



M40TM Internet Router

Hardware Guide

Juniper Networks, Inc.

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M40 Internet Router 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 *M40 Internet Router Hardware Guide*:

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- Audience on page xvii
- Document Organization on page xviii
- List of Technical Publications on page xviii
- Documentation Conventions on page xx
- Contact Juniper Networks on page xx
- Documentation Feedback on page xxi

Objectives

This manual describes hardware installation and basic troubleshooting procedures for the Juniper Networks M40 Internet router. It explains how to prepare your site for router installation, unpack and install the hardware, power on the router, perform initial software configuration, and perform routine maintenance. After completing the installation and basic configuration procedures covered in this manual, refer to the JUNOS Internet software configuration guides for information about further JUNOS software configuration.

To obtain additional information about the router—either corrections to information in this manual or information that might have been omitted from this manual—refer to the release notes available at the Juniper Networks hardware documentation Web site, <http://www.juniper.net/techpubs/hardware>. The most current version of this manual is available at the same URL.

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 M40 Internet router, or preparing their site for router installation. It assumes a broad understanding of networks in general, the Internet in particular, networking principles, and network configuration. A 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 obtain technical 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 and Replacement Procedures,” describes general maintenance procedures for the router and how to maintain and replace the router components.
- Part 4, “Troubleshooting,” describes general troubleshooting procedures for the router. It also tells you how to contact the Juniper Networks Technical Assistance Center (JTAC).
- Part 5, “Appendixes,” provides pinout specifications for several cable types, instructions for cleaning fiber-optic transceivers, instructions for returning the router or components, and a glossary of terms.
- Part 6, “Index,” provides an index of the manual.

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 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>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 Interfaces and Class of Service</i>	Provides an overview of the network interface and class-of-service functions of the JUNOS software and describes how to configure the network interfaces on the router.
<i>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.

Book	Description
<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 of Layer 2 and Layer 3 Virtual Private Networks (VPNs), describes how to configure VPNs, and 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	
<i>Comprehensive Index</i>	Provides a complete index of all JUNOS Internet software books and the <i>JUNOScript API Guide</i> .
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.
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.
JUNOScope Software	
<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.

Documentation Conventions

This manual uses the following text conventions:

- Router and router component labels are shown in a sans serif font. In the following example, **MANAGEMENT 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 **MANAGEMENT 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 are denoted by the following symbols:



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



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



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

Contact Juniper Networks

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).

Documentation Feedback

We are always interested in hearing from our customers. Please let us know what you like and do not like about the product 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 and comments to techpubs-comments@juniper.net.

Part 1

Product Overview

- System Overview on page 3
- Hardware Component Overview on page 7
- JUNOS Internet Software Overview on page 25
- System Architecture Overview on page 31

Chapter 1

System Overview

This chapter provides an overview of the M40 Internet router, discussing the following topics:

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

System Description

The M40 Internet router is a complete routing system that provides high-speed interfaces for large networks and network applications, such as those supported by Internet backbone service providers. Application-specific integrated circuits (ASICs), a definitive part of the router design, enable the router to forward data at the high speeds demanded by current network media.

The router accommodates up to eight Flexible PIC Concentrators (FPCs), each of which can be configured with a variety of network media types—altogether providing up to 128 physical interface ports per system. The router height of 35 in. (89 cm) enables stacked installation of two M40 routers in a single floor-to-ceiling rack, for increased port density per unit of floor space.

The router's maximum aggregate throughput is 40 gigabits per second (Gbps). The router provides very high throughput for any combination of Physical Interface Cards (PICs) that does not exceed 3 Gbps on an FPC. A combination that exceeds 3 Gbps is supported, but constitutes oversubscription.

The router architecture cleanly separates control operations from packet forwarding operations. This design eliminates processing and traffic bottlenecks, permitting the router to achieve high-performance line rates. Control operations in the router are performed by the Routing Engine, which runs JUNOS Internet software to handle routing protocols, traffic engineering, policy, monitoring, policing, 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 FRUs requires minimal router downtime. There are three types of FRUs:

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

Table 2 lists the FRUs for the M40 router.

Table 2: Field-Replaceable Units

Hot-Removable and Hot-Insertable FRUs	Hot-Pluggable FRUs	FRUs That Require Powering Down the Router
<ul style="list-style-type: none"> ■ Fan tray assembly ■ Flexible PIC Concentrator (FPC) ■ Front and rear impeller assemblies ■ Physical Interface Card (PIC) ■ Power supply 	<ul style="list-style-type: none"> ■ Routing Engine ■ System Control Board (SCB) 	<ul style="list-style-type: none"> ■ Craft interface

For FRU replacement instructions, see “Hardware Maintenance and Replacement Procedures” on page 131.

Component Redundancy

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

- Cooling system—When the temperature inside the router is below the acceptable maximum, the cooling system’s components function at less than full speed. If the temperature becomes excessive—for example, because a cooling system component is removed—the SCB automatically increases the speed of the remaining components to reduce the temperature. The cooling system can function at the higher speed indefinitely. For more information, see “Cooling System” on page 23.
- Power supply—The router has two load-sharing power supplies to distribute power to the other components. If one power supply fails, the second power supply can provide full power to the router’s components indefinitely. For more information, see “Power Supplies” on page 20.

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 the Site” on page 39. For a list of safety warnings, see “Regulatory Compliance and Safety Information” on page 55 and particularly “Electrical Safety Guidelines and Warnings” on page 60. However, providing an exhaustive set of guidelines for working with electrical equipment is beyond the scope of this manual.

System Specifications

Table 3 summarizes physical specifications for the M40 router. For environmental specifications, see “Site Environmental Requirements” on page 43.

Table 3: Physical and Environmental Specifications

Description	Value
Chassis height	35 in. (89 cm)
Chassis width	19 in. (48 cm)
Chassis depth	23.5 in. (60 cm)
Weight, maximum configuration	280 lb (127 kg)
Weight, minimum configuration	180 lb (81 kg)
Thermal output	3850 BTU/hour

Chapter 2

Hardware Component Overview


This chapter provides an overview of the hardware components on the M40 Internet router:

- Chassis on page 8
- Packet Forwarding Engine on page 9
 - Backplane on page 10
 - Physical Interface Cards (PICs) on page 10
 - Flexible PIC Concentrators (FPCs) on page 11
 - System Control Board (SCB) on page 13
- Routing Engine on page 15
- Craft Interface on page 17
- Power Supplies on page 20
- Cooling System on page 23
- Cable Management System on page 24

Chassis

The router chassis is a rigid sheet metal structure that houses all the other router hardware components (see Figure 1 and Figure 2). The chassis is 19 in. (48 cm) wide and 23.5 in. (60 cm) deep. The chassis height of 35 in. (89 cm) enables stacked installation of two M40 routers in a single floor-to-ceiling rack. The two front- or center-mounting ears (one on each side) enable installation into either a front-mount or a center-mount rack. For more information, see “Rack Requirements” on page 39.

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

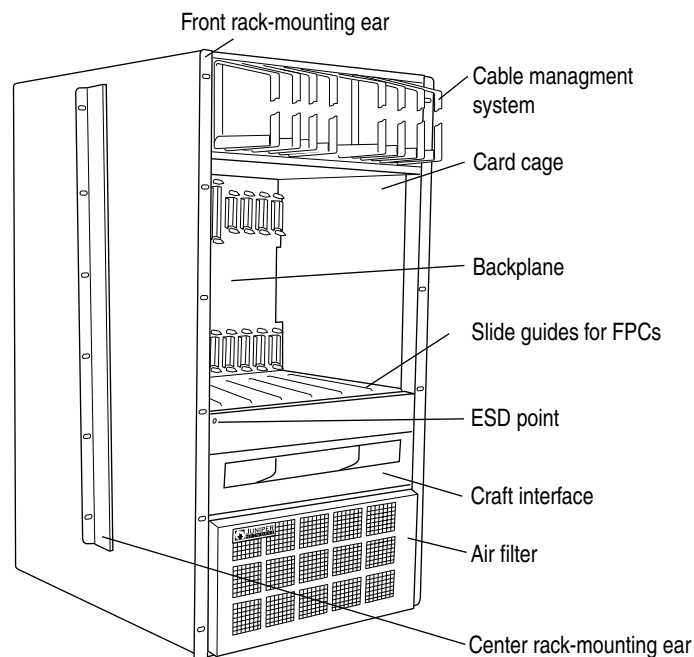


Before removing or installing components of a functioning router, attach an ESD strap to one of the ESD points and place the other end of the strap around your bare wrist. Failure to use an ESD strap could result in damage to the router.

