

M5 and M10 Internet Routers

Hardware Guide

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M5 and M10 Internet Routers: Hardware Guide

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YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. The JUNOS software has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

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About This Manual

This chapter provides a high-level overview of the *M5 and M10 Internet Routers Hardware Guide*:

- Objectives on page xv
- Audience on page xv
- Document Organization on page xvi
- Documentation Conventions on page xvi
- List of Technical Publications on page xvii
- Documentation Feedback on page xix
- How to Request Support on page xix

Objectives

This manual explains the hardware installation and basic troubleshooting for the M5 and M10 Internet routers. It contains procedures for preparing your site for router installation, unpacking and installing the hardware, starting up the router, performing initial software configuration, and doing routine maintenance and upgrades. After completing the installation and basic configuration procedures covered in this manual, refer to the JUNOS Internet software configuration guides for information about further configuring the JUNOS software.

To obtain additional information about Juniper Networks Internet routers and the Physical Interface Cards (PICs) they support—either corrections to information in this manual or information that might have been omitted from this manual—refer to the hardware release notes.

To obtain the most current version of this manual, the most current version of the hardware release notes, and other Juniper Networks technical documentation, refer to the product documentation page on the Juniper Networks Web site, which is located at <http://www.juniper.net>.

To order printed copies of this manual or to order a documentation CD-ROM, which contains this manual, please contact your sales representative.

Audience

This manual is designed for network administrators who are installing and maintaining a Juniper Networks router, or preparing a site for router installation. It assumes 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 manual.

Document Organization

This manual is divided into several parts:

- Preface "About This Manual" (this chapter), provides a brief description of the contents and organization of this manual and describes how to contact customer support.
- Part 1, "Product Overview," provides an overview of the router, describing its hardware components, the JUNOS Internet software, and the system architecture.
- Part 2, "Initial Installation," describes how to prepare your site for router installation, and how to unpack, install, and power on the router. It describes requirements and specifications for the installation site, power source, rack, wiring, and cabling. It also provides detailed safety guidelines and warnings.
- Part 3, "Hardware Maintenance, Replacement, and Troubleshooting Procedures," describes how to maintain, replace, and troubleshoot router components.

This manual also contains a complete index.

Documentation Conventions

General Conventions

This manual uses the following text conventions:

- Router and router component labels are shown in a sans serif font. In the following example, **ETHERNET** is the label for the Ethernet management port on the router:

The 10/100-Mbps Ethernet RJ-45 connector is used for out-of-band management of the router and is labeled **ETHERNET**.

- Statements, commands, filenames, directory names, IP addresses, and configuration hierarchy levels are shown in a sans serif font. In the following example, *stub* is a statement name and `[edit protocols ospf area area-id]` is a configuration hierarchy level:

To configure a stub area, include the **stub** statement at the `[edit protocols ospf area area-id]` hierarchy level.

- In examples, text that you type literally is shown in bold. In the following example, you type the words *show chassis alarms*:

For example, you can use the following command to get information about the source of an alarm condition:

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


Notes, Cautions, and Warnings

Notes, cautions, and warnings are denoted by the following symbols:



Note

A note indicates information that might be helpful in a particular situation or that might otherwise be overlooked.



Caution

A caution indicates a situation that requires careful attention. Failure to observe a cautionary note could result in minor injury or discomfort to yourself, or serious damage to the router.



Warning

A warning indicates a potentially dangerous situation. Failure to follow the guidelines in a warning could result in severe injury or death.

List of Technical Publications

Table 1 lists the software and hardware books for Juniper Networks routers and describes the contents of each book.

Table 1: Juniper Networks Technical Documentation

Book	Description
JUNOS Internet Software 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>Getting Started</i>	Provides an overview of the JUNOS Internet 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 Internet software and describes how to configure the network interfaces on the router.

Book	Description
<i>MPLS Applications</i>	Provides an overview of traffic engineering concepts and describes how to configure traffic engineering protocols.
<i>Multicast</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 and 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 Internet Software References	
<i>Operational Mode Command Reference: Interfaces</i>	Describes the JUNOS Internet software operational mode commands you use to monitor and troubleshoot network and services interfaces on Juniper Networks M-series and T-series routers.
<i>Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management</i>	Describes the JUNOS Internet software operational mode commands you use to monitor and troubleshoot most aspects of Juniper Networks M-series and T-series routers.
<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 API to monitor and configure Juniper Networks routers.
<i>JUNOScript API Reference</i>	Provides a reference page for each tag in the JUNOScript API.
JUNOS Internet Software 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.

Book	Description
JUNOScope Software Documentation	
<i>JUNOScope Software 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.
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.

Documentation Feedback

We are always interested in hearing from our customers. Please let us know what you like and do not like about the Juniper Networks documentation, and let us know of any suggestions you have for improving the documentation. Also, let us know if you find any mistakes in the documentation. Send your feedback to techpubs-comments@juniper.net.

How to Request Support

For technical support, contact Juniper Networks at support@juniper.net, or at 1-888-314-JTAC (within the United States) or 1-408-745-9500 (from outside the United States).

Part 1

Product Overview

- System Overview on page 3
- Hardware Component Overview on page 5
- JUNOS Internet Software Overview on page 21
- System Architecture Overview on page 29

Chapter 1

System Overview

This chapter provides an overview of the Juniper Networks M5 and M10 Internet routers, discussing the following topics:

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

System Description

The M5 and M10 Internet routers provide high-speed interfaces for medium and 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 M5 router supports up to four Physical Interface Cards (PICs), and the M10 router supports up to eight PICs. Each PIC accepts a specific type of network media, providing up to 16 physical interface ports per system on the M5 router and up to 32 ports per system on the M10 router. The router height of 5.25 in. (13.3 cm) enables stacked installation of 14 M5 or M10 routers in a single floor-to-ceiling rack, for increased port density per unit of floor space.

The router's maximum aggregate throughput is 6.4 gigabits per second (Gbps), full duplex. The router provides very high throughput for any combination of PICs that does not exceed 3 Gbps for the M5 router or 6 Gbps for the M10 router. 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.
- FRUs that require powering down the router—You must power down the router before removing these components.

Table 2 lists the FRUs for the M5 and M10 routers.

Table 2: Field-Replaceable Units

Hot-Removable and Hot-Insertable FRUs	FRUs That Require Powering Down the Router
Fan tray with cable management system	Forwarding Engine Board (FEB)
Physical Interface Card (PIC)	Routing Engine
Power supply (AC or DC)	
Small form factor pluggable (SFP)	

For FRU replacement instructions, see “Replace Hardware Components” on page 81.

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 “Prepare for Router Installation” on page 37. For a list of safety warnings, see “Safety and Regulatory Compliance Information” on page 129 and particularly “Electrical Safety Guidelines and Warnings” on page 135. 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 M5 and M10 Internet routers:

- Chassis on page 5
- Packet Forwarding Engine on page 8
- Routing Engine on page 12
- Craft Interface on page 14
- Power Supplies on page 16
- Fan Tray on page 19
- Cable Management System on page 20

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 24 in. (61 cm) deep. The chassis height of 5.25 in. (13.3 cm) enables stacked installation of 14 M5 and M10 routers in a single floor-to-ceiling rack. For more information, see “Rack Requirements” on page 37.

The two mounting ears (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 front and rear views of the router chassis.

Figure 1: Front of M5 Chassis

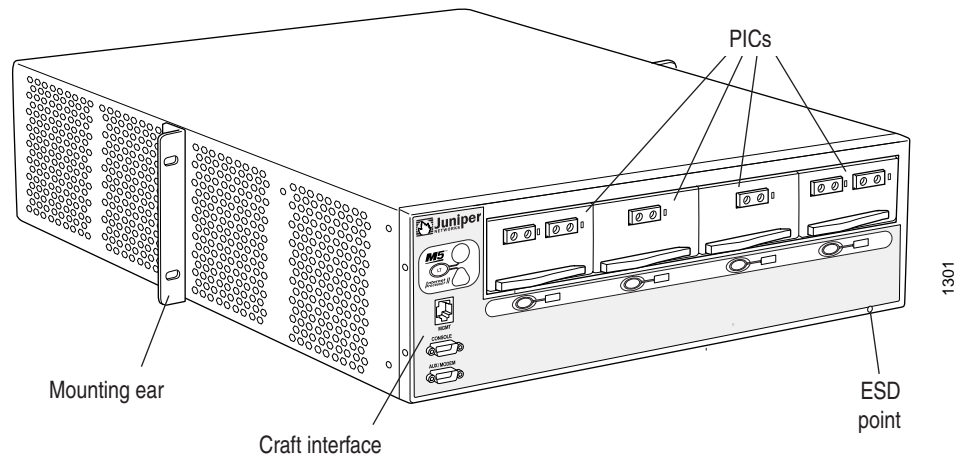


Figure 2: Front of M10 Chassis

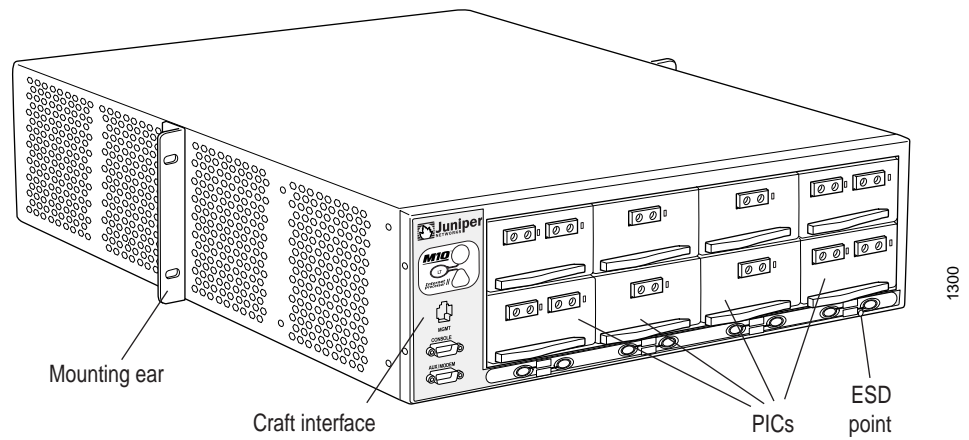
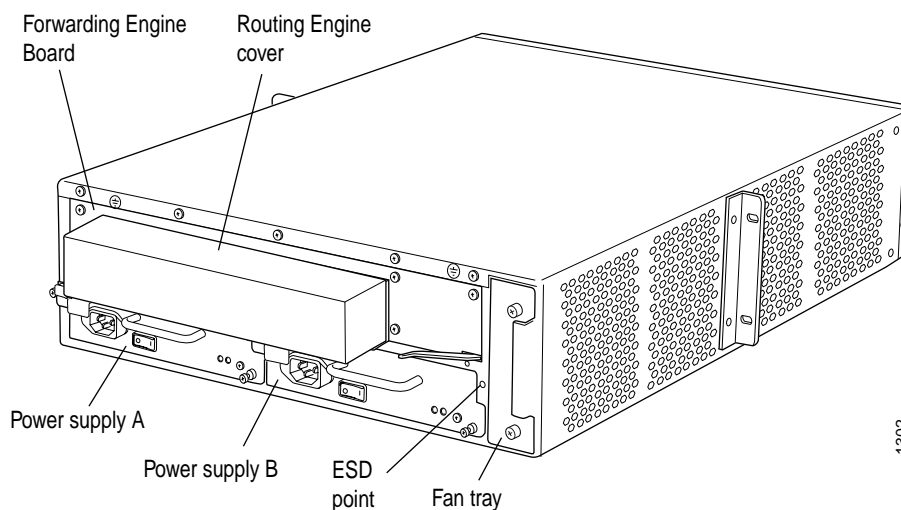


Figure 3: Rear of Chassis

The chassis includes two electrostatic discharge (ESD) points (banana plug receptacles) for electrical safety, one front and one rear, as shown in Figure 1, Figure 2, and Figure 3.

**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 129.

Table 3 summarizes physical specifications for the router chassis.

Table 3: Chassis Physical Specifications

Description	Value
Chassis height	5.25 in. (13.3 cm)
Chassis width	17.5 in. (44.5 cm) for sides of chassis 19 in. (48.3 cm) with mounting ears
Chassis depth	24 in. (61 cm)
Weight, maximum configuration	M5 router: 61 lb (27.6 kg) M10 router: 67 lb (29.5 kg)

Description	Value
Weight, minimum configuration	57 lb (25.8 kg)
Thermal output	2550 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, 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 Cards (PICs)—Physically connect the router to network media such as OC-12/STM-4, OC-48/STM-16, Ethernet, and channelized interfaces.
- Flexible PIC Concentrators (FPCs)—House PICs. On the M5 and M10 routers, FPCs are built in (cannot be removed from the chassis as on some other M-series platforms).
- Forwarding Engine Board (FEB)—Performs route lookup, filtering, and switching. It installs into the midplane from the rear of the chassis.

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

- Midplane on page 8
- Physical Interface Cards (PICs) on page 9
- Flexible PIC Concentrators (FPCs) on page 10
- Forwarding Engine Board (FEB) on page 10

Midplane

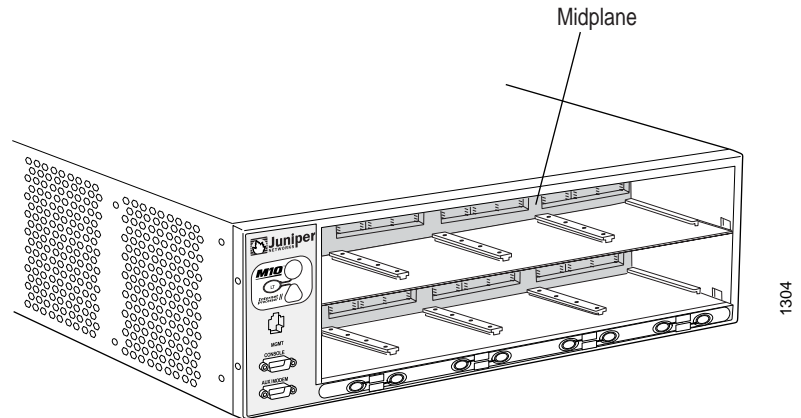
The midplane is a panel located in the center of the chassis, running from side to side and forming the rear of the PIC card cage (see Figure 4). All router components plug directly into the midplane. The midplane contains an EEPROM that stores the serial number and revision level of the midplane.

The midplane performs the following functions:

- Transfer of packets—After being processed by a PIC, an incoming data packet crosses the midplane to the FEB. The FEB performs switching and forwarding functions and transfers outgoing packets back across the midplane to the PICs 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 10.

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 *M5 and M10 Internet Routers 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 3. For SFP replacement instructions, see “Replace an SFP” on page 95. For information about PICs that use SFPs, see the *M5 and M10 Internet Routers PIC Guide*.

Up to four regular PICs install into an M5 router and up to eight regular PICs install into an M10 router, as shown in Figure 1 and Figure 2. The PIC slots on an M5 router and in the upper FPC on an M10 router are numbered from 0/0 (zero/zero) through 0/3, right to left. The PIC slots in the lower FPC on an M10 router are numbered from 1/0 (one/zero) through 1/3, right to left. The slot number for a PIC appears next to its offline button on the craft interface (see “PIC Offline Buttons” on page 16). The number of ports on a PIC depends on the type of PIC.

Quad-wide PICs, such as the 4-port Gigabit Ethernet and OC-48/STM-16 SONET/SDH PICs, occupy all four slots in an FPC. Some quad-wide PICs might not be supported on both the M5 and M10 routers; for more information, see the *M5 and M10 Internet Routers PIC Guide*.

Both regular and quad-wide PICs are hot-removable and hot-insertable. A removed PIC no longer receives or transmits data, and removing or inserting a PIC briefly interrupts forwarding of traffic through the remaining PICs.

For PIC replacement instructions, see “Replace a PIC” on page 87.

PIC Components

Most PICs supported on the M5 and M10 routers have the following components. For complete specifications, see the *M5 and M10 Internet Routers PIC Guide*. For information about pinouts for PIC cable connectors, see “Cable Connector Pinouts” on page 171.

- 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 *M5 and M10 Internet Routers PIC Guide*.
- Ejector lever—Controls the locking system that secures the PIC in the card cage.

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 9). On the M5 and M10 routers, each FPC is built in (cannot be removed from the chassis as on other M-series platforms) and corresponds to a horizontal row of PIC slots. The single FPC on the M5 router is numbered 0 (zero) and the two FPCs on the M10 router are numbered 0 and 1, top to bottom. Each FPC accommodates up to four regular PICs or one quad-wide PIC.

Forwarding Engine Board (FEB)

The Forwarding Engine Board (FEB) 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).

The FEB installs into the midplane from the rear of the chassis, as shown in Figure 3. It weighs approximately 7 lb (3.2 kg). The FEB is field-replaceable, but you must power down the router before removing it from the chassis. Packet forwarding halts until the FEB is replaced, the router is powered on, and the Routing Engine finishes booting.

For FEB replacement instructions, see “Replace the FEB” on page 84.

The FEB 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 FEB 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 FEB provide the following functions:

- Route lookups—The Internet Processor II ASIC on each FEB performs route lookups using the forwarding table stored in SSRAM.
- Creation and reassembly of data cells—The I/O Manager ASIC divides incoming packets into 64-byte data cells for easier processing, and reassembles the cells for each packet after the forwarding decision is made for it. There is one I/O Manager ASIC on the M5 router and two on the M10 router.
- Management of memory on the FEB—One Distributed Buffer Manager ASIC receives the 64-byte data cells into which the I/O Manager ASIC divides incoming packets, and uniformly allocates the cells throughout the memory buffers on the FEB.
- 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 FEB, which processes almost all of them. The FEB sends any remaining exception packets to the Routing Engine for further processing. When the FEB detects an error originating in the Packet Forwarding Engine, it sends it to the Routing Engine using system logging (syslog) messages.
- Monitoring of system components—The FEB monitors other system components for failure and alarm conditions. It collects statistics from all sensors in the system and relays them to the Routing Engine, which sets alarms as appropriate. For example, if the temperature of a component exceeds the lower of two internally defined thresholds, the Routing Engine issues a “high temperature” alarm. If the temperature exceeds the higher threshold, the Routing Engine initiates a system shutdown.
- Providing SONET/SDH clock source—The FEB generates a 19.44-MHz clock signal for use by SONET/SDH interfaces.

FEB Components

An FEB has the following components (see Figure 5):

- I/O Manager ASIC (one on the M5 router and two on the M10 router)—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.
- Two Distributed Buffer Manager ASICs—Process incoming and outgoing packets: one distributes data cells (which the I/O Manager ASIC derives from incoming packets) to the memory buffers on the FEB, while the second forwards notification of routing decisions to an I/O Manager ASIC.
- One Internet Processor II ASIC—Performs route lookups and makes routing decisions.
- Parity-protected synchronous SRAM (SSRAM)—Stores the forwarding table.

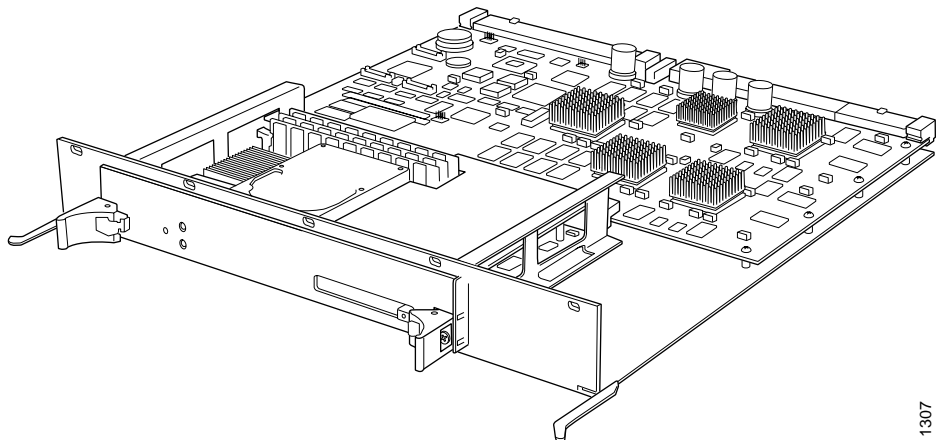
- Processor subsystem—Manages FEB functions and handles exception packets. The processor has the following components:
 - One PowerPC 603e processor
 - Parity-protected Level 2 cache
 - Parity-protected DRAM
- EEPROM—Stores the serial number and revision level.
- 19.44-MHz stratum 3 reference clock—Generates clock signal for SONET/SDH PICs.
- I²C controller—Monitors the status of router components.
- Ejector levers—Control the locking system that secures the FEB in the chassis.



Note

For specific information about FEB components (for example, the amount of DRAM), issue the `show chassis feb` command.

Figure 5: Forwarding Engine Board



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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.

The Routing Engine installs into a slot in the FEB at the rear of the chassis. The Routing Engine is field-replaceable, but you must power down the router before removing it from the chassis. Packet forwarding halts until the Routing Engine is replaced and the router is powered on. For replacement instructions, see “Replace the Routing Engine” on page 115.

