- Removing Components from the Chassis on page 84
- Installing the Chassis into the Rack on page 97
- Reinstalling Components into the Chassis on page 99

Tools and Parts Required

To install the chassis without using a mechanical lift, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- Flat-blade screwdriver, approximately 1/4 in. (6 mm), for removing craft interface
- 5/32-in. Allen (hexagonal) wrench for tightening the mounting screws provided in the accessory box; do not substitute a metric-size wrench
- Electrostatic bags or antistatic mats, one for each electronic component removed
- Electrostatic discharge (ESD) grounding wrist strap

Removing Components from the Chassis

To make the router light enough to install without a mechanical lift, you must remove most of the components.



WARNING: The procedures in this section apply only to initial installation and assume that you have not yet connected power to the router. If power is connected, completely disconnect it before continuing. See “Disconnecting Power from the Router” on page 200.

If you are installing or replacing components in an operational router, see “Replacing Hardware Components” on page 139.

Do not stack components on top of one another after removing them from the chassis. Place each one individually on a flat, stable surface, either on an antistatic mat or in an electrostatic bag.

Set the removed components far enough away from the installation site that they will not be in the way as you lift the chassis into the rack.

Perform the procedures described in the following sections to remove components from the chassis, first from the rear and then from the front:

- Removing the Power Supplies on page 86
 - Removing the Rear Component Cover on page 86
 - Removing the SFMs on page 87
 - Removing the MCSs on page 88
 - Removing the PCGs on page 89
 - Removing the Routing Engines on page 90
 - Removing the Rear Upper Impeller Assembly on page 91
 - Removing the Rear Lower Impeller Assembly on page 92
 - Removing the Fan Tray on page 93
 - Removing the FPCs on page 94
 - Removing the Front Impeller Assembly on page 96
-



NOTE: Do not remove the circuit breaker box or the Connector Interface Panel (CIP). This chapter does not include instructions for removing these components.

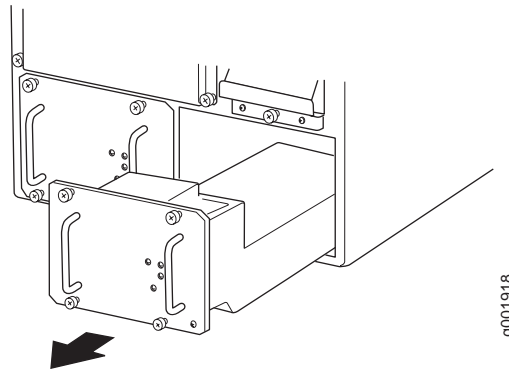
Removing the Power Supplies

The router has two power supplies located at the bottom rear of the chassis, as shown in Figure 2. A power supply weighs approximately 13 lb (5.9 kg).

To remove the power supplies, follow this procedure (see Figure 32):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Verify that the power switch for each power supply is in the OFF (O) position. The switches are on the circuit breaker box.
3. Loosen the thumbscrew at each corner of the power supply faceplate, using a Phillips screwdriver if necessary.
4. Grasp the handle or handles on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
5. Place one hand under the power supply to support it, then slide it completely out of the chassis.
6. Repeat the procedure to remove the second power supply.

Figure 32: Removing a Power Supply



Removing the Rear Component Cover

The rear component cover protects the SFMs, Routing Engines, MCSs, and PCGs, as shown in Figure 2. To remove it, follow this procedure:

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. Loosen the thumbscrew at each corner of the component cover, using a Phillips screwdriver if necessary.
3. Pull the cover straight off the chassis.



CAUTION: To maintain proper airflow and provide electromagnetic shielding, do not operate the router without the rear component cover in place.

Removing the SFMs

The router can have an SFM in each of the slots labeled **SFM 0** through **SFM 3** at the rear of the chassis, as shown in Figure 3. Each SFM weighs approximately 5 lb (2.3 kg).

To remove an SFM, follow this procedure (see Figure 33):

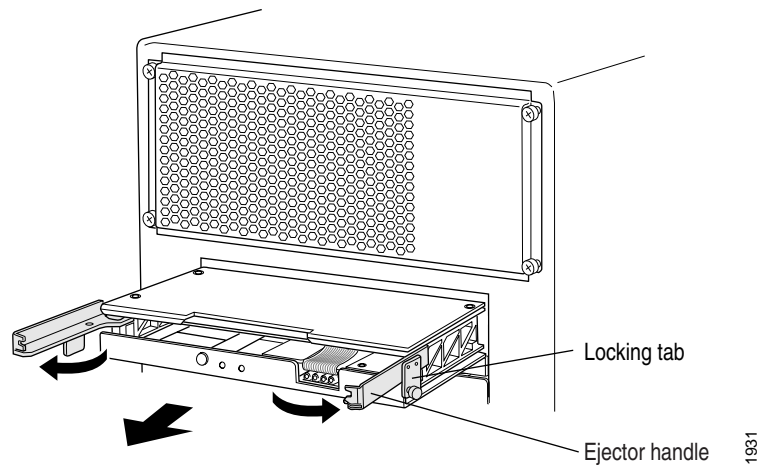
1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Loosen the thumbscrew on each ejector locking tab (shown in Figure 8), using a Phillips screwdriver if necessary.
4. Pull the end of each ejector handle outward until it is nearly perpendicular to the SFM faceplate.
5. Grasp the ejector handles and pull firmly to slide the SFM about halfway out of the chassis.
6. Place one hand under the SFM to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.



CAUTION: When an SFM is out of the chassis, do not hold it by the ejector handles. They cannot support its weight.

Do not stack SFMs on top of or under other components. Place each one individually in an electrostatic bag or on its own antistatic mat on a flat, stable surface.

If additional SFMs are installed, repeat the procedure to remove them.

Figure 33: Removing an SFM

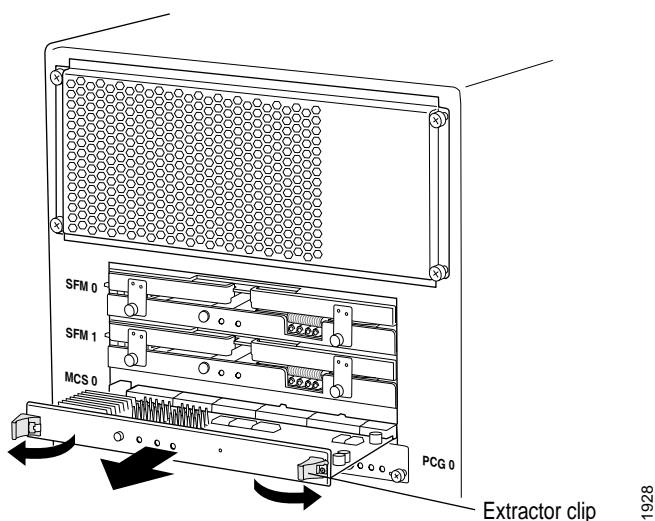
Removing the MCSs

The router can have an MCS in each of the slots labeled MCS 0 and MCS 1 at the rear of the chassis, as shown in Figure 3. Each MCS weighs approximately 2.5 lb (1 kg).

To remove the MCSs, follow this procedure (see Figure 34):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Push the end of each extractor clip (located at each end of the MCS) outward.
4. Grasp the extractor clips and slide the MCS about halfway out of the chassis.
5. Place one hand under the MCS to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

If a second MCS is installed, repeat the procedure to remove it.

Figure 34: Removing an MCS

Removing the PCGs

The router has two PCGs installed in the slots labeled PCG 0 and PCG 1 at the rear of the chassis, as shown in Figure 3. Each PCG weighs approximately 1 lb (0.5 kg).

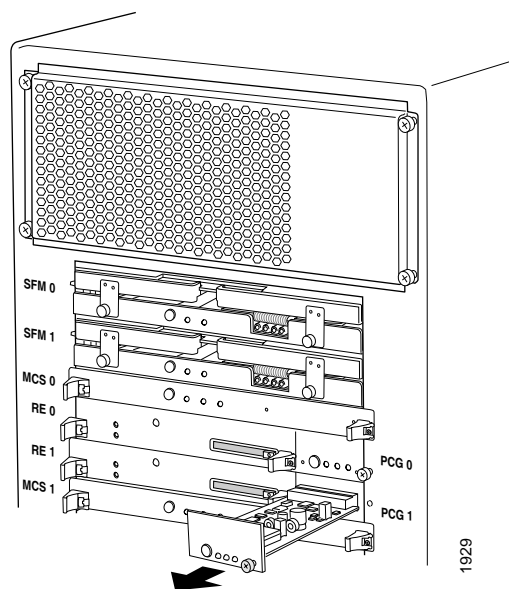
To remove the PCGs, follow this procedure (see Figure 35):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Loosen the thumbscrew at the lower right corner of the PCG faceplate, using a Phillips screwdriver if necessary.
4. Grasp the thumbscrew and slide the PCG about halfway out of the chassis.



CAUTION: Be careful to slide the PCG straight out of the chassis to avoid bending any of the pins on the underside of the board.

5. Place one hand under the PCG to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.
6. Repeat the procedure to remove the second PCG.

Figure 35: Removing a PCG

Removing the Routing Engines

The router can have a Routing Engine in each of the slots labeled RE 0 and RE 1 at the rear of the chassis, as shown in Figure 3. Each Routing Engine weighs approximately 1.5 lb (0.7 kg).

To remove a Routing Engine, follow this procedure (see Figure 36):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Using your thumbs, push and hold the red tab on each extractor clip toward the outer edge of the unit. Push the ends of the extractor clips outward to unseat the Routing Engine from the chassis.
4. Grasp the extractor clips and slide the unit about halfway out of the chassis.

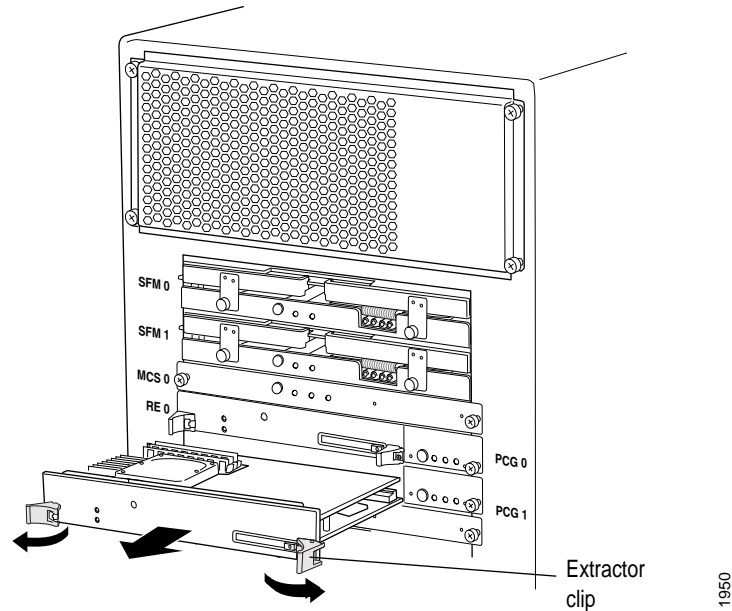


CAUTION: Slide the Routing Engine straight out of the chassis. Damage can result if it gets lodged because of uneven movement.

5. Place one hand under the Routing Engine to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

If a second Routing Engine is installed, repeat the procedure to remove it.

Figure 36: Removing a Routing Engine

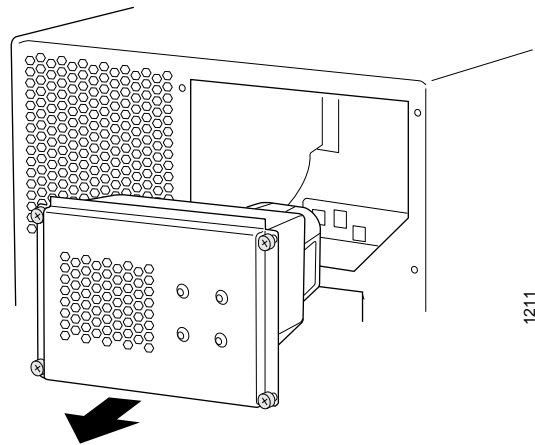
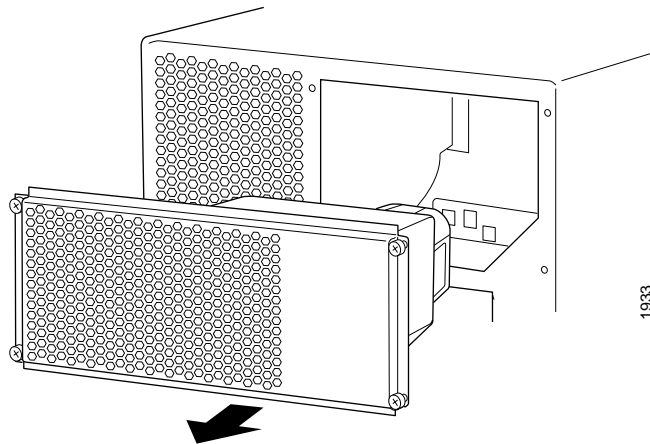


Removing the Rear Upper Impeller Assembly

The rear upper impeller assembly is located at the top of the chassis rear, as shown in Figure 2. The assembly weighs approximately 4 lb (1.8 kg).

To remove the rear upper impeller assembly, follow this procedure (see Figure 37 and Figure 38, which show the two types of impeller that can be installed):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Loosen the thumbscrew at each corner of the impeller cover, using a Phillips screwdriver if necessary.
3. Grasp the screws at opposite corners of the impeller cover and slide the assembly out of the chassis.

Figure 37: Removing the Rear Upper Impeller Assembly**Figure 38: Removing the Rear Upper Impeller Assembly**

Removing the Rear Lower Impeller Assembly

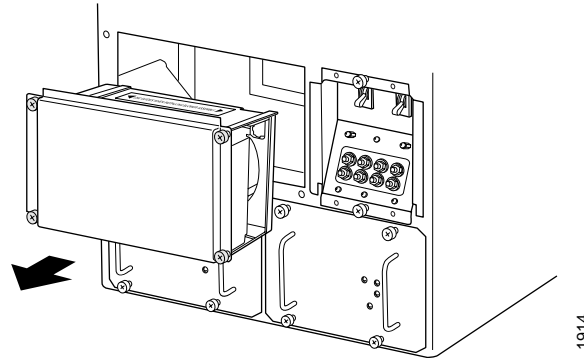
The rear lower impeller assembly is located to the left of the circuit breaker box on the rear of the chassis, as shown in Figure 2. The assembly weighs approximately 5 lb (2.3 kg).

To remove the rear lower impeller assembly, follow this procedure (see Figure 39):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Loosen the thumbscrew at each corner of the impeller cover, using a Phillips screwdriver if necessary.

3. Grasp the screws at opposite corners of the impeller cover and slide the assembly out of the chassis.

Figure 39: Removing the Rear Lower Impeller Assembly



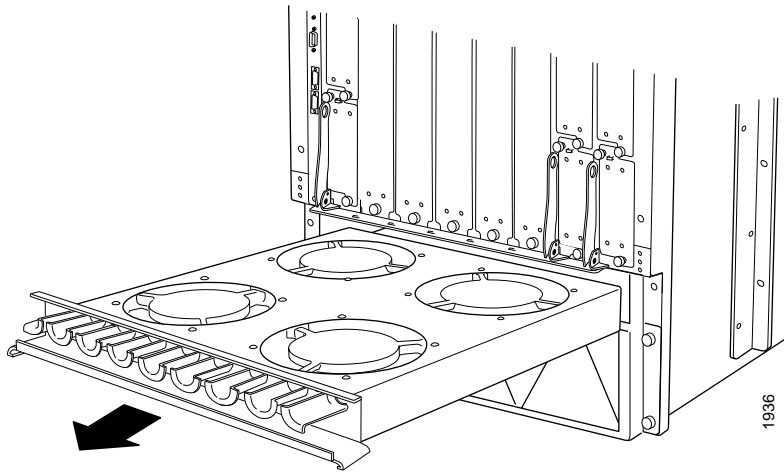
Removing the Fan Tray

The fan tray is located behind the cable management system on the front of the chassis, just above the air filter, as shown in Figure 1. The fan tray contains four fans and weighs approximately 13 lb (5.9 kg).

To remove the fan tray, follow this procedure (see Figure 40):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Loosen the thumbscrew at each end of the fan tray, using a Phillips screwdriver if necessary.
3. Grasp the sides of the fan tray and pull firmly to slide it out of the chassis.

Figure 40: Removing the Fan Tray



Removing the FPCs

The router can have up to eight FPCs mounted vertically in the FPC card cage on the front of the chassis, as shown in Figure 1. An FPC that houses four PICs weighs about 15 lb (6.8 kg).



NOTE: To help you work systematically, the following procedure directs you to remove FPCs starting at the left side of the card cage and working toward the right. You can remove FPCs in any order, however. As you remove each FPC, label it with its slot number and record the relevant information in the checklist in Table 23.

Table 23: FPC Removal Checklist

Slot	Media Types	Date Removed	Date Reinstalled
0			
1			
2			
3			
4			
5			
6			
7			

To remove the FPCs, follow this procedure (see Figure 41):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Locate the FPC or blank panel located in the leftmost slot of the card cage on the front of the chassis. It is directly below the offline button on the craft interface that is labeled **FPC0**.
4. If the slot is covered by a blank panel, you can leave it in place. If the slot contains an FPC, perform the following steps:
 - a. Loosen the thumbscrew at each end of the FPC, using a Phillips screwdriver if necessary.
 - b. Pull the ends of the ejector levers, which are adjacent to the thumbscrews, away from the face of the FPC until they are nearly perpendicular to it.
 - c. Grasp the top and bottom flanges of the card carrier and slide the FPC about halfway out of the card cage.
 - d. Place one hand around the front of the FPC (the PIC housing) and the other hand under it to support it. Slide the FPC completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

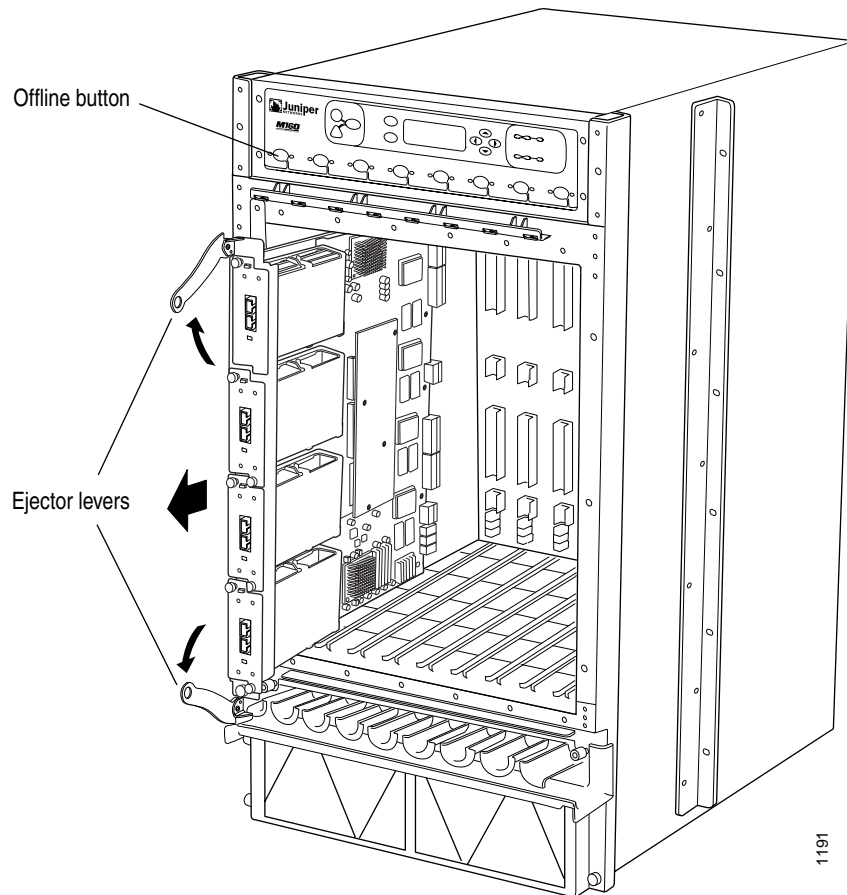


CAUTION: The weight of the FPC is concentrated in the back end. Be prepared to accept the full weight—up to 29 lb (13.2 kg)—as you slide the FPC out of the chassis.

When the FPC is out of the chassis, do not hold it by the ejector levers, bus bars, or edge connectors. They cannot support its weight.

Do not stack FPCs on top of one another after removal. Place each one individually in an electrostatic bag or on its own antistatic mat on a flat, stable surface.

5. Repeat Step 4 for each FPC card carrier or blank cover, proceeding from left to right.

Figure 41: Removing an FPC

Removing the Front Impeller Assembly

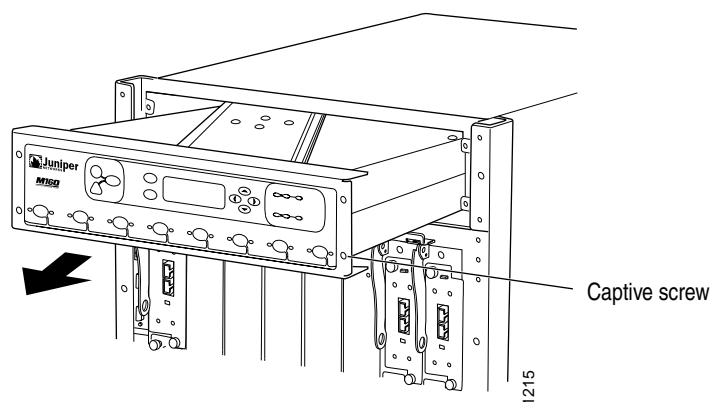
The front impeller assembly, which includes the craft interface, is located at the front of the chassis above the FPC card cage, as shown in Figure 1. The assembly weighs approximately 14.5 lb (6.6 kg).

To remove the front impeller assembly, follow this procedure (see Figure 42):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Using a Phillips screwdriver, loosen the captive screw at each corner of the craft interface.

4. Insert a flat-blade screwdriver into the gap around the craft interface and gently pry the impeller assembly forward until you can grasp the sides of the assembly and slide it halfway out of the chassis.
5. Place one hand under the assembly to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

Figure 42: Removing the Front Impeller Assembly



Installing the Chassis into the Rack

After you have removed components as described in Removing Components from the Chassis on page 84, the chassis is light enough for a team of installers to lift into the rack.



CAUTION: The reduced weight of the chassis is approximately 115 lb (52 kg). Installing it into the rack still requires three people to lift and an additional person to secure the mounting screws.

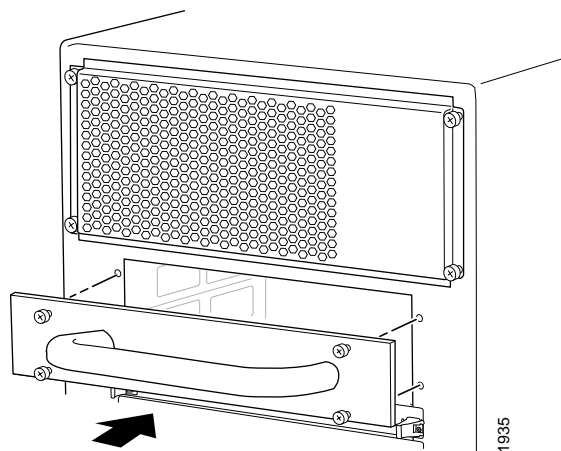
If you are installing multiple routers in a rack, install the lowest one first and proceed upward.

Perform the following procedures (see Figure 44):

1. If you are front-mounting the router, remove the center-mounting ear from each side of the chassis. (Also, we recommend installing a shelf or other support for the rear of the chassis.)
2. Attach the lifting handle to the rear of the chassis, screwing the thumbscrews at its corners into the holes located next to the SFM slots on the chassis (see Figure 43). If you are installing the chassis in a lower rack space, use the set of holes adjacent to the slots labeled **SFM 0** and **SFM 1**. If you are installing

the chassis in an upper rack space, use the set of holes adjacent to the slots labeled SFM 2 and SFM 3.

Figure 43: Attaching the Lifting Handle



3. Prepare to lift the router:
 - One person stands behind the chassis and grasps the lifting handle.
 - Two people stand on either side of the chassis. Each grasps the bar at the bottom of the FPC card cage with one hand and places the other hand under the chassis near the rear.
4. Lift the chassis and position it in the rack.

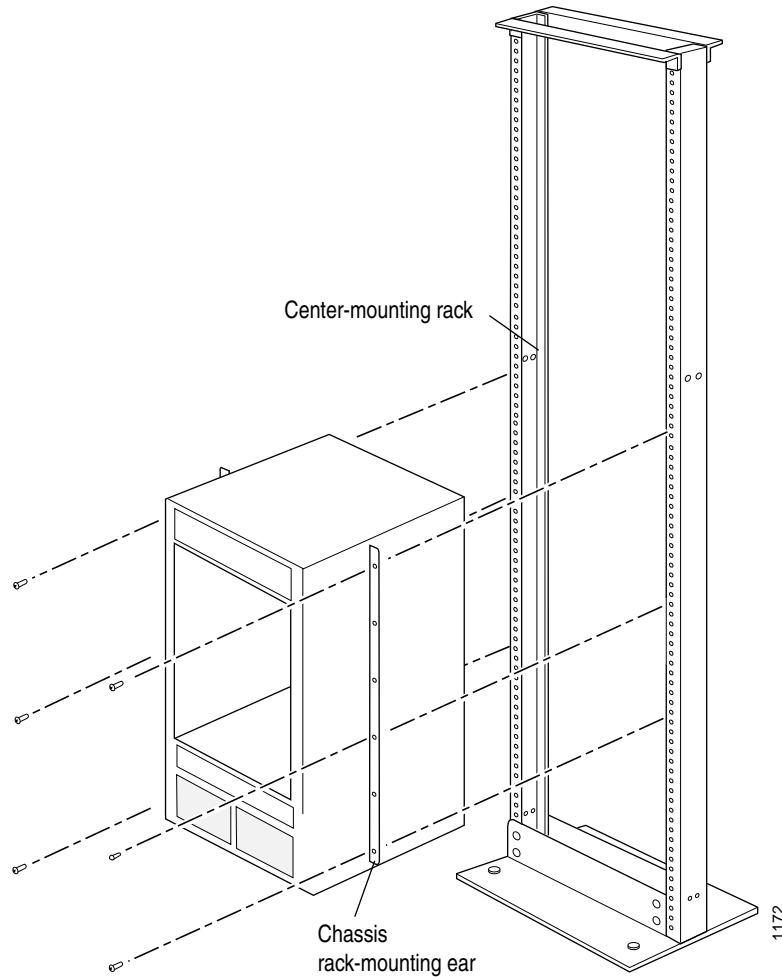


WARNING: To prevent injury, keep your back straight and lift with your legs, not your back. Avoid twisting your body as you lift. Balance the load evenly and be sure that your footing is solid.

5. Align the bottom hole in both front support posts or center-mounting brackets with a hole in each rack rail, making sure the chassis is level.
6. Install one of the mounting screws provided into each of the two aligned holes. Use a 5/32-in. Allen wrench to tighten the screws.
7. Moving up each post or ear, install a screw in every mounting hole.
8. Verify that all the mounting screws on one side of the rack are aligned with the mounting screws on the opposite side and that the router is level.
9. Loosen the thumbscrews on the lifting handle and remove it from the chassis.

10. Proceed to the instructions in Reinstalling Components into the Chassis on page 99.

Figure 44: Installing the Chassis in a Rack



Reinstalling Components into the Chassis

After you have mounted the chassis in the rack as described in Installing the Chassis into the Rack on page 97, reinstall the router components into the chassis.



WARNING: The procedures in this section apply only to initial installation and assume that you have not yet connected power to the router. If power is connected, completely disconnect it before continuing. See “Disconnecting Power from the Router” on page 200.

If you are installing or replacing components in an operational router, see “Replacing Hardware Components” on page 139.

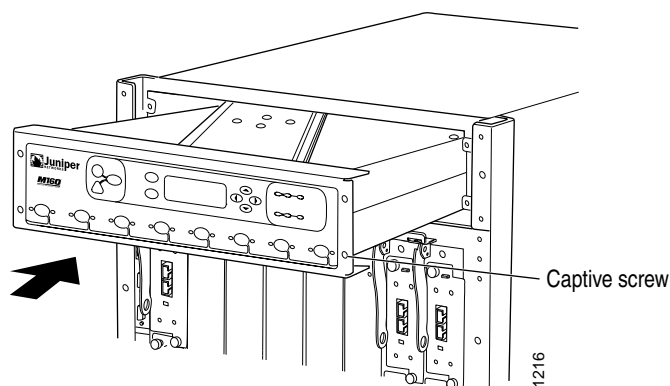
Perform the procedures described in the following sections to reinstall components into the chassis, first into the front and then into the rear:

- Reinstalling the Front Impeller Assembly on page 100
- Reinstalling the FPCs on page 101
- Reinstalling the Fan Tray on page 102
- Reinstalling the Rear Lower Impeller Assembly on page 103
- Reinstalling the Rear Upper Impeller Assembly on page 104
- Reinstalling the Routing Engines on page 105
- Reinstalling the PCGs on page 106
- Reinstalling the MCSs on page 107
- Reinstalling the SFMs on page 108
- Reinstalling the Rear Component Cover on page 109
- Reinstalling the Power Supplies on page 109

Reinstalling the Front Impeller Assembly

The front impeller assembly, which includes the craft interface, is located at the top of the chassis front, as shown in Figure 1. To reinstall it, follow this procedure (see Figure 45):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Grasp the sides of the impeller assembly and align the rear of the assembly with the guides inside the chassis.
3. Slide the impeller assembly all the way into the chassis.
4. Using a Phillips screwdriver, tighten the captive screw at each corner of the craft interface.

Figure 45: Reinstalling the Front Impeller Assembly

Reinstalling the FPCs

The FPCs install into the card cage at the front of the chassis, as shown in Figure 1.



NOTE: To help you work systematically, the following procedure directs you to reinstall FPCs starting at the left side of the card cage and working toward the right. You can install FPCs in any order, however.

Be sure there is a blank panel over every empty slot. The blank panels must be in place during router operation to guarantee adequate circulation of cooling air.

To reinstall the FPCs, follow this procedure (see Figure 46):

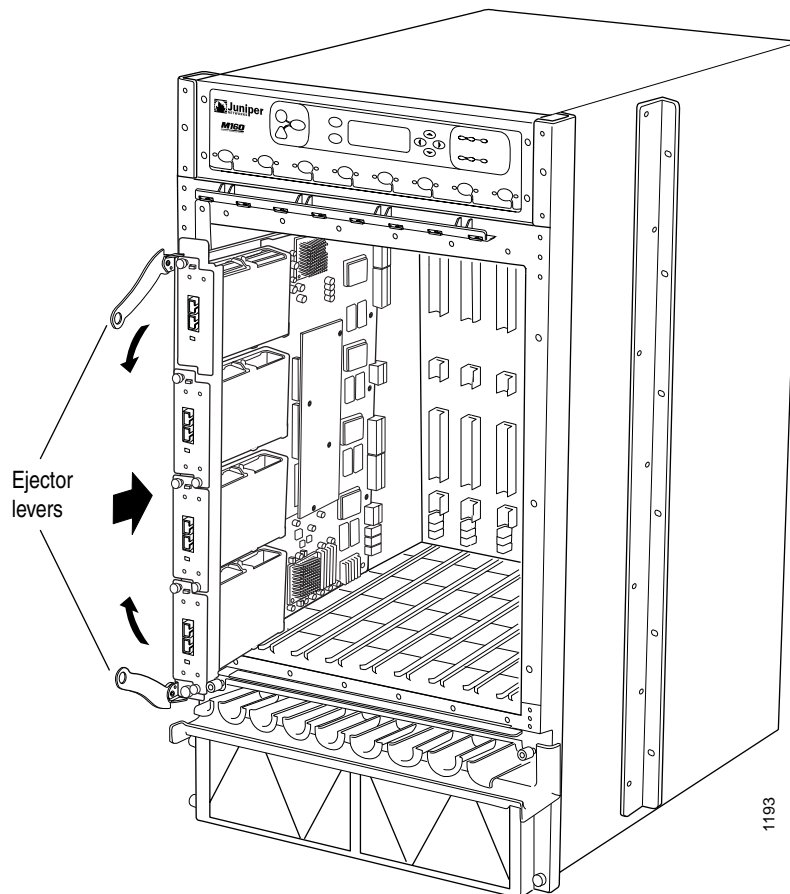
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Locate the leftmost slot in the FPC card cage on the front of the chassis. It is directly below the offline button on the craft interface that is labeled **FPC0**. Locate the FPC that you labeled **FPC0** during removal.
3. Verify that the ends of the ejector levers, which are located at each end of the FPC, are pushed outward, nearly perpendicular to the face of the FPC.
4. Grasp the front of the FPC with one hand and place the other hand under the FPC to support it.



CAUTION: When the FPC is out of the chassis, do not hold it by the ejector levers, bus bars, or edge connectors. They cannot support its weight.

5. Align the rear bottom corners of the FPC with the guides at the bottom of the FPC slot. Slide the FPC into the card cage until it contacts the midplane.
6. Push the ends of the ejector levers inward until they are nearly flush with the face of the FPC.
7. Tighten the thumbscrew at each end of the FPC to seat the FPC securely in the chassis.
8. Repeat the procedure for each FPC, proceeding from left to right through the slots with offline buttons labeled FPC1 through FPC7 on the craft interface.

Figure 46: Reinstalling an FPC

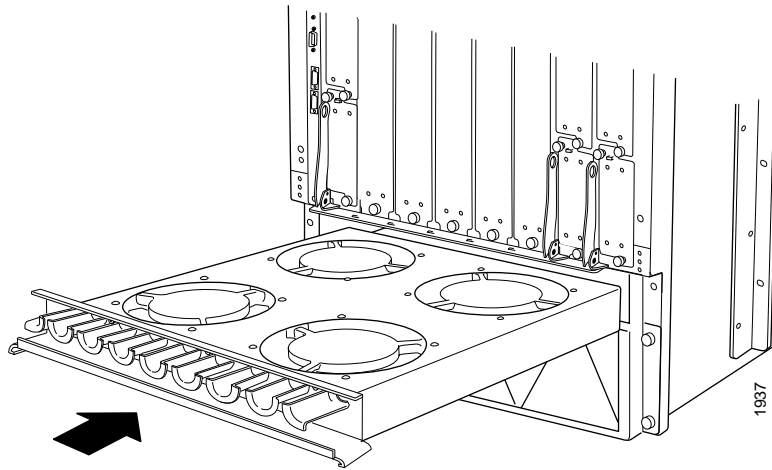


Reinstalling the Fan Tray

The fan tray, which includes the cable management system, is located on the front of the chassis, just above the air filter, as shown in Figure 1. To reinstall it, follow this procedure (see Figure 47):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Grasp the sides of the fan tray and align the rear of the tray with the guides inside the chassis.
3. Slide the fan tray all the way into the chassis.
4. Tighten the thumbscrew at each end of the cable management system.

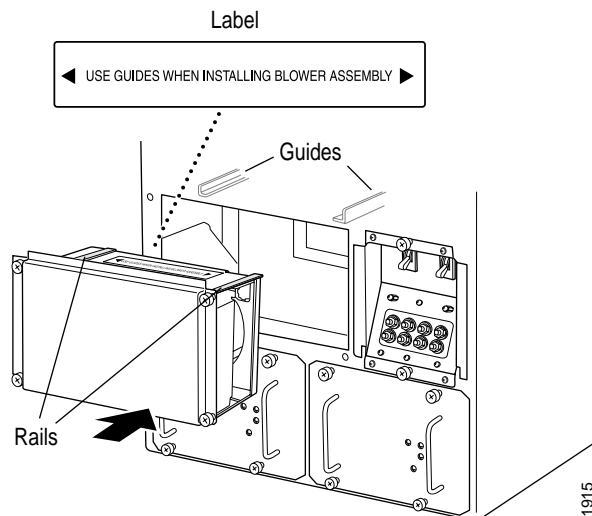
Figure 47: Reinstalling the Fan Tray



Reinstalling the Rear Lower Impeller Assembly

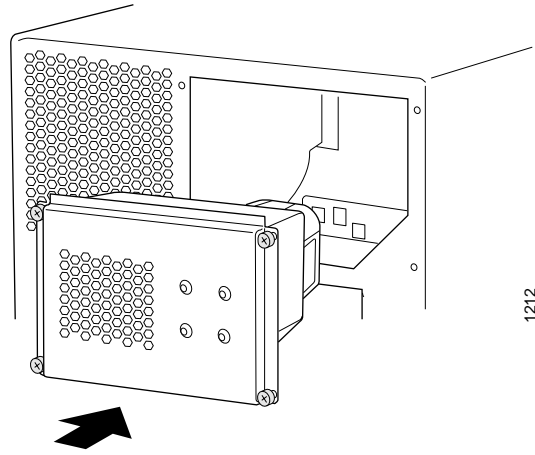
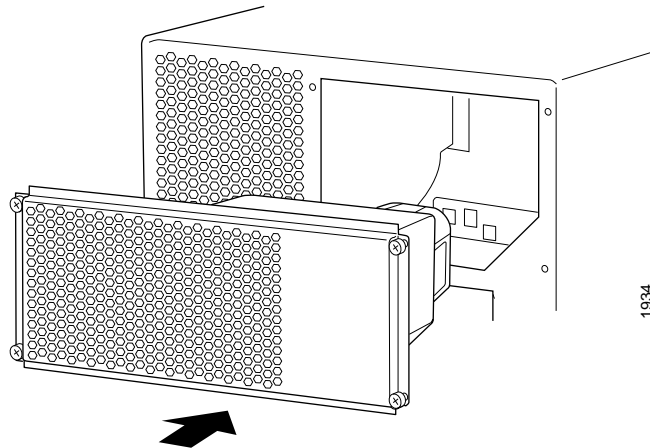
The rear lower impeller assembly is located to the left of the circuit breaker box on the rear of the chassis, as shown in Figure 2. To reinstall it, follow this procedure (see Figure 48):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Orient the impeller so that the label is on the top. Align the rails on the upper edges of the impeller assembly with the guides inside the chassis.
3. Push the impeller assembly up and to the right to start it into the chassis, then slide it all the way in.
4. Tighten the thumbscrew at each corner of the impeller cover.