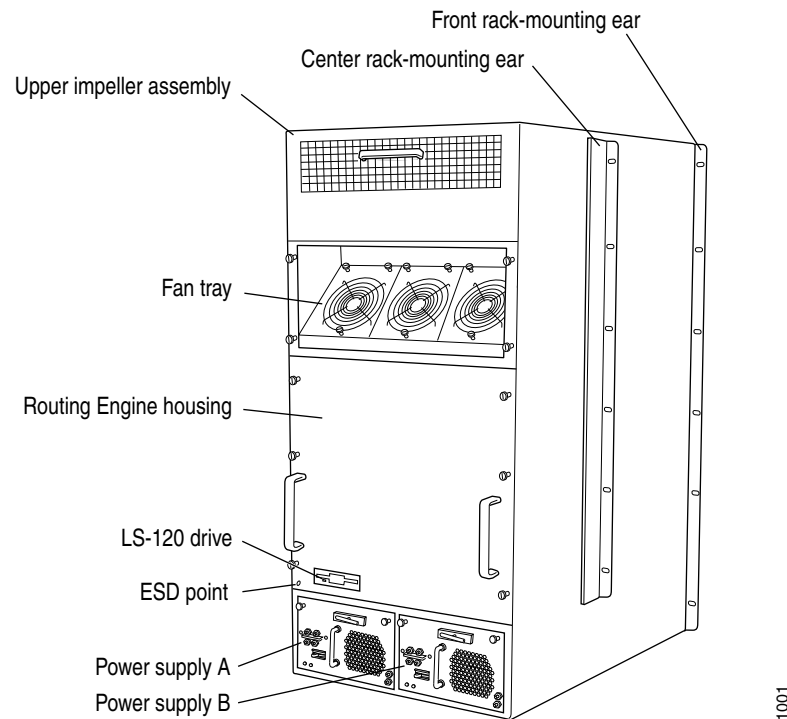
The router must be connected to earth ground during normal operation.

For further safety information, see “Regulatory Compliance and Safety Information” on page 55.

Figure 1: Front View of Chassis



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Figure 2: Rear View of Chassis

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, I/O Manager ASIC, Internet Processor or Internet Processor II ASIC, and various media-specific controllers.

The Packet Forwarding Engine has the following components:

- **Backplane**—Forms the rear of the FPC card cage, 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 ATM, OC-12 and OC-48 SONET/SDH, Channelized OC-12, and Gigabit Ethernet. PICs are housed in FPCs.
- **Flexible PIC Concentrators (FPCs)**—Process incoming and outgoing packets. From one to eight FPCs can plug into the backplane from the front of the chassis. Each FPC accommodates up to four Physical Interface Cards (PICs).
- **System Control Board (SCB)**—Performs route lookup, filtering, and switching. The SCB installs into the backplane from the front of the chassis.

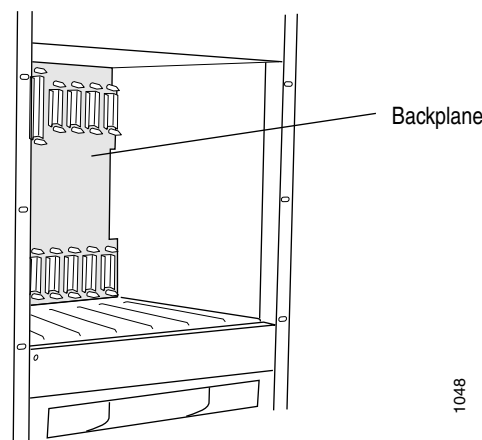
Backplane

The backplane is a panel that forms the back of the FPC card cage (see Figure 3). The SCB and all the FPCs install into the backplane from the front of the chassis. The backplane contains a temperature sensor and is cooled by three fans operating in unison. It also contains an EEPROM that stores the serial number and revision level of the backplane.

The backplane performs the following functions:

- **Power distribution**—The backplane distributes power to all router components from the power supplies attached to it.
- **Signal connectivity**—The backplane transports the signals exchanged by system components for monitoring and control purposes.
- **Management of shared memory on the FPCs**—One Distributed Buffer Manager ASIC on the backplane uniformly allocates incoming data packets throughout shared memory on the FPCs.
- **Transfer of outgoing data cells to the FPCs**—A second Distributed Buffer Manager ASIC on the backplane passes data cells to the FPCs for reassembly into packets when the data is ready to be transmitted.

Figure 3: The Backplane



Physical Interface Cards (PICs)

Physical Interface Cards (PICs) are housed on Flexible PIC Concentrators (FPCs) and physically connect the router to network media. For information about FPCs, see “Flexible PIC Concentrators (FPCs)” on page 11. The router supports various PICs, including ATM, Channelized OC-12/STM-4, Gigabit Ethernet, and SONET/SDH interfaces. Up to four PICs install in each FPC. The PIC slots are numbered 0 (zero) through 3, top to bottom.

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.

A regular PIC is hot-removable and hot-insertable in the sense that its absence does not disrupt routing functions; however, you must completely remove its host FPC from the chassis before removing the PIC, which affects all PICs on the FPC. For replacement instructions, see “Replace a PIC” on page 167.

Quad-wide PICs, such as the 4-port Gigabit Ethernet and OC-48/STM-16 SONET/SDH PICs, occupy an entire FPC slot and are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. The instructions for replacing a quad-wide PIC are the same as for an FPC. See “Replace an FPC or Quad-wide PIC” on page 163.

PIC Components

Most PICs supported on the M40 router have the following components, but for complete specifications see the *M20 and M40 Internet Routers PIC Guide*. For information about pinouts for PIC cable connectors, see “Cable Connectors and Pinouts” on page 207.

- 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 *M20 and M40 Internet Routers PIC Guide*.

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 10). Up to eight FPCs install vertically into the backplane from the front of the chassis. The FPC slots are numbered left to right, from 0 (zero) through 7. Each FPC accommodates up to four PICs and the PIC slots in each FPC are numbered from 0 (zero) through 3, top to bottom.

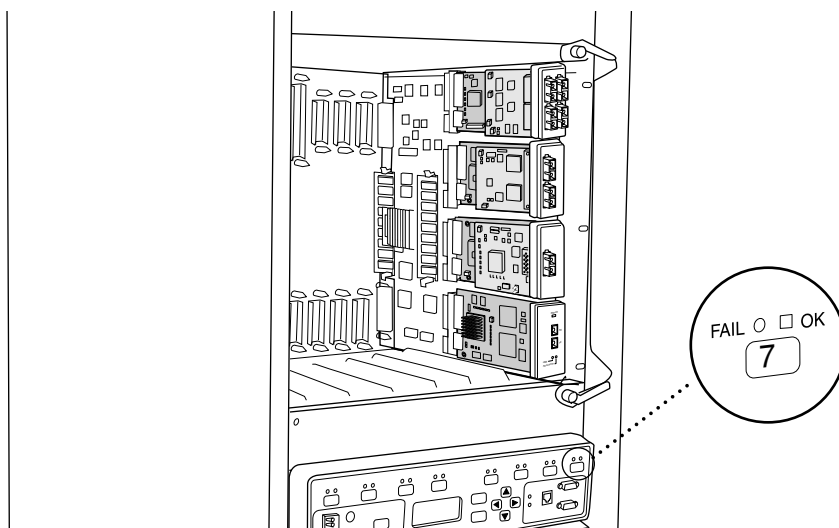
An FPC can be installed into any FPC slot, regardless of the PICs it contains, and any combination of slots can be used. If a slot is empty, you must install a blank FPC panel to shield it, so that cooling air can circulate properly throughout the card cage. Figure 4, which shows a chassis with an FPC in slot 7, omits the blank FPC panels to show the FPC’s position in the card cage.