Routing Engine Components


The Routing Engine (shown in Figure 6) 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 drive—Provides secondary storage for log files, memory dumps, and rebooting the system if the flash drive fails.
- PC card slot—Accepts a removable PC card, which stores 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 craft interface.
- EEPROM—Stores the serial number of the Routing Engine.
- Reset button—Reboots the Routing Engine when pressed.
- Extractor clips—Control the locking system that secures the Routing Engine in the chassis.



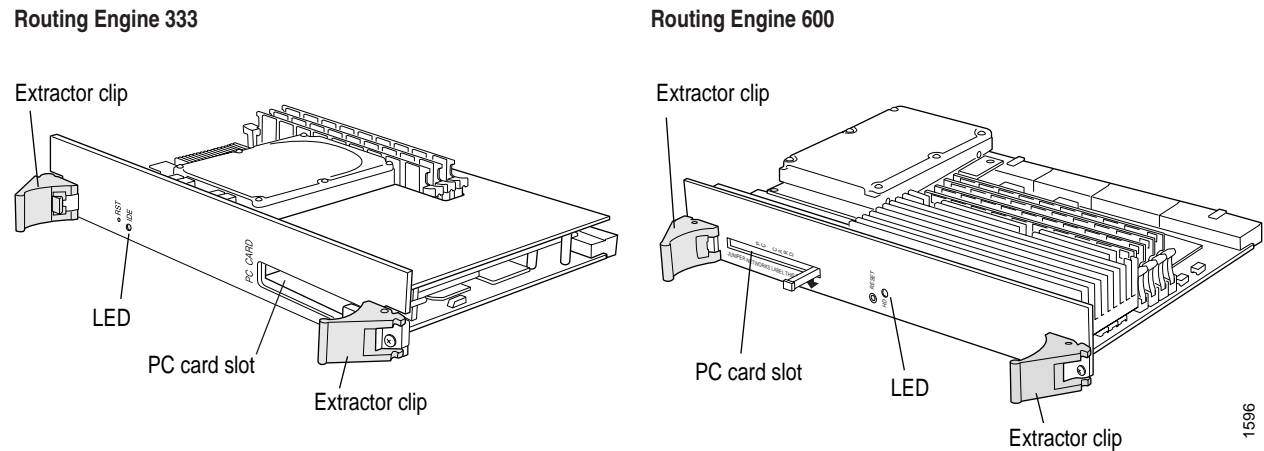
Note

The appearance and position of electronic components or the PC card slot on your Routing Engine might differ from Figure 6 and other figures in this document that depict the Routing Engine. These differences do not affect Routing Engine installation and removal or functionality.



Note For specific information about Routing Engine components (for example, the capacity of the hard drive), issue the `show chassis routing-engine` command.

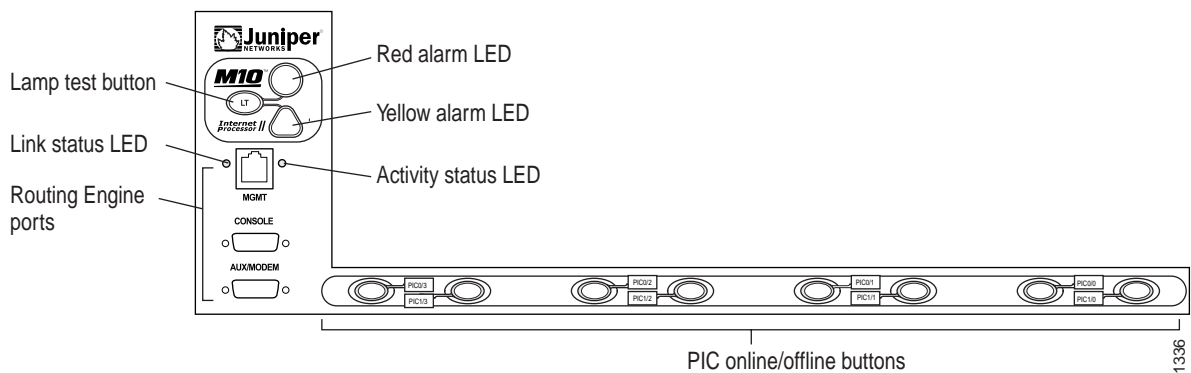
Figure 6: Routing Engine



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 L-shaped craft interface is located along the left and bottom edges of the front of the chassis, as shown in Figure 1 and Figure 2. It includes the elements shown in Figure 7. (The LEDs for the power supplies are located on the power supply faceplate, rather than on the craft interface. For more information, see “Power Supply LEDs and Self-test Button” on page 19.)

Figure 7: Craft Interface



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




- Alarm LEDs and Lamp Test Button on page 15
- Routing Engine Interface Ports and Status Indicators on page 15
- PIC Offline Buttons on page 16

Alarm LEDs and Lamp Test Button

Two large alarm LEDs are located at the top of the craft interface. 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. The button labeled LT (for “lamp test”), located to the left of the alarm LEDs, causes all LEDs on the craft interface to light when pressed and held; use it to test that LEDs are functional.

Table 4 describes the alarm LEDs and lamp test button in more detail.

Table 4: Alarm LEDs and 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.
	—	—	Lamp test button—Causes all LEDs on the craft interface to light (for testing purposes), when pressed and held.

Routing Engine Interface Ports and Status Indicators

Below the alarm LEDs on the craft interface are ports for connecting the Routing Engine to one or more external devices on which system administrators can issue JUNOS command-line interface (CLI) commands to manage the router (see Figure 7). The ports with the indicated label in each set function as follows:

- **MGMT**—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.

To the left of the port is a link status indicator, which lights to show that a link has been established over the Ethernet connection. To the right of the port is an activity indicator, which flashes when data is being transferred.

- **CONSOLE**—Connects the Routing Engine to a system console through an RS-232 (EIA-232) serial cable.
- **AUX/MODEM**— 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 171.

PIC Offline Buttons

An offline button for each PIC is located below the PIC slot along the bottom edge of the craft interface (see Figure 7). The button prepares the PIC for removal from the router when pressed. The buttons are labeled with the PIC slot numbers. The PIC slots on an M5 router and in the upper FPC on an M10 router are numbered from 0/0 (zero/zero) through 0/3, right to left. The PIC slots in the lower FPC on an M10 router are numbered from 1/0 (one/zero) through 1/3, right to left.

Power Supplies

The router uses either AC or DC power. There are two load-sharing, isolated power supplies located at the bottom rear of the chassis, as shown in Figure 3. 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.



Caution

Mixing AC and DC power supplies is not supported. The two power supplies must be either both AC or both DC.

An enable control signal on the output connector of each power supply ensures that the supply is fully seated into the router midplane before the supply can be turned on. The enable pin prevents a user-accessible energy hazard, so there is no interlocking mechanism. The enable pin disables the voltage at the output connector if the power supply is not turned off before removal.

Power supplies are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 3. To avoid electrical injury, carefully follow the instructions in “Replace an AC Power Supply” on page 98 and “Replace a DC Power Supply” on page 104.

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.

**Note**

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 “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.

After a power supply is powered on, it can take up to 60 seconds for status indicators—such as LEDs on the power supply and `show chassis` commands—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 about power system components:

- AC Power Supply on page 17
- DC Power Supply on page 18
- Power Supply LEDs and Self-test Button on page 19

AC Power Supply

An AC-powered router has two load-sharing AC power supplies, located at the bottom rear of the chassis, as shown in Figure 3. For information about power supply redundancy and replaceability, see “Power Supplies” on page 16.

Figure 8 shows the power supply and Table 5 lists electrical specifications. For information about the LED and self-test button, see “Power Supply LEDs and Self-test Button” on page 19.

Figure 8: AC Power Supply

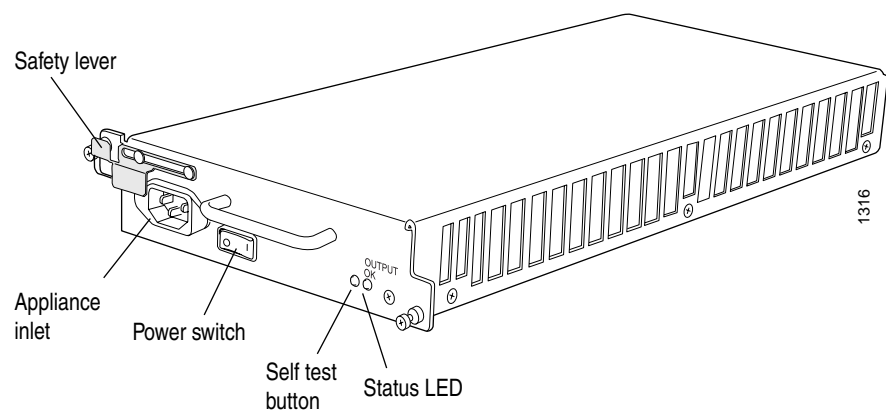


Table 5: Electrical Specifications for AC Power Supply

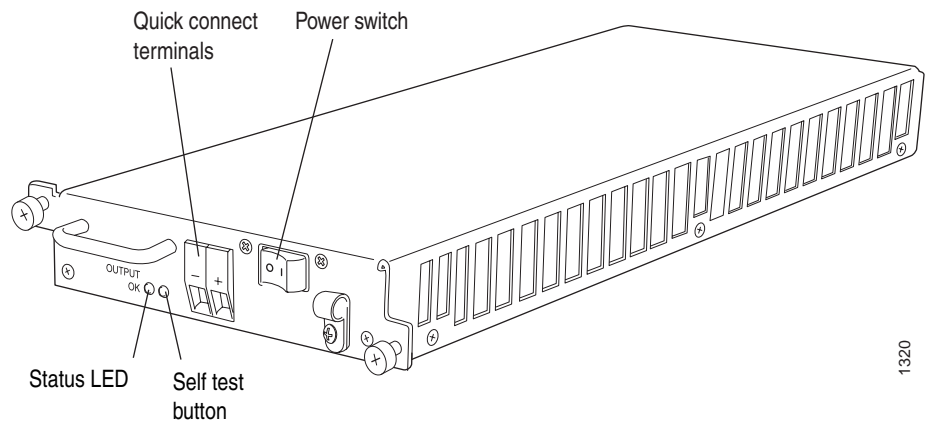
Description	Specification
Maximum power output	800 W
AC input voltage	Nominal range: 100–240 VAC Operating range: 100–264 VAC
AC input line frequency	47 – 63 Hz
AC input current rating	8 – 4 A
Output voltages	+ 1.5 V, + 2.5 V, + 3.3 V, + 5.0 V, + 12 V, + 12 V

DC Power Supply

A DC-powered router has two load-sharing DC power supplies, located at the bottom rear of the chassis, as shown in Figure 3. For information about power supply redundancy and replaceability, see “Power Supplies” on page 16.

Figure 9 shows the power supply and Table 6 lists electrical specifications. For information about the LED and self-test button, see “Power Supply LEDs and Self-test Button” on page 19.

Figure 9: DC Power Supply



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Table 6: Electrical Specifications for DC Power Supply

Description	Specification
Maximum power output	700 W
DC input voltage	Nominal: -48 VDC, -60 VDC Operating range: -42.5 to -72 VDC

Description	Specification
Input DC current rating	13.5 A @ -48 V
Output voltages	+1.5 V, +2.5 V, +3.3 V, +5.0 V, +12 V, +12 V

**Note**

The DC power supplies are marked -48 VDC. This is the nominal voltage associated with the battery circuit. Any higher voltages are to be associated only with float voltages for the charging function.

Power Supply LEDs and Self-test Button

Table 7 describes the LED on both AC and DC power supplies.

Table 7: States for Power Supply LED

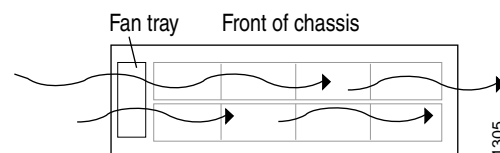
Label	Color	State	Description
OUTPUT OK	Blue	On steadily	Power supply is functioning normally, input is occurring, outputs are within range, and the temperature is within range.
		Blinking	Power supply has failed.

The self-test button on the power supply faceplate initiates a self-test sequence. Do not press this button; it is for use by qualified service personnel only.

Fan Tray

The router cooling system consists of a fan tray that installs into the chassis from the rear, as shown in Figure 3. It houses four fans, which draw room air into the chassis to keep the internal temperature below a maximum acceptable level. The air flows side-to-side in the chassis, as shown in Figure 10.

Figure 10: Airflow through the Chassis



The fan tray is hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 3. For instructions on replacing it, see “Replace the Fan Tray” on page 82.



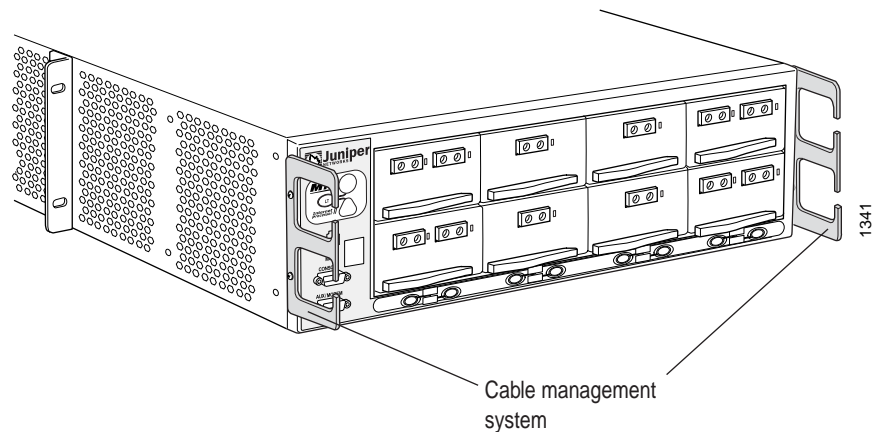
Caution

Do not remove the fan tray for more than a about one minute while the router is operating. The fans are the sole source of cooling, and the router can overheat when they are absent.

Cable Management System

The cable management system consists of racks that attach vertically to each side of the chassis at the front, as shown in Figure 11. Pass PIC cables through the openings in the racks to keep the cables organized and securely in place, and to avoid bending optical cables beyond the proper bend radius. The cable management system evenly distributes the weight of a cable, so that it is not subjected to undue stress at the connector.

Figure 11: 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 Internet Software Configuration Guide: Getting Started*. 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 21
- Tools for Accessing and Configuring the Software on page 27
- Tools for Monitoring the Software on page 27
- Software Upgrades on page 28

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 22
- VPNs on page 26
- Interface Process on page 26
- Chassis Process on page 26

- SNMP and MIB II Processes on page 26
- Management Process on page 27
- Routing Engine Kernel on page 27

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 22
- IPv6 Routing Protocols on page 24
- Routing and Forwarding Tables on page 24
- Routing Policy on page 25

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 25.

- 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 Internet Software Configuration Guide: Routing and Routing Protocols*.

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, IGP (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 Internet Software Configuration Guide: Getting Started*.

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 Internet Software Configuration Guide: Network Management*.

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 Internet Software Configuration Guide: Getting Started*.

Chapter 4

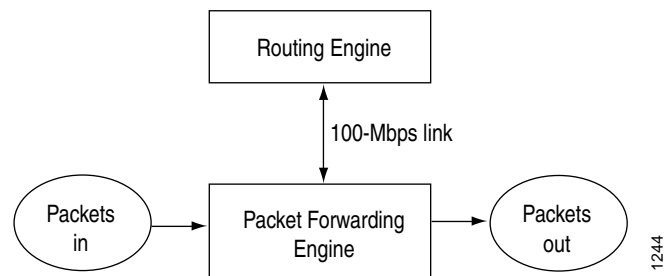
System Architecture Overview

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 12 illustrates the relationship between the Packet Forwarding Engine and the Routing Engine.

Figure 12: System Architecture



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

- Packet Forwarding Engine Architecture on page 29
- Routing Engine Architecture on page 31

Packet Forwarding Engine Architecture

The Packet Forwarding Engine performs Layer 2 and Layer 3 packet switching. It can forward up to 40 for all packet sizes. The aggregate throughput for the router is 6.4 gigabits per second (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:

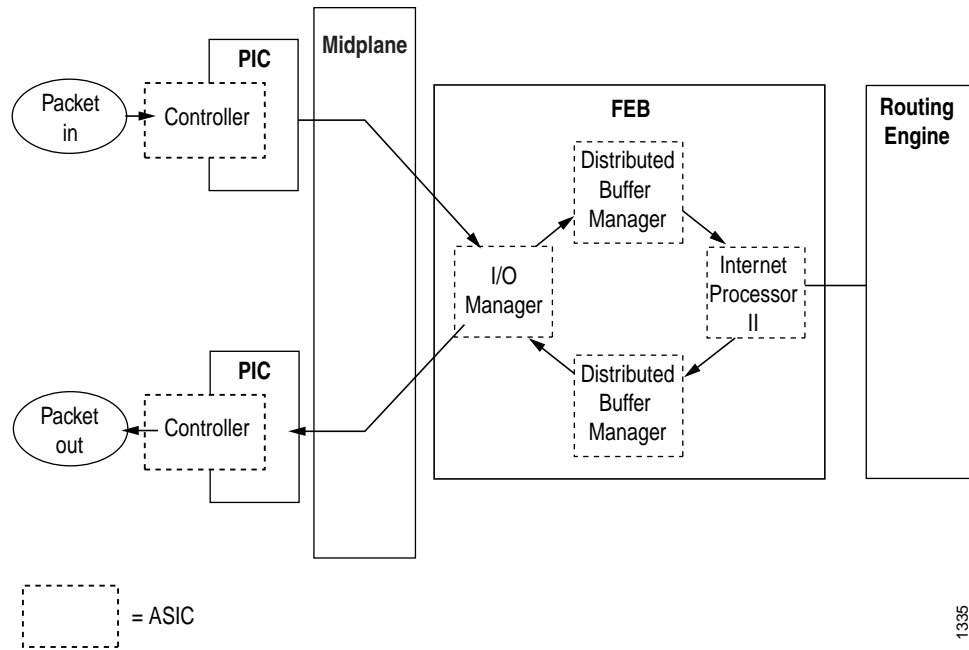
- Midplane—Transports packets, notifications, and other signals between the PICs and the Packet Forwarding Engine (as well as other system components).
- Physical Interface Card (PIC)—Physically connects the router to fiber-optic or digital network media. A controller ASIC in each PIC performs control functions specific to the PIC media type.
- Forwarding Engine Board (FEB)—Hosts the Internet Processor II ASIC, I/O Manager ASIC (one on the M5 router, two on the M10 router), and two Distributed Buffer Manager ASICs. An I/O Manager ASIC divides incoming packets into 64-byte data cells and reassembles cells into data packets for transmission on the network after the Internet Processor II ASIC decides how to forward the packets. One Distributed Buffer Manager ASIC distributes the data cells among the memory buffers on the FEB and the other notifies the PICs of the forwarding decision 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 13):

1. Packets arrive at an incoming PIC interface.
2. The PIC passes the packets through the midplane to the FEB.
3. An I/O Manager ASIC on the FEB processes the packet headers and divides the packets into 64-byte data cells.
4. A Distributed Buffer Manager ASIC on the FEB distributes the data cells throughout the memory buffers on the FEB.
5. The Internet Processor II ASIC on the FEB performs a route lookup for each packet and decides how to forward it.
6. The Internet Processor II ASIC notifies the second Distributed Buffer Manager ASIC of the forwarding decision, and the Distributed Buffer Manager ASIC forwards the notification to the appropriate outbound PIC.
7. The I/O Manager ASIC on the FEB reassembles data cells stored in shared memory into data packets as they are ready for transmission and passes them to the outbound PIC.
8. The outbound PIC transmits the data packets.

Figure 13: Packet Forwarding Engine Components and Data Flow

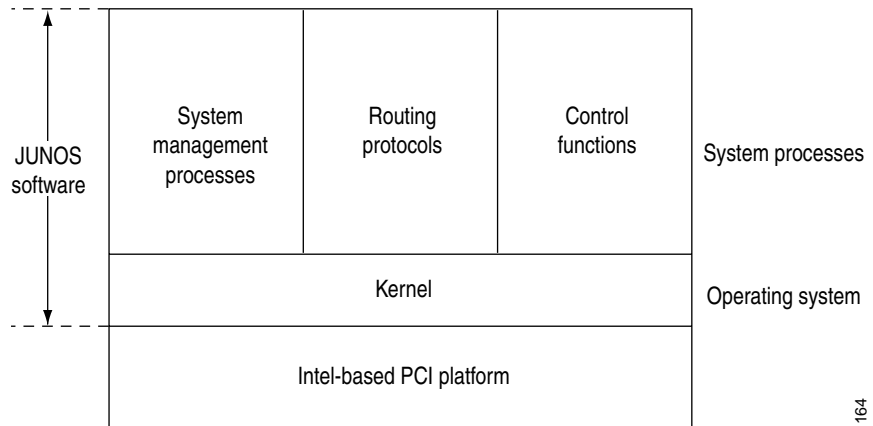


Routing Engine Architecture

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 14).

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

Figure 14: 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 21.