Figure 48: Reinstalling the Rear Lower Impeller Assembly**Reinstalling the Rear Upper Impeller Assembly**

The rear upper impeller assembly is installed at the top of the chassis rear, as shown in Figure 2. To reinstall the assembly, follow this procedure (see Figure 49 and Figure 50, which show the two types of impeller that can be installed):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Slide the assembly all the way into the chassis.
3. Tighten the thumbscrew at each corner of the impeller cover.

Figure 49: Reinstalling the Rear Upper Impeller Assembly**Figure 50: Reinstalling the Rear Upper Impeller Assembly**

Reinstalling the Routing Engines

The router can have a Routing Engine in each of the slots labeled RE 0 and RE 1 at the rear of the chassis, as shown in Figure 3.



NOTE: If two Routing Engines are installed, they must both be the same version.

To reinstall a Routing Engine, follow this procedure (see Figure 51):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. Verify that the extractor clip at each end of the Routing Engine is flipped toward the outer edge of the unit. If necessary, use your thumbs to push and hold the red tab on each extractor clip toward the outer edge, then push the ends of the extractor clips outward.
3. Place one hand under the Routing Engine to support it and grasp one of the extractor clips on the faceplate with the other hand.
4. Align the rear of the Routing Engine with the guide rails inside the chassis and slide it in completely.

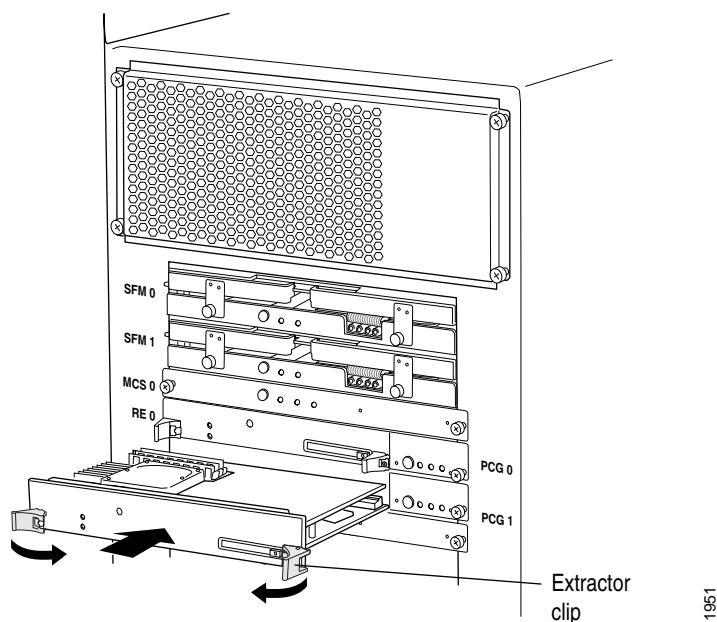


CAUTION: Align the Routing Engine carefully with the guide rails and push it in evenly. Damage can result if it gets lodged in the rails because of uneven movement.

5. Press the extractor clip at each end of the Routing Engine inward to seat the unit firmly in the chassis.

If there is a second Routing Engine, repeat the procedure to reinstall it.

Figure 51: Reinstalling a Routing Engine

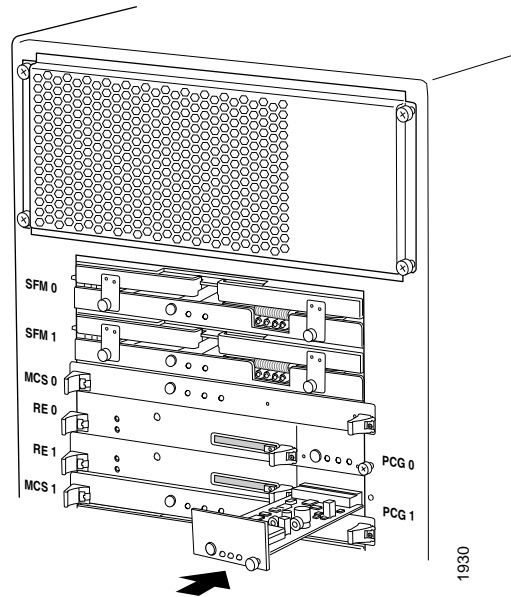


Reinstalling the PCGs

The router has two PCGs installed in the slots labeled PCG 0 and PCG 1 at the rear of the chassis, as shown in Figure 3. To reinstall the PCGs, follow this procedure (see Figure 52):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Place one hand under the PCG to support it and grasp the thumbscrew on the faceplate with the other hand.
3. Align the rear of the PCG with the guides inside the chassis and slide it in completely.
4. Tighten the thumbscrew on the faceplate to seat the PCG firmly in the chassis.
5. Repeat the procedure to reinstall the second PCG.

Figure 52: Reinstalling a PCG



Reinstalling the MCSs

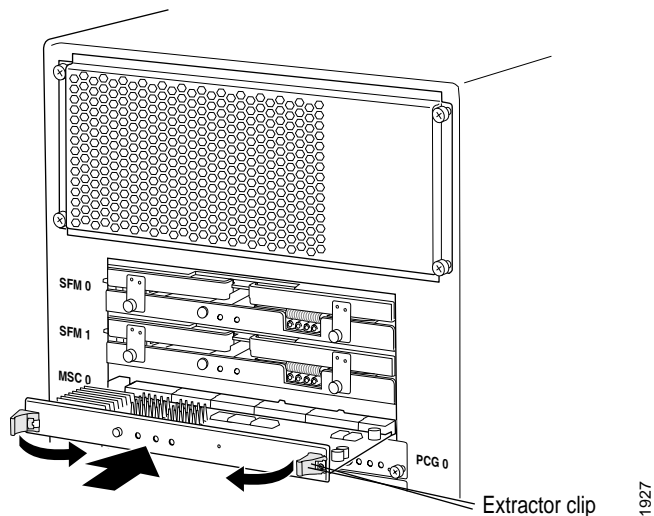
The router can have an MCS in each of the slots labeled MCS 0 and MCS 1 at the rear of the chassis, as shown in Figure 3. To reinstall an MCS, follow this procedure (see Figure 53):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Place one hand under the MCS to support it and grasp one of the extractor clips on the faceplate with the other hand.

3. Align the rear of the MCS with the guides inside the chassis and slide it in completely.
4. Press the extractor clip at each end of the MCS inward.

If there is a second MCS, repeat the procedure to reinstall it.

Figure 53: Reinstalling an MCS



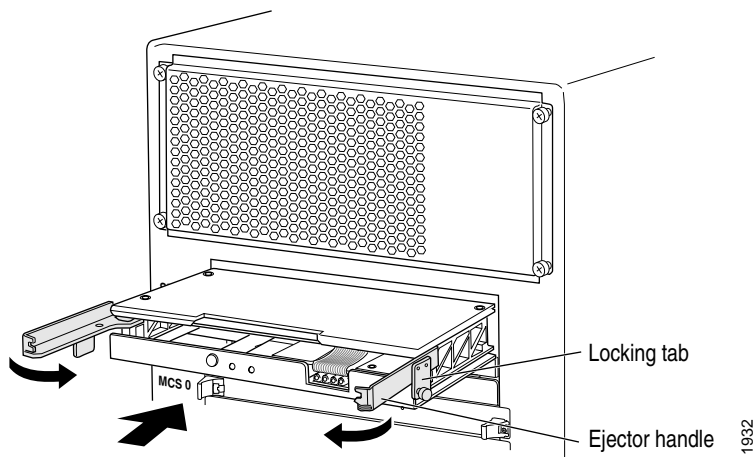
Reinstalling the SFMs

The router can have an SFM in each of the slots labeled SFM 0 through SFM 3 at the rear of the chassis, as shown in Figure 3. To reinstall an SFM, follow this procedure (see Figure 54):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Verify that the ends of the ejector handles are pulled outward to a position nearly perpendicular to the faceplate of the SFM.
3. Place one hand under the SFM to support it and grasp one of the ejector handles at the front with the other hand.
4. Align the rear of the SFM with the guides inside the chassis and slide it in completely.
5. Press the ejector handle at each end of the SFM inward.
6. Tighten the thumbscrew on each ejector locking tab (shown in Figure 8) to seat the SFM firmly in the chassis.

If there are additional SFMs, repeat the procedure to reinstall them.

Figure 54: Reinstalling an SFM



Reinstalling the Rear Component Cover

The rear component cover protects the Routing Engines, PCGs, MCSs, and SFMs, as shown in Figure 2. To reinstall the rear component cover, follow this procedure:

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Hold the component cover up to the rear of the chassis and align the flanges at the top and bottom with the top and bottom of the opening in the chassis.
3. Push the cover into place.
4. Tighten the thumbscrew at each corner of the cover.



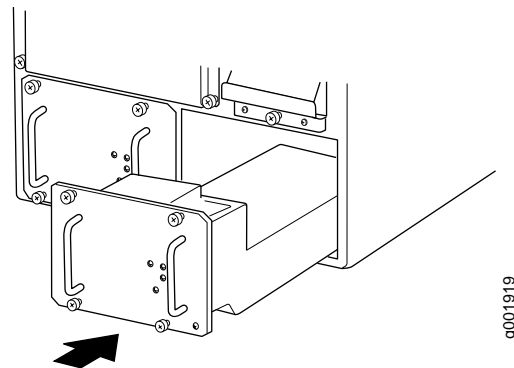
CAUTION: To maintain proper airflow and provide electromagnetic shielding, do not operate the router without the rear component cover in place.

Reinstalling the Power Supplies

The two power supplies are located at the bottom rear of the chassis, as shown in Figure 2. To reinstall the power supplies, follow this procedure (see Figure 55):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Verify that the power switch for each power supply is in the OFF (O) position. The switches are on the circuit breaker box.
3. Place one hand under the power supply and grasp a handle on the faceplate with the other hand. Slide the power supply into the chassis until it contacts the midplane.
4. Starting with the bottom screws, tighten (but do not overtighten) the thumbscrew at each corner of the power supply faceplate.
5. Repeat the procedure to reinstall the second power supply.
6. To continue the installation, proceed to “Connecting the Router and Performing Initial Configuration” on page 111.

Figure 55: Reinstalling a Power Supply



Chapter 9

Connecting the Router and Performing Initial Configuration

After installing the router into the rack as described in “Installing the Router Using a Mechanical Lift” on page 81 or “Installing the Router without a Mechanical Lift” on page 83, complete the installation by connecting management and alarm devices, PICs, and power cables. This chapter has the following sections:

- Tools and Parts Required on page 111
- Connecting the Router to Management and Alarm Devices on page 112
- Connecting PIC Cables on page 115
- Providing Power to the Router on page 117
- Configuring the JUNOS Internet Software on page 121

Tools and Parts Required

To connect the router to management devices and PICs and to power on the router, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- 2.5 mm flat-blade (-) screwdriver
- 7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a minimum of 30 lb-in. (3.5 Nm) tightening torque, for tightening nuts to terminal studs on the circuit breaker box

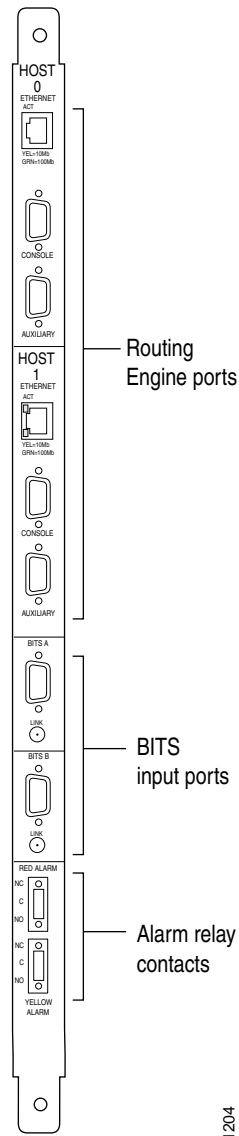


CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

- Wire cutters
- Pliers
- Electrostatic discharge (ESD) grounding wrist strap

Connecting the Router to Management and Alarm Devices

After you have installed the router into the rack, attach one or more external devices to the ports on the CIP that connect to the Routing Engines for management and service operations (see Figure 56). For specifications for the cable accepted by the Routing Engine management ports, see Routing Engine Interface Cable and Wire Specifications on page 74.

Figure 56: Routing Engine Management Ports and Alarm Relay Contacts

To connect external devices to the Routing Engine management ports, perform the procedures described in the following sections:

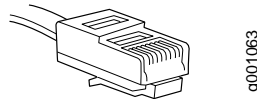
- Connecting to a Network for Out-of-Band Management on page 114
- Connecting to a Management Console or Auxiliary Device on page 114
- Connecting to an External Alarm-Reporting Device on page 115

Connecting to a Network for Out-of-Band Management

To connect the Routing Engine to a network for out-of-band management, connect an Ethernet cable with RJ-45/RJ-45 connectors to the **ETHERNET** port on the CIP. One such cable is provided with the router. For cable specifications, see Routing Engine Interface Cable and Wire Specifications on page 74. Follow this procedure:

1. Turn off the power to the management device.
2. Plug one end of the Ethernet cable (Figure 57 shows the connector) into the appropriate **ETHERNET** port on the CIP. Figure 56 shows the external device ports on the CIP. The ports labeled **HOST 0** connect to the Routing Engine in the upper Routing Engine slot (**RE 0**), and the ports labeled **HOST 1** connect to the Routing Engine in the lower Routing Engine slot (**RE 1**).
3. Plug the other end of the cable into the network device.

Figure 57: Routing Engine Ethernet Cable Connector

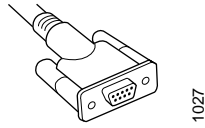


Connecting to a Management Console or Auxiliary Device

To use a system console to configure and manage the Routing Engine, connect it to the appropriate **CONSOLE** port on the CIP. To use a laptop, modem, or other auxiliary device, connect it to the appropriate **AUXILIARY** port on the CIP. Both ports accept an RS-232 (EIA-232) serial cable with DB-9/DB-9 connectors. One such cable is provided with the router. If you want to connect a device to both ports, you must supply another cable. For cable specifications, see Routing Engine Interface Cable and Wire Specifications on page 74.

To connect a management console or auxiliary device, follow this procedure:

1. Turn off the power to the console or auxiliary device.
2. Plug the female end (shown in Figure 58) of the provided serial cable into the appropriate **CONSOLE** or **AUXILIARY** port. Figure 56 shows the external device ports on the CIP. The ports labeled **HOST 0** connect to the Routing Engine in the upper Routing Engine slot (**RE 0**), and the ports labeled **HOST 1** connect to the Routing Engine in the lower Routing Engine slot (**RE 1**).
3. Using a 2.5 mm flat-blade screwdriver, tighten the screws on the connector.
4. Attach the other end of the cable to the console or auxiliary device.

Figure 58: Console and Auxiliary Serial Port Connector

Connecting to an External Alarm-Reporting Device

To connect the router to external alarm-reporting devices, attach wires to the RED ALARM and YELLOW ALARM relay contacts on the CIP. A system condition that triggers the red or yellow alarm LED on the craft interface also activates the corresponding alarm relay contact.

The terminal blocks that plug into the alarm relay contacts are supplied with the router. They accept wire of any gauge between 24-AWG and 12-AWG (0.20 and 3.33 mm²), which is not provided. Use the gauge of wire appropriate for the external device you are connecting.

To connect an external device to an alarm relay contact, follow this procedure (see Figure 56):

1. Prepare the required length of wire with gauge between 24-AWG and 12-AWG (0.20 and 3.33 mm²).
2. While the terminal block is not plugged into the relay contact, use a 2.5 mm flat-blade screwdriver to loosen the small screws on its side. Insert wires into the slots in the front of the block. Tighten the screws to secure the wire.
3. Orient the terminal block according to the labels to the left of the appropriate relay contact (NC means “normally closed,” C means “common,” and NO means “normally open”).
4. Plug the terminal block into the relay contact and use a 2.5 mm flat-blade screwdriver to tighten the screws on the face of the block.
5. Attach the other end of the wires to the external device.

If attaching a reporting device for the other kind of alarm, repeat the procedure.

Connecting PIC Cables

Now connect PICs to the network by plugging in network cable. To connect cable to the PICs, follow this procedure (see Figure 59, which shows a fiber-optic PIC):

1. Have ready a length of the type of cable used by the PIC. For cable specifications, see the *M160 Internet Router PIC Guide*.
2. If the PIC cable connector port is covered by a rubber safety plug, remove the plug.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

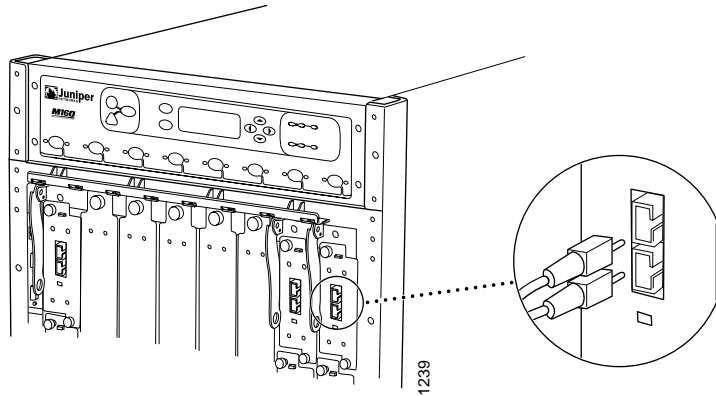
3. Insert the cable connector into the cable connector port on the PIC faceplate.
 4. Arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
-



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.



CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.

Figure 59: Attaching Cable to a PIC

Providing Power to the Router

Connect the router to external power sources and power it on by performing the following procedures:

- Connecting Power to the Router on page 117
- Powering On the Router on page 119

Connecting Power to the Router

Connect power to the router by attaching a grounding cable to the chassis grounding points and attaching power cables from external power sources to the terminal studs on the circuit breaker box. Power and grounding cables are not supplied with the router. For cable specifications, see “Power, Connection, and Cable Specifications” on page 67.



NOTE: The router must be connected to at least two separate external power sources.



CAUTION: There is no standard color coding for DC power cables. The color coding used by the external DC power source at your site determines the color coding for the leads on the power cables that attach to the terminal studs on the circuit breaker box. You must ensure that power connections maintain the proper polarity. The power source cables might be labeled (+) and (–) to indicate their polarity.

To connect power to the router, follow this procedure (see Figure 60):

1. Verify that there is no power flowing from either external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. For each power supply, verify that the power switch on the circuit breaker box is in the OFF (O) position.
3. Connect the grounding cable to a proper earth ground.
4. Verify that a licensed electrician has attached the cable lug provided with the router to the grounding cable.
5. Place the grounding cable lug over the grounding points on the bottom rear of the chassis. The grounding points are sized for 1/4-20 UNC screws.
6. Secure the grounding cable lug to the grounding points, first with the washers, then with the screws.



CAUTION: Do not substitute metric screws such as M6 for the 1/4-20 UNC screws that screw into the grounding points; screws other than 1/4-20 UNC screws can strip the threading in the grounding points.

7. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the circuit breaker box. Remove the cover.
8. Install one flat washer and one nut (in that order) on each power terminal stud:
 - If no washers and nuts are already installed, they should be in the accessory box.
 - If two pairs of nuts and washers are installed on the studs, use a 7/16-in. nut driver or wrench to loosen the outer nut on each stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

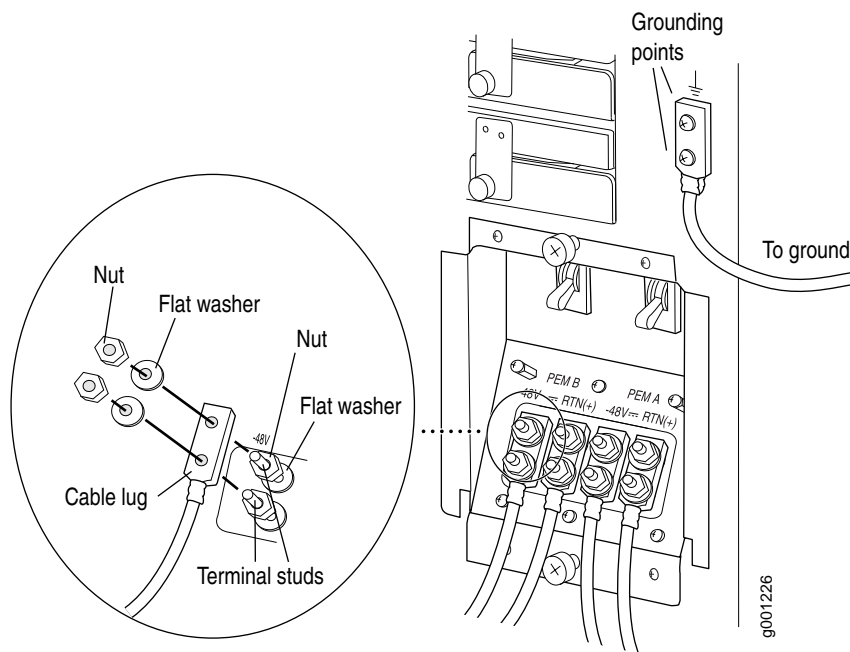


CAUTION: The inner washer and nut prevent direct contact between the power cable lug and the circuit breaker box, which can cause a short circuit.

9. Slide the power cable lugs onto the terminal studs:

- Connect the positive (+) source cable lugs to the return terminals, which are labeled RTN(+).
 - Connect the negative (–) source cable lugs to the input terminals, which are labeled –48V.
10. Install another washer and nut (in that order) on each terminal stud to secure the power cable lug. Using a 7/16-in. nut driver or wrench, tighten the nuts.
 11. Verify that the source power cabling and the grounding cabling are correct, that they are not touching or blocking access to router components, and that they do not drape where people could trip on them.
 12. Replace the protective shield over the terminal studs and use a Phillips screwdriver to tighten the screws.

Figure 60: Connecting Power and Grounding Cables



Powering On the Router

To power on the router, follow this procedure:

1. Verify that the power supplies are fully inserted in the chassis and the thumbscrews on their faceplates are tightened.

2. For each power supply, verify that the source power cables are connected to the appropriate terminal on the circuit breaker box: the positive (+) source cable to the return terminal (labeled RTN(+)) and the negative (-) source cable to the input terminal (labeled -48V).
3. Verify that an external management device is connected to one of the Routing Engine ports on the CIP (AUXILIARY, CONSOLE, or ETHERNET). For more information on connecting management devices, see *Connecting the Router to Management and Alarm Devices* on page 112.
4. Turn on the power to the external management device.
5. Press one power switch on the circuit box to the ON (|) position.
6. Observe the LEDs on the power supply faceplate:
 - As an enhanced power supply powers on, the green CB ON LED lights steadily, the blue OUTPUT OK LED blinks for a short time, then lights steadily, and the amber CB OFF LED does not light.
 - As an original power supply powers on, the green CB ON LED lights steadily, the blue OUTPUT OK LED blinks for a short time, then lights steadily, and the amber CB OFF and NO AIRFLOW LEDs do not light.



NOTE: After powering off a power supply, wait at least 60 seconds before turning it back on. After powering on a power supply, wait at least 60 seconds before turning it off.

If the router is completely powered down when you power on the power supply, the Routing Engine boots as the power supply completes its startup sequence. If the Routing Engine finishes booting and you need to power down the router again, first issue the CLI `request system halt` command. For more information, see “Disconnecting Power from the Router” on page 200.

After a power supply is powered on, it can take up to 60 seconds for status indicators—such as LEDs on the power supply, `show chassis` commands, and messages on the craft interface LCD—to indicate that the power supply is functioning normally. Ignore error indicators that appear during the first 60 seconds.

7. Press the other power switch on the circuit breaker box to the ON (|) position and observe the LEDs on the second power supply faceplate. They should light as described in the previous step.

If the LEDs are not lit in the appropriate pattern after 60 seconds, repeat the power supply and cable installation procedures described in “Reinstalling the Power Supplies” on page 109 and “Connecting Power to the Router” on page 117.

8. On the external management device connected to the Routing Engine, monitor the startup process to verify that the system has booted properly.

Configuring the JUNOS Internet Software

The router is shipped with the JUNOS Internet software preinstalled and ready to be configured when the router is powered on. There are three copies of the software: one on a nonrotating flash drive in the Routing Engine, one on a rotating hard drive in the Routing Engine, and one on a PC card that can be inserted into the slot in the Routing Engine faceplate.

When the router boots, it first attempts to start the image on the PC card. If a PC card is not inserted into the Routing Engine or the attempt otherwise fails, the router next tries the flash drive, and finally the hard drive.

You configure the router by issuing JUNOS command-line interface (CLI) commands, either on a console device attached to the **CONSOLE** port on the CIP, or over a telnet connection to a network connected to the **ETHERNET** port on the CIP.

Gather the following information before configuring the router:

- Name the router will use on the network
- Domain name the router will use
- IP address and prefix length information for the Ethernet interface
- IP address of a default router
- IP address of a DNS server
- Password for the root user

To configure the software, follow this procedure:

1. If the router is not already turned on, power it on as described in “Powering On the Router” on page 119.
2. Log in as the “root” user. There is no password.
3. Start the CLI.

```
root# cli
root@>
```

4. Enter configuration mode.

```
cli> configure
[edit]
root@#
```

5. Configure the name of the router. If the name includes spaces, enclose the name in quotation marks (“ ”).

```
[edit]
root@# set system host-name host-name
```

6. Configure the router's domain name.

```
[edit]
root@# set system domain-name domain-name
```

7. Configure the IP address and prefix length for the router's Ethernet interface.

```
[edit]
root@# set interfaces fxp0 unit 0 family inet address address/prefix-length
```

8. Configure the IP address of a backup router, which is used only while the routing protocol is not running.

```
[edit]
root@# set system backup-router address
```

9. Configure the IP address of a DNS server.

```
[edit]
root@# set system name-server address
```

10. Set the root authentication password by entering either a clear-text password, an encrypted password, or an ssh public key string (DSA or RSA).

```
[edit]
root@# set system root-authentication plain-text-password
New password: password
Retype new password: password
```

or

```
[edit]
root@# set system root-authentication encrypted-password encrypted-password
```

or

```
[edit]
root@# set system root-authentication ssh-dsa public-key
```

or

```
[edit]
root@# set system root-authentication ssh-rsa public-key
```

11. Optionally, display the configuration to verify that it is correct.

```
[edit]
root@# show
system {
    host-name host-name;
    domain-name domain-name;
    backup-router address;
    root-authentication {
        authentication-method (password | public-key);
    }
    name-server {
        address;
    }
}
```

```

    }
  }
  interfaces {
    fxp0 {
      unit 0 {
        family inet {
          address address/prefix-length;
        }
      }
    }
  }
}

```

12. Commit the configuration to activate it on the router.

```

[edit]
root@# commit

```

13. Optionally, configure additional properties by adding the necessary configuration statements. Then commit the changes to activate them on the router.

```

[edit]
root@host# commit

```

14. When you have finished configuring the router, exit configuration mode.

```

[edit]
root@host# exit
root@host>

```


Part 3

Hardware Maintenance, Replacement, and Troubleshooting Procedures

- Maintaining Hardware Components on page 127
- Replacing Hardware Components on page 139
- Troubleshooting Hardware Components on page 207

Chapter 10

Maintaining Hardware Components

This chapter describes how to maintain hardware components installed in the router. Some components, such as the Connector Interface Panel (CIP), require no maintenance.

For information about returning a part to Juniper Networks for repair or replacement, see “Contacting Customer Support and Returning Hardware” on page 255.

- Routine Maintenance Procedures on page 127
- Maintaining Cooling System Components on page 127
- Maintaining Host Module Components on page 131
- Maintaining Packet Forwarding Engine Components on page 132
- Maintaining Power Supplies on page 137

Routine Maintenance Procedures

For optimum router performance, perform the following preventive maintenance procedures regularly:

- Inspect the installation site for moisture, loose wires or cables, and excessive dust. Make sure that airflow is unobstructed around the router and into the air intake vents.
- Check the status-reporting devices on the craft interface: system alarms, LEDs, and LCD. See Craft Interface on page 27.
- Inspect the air filters at the bottom front and left rear of the router, cleaning or replacing it as needed for optimum cooling system performance. Do not run the router for more than a few minutes without the air filters in place. For maintenance instructions, see “Maintaining the Air Filter” on page 128.

Maintaining Cooling System Components

For instructions on maintaining cooling system components, see the following sections:

- Maintaining the Air Filter on page 128
- Maintaining the Fan Tray and Impellers on page 130

Maintaining the Air Filter

Check the air filter regularly for dust and debris. Clean or replace it as needed. The air filter is hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. Take note of the following caution, however.



CAUTION: Do not operate the router for more than a few minutes when the air filter has been removed. The fans and impellers are powerful enough to draw in foreign material, such as bits of wire, through the unfiltered air intake, which could damage router components.

To maintain the air filter, perform the following procedures:

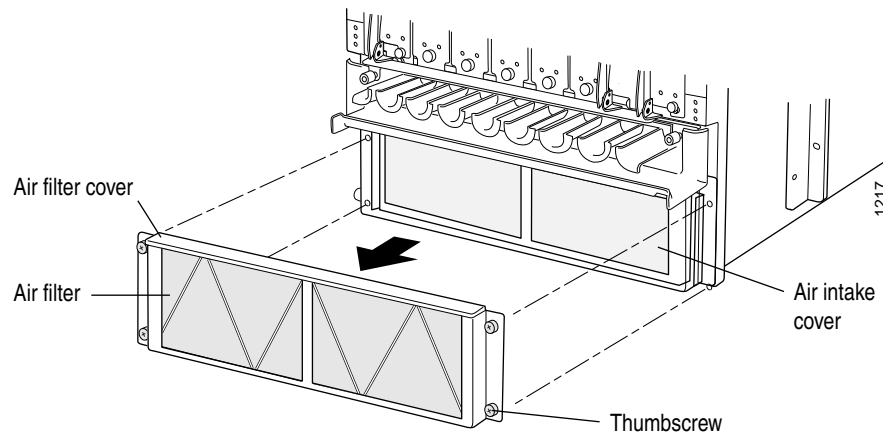
- Removing the Air Filter on page 128
- Cleaning the Air Filter on page 129
- Installing the Air Filter on page 129

Removing the Air Filter

The air filter is located at the front of the chassis, below the FPC card cage and cable management system (see Figure 61).

To remove the air filter, follow this procedure:

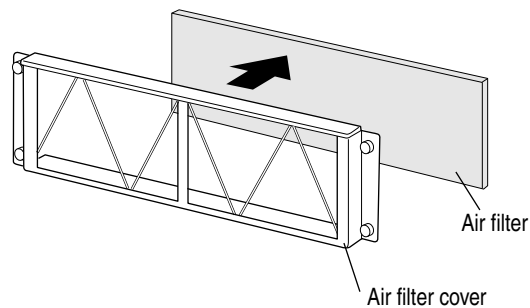
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Loosen the thumbscrew at each corner of the air filter cover.
3. Grasp the edges of the air filter and pull it away from the front of the chassis.
4. Inspect the filter for dust, dirt, and holes. If needed, clean it as described in “Cleaning the Air Filter” on page 129 or replace it.

Figure 61: Removing the Air Filter

Cleaning the Air Filter

To clean the air filter, follow this procedure:

1. Pull the filter free of the air filter cover (see Figure 62).
2. Rinse the filter with water, running the water from the back side to the front side to help remove dust and particles accumulated in the filter.
3. Allow the filter to dry completely.
4. Press the filter back into the air filter cover.

Figure 62: Removing the Filter from the Air Filter Cover

Installing the Air Filter

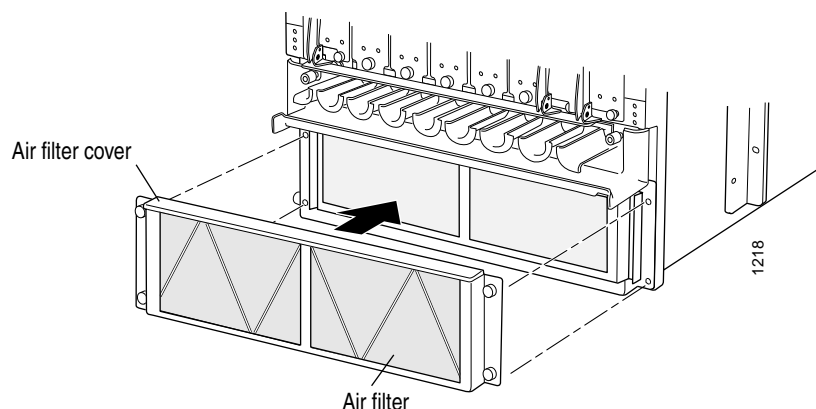
To install the air filter, follow this procedure (see Figure 63):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router

is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. Grasp the sides of the air filter and push it firmly into place over the air intake vent.
3. Tighten the thumbscrew at each corner of the air filter cover.

Figure 63: Installing the Air Filter



Maintaining the Fan Tray and Impellers

The fan tray is attached to the back of the cable management system and installs into the front of the chassis, as shown in Figure 1. There are also three separate, non-interchangeable impeller assemblies. The front impeller is located behind the craft interface (shown in Figure 1) and works together with the fan tray to cool the FPCs and midplane. The upper and lower impellers on the rear of the chassis (shown in Figure 2) work together to cool the components that install into the rear of the chassis.

To check the status of the impellers and the fans in the fan tray, issue the `show chassis environment` command. The output includes an entry for each impeller (which it refers to as a **Blower**) and for each fan in the fan tray:

```
user@host> show chassis environment
Class Item                               Status    Measurement
...
Fans   Rear Bottom Blower                   OK        Spinning at normal speed
       Rear Top Blower                     OK        Spinning at normal speed
       Front Top Blower                     OK        Spinning at normal speed
       Fan Tray Rear Left                    OK        Spinning at normal speed
       Fan Tray Rear Right                   OK        Spinning at normal speed
       Fan Tray Front Left                   OK        Spinning at normal speed
       Fan Tray Front Right                  OK        Spinning at normal speed
...
```

For further description of the output from the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Maintaining Host Module Components

The router can have a Routing Engine in each of the slots labeled RE 0 and RE 1 and a Miscellaneous Control Subsystem (MCS) in each of the slots labeled MCS 0 and MCS 1 at the rear of the chassis, as shown in Figure 3. Each paired Routing Engine and MCS function together as a host module. To maintain the host module, perform the following procedures regularly:

- Check the LCD and the host module LEDs on the craft interface. The LCD reports host module status during normal operation and describes the cause of failures when they occur. The green LEDs labeled **ONLINE** and **MASTER** light steadily for the master host module when it is functioning normally. The **ONLINE** LED also lights for the standby host module if it is installed. For more information about the LEDs and LCD, see Craft Interface on page 27.
- Issue the CLI `show chassis routing-engine` command to check the status of the Routing Engines. As shown in the sample output, the master Routing Engine is designated **Master** in the **Current state** field:

```
user@host> show chassis routing-engine
```

```
Routing Engine status:
```

```
Slot 0:
```

Current state	Master
Election priority	Master (default)
Temperature	37 degrees C / 98 degrees F
DRAM	768 MB
Memory utilization	18 percent
CPU utilization:	
User	0 percent
Background	0 percent
Kernel	2 percent
Interrupt	0 percent
Idle	98 percent
Model	RE-2.0
Serial ID	8b00000792898b01
Start time	2003-04-29 16:09:49 PDT
Uptime	16 days, 3 hours, 6 minutes, 34 seconds
Load averages:	1 minute 5 minute 15 minute
	0.00 0.00 0.00

```
Routing Engine status:
```

```
Slot 1:
```

Current state	Backup
Election priority	Backup (default)
Temperature	36 degrees C / 96 degrees F
DRAM	768 MB
Memory utilization	16 percent
CPU utilization:	
User	0 percent

```

Background          0 percent
Kernel              0 percent
Interrupt            0 percent
Idle                100 percent
Model                RE-2.0
Serial ID            6d000007c8150801
Start time           2003-04-22 10:01:29 PDT
Uptime               16 days, 3 hours, 6 minutes, 34 seconds

```

- Issue the CLI `show chassis environment mcs` command to check the status of the MCSs. As shown in the sample output, the MCS that belongs to the master host module is designated Master in the State field:

```

user@host> show chassis environment mcs

MCS 0 status:
State                Online Master
Temperature           48 degrees C / 118 degrees F
Power:
  3.3 V               3299 mV
  5.0 V               4971 mV
  12.0 V              11770 mV
  5.0 V bias          4989 mV
  8.0 V bias          8246 mV
BUS Revision          12
FPGA Revision         13
MCS 1 status:
State                Online Standby
Temperature           51 degrees C / 123 degrees F
Power:
  3.3V                3316 mV
  5.0 V               5001 mV
  12.0 V              11775 mV
  5.0 V bias          5001 mV
  8.0 V bias          8249 mV
BUS Revision          12
FPGA Revision         13

```

For further description of the output from the commands, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Maintaining Packet Forwarding Engine Components

For instructions on maintaining Packet Forwarding Engine components, see the following sections:

- Maintaining FPCs on page 133
- Maintaining PICs and PIC Cables on page 134
- Maintaining the PCGs on page 135

- Maintaining SFMs on page 136

Maintaining FPCs

The router can have up to eight Flexible PIC Concentrators (FPCs) mounted vertically in the FPC card cage at the front of the chassis, as shown in Figure 1. To maintain FPCs, perform the following procedures regularly:

- Check the LCD on the craft interface and the LEDs on the craft interface directly above each FPC slot. The green LED labeled OK lights steadily when an FPC is functioning normally. For more information, see “FPC LEDs and Offline Button” on page 31.
- Issue the CLI `show chassis fpc` command to check the status of installed FPCs. As shown in the sample output, the value `Online` in the column labeled `State` indicates that the FPC is functioning normally:

```
user@host> show chassis fpc
```

Slot	State	Temp (C)	CPU Total	Utilization (%) Interrupt	Memory DRAM (MB)	Utilization (%) Heap	Buffer
0	Online	37	4	0	32	1	39
1	Online	39	4	0	32	1	39
2	Empty						
3	Online	34	1	0	32	1	40
4	Empty						
5	Online	35	4	0	32	2	40
6	Online	36	4	0	32	1	39
7	Empty						

For more detailed output, add the `detail` option. The following example also specifies a slot number (0), which is optional:

```
user@host> show chassis fpc detail 0
```

```
Slot 0 information:
```

State	Online
Temperature	37 degrees C / 98 degrees F
Total CPU DRAM	32 MB
Total SRAM	4 MB
Total SDRAM	256 MB
I/O Manager ASIC information	Version 2.0, Foundry IBM, Part number 0
I/O Manager ASIC information	Version 2.0, Foundry IBM, Part number 0
I/O Manager ASIC information	Version 2.0, Foundry IBM, Part number 0
I/O Manager ASIC information	Version 2.0, Foundry IBM, Part number 0
Start time:	2003-04-29 16:11:55 PDT
Uptime:	5 days, 21 hours, 32 minutes, 41 seconds

For further description of the output from the commands, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Maintaining PICs and PIC Cables

To maintain PICs and PIC cables, follow these guidelines:

- Check the LEDs on PIC faceplates. Most PIC faceplates have an LED labeled STATUS. Some PICs have additional LEDs, often one per port. The meaning of the LED states differs for various PICs. For more information, see the *M160 Internet Router PIC Guide*. If the FPC that houses the PIC detects a PIC failure, the FPC generates an alarm message to be sent to the Routing Engine.
- Issue the CLI `show chassis fpc pic-status` command. The PIC slots in an FPC are numbered from 0 through 3, top to bottom:

```
user@host> show chassis fpc pic-status
```

```
Slot 0 Online
  PIC 0    4x OC-3 SONET, MM
  PIC 1    1x CSTM1, SMIR
  PIC 3    2x OC-3 ATM, MM
Slot 1 Online
  PIC 0    1x OC-12 SONET, MM
  PIC 1    1x OC-12 ATM, MM
  PIC 2    2x OC-3 ATM, MM
  PIC 3    2x OC-3 ATM, MM
```

For further description of the output from the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

- Use the cable management system (shown in Figure 21) to support cables and prevent cables from dislodging or developing stress points.
- Place excess cable out of the way in the cable management system. Do not allow fastened loops of cable to dangle from the connector or cable management system, because this stresses the cable at the fastening point. Putting fasteners on the loops helps to maintain their shape.
- Keep the cable connections clean and free of dust and other particles, which can cause drops in the received power level. Always inspect cables and clean them if necessary before connecting an interface.
- Label both ends of PIC cables to identify them.