The main function of an FPC is to connect the PICs installed in it to the other router components. The I/O Manager ASIC on the FPC divides each incoming data packet into 64-byte cells, which the Distributed Buffer Manager ASIC on the backplane distributes among the memory buffers located on and shared by all installed FPCs. After the SCB decides how to forward a packet, the I/O Manager ASIC on the FPC reassembles the corresponding data cells back into network-packet form and passes the packet to the appropriate PIC for transmission to the network. For more information, see “Data Flow through the Packet Forwarding Engine” on page 33.

FPCs are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. When you remove or install an FPC, packet forwarding halts for about 200 ms while the Packet Forwarding Engine adjusts to the change in the amount of memory available in the pool located on and shared by all FPCs. When you install an FPC into a functioning router, press its offline button to activate it and the PICs installed in it. The Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs housed on the FPC are enabled. Forwarding continues uninterrupted during this process. For FPC replacement instructions, see “Replace an FPC or Quad-wide PIC” on page 163.

The PICs that install on both types of FPC are also hot-removable and hot-insertable. For more information, see “Physical Interface Cards (PICs)” on page 10.

Figure 4: FPC Installed in Slot FPC7



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FPC Components

Each FPC contains the following components:

- FPC card carrier—Houses the other FPC components.
- I/O Manager ASIC—Parses Layer 2 and Layer 3 data and performs encapsulation and segmentation.
- Two identical SDRAM dual inline memory modules (DIMMs)—Form the memory pool shared with the other FPCs installed in the router.
- Parity-protected SSRAM—Stores data structures used by the I/O Manager ASIC.
- Processor subsystem—Manages packet handling in the FPC and communication with the SCB. It is a PowerPC 603e-based CPU with parity-protected DRAM.
- EEPROM—Stores the serial number and revision level of the FPC.
- Two LEDs—Indicate FPC status. There is a green one labeled **OK** and a red one labeled **FAIL**. The LEDs for each FPC are located directly below it, on the router craft interface. For more information, see “FPC LEDs and Offline Button” on page 18.
- Offline button—Prepares the FPC for removal from the router when pressed. Like the LEDs, an offline button is located on the craft interface directly below each FPC slot. For more information, see “FPC LEDs and Offline Button” on page 18.
- Extractor clips—Control the locking system that secures the FPC in the card cage.

System Control Board (SCB)

The System Control Board (SCB) performs route lookup, filtering, and switching on incoming data packets, then directs outbound packets to the appropriate FPC for transmission to the network. It occupies the center slot of the card cage, installing into the backplane from the front of the chassis (see Figure 1).

The SCB is hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. For SCB replacement instructions, see “Replace the SCB” on page 169.

The SCB performs the following functions:

- **Route lookups**—The Internet Processor or Internet Processor II ASIC on the SCB performs route lookups using the forwarding table stored in the synchronous SRAM (SSRAM). After performing the lookup, the ASIC informs the backplane of the forwarding decision, and the backplane forwards the decision to the appropriate outgoing interface.
- **Monitoring and control of router components**—The SCB collects statistics from all sensors in the system. When it detects a failure or alarm condition, it sends a signal to the Routing Engine, which generates control messages or sets an alarm. The SCB also relays control messages from the Routing Engine to the router components.
- **Transfer of exception and control packets**—The Internet Processor or Internet Processor II ASIC passes exception packets to the microprocessor on the SCB, which processes almost all of them. The SCB sends any remaining exception packets to the Routing Engine for further processing. When the SCB detects an error originating in the Packet Forwarding Engine, it sends it to the Routing Engine using system logging (syslog) messages.
- **Control of FPC resets**—If the SCB detects errors in an FPC, it attempts to reset the FPC. After three unsuccessful reset attempts, the SCB takes the FPC offline and informs the Routing Engine. Other FPCs are unaffected, and system operation continues.

SCB Components

The SCB (shown in Figure 5) has the following components:

- **One Internet Processor or Internet Processor II ASIC**—Performs route lookups and makes routing decisions.
- **Parity-protected SSRAM**—Stores the forwarding table.
- **Processor subsystem**—Manages SCB 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.

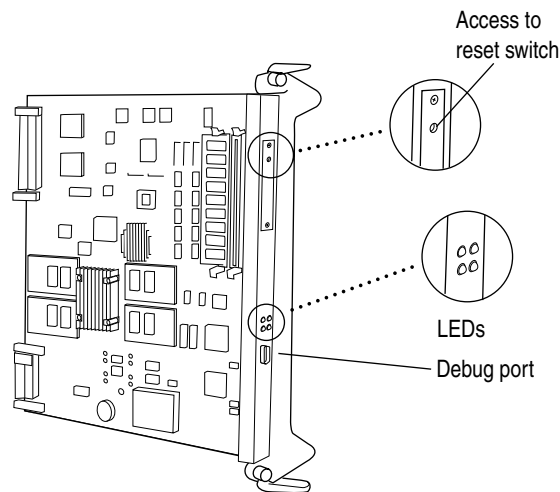
- 19.44-MHz stratum 3 reference clock—Generates clock signal for SONET/SDH PICs.
- I²C controller—Monitors the status of router components.
- Debug port—Connects the SCB to a laptop or other monitoring device through an RS-232 (EIA-232) serial cable. It uses a DB-25 connector.
- Four LEDs—Indicate SCB status. There are two green ones labeled **ACTIVE** and **RUN**, and two amber ones labeled **STAT1** and **STAT2**. Table 4 describes the LED states.
- Reset switch—Restarts the SCB when pressed, causing the Packet Forwarding Engine to reset and halting packet forwarding for up to approximately two minutes. Do not use the reset switch under normal circumstances; to access it, push the end of a paper clip or other small probing device through the hole in the SCB faceplate.
- Extractor clips—Control the locking system that secures the SCB in the chassis.



Note

For specific information about SCB components (for example, the amount of SSRAM and DRAM), issue the `show chassis scb` command.

Figure 5: System Control Board



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Table 4: States for SCB LEDs

Label	Color	State	Description
ACTIVE	Green	Flashing (pulsed with out-time proportional to traffic)	I/O interrupts are occurring.
RUN	Green	Blinking	SCB processor is running. Normally, the blinking is faint and becomes bright only when the SCB is processing many exceptions.
STAT1	Amber	Flashing	Internal diagnostics are running.
STAT2			

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 the rear of the chassis, in a compartment behind the card cage (see Figure 2). For information about the routing architecture, see “System Architecture Overview” on page 31.

The Routing Engine is hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. For replacement instructions, see “Maintain and Replace Routing Engine Components” on page 173.

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.
- 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.

- LED—Indicates disk activity for the internal IDE interface. It does not necessarily indicate routing-related activity.

The LEDs that report Routing Engine status are on the craft interface rather than the Routing Engine faceplate. See “Routing Engine LEDs and Interface Ports” on page 19.

- Reset button—Reboots the Routing Engine when pressed.
- Extractor clips—Control the locking system that secures the Routing Engine in the chassis.



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.



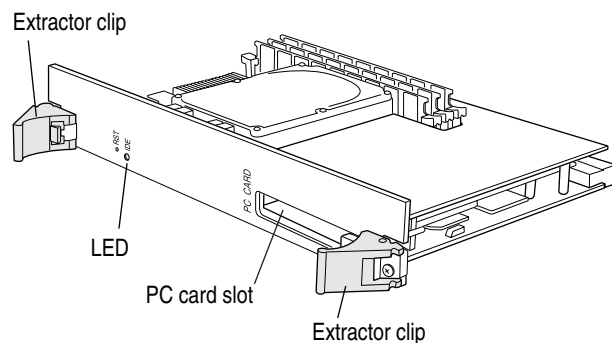
For specific information about components in a Routing Engine (for example, the capacity of the hard disk), issue the `show chassis routing-engine` command.



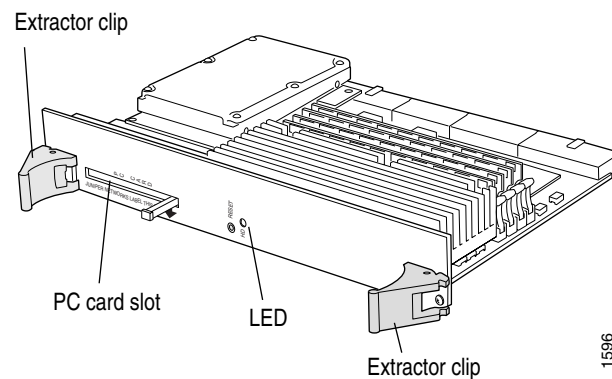
Although the Routing Engine has a PC card slot, it is disabled on the M40 router. The router instead uses an LS-120 disk.