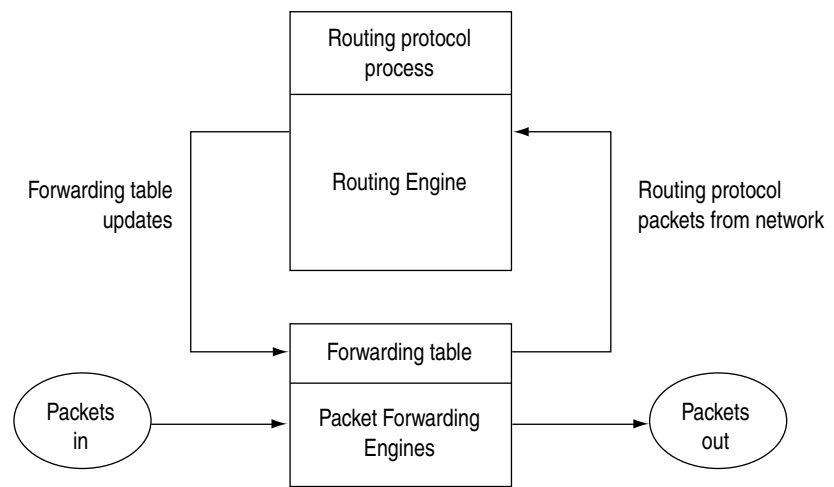
The Routing Engine includes the following functions and features:

- 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. 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. See Figure 15.

Figure 15: Control Packet Handling for Routing and Forwarding Table Updates



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Part 2

Initial Installation

- Prepare for Router Installation on page 37
- Unpack the Router on page 55
- Install the Router on page 59
- Connect the Router and Perform Initial Configuration on page 61

Chapter 5

Prepare for Router Installation

This chapter describes how to prepare your site for installation of the M5 and M10 Internet routers. It discusses the following topics:

- Rack Requirements on page 37
- Clearance Requirements for Airflow and Hardware Maintenance on page 40
- Router Environmental Tolerances on page 40
- Fire Safety Requirements on page 41
- Power Guidelines, Requirements, and Specifications on page 42
- Network Cable Specifications and Guidelines on page 48
- Cable Specifications for Routing Engine Management Interfaces on page 52
- Site Preparation Checklist on page 52

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 16.

The following sections describe rack requirements:

- Rack Size and Strength on page 37
- Spacing of Mounting Holes on page 39
- Connection to Building Structure on page 39

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 are usually wider than the router's mounting ears, 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: 5.25 in. (13.3 cm) high, 24 in. (61 cm) deep, and 17.5 in. (44.5 cm) wide. The outer edges of the mounting ears 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 40.



Note

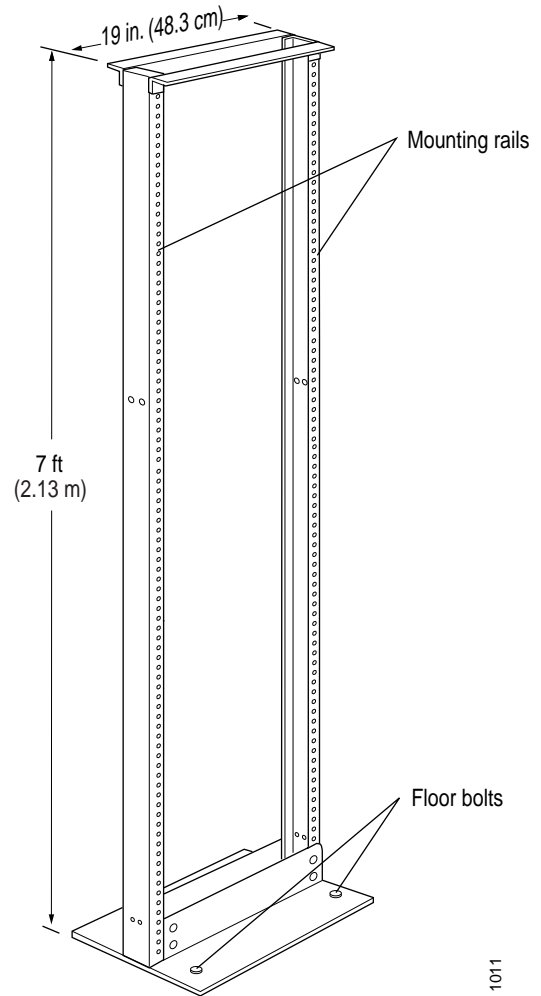
The router might not fit into an 800-mm-deep cabinet, even if you adjust the front-to-back position of the front mounting rails inside the cabinet.

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 5.25 in. (13.3 cm) equals 3 U, 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 14 M5 and M10 routers in a rack that has at least 42 U (73.5 in. or 1.87 m) of usable vertical space.

The rack must be strong enough to support the weight of the fully configured router, up to about 61 lb (27.6 kg) for the M5 router or 67 lb (29.5 kg) for the M10 router. If you stack 14 routers in one rack, it must be capable of supporting about 940 lb (427 kg).

Figure 16: Typical Center-Mount Rack

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Spacing of Mounting Holes

The holes in the mounting brackets are spaced at 2 U (3.5 in. or 8.89 cm), so the router can be mounted in any rack that provides holes spaced at that distance.

Connection to Building Structure

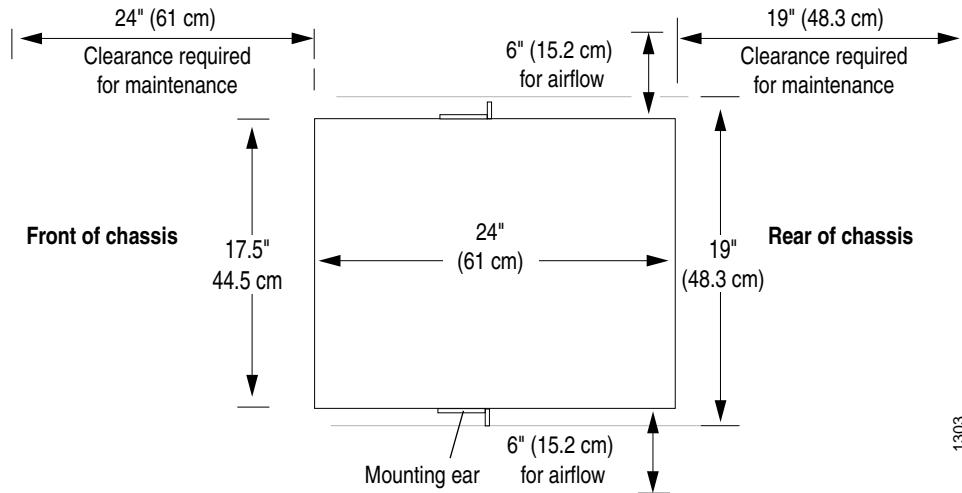
Always secure the rack to the structure of the building. If your geographical area is subject to earthquakes, bolt the rack to the floor. For maximum stability, also secure the rack to ceiling brackets. For more information, see “Rack-Mounting Requirements and Warnings” on page 147.

Clearance Requirements for Airflow and Hardware Maintenance

When planning the installation site, you need to allow sufficient clearance around the rack (see Figure 17):

- For the cooling system to function properly, the airflow around the chassis must be unrestricted. Allowing at least 6 in. (15.2 cm) of clearance between each side of the chassis and adjacent racks or equipment is recommended, particularly for routers in which air flows from side to side through the chassis. Figure 10 depicts the airflow in the M5 and M10 routers.
- 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) in front of the router and 19 in. (48.3 cm) behind it.

Figure 17: Chassis Dimensions and Clearance Requirements



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Router Environmental Tolerances

Table 8 specifies the environmental conditions 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 “Maintain Hardware Components” on page 75.

Table 8: Router Environmental Tolerances

Description	Tolerance
Altitude	No performance degradation to 10,000 ft (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5% to 90%, noncondensing

Description	Tolerance
Temperature	Normal operation ensured in temperature range of 32° F to 104° F (0° C to 40° C)
Seismic	Designed to meet Bellcore Zone 4 earthquake requirements

**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 129.

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 41.

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 either AC or DC power. There are two load-sharing, isolated power supplies located at the bottom rear of the chassis, as shown in Figure 3. 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.



Caution

Mixing AC and DC power supplies is not supported. The two power supplies must be either both AC or both DC.

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

- Site Electrical Wiring Guidelines on page 43
- Router Power Requirements on page 43
- AC Grounding and Power Cord Specifications on page 45
- DC Grounding, Connection, and Cable Specifications on page 46

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 9 lists the power requirements for various hardware components when the router is operating under typical voltage conditions. For PIC power requirements, see the *M5 and M10 Internet Routers PIC Guide*.

Table 9: Component Power Requirements

Component	Power Requirement (Watts)	Power Requirement (Amps)
Base system (all components except PICs, with fans running at normal speed)	188 (approximate)	4 A/48 V (approximate)
Fans running at full speed (additional power required)	40 (approximate)	0.833 A/48 V
Routing Engine	17	0.2 A/48 V
FEB	50	1.1 A/48 V

You can use the information in Table 9 and the *M5 and M10 Internet Routers 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:

$$\begin{aligned} &\text{Base system} + 1 \text{ FEB} + 1 \text{ Routing Engine} + 1 \text{ PIC} = \\ &4 \text{ A} + 1.1 \text{ A} + 0.2 \text{ A} + 0.625 \text{ A} = 5.925 \text{ A @ } 48 \text{ V} = 284 \text{ W DC} \end{aligned}$$

- Power consumption for maximum configuration (M5 router):

$$\begin{aligned} &\text{Base system} + 1 \text{ FEB} + 1 \text{ Routing Engine} + 4 \text{ PICs} = \\ &4 \text{ A} + 1.1 \text{ A} + 0.2 \text{ A} + 4(0.625 \text{ A}) = \\ &4 \text{ A} + 1.1 \text{ A} + 0.2 \text{ A} + 2.5 \text{ A} = 9.6 \text{ A @ } 48 \text{ V} = 461 \text{ W DC} \end{aligned}$$

- Power consumption for maximum configuration (M10 router):

$$\begin{aligned} &\text{Base system} + 1 \text{ FEB} + 1 \text{ Routing Engine} + 8 \text{ PICs} = \\ &4 \text{ A} + 1.1 \text{ A} + 0.2 \text{ A} + 8(0.625 \text{ A}) = \\ &4 \text{ A} + 1.1 \text{ A} + 0.2 \text{ A} + 5 \text{ A} = 10.3 \text{ A @ } 48 \text{ V} = 494 \text{ W DC} \end{aligned}$$

- Input current from a DC source other than 48 V (based on maximally configured M10 router; applies to DC power supply only):

$$\begin{aligned} &(54 \text{ VDC input}) \times (\text{input current } X) = (48 \text{ VDC input}) \times (\text{input current } Y) \\ &54 \times X = 48 \times 10.3 \text{ A} \\ &X = 48 \times 10.3 \text{ A} / 54 = 9.1 \text{ A} \end{aligned}$$

- System thermal output for maximally configured AC-powered M10 router:

$$\begin{aligned} &\text{Watts DC} / 0.85 / 0.293 = \text{BTU/hr} \\ &494 / 0.85 / 0.293 = 1984 \text{ BTU/hr} \end{aligned}$$

- System thermal output for maximally configured DC-powered M10 router:

$$\begin{aligned} &\text{Watts DC} / 0.293 = \text{BTU/hr} \\ &494 / 0.293 = 1686 \text{ BTU/hr} \end{aligned}$$

**Note**

If you plan to operate a maximally configured DC-powered router, we recommend that you provision at least 13.5 A @ 48 VDC and use a facility circuit breaker rated for 20 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 a DC-powered router at less than the maximum configuration and do not provision a 20 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.

AC Grounding and Power Cord Specifications

To ground an AC-powered router, plug each power supply into a grounded AC power receptacle. The receptacle provides the grounding for the router, so no additional grounding is necessary. The receptacle must be within about 8 ft (2.5 m) of the router and must be easily accessible.

Detachable AC power cords, each 2.5 m (approximately 8 ft) long, are supplied with the router. The appliance coupler at the female end of the cord inserts into the appliance inlet on the faceplate of the AC power supply. The coupler is type C13 as described by International Electrotechnical Commission (IEC) standard 60320. The plug at the male end of the power cord fits into the power source receptacle that is standard for your geographical location.

**Note**

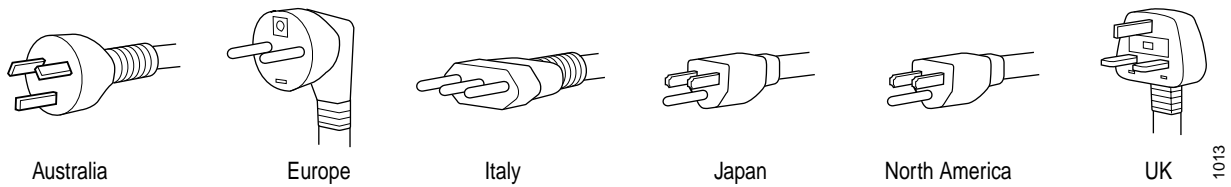
In North America, AC power cords must not exceed 4.5 m (approximately 14.75 ft) in length, to comply with National Electrical Code (NEC) Sections 400-8 (NFPA 75, 5-2.2) and 210-52, and Canadian Electrical Code (CEC) Section 4-010(3). The cords supplied with the router are in compliance.

Table 10 provides specifications and Figure 18 depicts the plug on the AC power cord provided for each country or region.


Table 10: AC Power Cord Specifications

Country	Electrical Specification	Plug Type
Australia	240 VAC, 50 Hz AC	SAA/3
Europe (except Italy and United Kingdom)	220 or 230 VAC, 50 Hz AC	VII
Italy	230 VAC, 50 Hz AC	I/3/16
Japan	110 VAC, 50 or 60 Hz AC	498 G
North America	120 VAC, 60 Hz AC	NEMA 5-15P
United Kingdom	240 VAC, 50 Hz AC	BS89/3

Figure 18: AC Plug Types



For information about the AC power supply, including electrical specifications and a description of components, see “AC Power Supply” on page 17. For instructions on connecting the power cord during initial installation, see “Connect Power to an AC-Powered Router” on page 65. For instructions on replacing the power cord on an operating router, see “Disconnect and Connect AC Power” on page 101.



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


DC Grounding, Connection, and Cable Specifications

To ground a DC-powered router, connect a grounding cable to earth ground and then attach it to one of the chassis grounding points on the upper rear edge of the chassis. To supply power to the router, connect power cables to a separate, dedicated DC power source for each power supply and attach the cables to the quick connect terminals on each power supply. Most sites distribute DC power through a main conduit that leads to frame-mounted DC 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 the quick connect terminals to the power distribution panel.

Table 11 summarizes the specifications for the grounding and power cables, which you supply.


Table 11: DC Power and Grounding Cable Specifications

Cable Type	Quantity and Specification	Maximum Equal Length
Power	Two 12-AWG (3.33 mm ²) single-strand-count wire cables	None
Grounding	One 12-AWG (3.33 mm ²) single-strand-count wire cable	None

 For field-wiring connections, use copper conductors only.

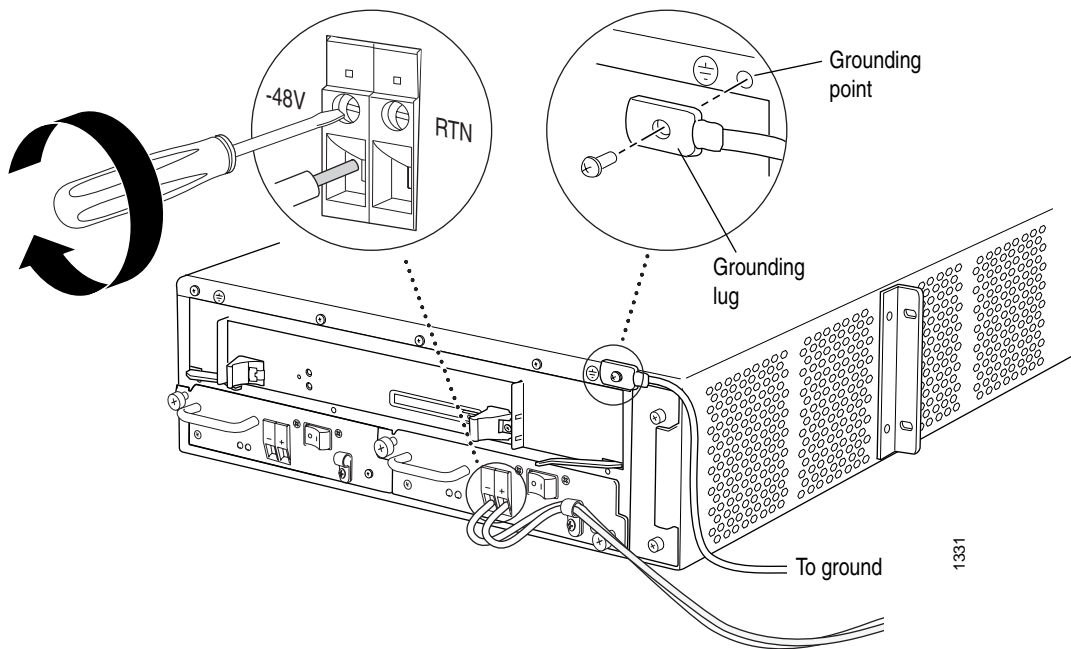
Warning For other electrical safety information, see “Electrical Safety Guidelines and Warnings” on page 135.

Figure 19 shows how to attach the grounding and power cables. The grounding cable attaches to one of the grounding points on the upper edge of the router rear panel. The accessory box shipped with the router contains the lug used to secure the grounding cable the grounding point. The power cables insert into the quick connect terminals located on each power supply—the input terminal is labeled **-48V** and the return terminal is labeled **RTN**.

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

Caution

Figure 19: DC Power and Grounding Cable Connections



For information about the DC power supply, including electrical specifications and a description of components, see “DC Power Supply” on page 18. For instructions on

connecting the DC power and grounding cables during initial installation, see “Connect Power to a DC-Powered Router” on page 66. For instructions on replacing the cables on an operating router, see “Disconnect and Connect DC Power” on page 108.



Note

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

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 48
- Signal Loss in Multimode and Single-Mode Fiber-Optic Cable on page 48
- Attenuation and Dispersion in Fiber-Optic Cable on page 49
- Calculating Power Budget for Fiber-Optic Cable on page 49
- Calculating Power Margin for Fiber-Optic Cable on page 50
- Attenuate to Prevent Saturation at SONET/SDH PICs on page 51

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 *M5 and M10 Internet Routers 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 M5 and M10 routers, see the *M5 and M10 Internet Routers 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 49.

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 49), 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 12 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 12: 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 12 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:

$$P_M = P_B - LL$$

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

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

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

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 12 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:

$$P_M = P_B - LL$$

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

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

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

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.

Attenuate 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 potentially 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 M5 and M10 routers, see the *M5 and M10 Internet Routers PIC Guide*.

Cable Specifications for Routing Engine Management Interfaces

For management and service operations, you connect the Routing Engine to an external console or management network through ports on the craft interface. For information about the ports, see “Routing Engine Interface Ports and Status Indicators” on page 15.

Table 13 lists the specifications for the cables that connect to management ports.

Table 13: Cable Specifications for Routing Engine Management Interfaces

Port	Cable Specification	Cable/Wire Supplied	Maximum Length	Router Receptacle
Routing Engine console or auxiliary interface	RS-232 (EIA-232) serial	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

Site Preparation Checklist

The checklist in Table 14 summarizes the tasks you need to perform when preparing a site for router installation.

Table 14: 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 “Router Environmental Tolerances” on page 40).			
Measure distance between external power sources and router installation site.			

Item or Task	Performed By	Date	Notes
Select the type of rack.			
Plan rack location, including required space clearances.			
Secure rack to floor and building structure.			
Acquire cables and connectors.			
Locate sites for connection of system grounding.			
Calculate power budget and power margin.			

Chapter 6

Unpack the Router

This chapter explains how to unpack the router and verify the parts received. Before beginning, prepare the installation site as described in “Prepare for Router Installation” on page 37 and review the safety information in “Safety and Regulatory Compliance Information” on page 129, especially “General Safety Guidelines and Warnings” on page 131 and “Installation Safety Guidelines and Warnings” on page 146. This chapter discusses the following topics:

- Tools Required on page 55
- Unpack the Router on page 55
- Choose Front or Center Mounting on page 57

Tools Required

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

- Utility knife for cutting the sealing tape on the shipping carton
- Phillips (+) screwdriver, to move the mounting brackets and install the support shelf if front-mounting the router

Unpack the Router

The router is shipped in a cardboard carton, held in place with foam packing material. The crate also contains an accessory box, the front-mounting shelf, and the *M5 and M10 Internet Router Installation Quick Start* poster.