The following guidelines apply specifically to fiber-optic cable:

- When you unplug a fiber-optic cable from a PIC, always place a rubber safety plug over the transceiver on the PIC faceplate and on the end of the cable.
- Anchor fiber-optic cable to avoid stress on the connectors. When attaching fiber to a PIC, be sure to secure the fiber so it is not supporting its own weight as it hangs to the floor. Never let fiber-optic cable hang free from the connector.
- Avoid bending fiber-optic cable beyond its bend radius. An arc smaller than a few inches can damage the cable and cause problems that are difficult to diagnose.
- Frequent plugging and unplugging of fiber-optic cable into and out of optical instruments, such as ATM or SONET/SDH analyzers, can cause damage to the instruments that is expensive to repair. Instead, attach a short fiber extension to the optical equipment. Any wear and tear due to frequent plugging and unplugging is then absorbed by the short fiber extension, which is easy and inexpensive to replace.
- Keep fiber-optic cable connections clean. Small micro-deposits of oil and dust in the canal of the transceiver or cable connector could cause loss of light, reducing signal power and possibly causing intermittent problems with the optical connection.

To clean the transceivers, use an appropriate fiber-cleaning device, such as RIFOCs Fiber Optic Adaptor Cleaning Wands (part number 946). Follow the directions for the cleaning kit you use.

After you have cleaned the transceiver on the fiber-optic PIC, make sure that the connector tip of the fiber-optic cable is clean. Use only an approved alcohol-free fiber-optic cable cleaning kit, such as the Opptex Cletop-S® Fiber Cleaner. Follow the directions for the cleaning kit you use.

Maintaining the PCGs

The router has two Packet Forwarding Engine Clock Generators (PCGs) installed in the slots labeled PCG 0 and PCG 1 on the rear of the chassis, as shown in Figure 3. To maintain the PCGs, perform the following procedures regularly:

- Check the LEDs on the PCG faceplates. The green LED labeled OK lights steadily when the PCG is functioning normally. The blue LED labeled MASTER lights steadily on the master PCG. For more information, see “PCG Components” on page 19.
- Issue the CLI `show chassis environment pcg` command to check the status of the PCGs. As shown in the sample output, the master PCG is designated Online - Master clock and the standby PCG Online - Standby:

```
user@host> show chassis environment pcg

PCG 0 status:
```

```

State                               Online - Master clock
Temperature                         40 degrees C / 104 degrees F
Frequency:
  Setting                           125.00 MHz
  Measurement                        125.01 MHz
Power:
  3.3 V                             3274 mV
  5.0 V bias                        4974 mV
  8.0 V bias                        8183 mV
BUS Revision                        12
PCG 1 status:
State                               Online - Standby
Temperature                         40 degrees C / 104 degrees F
Frequency:
  Setting                           125.00 MHz
  Measurement                        125.03 MHz
Power:
  3.3 V                             3267 mV
  5.0 V bias                        4993 mV
  8.0 V bias                        8190 mV
BUS Revision                        12

```

For further description of the output from the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Maintaining SFMs

The router can have a Switching and Forwarding Module (SFM) in each of the slots labeled SFM 0 through SFM 3 at the rear of the chassis, as shown in Figure 3. To maintain the SFMs, perform the following procedures regularly:

- Check the LEDs on the SFM faceplates. The green LED labeled OK lights steadily when an SFM is functioning normally. For more information, see “SFM Components” on page 20.
- Issue the CLI `show chassis sfm` command to check the status of the SFMs. The following sample output is for a router with four SFMs installed:

```

user@host> show chassis sfm

```

Slot	State	Temp (C)	CPU Utilization (%)	Memory Utilization (%)
			Total	DRAM (MB) Heap
0	Online	41	3	64 19
1	Online	42	5	64 19
2	Online	43	4	64 19
3	Online	41	3	64 19

For more detailed output, add the `detail` option. The following example also specifies a slot number (1), which is optional:

```

user@host> show chassis sfm detail 1

```



```

Slot 1 information:
  State                Online
  SPP Temperature      43 degrees C / 109 degrees F
  SPR Temperature      43 degrees C / 109 degrees F
  Total CPU DRAM       64 MB
  Total SSRAM          8 MB
  Internet Processor II Version 1, Foundry IBM, Part number 9
  Start time:          2003-04-29 16:12:26 PDT
  Uptime:              5 days, 22 hours, 28 minutes, 26 seconds

Packet scheduling mode : Disabled

```

For further description of the output from the commands, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Maintaining Power Supplies

To verify that the power system is functioning normally, perform the following procedures regularly:

- Check the LEDs on the faceplate of both power supplies. A power supply is functioning correctly when the green LED labeled **CB ON** is lit steadily (indicating that the circuit breaker is switched on) and the blue LED labeled **OUTPUT OK** is lit steadily (indicating that the supply is receiving power from the DC source).

If these LEDs are blinking or other LEDs are lit, there could be an error condition. For a summary of LED states, see “Power Supply” on page 36.

- Issue the following CLI command to check the status of the power supplies. The following example specifies a slot number (0), which is optional. As shown in the sample output, the value **Online** in the **State** column indicates that the power supply is operating normally:

```

user@host> show chassis environment pem 0

PEM 0 status:
  State                Online
  Temperature          OK
  DC input              OK
  DC Output             OK
  Load                 Less than 40 percent
  Voltage:
    48.0 V input        55059 mV
    48.0 V fan supply   50181 mV
    5.0 V bias          5032 mV
    8.0 V bias          8224 mV

```



NOTE: The messages in the craft interface LCD and the output from CLI `show` commands refer to the power supply on the right as **PEM 0** and the power supply on the left as **PEM 1**.

For further description of the output from the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

- Check the red and yellow alarm LEDs and the LCD on the craft interface. Power supply failure or removal triggers an alarm that causes one or both of the LEDs to light and an error message to appear on the LCD. You can display the associated error messages by issuing the following CLI command:

```
user@host> show chassis alarms
```

For a list of possible alarm messages, see “Chassis and Interface Alarm Messages” on page 209.

- Verify that the power source has the proper current rating and that each power supply is connected to a separate power source.
- Verify that the cable or cord connecting the power supply to the external power source is securely in place and that there is no moisture accumulating near the router.
- Verify that the cable or cord from the power source to the router is not damaged. If the insulation is cracked or broken, replace the cable or cord immediately.
- Verify that the power cables or cord do not touch or obstruct access to other router components, and that they do not drape where people could trip on them.
- Verify that the air flow in and out of cooling system components is not obstructed.

Chapter 11

Replacing Hardware Components

Most of the router's hardware components are field-replaceable units (FRUs), which means that you can remove and replace them yourself. When you need to replace a router component, contact your customer support or sales representative to order the field-replaceable unit (FRU) that contains the component. For instructions, see “Contacting Customer Support and Returning Hardware” on page 255. For a list of the FRUs on the M160 router, see Field-Replaceable Units (FRUs) on page 4.

- Tools and Parts Required on page 139
- Replacing the CIP and Routing Engine Interface Port Cables on page 141
- Replacing Cooling System Components on page 148
- Replacing Host Module Components on page 159
- Replacing Packet Forwarding Engine Components on page 169
- Replacing Power System Components on page 193

Tools and Parts Required

To replace hardware components, you need the tools and parts listed in Table 24.

Table 24: Tools and Parts Required

Tool or part	Components
Electrostatic bag or antistatic mat	CIP Craft interface FPC Front impeller assembly MCS PIC PCG Routing Engine SFM
Electrostatic discharge (ESD) grounding wrist strap	All
Flat-blade (–) screwdriver, 2.5 mm	Alarm relay contacts on CIP
Flat-blade screwdriver, approximately 1/4 in. (6 mm)	Craft interface Front impeller assembly
Phillips (+) screwdrivers, numbers 1 and 2	Air filter CIP Circuit breaker box Craft interface DC power cables (to remove protective shield over circuit breaker box) Fan tray Fuse (to remove rear lower impeller assembly) Impeller assembly PCG PIC Power supply Routing Engine SFM
7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a minimum of 30 lb-in. (3.5 Nm) tightening torque (See following note.)	Circuit breaker box (to remove or install power cables) DC power cables

Tool or part	Components
Wire cutters	Alarm relay contacts on CIP
Rubber safety cap	Fiber-optic PIC or PIC cable



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

Replacing the CIP and Routing Engine Interface Port Cables

The CIP is located to the left side of the FPC card cage, as shown in Figure 1. It houses the Routing Engine interface ports, which accept connections to external management and alarm-reporting devices.

The CIP is field-replaceable, but you must power off the router before removing or installing it. It weighs about 6.5 lb (3 kg). The cables and wire that connect to the Routing Engine interface ports are hot-removable and hot-insertable.

To replace the CIP and cables connecting to the Routing Engine interface ports, perform the following procedures:

- Removing the CIP on page 141
- Installing the CIP on page 143
- Replacing Connections to Routing Engine Interface Ports on page 145

Removing the CIP

To remove the CIP, follow this procedure (see Figure 64):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. On the console or other management device connected to the master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

```
user@host> request system halt
```



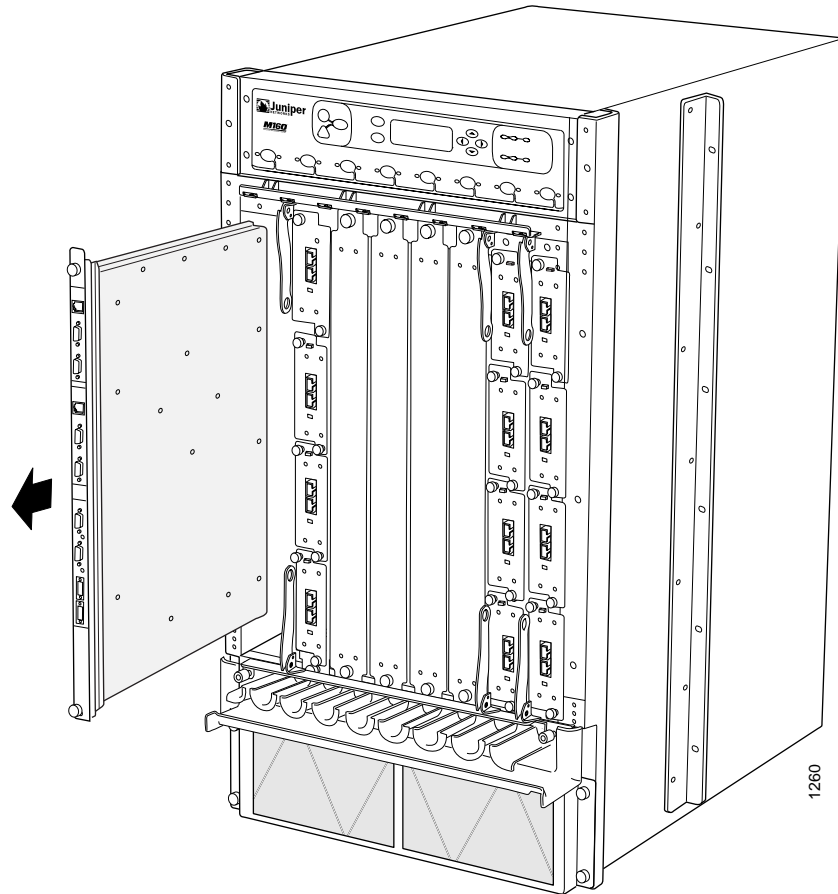
NOTE: Wait until a message appears on the console confirming that the operating system has halted.

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

3. Press the power switch for both power supplies to the OFF (0) position. The switches are on the circuit breaker box.
4. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
5. Disconnect any external devices connected to the CIP. For instructions, see “Replacing the Management Ethernet Cable” on page 146, “Replacing the Console or Auxiliary Cable” on page 146, and “Replace Alarm Relay Wires” on page 147.
6. Using a Phillips screwdriver, loosen and remove the screw at each end of the CIP faceplate.
7. Grasp the CIP and slide it out of the chassis. Place it in the electrostatic bag or on the antistatic mat.



CAUTION: Be sure to slide the CIP straight within the slot to avoid damaging the connector pins on the front of the midplane.

Figure 64: Removing the CIP

Installing the CIP

To install the CIP, follow this procedure (see Figure 65):

1. Verify that the router is powered down.
2. Carefully insert the rear of the CIP into the guides at the top and bottom of the CIP slot, which is located to the left of the FPC card cage.



NOTE: The components on the CIP are on the left side of the board, unlike the components of an FPC, which are on the right side. Verify that the components are on the left before inserting the CIP.

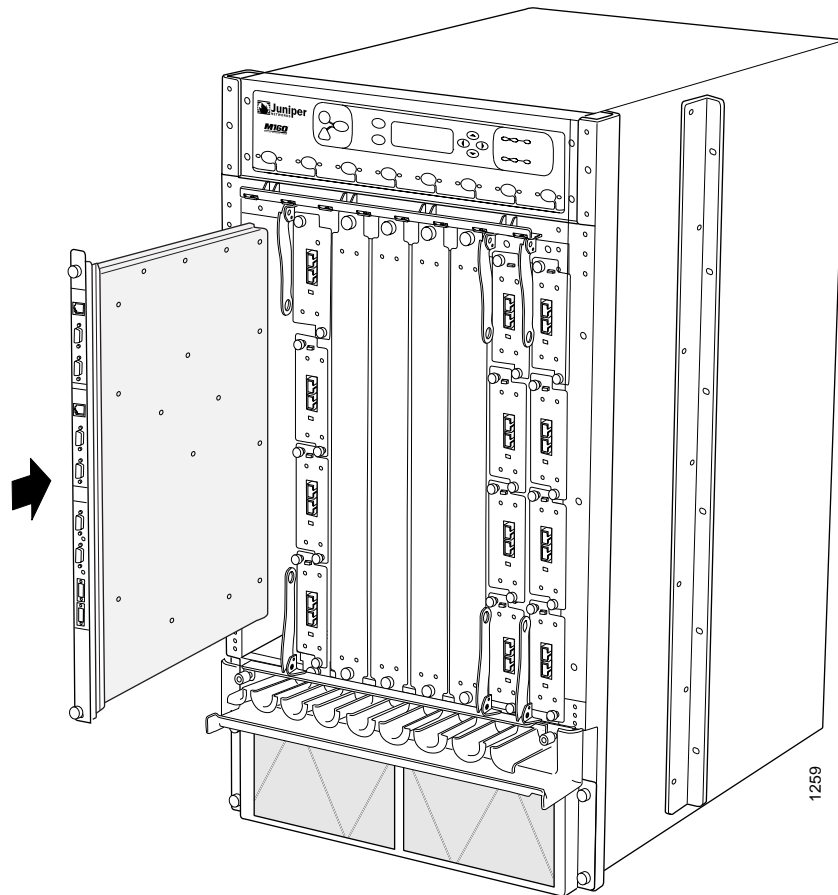
3. Slide the CIP into the chassis until it contacts the midplane.



CAUTION: Be sure to slide the CIP straight within the slot to avoid damaging the connector pins on the front of the midplane.

4. Using a Phillips screwdriver, tighten the screw at each end of the CIP faceplate.
5. Reattach an external management device to one of the Routing Engine ports on the CIP (AUXILIARY, CONSOLE, or ETHERNET). Also reattach alarm relay contacts if desired. For instructions, see “Replacing the Management Ethernet Cable” on page 146, “Replacing the Console or Auxiliary Cable” on page 146, and “Replace Alarm Relay Wires” on page 147.
6. Power on the router and verify correct startup by performing the procedures in “Powering On the Router” on page 119.

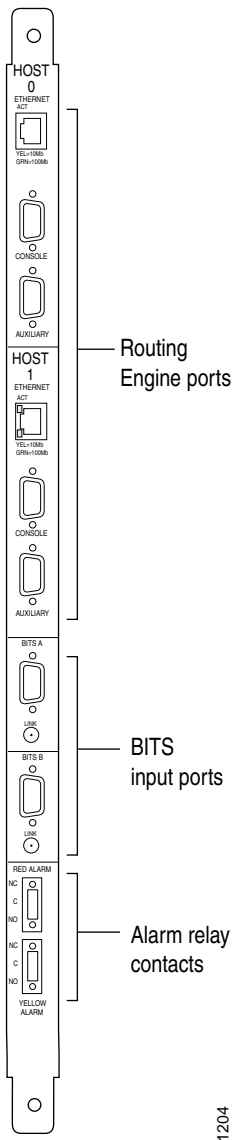
Figure 65: Installing the CIP



Replacing Connections to Routing Engine Interface Ports

The ports on the CIP connect the Routing Engine to external management devices (see Figure 66).

Figure 66: Routing Engine Interface Ports and Alarm Relay Contacts



To replace the cables that connect to the ports, perform the procedures described in the following sections:

- Replacing the Management Ethernet Cable on page 146

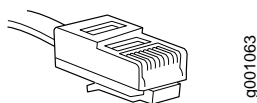
- Replacing the Console or Auxiliary Cable on page 146
- Replace Alarm Relay Wires on page 147

Replacing the Management Ethernet Cable

To connect the Routing Engine to a network for out-of-band management, connect an Ethernet cable with RJ-45/RJ-45 connectors to the **ETHERNET** port on the CIP. One such cable is provided with the router. For cable specifications, see Routing Engine Interface Cable and Wire Specifications on page 74. Follow this procedure:

1. If a cable is already installed in the **ETHERNET** port for the relevant Routing Engine, perform the following steps:
 - a. Press the tab on the connector and pull the connector straight out of the port. Figure 67 shows the connector.
 - b. Disconnect the cable from the network device.
2. Plug one end of the replacement Ethernet cable into the appropriate **ETHERNET** port. Figure 66 shows the external device ports on the CIP. The ports labeled **HOST 0** connect to the Routing Engine in the upper Routing Engine slot (**RE 0**), and the ports labeled **HOST 1** connect to the Routing Engine in the lower Routing Engine slot (**RE 1**).
3. Plug the other end of the cable into the network device.

Figure 67: Ethernet Cable Connector



Replacing the Console or Auxiliary Cable

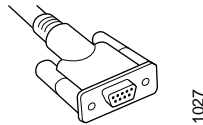
To use a system console to configure and manage the Routing Engine, connect it to the appropriate **CONSOLE** port on the CIP. To use a laptop, modem, or other auxiliary device, connect it to the appropriate **AUXILIARY** port on the CIP. Both ports accept an RS-232 (EIA-232) serial cable with DB-9/DB-9 connectors. One such cable is provided with the router. If you want to connect a device to both ports, you must supply another cable. For cable specifications, see Routing Engine Interface Cable and Wire Specifications on page 74.

To connect a management console or auxiliary device, follow this procedure:

1. If a cable is already installed in the **CONSOLE** or **AUXILIARY** port, perform the following steps:
 - a. Turn off the power to the console or auxiliary device.

- b. Unscrew the screws that secure the cable connector to the port, using a 2.5-mm flat-blade screwdriver if necessary.
 - c. Pull the cable connector straight out of the port.
 - d. Disconnect the cable from the console or auxiliary device.
2. Plug the female end of the replacement serial cable into the appropriate **CONSOLE** or **AUXILIARY** port. Figure 66 shows the external device ports on the CIP. The ports labeled **HOST 0** connect to the Routing Engine in the upper Routing Engine slot (**RE 0**), and the ports labeled **HOST 1** connect to the Routing Engine in the lower Routing Engine slot (**RE 1**).
3. Tighten the screws on the connector, using a 2.5-mm flat-blade screwdriver if necessary.
4. Power on the auxiliary or console device.

Figure 68: Serial Port Connector



Replace Alarm Relay Wires

To connect the router to external alarm-reporting devices, attach wires to the **RED ALARM** and **YELLOW ALARM** relay contacts on the CIP. A system condition that triggers the red or yellow alarm LED on the craft interface also activates the corresponding alarm relay contact.

The terminal blocks that plug into the alarm relay contacts are supplied with the router. They accept wire of any gauge between 24-AWG and 12-AWG (0.20 and 3.33 mm²), which is not provided. Use the gauge of wire appropriate for the external device you are connecting.

To replace the wires connecting to an alarm-reporting device, follow this procedure (see Figure 66):

1. Disconnect the existing wire at the external device.
2. Prepare the required length of replacement wire with gauge between 24-AWG and 12-AWG (0.20 and 3.33 mm²).
3. Using a 2.5 mm flat-blade screwdriver, loosen the small screws on the face of the terminal block and remove the block from the relay contact.
4. Using the 2.5 mm flat-blade screwdriver, loosen the small screws on the side of the terminal block. Remove existing wires from the slots in the front of the block and insert replacement wires. Tighten the screws to secure the wire.

5. Orient the terminal block according to the labels to the left of the appropriate relay contact (NC means “normally closed,” C means “common,” and NO means “normally open”).
6. Plug the terminal block into the relay contact and use a 2.5 mm flat-blade screwdriver to tighten the screws on the face of the block.
7. Attach the other end of the wires to the external device.

Replacing Cooling System Components

For instructions on replacing cooling system components, see the following sections:

- Replacing the Fan Tray on page 148
- Replacing the Front Impeller Assembly on page 150
- Replacing the Rear Lower Impeller Assembly on page 154
- Replacing the Rear Upper Impeller Assembly on page 156

Replacing the Fan Tray

To replace the fan tray, perform the following procedures:

- Removing the Fan Tray on page 148
- Installing the Fan Tray on page 149

Removing the Fan Tray

The fan tray is located behind the cable management system on the front of the chassis, as shown in Figure 1. It weighs approximately 13 lb (5.9 kg).

To remove the fan tray, follow this procedure (see Figure 69):

1. Unwrap any PIC cables from the spools on the cable management system and remove the cables from the tray. Arrange the cables so that they do not block the front of the cable management system and tray, and secure them with temporary fasteners so that they are not supporting their own weight as they hang from the connector.



CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.

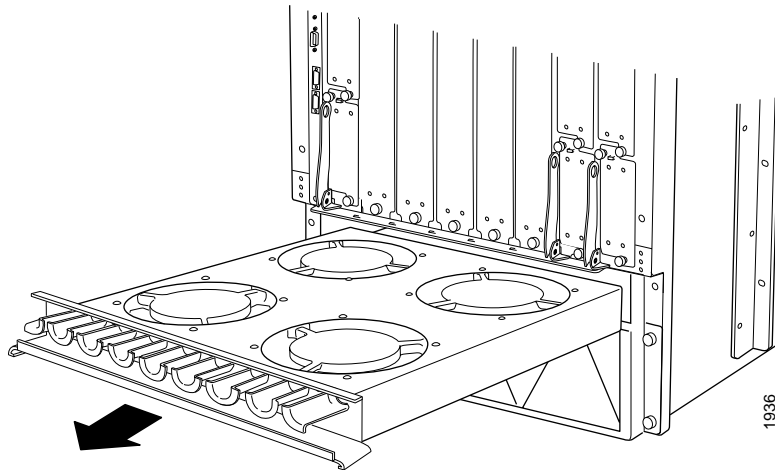
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Loosen the thumbscrew at each end of the fan tray, using a Phillips screwdriver if necessary.
4. Grasp the sides of the fan tray and pull firmly to slide it halfway out of the chassis.



CAUTION: To avoid injury, keep tools and your fingers away from the fans as you slide the fan tray out of the chassis. The fans might still be spinning.

5. Place one hand under the fan tray to support it and slide the tray completely out of the chassis after the fans stop spinning.

Figure 69: Removing the Fan Tray



Installing the Fan Tray

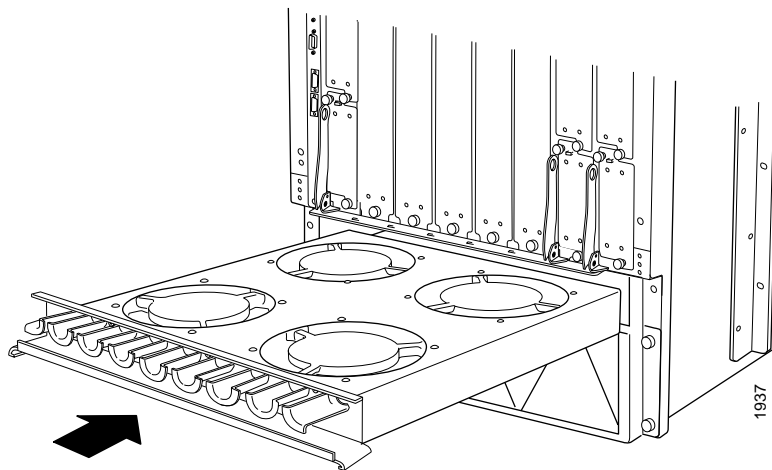
To install the fan tray, follow this procedure (see Figure 70):



CAUTION: When sliding the fan tray into the chassis, take care not to catch and pinch any dangling PIC cables with the edges of the tray. Also make sure your fingers are not near the fans, which start spinning as soon as the fan tray contacts the midplane.

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Grasp the sides of the fan tray and align the rear of the tray with the guides inside the chassis.
3. Slide the fan tray all the way into the chassis.
4. Tighten the thumbscrew at each end of the cable management system.
5. Rearrange the PIC cables in the cable management system. For more information about proper cable arrangement, see “Maintaining PICs and PIC Cables” on page 134.

Figure 70: Installing the Fan Tray



Replacing the Front Impeller Assembly

The front impeller assembly, which includes the craft interface, is located at the front of the chassis above the FPC card cage, as shown in Figure 1. The assembly weighs approximately 14.5 lb (6.6 kg). The assembly is hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4.

The craft interface is attached to the front of the front impeller assembly. If you are removing the front impeller assembly to replace it and the replacement assembly does not have a craft interface already installed on it, you must transfer the craft interface from the removed assembly to the replacement assembly. Perform the procedures described in the following sections:

- Removing the Front Impeller Assembly on page 151
- Removing the Craft Interface from the Front Impeller Assembly on page 152

- Installing the Craft Interface on the Front Impeller Assembly on page 153
- Installing the Front Impeller Assembly on page 154

If the replacement front impeller assembly already has a craft interface on it, perform only the procedures in “Removing the Front Impeller Assembly” on page 151 and “Installing the Front Impeller Assembly” on page 154.

Removing the Front Impeller Assembly

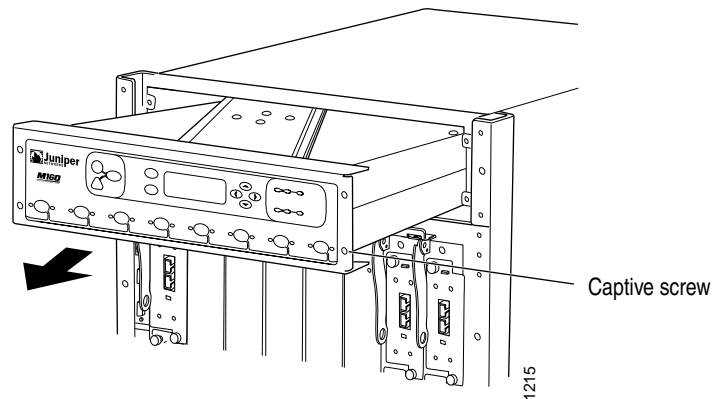
To remove the front impeller assembly, follow this procedure (see Figure 71):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Using a Phillips screwdriver, loosen the captive screw at each corner of the craft interface.
4. Insert a flat-blade screwdriver into the gap around the craft interface and gently pry the impeller assembly forward until you can grasp the sides of the assembly and slide it halfway out of the chassis.



CAUTION: To avoid injury, as you slide the assembly out of the chassis do not touch any part of the impeller behind the front panel—the impeller might still be spinning.

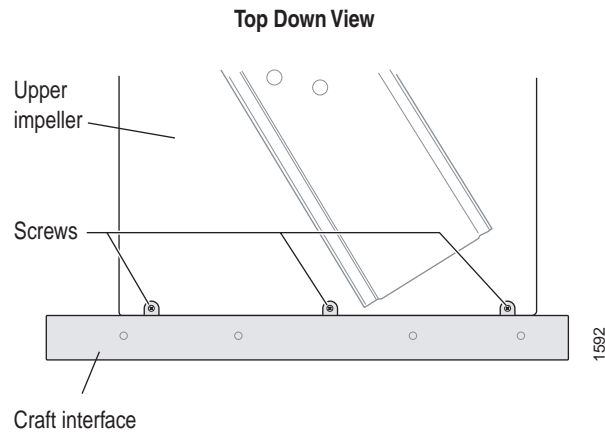
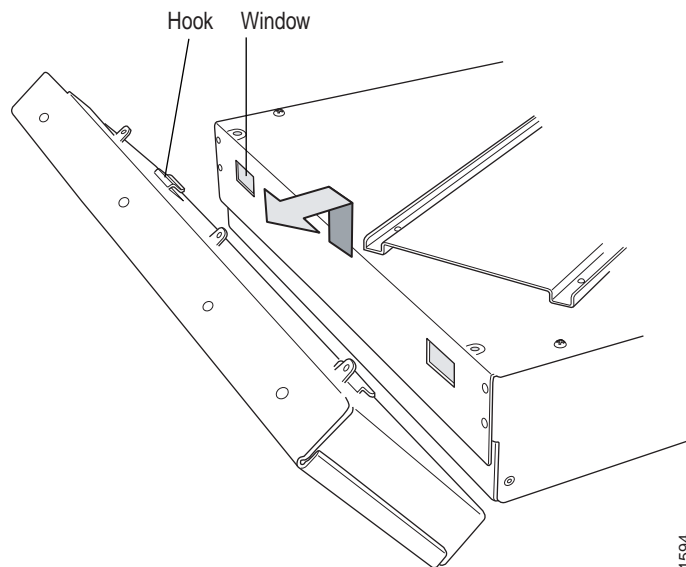
5. Place one hand under the assembly to support it. When the impeller is no longer spinning, slide the assembly completely out of the chassis and place it on the antistatic mat or in the electrostatic bag.
6. If you are replacing the front impeller assembly and the replacement assembly has a craft interface panel installed on it, proceed to “Installing the Front Impeller Assembly” on page 154. Otherwise, proceed to “Removing the Craft Interface from the Front Impeller Assembly” on page 152.

Figure 71: Removing the Front Impeller Assembly

Removing the Craft Interface from the Front Impeller Assembly

If you are replacing the front impeller assembly and the replacement assembly does not have a craft interface panel on the front, you must transfer the craft interface from the removed assembly to the replacement assembly. To remove the craft interface from the removed impeller assembly, follow this procedure:

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Place the removed and replacement impeller assemblies top side up on antistatic mats.
3. If not immediately transferring the craft interface panel to the replacement assembly, place an antistatic mat or electrostatic bag on a flat, stable surface to receive it.
4. Using a Phillips screwdriver, remove the screws from the three semicircular metal tabs on the back of the craft interface that secure it to the impeller assembly (see Figure 72). Save the screws.
5. Grasp the ends of the craft interface, pull upward to release the hooks on the back of it from the windows on the front of the impeller assembly, then pull it toward you to free the craft interface completely (see Figure 73). If not immediately transferring it to a replacement impeller assembly, place it in the electrostatic bag or on the antistatic mat.

Figure 72: Removing the Screws along the Top Front Edge of the Front Impeller Assembly**Figure 73: Removing the Craft Interface**

Installing the Craft Interface on the Front Impeller Assembly

To attach the craft interface to the front impeller assembly, follow this procedure:

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Place the replacement impeller assembly top side up on an antistatic mat on a flat, stable surface.

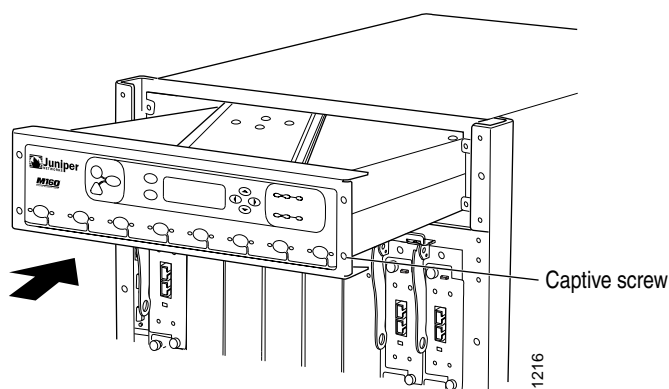
3. Attach the craft interface to the front of the impeller assembly, making sure that the hooks on the back of the craft interface clip securely into the windows on the front of the impeller assembly (see Figure 73).
4. Align the holes in the three semicircular metal tabs on the back of the craft interface with the corresponding holes in the top of the impeller assembly.
5. Insert the screws you saved when removing the craft interface into the three holes and tighten using a Phillips screwdriver (see Figure 72).

Installing the Front Impeller Assembly

To install the front impeller assembly, follow this procedure (see Figure 74):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Grasp the sides of the impeller assembly and align the rear of the assembly with the guides inside the chassis.
3. Slide the impeller assembly all the way into the chassis.
4. Using a Phillips screwdriver, tighten the captive screw at each corner of the craft interface.

Figure 74: Installing the Front Impeller Assembly



Replacing the Rear Lower Impeller Assembly

The rear lower impeller assembly is located at the lower left of the rear of the chassis, above the left power supply, as shown in Figure 2. It weighs about 4 lb (1.8 kg).

The assembly is hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. To replace it, perform the following procedures:

- Removing the Rear Lower Impeller Assembly on page 155
- Installing the Rear Lower Impeller Assembly on page 155

Removing the Rear Lower Impeller Assembly

To remove the rear lower impeller assembly, follow this procedure (see Figure 75):

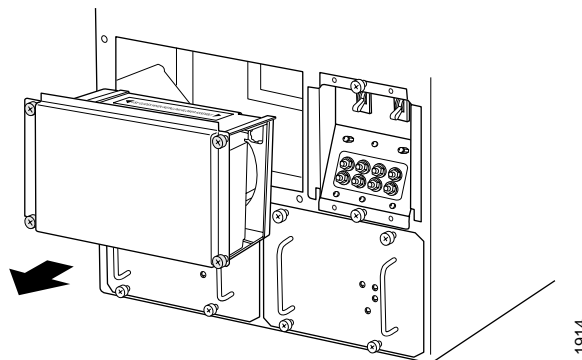
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Loosen the thumbscrew at each corner of the impeller cover, using a Phillips screwdriver if necessary.
3. Grasp the thumbscrews at opposite corners of the impeller cover and slide the assembly halfway out of the chassis.



CAUTION: To avoid injury, as you slide the assembly out of the chassis do not touch any part of the impeller behind the front panel—the impeller might still be spinning.

4. When the impeller is no longer spinning, slide the assembly completely out of the chassis.

Figure 75: Removing the Rear Lower Impeller Assembly

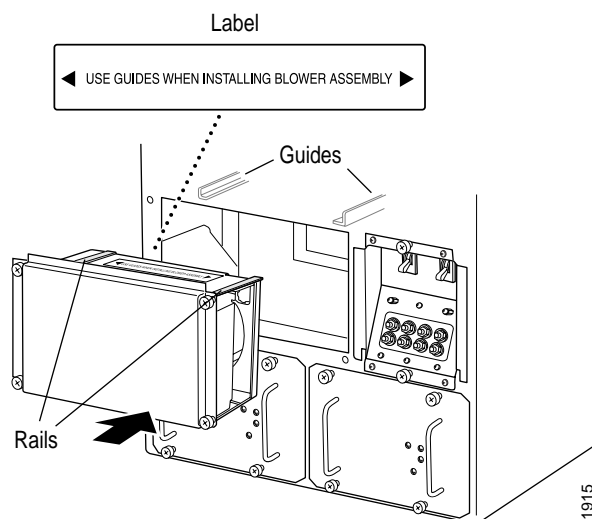


Installing the Rear Lower Impeller Assembly

To install the rear lower impeller assembly, follow this procedure (see Figure 76):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Orient the impeller so that the label is on the top. Align the rails on the upper edges of the impeller assembly with the guides inside the chassis.
3. Push the impeller assembly up and to the right to start it into the chassis, then slide it all the way in.
4. Tighten the thumbscrew at each corner of the impeller cover.

Figure 76: Installing the Rear Lower Impeller Assembly



Replacing the Rear Upper Impeller Assembly

The rear upper impeller assembly is located at the upper left of the rear of the chassis, as shown in Figure 2. It weighs about 4 lb (1.8 kg).

The assembly is hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. To replace it, perform the following procedures:

- Removing the Rear Upper Impeller Assembly on page 157
- Installing the Rear Upper Impeller Assembly on page 158

Removing the Rear Upper Impeller Assembly

To remove the rear upper impeller assembly, follow this procedure (see Figure 77 and Figure 78, which show the two types of impeller that can be installed):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Loosen the thumbscrew at each corner of the impeller cover, using a Phillips screwdriver if necessary.
3. Grasp the thumbscrews at opposite corners of the impeller cover and slide the assembly halfway out of the chassis.



CAUTION: To avoid injury, as you slide the assembly out of the chassis do not touch any part of the impeller behind the front panel—the impeller might still be spinning.