Figure 6: Routing Engine

Routing Engine 333



Routing Engine 600

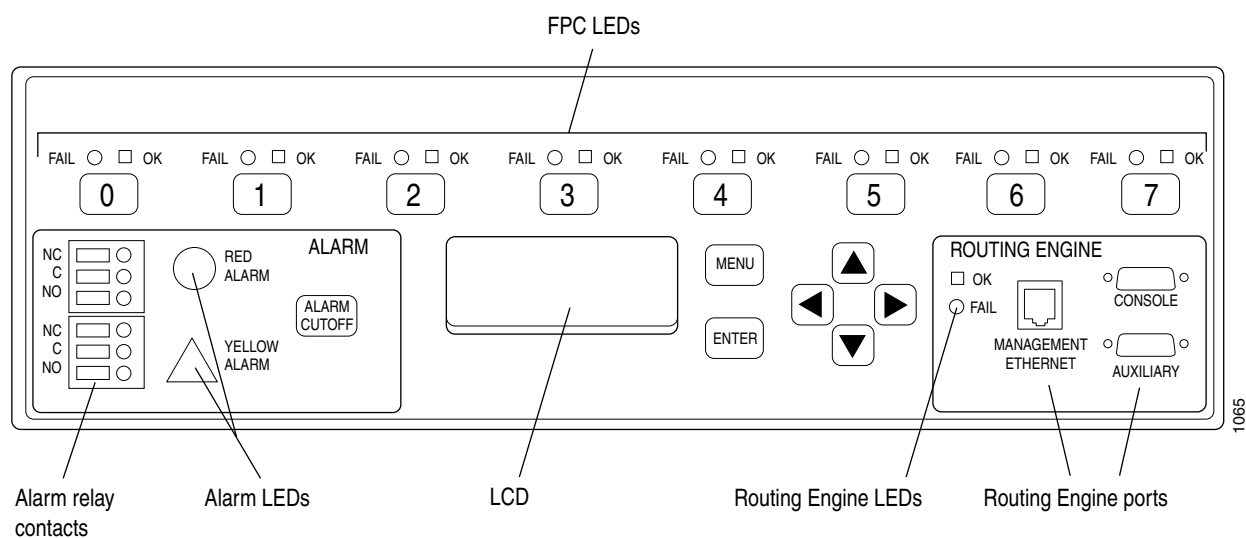


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Craft Interface

The craft interface provides status and troubleshooting information at a glance and has buttons for deactivating alarms and preparing FPCs for removal. The craft interface is located on the front of the chassis below the FPC card cage, as shown in Figure 1. It includes the elements shown in Figure 7.

Figure 7: Craft Interface



Note

The power supply LEDs are located on the power supply faceplate, rather than on the craft interface. For more information, see “Power Supplies” on page 20.

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



- FPC LEDs and Offline Button on page 18
- Alarm Relay Contacts, LEDs, and Cutoff Button on page 18
- LCD on page 19
- Routing Engine LEDs and Interface Ports on page 19

FPC LEDs and Offline Button

Each of the eight FPC slots in the router has two LEDs and an offline button located directly below it on the craft interface, as shown in Figure 7. The green LED labeled **OK** and red LED labeled **FAIL** indicate FPC status, as described in Table 5.

The offline button, labeled with the FPC slot number (for example, 4), prepares the FPC for removal from the router when pressed. Press and hold the button for about 5 seconds, until the **FAIL** LED lights.

Table 5: States for FPC LEDs

Label	Shape	Color	State	Description
OK		Green	On steadily	FPC is functioning normally.
			Blinking	FPC is starting up.
FAIL		Red	On steadily	FPC has failed or is offline.

Alarm Relay Contacts, LEDs, and Cutoff Button




The area labeled **ALARM** at the left side of the craft interface contains two alarm LEDs and relay contacts, and the alarm cutoff button (see Figure 7). The circular LED, labeled **RED ALARM**, lights to indicate a critical condition that can result in a system shutdown. The triangular LED, labeled **YELLOW ALARM**, lights to indicate a less severe condition that requires monitoring or maintenance. Both LEDs can be lit simultaneously. The LCD on the craft interface reports the cause of the alarm.

To the left of the LEDs are the corresponding relay contacts for connecting the router to external alarm-reporting devices. A system condition that causes the red or yellow alarm LED to light on the craft interface also activates the corresponding alarm relay contact. For instructions for attaching a device to the alarm relay contacts, see “Connect to an External Alarm-Reporting Device” on page 121.

To deactivate red and yellow alarms, press the button labeled **ALARM CUTOFF**, which is located to the right of the alarm LEDs. Deactivating an alarm turns off both LEDs and deactivates the device attached to the corresponding alarm relay contact. However, the LCD continues to report the alarm message until you clear the condition that caused the alarm.

Table 6 describes the alarm LEDs and alarm cutoff button in more detail.

Table 6: Alarm LEDs and Alarm Cutoff Button

Shape	Color	State	Description
	Red	On steadily	Critical alarm LED—Indicates a critical condition that can cause the router to stop functioning. Possible causes include component removal, failure, or overheating.
	Yellow	On steadily	Warning alarm LED—Indicates a serious but nonfatal error condition, such as a maintenance alert or a significant increase in component temperature.
	—	—	Alarm cutoff button—Deactivates red and yellow alarms and reset timers for system maintenance alerts.

LCD

A four-line LCD is located in the center part of the craft interface, next to six navigation buttons (see Figure 7). The LCD operates in two modes:



- Idle mode—Reports current system status during normal operation.
- Alarm mode—Reports alarm conditions when the red or yellow alarm LED is lit. For a list of alarm messages that can appear on the LCD, see “Hardware and Interface Alarm Messages” on page 192.

Routing Engine LEDs and Interface Ports

The area labeled ROUTING ENGINE at the right side of the craft interface contains Routing Engine status LEDs and three ports for connecting the Routing Engine to external devices on which system administrators can issue JUNOS command-line interface (CLI) commands to manage the router.

The green LED labeled OK and red LED labeled FAIL indicate Routing Engine status, as described in Table 7.

Table 7: States for Routing Engine LEDs

Label	Shape	Color	State	Description
OK		Green	On steadily	System Control Board detects presence of the Routing Engine.
			Blinking	Routing Engine is starting up.
FAIL		Red	On steadily	Routing Engine is not operational, or System Control Board does not detect its presence.

The interface ports with the indicated label function as follows:

- **MANAGEMENT ETHERNET**—Connects the Routing Engine through an Ethernet connection to a management LAN (or any other device that plugs into an Ethernet connection) for out-of-band management. The port uses an autosensing RJ-45 connector to support both 10- and 100-Mbps connections.
- **CONSOLE**—Connects the Routing Engine to a system console through an RS-232 (EIA-232) serial cable.
- **AUXILIARY**— Connects the Routing Engine to a laptop, modem, or other auxiliary device through an RS-232 (EIA-232) serial cable.

For information about the pinouts for the connectors, see “Cable Connectors and Pinouts” on page 207.

Power Supplies

The router can use either AC or DC power. In either case, there are two load-sharing power supplies that install into the bays located at the bottom rear of the chassis, as shown in Figure 2. As viewed from the rear of the chassis, the supply on the left is referred to as supply A and the supply on the right as supply B. The power supplies connect to the backplane, which distributes power to router components according to their individual voltage requirements. Each power supply has a system ground connector and an integrated fan to cool the power assembly.

The power supplies are fully redundant. When both power supplies are operational, they automatically share the electrical load. If one power supply stops functioning for any reason, the remaining power supply instantly begins providing all the power the router needs for normal functioning, and can provide full power indefinitely.

Power supplies are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. Each power supply has a safety interlock lever that prevents removal of the supply while it is on, but to avoid electrical injury, carefully follow the instructions in “Replace an AC Power Supply” on page 136 and “Replace a DC Power Supply” on page 141.



Note

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

If the router is completely powered down when you power on a 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.

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

For information about the cables required for each type of power supply, see “Power System Requirements and Specifications” on page 44.