Note

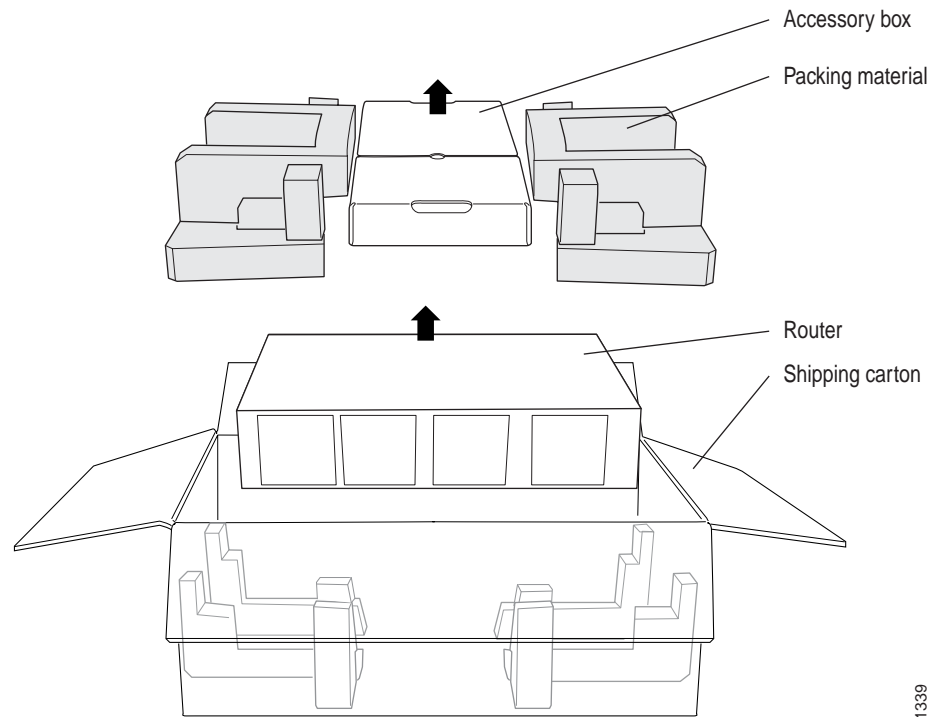
The router is maximally protected inside the shipping carton. Do not unpack it until you are ready to begin installation.

To unpack the router, perform these steps:

1. Move the shipping carton to a staging area as close to the installation site as possible.

2. Position the carton so that the arrows are pointing up.
3. Using a utility knife, cut through the sealing tape on the top seam of the carton. Open the top flaps of the carton.
4. Remove the accessory box and packing material from the top of the router.
5. Open the accessory box and verify the contents against the parts inventory on the label attached to the box.
6. Remove the router from the shipping carton.
7. Verify the chassis components received against the packing list included with the router. A generic parts inventory appears in Table 15.
8. Save the shipping carton, packing materials, and pallet in case you later need to move or ship the router.

Figure 20: Unpack the Router



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Table 15: Generic Inventory of Router Components

Component	Quantity
Fan tray	1
FEB	1

Component	Quantity
Front-mounting shelf	1
Mounting ears	2
PIC and PIC blank	Up to 4 on an M5 router Up to 8 on an M10 router
Power supply	2
Routing Engine	1

Choose Front or Center Mounting

You can mount the router into either a center-mount rack, or into front-mount rack, four-post rack, or cabinet. In general, a center-mount rack is preferable, because the more even distribution of weight in the center-mount rack provides greater stability. If installing the router in a front-mount rack, four-post rack, or cabinet, use the shelf that is provided in the shipping carton to support the router. Before router installation, attach the shelf to the back of the support posts in a front-mount rack, or to the front side of the rear posts in a four-post rack or cabinet.

The router is shipped with the mounting ears installed in the center-mounting position, as shown in Figure 1 and Figure 2. If you are front-mounting the router, use a Phillips screwdriver to remove the mounting ears from the center-mounting position. Remove the screws from the two holes on each side of the chassis that are approximately 1.5 in. (3.8 cm) back from the router faceplate. Install the mounting ears into those holes. If front-mounting the router, also install the support shelf into the rack before installing the chassis. Attach the shelf to the rear of the rack's front posts.

Choose Front or Center Mounting

Chapter 7

Install the Router

Because the router weighs between 57 lb (25.8 kg) and about 61 lb (27.6 kg) for the M5 router or 67 lb (29.5 kg) for the M10 router, using a mechanical lift to install it is recommended.

If you do not use a mechanical lift, installing the chassis safely requires two people to lift and an additional person to insert the mounting screws.

This chapter has the following sections:

- Tools and Parts Required on page 59
- Install the Chassis into the Rack on page 59

Tools and Parts Required

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

- Mechanical lift (recommended)
- Phillips (+) screwdrivers, numbers 1 and 2

Install the Chassis into the Rack

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 57 lb (25.8 kg) and about 61 lb (27.6 kg) for the M5 router or 67 lb (29.5 kg) for the M10 router depending on configuration—and must fit between the support posts of the rack.



Note

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

First, perform the following prerequisite procedures:

- Verify that the router site meets the requirements described in “Prepare for Router Installation” on page 37.

- 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 37.
- Read the information in “Installation Safety Guidelines and Warnings” on page 146, with particular attention to “Chassis Lifting Guidelines” on page 146.
- Remove the router from the shipping carton, as described in “Unpack the Router” on page 55.

Then, perform the following procedures to install the router:

1. If you are front-mounting the router, move the mounting ears on the chassis from the center-mounting position to the front-mounting position, and install the support shelf. For instructions, see “Choose Front or Center Mounting” on page 57.
2. Position the chassis at the appropriate height in the rack:
 - If using a mechanical lift, load the router onto the lift, making sure it rests securely on the lift platform. Use the lift to raise the chassis to the correct height.
 - If not using a mechanical lift, have one person stand behind the router and another person in front. Grasp the chassis, lift it, and position it at the correct height. Have a third person ready to install the mounting screws.
3. Align the bottom hole in both mounting ears with a hole in each rack rail, making sure the chassis is level.
4. Install one of the mounting screws provided (in the accessory box shipped with the router) into each of the two aligned holes. Use a Phillips screwdriver to tighten the screws.
5. Install a mounting screw into the top hole in each mounting ear.
6. Verify that the router is level.
7. If using a mechanical lift, move it away from the rack.
8. To continue the installation, proceed to “Connect the Router and Perform Initial Configuration” on page 61.

Chapter 8

Connect the Router and Perform Initial Configuration

After installing the router into the rack as described in “Initial Installation” on page 35, 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 61
- Connect the Router to Management Devices on page 61
- Connect PIC Cables on page 63
- Provide Power to the Router on page 65
- Configure the JUNOS Internet Software on page 69

Tools and Parts Required

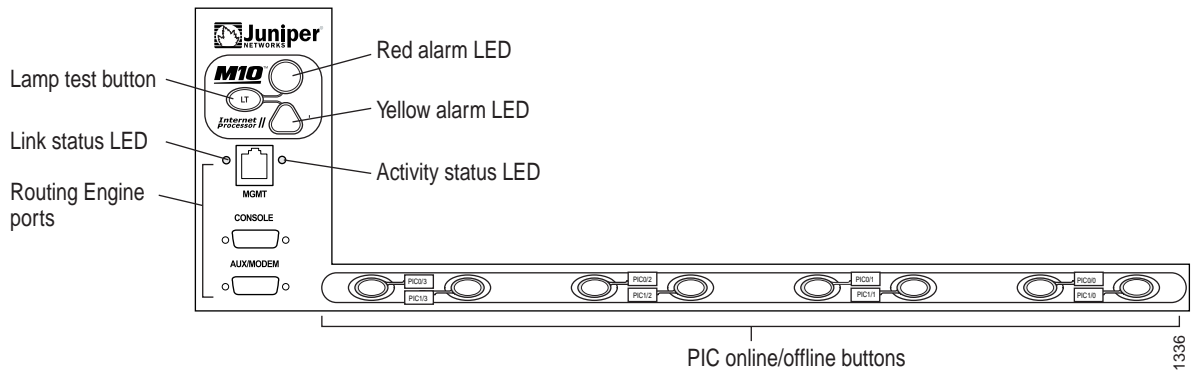
To connect the router to management devices and PICs and to power on the router, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- Flat-blade (-) screwdrivers, 2.5 mm and 3 mm
- Electrostatic damage (ESD) grounding wrist strap

Connect the Router to Management Devices

After you have installed the router into the rack, attach one or more external devices to the ports on the craft interface that connect to the Routing Engine for management and service operations (see Figure 21). For specifications for the cable accepted by the Routing Engine management ports, see “Cable Specifications for Routing Engine Management Interfaces” on page 52.

Figure 21: Routing Engine Management Ports



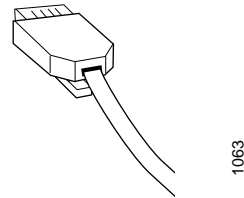
To connect external devices to the Routing Engine management ports, perform the procedures described in the following sections:

- Connect to a Network for Out-of-Band Management on page 62
- Connect to a Management Console or Auxiliary Device on page 63

Connect 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 **MGMT** port on the craft interface. One such cable is provided with the router. For cable specifications, see “Cable Specifications for Routing Engine Management Interfaces” on page 52. Follow this procedure:

1. Turn off the power to the management device.
2. Plug one end of the Ethernet cable (Figure 22 shows the connector) into the **MGMT** port on the craft interface (see Figure 21).
3. Plug the other end of the cable into the network device.

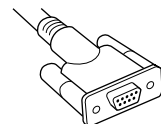
Figure 22: Routing Engine Ethernet Cable Connector

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Connect to a Management Console or Auxiliary Device

To use a system console to configure and manage the Routing Engine, connect it to the **CONSOLE** port on the craft interface. To use a laptop, modem, or other auxiliary device, connect it to the appropriate **AUX/MODEM** port on the craft interface. 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. See “Cable Specifications for Routing Engine Management Interfaces” on page 52. 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 23) of the provided console cable into the **CONSOLE** or **AUX/MODEM** port (see Figure 21).
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 23: Console and Auxiliary Serial Port Connector


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Connect PIC Cables

Now connect PICs to the network by plugging in network cable. To connect cable to the PICs, follow this procedure (see Figure 24, 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 *M5 and M10 Internet Routers 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.


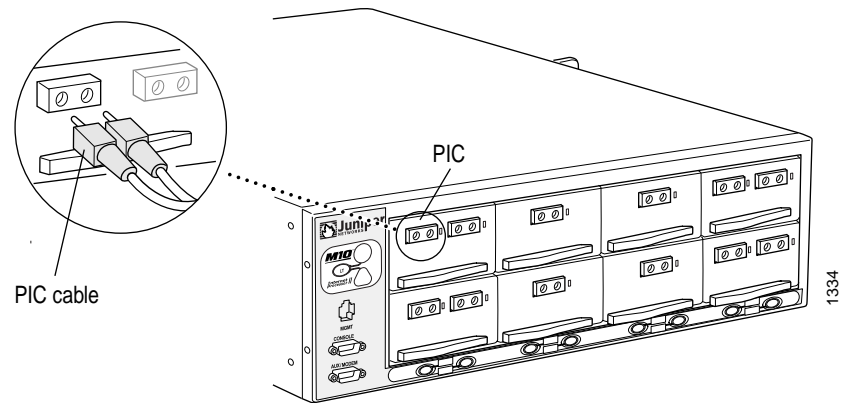
**Caution** Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.

Figure 24: Attach Cable to a PIC

Provide Power to the Router

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

- Connect Power to an AC-Powered Router on page 65
- Connect Power to a DC-Powered Router on page 66
- Power On the Router on page 67

Connect Power to an AC-Powered Router

Connect AC power to the router by plugging the power cord supplied with each power supply into the appliance inlet on the power supply faceplate and into an AC power source receptacle. Follow this procedure:

1. Locate the power cords shipped with the router, which should have a plug appropriate for your geographical location (see “AC Grounding and Power Cord Specifications” on page 45).
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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
3. Verify that the switch on each power supply faceplate is in the **OFF (O)** position.
4. For each power supply, insert the appliance coupler end of a power cord into the appliance inlet on a power supply faceplate and insert the plug into an AC power source receptacle. Verify that the power cord does not block access to router components or drape where people could trip on it.

Connect Power to a DC-Powered Router

Connect DC power to the router by inserting power cables from external DC power sources into the quick-connect terminals on the faceplate of each power supply. Power and grounding cables are not supplied with the router. For information about the required cable type, see “DC Grounding, Connection, and Cable Specifications” on page 46.



Note

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



Caution

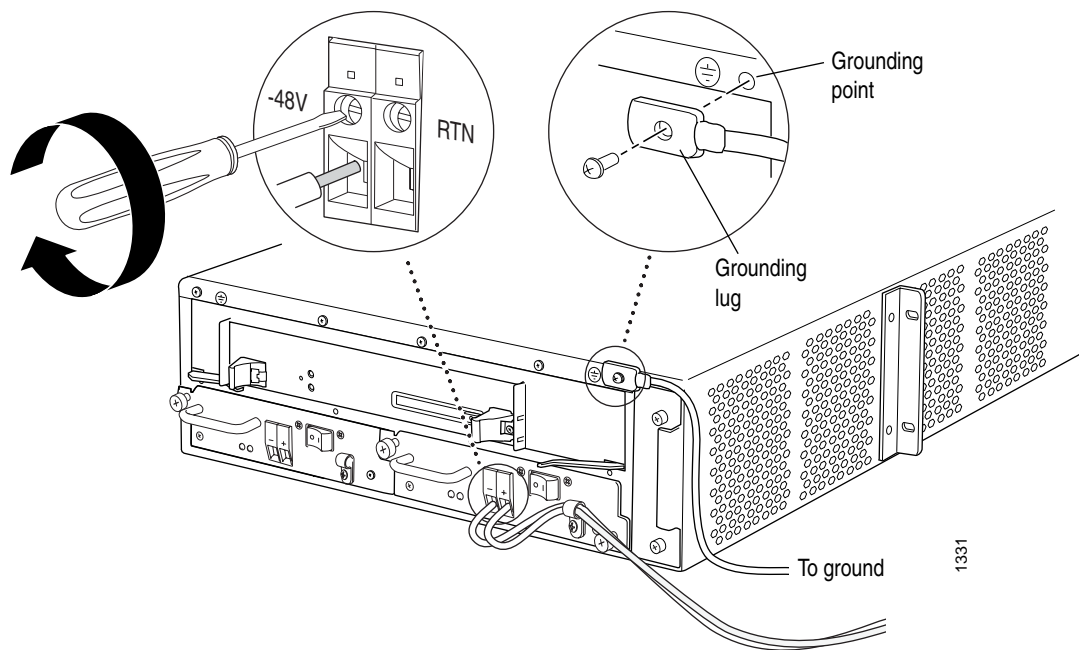
There is no standard color coding for DC power cables. The color coding used by the external DC power source at your site determines the color coding for the leads on the power cables that attach to the terminal studs on the power supply faceplate. You must ensure that power connections maintain the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

To connect DC power to the router, follow this procedure (see Figure 25):

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 power supply faceplate is in the OFF (O) position.
3. Connect the grounding cable to a proper earth ground for both external DC power sources, if it is not already.
4. Verify that a licensed electrician has attached the cable lug provided with the router to the grounding cable.
5. Using a Phillips screwdriver, remove the screw that is next to one of the grounding symbols along the upper edge of the chassis rear. Secure the grounding cable lug to the chosen grounding point by reinstalling and tightening the screw.
6. If necessary, strip a short section of the protective cladding from the end of each power cable so that the metal core can come in direct contact with the quick-connect terminal.
7. Thread the power cables through the hook located on the faceplate to the right of the quick-connect terminals.

8. Insert the exposed end of each power cable straight into the appropriate quick-connect terminal:
 - Insert the positive (+) source cable into the return terminal, which is labeled RTN.
 - Insert the negative (-) source cable into the input terminal, which is labeled -48V.
9. Using a 3-mm flat-blade screwdriver, turn the screw on each quick-connect terminal clockwise to tighten the terminal connector around the cable.
10. Verify that the DC 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.

Figure 25: Connect DC Power and Grounding Cables



Power 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 on an AC-powered router, verify that the ends of the power cord are firmly plugged into the appliance inlet on the power supply faceplate and the external power source receptacle.

For each power supply on a DC-powered router, verify that the source DC power cables are connected to the appropriate terminal on the power supply faceplate: 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 craft interface (**AUX/MODEM**, **CONSOLE**, or **MGMT**). For more information on connecting management devices, see “Connect the Router to Management Devices” on page 61.
4. Turn on the power to the external management device.
5. Press the power switch for one power supply to the **ON** (|) position. On both AC and DC power supplies, the switch is located on the power supply faceplate.
6. Verify that the **OUTPUT OK** LED on the power supply faceplate eventually lights steadily.

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.



Note

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 “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.

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

7. Press the power switch for the second power supply to the **ON** (|) position and verify that the **OUTPUT OK** LED on the power supply faceplate lights steadily. If the LED does not light after 60 seconds, verify that the power supply is properly inserted into the chassis and repeat the cable installation procedures described in “Connect Power to an AC-Powered Router” on page 65 or “Connect Power to a DC-Powered Router” on page 66.
8. On the external management device connected to the Routing Engine, monitor the startup process to verify that the system has booted properly.

Configure 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 craft interface, or over a telnet connection to a network connected to the **MGMT** port on the craft interface. 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 “Power On the Router” on page 67.
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>
```

The commands in Steps 5 through 12 connect the router to the network but do not enable it to forward traffic. For complete information about the commands to issue in Step 13, including examples, see the JUNOS Internet software configuration guides.

Part 3

Hardware Maintenance, Replacement, and Troubleshooting Procedures

- Maintain Hardware Components on page 75
- Replace Hardware Components on page 81
- Troubleshoot Hardware Components on page 121

Chapter 9

Maintain Hardware Components

This chapter describes how to maintain hardware components installed in the router. For information about returning a part to Juniper Networks for repair or replacement, see “Return the Router or Its Components” on page 163.

- Routine Maintenance Procedures on page 75
- Maintain the Fan Tray on page 75
- Maintain Packet Forwarding Engine Components on page 76
- Maintain the Power Supplies on page 78
- Maintain the Routing Engine on page 79

Routine Maintenance Procedures

For optimum router performance, perform the following preventive maintenance procedures on a regular basis:

- Inspect the installation site for potential problems caused by moisture, loose wires or cables, and excessive dust. Make sure that airflow around the router is unobstructed.
- Check the LEDs on the craft interface and on hardware components. See “Craft Interface” on page 14.

Maintain the Fan Tray

The fan tray installs into the rear of the chassis, as shown in Figure 3. To check the status of the fans in the fan tray, issue the `show chassis environment` command. The output includes an entry for each fan, as shown in this example:

```
user@host> show chassis environment
Class Item                Status Measurement
...
Fans  Left Fan 1           OK      Spinning at normal speed
      Left Fan 2           OK      Spinning at normal speed
      Left Fan 3           OK      Spinning at normal speed
      Left Fan 4           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*.