4. When the impeller is no longer spinning, slide the assembly completely out of the chassis.

Figure 77: Removing the Rear Upper Impeller Assembly

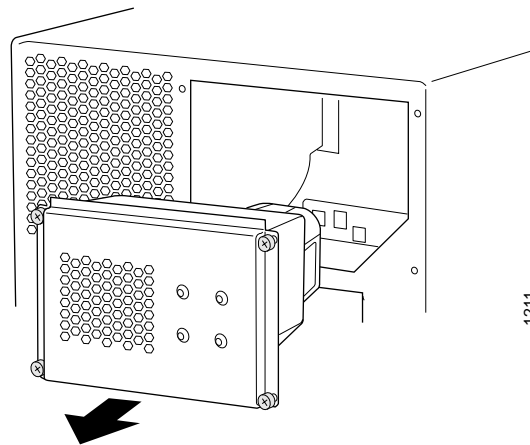
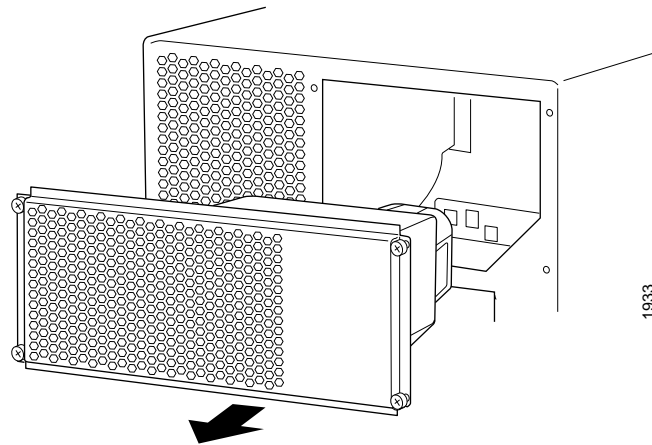


Figure 78: Removing the Rear Upper Impeller Assembly

Installing the Rear Upper Impeller Assembly

To install the rear upper impeller assembly, follow this procedure (see Figure 79 and Figure 80, which show the two types of impeller that can be installed):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Slide the assembly all the way into the chassis.
3. Tighten the thumbscrew at each corner of the impeller cover.

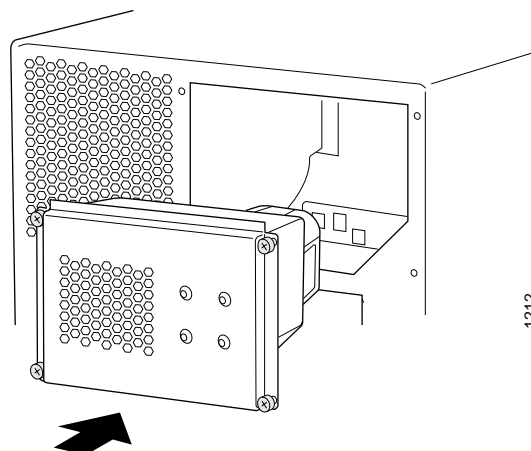
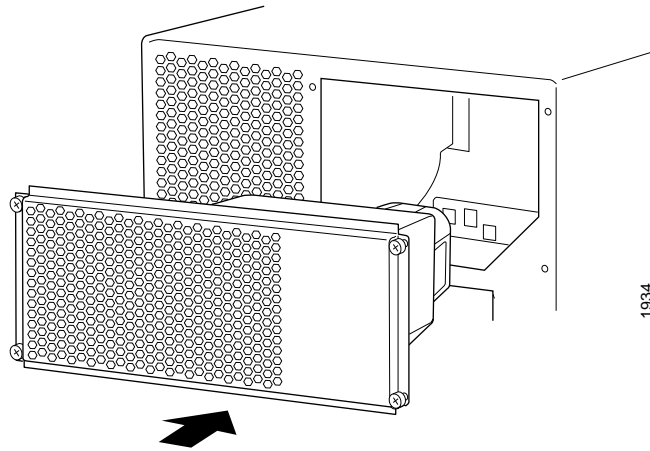
Figure 79: Installing the Rear Upper Impeller Assembly

Figure 80: Installing the Rear Upper Impeller Assembly

Replacing Host Module Components

For instructions on replacing host module components, see the following sections:

- Replacing an MCS on page 159
- Removing and Insert the PC Card on page 163
- Replacing a Routing Engine on page 165

Replacing an MCS

The MCSs are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. For a description of the effect of removing an MCS, see Host Module on page 22. To replace an MCS, perform the following procedures:

- Removing an MCS on page 159
- Installing an MCS on page 161

Removing an MCS

To remove an MCS, follow this procedure (see Figure 81):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

3. Remove the rear component cover by loosening the thumbscrew at each corner of the cover and pulling it straight off the chassis. For complete instructions, see “Removing the Rear Component Cover” on page 86.
4. If two host modules are installed, use one of the following two methods to determine which is functioning as master:
 - Note which of the green host module MASTER LEDs is lit on the craft interface.
 - Issue the following CLI command. The master Routing Engine is designated **Master** in the **Current state** field:

```
user@host> show chassis routing-engine

Routing Engine status:
  Slot 0:
    Current state           Master
  ...
```

5. If the component you are removing belongs to the master host module and a second host module is installed, issue the following CLI command to switch mastership to the standby host module:

```
user@host> request chassis routing-engine master switch
```

If the Routing Engines are running JUNOS Release 6.0 or later and are configured for graceful switchover, the standby Routing Engine immediately assumes Routing Engine functions and there is no interruption to packet forwarding. Otherwise, packet forwarding halts while the standby Routing Engine becomes the master and the Packet Forwarding Engine components reset and connect to the new master Routing Engine. For information about configuring graceful switchover, see the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.



NOTE: Router performance might change if the standby Routing Engine’s configuration differs from the former master’s configuration. For the most predictable performance, configure the two Routing Engines identically, except for parameters unique to a Routing Engine, such as the hostname defined at the [edit system] hierarchy level and the management interface (fxp0 or equivalent) defined at the [edit interfaces] hierarchy level.

To configure Routing Engine-specific parameters and still use the same configuration on both Routing Engines, include the appropriate configuration statements under the re0 and re1 statements at the [edit groups] hierarchy level and use the apply-groups statement. For instructions, see the *JUNOS System Basics Configuration Guide*.

6. On the console or other management device connected to the Routing Engine that is paired with the CB you are removing, enter CLI operational mode and issue the following command. The command shuts down the Routing Engine cleanly, so its state information is preserved:

```
user@host> request system halt
```

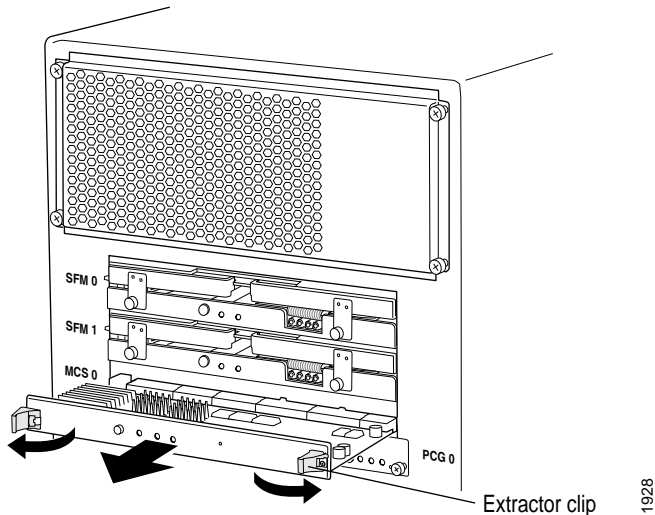


NOTE: Wait until a message appears on the console confirming that the operating system has halted.

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

7. Push the end of each extractor clip (located at each end of the MCS) outward.
8. Grasp the extractor clips and slide the MCS about halfway out of the chassis.
9. Place one hand under the MCS to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

Figure 81: Removing an MCS



Installing an MCS

To install an MCS, follow this procedure (see Figure 82):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. Place one hand under the MCS to support it and grasp one of the extractor clips on the faceplate with the other hand.
3. Align the rear of the MCS with the guides inside the chassis and slide it in completely.
4. Press the extractor clip at each end of the MCS inward.
5. Verify that the green LED labeled **OK** on the MCS faceplate is lit. Also check the host module LEDs on the craft interface to verify that the green LED labeled **ONLINE** is lit for the host module to which the MCS belongs (Figure 11 shows the LEDs).

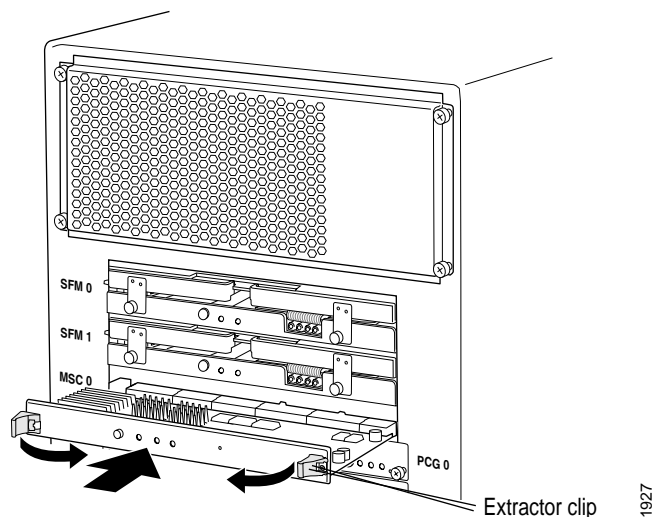
You can also verify correct MCS functioning by issuing the `show chassis environment mcs` command described in Maintaining Host Module Components on page 131.

6. Reinstall the rear component cover and tighten the thumbscrew at each corner to secure it to the chassis. For complete instructions, see “Reinstalling the Rear Component Cover” on page 109.



CAUTION: To maintain proper airflow and provide electromagnetic shielding, do not operate the router without the rear component cover in place.

Figure 82: Installing an MCS



Removing and Insert the PC Card

The slot labeled **PC CARD** on the Routing Engine faceplate accepts a Type I PC card, as defined in the *PC Card Standard* published by the Personal Computer Memory Card International Association (PCMCIA). The router is shipped with a PC card that contains JUNOS Internet software. The PC card can be used to copy JUNOS software from the PC card onto the Routing Engine. You can also copy JUNOS software from the Routing Engine onto a PC card, for example, to create a backup copy of upgrade software that you have obtained from Juniper Networks. Instructions for copying software to a PC card are available at the Juniper Networks Support Web site (<http://www.juniper.net/support/>); after logging in, navigate to the Customer Support Center, then to the download page for JUNOS Internet software.



NOTE: The appearance and position of electronic components or the PC card slot on your Routing Engine might differ from the figures in this section. These differences do not affect Routing Engine installation and removal or functionality.



NOTE: The software on a PCMCIA card is loaded only onto the Routing Engine into which the PCMCIA card is inserted. It is not automatically copied to the other Routing Engine.

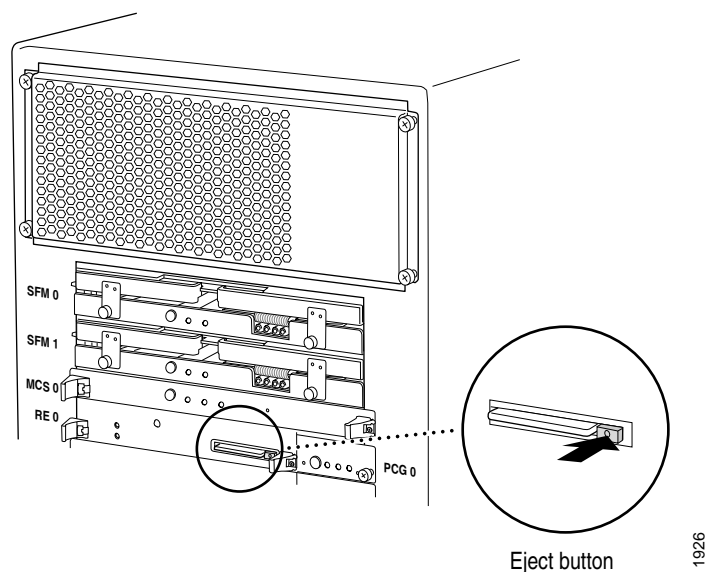
To remove and insert a PC card, perform the following procedures:

- Removing the PC Card on page 163
- Insert the PC Card on page 164

Removing the PC Card

The PC card is inserted in the slot labeled **PC CARD** in the Routing Engine faceplate. To remove the PC card, follow this procedure (see Figure 83):

1. Remove the rear component cover by loosening the thumbscrew at each corner of the cover and pulling it straight off the chassis. For complete instructions, see “Removing the Rear Component Cover” on page 86.
2. Press the eject button located next to the PC card slot in the Routing Engine faceplate. Note that the PC card slot might be located in a different position from that shown in Figure 83.
3. When the PC card pops partially out of the slot, grasp the card and pull it straight out of the slot.

Figure 83: Removing the PC Card

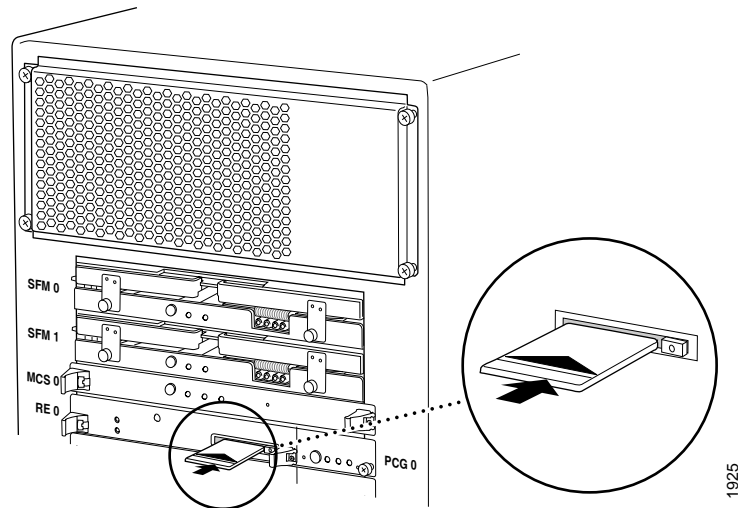
Insert the PC Card

To insert the PC card, follow this procedure (see Figure 84):

1. Orient the PC card with the Juniper Networks logo facing in the direction specified on the Routing Engine faceplate. Insert the card into the slot.
2. Press the card firmly all the way into the slot. Note that the PC card slot might be located in a different position from that shown in Figure 84.
3. Reinstall the rear component cover and tighten the thumbscrew at each corner to secure it to the chassis. For complete instructions, see “Reinstalling the Rear Component Cover” on page 109.



CAUTION: To maintain proper airflow and provide electromagnetic shielding, do not operate the router without the rear component cover in place.

Figure 84: Insert the PC Card

Replacing a Routing Engine

The Routing Engines are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. For a description of the effect of removing a Routing Engine, see Host Module on page 22. To replace a Routing Engine, perform the following procedures:

- Removing a Routing Engine on page 165
- Installing a Routing Engine on page 168

Removing a Routing Engine

To remove a Routing Engine, follow this procedure (see Figure 85):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Remove the rear component cover by loosening the thumbscrew at each corner of the cover and pulling it straight off the chassis. For complete instructions, see “Removing the Rear Component Cover” on page 86.
4. If two host modules are installed, use one of the following two methods to determine which is functioning as master:
 - Note which of the green host module MASTER LEDs is lit on the craft interface.

- Issue the following CLI command. The master Routing Engine is designated **Master** in the **Current state** field:

```
user@host> show chassis routing-engine
```

```
Routing Engine status:
Slot 0:
  Current state          Master
...
```

5. If the component you are removing belongs to the master host module and a second host module is installed, issue the following CLI command to switch mastership to the standby host module:

```
user@host> request chassis routing-engine master switch
```

If the Routing Engines are running JUNOS Release 6.0 or later and are configured for graceful switchover, the standby Routing Engine immediately assumes Routing Engine functions and there is no interruption to packet forwarding. Otherwise, packet forwarding halts while the standby Routing Engine becomes the master and the Packet Forwarding Engine components reset and connect to the new master Routing Engine. For information about configuring graceful switchover, see the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.



NOTE: Router performance might change if the standby Routing Engine's configuration differs from the former master's configuration. For the most predictable performance, configure the two Routing Engines identically, except for parameters unique to a Routing Engine, such as the hostname defined at the [edit system] hierarchy level and the management interface (fxp0 or equivalent) defined at the [edit interfaces] hierarchy level.

To configure Routing Engine-specific parameters and still use the same configuration on both Routing Engines, include the appropriate configuration statements under the **re0** and **re1** statements at the [edit groups] hierarchy level and use the **apply-groups** statement. For instructions, see the *JUNOS System Basics Configuration Guide*.

6. On the console or other management device connected to the Routing Engine you are removing, enter CLI operational mode and issue the following command. The command shuts down the Routing Engine cleanly, so its state information is preserved:

```
user@host> request system halt
```



NOTE: Wait until a message appears on the console confirming that the operating system has halted.

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

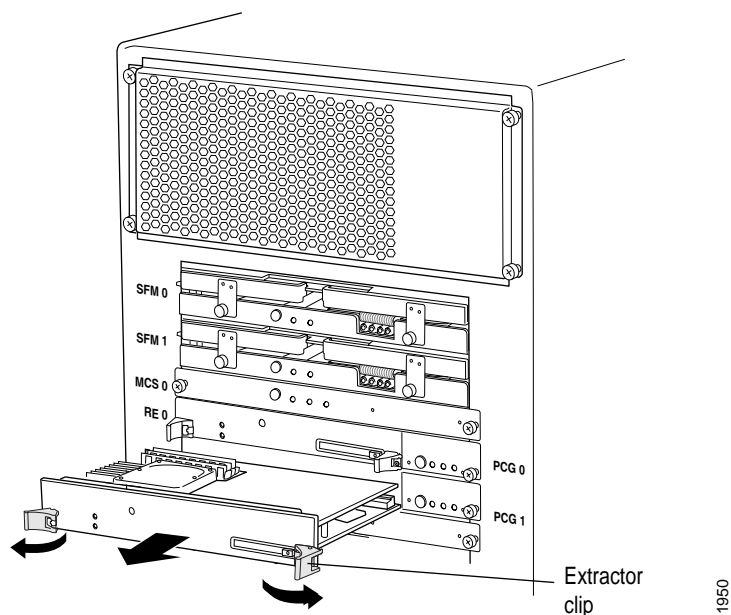
7. Using your thumbs, push and hold the red tab on each extractor clip toward the outer edge of the unit. Push the ends of the extractor clips outward to unseat the Routing Engine from the chassis.
8. Grasp the extractor clips and slide the unit about halfway out of the chassis.



CAUTION: Slide the Routing Engine straight out of the chassis. Damage can result if it gets lodged because of uneven movement.

9. Place one hand under the Routing Engine to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

Figure 85: Removing a Routing Engine



Installing a Routing Engine



NOTE: If two Routing Engines are installed, they must both be the same version.

To install a Routing Engine, follow this procedure (see Figure 86):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Verify that the extractor clip at each end of the Routing Engine is flipped toward the outer edge of the unit. If necessary, use your thumbs to push and hold the red tab on each extractor clip toward the outer edge, then push the ends of the extractor clips outward.
3. Place one hand under the Routing Engine to support it and grasp one of the extractor clips on the faceplate with the other hand.
4. Align the rear of the Routing Engine with the guide rails inside the chassis and slide it in completely.



CAUTION: Align the Routing Engine carefully with the guide rails and push it in evenly. Damage can result if it gets lodged in the rails because of uneven movement.

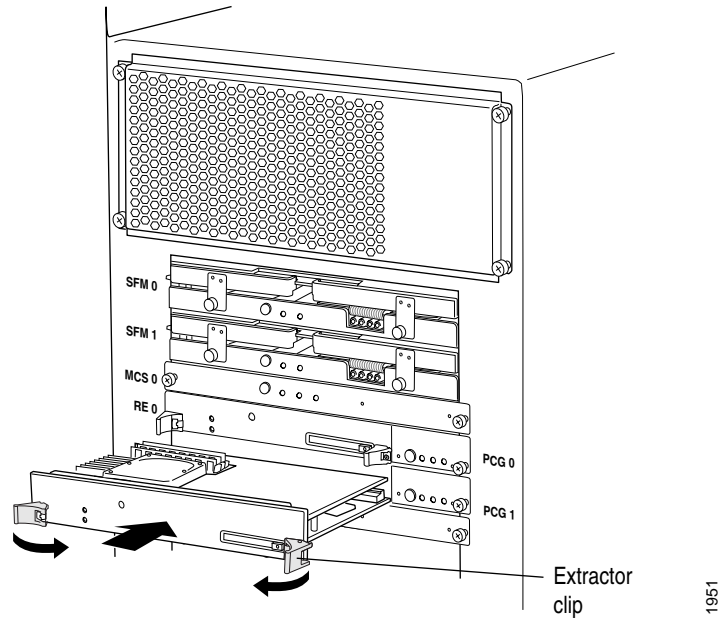
5. Press the extractor clip at each end of the Routing Engine inward to seat the unit firmly in the chassis.
6. Check the host module LEDs on the craft interface to verify that the green LED labeled **ONLINE** is lit for the host module to which the Routing Engine belongs (Figure 11 shows the LEDs).

You can also verify correct Routing Engine functioning by issuing the `show chassis routing-engine` command described in Maintaining Host Module Components on page 131.

7. Reinstall the rear component cover and tighten the thumbscrew at each corner to secure it to the chassis. For complete instructions, see “Reinstalling the Rear Component Cover” on page 109.



CAUTION: To maintain proper airflow and provide electromagnetic shielding, do not operate the router without the rear component cover in place.

Figure 86: Installing a Routing Engine

Replacing Packet Forwarding Engine Components

For instructions on replacing Packet Forwarding Engine components, see the following sections:

- Replacing an FPC on page 169
- Replacing a PCG on page 176
- Replacing a PIC on page 179
- Replace PIC Cables on page 185
- Replacing an SFM on page 188
- Replace an SFP on page 190

Replacing an FPC

FPCs are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. When you remove an FPC, forwarding operations halt for about 200 ms while the Packet Forwarding Engine flushes the shared memory buffers on the remaining FPCs.

To replace an FPC, perform the following procedures:

- Removing an FPC on page 170

- Installing an FPC on page 172

Removing an FPC

To remove an FPC, follow this procedure (see Figure 87):

1. Place an antistatic mat on a flat, stable surface to receive the FPC. If you are removing PICs from the FPC, prepare an antistatic mat or electrostatic bag for each one. If any of the PICs on the FPC use fiber-optic cable, have ready a rubber safety cap for each transceiver and cable.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Label the cables connected to each PIC on the FPC so that you can later reconnect the cables to the correct PICs.
4. Use one of the following methods to take the FPC offline:
 - Press and hold the FPC offline button. The green OK LED next to the button begins to blink. Hold the button down until the LED goes out. The LEDs and offline button for each FPC are located directly above it on the craft interface.
 - Issue the following CLI command:


```
user@host>request chassis fpc slot slot-number offline
```

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.
5. Disconnect the cables from the PICs installed in the FPC. If a PIC uses fiber-optic cable, immediately cover each transceiver and the end of each cable with a rubber safety cap. Arrange the disconnected cables in the cable management system, to prevent the cables from developing stress points.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

6. If you are transferring any PICs to a different FPC, follow this procedure to remove them while the FPC is still installed:
 - a. Unscrew the thumbscrews at the top and bottom of the PIC faceplate simultaneously and at about the same rate (unscrewing the two screws alternately or at very different rates can cause the PIC to become lodged in the FPC slot, making it difficult to turn the screws).
 - b. Slide the PIC out of the slot and immediately place it on an antistatic mat or in an electrostatic bag.
 7. Loosen the thumbscrew at each end of the FPC, using a Phillips screwdriver if necessary.
 8. Pull the ends of the ejector levers, which are adjacent to the thumbscrews, away from the face of the FPC until they are nearly perpendicular to it.
 9. Grasp the top and bottom flanges of the card carrier and slide the FPC about halfway out of the card cage.
 10. Place one hand around the front of the FPC (the PIC housing) and the other hand under it to support it. Slide the FPC completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.
-



CAUTION: The weight of the FPC is concentrated in the back end. Be prepared to accept the full weight—up to 29 lb (13.2 kg)—as you slide the FPC out of the chassis.

When the FPC is out of the chassis, do not hold it by the ejector levers, bus bars, or edge connectors. They cannot support its weight.

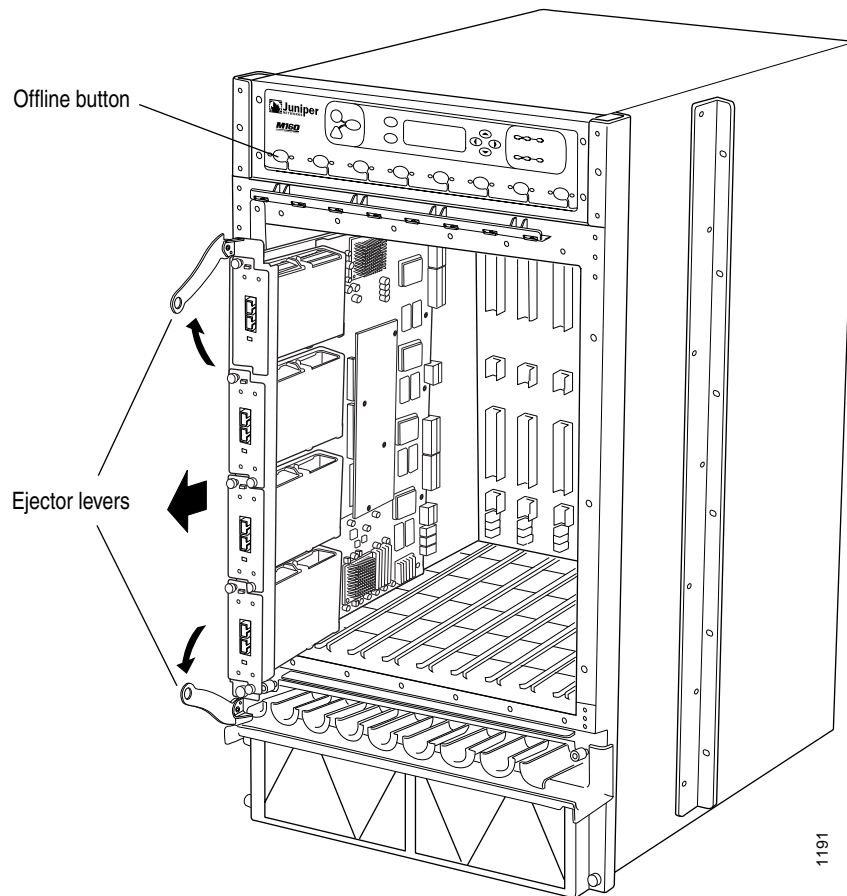
Do not stack FPCs on top of one another after removal. Place each one individually in an electrostatic bag or on its own antistatic mat on a flat, stable surface.

11. If you are not reinstalling an FPC into the emptied FPC slot within a short time, install a blank FPC panel over the slot to maintain proper airflow in the FPC card cage.



CAUTION: After removing an FPC from the chassis, wait at least 30 seconds before reinserting it, removing an FPC from a different slot, or inserting an FPC into a different slot.

Figure 87: Removing an FPC



Installing an FPC

To install an FPC, follow this procedure (see Figure 88 and Figure 89):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router

is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. Verify that the ends of the ejector levers, which are located at each end of the FPC, are pushed outward, nearly perpendicular to the face of the FPC.
3. Grasp the front of the FPC with one hand and place the other hand under the FPC to support it.



CAUTION: When the FPC is out of the chassis, do not hold it by the ejector levers, bus bars, or edge connectors. They cannot support its weight.

4. Align the rear bottom corners of the FPC with the guides at the bottom of the FPC slot. Slide the FPC into the card cage until it contacts the midplane.
5. Push the ends of the ejector levers inward until they are nearly flush with the face of the FPC.
6. Tighten the thumbscrew at each end of the FPC to seat the FPC securely in the chassis.
7. If you are installing different PICs in the FPC, follow this procedure for each one:
 - a. If the PIC uses fiber-optic cable, verify that there is a rubber safety cap over each transceiver on the faceplate. Install a cap if necessary.
 - b. Slide the PIC into a slot in the FPC, aligning the notches in the connector at the rear of the PIC with the notches in the FPC slot and then firmly pushing the PIC into place.



CAUTION: Insert the PIC straight into the FPC slot to avoid damaging the components on the bottom of the PIC.

- c. Tighten the thumbscrews at the ends of the PIC faceplate simultaneously and at about the same rate (tightening the two screws alternately or at very different rates can cause the PIC to become lodged in the FPC slot, making it difficult to turn the screws). Verify that the PIC is seated properly.
8. If any of the PICs on the FPC connect to fiber-optic cable, remove the rubber safety cap from each transceiver and cable.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the

interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.

-
9. Insert the appropriate cable into the cable connector ports on each PIC on the FPC. Secure the cables so that they are not supporting their own weight. Place excess cable out of the way in a neatly coiled loop, using the cable management system. Placing fasteners on a loop helps to maintain its shape.
-



CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

10. Use one of the following methods to bring the FPC online:

- Press and hold the FPC offline button until the green OK LED next to the button lights steadily, in about 5 seconds. The LEDs and offline button for each FPC are located directly above it on the craft interface.
- Issue the following CLI command:

```
user@host>request chassis fpc slot slot-number online
```

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

As the FPC comes online, the green FPC LED labeled OK begins to blink. It continues to blink while the Routing Engine downloads software to the FPC, the FPC runs its diagnostics, and the PICs housed in the FPC are enabled. Packet forwarding then halts for about 200 ms while the Packet Forwarding Engine incorporates the memory on the new FPC into the memory buffers shared by all FPCs. When the FPC is online, the OK LED lights steadily.



CAUTION: After the OK LED lights steadily, wait at least 30 seconds before removing the FPC again, removing a FPC from a different slot, or inserting an FPC in a different slot.

You can also verify correct FPC and PIC functioning by issuing the `show chassis fpc` and `show chassis fpc pic-status` commands described in “Maintaining FPCs” on page 133 and “Maintaining PICs and PIC Cables” on page 134.

Figure 88: Installing an FPC

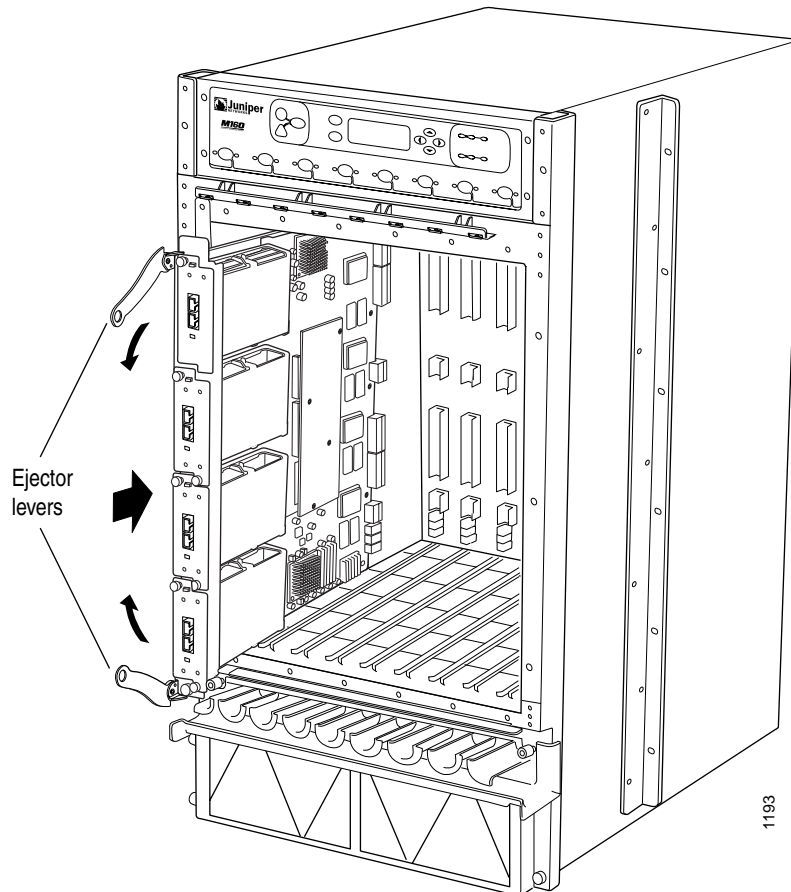
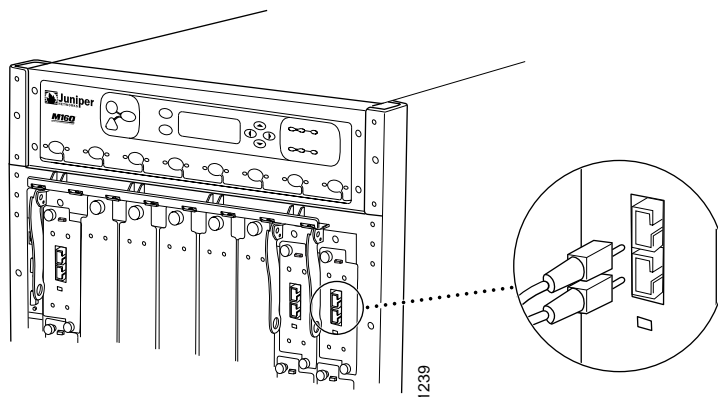


Figure 89: Connecting Fiber-Optic Cable to a PIC

Replacing a PCG

During normal operation, both PCGs generate a 125-MHz clock signal, but only one is designated as the master. The modules and ASICs in the Packet Forwarding Engine that use the clock signal to gate packet processing use only the signal from the master PCG. For information about determining which PCG is the master, see “Maintaining the PCGs” on page 135.

PCGs are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. Removal or failure of the backup PCG does not affect router function. If the master PCG fails or is removed from the chassis, however, the Packet Forwarding Engine resets so that the components start using the signal from the other PCG (which becomes the master). Packet forwarding halts while there is no clock signal, because the Packet Forwarding Engine does not accept incoming packets.

To replace a PCG, perform the following procedures:

- Removing a PCG on page 176
- Installing a PCG on page 178

Removing a PCG

To remove a PCG, follow this procedure (see Figure 90):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

3. Remove the rear component cover by loosening the thumbscrew at each corner of the cover and pulling it straight off the chassis. For complete instructions, see “Removing the Rear Component Cover” on page 86.
4. Press and hold the offline button on the PCG faceplate until the amber LED labeled **FAIL** lights, which takes about 3 seconds.

(Keep in mind that if you are removing the master PCG, forwarding halts while the Packet Forwarding Engine resets so that the components start using the clock signal from the other PCG, which becomes the master. For more information, see “Replacing a PCG” on page 176.)

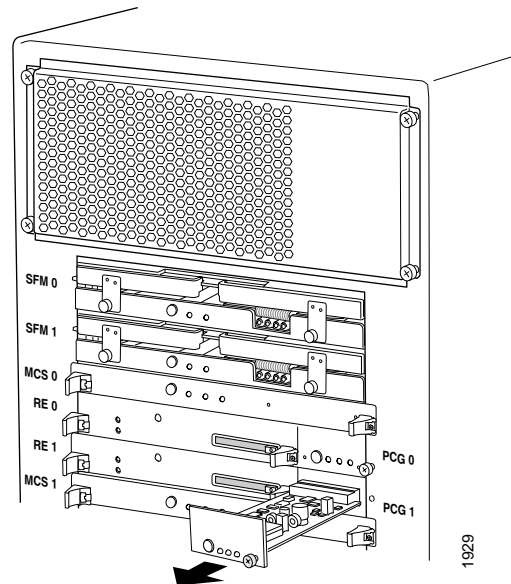
5. Loosen the thumbscrew at the lower right corner of the PCG faceplate, using a Phillips screwdriver if necessary.
6. Grasp the thumbscrew and slide the PCG about halfway out of the chassis.



CAUTION: Be careful to slide the PCG straight out of the chassis to avoid bending any of the pins on the underside of the board.

7. Place one hand under the PCG to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

Figure 90: Removing a PCG



Installing a PCG

To install a PCG, follow this procedure (see Figure 91):

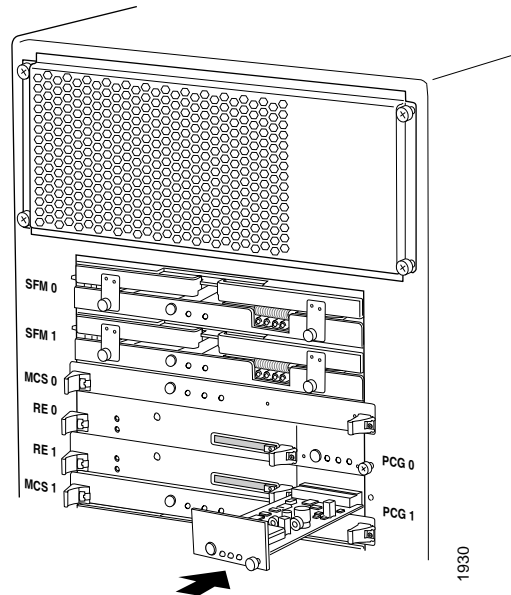
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Place one hand under the PCG to support it and grasp the thumbscrew on the faceplate with the other hand.
3. Align the rear of the PCG with the guides inside the chassis and slide it in completely.
4. Tighten the thumbscrew on the faceplate to seat the PCG firmly in the chassis.
5. Verify that the green LED labeled OK lights steadily, which takes about 3 seconds.

You can also verify correct PCG functioning by issuing the `show chassis environment pcg` command, as described in “Maintaining the PCGs” on page 135.

6. Reinstall the rear component cover and tighten the thumbscrew at each corner to secure it to the chassis. For complete instructions, see “Reinstalling the Rear Component Cover” on page 109.



CAUTION: To maintain proper airflow and provide electromagnetic shielding, do not operate the router without the rear component cover in place.

Figure 91: Installing a PCG

Replacing a PIC

PICs are housed in the FPCs installed in the front of the router, as shown in Figure 1. PICs are hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. Removing a PIC does not affect router function, except that the PIC no longer receives or transmits data.

To replace a PIC, perform the following procedures:

- Removing a PIC on page 179
- Installing a PIC on page 181

Removing a PIC

To remove a PIC, follow this procedure (see Figure 92):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the PIC. If the PIC connects to fiber-optic cable, have ready a rubber safety cap for each transceiver and cable.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. If the PIC has multiple cable connector ports, label the cable connected to each port, to make it easier to reconnect the cables correctly.