See the following sections for further information about the power supplies:

- AC Power Supply on page 21
- DC Power Supply on page 22
- Power Supply LEDs on page 22

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 2. Figure 8 shows the power supply and Table 8 lists electrical specifications. For information about the LEDs on the power supply, see “Power Supply LEDs” on page 22.

Figure 8: AC Power Supply

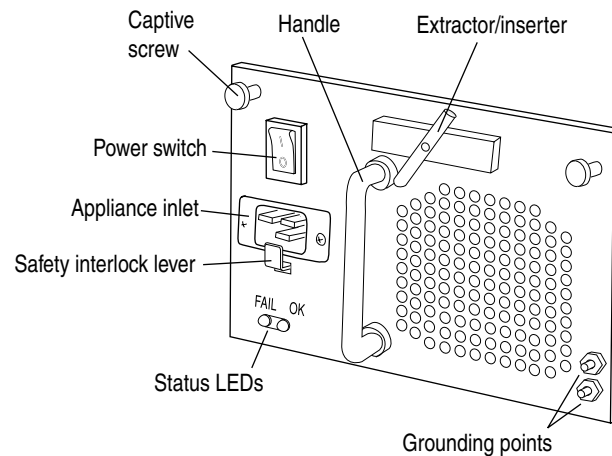


Table 8: AC Power Supply Electrical Specifications

Description	Specification
Maximum power output	1500 W
Input voltage	180–264 VAC operating range
Input line frequency	50–60 Hz, autoranging
Input current rating	8A @ 208V
Output voltage	+3.3V, +5V, +2.5V, +12V, +24V

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 2. Each power supply has an internal circuit breaker. Figure 9 shows the power supply and Table 9 lists electrical specifications. For information about the LEDs on the power supply, see “Power Supply LEDs” on page 22.

Figure 9: DC Power Supply

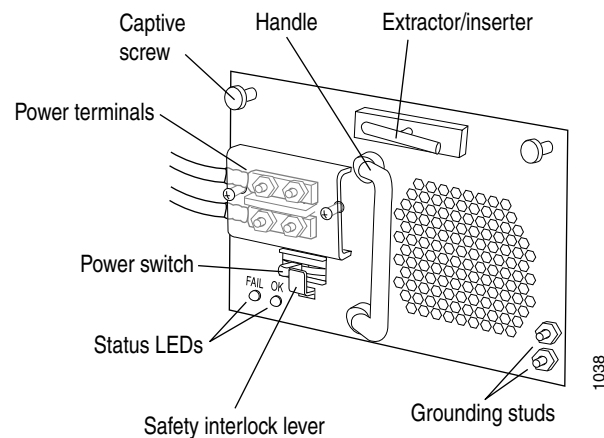


Table 9: DC Power Supply Electrical Specifications

Description	Specification
Maximum power output	1500 W
Input voltage	–40 through –75 VDC operating range
Input current rating	35A @ 48V
Output voltage	+ 3.3V, + 5V, + 2.5V, + 12V, + 24V

Power Supply LEDs

Table 10 describes the LEDs on both AC and DC power supplies.

Table 10: States for Power Supply LEDs

Label	Color	State	Description
OK	Green	On steadily	Power supply is functioning normally, input is occurring, outputs are within range, temperature is within range, and fans are operational.
FAIL	Red	On steadily	Power supply has failed.

Cooling System

The cooling system consists of separate subsystems (sets of fans and impellers) that draw room air into the chassis to keep its internal temperature below a maximum acceptable level. When the temperature is below the maximum, the fans and impellers function at less than full speed. If sensors detect that the temperature of a component has exceeded the acceptable maximum—for example, because an impeller is removed—the speed of the remaining impellers and fans is automatically increased to reduce the temperature. The fans and impellers can function at the higher speed indefinitely.

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

- Cooling System Components on page 23
- Airflow through the Chassis on page 24

Cooling System Components

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

- Air intake vent and air filter—Provide an opening for room air to enter the router. They are located at the bottom of the chassis front, below the craft interface, as shown in Figure 1. The air filter prevents dust and other particles from entering the cooling system. For replacement instructions, see “Maintain and Replace the Air Filter” on page 154.



Caution

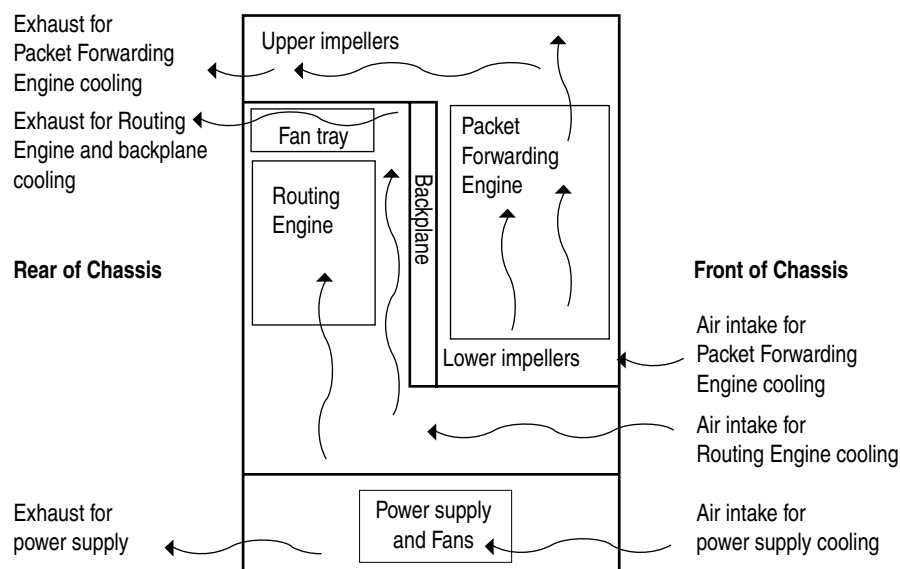
Do not remove the air filter for more than a minute or so while the router is operating. The fans and impellers are powerful enough to draw in foreign material, such as bits of wire, through the unfiltered air intake, which could damage router components.

- Upper and lower impeller assemblies—Cool the Packet Forwarding Engine components (backplane, SCB, FPCs, and PICs). The lower impeller assembly is located behind the craft interface at the front the chassis, and the upper assembly is located above the fan tray at the rear of the chassis. Each assembly houses two impellers for redundancy. The assemblies are not interchangeable. For replacement instructions, see “Replace the Lower Impeller Assembly” on page 158 and “Replace the Upper Impeller Assembly” on page 159.
- Fan tray—Cools the Routing Engine and backplane. The tray houses three fans for redundancy and is located above the Routing Engine at the upper rear of the chassis (see Figure 2). For replacement instructions, see “Maintain and Replace the Fan Tray” on page 155.
- Power supply integrated fan—Cools the power supply. It is not field-replaceable.

Airflow through the Chassis

Figure 10 shows airflow through the chassis and the location of the cooling subsystems.

Figure 10: Side View of Air Flow through the Chassis



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Cable Management System

The cable management system is a row of staggered metal hooks located at the top of the chassis front (see Figure 1). Each hook is draped with a rounded plastic shield and the row is shielded by a removable cover. Threading PIC cables through the hooks keeps cables in place, reduces tangling, prevents undue stress on a cable by distributing its weight evenly, and helps maintain the proper bend radius for optical cables.

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.

This chapter discusses the following topics:

- Routing Engine Software Components on page 26
- Tools for Accessing and Configuring the Software on page 30
- Software Monitoring Tools on page 30
- Software Upgrades on page 30

For complete information about configuring the software, including examples, see the JUNOS Internet software configuration guides.

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 26
- Interface Process on page 29
- SNMP and MIB II Processes on page 29
- Management Process on page 29
- Routing Engine Kernel on page 29

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:

- Routing Protocols on page 26
- Routing and Forwarding Tables on page 28
- Routing Policy on page 28

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

Routing Protocols

The JUNOS Internet software implements full IP routing functionality, providing support for IP Version 4 (IPv4) and 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 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 an 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. The JUNOS RIP software is compatible with RIP Version 1.
- 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.
- Traffic engineering protocols
- LDP—Label Distribution Protocol provides a mechanism for distributing labels in non-traffic-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 paths.

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 28.

- 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.

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

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

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

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

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

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.