Maintain Packet Forwarding Engine Components

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

- Maintain the FEB on page 76
- Maintain PICs and PIC Cables on page 76

Maintain the FEB

The Forwarding Engine Board (FEB) installs into the rear of the chassis, as shown in Figure 3. To maintain the FEB, perform the following procedures on a regular basis:

- Check the system logging messages on the management console. The FEB notifies the Routing Engine of any errors it detects during normal operation.
- Issue the CLI `show chassis feb` command to check the status of the FEB.

```
user@host> show chassis feb
FEB status:
  Temperature           32 degrees C / 89 degrees F
  CPU utilization       3 percent
  Interrupt utilization  0 percent
  Heap utilization      18 percent
  Buffer utilization     44 percent
  Total CPU DRAM       64 MB
  Internet Processor II Version 1, Foundry IBM, Part number 9
  Start time:          2003-05-01 15:08:59 PDT
  Uptime:              3 days, 9 hours, 3 minutes, 13 seconds
```

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

Maintain 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 *M5 and M10 Internet Routers 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, right to left:

```
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 Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

- Use the cable management system (shown in Figure 11) 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 Optplex Cletop-S® Fiber Cleaner. Follow the directions for the cleaning kit you use.

Maintain the Power Supplies

To verify that the power supplies are functioning normally, perform the following procedures on a regular basis:

- Check that the blue OUTPUT OK LED is lit on the faceplate of both power supplies. For more information about the LED, see “Power Supply LEDs and Self-test Button” on page 19.
- Issue the following CLI command to check the status of the power supplies. As shown in the sample output, the value **OK** in the **Status** column indicates that the power supply is operating normally:

```
user@host> show chassis environment
Class Item                Status  Measurement
Power Power Supply A      OK
      Power Supply B      OK
...
```

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 on the craft interface. Power supply failure or removal triggers an alarm that causes one or both of the LEDs to light. 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 “Hardware and Interface Alarm Messages” on page 122.

- 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.

Maintain the Routing Engine

The Routing Engine installs into a slot in the Forwarding Engine Board (FEB) at the rear of the chassis, as shown in Figure 3. To maintain the Routing Engines, issue the CLI `show chassis routing-engine` command on a regular basis to check the status of the Routing Engine:

```

user@host> show chassis routing-engine
Routing Engine status:
  Temperature      35 degrees C / 95 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       f1000004f91d2901
  Start time      2003-05-01 15:07:12 PDT
  Uptime          3 days, 9 hours, 4 minutes, 5 seconds
  Load averages:  1 minute   5 minute  15 minute
                  0.04      0.01     0.00

```

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*.

Chapter 10

Replace 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 "Return the Router or Its Components" on page 163. For a list of the FRUs on the M5 and M10 routers, see "Field-Replaceable Units (FRUs)" on page 3.

- Tools and Parts Required on page 81
- Replace the Fan Tray on page 82
- Replace Packet Forwarding Engine Components on page 84
- Replace Power System Components on page 98
- Replace Routing Engine Components on page 112

Tools and Parts Required

To replace hardware components, you need the tools and parts listed in Table 16.

Table 16: Tools and Parts Required

Tool or part	Components
Electrostatic bag or antistatic mat	FEB PIC Routing Engine
Electrostatic discharge (ESD) grounding wrist strap	All
Flat-blade (-) screwdriver, 2.5 mm	Serial cable to AUX/MODEM or CONSOLE Routing Engine port
Flat-blade (-) screwdriver, 3.0 mm	DC power cables

Tool or part	Components
Phillips (+) screwdrivers, numbers 1 and 2	Fan tray FEB PIC Power supply (AC or DC) Routing Engine
Rubber safety cap	Fiber-optic PIC or PIC cable

Replace the Fan Tray

The fan tray installs into the rear of the chassis, as shown in Figure 3. It houses four fans and weighs approximately 4 lb (1.8 kg). To replace the fan tray, perform the following procedures:

- Remove the Fan Tray on page 82
- Install the Fan Tray on page 83

Remove the Fan Tray

To remove the fan tray, follow this procedure (see Figure 26):



Caution

Do not remove the fan tray for more than a about one minute while the router is operating. The fans are the sole source of cooling, and the router can overheat when they are absent.

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
2. Loosen the thumbscrews above and below the handle on the fan tray faceplate, using a Phillips screwdriver if necessary.
3. Grasp the handle on the faceplate and slide the tray about halfway out of the chassis.

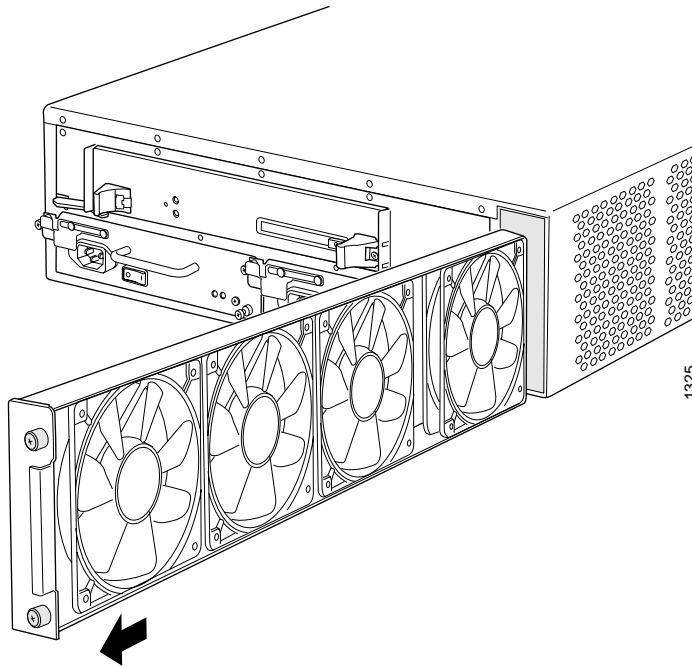


Caution

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.

4. 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 26: Remove the Fan Tray

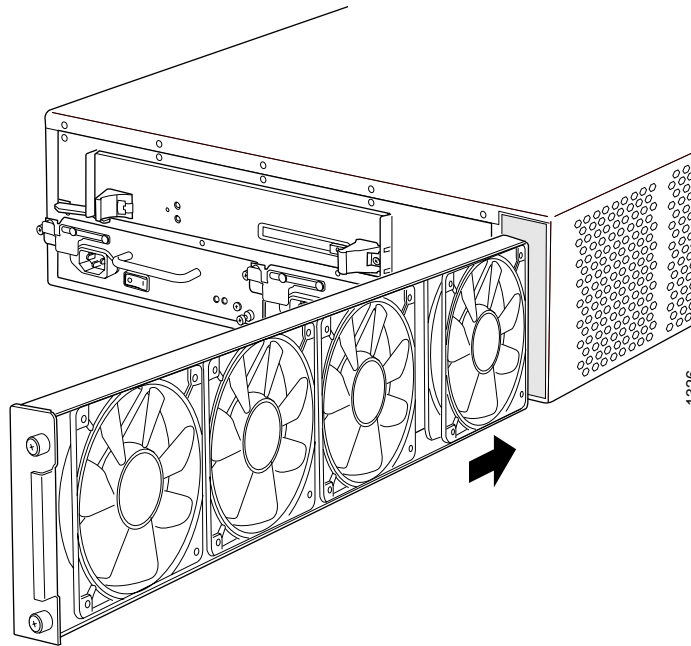


Install the Fan Tray

To install the fan tray, follow this procedure (see Figure 27):

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
2. Grasp the handle on the faceplate of the fan tray with one hand and place the other hand under the unit to support it. Orient the tray so that the handle and thumbscrews fans are on the right side, toward the outer edge of the router.
3. Slide the tray into the slot.
4. Tighten the thumbscrews to seat the fan tray firmly in the chassis.

Figure 27: Install the Fan Tray



Replace Packet Forwarding Engine Components

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

- Replace the FEB on page 84
- Replace a PIC on page 87
- Replace PIC Cables on page 92
- Replace an SFP on page 95

Replace the FEB

The FEB installs into the midplane from the rear of the chassis, as shown in Figure 3. It weighs approximately 7 lb (3.2 kg). The FEB is field-replaceable, but you must power down the router before removing it from the chassis. Packet forwarding halts until the FEB is replaced, the router is powered on, and the Routing Engine finishes booting.

To replace the FEB, perform the following procedures:

- Remove the FEB on page 85
- Install the FEB on page 86

Remove the FEB

To remove the FEB, follow this procedure (see Figure 28):


1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. On the console or other management device connected to the Routing Engine, enter CLI operational mode and issue the following command to shut down the router software cleanly and preserve Routing Engine state information.

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

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

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

3. Press the power switch for both power supplies to the **OFF (O)** position. On both AC and DC power supplies, the switch is located on the power supply faceplate.
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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
5. Using a Phillips screwdriver, loosen and remove the five screws that secure the Routing Engine cover to the FEB faceplate (the cover is shown in Figure 3). Pull the cover straight off the Routing Engine. Save the screws.
6. Pull the ends of the ejector levers (located at each end of the unit) outward until they are nearly perpendicular to the faceplate of the FEB.
7. Grasp the ejector levers and pull firmly to slide the FEB about halfway out of the chassis.
8. Place one hand under the FEB to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

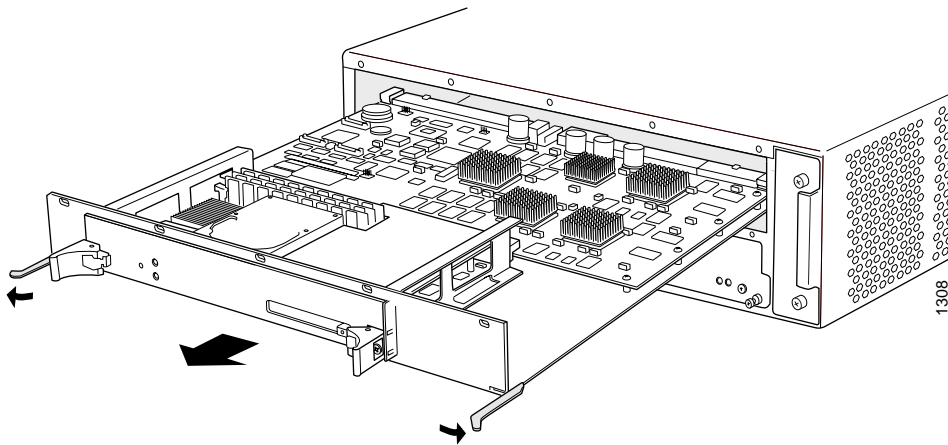


When the FEB is out of the chassis, do not hold it by the ejector levers. They cannot support its weight.

Do not stack the FEB on top of or under other components after removal. Place it individually in an electrostatic bag or on its own antistatic mat on a flat, stable surface.

Caution

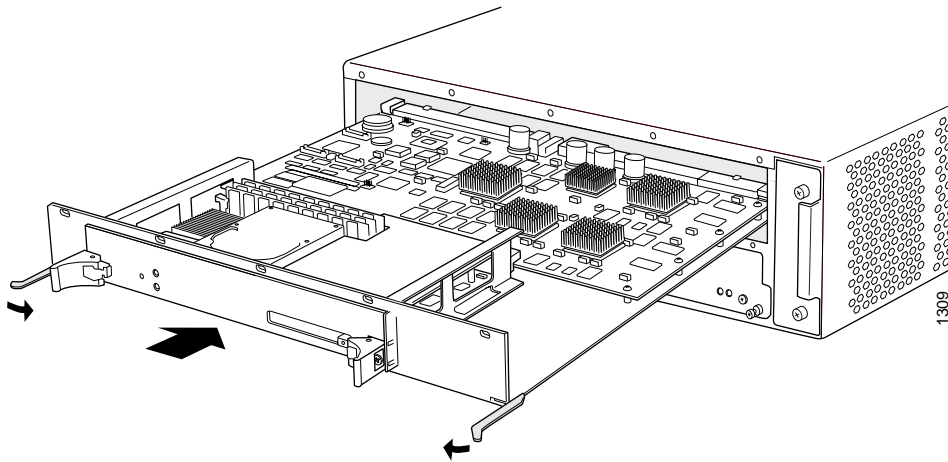
Figure 28: Remove the FEB



Install the FEB

To install the FEB, follow this procedure (see Figure 29):

1. Verify that the power switch on both power supply faceplates is in the **OFF (O)** position.
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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
3. Verify that the ends of the ejector levers (which are located at each end of the unit) are pulled away from the faceplate and are nearly perpendicular to it.
4. Place one hand under the FEB to support it and grasp one of the ejector levers at the front with the other hand.
5. Align the rear of the FEB with the guides inside the chassis and slide it in completely.
6. Press the end of each ejector lever inward toward the FEB faceplate.
7. Replace the Routing Engine cover on the FEB faceplate, by sliding the hooks at the bottom of the cover under the lower edge of the FEB ejector levers and aligning the holes in the cover with the holes in the faceplate (the cover is shown in Figure 3). Insert screws into the five holes in the cover and use a Phillips screwdriver to tighten them.
8. Perform the procedures in “Power On the Router” on page 67 to power on the router and verify correct startup.
9. Issue the **show chassis feb** command described in “Maintain the FEB” on page 76 to verify correct FEB functioning.

Figure 29: Install the FEB

Replace a PIC

Up to four regular PICs install into an M5 router and up to eight regular PICs install into an M10 router, as shown in Figure 1 and Figure 2. Quad-wide PICs occupy all four slots in an FPC row.

Both regular and quad-wide PICs are hot-removable and hot-insertable. A removed PIC no longer receives or transmits data, and removing or inserting a PIC briefly interrupts forwarding of traffic through the remaining PICs.

To replace a PIC, perform the following procedures:

- Remove a PIC on page 87
- Install a PIC on page 89

Remove a PIC

To remove a PIC, follow this procedure (see Figure 30):

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
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 *M5 and M10 Internet Routers PIC Guide*. The offline button for each PIC is located below it on the craft interface and is labeled with the PIC slot number.
 - 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 Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

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.

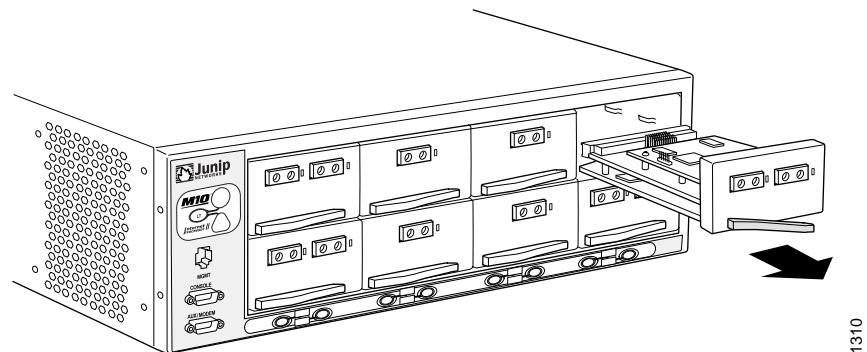


Caution

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. Unseat the PIC from the chassis:
 - For a regular PIC, pull the right end of the PIC ejector lever away from the PIC faceplate.
 - For a quad-wide PIC, pull the end of each ejector lever away from the PIC faceplate, toward the outer edges of the PIC.
8. Grasp both sides of the PIC faceplate and slide it out of the chassis. Do not use the ejector lever as a handle.
9. Place the PIC in the electrostatic bag or on the antistatic mat.
10. If you are not reinstalling a PIC into the emptied slot within a short time, install a blank PIC panel over the slot to maintain proper airflow in the chassis.

Figure 30: Remove a PIC



Install a PIC

To install a PIC, follow this procedure (see Figure 31):

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
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. Prepare the PIC for insertion into the chassis:
 - For a regular PIC, hold the PIC in one hand and with your other hand pull the end of the ejector lever away from the PIC faceplate. Hold the lever out while you insert the PIC.
 - For a quad-wide PIC, verify that the end of each ejector lever is pulled away from the PIC faceplate, toward the ends of the PIC.
4. Align the rear of the PIC with the guides located at the bottom corners of the PIC slot.

5. Slide the PIC into the slot:
 - For a regular PIC, slide the PIC into the slot until about 0.5 in. (1 cm) of the PIC remains outside the slot and you feel some resistance. Release the ejector lever and gently push the PIC faceplate until you hear a click as the PIC contacts the midplane. The ejector lever engages and closes automatically.
 - For a quad-wide PIC, slide the PIC into the slot until it contacts the midplane. Push the ejector levers inward toward the PIC faceplate to seat the PIC securely in the chassis.



Caution

Slide the PIC straight into the slot to avoid damaging the components on the PIC.

6. 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.

7. Insert the appropriate cables into the cable connectors on the PIC.

8. 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.

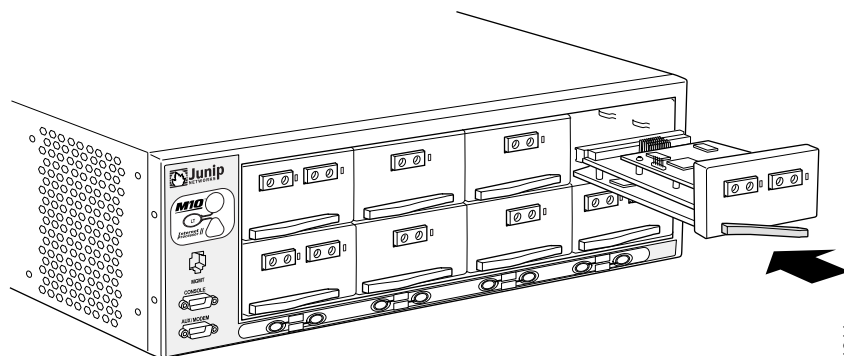
9. Use one of the following methods to bring the PIC online:
 - Press and hold the PIC offline button until the status LED on the PIC faceplate indicates normal functioning, which usually takes about 5 seconds. The LED is usually green; for more information, see the *M5 and M10 Internet Routers PIC Guide*. The offline button for each PIC is located below it on the craft interface and is labeled with the PIC slot number.
 - 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 Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

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 “Maintain PICs and PIC Cables” on page 76.

Figure 31: Install 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:

- Remove a PIC Cable on page 92
- Install a PIC Cable on page 93

Remove 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 *M5 and M10 Internet Routers PIC Guide*. The offline button for each PIC is located below it on the craft interface and is labeled with the PIC slot number.
 - 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 Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

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.

Install a PIC Cable

To install a PIC cable, follow this procedure (see Figure 32):

1. Have ready a length of the type of cable used by the PIC. For cable specifications, see the *M5 and M10 Internet Routers 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.

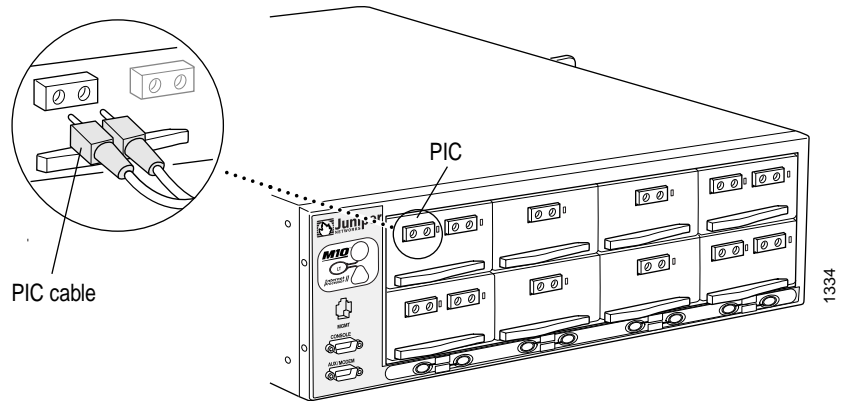
5. Insert the other end of the cable into the destination port.
6. Repeat the previous steps for any additional cables.
7. If the PIC is offline (its failure indicator LED is lit), use one of the following methods to bring the PIC online:
 - Press and hold the PIC offline button until the status LED on the PIC faceplate indicates normal functioning, which usually takes about 5 seconds. The LED is usually green; for more information, see the *M5 and M10 Internet Routers PIC Guide*. The offline button for each PIC is located below it on the craft interface and is labeled with the PIC slot number.
 - 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 Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

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 “Maintain PICs and PIC Cables” on page 76.

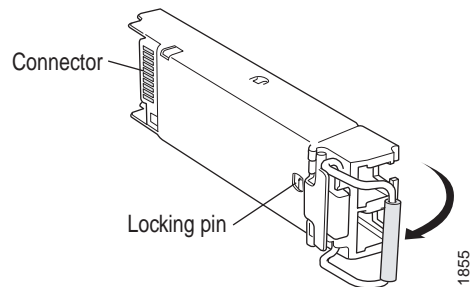
Figure 32: Connect Fiber-Optic Cable to a PIC



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 9).

Figure 33: 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:

- Remove an SFP on page 95
- Install an SFP on page 96

Remove an SFP

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

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
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.

Install an SFP

To install a replacement SFP, follow this procedure (see Figure 33):

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.

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 *M5 and M10 Internet Routers PIC Guide*. You can also verify PIC functioning by issuing the `show chassis fpc pic-status` command described in “Maintain PICs and PIC Cables” on page 76.

Replace Power System Components

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

- Replace an AC Power Supply on page 98
- Disconnect and Connect AC Power on page 101
- Replace an AC Power Cord on page 103
- Replace a DC Power Supply on page 104
- Disconnect and Connect DC Power on page 108

Replace an AC Power Supply


An AC-powered router has two load-sharing, redundant AC power supplies. Each power supply is hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 3. When one power supply fails or is powered down, the other power supply automatically assumes the entire electrical load for the router. For more information about AC power supplies, see “AC Power Supply” on page 17.

To replace an AC power supply, perform the following procedures:

- Remove an AC Power Supply on page 99
- Install an AC Power Supply on page 100

Remove an AC Power Supply

The AC power supplies are located at the bottom rear of the chassis, as shown in Figure 3. Each AC power supply weighs approximately 12 lb (5.5 kg).




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.

Caution

To remove an AC power supply, follow this procedure (see Figure 34):

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
2. Press the power switch on the power supply faceplate to the **OFF (O)** position.

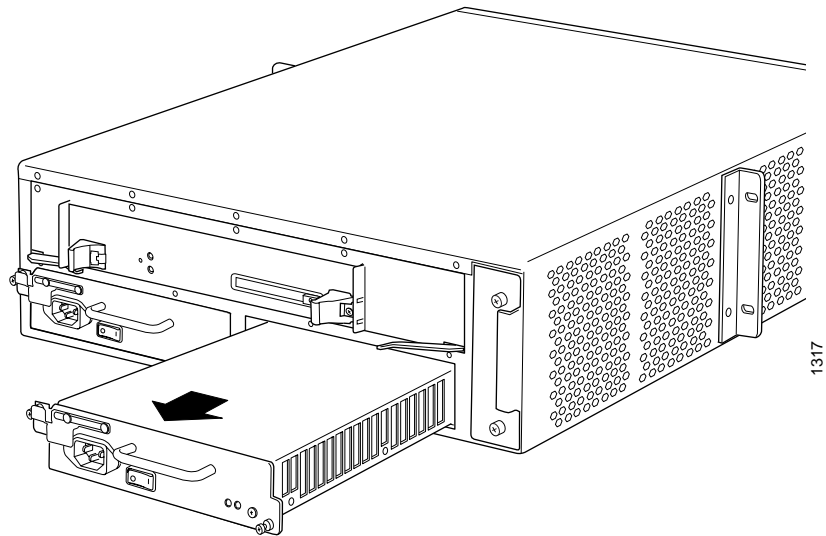


If you are not removing the power supply, but simply powering it off, wait at least 60 seconds before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

Note

3. Unplug the power cord from the appliance inlet on the faceplate, then move the safety lever to the open (unlatched) position.
4. Loosen the thumbscrew at each end of the power supply faceplate, using a Phillips screwdriver if necessary. Unscrew both thumbscrews simultaneously and at about the same rate (unscrewing the two screws alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
5. Grasp the handle 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.

Figure 34: Remove an AC Power Supply




Install an AC Power Supply

To install an AC power supply, follow this procedure (see Figure 35):

1. Verify that the switch on the power supply faceplate is in the **OFF (O)** position.
2. Locate the power cord shipped with the router, which should be appropriate for your geographical location (see “AC Grounding and Power Cord Specifications” on page 45).
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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
4. Grasp the handle on the power supply faceplate with one hand and place the other hand under the supply to support it.
5. Align the rear of the supply with the slide guides inside the chassis and slide the supply into the chassis until it contacts the midplane.
6. Tighten (but do not overtighten) the thumbscrews on the power supply faceplate. Turn both thumbscrews simultaneously and at about the same rate (turning them alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
7. Insert the appliance coupler end of the power cord into the appliance inlet on the power supply faceplate and insert the plug into an AC power source receptacle. Verify that the power cord does not block access to router components or drape where people could trip on it.

8. Press the power switch on the faceplate to the ON (|) position. Verify that the blue OUTPUT OK LED eventually lights steadily.

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.

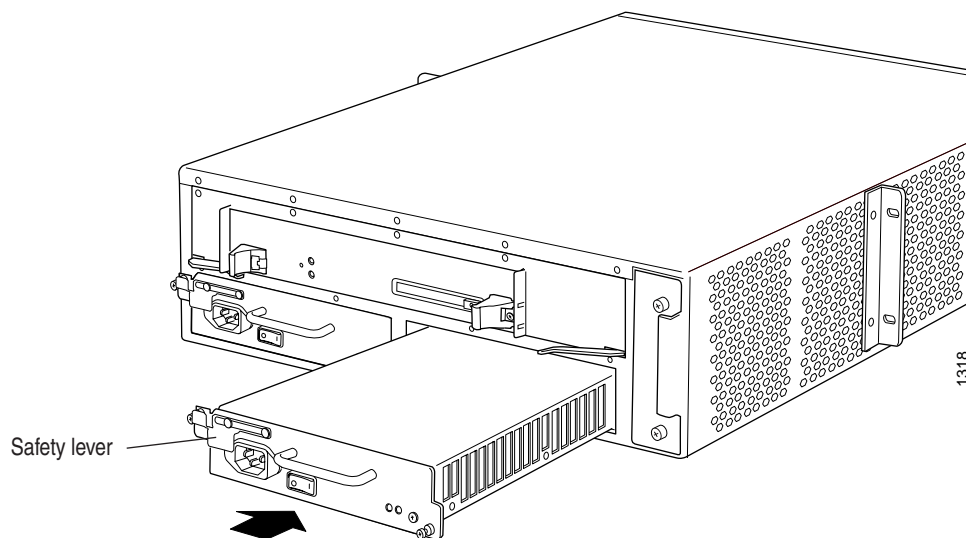


Note

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 “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.

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

Figure 35: Install an AC Power Supply



Disconnect and Connect AC Power

The power cord that plugs into the appliance inlet on the faceplate of each AC power supply provides direct connection to the external power source. See the following sections:

- Disconnect AC Power from the Router on page 102
- Connect AC Power to the Router on page 102

Disconnect AC Power from the Router

To disconnect AC power from the router, follow this procedure:


1. On the console or other management device connected to the Routing Engine, enter CLI operational mode and issue the following command to shut down the router software cleanly and preserve Routing Engine state information.

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

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

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

2. Press the power switch on each power supply faceplate to the OFF (O) position.
3. Unplug the power cord from each power supply.



When multiple AC power supplies are installed in the chassis, each power cord (one for each power supply) must be unplugged to disconnect power completely.

Note

Connect AC Power to the Router

To connect AC power to 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 ends of the power cord are firmly plugged into the appliance inlet on the power supply faceplate and the external power source receptacle.
3. Connect a management device to one of the ports on the craft interface (**AUX/MODEM**, **CONSOLE**, or **MGMT**). For more information on connecting management devices, see “Replace Connectors to Routing Engine Interface Ports” on page 118.
4. Turn on the management device.

5. Press the power switch on the faceplate of one power supply to the **ON (|)** position. Verify that the blue **OUTPUT OK** LED eventually lights steadily.

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.



Note

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 “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.

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

6. Press the power switch on the other power supply to the **ON (|)** position and observe the LEDs on the 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 procedures in “Install an AC Power Supply” on page 100 and the previous steps in this procedure.



Note

When two power supplies are installed, at least one Routing Engine and one FPC must also be installed for both power supplies to power on. In the absence of this minimum load, only one power supply starts. (The router powers on and operates correctly with one power supply, but without the redundancy benefit of having a second power supply installed.)

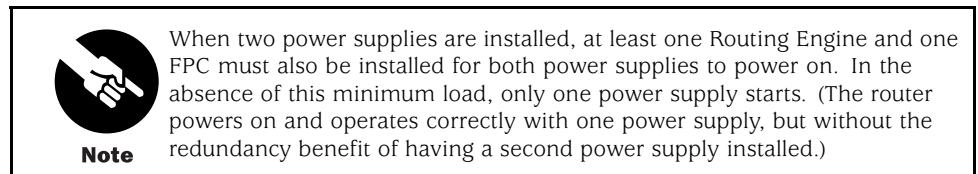
7. On the external management device connected to the Routing Engine, monitor the startup process to verify that the system has booted properly.

Replace an AC Power Cord

To replace the power cord for an AC power supply, follow this procedure:

1. Locate a replacement power cord with the type of plug appropriate for your geographical location (see “AC Grounding and Power Cord Specifications” on page 45).
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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
3. Press the power switch on the power supply faceplate to the **OFF (O)** position.

4. Unplug the power cord from the appliance inlet on the faceplate and from the power source receptacle.
5. Insert the appliance coupler end of the replacement power cord into the appliance inlet on the power supply faceplate and insert the plug into an AC power source receptacle. Verify that the power cord does not block access to router components or drape where people could trip on it.
6. Press the power switch on the power supply faceplate to the ON (|) position. Verify that the blue OUTPUT OK LED eventually lights steadily.



Replace a DC Power Supply