4. Use one of the following methods to take the PIC offline:
 - Press and hold the PIC offline button until its failure indicator LED lights, which usually takes about 5 seconds. The failure LED is usually red; for more information, see the *M160 Internet Router PIC Guide*. For the PICs that install on an FPC1, the offline button for each PIC is next to it on the FPC card carrier. For the PICs that install on an FPC2, the offline button is on the PIC faceplate. See Figure 6.
 - Issue the following CLI command:


```
user@host>request chassis pic fpc-slot fpc-slot pic-slot pic-slot
offline
```

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.
5. Disconnect the cables from the PIC. If the PIC uses fiber-optic cable, immediately cover each transceiver and the end of each cable with a rubber safety cap.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

6. Arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.



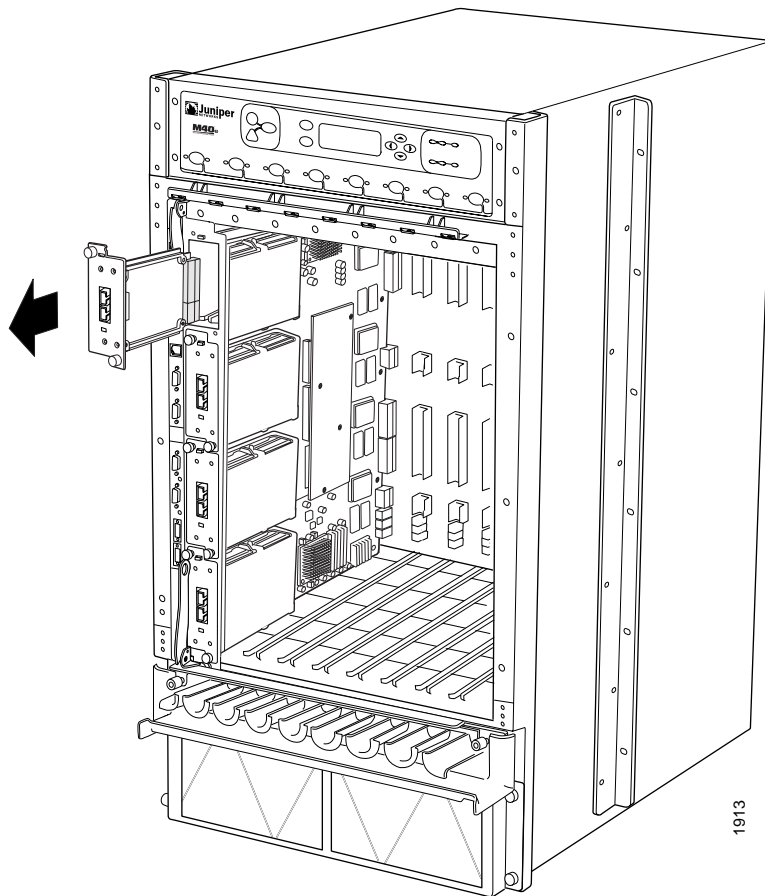
CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

7. Unscrew the thumbscrews at the top and bottom of the PIC faceplate simultaneously and at about the same rate (unscrewing the two screws

alternately or at very different rates can cause the PIC to become lodged in the FPC slot, making it difficult to turn the screws).

8. Slide the PIC out of the FPC card carrier and place it in the electrostatic bag or on the antistatic mat.
9. If you are not reinstalling a PIC into the emptied PIC slot within a short time, install a blank PIC panel over the slot to maintain proper airflow in the FPC card cage.

Figure 92: Removing a PIC



Installing a PIC

To install a PIC, follow this procedure (see Figure 93 and Figure 94):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. If the PIC uses fiber-optic cable, verify that there is a rubber safety cap over each transceiver on the faceplate. Install a cap if necessary.
3. Align the notches in the connector at the rear of the PIC with the notches in the PIC slot in the FPC and then slide the PIC in until it lodges firmly in the FPC.



CAUTION: Slide the PIC straight into the slot to avoid damaging the components on the bottom of the PIC.

4. Tighten the thumbscrews at the top and bottom of the PIC faceplate simultaneously and at about the same rate (tightening the two screws alternately or at very different rates can cause the PIC to become lodged in the FPC slot, making it difficult to turn the screws). Verify that the PIC is seated properly.
5. If the PIC uses fiber-optic cable, remove the rubber safety cap from each transceiver and the end of each cable.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

6. Insert the appropriate cables into the cable connectors on the PIC.
7. Arrange each cable in the cable management system to prevent the cable from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.



CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

8. Use one of the following methods to bring the PIC online:

- Press and hold the PIC offline button until the status LED on the PIC faceplate indicates normal functioning, which usually takes about 5 seconds. The LED is usually green; for more information, see the *M160 Internet Router PIC Guide*. For the PICs that install on an FPC1, the offline button for each PIC is next to it on the FPC card carrier. For the PICs that install on an FPC2, the offline button is on the PIC faceplate. See Figure 6.
- Issue the following CLI command:

```
user@host>request chassis pic fpc-slot fpc-slot pic-slot  
online
```

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

The normal functioning indicator LED confirms that the PIC is online. You can also verify correct PIC functioning by issuing the `show chassis fpc pic-status` command described in “Maintaining PICs and PIC Cables” on page 134.

Figure 93: Installing a PIC

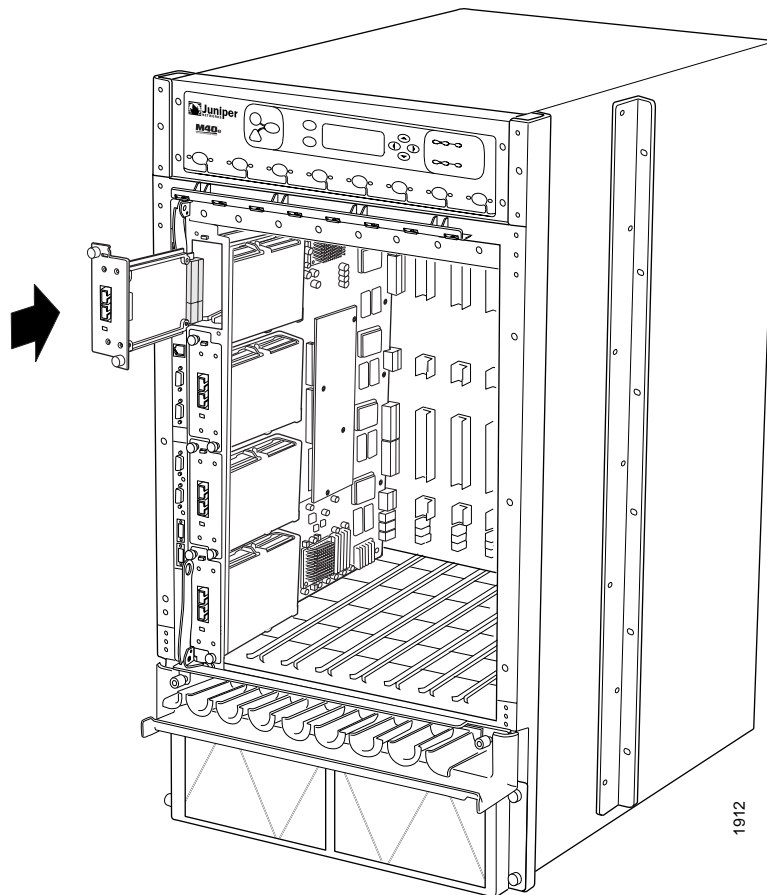
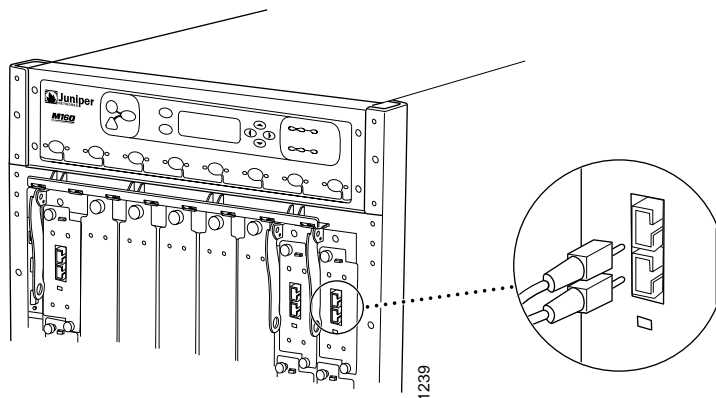


Figure 94: Connecting Fiber-Optic Cable to a PIC



Replace PIC Cables

Removing and installing PIC cables does not affect router function, except that a PIC does not receive or transmit data while its cable is disconnected. To replace a PIC cable, perform the following procedures:

- Removing a PIC Cable on page 185
- Installing a PIC Cable on page 186

Removing a PIC Cable

To remove a PIC cable, follow this procedure:

1. If the PIC connects to fiber-optic cable, have ready a rubber safety cap for each cable and transceiver.
2. If removing all cables connected to the PIC, use one of the following methods to take the PIC offline:
 - Press and hold the PIC offline button until its failure indicator LED lights, which usually takes about 5 seconds. The failure LED is usually red; for more information, see the *M160 Internet Router PIC Guide*. For the PICs that install on an FPC1, the offline button for each PIC is next to it on the FPC card carrier. For the PICs that install on an FPC2, the offline button is on the PIC faceplate. See Figure 6.
 - Issue the following CLI command:

```
user@host>request chassis pic fpc-slot fpc-slot pic-slot pic-slot
offline
```

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

3. Unplug the cable from the cable connector port. If the PIC uses fiber-optic cable, immediately cover each transceiver and the end of each cable with a rubber safety cap.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

4. Remove the cable from the cable management system and detach it from the destination port.

Installing a PIC Cable

To install a PIC cable, follow this procedure (see Figure 95):

1. Have ready a length of the type of cable used by the PIC. For cable specifications, see the *M160 Internet Router PIC Guide*.
2. If the PIC cable connector port is covered by a rubber safety plug, remove the plug.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

3. Insert the cable connector into the cable connector port on the PIC faceplate.
4. Arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.



CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.

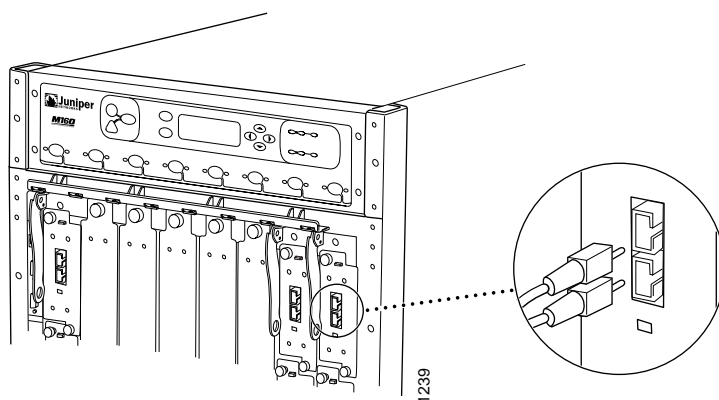
5. Insert the other end of the cable into the destination port.
6. Repeat the previous steps for any additional cables.
7. If the PIC is offline (its failure indicator LED is lit), use one of the following methods to bring the PIC online:
 - Press and hold the PIC offline button until the status LED on the PIC faceplate indicates normal functioning, which usually takes about 5 seconds. The LED is usually green; for more information, see the *M160 Internet Router PIC Guide*. For the PICs that install on an FPC1, the offline button for each PIC is next to it on the FPC card carrier. For the PICs that install on an FPC2, the offline button is on the PIC faceplate. See Figure 6.
 - Issue the following CLI command:

```
user@host>request chassis pic fpc-slot fpc-slot pic-slot pic-slot
online
```

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

The normal functioning indicator LED confirms that the PIC is online. You can also verify correct PIC functioning by issuing the `show chassis fpc pic-status` command described in “Maintaining PICs and PIC Cables” on page 134.

Figure 95: Connecting Fiber-Optic Cable to a PIC



Replacing an SFM

Up to four SFMs can be installed in the router, processing a total of 160 Mpps. The SFMs are hot-pluggable, as described in Field-Replaceable Units (FRUs) on page 4. Removing or inserting an SFM causes a brief interruption in forwarding performance (about 500 ms) as the Packet Forwarding Engine reconfigures the distribution of packets across the remaining SFMs.

To replace an SFM, perform the following procedures:

- Removing an SFM on page 188
- Installing an SFM on page 189

Removing an SFM

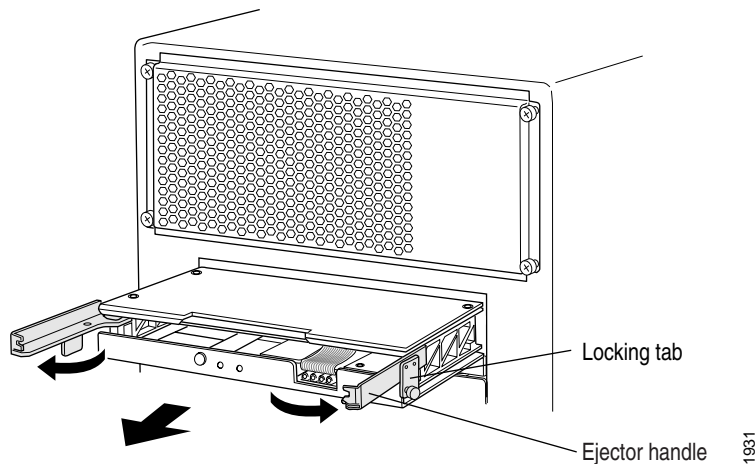
To remove an SFM, follow this procedure (see Figure 96):

1. Remove the rear component cover by loosening the thumbscrew at each corner of the cover and pulling it straight off the chassis. For complete instructions, see “Removing the Rear Component Cover” on page 86.
2. Place an electrostatic bag or antistatic mat on a flat, stable surface.
3. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
4. Press and hold the offline button on the SFM faceplate until the amber LED labeled **FAIL** lights, in about 5 seconds.
5. Loosen the thumbscrew on each ejector locking tab (shown in Figure 8), using a Phillips screwdriver if necessary.
6. Pull the end of each ejector handle outward until it is nearly perpendicular to the SFM faceplate.
7. Grasp the ejector handles and pull firmly to slide the SFM about halfway out of the chassis.
8. Place one hand under the SFM to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.



CAUTION: When an SFM is out of the chassis, do not hold it by the ejector handles. They cannot support its weight.

Do not stack SFMs on top of or under other components. Place each one individually in an electrostatic bag or on its own antistatic mat on a flat, stable surface.

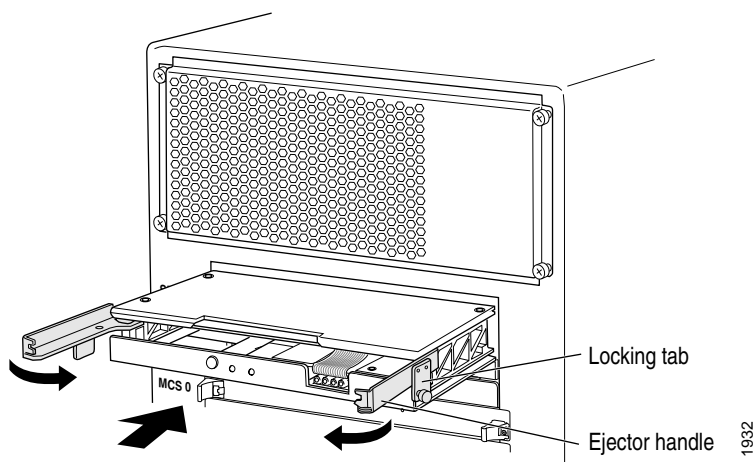
Figure 96: Removing an SFM

Installing an SFM

To install an SFM, follow this procedure (see Figure 97):

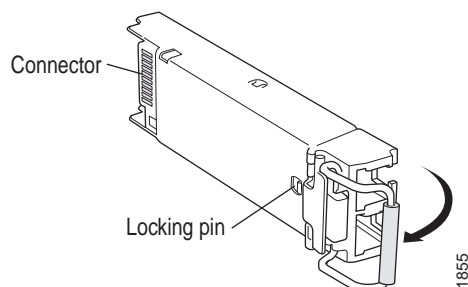
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Verify that the ends of the ejector handles are pulled outward to a position nearly perpendicular to the faceplate of the SFM.
3. Place one hand under the SFM to support it and grasp one of the ejector handles at the front with the other hand.
4. Align the rear of the SFM with the guides inside the chassis and slide it in completely.
5. Press the ejector handle at each end of the SFM inward.
6. Tighten the thumbscrew on each ejector locking tab (shown in Figure 8) to seat the SFM firmly in the chassis.
7. Press the offline button on the SFM faceplate and hold it down until the green LED labeled OK lights steadily, in about 5 seconds.

You can also verify correct SFM functioning by issuing the `show chassis sfm` commands described in “Maintaining SFMs” on page 136.

Figure 97: Installing an SFM

Replace an SFP

Small form factor pluggables (SFPs) are optical transceivers that can be removed from a PIC (for more information, see “Physical Interface Cards (PICs)” on page 13).

Figure 98: Small Form Factor Pluggable (SFP)

SFPs are hot-insertable and hot-removable. Removing an SFP does not interrupt PIC functioning, but the removed SFP no longer receives or transmits data. To replace an SFP, perform the following procedures:

- Removing an SFP on page 190
- Installing an SFP on page 191

Removing an SFP

To remove an SFP, follow this procedure (see Figure 98):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the SFP. Have ready a rubber safety cap for the SFP transceiver and the cable.

2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. Label the cable connected to the SFP so that you can later reconnect it to the correct SFP.
4. Disconnect the cable from the SFP. Immediately cover the transceiver and the end of the cable with a rubber safety cap.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

5. Arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
-



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

6. Pull the ejector handle away from the SFP faceplate to unseat the SFP from the PIC. Pull the SFP out of the PIC and place it on the antistatic mat or in the electrostatic bag.

Installing an SFP

To install a replacement SFP, follow this procedure (see Figure 98):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router

is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.

2. Verify that a rubber safety cap covers the SFP transceiver, installing one if necessary.
3. Orient the SFP over the port in the PIC such that the connector end will enter the slot first and the SFP connector faces the appropriate direction:
 - If the PIC has ten SFP ports, the ports are arranged in two columns. The SFP connector faces to the right for ports in the left column, and to the left for ports in the right column.
 - If the PIC has one or two SFP ports, the SFP connector faces to the left on platforms in which FPCs install vertically in the chassis, and faces upward on platforms in which FPCs install horizontally in the chassis.
4. Slide the SFP into the slot. If there is resistance, remove the SFP and try flipping it so that the connector faces the other direction.
5. Remove the rubber safety cap from the transceiver and the end of the cable, and insert the cable into the transceiver.



WARNING: Do not look directly into the ends of fiber-optic cables or into the transceivers on the interface faceplate. Single-mode fiber-optic cable and the interfaces that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.



CAUTION: Do not leave a fiber-optic transceiver uncovered except when inserting or removing cable. The safety cap keeps the port clean and prevents accidental exposure to laser light.

6. Arrange the cable in the cable management system to prevent the cable from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
-



CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.



CAUTION: Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

7. Verify that the status LEDs on the PIC faceplate indicate that the SFP is functioning correctly (there is an LED for each SFP port). For more information about the PIC LEDs, see the *M160 Internet Router PIC Guide*. You can also verify PIC functioning by issuing the `show chassis fpc pic-status` command described in “Maintaining PICs and PIC Cables” on page 134.

Replacing Power System Components

For instructions on replacing power system components, see the following sections:

- Replacing the Circuit Breaker Box on page 193
- Replacing a Power Supply on page 197
- Disconnecting and Connecting Power on page 200
- Replacing a Fuse on page 204

Replacing the Circuit Breaker Box

The circuit breaker box is field-replaceable, but you must power off the router before removing or replacing it.

To replace the circuit breaker box, perform the following procedures:

- Removing the Circuit Breaker Box on page 193
- Installing the Circuit Breaker Box on page 195

Removing the Circuit Breaker Box

The circuit breaker box is located on the rear of the chassis above the right power supply, as shown in Figure 2. It weighs about 6 lb (2.7 kg).



CAUTION: Do not remove the grounding lug from the grounding points on the chassis during this procedure.

To remove the circuit breaker box, follow this procedure (see Figure 99):

1. On the console or other management device connected to the master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

```
user@host> request system halt
```



NOTE: Wait until a message appears on the console confirming that the operating system has halted.

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

2. For each power supply, press the power switch on the circuit breaker box to the OFF (O) position.



NOTE: If you are power cycling the power supply rather than shutting it off for a time, wait at least 60 seconds after turning it off before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

3. Shut off the power flowing from both external power sources, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
4. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
5. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the circuit breaker box. Remove the cover.
6. Using a 7/16-in. nut driver or wrench, loosen the outer nut securing the cable lug to each terminal stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.

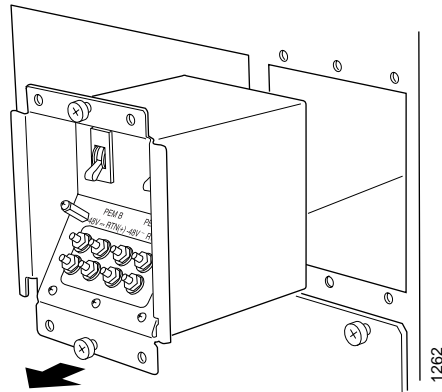


CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

7. Slide the cable lug off of each terminal stud. Leave the inner washer and nut on each stud.

8. Remove the rear lower impeller assembly by loosening the thumbscrew at each corner and pulling the impeller assembly straight out of the chassis. For complete instructions, see “Removing the Rear Lower Impeller Assembly” on page 155.
9. Using a Phillips screwdriver, loosen and remove the screw at each corner of the circuit breaker box. Loosen the thumbscrews at the top and bottom edge of the box.
10. Pull the circuit breaker box straight out of the chassis.

Figure 99: Removing the Circuit Breaker Box



Installing the Circuit Breaker Box

To install the circuit breaker box, follow this procedure (see Figure 100):

1. Verify that there is no power flowing from either external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. For each power supply, verify that the power switch on the circuit breaker box is in the OFF (O) position.
3. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
4. Align the guide pin on the back of the circuit breaker box with the opening in the chassis, then push the circuit breaker box straight in.
5. Tighten the thumbscrews at the top and bottom edge of the circuit breaker box. Using a Phillips screwdriver, tighten the screw at each corner of the box.
6. Slide the power cable lugs for both power sources onto the terminal studs on the circuit breaker box:

- Connect the positive (+) source cable lugs to the return terminals on the circuit breaker box, which are labeled RTN(+).
 - Connect the negative (–) source cable lugs to the input terminals on the circuit breaker box, which are labeled –48V.
7. Slide a washer and then screw a nut onto each terminal stud (if the washers and nuts were not installed on the studs, they should be in the accessory box). Using a 7/16-in. nut driver or wrench, tighten the nuts.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

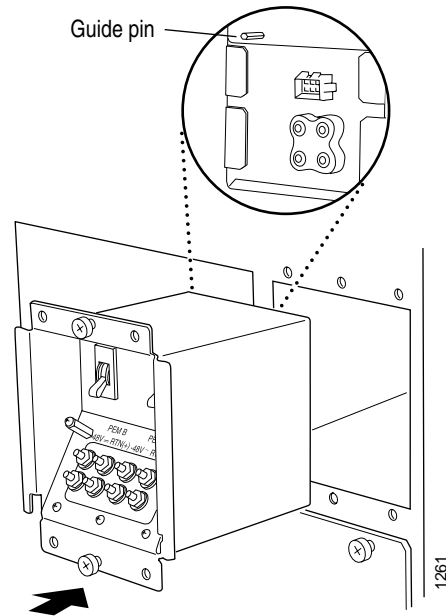
8. Replace the protective shield on the circuit breaker box and tighten the screws that secure it to the box.
9. Replace the rear lower impeller assembly by lining up the rails with the guides inside the chassis, pushing the impeller straight in, and tightening the thumbscrew at each corner of the impeller cover. For complete instructions, see “Installing the Rear Lower Impeller Assembly” on page 155.
10. Apply voltage from the DC power sources to the power cables so the router receives power.
11. Press the switches on the circuit breaker box to the ON (|) position.
12. Confirm that the LEDs on the power supply faceplates indicate correct operation: the green CB ON LED lights steadily, the blue OUTPUT OK LED blinks briefly, then lights steadily, and the amber CB OFF LED does not light.



NOTE: After powering off a power supply, wait at least 60 seconds before turning it back on. After powering on a power supply, wait at least 60 seconds before turning it off.

If the router is completely powered down when you power on the power supply, the Routing Engine boots as the power supply completes its startup sequence. If the Routing Engine finishes booting and you need to power down the router again, first issue the CLI `request system halt` command. For more information, see “Disconnecting Power from the Router” on page 200.

After a power supply is powered on, it can take up to 60 seconds for status indicators—such as LEDs on the power supply, `show chassis` commands, and messages on the craft interface LCD—to indicate that the power supply is functioning normally. Ignore error indicators that appear during the first 60 seconds.

Figure 100: Installing the Circuit Breaker Box

Replacing a Power Supply

The router has two load-sharing, redundant power supplies. Each power supply is hot-removable and hot-insertable, as described in Field-Replaceable Units (FRUs) on page 4. When one power supply fails or is powered down, the other power supply automatically assumes the entire electrical load for the router.

To replace a power supply, perform the following procedures:

- Removing a Power Supply on page 197
- Installing a Power Supply on page 199

Removing a Power Supply

The power supplies are located at the bottom rear of the chassis, as shown in Figure 2. Each power supply weighs approximately 13 lb (5.9 kg).



CAUTION: Do not leave a power supply slot empty for more than a short time while the router is operational. The power supply must remain in the chassis for proper airflow.

To remove a power supply, follow this procedure (see Figure 101):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Press the power switch for the power supply (located on the circuit breaker box) to the OFF (O) position.



NOTE: If you are power cycling the power supply rather than shutting it off for a time, wait at least 60 seconds after turning it off before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

3. Shut off the power flowing to the power supply from the external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
4. Loosen the thumbscrew at each corner of the power supply faceplate, using a Phillips screwdriver if necessary.
5. Grasp the handle or handles on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
6. Place one hand under the power supply to support it, then slide it completely out of the chassis.



WARNING: Do not touch the power connectors on the rear of the power supply (see Figure 102). They can contain dangerous voltages.

Figure 101: Removing a Power Supply

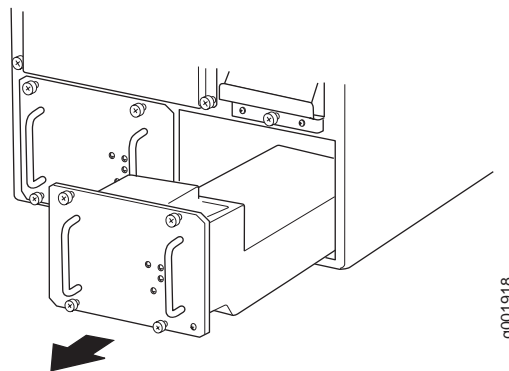
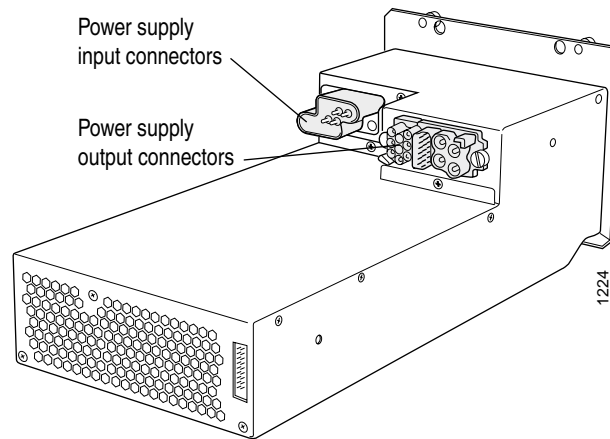


Figure 102: Rear of Power Supply Showing Midplane Connectors

Installing a Power Supply

To install a power supply, follow this procedure (see Figure 103):

1. Verify that there is no power flowing to the power supply from the external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. Verify that the power switch for the power supply (located on the circuit breaker box) is in the OFF (O) position.
3. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
4. Place one hand under the power supply and grasp a handle on the faceplate with the other hand. Slide the power supply into the chassis until it contacts the midplane.
5. Starting with the bottom screws, tighten (but do not overtighten) the thumbscrew at each corner of the power supply faceplate.
6. Press the switch on the corresponding circuit breaker to the ON (|) position. Verify that on the power supply faceplate the green LED labeled CB ON lights steadily, the blue LED labeled OUTPUT OK blinks momentarily, then lights steadily, and the amber LED labeled CB OFF does not light.

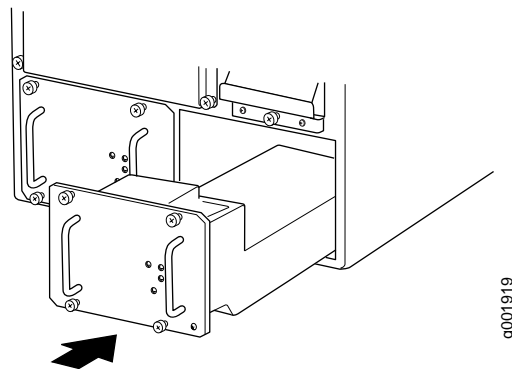


NOTE: After powering off a power supply, wait at least 60 seconds before turning it back on. After powering on a power supply, wait at least 60 seconds before turning it off.

If the router is completely powered down when you power on the power supply, the Routing Engine boots as the power supply completes its startup sequence. If the Routing Engine finishes booting and you need to power down the router again, first issue the CLI `request system halt` command. For more information, see “Disconnecting Power from the Router” on page 200.

After a power supply is powered on, it can take up to 60 seconds for status indicators—such as LEDs on the power supply, `show chassis` commands, and messages on the craft interface LCD—to indicate that the power supply is functioning normally. Ignore error indicators that appear during the first 60 seconds.

Figure 103: Installing a Power Supply



Disconnecting and Connecting Power

The power cables from the external power sources connect to terminal studs on the circuit breaker box located at the lower right rear of the chassis. To disconnect or connect power to the router, perform the following procedures. Also follow these procedures when replacing the power cables, grounding cable, or both:

- Disconnecting Power from the Router on page 200
- Connecting Power to the Router on page 202

Disconnecting Power from the Router

To disconnect power from the router, follow this procedure (see Figure 104):

1. On the console or other management device connected to the master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

```
user@host> request system halt
```




NOTE: Wait until a message appears on the console confirming that the operating system has halted.

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

2. For each power supply, press the power switch on the circuit breaker box to the OFF (O) position.
-



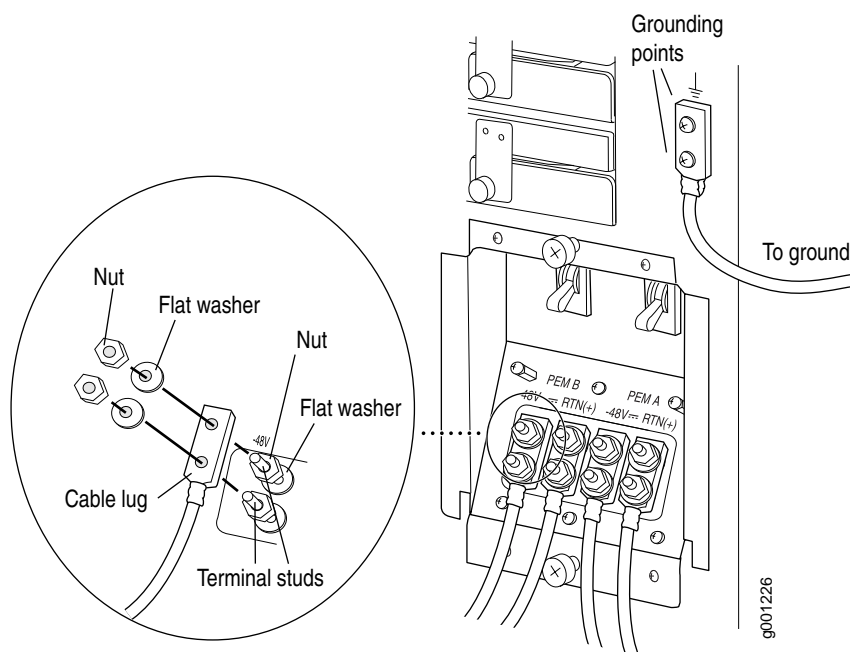
NOTE: If you are power cycling the power supply rather than shutting it off for a time, wait at least 60 seconds after turning it off before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

3. Shut off the power flowing from both external power sources, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
 4. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the circuit breaker box. Remove the cover.
 5. Using a 7/16-in. nut driver or wrench, loosen the outer nut securing the cable lug to each terminal stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.
-



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

6. Slide the cable lug off of each terminal stud. Leave the inner washer and nut on each stud.
7. If you are decommissioning the router, loosen and remove the screws that secure the grounding lug to the chassis and remove the grounding lug.
8. If not immediately attaching replacement cables, replace the protective shield on the circuit breaker box and tighten the screws that secure it to the box.
9. Verify that the removed cables are not touching or blocking access to any router components.

Figure 104: Disconnecting Power Cables

Connecting Power to the Router

Connect power to the router by attaching a grounding cable to the chassis grounding points and attaching power cables from external power sources to the terminal studs on the circuit breaker box. Power and grounding cables are not supplied with the router. For cable specifications, see “Power, Connection, and Cable Specifications” on page 67.



NOTE: The router must be connected to at least two separate external power sources.



CAUTION: There is no standard color coding for DC power cables. The color coding used by the external DC power source at your site determines the color coding for the leads on the power cables that attach to the terminal studs on the circuit breaker box. You must ensure that power connections maintain the proper polarity. The power source cables might be labeled (+) and (–) to indicate their polarity.

To connect power to the router, follow this procedure (see Figure 105):

1. Verify that there is no power flowing from either external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. For each power supply, verify that the power switch on the circuit breaker box is in the OFF (O) position.
3. Connect the grounding cable to a proper earth ground.
4. Verify that a licensed electrician has attached the cable lug provided with the router to the grounding cable.
5. Place the grounding cable lug over the grounding points on the bottom rear of the chassis. The grounding points are sized for 1/4-20 UNC screws.
6. Secure the grounding cable lug to the grounding points, first with the washers, then with the screws.



CAUTION: Do not substitute metric screws such as M6 for the 1/4-20 UNC screws that screw into the grounding points; screws other than 1/4-20 UNC screws can strip the threading in the grounding points.

7. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the circuit breaker box. Remove the cover.
8. Install one flat washer and one nut (in that order) on each power terminal stud:
 - If no washers and nuts are already installed, they should be in the accessory box.
 - If two pairs of nuts and washers are installed on the studs, use a 7/16-in. nut driver or wrench to loosen the outer nut on each stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

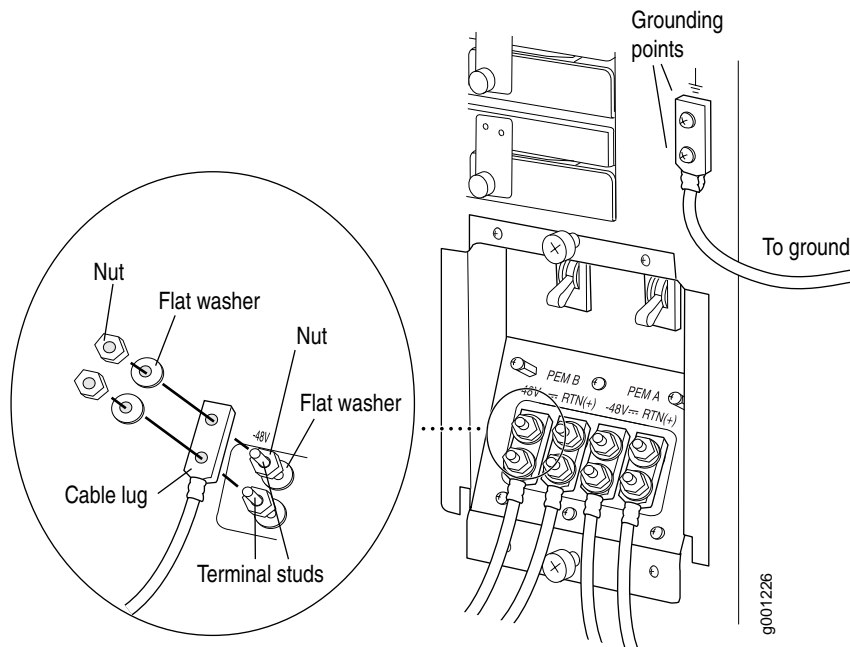


CAUTION: The inner washer and nut prevent direct contact between the power cable lug and the circuit breaker box, which can cause a short circuit.

9. Slide the power cable lugs onto the terminal studs:

- Connect the positive (+) source cable lugs to the return terminals, which are labeled RTN(+).
 - Connect the negative (-) source cable lugs to the input terminals, which are labeled -48V.
10. Install another washer and nut (in that order) on each terminal stud to secure the power cable lug. Using a 7/16-in. nut driver or wrench, tighten the nuts.
 11. Verify that the source power cabling and the grounding cabling are correct, that they are not touching or blocking access to router components, and that they do not drape where people could trip on them.
 12. Replace the protective shield over the terminal studs and use a Phillips screwdriver to tighten the screws.
 13. Turn on the current from the power source so that voltage flows to the router.

Figure 105: Connecting Power and Grounding Cables



Replacing a Fuse

To replace a fuse, follow this procedure (see Figure 106):



WARNING: You must power off the router before removing or installing a fuse.

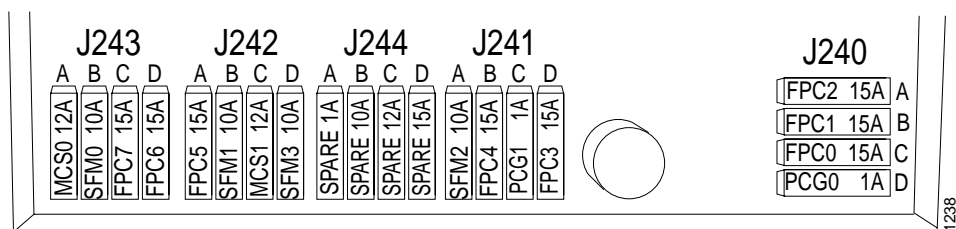
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
2. Remove the rear lower impeller assembly by loosening the thumbscrew at each corner of the impeller cover and sliding the impeller assembly out of the chassis. For complete instructions, see “Removing the Rear Lower Impeller Assembly” on page 155.
3. Determine which fuse has blown. The amber LED under the fuse lights and the indicator bulb becomes visible through the clear cover on the fuse.
4. Power off the router as described in or “Disconnecting Power from the Router” on page 200.
5. Grasp the blown fuse by the edges and rock it in its slot until it comes loose and disconnects. Rock up and down for a vertically oriented fuse (in the groups labeled J241 through J243 in Figure 106) and side to side for a horizontally oriented fuse (in the group labeled J240). If the cover slips off the fuse, snap the cover back into place and begin again.