SNMP and MIB II Processes

The JUNOS Internet software supports the Simple Network Management Protocol (SNMP), Versions 1 and 2, 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 from the console or through a remote network connection. (For information about connecting a console or other management device to the router, see “Routing Engine LEDs and Interface Ports” on page 19.) 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*.

Software Monitoring Tools

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 `tracert` 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 the router’s flash disk. 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

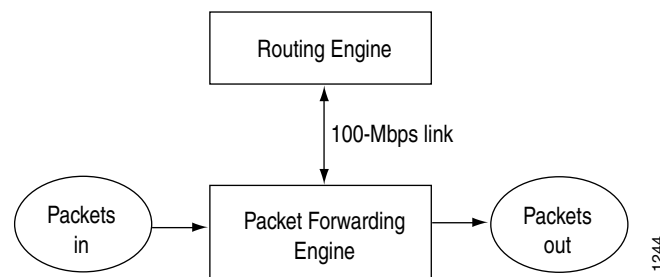
System Architecture Overview

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

Figure 11: System Architecture



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

- Packet Forwarding Engine Architecture on page 32
- Routing Engine Architecture on page 33

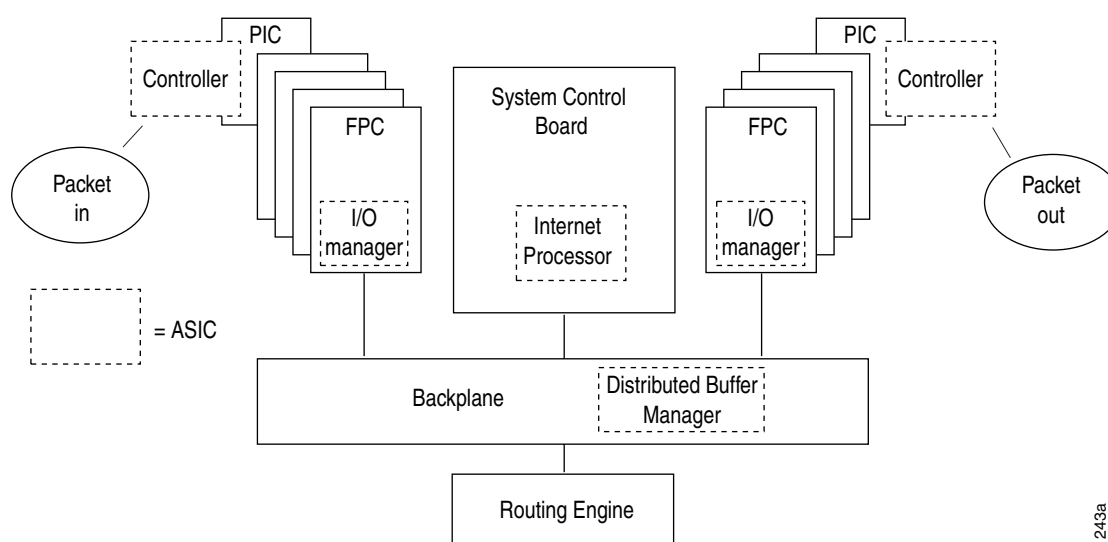
Packet Forwarding Engine Architecture

The Packet Forwarding Engine performs Layer 2 and Layer 3 packet switching. It can forward up to 40 million packets per second for all packet sizes, which exceeds the line speed of eight OC-48/STM-16 lines. The aggregate throughput for the router is 40 gigabits per second (Gbps) simplex or 2.5 Gbps per FPC installed in the system. The Packet Forwarding Engine is implemented in application-specific integrated circuits (ASICs). It uses a centralized route lookup engine and shared memory.

Packet Forwarding Engine includes the following components (see Figure 12):

- **Physical Interface Cards (PICs)**—Physically connect the router to a complete range of fiber-optic and digital network media. A controller ASIC in each PIC performs control functions specific to the PIC media type.
- **Flexible PIC Concentrators (FPCs)**—House PICs and provide shared memory for processing incoming and outgoing packets. Each FPC hosts an I/O Manager ASIC, which divides incoming data packets into memory blocks (cells) and reassembles the cells into data packets when they are ready for transmission.
- **Backplane**—Transports packets, notifications, and other signals between the FPCs and the SCB (as well as other system components). Hosts the Distributed Buffer Manager ASIC, which distributes incoming data cells to the shared memory buffers on the FPCs and notifies the FPCs of forwarding decisions for outgoing packets.
- **System Control Board (SCB)**—Hosts the Internet Processor or Internet Processor II ASIC, which makes forwarding decisions.

Figure 12: Packet Forwarding Engine Components and Data Flow



Data Flow through the Packet Forwarding Engine

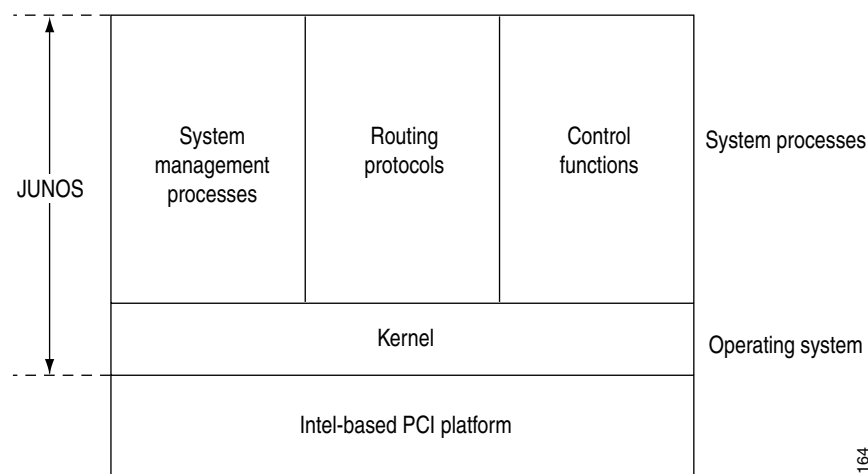
Use of ASICs promotes efficient movement of data packets through the system. Packets flow through the Packet Forwarding Engine in the following sequence (see Figure 12):

1. Packets arrive at an incoming PIC interface.
2. The PIC passes the packets to the FPC, where the I/O Manager ASIC processes the packet headers, divides the packets into 64-byte data cells, and passes the cells to the backplane.
3. The Distributed Buffer Manager ASIC on the backplane distributes the data cells throughout the memory buffers located on and shared by all the FPCs.
4. The Internet Processor or Internet Processor II ASIC on the SCB performs route lookups and makes forwarding decisions.
5. The Internet Processor or Internet Processor II ASIC notifies a second Distributed Buffer Manager ASIC on the backplane of the routing decision.
6. The Distributed Buffer Manager ASIC forwards the notification to the FPC that hosts the outbound PIC.
7. The I/O Manager ASIC on the FPC reassembles data cells in shared memory into data packets as they are ready for transmission and passes them to the outbound PIC.
8. The outbound PIC transmits the data packets.

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 13).

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

Figure 13: 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 26.

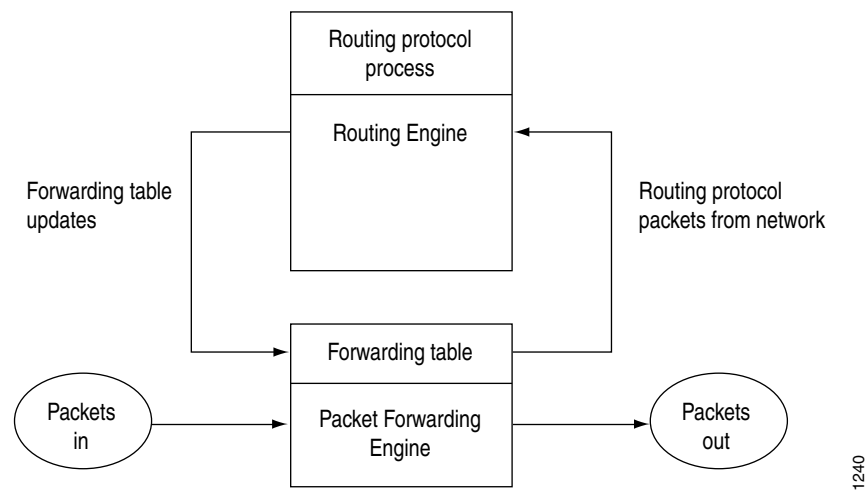
The Routing Engine includes the following functions and features:

- **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 Internet Processor II ASIC allows the forwarding table in the Packet Forwarding Engine to be updated without interrupting forwarding performance. See Figure 14.