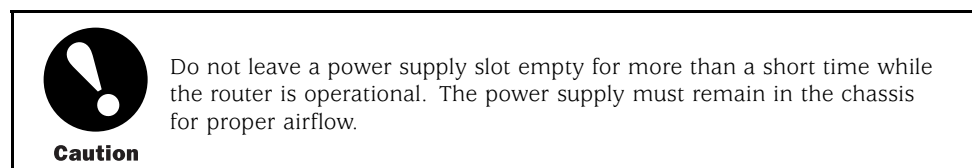
A DC-powered router has two load-sharing, redundant DC power supplies that install into the rear of the router as shown in Figure 3. Each power supply is hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 3. When one power supply fails or is powered down, the other power supply automatically assumes the entire electrical load for the router. For more information about DC power supplies, see “DC Power Supply” on page 18.

To replace a DC power supply, perform the following procedures:

- Remove a DC Power Supply on page 104
- Install a DC Power Supply on page 106

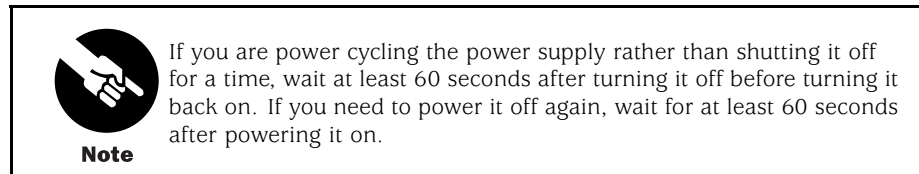
Remove a DC Power Supply

The DC power supplies are located at the bottom rear of the chassis, as shown in Figure 3. Each DC power supply weighs approximately 7 lb (3.2 kg).



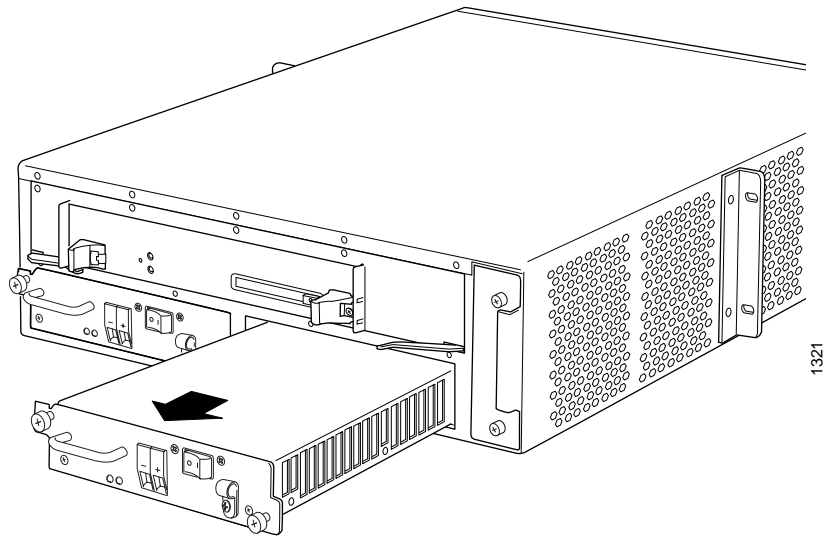
To remove a DC power supply, follow this procedure (see Figure 36):

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
2. Press the power switch for the power supply (located on the power supply faceplate) to the **OFF (O)** position.



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. Using a 3-mm flat-blade screwdriver, turn the screw on each quick-connect terminal counter-clockwise to loosen the terminal connector from around the cable.
5. Remove the cables from the terminal connectors and from the hook located on the faceplate to the right of the quick-connect terminals.
6. Loosen the thumbscrew at each end of the power supply faceplate, using a Phillips screwdriver if necessary. Unscrew both thumbscrews simultaneously and at about the same rate (unscrewing the two screws alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
7. Grasp the handle on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
8. Place one hand under the power supply to support it, then slide it completely out of the chassis.

Figure 36: Remove a DC Power Supply



Install a DC Power Supply

To install a DC power supply, follow this procedure (see Figure 37 and Figure 38):

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 power supply faceplate) is in the OFF (O) position.
3. Verify that the grounding cable is attached to the chassis and properly connected to an earth ground.
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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
5. Grasp the handle on the power supply faceplate with one hand and place the other hand under the supply to support it.
6. Align the rear of the supply with the slide guides inside the chassis and slide the supply into the chassis until it contacts the midplane.
7. Tighten (but do not overtighten) the thumbscrews on the power supply faceplate. Turn both thumbscrews simultaneously and at about the same rate (turning them alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
8. If necessary, strip a short section of the protective cladding from the end of each power cable so that the metal core can come in direct contact with the quick-connect terminal.

9. Thread the power cables through the hook located on the faceplate to the right of the quick-connect terminals.
10. Insert the exposed end of each power cable straight into the appropriate quick-connect terminal:
 - Insert the positive (+) source cable into the return terminal, which is labeled RTN.
 - Insert the negative (-) source cable into the input terminal, which is labeled -48V.
11. Using a 3-mm flat-blade screwdriver, turn the screw on each quick-connect terminal clockwise to tighten the terminal connector around the cable.
12. Verify that the DC 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.
13. Turn on the DC power source so that voltage flows to the power supply.
14. Press the switch on the power supply faceplate to the **ON** (|) position and engage the safety interlock lever below the power switch. Verify that the blue **OUTPUT OK** LED eventually lights steadily.

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.



Note

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 “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.

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

Figure 37: Install a DC Power Supply

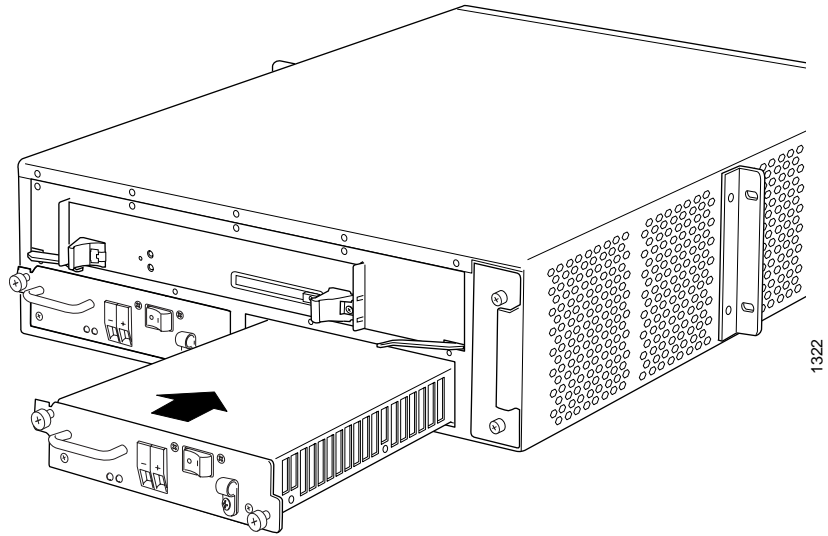
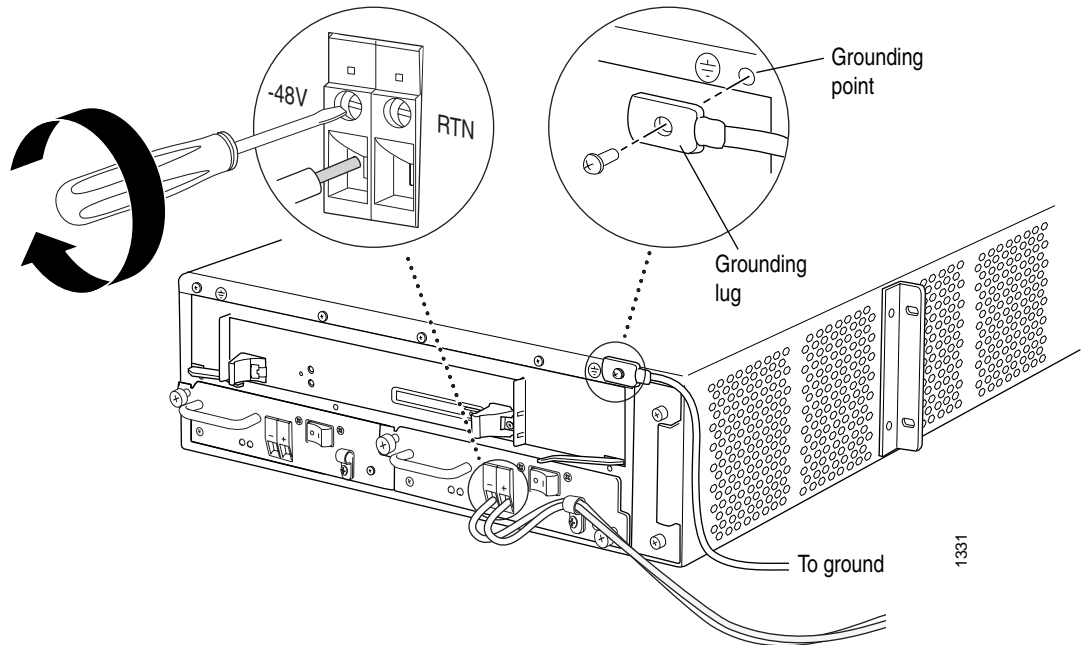


Figure 38: Connect Power Cables to a DC Power Supply



Disconnect and Connect DC Power

On a DC-powered router, the power cables from the external DC power sources connect to terminal studs on each power supply. 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:

- Disconnect DC Power from the Router on page 109
- Connect DC Power to the Router on page 110

Disconnect DC Power from the Router

To disconnect DC power from the router, follow this procedure:


1. On the console or other management device connected to the Routing Engine, enter CLI operational mode and issue the following command to shut down the router software cleanly and preserve Routing Engine state information.

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

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

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

2. For each power supply, press the power switch on the power supply faceplate 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 3-mm flat-blade screwdriver, turn the screw on each quick-connect terminal counter-clockwise to loosen the terminal connector from around the cable.
5. Remove the cables from the terminal connectors and from the hook located on the faceplate to the right of the quick-connect terminals.
6. If you are decommissioning the router, loosen and remove the screw that secures the grounding cable to the chassis and remove the grounding cable.
7. Verify that the removed cables are not touching or blocking access to any router components.

Connect DC Power to the Router

Connect DC power to the router by inserting power cables from external DC power sources into the quick-connect terminals on the faceplate of each power supply. Power and grounding cables are not supplied with the router. For information about the required cable type, see “DC Grounding, Connection, and Cable Specifications” on page 46.



Note

The router must be connected to at least two separate external DC 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 power supply faceplate. You must ensure that power connections maintain the proper polarity. The power source cables might be labeled (+) and (-) to indicate their polarity.

To connect DC power to the router, follow this procedure (see Figure 39):

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 power supply faceplate is in the OFF (O) position.
3. Connect the grounding cable to a proper earth ground for both external DC power sources, if it is not already.
4. Verify that a licensed electrician has attached the cable lug provided with the router to the grounding cable, and that the cable is attached to a grounding point on the chassis rear.
5. If necessary, strip a short section of the protective cladding from the end of each power cable so that the metal core can come in direct contact with the quick-connect terminal.
6. Thread the power cables through the hook located on the faceplate to the right of the quick-connect terminals.
7. Insert the exposed end of each power cable straight into the appropriate quick-connect terminal:
 - Insert the positive (+) source cable into the return terminal, which is labeled RTN.
 - Insert the negative (-) source cable into the input terminal, which is labeled -48V.

8. Using a 3-mm flat-blade screwdriver, turn the screw on each quick-connect terminal clockwise to tighten the terminal connector around the cable.
9. Verify that the DC 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.
10. Turn on the DC power source so that voltage flows to the router.
11. Turn on the power to a management device that is connected to the Routing Engine (through the craft interface port labeled **AUX/MODEM,CONSOLE**, or **MGMT**). For more information on connecting management devices, see “Replace Connectors to Routing Engine Interface Ports” on page 118.
12. Press the power switch on one power supply faceplate to the **ON** position and engage the safety interlock lever below the power switch. Verify that the blue **OUTPUT OK** LED eventually lights steadily.

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.



Note

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 “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.

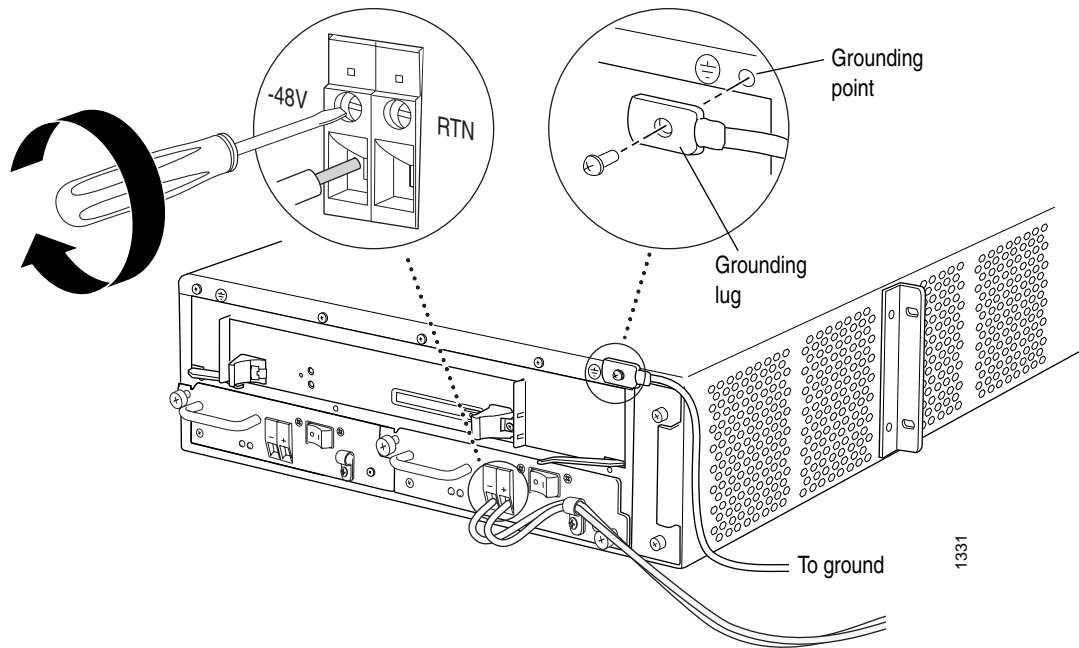
After a power supply is powered on, it can take up to 60 seconds for status indicators—such as LEDs on the power supply and **show chassis** commands—to indicate that the power supply is functioning normally. Ignore error indicators that appear during the first 60 seconds.

13. Press the power switch for the second power supply 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 “Install a DC Power Supply” on page 106 and the previous steps in this section.

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

Figure 39: Connect Power Cables to a DC Power Supply



Replace Routing Engine Components

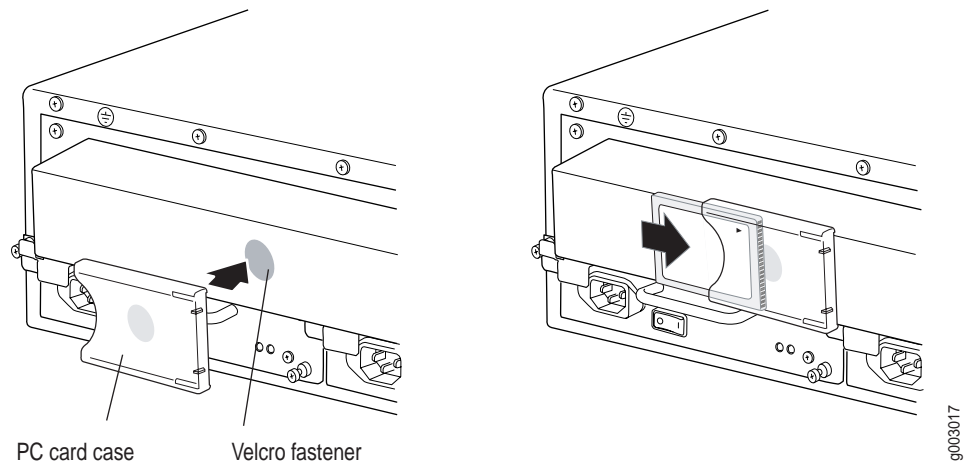
For instructions on replacing Routing Engine components, see the following sections:


- Remove and Insert the PC Card on page 112
- Replace the Routing Engine on page 115
- Replace Connectors to Routing Engine Interface Ports on page 118

Remove 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. 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 Customer Support Center Web site (<http://www.juniper.net/support>); after logging in, navigate to the download page for JUNOS Internet software.

On some routers, the accessory box includes a plastic PC card storage case that you can affix to the router chassis for easy access to the PC card. shows the recommended installation location for the case and how to insert the PC card into the case.



 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 PC card is loaded only onto the Routing Engine into which the PC card is inserted. It is not automatically copied to the other Routing Engine.

Note

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

- Remove the PC Card on page 113
- Insert the PC Card on page 114

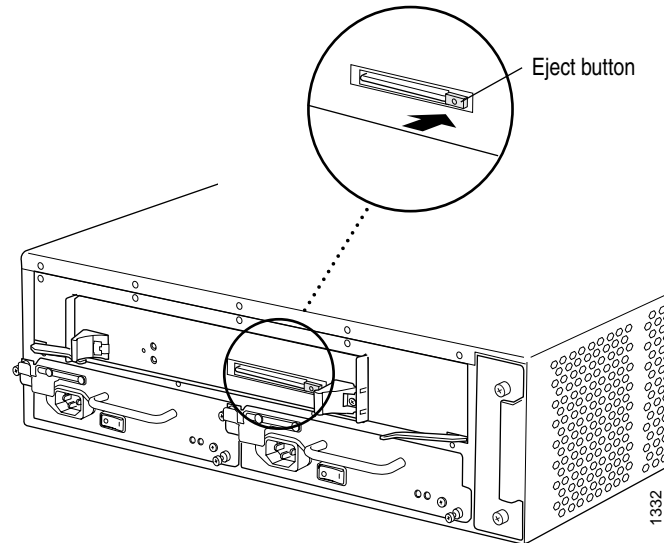
Remove the PC Card

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 40):

1. 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 40.

2. When the PC card pops partially out of the slot, grasp the card and pull it straight out of the slot.

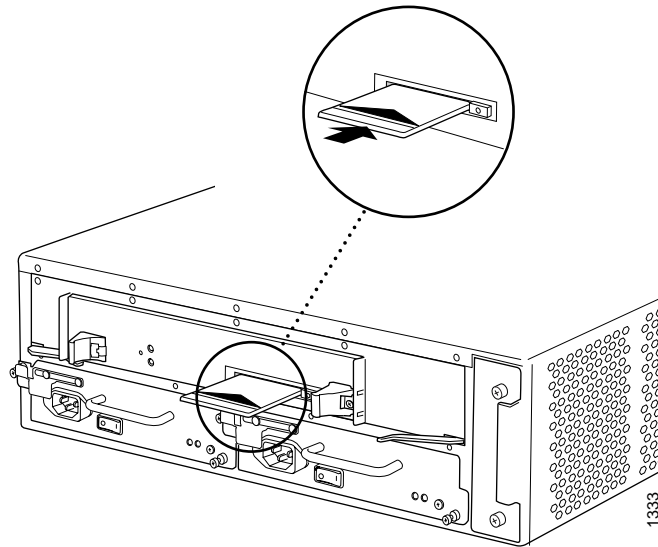
Figure 40: Remove the PC Card



Insert the PC Card

To insert the PC card, follow this procedure (see Figure 41):

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 41.

Figure 41: Insert the PC Card

Replace the Routing Engine

The Routing Engine installs into a slot in the FEB at the rear of the chassis, as shown in Figure 3. The Routing Engine weighs approximately 3 lb (1.5 kg). To replace the Routing Engine, perform the following procedures:

- Remove the Routing Engine on page 115
- Install the Routing Engine on page 116

Remove the Routing Engine

To remove the Routing Engine, follow this procedure (see Figure 42):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. On the console or other management device connected to the Routing Engine, enter CLI operational mode and issue the following command to shut down the router software cleanly and preserve Routing Engine state information.

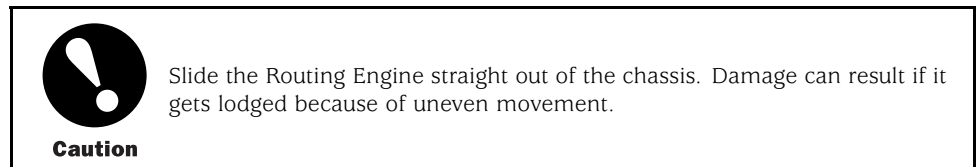
```
user@host> request system halt
```

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

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

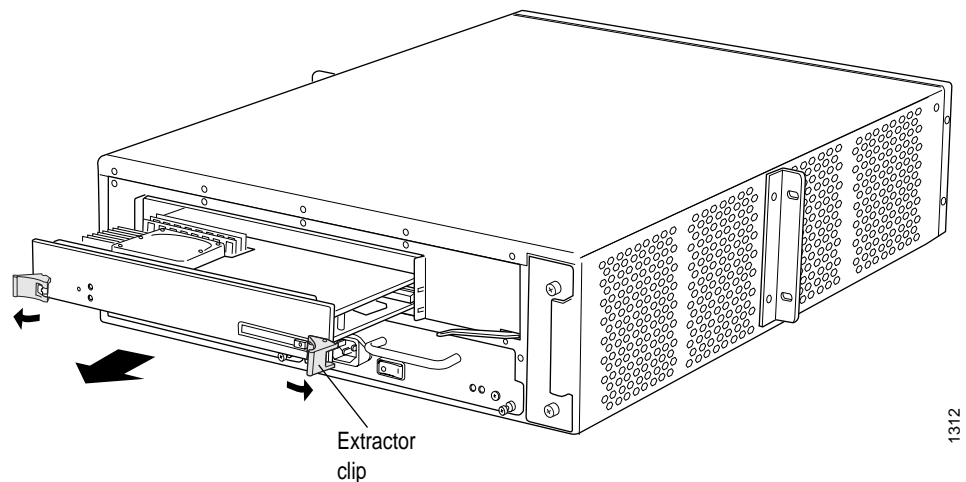
3. Press the power switch for both power supplies to the **OFF (0)** position. On both AC and DC power supplies, the switch is located on the power supply faceplate.

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
5. Using a Phillips screwdriver, loosen and remove the five screws that secure the Routing Engine cover to the FEB faceplate (the cover is shown in Figure 3). Pull the cover straight off the Routing Engine. Save the screws.
6. 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.
7. Grasp the extractor clips and slide the unit about halfway out of the chassis.



8. 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 42: Remove the Routing Engine



Install the Routing Engine

To install the Routing Engine, follow this procedure (see Figure 43):

1. Verify that the power switch on both power supply faceplates is in the **OFF (O)** position.

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. For more information about ESD, see “Prevent Electrostatic Discharge Damage” on page 134.
3. 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.
4. Place one hand under the Routing Engine to support it and grasp one of the extractor clips on the faceplate with the other hand.
5. Align the rear of the Routing Engine with the guide rails inside the chassis and slide it in completely.

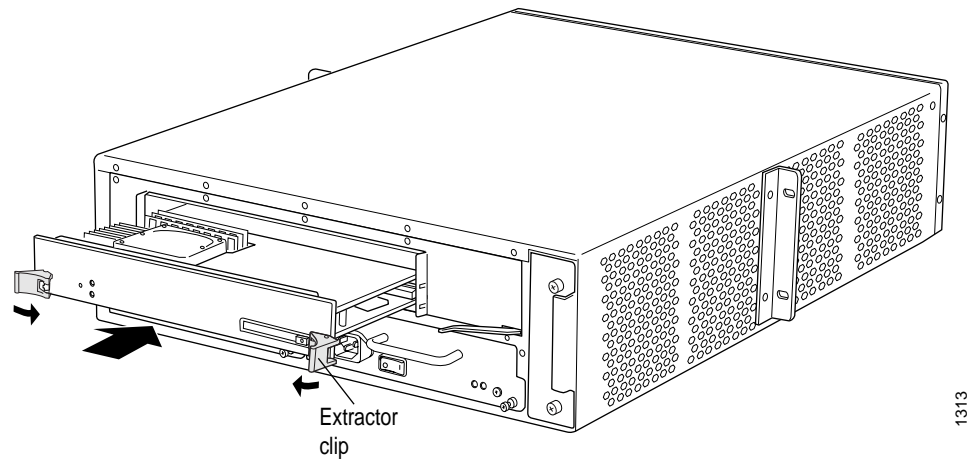


Caution

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.

6. Press the extractor clip at each end of the Routing Engine inward to seat the unit firmly in the chassis.
7. Replace the Routing Engine cover on the FEB faceplate, by sliding the hooks at the bottom of the cover under the lower edge of the FEB ejector levers and aligning the holes in the cover with the holes in the faceplate (the cover is shown in Figure 3). Insert screws into the five holes in the cover and use a Phillips screwdriver to tighten them.
8. Perform the procedures in “Power On the Router” on page 67 to power on the router and verify correct startup.
9. Issue the **show chassis routing-engine** command described in “Maintain the Routing Engine” on page 79 to verify correct Routing Engine functioning.

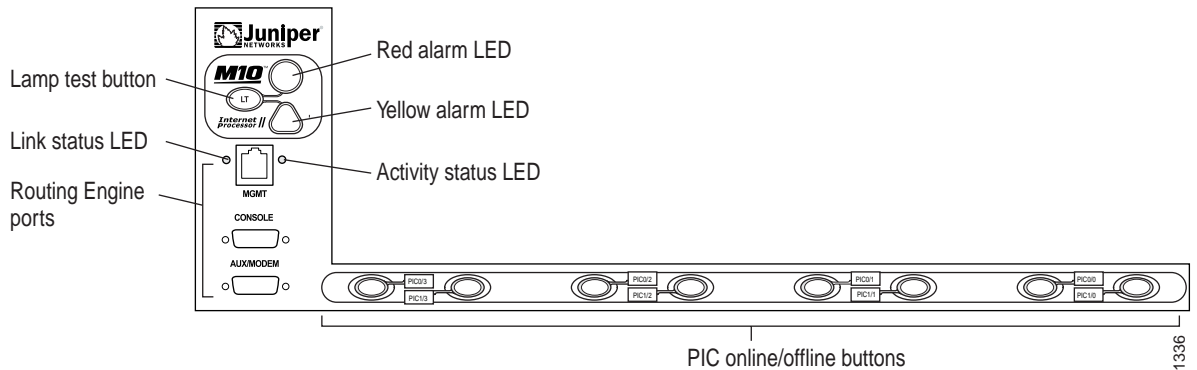
Figure 43: Install the Routing Engine



Replace Connectors to Routing Engine Interface Ports

The ports on the craft interface connect the Routing Engine to external management devices (see Figure 44).

Figure 44: 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:

- Replace the Management Ethernet Cable on page 118
- Replace the Console or Auxiliary Cable on page 119

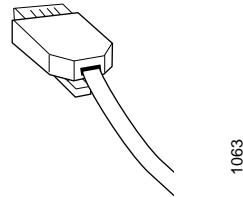
Replace the Management Ethernet Cable

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 MGMT port on the craft interface. One

such cable is provided with the router. For cable specifications, see “Cable Specifications for Routing Engine Management Interfaces” on page 52. Follow this procedure:

1. If a cable is already installed in the **MGMT** 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 45 shows the connector.
 - b. Disconnect the cable from the network device.
2. Plug one end of the replacement Ethernet cable into the appropriate **MGMT** port. Figure 44 shows the external device ports on the craft interface.
3. Plug the other end of the cable into the network device.

Figure 45: Ethernet Cable Connector



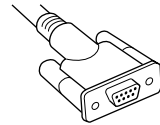
Replace the Console or Auxiliary Cable

To use a system console to configure and manage the Routing Engine, connect it to the appropriate **CONSOLE** port on the craft interface. To use a laptop, modem, or other auxiliary device, connect it to the appropriate **AUX/MODEM** port on the craft interface. 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 “Cable Specifications for Routing Engine Management Interfaces” on page 52.

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

1. If a cable is already installed in the **CONSOLE** or **AUX/MODEM** 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 **AUX/MODEM** port. Figure 44 shows the external device ports on the craft interface.
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 46: Serial Port Connector



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Chapter 11

Troubleshoot 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 “How to Request Support” on page xix.

- Overview of Troubleshooting Resources on page 121
- Troubleshoot the Fan Tray on page 124
- Troubleshoot Packet Forwarding Engine Components on page 124
- Troubleshoot the Power System on page 125

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 121
- LEDs on page 122
- Hardware and Interface Alarm Messages on page 122
- Juniper Networks Technical Assistance Center on page 124

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 craft interface. The port labeled `AUX/MODEM` 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 `MGMT` attaches to a management LAN. For more information, see “Routing Engine Interface Ports and Status Indicators” on page 15.

For information about using the CLI to display details about alarms generated by interfaces and hardware components, see “Hardware and Interface Alarm Messages” on page 122.

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 and Figure 2. The LEDs on the craft interface include two alarm LEDs. 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 below it indicates a less severe condition that requires monitoring or maintenance. Both alarms can occur simultaneously. For more information about the alarm LEDs, see “Alarm LEDs and Lamp Test Button” on page 15. For more information about the causes of alarms, see “Hardware and Interface Alarm Messages” on page 122.

LEDs on Hardware Components

LEDs on the faceplates of the following hardware components report their status:

- PIC—Most PICs have an LED labeled **STATUS** on their 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 *M5 and M10 Internet Routers PIC Guide*.
- Power supply—A blue LED labeled **OUTPUT OK** reports the status of the power supply. For more information, see “Power Supply LEDs and Self-test Button” on page 19.

Hardware 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. 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 17.
- Interface alarms—Indicate a problem with a specific network interface, as described in Table 18.

In both tables, the text in the column labeled “CLI Message” appears in the output from the **show chassis alarms** command.

Table 17: Chassis Alarm Messages

Component	CLI Message
Craft interface	Craft interface not responding
Fans	<i>fan-name</i> removed
	<i>fan-name</i> stopped spinning
	Too few fans installed or working
PICs	Too many recoverable errors
	Too many unrecoverable errors
Power supplies	Power supply x not providing power
	Power supply x 2.5V failed
	Power supply x 3.3V failed
	Power supply x 5V failed
Temperature sensors	<i>temperature-sensor</i> temperature sensor failed
	A temperature sensor exceeds 54 degrees C

Table 18: SONET/SDH Interface Alarm Messages

CLI Message
<i>interface-name</i> so-x/x/x - SONET bit error rate defect
<i>interface-name</i> so-x/x/x - SONET bit error rate fault
<i>interface-name</i> so-x/x/x - SONET line AIS
<i>interface-name</i> so-x/x/x - SONET line remote defect indicator
<i>interface-name</i> so-x/x/x - SONET loss of frame
<i>interface-name</i> so-x/x/x - SONET loss of light
<i>interface-name</i> so-x/x/x - SONET loss of pointer
<i>interface-name</i> so-x/x/x - SONET loss of signal
<i>interface-name</i> so-x/x/x - SONET path AIS
<i>interface-name</i> so-x/x/x - SONET path mismatch
<i>interface-name</i> so-x/x/x - SONET path remote defect indicator
<i>interface-name</i> so-x/x/x - SONET PLL lock
<i>interface-name</i> so-x/x/x - SONET remote error indicator
<i>interface-name</i> so-x/x/x - SONET severely errored frame
<i>interface-name</i> so-x/x/x - SONET unequipped

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 “How to Request Support” on page xix.

Troubleshoot the Fan Tray

The fan tray installed along one side of the chassis houses four fans that draw room air into the chassis to maintain an acceptable operating temperature for the Routing Engine, PICs, FEB, and other components. For a graphic depiction of the airflow, see Figure 10.

For the fan tray to function properly, the clearance around the chassis must be sufficient for unobstructed airflow. See “Clearance Requirements for Airflow and Hardware Maintenance” on page 40.

Temperature sensors on the components detect temperatures above the acceptable range. Fan failure or an excessive temperature condition triggers the red alarm LED on the craft interface. If the temperature passes the acceptable maximum, the Routing Engine shuts down the router by turning off the power supplies.

To troubleshoot the fan tray, follow these guidelines:

- Check the status of the fans in the fan tray by issuing the **show chassis environment** command. The output includes an entry for each fan, as shown in this example:

```
user@host> show chassis environment
Class Item                Status Measurement
...
Fans  Left Fan 1           OK      Spinning at normal speed
      Left Fan 2           OK      Spinning at normal speed
      Left Fan 3           OK      Spinning at normal speed
      Left Fan 4           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*.

- If the fan tray fails, determine whether you can distinguish individual blades in a fan—this is not possible when the fans are rotating at normal speed.

Troubleshoot Packet Forwarding Engine Components

The following sections describe how to troubleshoot the FEB and PICs:

- Troubleshoot the FEB on page 125
- Troubleshoot PICs on page 125

Troubleshoot the FEB

If the FEB fails, the forwarding and routing functions of the router halt immediately and do not resume until the FEB failure has been corrected.

To troubleshoot an FEB, follow these guidelines:

- Make sure the FEB is properly seated in the midplane. Use a Phillips screwdriver to ensure that the screws at the top of the FEB are securely tightened.
- Check the alarm LEDs on the craft interface. An FEB failure generates either a red or yellow alarm, depending on the type of failure.

Troubleshoot 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 *M5 and M10 Internet Routers 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, right to left:

```
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 Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

Troubleshoot the Power System

When a power supply is functioning correctly, the blue LED labeled OUTPUT OK is lit steadily.

If any other LED states apply, consult the following sections:

- LED on Both Supplies Is Off on page 126
- LED on One Supply Is Off on page 126

LED on Both Supplies Is Off

If the LED is 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 Routing Engine shuts down both power supplies. There is no power to the router, so no LED is lit, including the alarm LEDs on the craft interface.

Excessive system temperature is almost always caused by excessive environmental temperature. Correct the environmental temperature before repowering the router.

LED on One Supply Is Off

If the LED on one power supply is off, but the LED on the other supply indicates that it is functioning properly, perform the following diagnostic procedure:

1. Check the red alarm LED on the craft interface:
 - If it is lit, issue the following CLI command for information about the cause of an alarm condition:

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

For a list of messages that can appear in the output, see “Hardware and Interface Alarm Messages” on page 122. A common cause of power supply shutdown is that the temperature of the power supply or another router component has exceeded the maximum limit.
 - If the red alarm LED is not lit, check that the power switch is in the **ON** position on the power supply faceplate.
2. Replace the faulty power supply with a spare. For instructions, see “Replace an AC Power Supply” on page 98 and “Replace a DC Power Supply” on page 104. If the LED lights correctly on the spare, the original power supply is faulty. Return it to Juniper Networks for replacement, as described in “Return the Router or Its Components” on page 163.
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 (on an AC-powered router) or power cable (on a DC-powered router). For instructions, see “Replace an AC Power Cord” on page 103 and “Disconnect and Connect DC Power” on page 108 (you do not need to disconnect and reconnect the grounding cable on a DC-powered router).
4. If you cannot determine the cause of the problem or need additional assistance, see “Juniper Networks Technical Assistance Center” on page 124.

Part 4

Appendixes

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 129
- Safety Guidelines and Warnings on page 131
- Agency Approvals on page 160
- Compliance Statements for EMC Requirements on page 161

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 varoituserkki 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 131
- Electrical Safety Guidelines and Warnings on page 135
- Installation Safety Guidelines and Warnings on page 146
- Laser and LED Safety Guidelines and Warnings on page 152
- Maintenance and Operational Safety Guidelines and Warnings on page 155

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 132
- Restricted Access Area Warning on page 133
- Prevent Electrostatic Discharge Damage on page 134

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.

Warning! 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 possui 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.

Prevent 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:

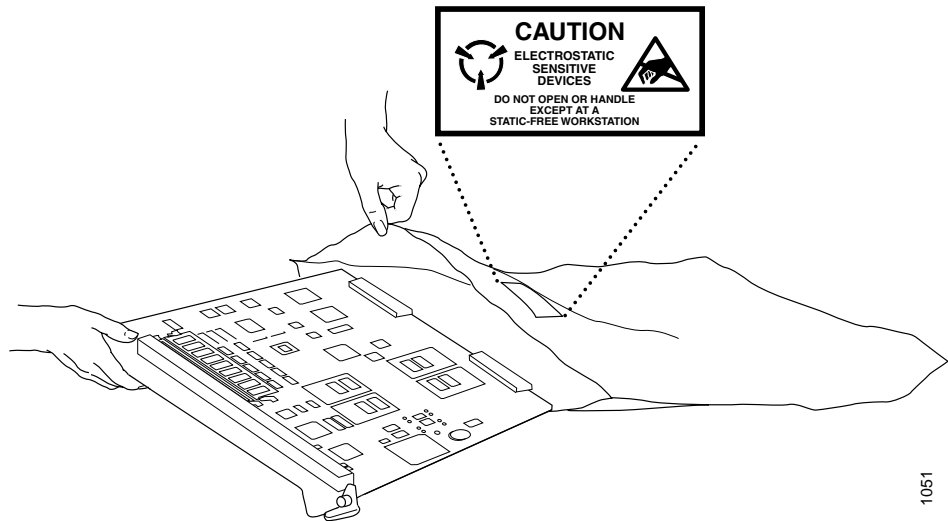
- Always use an ESD wrist strap or ankle strap, and make sure that it is in direct contact with your skin.



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, Figure 2, and Figure 3.
- 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 47). If you are returning a component, place it in an electrostatic bag before packing it.

Figure 47: Place a Component into an Electrostatic Bag

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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 136
- AC Power Electrical Safety Guidelines on page 136
- DC Power Electrical Safety Guidelines on page 137
- Copper Conductors Warning on page 138
- DC Power Disconnection Warning on page 138
- DC Power Grounding Requirements and Warning on page 139
- DC Power Wiring Sequence Warning on page 140
- DC Power Wiring Terminations Warning on page 141
- Grounded Equipment Warning on page 142
- In Case of Electrical Accident on page 143
- Midplane Energy Hazard Warning on page 143
- Multiple Power Supplies Disconnection Warning on page 144
- Power Disconnection Warning on page 144
- TN and IT Power Warning on page 145

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 and IT power systems.
- 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 3. Never install equipment if it appears damaged.

AC Power Electrical Safety Guidelines

The following electrical safety guidelines apply to AC-powered routers:

- AC-powered routers are shipped with a three-wire electrical cord with a grounding-type plug that fits only a grounding-type power outlet. Do not circumvent this safety feature. Equipment grounding should comply with local and national electrical codes.
- You must provide an external circuit breaker rated minimum 20 A, 125/250 VAC in the building installation.
- The power cord serves as the main disconnecting device. The socket outlet must be near the router and be easily accessible.
- The cores in the mains lead are colored in accordance with the following code:

- Green and yellow—Earth
 - Blue—Neutral
 - Brown—Live
- When a router is equipped with two AC power supplies, both power cords (one for each power supply) must be unplugged to completely disconnect power to the router.

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 13.5 A @ 48 VDC. The 48 VDC facility DC source should be equipped with a circuit breaker rated at 20 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 20 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.

Warning! 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 schakelaarhandel 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 tejp 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 “DC Grounding, Connection, and Cable Specifications” on page 46.



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.

Warning! 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'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 tilkopplingssekvens er jord til jord, + RTN til + RTN, -48 V til - 48 V. Riktig frakoples tilkopplingssekvens 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.

Varoitus Jos säikeellinen johdin on tarpeen, käytä hyväksyttyä johdinliitäntää, esimerkiksi suljettua silmukkaa tai kourumaista liitäntää, jossa on ylöspäin käännetty kiinnityskorvat. Tällaisten liitännöjen 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 ledningen.

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.

Warning! 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 avpassad 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.

Varoitus Tässä laitteessa on useampia virtalähdekytkentöjä. 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.

Varoitus 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 and IT 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 146
- Installation Instructions Warning on page 147
- Rack-Mounting Requirements and Warnings on page 147
- Ramp Warning on page 151

Chassis Lifting Guidelines

The fully configured chassis weight is about 61 lb (27.6 kg) for the M5 router or 67 lb (29.5 kg) for the M10 router. Observe the following guidelines for lifting and moving the router:

- Before moving the router, read the guidelines in “Prepare for Router Installation” on page 37 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 two people must lift the router.
- 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.

Varoitus 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.

Warning! 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.

Varoitus 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 diretrizes 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 käytä 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

Warning! 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 152
- Class 1 Laser Product Warning on page 153
- Class 1 LED Product Warning on page 153
- Laser Beam Warning on page 154
- Radiation From Open Port Apertures Warning on page 154

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 1.

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.

Warning! 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 stråling kan avges från en portöppning utan ansluten fiberkabel och du bör därför undvika att bli utsatt för stråling 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 155
- Jewelry Removal Warning on page 156
- Lightning Activity Warning on page 157
- Operating Temperature Warning on page 158
- Product Disposal Warning on page 159

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 ontploffingsgevaar 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.

Varoitus 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.

Warning! 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 kuumenevat, 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.

Warning! 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.

Warning! 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.

Varoitus Ettei Juniper Networks router-sarjan reititin ylikuumentuisi, 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 Lüftungverschluss 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.

Warning! 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

Warning! 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 60950 Safety of Information Technology Equipment
 - EN 60825-1 Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
 - EN 60825-2 Safety of Laser Products - Part 2: Safety of Optical Fibre Communication Systems
- EMC
 - AS/NZS 3548 Class A (Australia/New Zealand)
 - BSMI Class A (Taiwan)
 - 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
- 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)

- ETSI
 - ETS-300386-2 Telecommunication Network Equipment. Electromagnetic Compatibility Requirements

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

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。 VCCI-A

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

Taiwan

警告使用者

這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

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

Return the Router or Its Components

This chapter describes how to return the router or individual components to Juniper Networks for repair or replacement:

- Tools and Parts Required on page 163
- Return Procedure on page 163
- Locate Component Serial Numbers on page 164
- Pack the Router for Shipment on page 168
- Pack Components for Shipment on page 169

Tools and Parts Required

To remove components from the chassis or the chassis from a rack, you need the following tools and parts:

- Mechanical lift, if available
- Phillips (+) screwdrivers, numbers 1 and 2
- Electrostatic damage (ESD) grounding wrist strap

Return Procedure

When you need to return a component, follow this procedure:

1. Determine the part number and serial number of the component. For instructions, see “Locate Component Serial Numbers” on page 164.

2. Obtain a Return Materials Authorization (RMA) number from the Juniper Networks Technical Assistance Center (JTAC). You can send e-mail or telephone as specified in “How to Request Support” on page xix.

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
- The shipping address for the replacement component, including contact name and phone number
- Description of the failure

The support representative validates your request and issues an RMA number for return of the component.

3. Pack the router or component for shipment, performing the procedure described in “Pack the Router for Shipment” on page 168 or “Pack Components for Shipment” on page 169.

Locate Component Serial Numbers

Your request for an RMA must include the component part and serial numbers. Issue the CLI `show chassis hardware` command to list the numbers for all components installed in the chassis:

```

user@host> show chassis hardware
Hardware inventory:
Item          Version Part number Serial number Description
Chassis                               61322      M10
Midplane      REV 03  710-001950 HK3744
Power Supply A Rev 03  740-002498 LL31699    DC
Display       REV 04  710-001995 HK9437
Routing Engine REV 01  740-007603 P11075100172 RE-3.0
FEB           REV 07  710-003310 HH9725     E-FEB
FPC 0
  PIC 1       REV 04  750-003163 HJ6423     1x G/E, 1000 BASE-SX
  PIC 2       REV 02  750-003163 HF8954     1x G/E, 1000 BASE-SX
  PIC 3       REV 04  750-003163 HJ6426     1x G/E, 1000 BASE-SX
FPC 1
  PIC 3       REV 01  750-008425 BE2069     Adaptive Services
    
```

Most components also have a small rectangular serial number ID label (see Figure 48) attached to the component body.

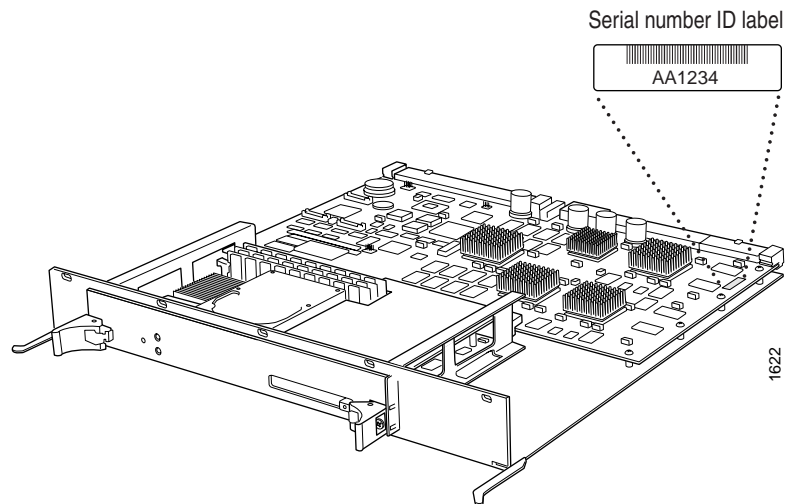
Figure 48: Serial Number ID Label

The following sections describe the tag location on each type of component:

- FEB Serial Number ID Label on page 165
- PIC Serial Number ID Label on page 165
- Power Supply Serial Number ID Label on page 166
- Routing Engine Serial Number ID Label on page 167

FEB Serial Number ID Label

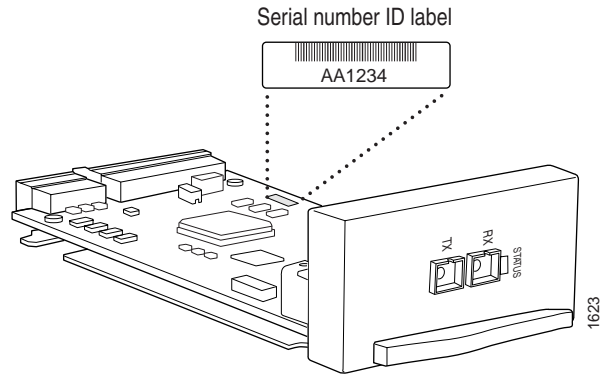
The serial number ID label on an FEB is located near the rear on the right side, as shown in Figure 49.

Figure 49: FEB Serial Number ID Label

PIC Serial Number ID Label

The serial number ID label on a PIC is located on the left side when the PIC is horizontal, as it is when installed in the router. See Figure 50.

Figure 50: PIC Serial Number ID Label



Power Supply Serial Number ID Label

The serial number ID label on a power supply is located on the power supply faceplate, as shown in Figure 51 and Figure 52.

Figure 51: AC Power Supply Serial Number ID Label

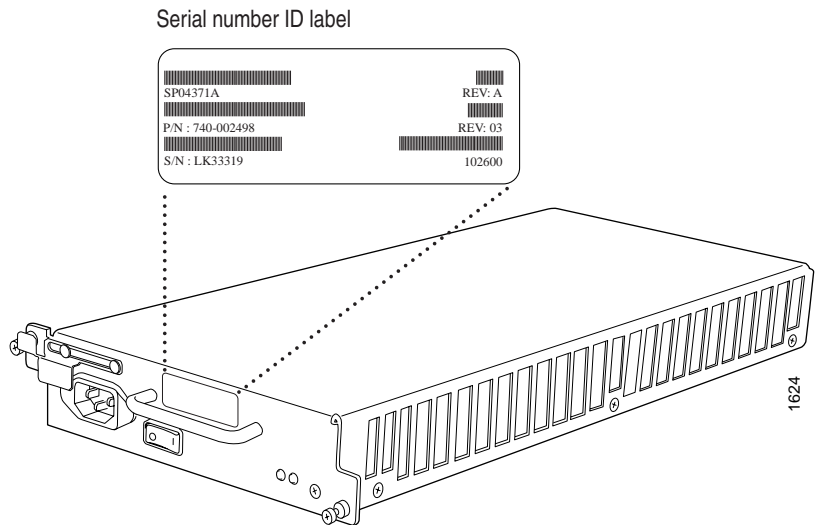
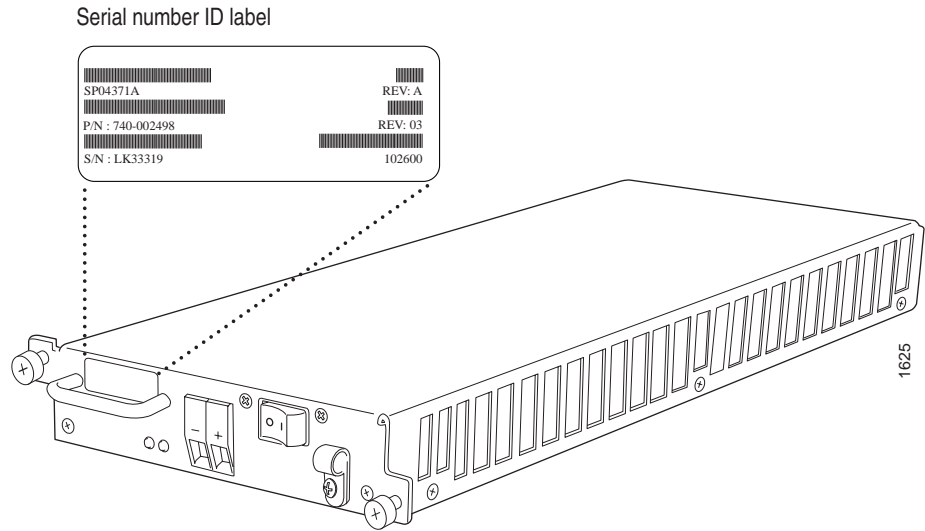


Figure 52: DC Power Supply Serial Number ID Label



Routing Engine Serial Number ID Label

The location of the serial number ID label depends on the type of Routing Engine (see Figure 53 and Figure 54). 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 53: Routing Engine 333 Serial Number ID Label

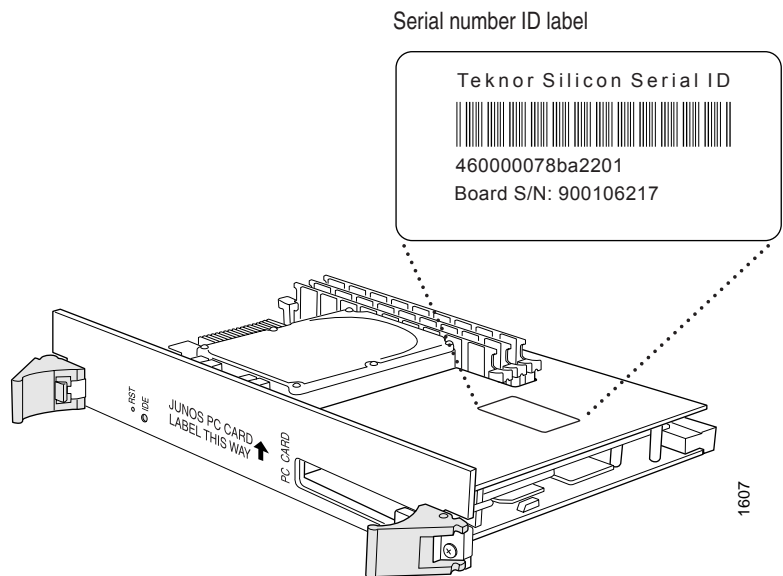
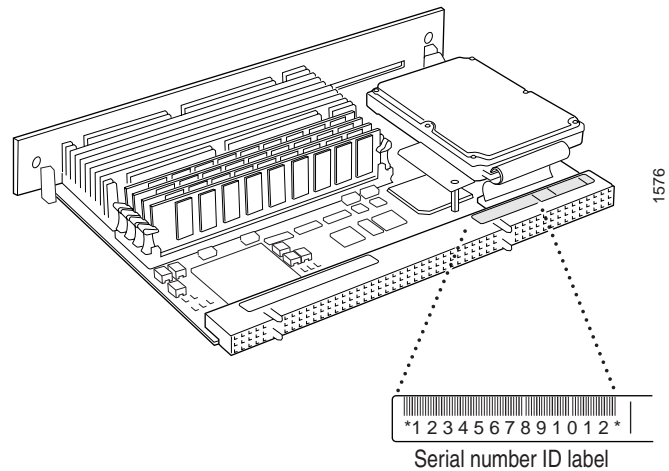


Figure 54: Routing Engine 600 Serial Number ID Label



Pack the Router for Shipment

To pack the router for shipment, follow this procedure:

1. Retrieve the shipping box and packing materials in which the router was originally shipped.
2. On the console or other management device connected to the Routing Engine, enter CLI operational mode and issue the following command to shut down the router software cleanly and preserve Routing Engine state information.

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

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

For more information about the command, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

3. Shut down power to the router by pressing the power switch for both power supplies to the **OFF (O)** position. On both AC and DC power supplies, the switch is located on the power supply faceplate.
4. Disconnect power from the router. For instructions, see “Disconnect AC Power from the Router” on page 102 or “Disconnect DC Power from the Router” on page 109.
5. Remove the cables that connect to all PICs and external devices. For instructions, see “Replace Connectors to Routing Engine Interface Ports” on page 118 and “Remove a PIC” on page 87.

6. Remove the chassis from the rack:
 - If you are using a mechanical lift, place the lift platform under the chassis, unscrew and remove the mounting screws from the rack, and move the chassis to the shipping box.
 - If you are not using a mechanical lift and the chassis weight is fully supported by a shelf or another chassis, unscrew and remove the mounting screws from the rack. Two people can then lift the chassis and move it to the shipping box.
 - If you are not using a mechanical lift and the chassis weight is not fully supported by a shelf or another chassis, two people should grasp the router while a third person unscrews and removes the mounting screws from the rack. The two lifters can then move the chassis to the shipping box.
7. Place the chassis in the shipping box.
8. Replace the packing foam on top of the chassis.
9. Replace the accessory box on top of the packing foam.
10. Securely tape the box closed.

Pack Components for Shipment

To pack and ship individual router components, follow these guidelines:

- Protect the component with enough packing material to prevent movement inside the carton. Use the original shipping materials if they are available.
- Place individual boards in electrostatic bags.



Caution

Do not stack components.

Appendix C

Cable Connector Pinouts

This chapter describes the pinouts for the following cable connectors:

- RJ-45 Connector Pinouts for the Routing Engine MGMT Port on page 171
- DB-9 Connector Pinouts for the Routing Engine AUX/MODEM and CONSOLE Ports on page 171
- RJ-48 Cable Pinouts for E1 and T1 PICs on page 172
- RJ-21 Cable Pinouts for Fast Ethernet 12-Port PIC on page 175

RJ-45 Connector Pinouts for the Routing Engine MGMT Port

The port on the craft interface labeled **MGMT** 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 Interface Ports and Status Indicators” on page 15. Table 19 describes the RJ-45 connector pinout.

Table 19: 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 AUX/MODEM and CONSOLE Ports

The ports on the craft interface labeled **AUX/MODEM** and **CONSOLE** are DB-9 receptacles that accept RS-232 (EIA-232) cable. The **AUX/MODEM** 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 Interface Ports and Status Indicators” on page 15. Table 20 describes the DB-9 connector pinouts.

Table 20: 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.



To maintain agency approvals, use only a properly constructed, shielded cable.

Caution

Table 21, Table 22, Table 23, and Table 24 describe the RJ-48 connector pinouts.

Table 21: 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 22: 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 23: 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 24: 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

RJ-21 Cable Pinouts for Fast Ethernet 12-Port PIC

The Fast Ethernet 12-port PIC has a VHDCI connector port on its faceplate (see Figure 55), which accepts the RJ-21 cable supplied with the PIC (see Figure 56).

Figure 55: Fast Ethernet 12-port PIC

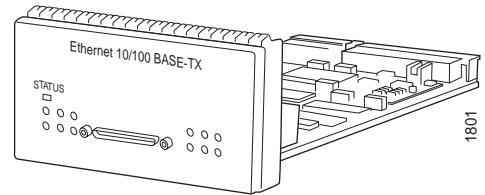


Figure 56: VHDCI to RJ-21 Cable

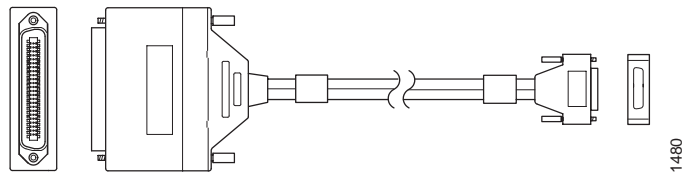



Table 25 describes the RJ-21 cable pinouts.



RJ-21 pin numbers 25 and 50 do not appear in the table because they are ground connectors.

Note

Table 25: RJ-21 Pin Assignments

Ethernet Port Numbers	RJ-21 Pin Assignment			
	TX -	TX +	RX -	RX +
0	2	27	1	26
1	4	29	3	28
2	6	31	5	30
3	8	33	7	32
4	10	35	9	34
5	12	37	11	36
6	14	39	13	38
7	16	41	15	40
8	18	43	17	42
9	20	45	19	44
10	22	47	21	46
11	24	49	23	48

Part 5

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