NOTE: We recommend you use an insulated fuse removal tool to remove fuses.

6. Remove the appropriate spare fuse from the group of fuses labeled J244 in Figure 106. (The labels shown in the figure do not appear on the actual fuses—the clear cover on every fuse reads **BUSS GMT-X**—but a table on the midplane below the fuse box displays the same information.) Verify that the spare has the same rating and color coding as the fuse it is replacing, as specified in Table 25. To see the indicator bulb and printed rating, look at the fuse from the side.
7. For a vertically oriented fuse, orient the replacement fuse over the slot so that the text on the fuse cover (**BUSS GMT-X**) reads from bottom to top. For a horizontally oriented fuse, orient the replacement fuse over the slot so that the text on the fuse cover is upside down.
8. Press the new fuse into the slot.
9. Power on the router as described in “Powering On the Router” on page 119.
10. Verify that the amber LED under the replacement fuse is no longer lit.

11. Reinstall the rear lower impeller by sliding it back into the chassis and tightening the thumbscrew at each corner of the impeller cover. For complete instructions, see “Installing the Rear Lower Impeller Assembly” on page 155.
12. Order new fuses from an electrical supply house to replace the spares in the J244 group. The Cooper Bussman product number for each fuse is GMT-X, where X is the amperage rating. For example, product number GMT-15 is a 15-A fuse, required for an FPC.

Figure 106: Fuse Locations in the Fuse Box**Table 25: Fuse Specifications**

Indicator Bulb Color	Component	Fuse Rating	Quantity	Locations
Red and blue	FPC	15 A	9	J240 A, B, and C J241 B and D J242 A J243 C and D J244 D (spare)
Yellow and green	MCS	12 A	3	J242 C J243 A J244 C (spare)
Red and white	SFM	10 A	5	J241 A J242 B and D J243 B J244 B (spare)
Gray	PCG	1 A	3	J240 D J241 C J244 A (spare)

Chapter 12

Troubleshooting Hardware Components

This chapter describes how to troubleshoot problems with hardware components installed in the router. If you encounter software problems, or problems with hardware components not discussed here, contact the Juniper Networks Technical Assistance Center (JTAC) as described in “Requesting Support” on page xxiii.

- Overview of Troubleshooting Resources on page 207
- Troubleshooting the Cooling System on page 212
- Troubleshooting Packet Forwarding Engine Components on page 213
- Troubleshooting the Power System on page 215

Overview of Troubleshooting Resources

This section provides an overview of the resources you can use while troubleshooting problems with the router:

- Command-Line Interface on page 207
- LEDs on page 208
- Chassis and Interface Alarm Messages on page 209
- Blown Fuse Indicators on page 211
- Juniper Networks Technical Assistance Center on page 212

Command-Line Interface

The JUNOS Internet software command-line interface (CLI) is the primary tool for controlling and troubleshooting router hardware, the JUNOS Internet software, routing protocols, and network connectivity. CLI commands display information from routing tables, information specific to routing protocols, and information about network connectivity derived from the `ping` and `traceroute` utilities.

You enter CLI commands on one or more external management devices connected to the Routing Engine through ports on the Connector Interface Panel (CIP). The port labeled `AUXILIARY` attaches the Routing Engine to a laptop, modem, or other auxiliary device, the port labeled `CONSOLE` attaches to a system

console, and the port labeled **ETHERNET** attaches to a management LAN. For more information, see “Routing Engine Management Ports” on page 33.

For information about using the CLI to display details about alarms generated by interfaces and hardware components, see “Chassis and Interface Alarm Messages” on page 209.

For information about using the CLI to troubleshoot the JUNOS Internet software, see the appropriate JUNOS Internet software configuration guide.

LEDs

The LEDs described in the following sections indicate the basic status of hardware components.

LEDs on the Craft Interface

The craft interface provides status and troubleshooting information at a glance. It is located on the front of the chassis above the FPC card cage, as shown in Figure 1. The LEDs on the craft interface include the following:

- **Alarm**—The circular red alarm LED at the upper left of the craft interface indicates a critical condition that can result in a system shutdown. The triangular yellow alarm next to it indicates a less severe condition that requires monitoring or maintenance. Both alarms can occur simultaneously. When an alarm LED is lit, the LCD describes the cause of the alarm. For more information about the alarm LEDs, see “Alarm LEDs and Alarm Cutoff/Lamp Test Button” on page 28. For more information about the causes of alarms, see “Chassis and Interface Alarm Messages” on page 209.
- **FPC**—For each of the FPC slots in the router, there are two LEDs and an offline button located on the craft interface directly above the slot. The green LED labeled **OK** and the red LED labeled **FAIL** indicate FPC status. For more information, see “FPC LEDs and Offline Button” on page 31.
- **Host module**—Two sets of LEDs at the upper right corner of the craft interface indicate the status of the two host modules. Each set includes three LEDs—a green one labeled **MASTER**, another green one labeled **ONLINE**, and a red one labeled **OFFLINE**. For more information, see “Host Module LEDs” on page 31.

LEDs on Hardware Components

LEDs on the faceplates of the following hardware components report their status:

- DC power supply—A green LED labeled **CB ON**, a blue one labeled **OUTPUT OK**, and an amber one labeled **CB OFF**. The original power supply also has an amber LED labeled **NO AIRFLOW**. For more information, see “Power Supply” on page 36.
- MCS—A blue LED labeled **MASTER**, a green one labeled **OK**, and an amber one labeled **FAIL**. For more information, see “MCS Components” on page 26.
- PCG—A blue LED labeled **MASTER**, a green one labeled **OK**, and an amber one labeled **FAIL**. For more information, see “PCG Components” on page 19.
- PIC—Most PICs have an LED labeled **STATUS** on the PIC faceplate. Some PICs have additional LEDs, often one per port. The meaning of the LED states differs for various PICs. For more information, see the *M160 Internet Router PIC Guide*.
- SFM—A green LED labeled **OK** and a red one labeled **FAIL**. For more information, see “SFM Components” on page 20.

Chassis and Interface Alarm Messages

When the Routing Engine detects an alarm condition, it lights the red or yellow alarm LED on the craft interface as appropriate, trips the corresponding alarm relay contact on the CIP, and reports the cause of the alarm in the craft interface LCD. To view a more detailed description of the alarm cause, issue the `show chassis alarms` CLI command:

```
user@host> show chassis alarms
```

There are two classes of alarm messages:

- Chassis alarms—Indicate a problem with a chassis component such as the cooling system or power supplies, as described in Table 26.
- Interface alarms—Indicate a problem with a specific network interface, as described in Table 27.

In both Table 26 and Table 27, the text in the column labeled “LCD Message” appears in the LCD. The text in the column labeled “CLI Message” appears in the output from the `show chassis alarms` command.

Table 26: Chassis Alarm Messages

Component	LCD Message	CLI Message
Fans and impellers	Fan Failure	RED ALARM - <i>fan name</i> Failure
	Fan Removed	YELLOW ALARM - <i>fan name</i> Removed
	Fans Missing	RED ALARM - Too many fans missing or failing

Component	LCD Message	CLI Message
Temperature sensors	Temperature Warm	YELLOW ALARM - Temperature Warm
	Temperature Hot	RED ALARM - Temperature Hot
	Sensor Failure	RED ALARM - Temperature sensor failure
Power supplies	PEM <i>pem-ID</i> Removed	YELLOW ALARM - PEM <i>pem-ID</i> Removed
	PEM <i>pem-ID</i> High Temp	RED ALARM - PEM <i>pem-ID</i> High Temperature
	PEM <i>pem-ID</i> Output Fail	RED ALARM - PEM <i>pem-ID</i> Output Failure
	PEM <i>pem-ID</i> Input Fail	RED ALARM - PEM <i>pem-ID</i> Input Failure
SFM s	SFM <i>sfm-number</i> Failure	RED ALARM - SFM <i>sfm-number</i> Failure(displayed only if no alternate SFM is housed in chassis)
	SFM <i>sfm-number</i> Removed	RED ALARM - SFM <i>sfm-number</i> Removed(displayed only if no alternate SFM is housed in chassis)
Host modules	Host <i>host-number</i> Failure	RED ALARM - Host <i>host-number</i> Failure
	Host <i>host-number</i> Removed	RED ALARM - Host <i>host-number</i> Removed
Craft interface	Craft Failure	YELLOW ALARM - Craft Failure

Table 27: SONET/SDH Interface Alarm Messages

LCD Message	CLI Message
<i>interface-name</i> so-x/x/x BERR-SD	<i>interface-name</i> so-x/x/x - SONET bit error rate defect
<i>interface-name</i> so-x/x/x BERR-SF	<i>interface-name</i> so-x/x/x - SONET bit error rate fault
<i>interface-name</i> so-x/x/x LAIS	<i>interface-name</i> so-x/x/x - SONET line AIS
<i>interface-name</i> so-x/x/x LOF	<i>interface-name</i> so-x/x/x - SONET loss of frame
<i>interface-name</i> so-x/x/x LOL	<i>interface-name</i> so-x/x/x - SONET loss of light
<i>interface-name</i> so-x/x/x LOP	<i>interface-name</i> so-x/x/x - SONET loss of pointer
<i>interface-name</i> so-x/x/x LOS	<i>interface-name</i> so-x/x/x - SONET loss of signal
<i>interface-name</i> so-x/x/x LRDI	<i>interface-name</i> so-x/x/x - SONET line remote defect indicator
<i>interface-name</i> so-x/x/x PAIS	<i>interface-name</i> so-x/x/x - SONET path AIS
<i>interface-name</i> so-x/x/x PLL	<i>interface-name</i> so-x/x/x - SONET PLL lock
<i>interface-name</i> so-x/x/x PMIS	<i>interface-name</i> so-x/x/x - SONET path mismatch
<i>interface-name</i> so-x/x/x PRDI	<i>interface-name</i> so-x/x/x - SONET path remote defect indicator
<i>interface-name</i> so-x/x/x REI	<i>interface-name</i> so-x/x/x - SONET remote error indicator

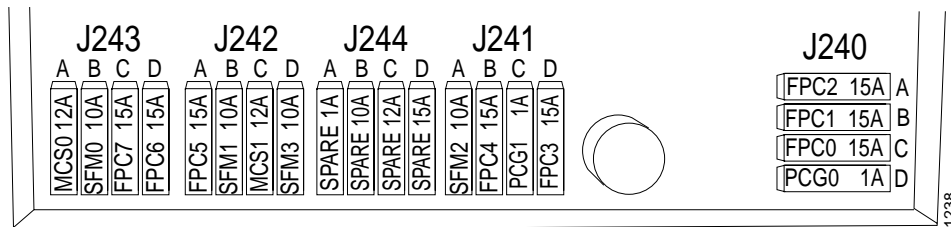
LCD Message	CLI Message
<i>interface-name</i> so-x/x/x SEF	<i>interface-name</i> so-x/x/x - SONET severely errored frame
<i>interface-name</i> so-x/x/x UNEQ	<i>interface-name</i> so-x/x/x - SONET unequipped

Blown Fuse Indicators

The router uses fuses from the Cooper Bussman brand GMT series for the FPCs, MCSs, PCGs, and SFMs. They are located in a fuse box on the rear of the midplane. When the fuse for a component blows, the component stops functioning even though it is installed correctly and the power supplies are still providing power to the router.

Figure 107 shows the location in the fuse box of the fuse for each component. The labels shown in the figure do not appear on the actual fuses (the clear cover on every fuse reads BUSS GMT-X), but a table on the surface of the midplane below the fuse box displays the same information.

Figure 107: Fuse Locations in the Fuse Box



When a fuse has blown but the power supplies are still delivering power to router, the amber LED adjacent to the fuse lights. For vertically oriented fuses (in the groups labeled J241 through J244 in Figure 107), the LED is located below the fuse; for horizontally oriented fuses (in the group labeled J240), it is to the left of the fuse.



NOTE: The LEDs are each about 0.1" (2 mm) square. They might be difficult to see when not lit.

Another indication that a fuse has blown is that the colored indicator bulb inside it becomes visible through the clear cover on the fuse. For information about the indicator bulb color for each fuse type, see Table 25.

A blown fuse can cause a component to fail even though it is correctly installed and the power supplies are functioning. Check for a blown fuse in the following circumstances:

- The LED that indicates normal operation for the component fails to light.
- The appropriate CLI `show chassis environment` command indicates that the component is installed but is not receiving power.

For instructions for replacing a blown fuse, see “Replacing a Fuse” on page 204.

Juniper Networks Technical Assistance Center

If you need assistance during troubleshooting, you can contact the Juniper Networks Technical Assistance Center (JTAC) by e-mail or telephone. See “Requesting Support” on page xxiii.

Troubleshooting the Cooling System

The router’s cooling system comprises separate front and rear subsystems:

- The front subsystem includes the fan tray located behind the cable management system and the impeller located behind the craft interface. They cool the FPCs, PICs, and midplane. See Figure 1.
- The rear subsystem include upper and lower impellers in the rear of the chassis. They cool the SFMs, host module, PCGs, and power supplies. See Figure 2.

The cooling system draws in room air through the air intake vent located at the front of the chassis below the cable management system. After entering the chassis, the air stream separates into separate flows for the front and rear subsystems, and the MCS monitors the temperature of each flow independently. For a graphic depiction of the airflow, see Figure 20.

For the cooling system to function properly, the clearance around the chassis must be sufficient for unobstructed airflow. See Clearance Requirements for Airflow and Hardware Maintenance on page 62.

During normal operation, the impellers and fans in the fan tray function at less than full speed. The MCS constantly monitors the temperatures detected by sensors on the midplane and router components, adjusting the speed of the fans and impellers as necessary. If the router temperature exceeds the acceptable maximum, the MCS

turns off the power supplies. The following conditions automatically cause the fans and impellers to run at full speed and also trigger the indicated alarm:

- A fan or impeller fails (red alarm).
- One of the impellers is removed (yellow alarm).
- The router temperature exceeds the “temperature warm” threshold (yellow alarm).
- The temperature of the router exceeds the maximum (“temperature hot”) threshold (red alarm and automatic shutdown of the power supplies).

For more information about impeller-related alarms, see “Chassis and Interface Alarm Messages” on page 209.

To troubleshoot the fans and impellers, follow these guidelines:

- If the red alarm LED on the craft interface lights, check the LCD on the craft interface for the source of the problem. The display reports the number of alarm conditions and the source of each alarm, as described in “LCD Alarm Mode” on page 30. For a list of messages, see “Chassis and Interface Alarm Messages” on page 209.
- Issue the following CLI command for more information about the source of an alarm condition:


```
user@host> show chassis alarms
```
- If the blue OUTPUT OK LED on an enhanced power supply (or the amber NO AIRFLOW LED on an original power supply) is blinking, the airflow passing by the power supply might be insufficient. Place your hand near the exhaust vents at the rear of the chassis to determine whether the impellers are expelling air.
- If both power supplies have failed, the system temperature might have exceeded the threshold, causing the system to shut down. See “All LEDs on Both Supplies Are Off” on page 215.
- If the LCD on the craft interface reports failure of only one impeller and the other impellers are functioning normally, the impeller is probably faulty and needs to be replaced. For replacement instructions, see “Replacing Hardware Components” on page 139. For instructions about returning a faulty component to Juniper Networks, see “Contacting Customer Support and Returning Hardware” on page 255.

Troubleshooting Packet Forwarding Engine Components

The following sections describe how to troubleshoot FPCs and PICs:

- Troubleshooting FPCs on page 214
- Troubleshooting PICs on page 215

Troubleshooting FPCs

As soon as an FPC is seated in an operating router, the Routing Engine downloads the FPC software to it. The FPC then runs diagnostics and enables the PICs housed on it. During this time, the green LED labeled OK above the FPC on the craft interface blinks. When the FPC is online and functioning normally, the OK LED lights steadily.

To troubleshoot the FPCs, follow these guidelines:

- If the red LED labeled FAIL above the FPC on the craft interface lights steadily, check the LCD on the craft interface for a message about the status of the FPC and the PICs housed in it.
- Make sure the FPC is properly seated in the midplane—use a Phillips screwdriver to check that the screws at the top and bottom of the card carrier are tight.
- To check the status of an FPC, issue the following CLI command:

```
user@host> show chassis fpc
```

Slot	State	Temp (C)	CPU Utilization (%) Total Interrupt	Memory DRAM (MB)	Utilization (%) Heap Buffer
0	Online	37	4 0	32	1 39
1	Online	39	4 0	32	1 39
2	Empty				
3	Online	34	1 0	32	1 40
4	Empty				
5	Online	35	4 0	32	2 40
6	Online	36	4 0	32	1 39
7	Empty				

For more detailed output, add the `detail` option. The following example also specifies a slot number (0), which is optional:

```
user@host> show chassis fpc detail 0
```

```
Slot 0 information:
State                               Online
Temperature                         37 degrees C / 98 degrees F
Total CPU DRAM                      32 MB
Total SRAM                          4 MB
Total SDRAM                         256 MB
I/O Manager ASIC information        Version 2.0, Foundry IBM, Part number 0
I/O Manager ASIC information        Version 2.0, Foundry IBM, Part number 0
I/O Manager ASIC information        Version 2.0, Foundry IBM, Part number 0
I/O Manager ASIC information        Version 2.0, Foundry IBM, Part number 0
Start time:                         2003-04-29 16:11:55 PDT
Uptime:                             5 days, 21 hours, 32 minutes, 41 seconds
```

For further description of the output from the commands, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Troubleshooting PICs

To troubleshoot the PICs, follow these guidelines:

- To check the status of each port on a PIC, look at the LED located on the PIC faceplate. For information about the meaning of LED states on different PICs, see the *M160 Internet Router PIC Guide*.
- To check the status of a PIC, issue the following CLI command. The PIC slots in the FPC are numbered from 0 through 3, top to bottom:

```
user@host> show chassis fpc pic-status
```

```
Slot 0 Online
  PIC 0    4x OC-3 SONET, MM
  PIC 1    1x CSTM1, SMIR
  PIC 3    2x OC-3 ATM, MM
Slot 1 Online
  PIC 0    1x OC-12 SONET, MM
  PIC 1    1x OC-12 ATM, MM
  PIC 2    2x OC-3 ATM, MM
  PIC 3    2x OC-3 ATM, MM
```

For further description of the output from the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

Troubleshooting the Power System

The following LED states indicate that a power supply is functioning correctly:

- On the enhanced power supply, the green LED labeled CB ON and blue LED labeled OUTPUT OK are lit and the amber LED labeled CB OFF is not lit.
- On the enhanced power supply, the green LED labeled CB ON and blue LED labeled OUTPUT OK are lit, and the amber LEDs labeled CB OFF and NO AIRFLOW are not lit.

If any other LED states apply, consult the following sections:

- All LEDs on Both Supplies Are Off on page 215
- All LEDs on One Supply Are Off or LED States Are not Correct on page 216

All LEDs on Both Supplies Are Off

If all LEDs are off on both power supply faceplates, either someone has switched off power to the router or the system temperature has exceeded the acceptable maximum. In the latter case, the host module shuts down both power supplies. There is no power to the router, so the alarm LEDs on the craft interface are not lit and the LCD also goes blank.

Excessive system temperature is almost always caused by excessive environmental temperature. Correct the environmental temperature before powering on the router.

All LEDs on One Supply Are Off or LED States Are not Correct

If either of the following conditions applies, perform the diagnostic procedure described following the list of conditions:

- The LEDs on one power supply are all off, but the LEDs on the other supply indicate that it is functioning properly.
- The LED states on one or both supplies indicate a problem:
 - On the enhanced power supply, the green LED labeled CB ON is not lit and the amber LED labeled CB OFF is lit, or the blue LED labeled OUTPUT OK is blinking or is not lit.
 - On the original power supply, the green LED labeled CB ON is not lit and the amber LED labeled CB OFF is lit, or the amber LED labeled NO AIRFLOW is lit, or the blue LED labeled OUTPUT OK is blinking or is not lit.

Perform the following steps to diagnose and correct the problem:

1. Check the red alarm LED on the craft interface:
 - If it is lit, read the message on the craft interface LCD. The display reports the number of alarm conditions and the source of each alarm, as described in “LCD Alarm Mode” on page 30. For a list of messages, see “Chassis and Interface Alarm Messages” on page 209. Issue the following CLI command for more information about the cause of an alarm condition:

```
user@host> show chassis alarms
```



NOTE: The messages in the craft interface LCD and the output from CLI `show` commands refer to the power supply on the right as PEM 0 and the power supply on the left as PEM 1.

A common cause of power supply shutdown is that the temperature of the power supply or another router component has exceed the maximum limit.

- If the red alarm LED is not lit, check that the power switch is in the ON (|) position. The switches are on the circuit breaker box.
2. Replace the faulty power supply with a spare. For instructions, see “Replacing a Power Supply” on page 197. If the LEDs light correctly on the spare, the original power supply is faulty. Return it to Juniper Networks for replacement, as described in “Contacting Customer Support and Returning Hardware” on page 255.

3. If the spare power supply also does not work, connect the router to a different power source. You might also try replacing the power cord or cable. For instructions, see “Disconnecting and Connecting Power” on page 200 (you do not need to disconnect and reconnect the grounding cable).
4. If you cannot determine the cause of the problem or need additional assistance, see “Juniper Networks Technical Assistance Center” on page 212.

Part 4

Appendixes

- Safety and Regulatory Compliance Information on page 221
- Contacting Customer Support and Returning Hardware on page 255
- Cable Connector Pinouts on page 269

Appendix A

Safety and Regulatory Compliance Information

To install and use the router safely, follow proper safety procedures. This chapter discusses the following safety and regulatory compliance information:

- Definition of Safety Warning Levels on page 221
- Safety Guidelines and Warnings on page 222
- Agency Approvals on page 253
- Compliance Statements for EMC Requirements on page 254

Definition of Safety Warning Levels

This manual uses the following three levels of safety warnings:



NOTE: You might find this information helpful in a particular situation, or might otherwise overlook it.



CAUTION: You need to observe the specified guidelines to avoid minor injury or discomfort to you, or severe damage to the router.



WARNING: This 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.

Waarschuwing Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van standaard maatregelen om ongelukken te voorkomen.

Varoitus Tämä varoitusmerkki merkitsee vaaraa. Olet tilanteessa, joka voi johtaa ruumiinvammaan. Ennen kuin työskentelet minkään laitteiston parissa, ota selvää sähkökytkentöihin liittyvistä vaaroista ja tavanomaisista onnettomuuksien ehkäisykeinoista.

Attention Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents.

Warnung Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an irgendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt.

Avvertenza Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti.

Advarsel Dette varselsymbolet betyr fare. Du befinner deg i en situasjon som kan føre til personskade. Før du utfører arbeid på utstyr, må du være oppmerksom på de faremomentene som elektriske kretser innebærer, samt gjøre deg kjent med vanlig praksis når det gjelder å unngå ulykker.

Aviso Este símbolo de aviso indica perigo. Encontra-se numa situação que lhe poderá causar danos físicos. Antes de começar a trabalhar com qualquer equipamento, familiarize-se com os perigos relacionados com circuitos eléctricos, e com quaisquer práticas comuns que possam prevenir possíveis acidentes.

¡Atención! Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes.

Varning! Denna varningssymbol signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanligt förfarande för att förebygga skador.

Safety Guidelines and Warnings

This section lists safety guidelines and warnings for installing, operating, and maintaining the router:

- General Safety Guidelines and Warnings on page 224

- Electrical Safety Guidelines and Warnings on page 227
- Installation Safety Guidelines and Warnings on page 239
- Laser and LED Safety Guidelines and Warnings on page 244
- Maintenance and Operational Safety Guidelines and Warnings on page 247

General Safety Guidelines and Warnings

The following guidelines help ensure your safety and protect the router from damage. The list of guidelines might not address all potentially hazardous situations in your working environment, so be alert and exercise good judgment at all times.

- Perform only the procedures explicitly described in this manual. Make sure that only authorized service personnel perform other system services.
- Keep the area around the chassis clear and free from dust before, during, and after installation.
- Keep tools away from areas where people could trip over them while walking.
- Do not wear loose clothing or jewelry, such as rings, bracelets, or chains, which could become caught in the chassis.
- Wear safety glasses if you are working under any conditions that could be hazardous to your eyes.
- Do not perform any actions that create a potential hazard to people or make the equipment unsafe.
- Never attempt to lift an object that is too heavy for one person to handle.
- Never install or manipulate wiring during electrical storms.
- Never install electrical jacks in wet locations unless the jacks are specifically designed for wet environments.
- Operate the router only when it is properly grounded.
- Replace fuses only with fuses of the same type and rating.
- Do not open or remove chassis covers or sheet metal parts unless instructions are provided in this manual. Such an action could cause severe electrical shock.
- Do not push or force any objects through any opening in the chassis frame. Such an action could result in electrical shock or fire.
- Avoid spilling liquid onto the router chassis or onto any router component. Such an action could cause electrical shock or damage the router.
- Avoid touching uninsulated electrical wires or terminals that have not been disconnected from their power source. Such an action could cause electrical shock.

In addition, observe the following warnings and guidelines:

- Qualified Personnel Warning on page 225
- Restricted Access Area Warning on page 225

- Preventing Electrostatic Discharge Damage on page 226

Qualified Personnel Warning



WARNING: Only trained and qualified personnel should install or replace the router.

Waarschuwing Installatie en reparaties mogen uitsluitend door getraind en bevoegd personeel uitgevoerd worden.

Varoitus Ainoastaan koulutettu ja pätevä henkilökunta saa asentaa tai vaihtaa tämän laitteen.

Attention Tout installation ou remplacement de l'appareil doit être réalisé par du personnel qualifié et compétent.

Warnung Gerät nur von geschultem, qualifiziertem Personal installieren oder auswechseln lassen.

Avvertenza Solo personale addestrato e qualificato deve essere autorizzato ad installare o sostituire questo apparecchio.

Advarsel Kun kvalifisert personell med riktig opplæring bør montere eller bytte ut dette utstyret.

Aviso Este equipamento deverá ser instalado ou substituído apenas por pessoal devidamente treinado e qualificado.

¡Atención! Estos equipos deben ser instalados y reemplazados exclusivamente por personal técnico adecuadamente preparado y capacitado.

Varning! Denna utrustning ska endast installeras och bytas ut av utbildad och kvalificerad personal.

Restricted Access Area Warning



WARNING: The router is intended for installation in restricted access areas. A restricted access area is an area to which access can be gained only by service personnel through the use of a special tool, lock and key, or other means of security, and which is controlled by the authority responsible for the location.

Waarschuwing Dit toestel is bedoeld voor installatie op plaatsen met beperkte toegang. Een plaats met beperkte toegang is een plaats waar toegang slechts door servicepersoneel verkregen kan worden door middel van een speciaal instrument, een slot en sleutel, of een ander veiligheidsmiddel, en welke beheerd wordt door de overheidsinstantie die verantwoordelijk is voor de locatie.

Varoitus Tämä laite on tarkoitettu asennettavaksi paikkaan, johon pääsy on rajoitettua. Paikka, johon pääsy on rajoitettua, tarkoittaa paikkaa, johon vain huoltohenkilöstö pääsee jonkin erikoistyökalun, lukkoon sopivan avaimen tai jonkin muun turvalaitteen avulla ja joka on paikasta vastuussa olevien toimivaltaisten henkilöiden valvoma.

Attention Cet appareil est à installer dans des zones d'accès réservé. Ces dernières sont des zones auxquelles seul le personnel de service peut accéder en utilisant un outil spécial, un mécanisme de verrouillage et une clé, ou tout autre moyen de sécurité. L'accès aux zones de sécurité est sous le contrôle de l'autorité responsable de l'emplacement.

Warnung Diese Einheit ist zur Installation in Bereichen mit beschränktem Zutritt vorgesehen. Ein Bereich mit beschränktem Zutritt ist ein Bereich, zu dem nur Wartungspersonal mit einem Spezialwerkzeugs, Schloß und Schlüssel oder anderer Sicherheitsvorkehrungen Zugang hat, und der von dem für die Anlage zuständigen Gremium kontrolliert wird.

Avvertenza Questa unità deve essere installata in un'area ad accesso limitato. Un'area ad accesso limitato è un'area accessibile solo a personale di assistenza tramite un'attrezzo speciale, lucchetto, o altri dispositivi di sicurezza, ed è controllata dall'autorità responsabile della zona.

Advarsel Denne enheten er laget for installasjon i områder med begrenset adgang. Et område med begrenset adgang gir kun adgang til servicepersonale som bruker et spesielt verktøy, lås og nøkkel, eller en annen sikkerhetsanordning, og det kontrolleres av den autoriteten som er ansvarlig for området.

Aviso Esta unidade foi concebida para instalação em áreas de acesso restrito. Uma área de acesso restrito é uma área à qual apenas tem acesso o pessoal de serviço autorizado, que possua uma ferramenta, chave e fechadura especial, ou qualquer outra forma de segurança. Esta área é controlada pela autoridade responsável pelo local.

¡Atención! Esta unidad ha sido diseñada para instalarse en áreas de acceso restringido. Área de acceso restringido significa un área a la que solamente tiene acceso el personal de servicio mediante la utilización de una herramienta especial, cerradura con llave, o algún otro medio de seguridad, y que está bajo el control de la autoridad responsable del local.

Varning! Denna enhet är avsedd för installation i områden med begränsat tillträde. Ett område med begränsat tillträde får endast tillträdas av servicepersonal med ett speciellt verktyg, lås och nyckel, eller annan säkerhetsanordning, och kontrolleras av den auktoritet som ansvarar för området.

Preventing Electrostatic Discharge Damage

Many router hardware components are sensitive to damage from static electricity. Some components can be impaired by voltages as low as 30 V. You can easily generate potentially damaging static voltages whenever you handle plastic or foam

packing material or if you move components across plastic or carpets. Observe the following guidelines to minimize the potential for electrostatic discharge (ESD) damage, which can cause intermittent or complete component failures:

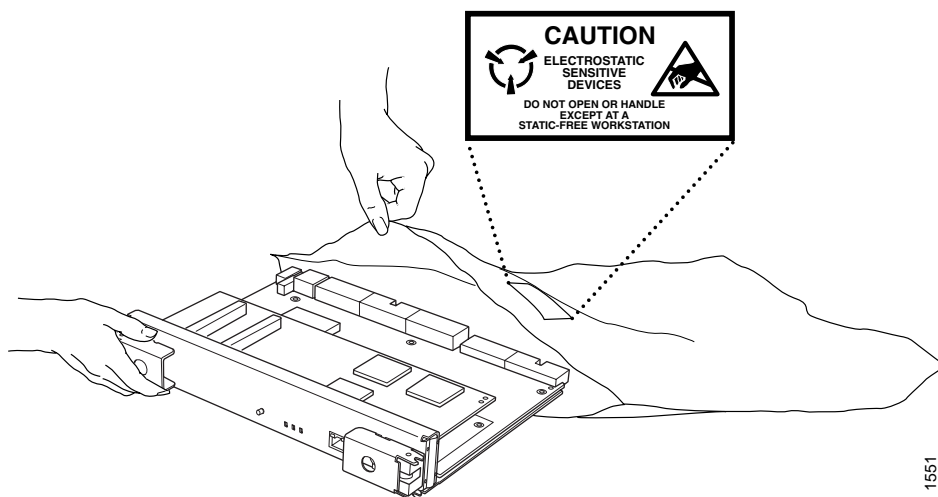
- Always use an ESD wrist strap or ankle strap, and make sure that it is in direct contact with your skin.



CAUTION: For safety, periodically check the resistance value of the ESD strap. The measurement should be in the range of 1 to 10 Mohms.

- When handling any component that is removed from the chassis, make sure the equipment end of your ESD strap is attached to one of the electrostatic discharge points on the chassis, which are shown in Figure 1 and Figure 2.
- Avoid contact between the component and your clothing. ESD voltages emitted from clothing can still damage components.
- When removing or installing a component, always place it component-side up on an antistatic surface, in an antistatic card rack, or in an electrostatic bag (see Figure 108). If you are returning a component, place it in an electrostatic bag before packing it.

Figure 108: Placing a Component into an Electrostatic Bag



Electrical Safety Guidelines and Warnings

When working on equipment powered by electricity, follow the guidelines described in the following sections:

- General Electrical Safety Guidelines on page 229

- DC Power Electrical Safety Guidelines on page 229
- Copper Conductors Warning on page 230
- DC Power Disconnection Warning on page 231
- DC Power Grounding Requirements and Warning on page 232
- DC Power Wiring Sequence Warning on page 233
- DC Power Wiring Terminations Warning on page 234
- Grounded Equipment Warning on page 235
- In Case of Electrical Accident on page 236
- Midplane Energy Hazard Warning on page 236
- Multiple Power Supplies Disconnection Warning on page 236
- Power Disconnection Warning on page 237
- TN Power Warning on page 238

General Electrical Safety Guidelines

- Install the router in compliance with the following local, national, or international electrical codes:
 - United States—National Fire Protection Association (NFPA 70), United States National Electrical Code.
 - Canada—Canadian Electrical Code, Part 1, CSA C22.1.
 - Other countries—International Electromechanical Commission (IEC) 60364, Part 1 through Part 7.
 - Evaluated to the TN power system.
- Locate the emergency power-off switch for the room in which you are working so that if an electrical accident occurs, you can quickly turn off the power.
- Do not work alone if potentially hazardous conditions exist anywhere in your workspace.
- Never assume that power is disconnected from a circuit. Always check the circuit before starting to work.
- Carefully look for possible hazards in your work area, such as moist floors, ungrounded power extension cords, and missing safety grounds.
- Operate the router within marked electrical ratings and product usage instructions.
- For the router and peripheral equipment to function safely and correctly, use the cables and connectors specified for the attached peripheral equipment, and make certain they are in good condition.

Many router components can be removed and replaced without powering down or disconnecting power to the router, as detailed in Field-Replaceable Units (FRUs) on page 4. Never install equipment if it appears damaged.

DC Power Electrical Safety Guidelines

The following electrical safety guidelines apply to DC-powered routers:

- DC-powered routers are equipped with a DC terminal block that is rated for the power requirements of a maximally configured router. To supply sufficient power, terminate the DC input wiring on a facility DC source capable of supplying at least 65 A @ 48 VDC. The 48 VDC facility DC source should be equipped with a circuit breaker rated at 90 A minimum. Incorporate an easily accessible disconnect device into the facility wiring. Be sure to connect the

ground wire or conduit to a solid office (earth) ground. A closed loop ring is recommended for terminating the ground conductor at the ground stud.

- Run two wires from the circuit breaker box to a source of 48 VDC. Use appropriate gauge wire to handle up to 90 A.
- You must connect only to a DC power source for which the output complies with the safety extra low-voltage (SELV) requirements of UL 1950, CSA C22.2 No. 950-95, EN 60950, and IEC 60950 to a DC-input terminal block.
- A DC-powered router that is equipped with a DC terminal block is intended only for installation in a restricted access location. In the United States, a restricted access area is one in accordance with Articles 110-16, 110-17, and 110-18 of the National Electrical Code ANSI/NFPA 70.



NOTE: Primary overcurrent protection is provided by the building circuit breaker. This breaker should protect against excess currents, short circuits, and earth faults in accordance with NEC ANSI/NFPA70.

- Ensure that the polarity of the DC input wiring is correct. Under certain conditions, connections with reversed polarity might trip the primary circuit breaker or damage the equipment.
- For personal safety, connect the green and yellow wire to safety (earth) ground at both the router and the supply side of the DC wiring.
- The marked input voltage of –48 VDC for DC-powered routers is the nominal voltage associated with the battery circuit, and any higher voltages are only to be associated with float voltages for the charging function.
- Because the router is a positive ground system, you must connect the positive lead to the terminal labeled RTN(+), the negative lead to the terminal labeled –48V, and the earth ground to the chassis grounding points.

Copper Conductors Warning



WARNING: Use copper conductors only.

Waarschuwing Gebruik alleen koperen geleiders.

Varoitus Käytä vain kuparijohtimia.

Attention Utilisez uniquement des conducteurs en cuivre.

Warnung Verwenden Sie ausschließlich Kupferleiter.

Avvertenza Usate unicamente dei conduttori di rame.

Advarsel Bruk bare kobberledninger.

Aviso Utilize apenas fios condutores de cobre.

¡Atención! Emplee sólo conductores de cobre.

Varning! Använd endast ledare av koppar.

DC Power Disconnection Warning



WARNING: Before performing any of the following procedures, ensure that power is removed from the DC circuit. To ensure that all power is off, locate the circuit breaker on the panel board that services the DC circuit, switch the circuit breaker to the OFF position, and tape the switch handle of the circuit breaker in the OFF position.

Waarschuwing Voordat u een van de onderstaande procedures uitvoert, dient u te controleren of de stroom naar het gelijkstroom circuit uitgeschakeld is. Om u ervan te verzekeren dat alle stroom UIT is geschakeld, kiest u op het schakelbord de stroomverbreker die het gelijkstroom circuit bedient, draait de stroomverbreker naar de UIT positie en plakt de schakelaarhendel van de stroomverbreker met plakband in de UIT positie vast.

Varoitus Varmista, että tasavirtapiirissä ei ole virtaa ennen seuraavien toimenpiteiden suorittamista. Varmistaaksesi, että virta on KATKAISTU täysin, paikanna tasavirrasta huolehtivassa kojetaulussa sijaitseva suojakytkin, käännä suojakytkin KATKAISTU-asentoon ja teippaa suojakytkimen varsi niin, että se pysyy KATKAISTU-asennossa.

Attention Avant de pratiquer l'une quelconque des procédures ci-dessous, vérifier que le circuit en courant continu n'est plus sous tension. Pour en être sûr, localiser le disjoncteur situé sur le panneau de service du circuit en courant continu, placer le disjoncteur en position fermée (OFF) et, à l'aide d'un ruban adhésif, bloquer la poignée du disjoncteur en position OFF.