Figure 14: Control Packet Handling: Routing and Forwarding Table Updates



Part 2

Initial Installation

- Prepare the Site on page 39
- Regulatory Compliance and Safety Information on page 55
- Prepare to Install the Router on page 89
- Install the Router and Configure Software on page 97

Chapter 5

Prepare the Site

This chapter describes how to prepare your site so that you can install a router, discussing the following topics:

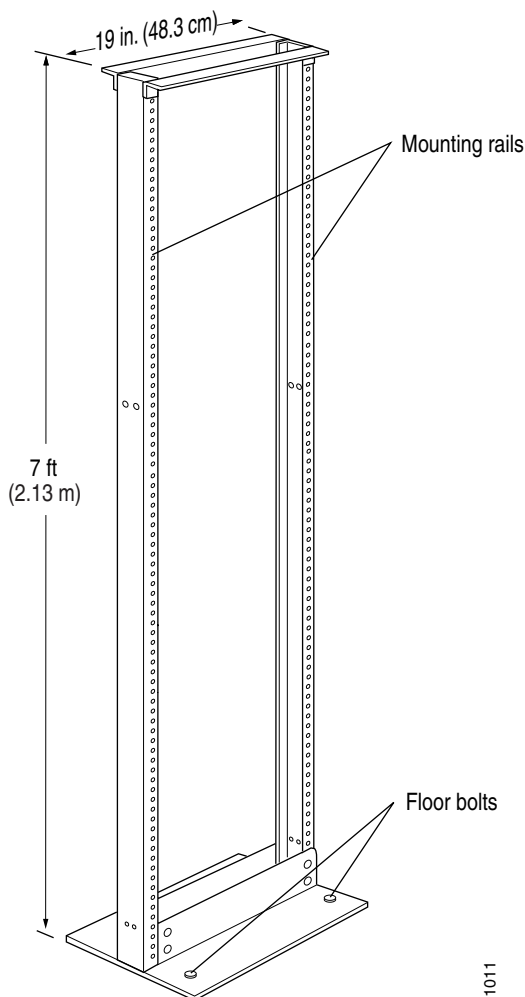
- Rack Requirements on page 39
- Clearance Requirements for Airflow and Hardware Maintenance on page 42
- Site Environmental Requirements on page 43
- Fire Safety Requirements on page 43
- Power System Requirements and Specifications on page 44
- Site Electrical Wiring and Cable Guidelines on page 49
- Fiber-Optic and Network Cable Guidelines on page 49
- Routing Engine Interface Cable and Wire Specifications on page 53
- Site Preparation Checklist on page 54

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 which appears in Figure 15.

The following sections describe rack requirements:

- Rack Size and Strength on page 40
- Spacing of Mounting Holes on page 41
- Connection to Building Structure on page 41

Figure 15: Typical Center-Mount Rack

Rack Size and Strength

The router is designed for installation in a rack that complies with either 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 front- or center-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: 35 in. (89 cm) high, 23.5 in. (60 cm) deep, and 17.5 in. (44.5 cm) wide. The outer edges of the front- and center-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 42.



Note

The router might not fit into an 800-mm-deep cabinet, though adjusting the front-to-back position of the front mounting rails inside the cabinet might help.

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

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

The chassis height of 35 in. (89 cm) equals 20 U, the standard rack unit defined in *Cabinets, Racks, Panels, and Associated Equipment* (document number EIA-310-D) published by the Electronics Industry Association. Two routers can be stacked 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 280 lb (127 kg). If you stack two routers in one rack, it must be capable of supporting about 560 lb (254 kg).

Spacing of Mounting Holes

The mounting holes on the rack rails must align with the mounting holes on the chassis mounting ears. The chassis is equipped with two different sets of vertical mounting ears, one set intended for center-mount racks and one set intended for front-mount racks. Table 11 lists the spacing between mounting holes on these ears.

Table 11: Rack Mounting Hole Spacing

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

Connection to Building Structure

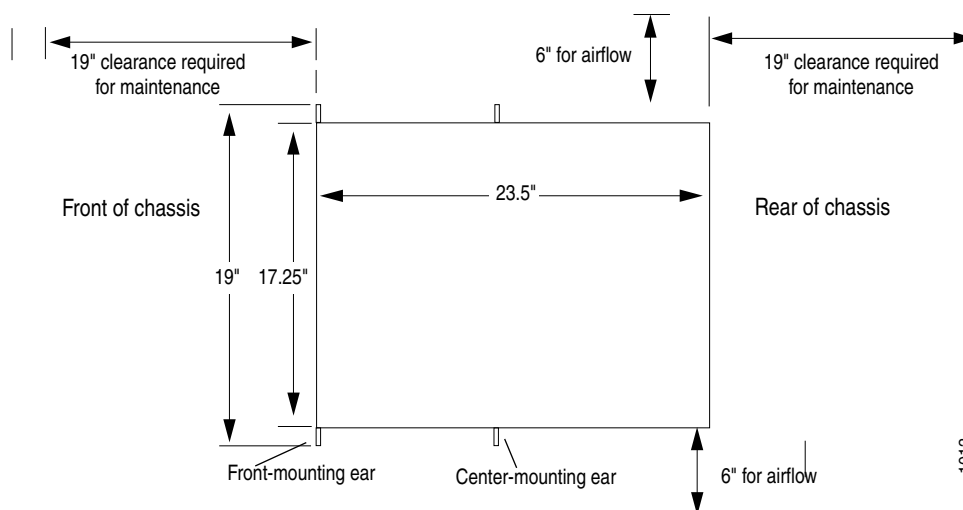
Always secure the rack to the structure of the building. If your geographical area is subject to earthquakes, bolt the rack to the floor. For maximum stability, also secure the rack to ceiling brackets. For more information, see "Laser and LED Safety Guidelines and Warnings" on page 76.

Clearance Requirements for Airflow and Hardware Maintenance

When planning the installation site, you need to allow sufficient clearance around the rack (see Figure 16):

- 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.
- 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 19 in. (50 cm) both in front of and behind the rack.

Figure 16: Chassis Dimensions (Top View) and Recommended Clearances



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Site Environmental Requirements

Table 17 specifies the environmental conditions required for normal router operation. In addition, the site should be as dust-free as possible. Dust can clog the air filter, reducing cooling system efficiency. Check the air filter under the cable management system and the covers on all cooling subsystems frequently, cleaning them as necessary. For more information, see “Maintain and Replace Cooling System Components” on page 153.

Figure 17: Site Environment Specifications

Description	Specification
Altitude	No performance degradation to 10,000 ft. (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5% to 90%, noncondensing
Temperature	Normal operation ensured in temperature range of 0°C (32°F) to +40°C (104°F)
Shock	Tested 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 “Regulatory Compliance and Safety Information” on page 55.

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 44.

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 System Requirements and Specifications

The router can use either AC or DC power. In either case, there are two load-sharing power supplies located at the bottom rear of the chassis (see Figure 2). Each power supply requires a dedicated power source.

For information about the power supplies, including electrical specifications and a description of components, see “AC Power Supply” on page 21 and “DC Power Supply” on page 22.

For power system guidelines, see the following sections:

- Power Supply Load Sharing, Redundancy, and Replacement on page 45
- Connection and Grounding Requirements on page 45
- AC Power Cord Specifications on page 45
- DC Power and Grounding Cable Specifications on page 46
- System Power Requirements on page 48

Power Supply Load Sharing, Redundancy, and Replacement

When two power supplies are installed, they are redundant, sharing the electrical load equally if both supplies are operational. If one power supply stops functioning for any reason, the remaining power supply instantly begins providing all the power the router needs for normal functioning, and can provide full power indefinitely.

Power supplies are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. For replacement instructions, see “Replace an AC Power Supply” on page 136 and “Replace a DC Power Supply” on page 141.

Connection and Grounding Requirements

On an AC-powered router, plug each power supply into a grounded 180–264 VAC 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.

On a DC-powered router, connect each power supply to a separate, dedicated DC power source. 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 each power supply to the power distribution panel.