Warnung Vor Ausführung der folgenden Vorgänge ist sicherzustellen, daß die Gleichstromschaltung keinen Strom erhält. Um sicherzustellen, daß sämtlicher Strom abgestellt ist, machen Sie auf der Schalttafel den Unterbrecher für die Gleichstromschaltung ausfindig, stellen Sie den Unterbrecher auf AUS, und kleben Sie den Schaltergriff des Unterbrechers mit Klebeband in der AUS-Stellung fest.

Avvertenza Prima di svolgere una qualsiasi delle procedure seguenti, verificare che il circuito CC non sia alimentato. Per verificare che tutta l'alimentazione sia scollegata (OFF), individuare l'interruttore automatico sul quadro strumenti che alimenta il circuito CC, mettere l'interruttore in posizione OFF e fissarlo con nastro adesivo in tale posizione.

Advarsel Før noen av disse prosedyrene utføres, kontroller at strømmen er frakoblet likestrømkretsen. Sørg for at all strøm er slått AV. Dette gjøres ved å lokalisere strømbryteren på brytertavlen som betjener likestrømkretsen, slå strømbryteren AV og teipe bryterhåndtaket på strømbryteren i AV-stilling.

Aviso Antes de executar um dos seguintes procedimentos, certifique-se que desligou a fonte de alimentação de energia do circuito de corrente contínua. Para se assegurar que toda a corrente foi DESLIGADA, localize o disjuntor no painel que serve o circuito de corrente contínua e coloque-o na posição OFF (Desligado), segurando nessa posição a manivela do interruptor do disjuntor com fita isoladora.

¡Atención! Antes de proceder con los siguientes pasos, comprobar que la alimentación del circuito de corriente continua (CC) esté cortada (OFF). Para asegurarse de que toda la alimentación esté cortada (OFF), localizar el interruptor automático en el panel que alimenta al circuito de corriente continua, cambiar el interruptor automático a la posición de Apagado (OFF), y sujetar con cinta la palanca del interruptor automático en posición de Apagado (OFF).

Warning! Innan du utför någon av följande procedurer måste du kontrollera att strömförsörjningen till likströmskretsen är bruten. Kontrollera att all strömförsörjning är BRUTEN genom att slå AV det överspänningsskydd som skyddar likströmskretsen och tejpa fast överspänningsskyddets omkopplare i FRÅN-läget.

DC Power Grounding Requirements and Warning

An insulated grounding conductor that is identical in size to the grounded and ungrounded branch circuit supply conductors, but is identifiable by green and yellow stripes, is installed as part of the branch circuit that supplies the unit. The grounding conductor is a separately derived system at the supply transformer or motor generator set.

For further information, see “Power, Connection, and Cable Specifications” on page 67.



WARNING: When installing the router, the ground connection must always be made first and disconnected last.

Waarschuwing Bij de installatie van het toestel moet de aardverbinding altijd het eerste worden gemaakt en het laatste worden losgemaakt.

Varoitus Laitetta asennettaessa on maahan yhdistäminen aina tehtävä ensiksi ja maadoituksen irti kytkeminen viimeiseksi.

Attention Lors de l'installation de l'appareil, la mise à la terre doit toujours être connectée en premier et déconnectée en dernier.

Warnung Der Erdanschluß muß bei der Installation der Einheit immer zuerst hergestellt und zuletzt abgetrennt werden.

Avvertenza In fase di installazione dell'unità, eseguire sempre per primo il collegamento a massa e disconnetterlo per ultimo.

Advarsel Når enheten installeres, må jordledningen alltid tilkobles først og frakobles sist.

Aviso Ao instalar a unidade, a ligação à terra deverá ser sempre a primeira a ser ligada, e a última a ser desligada.

¡Atención! Al instalar el equipo, conectar la tierra la primera y desconectarla la última.

Varning! Vid installation av enheten måste jordledningen alltid anslutas först och kopplas bort sist.

DC Power Wiring Sequence Warning



WARNING: Wire the DC power supply using the appropriate lugs. When connecting power, the proper wiring sequence is ground to ground, + RTN to + RTN, then -48 V to -48 V. When disconnecting power, the proper wiring sequence is -48 V to -48 V, + RTN to + RTN, then ground to ground. Note that the ground wire should always be connected first and disconnected last.

Waarschuwing De juiste bedradingsvolgorde verbonden is aarde naar aarde, + RTN naar + RTN, en -48 V naar -48 V. De juiste bedradingsvolgorde losgemaakt is en -48 V naar -48 V, + RTN naar + RTN, aarde naar aarde.

Varoitus Oikea yhdistettävä kytkentäjäjestys on maajohto maajohtoon, + RTN varten + RTN, -48 V varten -48 V. Oikea irrotettava kytkentäjäjestys on -48 V varten -48 V, + RTN varten + RTN, maajohto maajohtoon.

Attention Câblez l’approvisionnement d’alimentation CC En utilisant les crochets appropriés à l’extrémité de câblage. En reliant la puissance, l’ordre approprié de câblage est rectifié pour rectifier, + RTN à + RTN, puis -48 V à -48 V. En débranchant la puissance, l’ordre approprié de câblage est -48 V à -48 V, + RTN à + RTN, a alors rectifié pour rectifier. Notez que le fil de masse devrait toujours être relié d’abord et débranché pour la dernière fois. Notez que le fil de masse devrait toujours être relié d’abord et débranché pour la dernière fois.

Warnung Verdrahten Sie die Gleichstrom-Versorgung mit den passenden Ansätzen am Verdrahtung Ende. Wenn man Energie anschließt, wird die korrekte Verdrahtung Reihenfolge gerieben, um, + RTN zu + RTN, dann -48 V bis -48 V zu reiben. Wenn sie Energie trennt, ist die korrekte Verdrahtung Reihenfolge -48 V bis -48 V, + RTN zu + RTN, rieb dann, um zu reiben. Beachten Sie, daß der Erdungsdraht immer zuerst angeschlossen werden und zuletzt getrennt werden sollte.

Avvertenza Mostra la morsettiera dell alimentatore CC. Cablare l’alimentatore CC usando i connettori adatti all’estremità del cablaggio, come illustrato. La corretta sequenza di cablaggio è da massa a massa, da positivo a positivo (da linea ad L) e da negativo a negativo (da neutro a N). Tenere presente che il filo di massa deve sempre venire collegato per primo e scollegato per ultimo.

Advarsel Riktig tilkoples tilkoplingssekvens er jord til jord, + RTN til + RTN, -48 V til - 48 V. Riktig frakoples tilkoplingssekvens er -48 V til - 48 V, + RTN til + RTN, jord til jord.

Aviso Ate con alambre la fuente de potencia cc Usando los terminales apropiados en el extremo del cableado. Al conectar potencia, la secuencia apropiada del cableado se muele para moler, + RTN a + RTN, entonces -48 V a -48 V. Al desconectar potencia, la secuencia apropiada del cableado es -48 V a -48 V, + RTN a + RTN, entonces molió para moler. Observe que el alambre de tierra se debe conectar siempre primero y desconectar por último. Observe que el alambre de tierra se debe conectar siempre primero y desconectar por último.

¡Atención! Wire a fonte de alimentação de DC Usando os talões apropriados na extremidade da fiação. Ao conectar a potência, a seqüência apropriada da fiação é moída para moer, + RTN a + RTN, então -48 V a -48 V. Ao desconectar a potência, a seqüência apropriada da fiação é -48 V a -48 V, + RTN a + RTN, moeu então para moer. Anote que o fio à terra deve sempre ser conectado primeiramente e desconectado por último. Anote que o fio à terra deve sempre ser conectado primeiramente e desconectado por último.

Warning! Korrekt kopplingssekvens ar jord till jord, + RTN till + RTN, -48 V till - 48 V. Korrekt kopplas kopplingssekvens ar -48 V till - 48 V, + RTN till + RTN, jord till jord.

DC Power Wiring Terminations Warning



WARNING: When stranded wiring is required, use approved wiring terminations, such as closed-loop or spade-type with upturned lugs. These terminations should be the appropriate size for the wires and should clamp both the insulation and conductor.

Waarschuwing Wanneer geslagen bedrading vereist is, dient u bedrading te gebruiken die voorzien is van goedgekeurde aansluitingspunten, zoals het gesloten-lus type of het grijperschop type waarbij de aansluitpunten omhoog wijzen. Deze aansluitpunten dienen de juiste maat voor de draden te hebben en dienen zowel de isolatie als de geleider vast te klemmen.

Varoituis Jos säikeellinen johdin on tarpeen, käytä hyväksyttyä johdinliitäntää, esimerkiksi suljettua silmukkaa tai kourumaista liitäntää, jossa on ylöspäin käännetyt kiinnityskorvat. Tällaisten liitäntöjen tulee olla kooltaan johtimiin sopivia ja niiden tulee puristaa yhteen sekä eristeen että johdinosan.

Attention Quand des fils torsadés sont nécessaires, utiliser des douilles terminales homologuées telles que celles à circuit fermé ou du type à plage ouverte avec cosses rebroussées. Ces douilles terminales doivent être de la taille qui convient aux fils et doivent être refermées sur la gaine isolante et sur le conducteur.

Warnung Wenn Litzenverdrahtung erforderlich ist, sind zugelassene Verdrahtungsabschlüsse, z.B. für einen geschlossenen Regelkreis oder gabelförmig, mit nach oben gerichteten Kabelschuhen zu verwenden. Diese Abschlüsse sollten die angemessene Größe für die Drähte haben und sowohl die Isolierung als auch den Leiter festklemmen.

Avvertenza Quando occorre usare trecce, usare connettori omologati, come quelli a occhiello o a forcilla con linguette rivolte verso l'alto. I connettori devono avere la misura adatta per il cablaggio e devono serrare sia l'isolante che il conduttore.

Advarsel Hvis det er nødvendig med flertrådede ledninger, brukes godkjente ledningsavslutninger, som for eksempel lukket sløyfe eller spadetype med oppoverbøyde kabelsko. Disse avslutningene skal ha riktig størrelse i forhold til ledningene, og skal klemme sammen både isolasjonen og ledaren.

Aviso Quando forem requeridas montagens de instalação eléctrica de cabo torcido, use terminações de cabo aprovadas, tais como, terminações de cabo em circuito fechado e planas com terminais de orelha voltados para cima. Estas terminações de cabo deverão ser do tamanho apropriado para os respectivos cabos, e deverão prender simultaneamente o isolamento e o fio condutor.

¡Atención! Cuando se necesite hilo trenzado, utilizar terminales para cables homologados, tales como las de tipo "bucle cerrado" o "espada", con las lengüetas de conexión vueltas hacia arriba. Estos terminales deberán ser del tamaño apropiado para los cables que se utilicen, y tendrán que sujetar tanto el aislante como el conductor.

Varning! När flertrådiga ledningar krävs måste godkända ledningskontakter användas, t.ex. kabelsko av sluten eller öppen typ med uppåtvänd tapp. Storleken på dessa kontakter måste vara anpassad till ledningarna och måste kunna hålla både isoleringen och ledaren fastklämda.

Grounded Equipment Warning



WARNING: The router is intended to be grounded. Ensure that the router is connected to earth ground during normal use.

Waarschuwing Deze apparatuur hoort geaard te worden. Zorg dat de host-computer tijdens normaal gebruik met aarde is verbonden.

Varoitus Tämä laitteisto on tarkoitettu maadoitettavaksi. Varmista, että isäntälaitte on yhdistetty maahan normaalikäytön aikana.

Attention Cet équipement doit être relié à la terre. S'assurer que l'appareil hôte est relié à la terre lors de l'utilisation normale.

Warnung Dieses Gerät muß geerdet werden. Stellen Sie sicher, daß das Host-Gerät während des normalen Betriebs an Erde gelegt ist.

Avvertenza Questa apparecchiatura deve essere collegata a massa. Accertarsi che il dispositivo host sia collegato alla massa di terra durante il normale utilizzo.

Advarsel Dette utstyret skal jordes. Forviss deg om vertsterminalen er jordet ved normalt bruk.

Aviso Este equipamento deverá estar ligado à terra. Certifique-se que o host se encontra ligado à terra durante a sua utilização normal.

¡Atención! Este equipo debe conectarse a tierra. Asegurarse de que el equipo principal esté conectado a tierra durante el uso normal.

Warning! Denna utrustning är avsedd att jordas. Se till att värdenheten är jordad vid normal användning.

In Case of Electrical Accident

If an electrical accident results in an injury, take the following actions in this order:

1. Use caution. Be aware of potentially hazardous conditions that could cause further injury.
2. Disconnect power from the router.
3. If possible, send another person to get medical aid. Otherwise, assess the condition of the victim, then call for help.

Midplane Energy Hazard Warning



WARNING: High levels of electrical energy are distributed across the router midplane. Be careful not to contact the midplane connectors, or any component connected to the midplane, with any metallic object while servicing components installed in the router.

Multiple Power Supplies Disconnection Warning



WARNING: The router has more than one power supply connection. All connections must be removed completely to remove power from the unit completely.

Waarschuwing Deze eenheid heeft meer dan één stroomtoevoerverbinding; alle verbindingen moeten volledig worden verwijderd om de stroom van deze eenheid volledig te verwijderen.

Varoit Tässä laitteessa on useampia virtalähdetyöntöjä. Kaikki kytkennät on irrotettava kokonaan, jotta virta poistettaisiin täysin laitteesta.

Attention Cette unité est équipée de plusieurs raccordements d'alimentation. Pour supprimer tout courant électrique de l'unité, tous les cordons d'alimentation doivent être débranchés.

Warnung Diese Einheit verfügt über mehr als einen Stromanschluß; um Strom gänzlich von der Einheit fernzuhalten, müssen alle Stromzufuhren abgetrennt sein.

Avvertenza Questa unità ha più di una connessione per alimentatore elettrico; tutte le connessioni devono essere completamente rimosse per togliere l'elettricità dall'unità.

Advarsel Denne enheten har mer enn én strømtilkobling. Alle tilkoblinger må kobles helt fra for å eliminere strøm fra enheten.

Aviso Este dispositivo possui mais do que uma conexão de fonte de alimentação de energia; para poder remover a fonte de alimentação de energia, deverão ser desconectadas todas as conexões existentes.

¡Atención! Esta unidad tiene más de una conexión de suministros de alimentación; para eliminar la alimentación por completo, deben desconectarse completamente todas las conexiones.

Warning! Denna enhet har mer än en strömförsörjningsanslutning; alla anslutningar måste vara helt avlägsnade innan strömtillförseln till enheten är fullständigt bruten.

Power Disconnection Warning



WARNING: Before working on the router or near power supplies, unplug the power cord from an AC router; switch off the power at the circuit breaker on a DC router.

Waarschuwing Voordat u aan een frame of in de nabijheid van voedingen werkt, dient u bij wisselstroom toestellen de stekker van het netsnoer uit het stopcontact te halen; voor gelijkstroom toestellen dient u de stroom uit te schakelen bij de stroomverbreker.

Varoit Kytke irti vaihtovirtalaitteiden virtajohto ja katkaise tasavirtalaitteiden virta suojakytkimellä, ennen kuin teet mitään asennuspohjalle tai työskentelet virtalähteiden läheisyydessä.

Attention Avant de travailler sur un châssis ou à proximité d'une alimentation électrique, débrancher le cordon d'alimentation des unités en courant alternatif; couper l'alimentation des unités en courant continu au niveau du disjoncteur.

Warnung Bevor Sie an einem Chassis oder in der Nähe von Netzgeräten arbeiten, ziehen Sie bei Wechselstromeinheiten das Netzkabel ab bzw. schalten Sie bei Gleichstromeinheiten den Strom am Unterbrecher ab.

Avvertenza Prima di lavorare su un telaio o intorno ad alimentatori, scollegare il cavo di alimentazione sulle unità CA; scollegare l'alimentazione all'interruttore automatico sulle unità CC.

Advarsel Før det utføres arbeid på kabinettet eller det arbeides i nærheten av strømforsyningsenheter, skal strømledningen trekkes ut p vekselstrømsenheter og strømmen kobles fra ved strømbryteren på likestrømsenheter.

Aviso Antes de trabalhar num chassis, ou antes de trabalhar perto de unidades de fornecimento de energia, desligue o cabo de alimentação nas unidades de corrente alternada; desligue a corrente no disjuntor nas unidades de corrente contínua.

¡Atención! Antes de manipular el chasis de un equipo o trabajar cerca de una fuente de alimentación, desenchufar el cable de alimentación en los equipos de corriente alterna (CA); cortar la alimentación desde el interruptor automático en los equipos de corriente continua (CC).

Warning! Innan du arbetar med ett chassi eller nära strömförsörjningsenheter skall du för växelströmsenheter dra ur nätsladden och för likströmsenheter bryta strömmen vid överspänningsskyddet.

TN Power Warning



WARNING: The router is designed to work with TN, IT power systems.

Waarschuwing Het apparaat is ontworpen om te functioneren met TN, IT energiesystemen.

Varoitus Koje on suunniteltu toimimaan TN-, IT-sähkövoimajärjestelmien yhteydessä.

Attention Ce dispositif a été conçu pour fonctionner avec des systèmes d'alimentation TN.

Warnung Das Gerät ist für die Verwendung mit TN-, IT-Stromsystemen ausgelegt.

Avvertenza Il dispositivo è stato progettato per l'uso con sistemi di alimentazione TN, IT.

Advarsel Utstyret er utfomet til bruk med TN-, IT-strømsystemer.

Aviso O dispositivo foi criado para operar com sistemas de corrente TN, IT.

¡Atención! El equipo está diseñado para trabajar con sistemas de alimentación tipo TN, IT.

Varning! Enheten är konstruerad för användning tillsammans med elkraftssystem av TN-, IT-typ.

Installation Safety Guidelines and Warnings

Observe the following guidelines and warnings before and during router installation:

- Chassis Lifting Guidelines on page 239
- Installation Instructions Warning on page 239
- Rack-Mounting Requirements and Warnings on page 240
- Ramp Warning on page 244

Chassis Lifting Guidelines

The weight of a fully configured chassis is about 370.5 lb (168 kg). Observe the following guidelines for lifting and moving the router:

- Before moving the router, read the guidelines in “Preparing for Router Installation” on page 59 to verify that the intended site meets the specified power, environmental, and clearance requirements.
- Do not attempt to lift a fully configured router by yourself. Using a mechanical lift to maneuver the router into a rack is recommended. If a lift cannot be used, a minimum of three people must lift the router, and you must remove components from the chassis before lifting. For lifting and component removal instructions, see “Initial Installation” on page 57.
- Before lifting or moving the router, disconnect all external cables.
- As when lifting any heavy object, lift most of the weight with your legs rather than your back. Keep your knees bent and your back relatively straight and avoid twisting your body as you lift. Balance the load evenly and be sure that your footing is solid.

Installation Instructions Warning



WARNING: Read the installation instructions before you connect the router to a power source.

Waarschuwing Raadpleeg de installatie-aanwijzingen voordat u het systeem met de voeding verbindt.

Varoituis Lue asennusohjeet ennen järjestelmän yhdistämistä virtalähteeseen.

Attention Avant de brancher le système sur la source d'alimentation, consulter les directives d'installation.

Warnung Lesen Sie die Installationsanweisungen, bevor Sie das System an die Stromquelle anschließen.

Avvertenza Consultare le istruzioni di installazione prima di collegare il sistema all'alimentatore.

Advarsel Les installasjonsinstruksjonene før systemet kobles til strømkilden.

Aviso Leia as instruções de instalação antes de ligar o sistema à sua fonte de energia.

¡Atención! Ver las instrucciones de instalación antes de conectar el sistema a la red de alimentación.

Varning! Läs installationsanvisningarna innan du kopplar systemet till dess strömförsörjningsenhet.

Rack-Mounting Requirements and Warnings

Ensure that the equipment rack into which the router is installed is evenly and securely supported, to avoid the hazardous condition that could result from uneven mechanical loading.



WARNING: To prevent bodily injury when mounting or servicing the router in a rack, take the following precautions to ensure that the system remains stable. The following directives help maintain your safety:

- The router must be installed into a rack that is secured to the building structure.
- The router should be mounted at the bottom of the rack if it is the only unit in the rack.
- When mounting the router in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.
- If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the router in the rack.

Waarschuwing Om lichamelijk letsel te voorkomen wanneer u dit toestel in een rek monteert of het daar een servicebeurt geeft, moet u speciale

voorzorgsmaatregelen nemen om ervoor te zorgen dat het toestel stabiel blijft. De onderstaande richtlijnen worden verstrekt om uw veiligheid te verzekeren:

- De Juniper Networks router moet in een stellage worden geïnstalleerd die aan een bouwsel is verankerd.
- Dit toestel dient onderaan in het rek gemonteerd te worden als het toestel het enige in het rek is.
- Wanneer u dit toestel in een gedeeltelijk gevuld rek monteert, dient u het rek van onderen naar boven te laden met het zwaarste onderdeel onderaan in het rek.
- Als het rek voorzien is van stabiliseringshulpmiddelen, dient u de stabilisatoren te monteren voordat u het toestel in het rek monteert of het daar een servicebeurt geeft.

Varoituis Kun laite asetetaan telineeseen tai huolletaan sen ollessa telineessä, on noudatettava erityisiä varotoimia järjestelmän vakavuuden säilyttämiseksi, jotta vältetään loukkaantumiselta. Noudata seuraavia turvallisuusohjeita:

- Juniper Networks router on asennettava telineeseen, joka on kiinnitetty rakennukseen.
- Jos telineessä ei ole muita laitteita, aseta laite telineen alaosaan.
- Jos laite asetetaan osaksi täytettyyn telineeseen, aloita kuormittaminen sen alaosasta kaikkein raskaimmalla esineellä ja siirry sitten sen yläosaan.
- Jos telinettä varten on vakaimet, asenna ne ennen laitteen asettamista telineeseen tai sen huoltamista siinä.

Attention Pour éviter toute blessure corporelle pendant les opérations de montage ou de réparation de cette unité en casier, il convient de prendre des précautions spéciales afin de maintenir la stabilité du système. Les directives ci-dessous sont destinées à assurer la protection du personnel:

- Le rack sur lequel est monté le Juniper Networks router doit être fixé à la structure du bâtiment.
- Si cette unité constitue la seule unité montée en casier, elle doit être placée dans le bas.
- Si cette unité est montée dans un casier partiellement rempli, charger le casier de bas en haut en plaçant l'élément le plus lourd dans le bas.
- Si le casier est équipé de dispositifs stabilisateurs, installer les stabilisateurs avant de monter ou de réparer l'unité en casier.

Warnung Zur Vermeidung von Körperverletzung beim Anbringen oder Warten dieser Einheit in einem Gestell müssen Sie besondere Vorkehrungen treffen, um

sicherzustellen, daß das System stabil bleibt. Die folgenden Richtlinien sollen zur Gewährleistung Ihrer Sicherheit dienen:

- Der Juniper Networks router muß in einem Gestell installiert werden, das in der Gebäudestruktur verankert ist.
- Wenn diese Einheit die einzige im Gestell ist, sollte sie unten im Gestell angebracht werden.
- Bei Anbringung dieser Einheit in einem zum Teil gefüllten Gestell ist das Gestell von unten nach oben zu laden, wobei das schwerste Bauteil unten im Gestell anzubringen ist.
- Wird das Gestell mit Stabilisierungszubehör geliefert, sind zuerst die Stabilisatoren zu installieren, bevor Sie die Einheit im Gestell anbringen oder sie warten.

Avvertenza Per evitare infortuni fisici durante il montaggio o la manutenzione di questa unità in un supporto, occorre osservare speciali precauzioni per garantire che il sistema rimanga stabile. Le seguenti direttive vengono fornite per garantire la sicurezza personale:

- Il Juniper Networks router deve essere installato in un telaio, il quale deve essere fissato alla struttura dell'edificio.
- Questa unità deve venire montata sul fondo del supporto, se si tratta dell'unica unità da montare nel supporto.
- Quando questa unità viene montata in un supporto parzialmente pieno, caricare il supporto dal basso all'alto, con il componente più pesante sistemato sul fondo del supporto.
- Se il supporto è dotato di dispositivi stabilizzanti, installare tali dispositivi prima di montare o di procedere alla manutenzione dell'unità nel supporto.

Advarsel Unngå fysiske skader under montering eller reparasjonsarbeid på denne enheten når den befinner seg i et kabinett. Vær nøye med at systemet er stabilt. Følgende retningslinjer er gitt for å verne om sikkerheten:

- Juniper Networks router må installeres i et stativ som er forankret til bygningsstrukturen.
- Denne enheten bør monteres nederst i kabinettet hvis dette er den eneste enheten i kabinettet.
- Ved montering av denne enheten i et kabinett som er delvis fylt, skal kabinettet lastes fra bunnen og opp med den tyngste komponenten nederst i kabinettet.
- Hvis kabinettet er utstyrt med stabiliseringsutstyr, skal stabilisatorene installeres før montering eller utføring av reparasjonsarbeid på enheten i kabinettet.

Aviso Para se prevenir contra danos corporais ao montar ou reparar esta unidade numa estante, deverá tomar precauções especiais para se certificar de que o sistema possui um suporte estável. As seguintes directrizes ajudá-lo-ão a efectuar o seu trabalho com segurança:

- O Juniper Networks router deverá ser instalado numa prateleira fixa à estrutura do edifício.
- Esta unidade deverá ser montada na parte inferior da estante, caso seja esta a única unidade a ser montada.
- Ao montar esta unidade numa estante parcialmente ocupada, coloque os itens mais pesados na parte inferior da estante, arrumando-os de baixo para cima.
- Se a estante possuir um dispositivo de estabilização, instale-o antes de montar ou reparar a unidade.

¡Atención! Para evitar lesiones durante el montaje de este equipo sobre un bastidor, o posteriormente durante su mantenimiento, se debe poner mucho cuidado en que el sistema quede bien estable. Para garantizar su seguridad, proceda según las siguientes instrucciones:

- El Juniper Networks router debe instalarse en un bastidor fijado a la estructura del edificio.
- Colocar el equipo en la parte inferior del bastidor, cuando sea la única unidad en el mismo.
- Cuando este equipo se vaya a instalar en un bastidor parcialmente ocupado, comenzar la instalación desde la parte inferior hacia la superior colocando el equipo más pesado en la parte inferior.
- Si el bastidor dispone de dispositivos estabilizadores, instalar éstos antes de montar o proceder al mantenimiento del equipo instalado en el bastidor.

Varning! För att undvika kroppsskada när du installerar eller utför underhållsarbete på denna enhet på en ställning måste du vidta särskilda försiktighetsåtgärder för att försäkra dig om att systemet står stadigt. Följande riktlinjer ges för att trygga din säkerhet:

- Juniper Networks router måste installeras i en ställning som är förankrad i byggnadens struktur.
- Om denna enhet är den enda enheten på ställningen skall den installeras längst ned på ställningen.
- Om denna enhet installeras på en delvis fylld ställning skall ställningen fyllas nedifrån och upp, med de tyngsta enheterna längst ned på ställningen.
- Om ställningen är försedd med stabiliseringsdon skall dessa monteras fast innan enheten installeras eller underhålls på ställningen.

Ramp Warning



WARNING: When installing the router, do not use a ramp inclined at more than 10 degrees.

Waarschuwing Gebruik een oprijplaat niet onder een hoek van meer dan 10 graden.

Varoitus Älä käyttää sellaista kaltevaa pintaa, jonka kaltevuus ylittää 10 astetta.

Attention Ne pas utiliser une rampe dont l'inclinaison est supérieure à 10 degrés.

Warnung Keine Rampen mit einer Neigung von mehr als 10 Grad verwenden.

Avvertenza Non usare una rampa con pendenza superiore a 10 gradi.

Advarsel Bruk aldri en rampe som heller mer enn 10 grader.

Aviso Não utilize uma rampa com uma inclinação superior a 10 graus.

¡Atención! No usar una rampa inclinada más de 10 grados

Varning! Använd inte ramp med en lutning på mer än 10 grader.

Laser and LED Safety Guidelines and Warnings

Single-mode Physical Interface Cards (PICs) are equipped with laser transmitters, which are considered a Class 1 Laser Product by the U.S. Food and Drug Administration, and are evaluated as a Class 1 Laser Product per EN 60825-1 + A11 + A2 requirements.

Observe the following guidelines and warnings:

- General Laser Safety Guidelines on page 245
- Class 1 Laser Product Warning on page 245
- Class 1 LED Product Warning on page 245
- Laser Beam Warning on page 246
- Radiation From Open Port Apertures Warning on page 247

General Laser Safety Guidelines

When working around PICs, observe the following safety guidelines to prevent eye injury:

- Do not look into unterminated ports or at fibers that connect to unknown sources.
- Do not examine unterminated optical ports with optical instruments.
- Avoid direct exposure to the beam.



WARNING: Unterminated optical connectors can emit invisible laser radiation. The lens in the human eye focuses all the laser power on the retina, so focusing the eye directly on a laser source—even a low-power laser—could permanently damage the eye.

Class 1 Laser Product Warning



WARNING: Class 1 laser product.

Waarschuwing Klasse-1 laser produkt.

Varoitus Luokan 1 lasertuote.

Attention Produit laser de classe I.

Warnung Laserprodukt der Klasse 1.

Avvertenza Prodotto laser di Classe 1.

Advarsel Laserprodukt av klasse 1.

Aviso Produto laser de classe 1.

¡Atención! Producto láser Clase I.

Varning! Laserprodukt av klass 1.

Class 1 LED Product Warning



WARNING: Class 1 LED product.

Waarschuwing Klasse 1 LED-product.

Varoitus Luokan 1 valodiodituote.

Attention Alarme de produit LED Class I.

Warnung Class 1 LED-Produktwarnung.

Avvertenza Avvertenza prodotto LED di Classe 1.

Advarsel LED-produkt i klasse 1.

Aviso Produto de classe 1 com LED.

¡Atención! Aviso sobre producto LED de Clase 1.

Varning! Lysdiodprodukt av klass 1.

Laser Beam Warning



WARNING: Do not stare into the laser beam or view it directly with optical instruments.

Waarschuwing Niet in de straal staren of hem rechtstreeks bekijken met optische instrumenten.

Varoitus Älä katso säteeseen äläkä tarkastele sitä suoraan optisen laitteen avulla.

Attention Ne pas fixer le faisceau des yeux, ni l'observer directement à l'aide d'instruments optiques.

Warnung Nicht direkt in den Strahl blicken und ihn nicht direkt mit optischen Geräten prüfen.

Avvertenza Non fissare il raggio con gli occhi né usare strumenti ottici per osservarlo direttamente.

Advarsel Stirr eller se ikke direkte p strlen med optiske instrumenter.

Aviso Não olhe fixamente para o raio, nem olhe para ele directamente com instrumentos ópticos.

¡Atención! No mirar fijamente el haz ni observarlo directamente con instrumentos ópticos.

Varning! Rikta inte blicken in mot strålen och titta inte direkt på den genom optiska instrument.

Radiation From Open Port Apertures Warning



WARNING: Because invisible radiation may be emitted from the aperture of the port when no fiber cable is connected, avoid exposure to radiation and do not stare into open apertures.

Waarschuwing Aangezien onzichtbare straling vanuit de opening van de poort kan komen als er geen fiberkabel aangesloten is, dient blootstelling aan straling en het kijken in open openingen vermeden te worden.

Varoitus Koska portin aukosta voi emittoitua näkymätöntä säteilyä, kun kuitukaapelia ei ole kytkettynä, vältä säteilylle altistumista äläkä katso avoimiin aukkoihin.

Attention Des radiations invisibles à l'il nu pouvant traverser l'ouverture du port lorsqu'aucun câble en fibre optique n'y est connecté, il est recommandé de ne pas regarder fixement l'intérieur de ces ouvertures.

Warnung Aus der Port-Öffnung können unsichtbare Strahlen emittieren, wenn kein Glasfaserkabel angeschlossen ist. Vermeiden Sie es, sich den Strahlungen auszusetzen, und starren Sie nicht in die Öffnungen!

Avvertenza Quando i cavi in fibra non sono inseriti, radiazioni invisibili possono essere emesse attraverso l'apertura della porta. Evitate di esporvi alle radiazioni e non guardate direttamente nelle aperture.

Advarsel Unngå utsettelse for stråling, og stirr ikke inn i åpninger som er åpne, fordi usynlig stråling kan emitteres fra portens åpning når det ikke er tilkoblet en fiberkabel.

Aviso Dada a possibilidade de emissão de radiação invisível através do orifício da via de acesso, quando esta não tiver nenhum cabo de fibra conectado, deverá evitar a exposição à radiação e não deverá olhar fixamente para orifícios que se encontrarem a descoberto.

¡Atención! Debido a que la apertura del puerto puede emitir radiación invisible cuando no existe un cable de fibra conectado, evite mirar directamente a las aperturas para no exponerse a la radiación.

Warning! Osynlig strålning kan avges från en portöppning utan ansluten fiberkabel och du bör därför undvika att bli utsatt för strålning genom att inte stirra in i oskyddade öppningar.

Maintenance and Operational Safety Guidelines and Warnings

As you maintain the router, observe the following guidelines and warnings:

- Battery Handling Warning on page 248

- Jewelry Removal Warning on page 249
- Lightning Activity Warning on page 250
- Operating Temperature Warning on page 251
- Product Disposal Warning on page 252

Battery Handling Warning



WARNING: Replacing the battery incorrectly might result in an explosion. Replace the battery only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

Waarschuwing Er is ontplofingsgevaar als de batterij verkeerd vervangen wordt. Vervang de batterij slechts met hetzelfde of een equivalent type dat door de fabrikant aanbevolen is. Gebruikte batterijen dienen overeenkomstig fabrieksvoorschriften weggeworpen te worden.

Varoituis Räjähdyksen vaara, jos akku on vaihdettu väärään akkuun. Käytä vaihtamiseen ainoastaan saman- tai vastaavantyyppistä akkua, joka on valmistajan suosittelema. Hävitä käytetyt akut valmistajan ohjeiden mukaan.

Attention Danger d'explosion si la pile n'est pas remplacée correctement. Ne la remplacer que par une pile de type semblable ou équivalent, recommandée par le fabricant. Jeter les piles usagées conformément aux instructions du fabricant.

Warnung Bei Einsetzen einer falschen Batterie besteht Explosionsgefahr. Ersetzen Sie die Batterie nur durch den gleichen oder vom Hersteller empfohlenen Batterietyp. Entsorgen Sie die benutzten Batterien nach den Anweisungen des Herstellers.

Avvertenza Pericolo di esplosione se la batteria non è installata correttamente. Sostituire solo con una di tipo uguale o equivalente, consigliata dal produttore. Eliminare le batterie usate secondo le istruzioni del produttore.

Advarsel Det kan være fare for eksplosjon hvis batteriet skiftes på feil måte. Skift kun med samme eller tilsvarende type som er anbefalt av produsenten. Kasser brukte batterier i henhold til produsentens instruksjoner.

Aviso Existe perigo de explosão se a bateria for substituída incorrectamente. Substitua a bateria por uma bateria igual ou de um tipo equivalente recomendado pelo fabricante. Destrua as baterias usadas conforme as instruções do fabricante.

¡Atención! Existe peligro de explosión si la batería se reemplaza de manera incorrecta. Reemplazar la batería exclusivamente con el mismo tipo o el equivalente recomendado por el fabricante. Desechar las baterías gastadas según las instrucciones del fabricante.

Varning! Explosionsfara vid felaktigt batteribyte. Ersätt endast batteriet med samma batterityp som rekommenderas av tillverkaren eller motsvarande. Följ tillverkarens anvisningar vid kassering av använda batterier.

Jewelry Removal Warning



WARNING: Before working on equipment that is connected to power lines, remove jewelry, including rings, necklaces, and watches. Metal objects heat up when connected to power and ground and can cause serious burns or weld the metal object to the terminals.

Waarschuwing Alvorens aan apparatuur te werken die met elektrische leidingen is verbonden, sieraden (inclusief ringen, kettingen en horloges) verwijderen. Metalen voorwerpen worden warm wanneer ze met stroom en aarde zijn verbonden, en kunnen ernstige brandwonden veroorzaken of het metalen voorwerp aan de aansluitklemmen lassen.

Varoitus Ennen kuin työskentelet voimavirtajohtoihin kytkettyjen laitteiden parissa, ota pois kaikki korut (sormukset, kaulakorut ja kellot mukaan lukien). Metalliesineet kuumentuvat, kun ne ovat yhteydessä sähkövirran ja maan kanssa, ja ne voivat aiheuttaa vakavia palovammoja tai hitsata metalliesineet kiinni liitäntänapoihin.

Attention Avant d'accéder à cet équipement connecté aux lignes électriques, ôter tout bijou (anneaux, colliers et montres compris). Lorsqu'ils sont branchés à l'alimentation et reliés à la terre, les objets métalliques chauffent, ce qui peut provoquer des blessures graves ou souder l'objet métallique aux bornes.

Warnung Vor der Arbeit an Geräten, die an das Netz angeschlossen sind, jeglichen Schmuck (einschließlich Ringe, Ketten und Uhren) abnehmen. Metallgegenstände erhitzen sich, wenn sie an das Netz und die Erde angeschlossen werden, und können schwere Verbrennungen verursachen oder an die Anschlußklemmen angeschweißt werden.

Avvertenza Prima di intervenire su apparecchiature collegate alle linee di alimentazione, togliersi qualsiasi monile (inclusi anelli, collane, braccialetti ed orologi). Gli oggetti metallici si riscaldano quando sono collegati tra punti di alimentazione e massa: possono causare ustioni gravi oppure il metallo può saldarsi ai terminali.

Advarsel Fjern alle smykker (inkludert ringer, halskjeder og klokker) før du skal arbeide på utstyr som er koblet til kraftledninger. Metallgjenstander som er koblet til kraftledninger og jord blir svært varme og kan forårsake alvorlige brannskader eller smelte fast til polene.

Aviso Antes de trabalhar em equipamento que esteja ligado a linhas de corrente, retire todas as jóias que estiver a usar (incluindo anéis, fios e relógios). Os objectos metálicos aquecerão em contacto com a corrente e em contacto com a ligação à terra, podendo causar queimaduras graves ou ficarem soldados aos terminais.

¡Atención! Antes de operar sobre equipos conectados a líneas de alimentación, quitarse las joyas (incluidos anillos, collares y relojes). Los objetos de metal se calientan cuando se conectan a la alimentación y a tierra, lo que puede ocasionar quemaduras graves o que los objetos metálicos queden soldados a los bornes.

Varning! Tag av alla smycken (inklusive ringar, halsband och armbandsur) innan du arbetar på utrustning som är kopplad till kraftledningar. Metallobjekt hettas upp när de kopplas ihop med ström och jord och kan förorsaka allvarliga brännskador; metallobjekt kan också sammansvetsas med kontakterna.

Lightning Activity Warning



WARNING: Do not work on the system or connect or disconnect cables during periods of lightning activity.

Waarschuwing Tijdens onweer dat gepaard gaat met bliksem, dient u niet aan het systeem te werken of kabels aan te sluiten of te ontkoppelen.

Varoitus Älä työskentele järjestelmän parissa äläkä yhdistä tai irrota kaapeleita ukkosilmalla.

Attention Ne pas travailler sur le système ni brancher ou débrancher les câbles pendant un orage.

Warnung Arbeiten Sie nicht am System und schließen Sie keine Kabel an bzw. trennen Sie keine ab, wenn es gewittert.

Avvertenza Non lavorare sul sistema o collegare oppure scollegare i cavi durante un temporale con fulmini.

Advarsel Utfør aldri arbeid på systemet, eller koble kabler til eller fra systemet når det tordner eller lyner.

Aviso Não trabalhe no sistema ou ligue e desligue cabos durante períodos de mau tempo (trovoada).

¡Atención! No operar el sistema ni conectar o desconectar cables durante el transcurso de descargas eléctricas en la atmósfera.

Varning! Vid åska skall du aldrig utföra arbete på systemet eller ansluta eller koppla loss kablar.

Operating Temperature Warning



WARNING: To prevent the router from overheating, do not operate it in an area that exceeds the maximum recommended ambient temperature of 104°F (40°C). To prevent airflow restriction, allow at least 6 inches (15.2 cm) of clearance around the ventilation openings.

Waarschuwing Om te voorkomen dat welke router van de Juniper Networks router dan ook oververhit raakt, dient u deze niet te bedienen op een plaats waar de maximale aanbevolen omgevingstemperatuur van 40°C wordt overschreden. Om te voorkomen dat de luchtstroom wordt beperkt, dient er minstens 15,2 cm speling rond de ventilatie-openingen te zijn.

Varoituis Ettei Juniper Networks router-sarjan reititin ylikuumentuusi, sitä ei saa käyttää tilassa, jonka lämpötila ylittää korkeimman suositellun ympäristölämpötilan 40°C. Ettei ilmanvaihto estyisi, tuuletusaukkojen ympärille on jätettävä ainakin 15,2 cm tilaa.

Attention Pour éviter toute surchauffe des routeurs de la gamme Juniper Networks router, ne l'utilisez pas dans une zone où la température ambiante est supérieure à 40°C. Pour permettre un flot d'air constant, dégagez un espace d'au moins 15,2 cm autour des ouvertures de ventilations.

Warnung Um einen Router der router vor Überhitzung zu schützen, darf dieser nicht in einer Gegend betrieben werden, in der die Umgebungstemperatur das empfohlene Maximum von 40°C überschreitet. Um Lüftungsverschluß zu verhindern, achten Sie darauf, daß mindestens 15,2 cm lichter Raum um die Lüftungsöffnungen herum frei bleibt.

Avvertenza Per evitare il surriscaldamento dei router, non adoperateli in un locale che ecceda la temperatura ambientale massima di 40°C. Per evitare che la circolazione dell'aria sia impedita, lasciate uno spazio di almeno 15.2 cm di fronte alle aperture delle ventole.

Advarsel Unngå overoppheting av eventuelle rutere i Juniper Networks router Disse skal ikke brukes på steder der den anbefalte maksimale omgivelsestemperaturen overstiger 40°C (104°F). Sørg for at klaringen rundt lufteåpningene er minst 15,2 cm (6 tommer) for å forhindre nedsatt luftsirkulasjon.

Aviso Para evitar o sobreaquecimento do encaminhador Juniper Networks router, não utilize este equipamento numa área que exceda a temperatura máxima recomendada de 40°C. Para evitar a restrição à circulação de ar, deixe pelo menos um espaço de 15,2 cm à volta das aberturas de ventilação.

¡Atención! Para impedir que un encaminhador de la serie Juniper Networks router se recaliente, no lo haga funcionar en un área en la que se supere la temperatura ambiente máxima recomendada de 40°C. Para impedir la restricción de la entrada de aire, deje un espacio mínimo de 15,2 cm alrededor de las aperturas para ventilación.

Varning! Förhindra att en Juniper Networks router överhettas genom att inte använda den i ett område där den maximalt rekommenderade omgivningstemperaturen på 40°C överskrids. Förhindra att luftcirkulationen inskränks genom att se till att det finns fritt utrymme på minst 15,2 cm omkring ventilationsöppningarna.

Product Disposal Warning



WARNING: Disposal of this product must be handled according to all national laws and regulations.

Waarschuwing Dit produkt dient volgens alle landelijke wetten en voorschriften te worden afgedankt.

Varoitus Tämän tuotteen lopullisesta hävittämisestä tulee huolehtia kaikkia valtakunnallisia lakeja ja säännöksiä noudattaen.

Attention La mise au rebut définitive de ce produit doit être effectuée conformément à toutes les lois et réglementations en vigueur.

Warnung Dieses Produkt muß den geltenden Gesetzen und Vorschriften entsprechend entsorgt werden.

Avvertenza L'eliminazione finale di questo prodotto deve essere eseguita osservando le normative italiane vigenti in materia

Advarsel Endelig disponering av dette produktet må skje i henhold til nasjonale lover og forskrifter.

Aviso A descartagem final deste produto deverá ser efectuada de acordo com os regulamentos e a legislação nacional.

¡Atención! El desecho final de este producto debe realizarse según todas las leyes y regulaciones nacionales

Varning! Slutlig kassering av denna produkt bör skötas i enlighet med landets alla lagar och föreskrifter.

Agency Approvals

The router complies with the following standards:

- Safety
 - CAN/CSA-22.2 No. 60950-00/UL 1950 Third Edition, Safety of Information Technology Equipment
 - EN 60825-1 Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
 - EN 60950 Safety of Information Technology Equipment
- EMC
 - AS/NZS 3548 Class A (Australia/New Zealand)
 - EN 55022 Class A Emissions (Europe)
 - FCC Part 15 Class A (USA)
 - VCCI Class A (Japan)
- Immunity
 - EN 61000-3-2 Power Line Harmonics
 - EN 61000-4-2 ESD
 - EN 61000-4-3 Radiated Immunity
 - EN 61000-4-4 EFT
 - EN 61000-4-5 Surge
 - EN 61000-4-6 Low Frequency Common Immunity
 - EN 1000-4-11 Voltage Dips and Sags
- ETSI
 - ETS-300386-2 Telecommunication Network Equipment. Electromagnetic Compatibility Requirements
- NEBS
 - GR-63-Core: NEBS, Physical Protection
 - GR-1089-Core: EMC and Electrical Safety for Network Telecommunications Equipment
 - SR-3580 NEBS Criteria Levels (Level 3 Compliance)

Compliance Statements for EMC Requirements

Canada

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

European Community

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Japan

<p>この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用する と電波妨害を引き起こすことがあります。この場合には使用者が適切な対策 を講ずるよう要求されることがあります。</p> <p>VCCI-A</p>

The preceding translates as:

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures. VCCI-A

United States

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

Appendix B

Contacting Customer Support and Returning Hardware

This chapter describes how to return the router or individual components to Juniper Networks for repair or replacement:

- Locating Component Serial Numbers on page 255
- Contacting Customer Support on page 262
- Return Procedure on page 263
- Tools and Parts Required on page 264
- Packing the Routing Node for Shipment on page 265
- Packing Components for Shipment on page 267

Locating Component Serial Numbers

Before contacting Juniper Networks, Inc. to request a Return Materials Authorization (RMA), you must find the serial number on the router or component. To list all of the router components and their serial numbers, enter the following command-line interface (CLI) command:

```
user@host> show chassis hardware
Hardware inventory:
Item          Version  Part number  Serial number  Description
Chassis                               20082          M160
Midplane      REV 05   710-001245   AW3196
FPM CMB       REV 03   710-001642   AE6482
FPM Display   REV 03   710-001647   AW2008
CIP           REV 04   710-002649   HE0493
PEM 0         Rev 03   740-001243   LK16669        Power Entry Module
PCG 0         REV 07   710-001568   HE0486
PCG 1         REV 07   710-001568   HF1163
Routing Engine 0                               8b00000792898b01 RE-2.0
Routing Engine 1                               6d000007c8150801 RE-2.0
MCS 0         REV 11   710-001226   AV4497
MCS 1         REV 11   710-001226   HD2643
SFM 0 SPP     REV 07   710-001228   AG6106
SFM 0 SPR     REV 04   710-002189   AG6176        Internet Processor II
SFM 1 SPP     REV 07   710-001228   HC5574
```

SFM 1 SPR	REV 04	710-002189	HC5964	Internet Processor II
SFM 2 SPP	REV 07	710-001228	HE0083	
SFM 2 SPR	REV 04	710-002189	HD6410	Internet Processor II
SFM 3 SPP	REV 07	710-001228	HC5376	
SFM 3 SPR	REV 04	710-002189	AV8604	Internet Processor II
FPC 0	REV 10	710-001255	HB2143	FPC Type 1
CPU	REV 05	710-001217	HE1067	
PIC 0	REV 02	750-003064	HF1353	4x T1, RJ48
PIC 1	REV 04	750-001894	HA9492	1x G/E, 1000 BASE-SX
PIC 2	REV 04	750-001895	HE0917	1x OC-12 SONET, MM
PIC 3	REV 04	750-001895	HE0562	1x OC-12 SONET, MM
FPC 4	REV 10	710-001882	HA9606	FPC Type OC192
CPU	REV 05	710-001217	AV8340	
PIC 0	REV 06	750-003184	HA9606	1x OC-192 SM SR-2
FPC 5	REV 10	710-001255	AH0357	FPC Type 1
CPU	REV 01	710-004600	BD2316	
PIC 0	REV 02	750-003104	AD9192	4x T3 ATM
PIC 1	REV 05	750-005656	BE1888	2x EIA-530
PIC 2	REV 04	750-003105	AS6972	4x E3 ATM
PIC 3	REV 04	750-001895	HD8100	1x OC-12 SONET, MM
FPC 6	REV 04	710-003950	BC0951	E-FPC Type 2
CPU	REV 01	710-004600	AE9024	
PIC 0	REV 05	750-001900	AD5625	1x OC-48 SONET, SMSR

Most components also have a small rectangular serial number ID label (see Figure 109) attached to the component body.

Figure 109: Serial Number ID Label



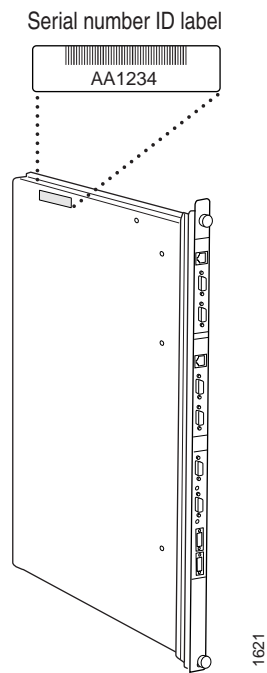
The following sections describe the label location on each type of component:

- CIP Serial Number ID Label on page 257
- Craft Interface Serial Number ID Label on page 257
- DC Power Supply Serial Number ID Label on page 258
- FPC Serial Number ID Label on page 259
- MCS Serial Number ID Label on page 259
- PCG Serial Number ID Label on page 260
- PIC Serial Number ID Label on page 260
- Routing Engine Serial Number ID Label on page 261
- SFM Serial Number ID Label on page 262

CIP Serial Number ID Label

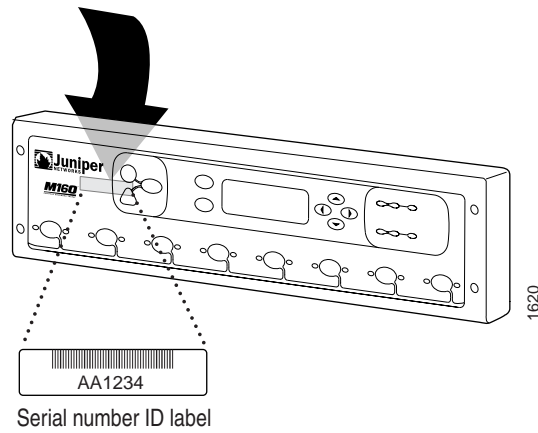
The serial number ID label on the CIP is located at the top of the left side, as shown in Figure 110.

Figure 110: CIP Serial Number ID Label

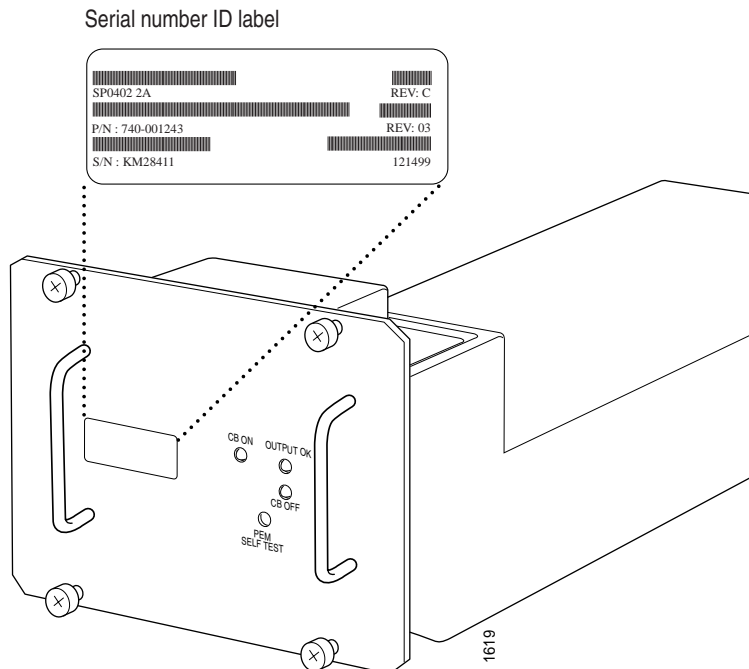


Craft Interface Serial Number ID Label

The serial number on the craft interface is located on the back of the panel, behind the alarm LEDs, as shown in Figure 111.

Figure 111: Craft Interface Serial Number ID Label**DC Power Supply Serial Number ID Label**

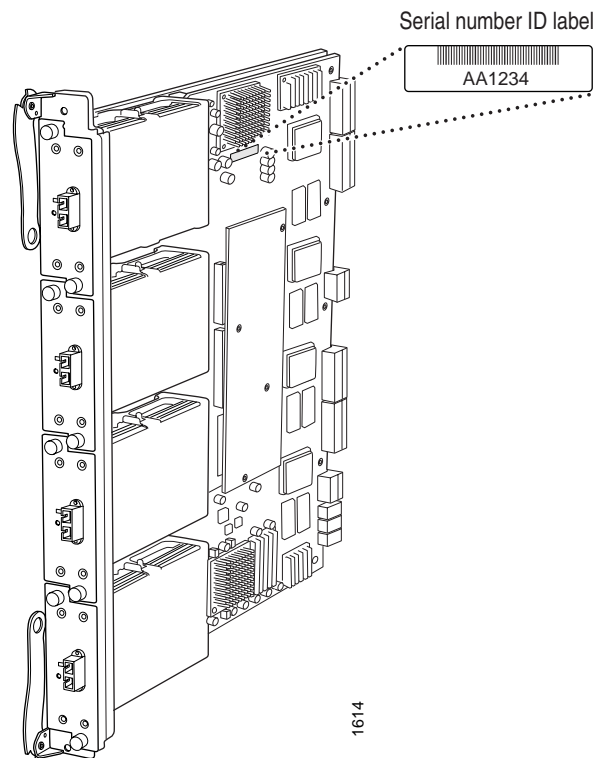
The serial number ID label on a DC power supply is located on the faceplate, as shown in Figure 112.

Figure 112: DC Power Supply Serial Number ID Label

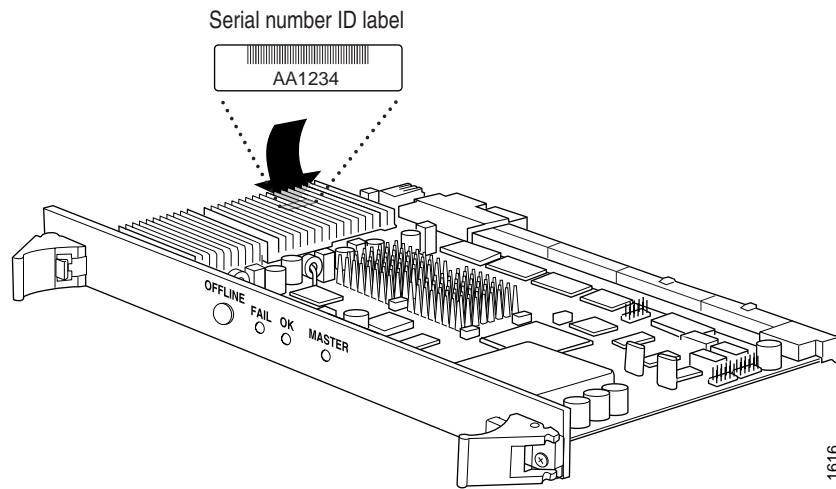
FPC Serial Number ID Label

The serial number ID label on an FPC is located on the right side, as shown in Figure 113.

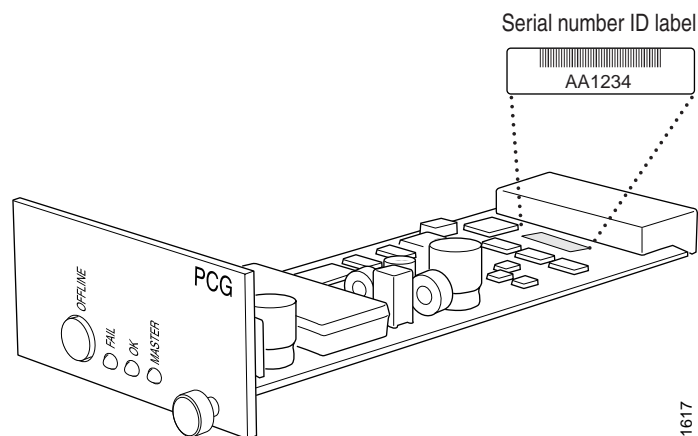
Figure 113: FPC Serial Number ID Label

**MCS Serial Number ID Label**

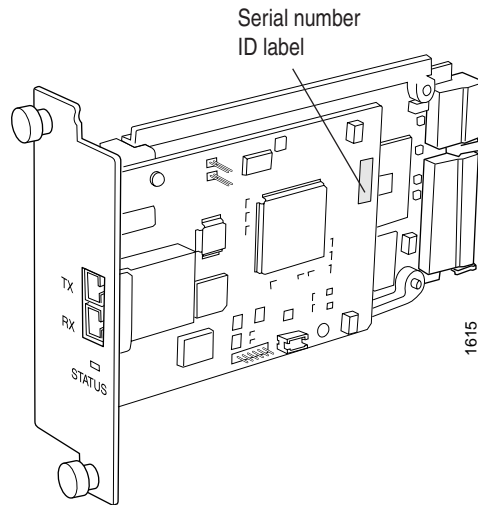
The serial number on an MCS is located on the bottom at the left side, as shown in Figure 114.

Figure 114: MCS Serial Number ID Label**PCG Serial Number ID Label**

The serial number on a PCG is located on the top, close to the midplane connector, as shown in Figure 115.

Figure 115: PCG Serial Number ID Label**PIC Serial Number ID Label**

The serial number ID label for a PIC is located on the right side of the PIC, as shown in Figure 116.

Figure 116: PIC Serial Number ID Label**Routing Engine Serial Number ID Label**

The location of the serial number ID label depends on the type of Routing Engine (see Figure 117 and Figure 118). Some Routing Engines might have more than one serial number. Contact your Juniper Networks support representative if you need assistance in determining which serial number to provide.

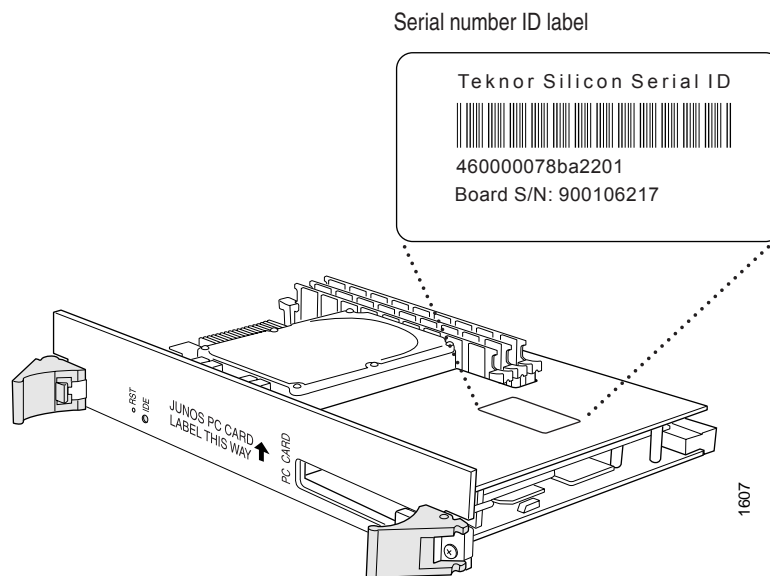
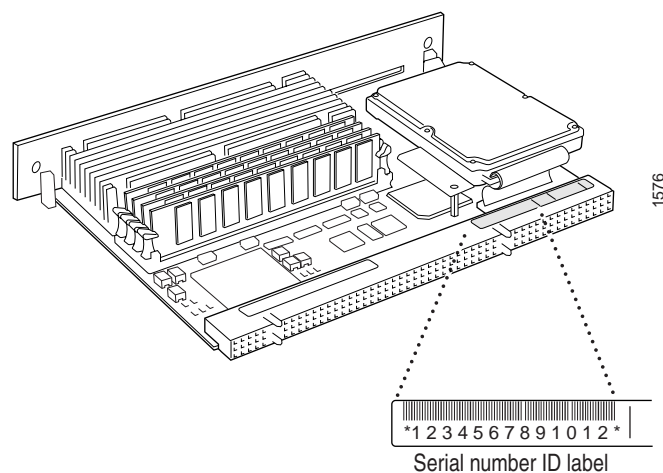
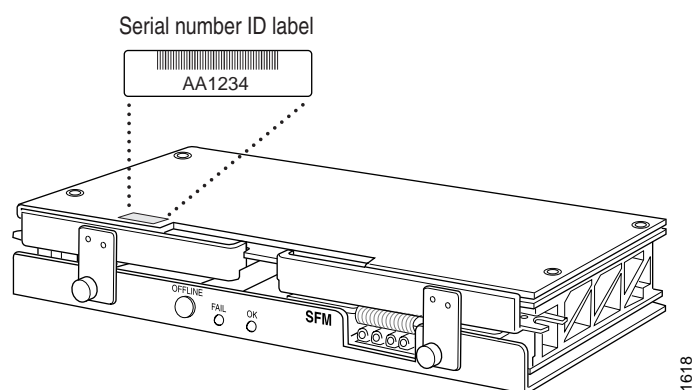
Figure 117: Routing Engine 333 Serial Number ID Label

Figure 118: Routing Engine 600 Serial Number ID Label

SFM Serial Number ID Label

The serial number ID label on an SFM is located on the left side of the top panel, as shown in Figure 119.

Figure 119: SFM Serial Number ID Label

Contacting Customer Support

After you have located the serial numbers of the components you need to return, contact Juniper Networks Technical Assistance Center (JTAC) in one of the following ways. You can contact JTAC 24 hours a day, seven days a week:

- On the Web, using the Case Manager link at:

<http://www.juniper.net/support/>

■ By telephone:

From the US and Canada: 1-888-314-JTAC

From all other locations: 1-408-745-9500

If contacting JTAC by phone, enter your 11-digit case number followed by the # key if this is an existing case, or press the * key to be routed to the next available support engineer.

Information You Might Need to Supply to JTAC

When requesting support from JTAC by telephone, be prepared to provide the following information:

- Your existing case number, if you have one
- Details of the failure or problem
- Type of activity being performed on the router when the problem occurred
- Configuration data using one or more of the show commands

Return Procedure

If the problem cannot be resolved by the JTAC technician, an RMA is issued. This number is used to track the returned material at the factory and to return repaired or new components to the customer as needed.



NOTE: Do not return any component to Juniper Networks, Inc. unless you have first obtained an RMA number. Juniper Networks, Inc. reserves the right to refuse shipments that do not have an RMA. Refused shipments will be returned to the customer via collect freight.

For more information about return and repair policies, see the customer support Web page at <http://www.juniper.net/support/guidelines.html>.

For product problems or technical support issues, contact the Juniper Networks Technical Assistance Center (JTAC) using the Case Manager link at <http://www.juniper.net/support/>, or at 1-888-314-JTAC (within the United States) or 1-408-745-9500 (from outside the United States).

When you need to return a component, follow this procedure:

1. Determine the part number and serial number of the component. For instructions, see “Locating Component Serial Numbers” on page 255.

2. Obtain a Return Materials Authorization (RMA) number from the Juniper Networks Technical Assistance Center (JTAC). You can send e-mail or telephone as described above.
3. Provide the following information in your e-mail message or during the telephone call:
 - Part number and serial number of component
 - Your name, organization name, telephone number, and fax number
 - Description of the failure
4. The support representative validates your request and issues an RMA number for return of the component.
5. Pack the router or component for shipment, as described “Packing the Routing Node for Shipment” on page 265 or “Packing Components for Shipment” on page 267.

Tools and Parts Required

To remove components from the router or the router from a rack, you need the following tools and parts:

- 2.5 mm flat-blade (–) screwdriver, for detaching alarm relay terminal block
- 5/32-in. Allen (hexagonal) wrench for loosening the mounting screws that secure the router to the rack; do not substitute a metric-size wrench
- 7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a minimum of 30 lb-in. (3.5 Nm) tightening torque, for loosening nuts from terminal studs on the circuit breaker box



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

- Blank panels to cover empty slots
- Electrostatic bags or antistatic mats, one for each electronic component removed
- Electrostatic discharge (ESD) grounding wrist strap
- Flat-blade screwdriver, approximately 1/4 in. (6 mm), for removing craft interface
- Mechanical lift, if available
- Phillips (+) screwdrivers, numbers 1 and 2
- Rubber safety cap for fiber-optic PICs or PIC cable

Packing the Routing Node for Shipment

To pack the router for shipment, follow this procedure:

1. Retrieve the shipping crate and packing materials in which the router was originally shipped. If you do not have these materials, contact your Juniper Networks representative about approved packaging materials.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Make sure the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 226.
3. On the console or other management device connected to the master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

```
user@host> request system halt
```



NOTE: Wait until a message appears on the console confirming that the operating system has halted.

For more information about the command, see the *JUNOS Protocols, Class of Service, and System Basics Command Reference*.

4. Shut down power to the router by pressing the power switch for all power supplies to the off (0) position. The switches are on the circuit breaker box.
5. Disconnect power from the router. For instructions, see “Disconnecting and Connecting Power” on page 200.
6. Remove the cables that connect to all external devices. For instructions, see “Replacing the Management Ethernet Cable” on page 146, “Replacing the Console or Auxiliary Cable” on page 146, “Replace Alarm Relay Wires” on page 147, and “Replace PIC Cables” on page 185.
7. Remove all Field Replaceable Units (FRUs) from the router.
8. Remove the router from the rack:
 - If you are using a mechanical lift, place the lift platform under the router, unscrew and remove the mounting screws from the rack, and move the router to the shipping crate.
 - If you are not using a mechanical lift and the router weight is fully supported by a shelf or another router, unscrew and remove the mounting screws from the rack. Four people can then lift the router and move it to the shipping crate.
 - If you are not using a mechanical lift and the router weight is not fully supported by a shelf, four people should grasp the router while a fifth person unscrews and removes the mounting screws from the rack. The four lifters can then move the router to the shipping crate.
9. Place the router in the shipping crate or onto the pallet. If on a pallet, bolt the router to the pallet.
10. Cover the router with an ESD bag and place the packing foam on top of and around the router.
11. Replace the accessory box on top of the packing foam.
12. Securely tape the box closed or place the crate cover over the router.
13. Write the RMA number on the exterior of the box to ensure proper tracking.

Packing Components for Shipment

To pack and ship individual components, follow these guidelines:

- When you return components, make sure they are adequately protected with packing materials and packed so that the pieces are prevented from moving around inside the carton.
- Use the original shipping materials if they are available.
- Place individual boards in electrostatic bags.
- Write the RMA number on the exterior of the box to ensure proper tracking.



CAUTION: Do not stack any of the router components.

Appendix C

Cable Connector Pinouts

This chapter describes the pinouts for the following cable connectors:

- RJ-45 Connector Pinouts for the Routing Engine ETHERNET Port on page 269
- DB-9 Connector Pinouts for the Routing Engine AUXILIARY and CONSOLE Ports on page 270
- RJ-48 Cable Pinouts for E1 and T1 PICs on page 270
- X.21 and V.35 Cable Pinouts for EIA-530 PIC on page 273
- Fast Ethernet 48-port Cable Pinouts on page 274

RJ-45 Connector Pinouts for the Routing Engine ETHERNET Port

The port on the CIP labeled ETHERNET is an autosensing 10/100-Mbps Ethernet RJ-45 receptacle that accepts an Ethernet cable for connecting the Routing Engine to a management LAN (or other device that supports out-of-band management). For more information, see “Routing Engine Management Ports” on page 33. Table 28 describes the RJ-45 connector pinout.

Table 28: RJ-45 Connector Pinout

Pin	Signal
1	TX +
2	TX-
3	RX +
4	Termination network
5	Termination network
6	RX-
7	Termination network
8	Termination network

DB-9 Connector Pinouts for the Routing Engine AUXILIARY and CONSOLE Ports

The ports on the CIP labeled AUXILIARY and CONSOLE are DB-9 receptacles that accept RS-232 (EIA-232) cable. The AUXILIARY port connects the Routing Engine to a laptop, modem, or other auxiliary unit, and the CONSOLE port connects it to a management console. The ports are configured as data terminal equipment (DTE). For more information, see “Routing Engine Management Ports” on page 33. Table 29 describes the DB-9 connector pinouts.

Table 29: DB-9 Connector Pinout

Pin	Signal	Direction	Description
1	DCD	< –	Carrier Detect
2	RxD	< –	Receive Data
3	TxD	– >	Transmit Data
4	DTR	– >	Data Terminal Ready
5	Ground	—	Signal Ground
6	DSR	< –	Data Set Ready
7	RTS	– >	Request To Send
8	CTS	< –	Clear To Send
9	RING	< –	Ring Indicator

RJ-48 Cable Pinouts for E1 and T1 PICs

The E1 and T1 PICs use an RJ-48 cable, which is not supplied with the PIC.



CAUTION: To maintain agency approvals, use only a properly constructed, shielded cable.

Table 30, Table 31, Table 32, and Table 33 describe the RJ-48 connector pinouts.

Table 30: RJ-48 Connector to RJ-48 Connector (Straight) Pinout

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	RJ-48 Pin (Data numbering form)	Signal
1	1	RX, Ring, –
2	2	RX, Tip, +
4	4	TX, Ring, –
5	5	TX, Tip, +

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	RJ-48 Pin (Data numbering form)	Signal
3	3	Shield/Return/Ground
6	6	Shield/Return/Ground
7	No connect	No connect
8	No connect	No connect
9	No connect	No connect
10	No connect	No connect
11	No connect	No connect
12	No connect	No connect
13	No connect	No connect
14	No connect	No connect
15	No connect	No connect

Table 31: RJ-48 Connector to RJ-48 Connector (Crossover) Pinout

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	RJ-48 Pin (Data numbering form)	Signal
1	4	RX/Ring/- <--> TX/Ring/-
2	5	RX/Tip/+ <--> TX/Tip/+
4	1	TX/Ring/- <--> RX/Ring/-
5	2	TX/Tip/+ <--> RX/Tip/+
3	3	Shield/Return/Ground
6	6	Shield/Return/Ground
7	No connect	No connect
8	No connect	No connect
9	No connect	No connect
10	No connect	No connect
11	No connect	No connect
12	No connect	No connect
13	No connect	No connect
14	No connect	No connect
15	No connect	No connect

Table 32: RJ-48 Connector to DB-15 Connector (Straight) Pinout

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	DB-15 Pin (Data numbering form)	Signal
1	11	RX/Ring/- <--> RX/Ring/-
2	3	RX/Tip/+ <--> RX/Tip/+
4	9	TX/Ring/- <--> TX/Ring/-
5	1	TX/Tip/+ <--> TX/Tip/+
3	4	Shield/Return/Ground
6	2	Shield/Return/Ground
7	No connect	No connect
8	No connect	No connect
9	No connect	No connect
10	No connect	No connect
11	No connect	No connect
12	No connect	No connect
13	No connect	No connect
14	No connect	No connect
15	No connect	No connect

Table 33: RJ-48 Connector to DB-15 Connector (Crossover) Pinout

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	DB-15 Pin (Data numbering form)	Signal
1	9	RX/Ring/- <--> TX/Ring/-
2	1	RX/Tip/+ <--> TX/Tip/+
4	11	TX/Ring/- <--> RX/Ring/-
5	3	TX/Tip/+ <--> RX/Tip/+
3	4	Shield/Return/Ground
6	2	Shield/Return/Ground
7	No connect	No connect
8	No connect	No connect
9	No connect	No connect
10	No connect	No connect
11	No connect	No connect
12	No connect	No connect
13	No connect	No connect

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	DB-15 Pin (Data numbering form)	Signal
14	No connect	No connect
15	No connect	No connect

X.21 and V.35 Cable Pinouts for EIA-530 PIC

The EIA-530 PIC accepts X.21 and V.35 cable connectors.

- A V.35 connection requires an DB-25 to V.35 cable and connects to a V.35 data terminal equipment (DTE) 34-pin Winchester type male cable (one per port). Table 34 describes the V.35 cable pinouts.
- An X.21 connection requires an DB-25 to X.21 cable and connects to a X.21 DTE DB-15 male cable. Table 35 describes the X.21 cable pinouts.

Figure 120: EIA-530 PIC

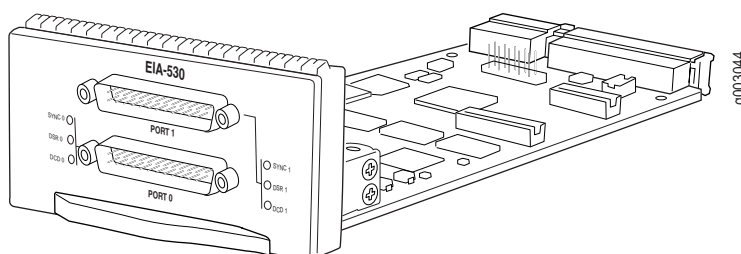


Table 34: DB-25 Connector to V.35 Connector Pinout

DB-25 Pin	Signal	V.35 Pin	Description
2	TD	P	Transmit Data
14	TD	S	Transmit Data
3	RD	R	Receive Data
16	RD	T	Receive Data
4	RTS	C	Ready To Send
5	CTS	D	Clear To Send
6	DSR	E	Data Set Ready
20	DTR	H	Data Terminal Ready
24	XTC	U	DTE Transmit Clock
11	XTC	W	DTE Transmit Clock
15	TC	Y	Transmit Clock

DB-25 Pin	Signal	V.35 Pin	Description
12	TC	AA	Transmit Clock
17	RC	V	Receive Clock
9	RC	X	Receive Clock
1	FGND	A	Protective Ground
7	GND	B	Signal Ground
8	DCD	F	Data Carrier Detect

Table 35: DB-25 Connector to DB-15 (X.21) Connector Pinout

DB-25 Pin	Signal	DB-15 (X.21) Pin	Description
1	FGND	1	Protective Ground
7	GND	8	Signal Ground
2	T	2	Transmit Data
14	T	9	Transmit Data
3	R	4	Receive Data
16	R	11	Receive Data
4	C	3	Request To Send
19	C	10	Request To Send
8	I	5	Data Carrier Detect
10	I	12	Data Carrier Detect
17	S	6	Receive Clock
9	S	13	Receive Clock

Fast Ethernet 48-port Cable Pinouts

The Fast Ethernet 48-port PIC has four VHDCI connector ports on its faceplate (see Figure 121), each of which accepts one of the four RJ-21 cables supplied with the PIC (see Figure 122). Each VHDCI connector port supports 12 Ethernet ports.

Figure 121: Fast Ethernet 48-port PIC

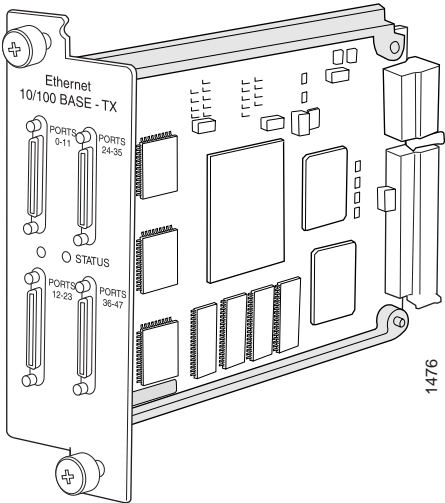


Figure 122: VHDCI to RJ-21 Cable

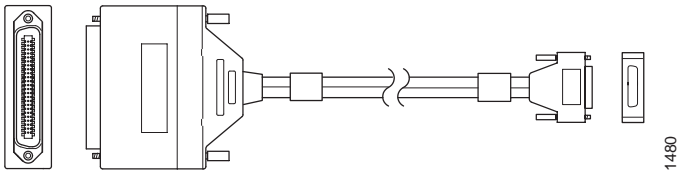


Table 36 describes the RJ-21 cable pinouts.



NOTE: RJ-21 pin numbers 25 and 50 do not appear in the table because they are ground connectors.

Table 36: RJ-21 Pin Assignments

Ethernet Port Numbers	RJ-21 Pin Assignment			
	TX -	TX +	RX -	RX +
0, 12, 24, 36	2	27	1	26
1, 13, 25, 37	4	29	3	28
2, 14, 26, 38	6	31	5	30
3, 15, 27, 39	8	33	7	32
4, 16, 28, 40	10	35	9	34
5, 17, 29, 41	12	37	11	36

Ethernet Port Numbers	RJ-21 Pin Assignment			
6, 18, 30, 42	14	39	13	38
7, 19, 31, 43	16	41	15	40
8, 20, 32, 44	18	43	17	42
9, 21, 33, 45	20	45	19	44
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Part 5

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