To meet safety and EMC requirements and to ensure proper operation, a DC-powered router must be earth-grounded before power is connected. Each power supply has a pair of terminal studs for connecting the router to earth ground.

For power and grounding connection instructions, see “Provide Power to the Router” on page 122.



For both AC- and DC-powered routers, power cords and cables must not block access to router components or drape where people could trip on them.

AC Power Cord Specifications

Two 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 C19 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.



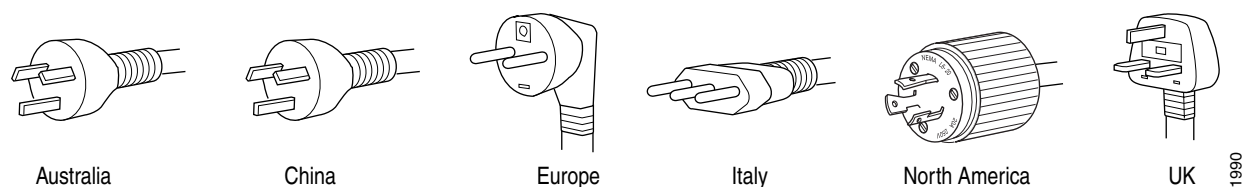
In North America, AC power cords must not exceed 4.5 m (approximately 14.75 ft) in length, to comply with National Electrical Code (NEC) Sections 400-8 (NFPA 75, 5-2.2) and 210-52, and Canadian Electrical Code (CEC) Section 4-010(3). The cords supplied with the router are in compliance.

Table 12 lists specifications for AC power cords and Figure 18 shows the types of plugs used in different regions.

Table 12: AC Power Cable Specifications

Country	Electrical Specification	Plug Type
Australia	240 VAC, 50 Hz AC	SAA/3
China	220 VAC, 50 Hz AC	CH2-16P
Europe	220 or 230 VAC, 50 Hz AC	VII
Italy	230 VAC, 50 Hz AC	I/3/16
North America	208 VAC, 60 Hz AC	NEMA 6-20P
United Kingdom	240 VAC, 50 Hz AC	BS89/3

Figure 18: AC Plug Types



DC Power and Grounding Cable Specifications

On a DC-powered router, the power cable from each external DC power source attaches to terminal studs on the power supply, as shown in Figure 19. There are two sets of 1/4–20 UNC terminal studs for each power supply—the input set is labeled **-48V** and the return set is labeled **RTN(+)**. The grounding cable attaches to the 1/4–20 UNC grounding studs located at the lower right corner of the power supply.

Figure 19: DC Power Supply Cable Connectors

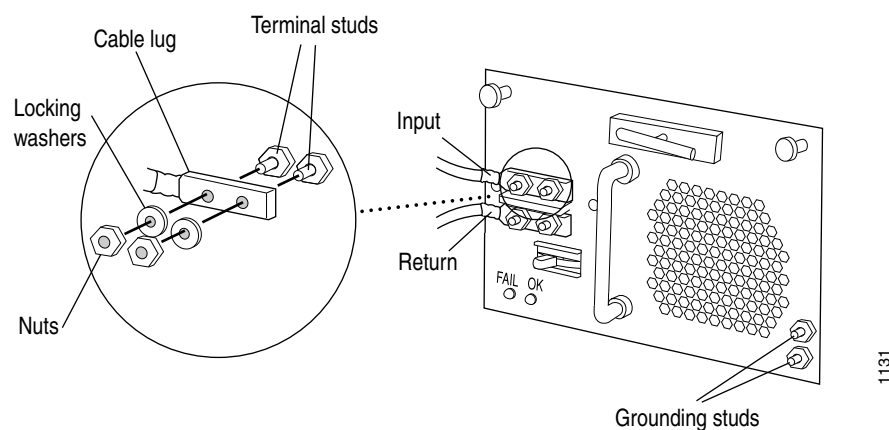



Table 13 summarizes the specifications for the cables that you must supply for connecting to the power supply terminal studs and grounding studs.

Table 13: DC Power and Grounding Cable Specifications


Cable Type	Quantity and Specification	Maximum Equal Length
Power cables	Four 6-AWG (13.3 mm ²) wire cables	None
Grounding cable	One 6-AWG (13.3 mm ²) high-strand-count wire cable	None



For field-wiring connections, use copper conductors only.

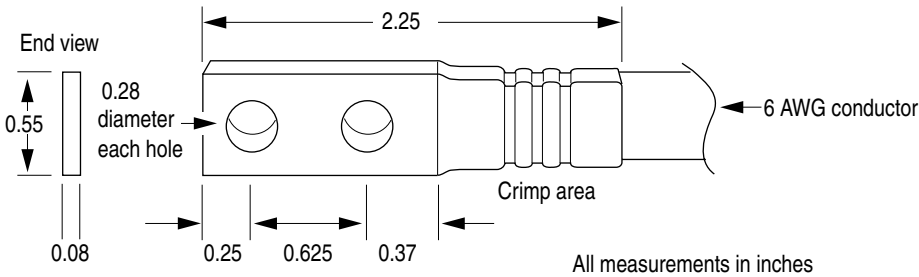
For other electrical safety information, see “Electrical Safety Guidelines and Warnings” on page 60.

Both the grounding studs and each pair of terminal studs on the circuit breaker box are spaced at 0.625-in. (15.86-mm) centers. The accessory box shipped with the router includes the cable lugs that attach to the end of the power and grounding cables (see Figure 20). The spacing of the holes in the lug matches the spacing of the terminal grounding studs.



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

Figure 20: DC Power Supply Terminal and Grounding Lug



During router installation, secure the grounding cable to the grounding studs and the power cables to the terminal studs, in that order. Secure the grounding cable lug with washers, then with 7/16-in. nuts. Then remove the plastic protective shield that covers the power supply terminal studs as shipped, and secure the power cable lugs to the terminal studs with locking washers, then with nuts, as shown in Figure 19. Replace the plastic protective shield. The nuts and washers that secure the power cables to the terminal studs are already installed on the studs.

For complete instructions, see “Connect Power to a DC-Powered Router” on page 123.



Caution

Do not substitute a metric nut driver or wrench for the 7/16-in. nut driver or wrench needed to tighten and loosen the nuts on the terminal studs. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

System Power Requirements

Table 14 lists the power requirements for the individual hardware components. The values in this table are listed under typical voltage conditions. The power requirements are the same for both the DC and AC power supplies.

Table 14: System Power Requirements

Component	Power (Watts)
Base system (all items except the FPCs and PICs, with the fans running in normal mode)	287 (approximate)
Fans at full speed (additional power consumed when all the fans are running at their maximum)	144 (approximate)
FPC	23.7

The numbers listed in Table 14 are fairly accurate for larger, typical configurations. When the total power consumption is calculated to be less than 600 watts, you should increase the number by 10 percent because the efficiency of the power supply is lower when supplying less current. The 10 percent reduction at lower power levels is an approximation. The actual reduction in efficiency is nonlinear and depends on the particular mix of PICs.



Note

Because of variation in components, temperature, and supply voltage, we recommend you provision at least 35A @ 48V DC for a DC-powered router, or 8A @ 208V AC for an AC-powered router. This allows you to operate the router in any configuration without upgrading the power infrastructure.

Site Electrical Wiring and Cable Guidelines

When planning the electrical wiring and cabling 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.

Fiber-Optic and Network Cable Guidelines

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 *M20 and M40 Internet Routers PIC Guide*.

For more information about fiber-optic cable, see the following sections:

- Multimode and Single-Mode Fiber on page 50
- Attenuation and Dispersion on page 50
- Power Budget Calculation on page 51
- Power Margin Calculation on page 51
- Attenuate to Prevent Saturation at SONET/SDH PICs on page 53

Multimode and Single-Mode Fiber

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 M40 router, see the *M20 and M40 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 Telcordia Technologies document GR-253-CORE Issue 2, December 1995 and ANSI T1.105.06.

Attenuation and Dispersion

A functional optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated. *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 calculating the power budget, see “Power Budget Calculation” on page 51.

Power Budget Calculation

A link’s power budget 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).

Table 15 lists equations for calculating the power budget for SONET/SDH PIC interfaces. The values are measured in decibels (dB) and decibels referred to one milliwatt (dBm).

Table 15: Calculating Power Budget for SONET/SDH PIC Interfaces

PIC Interface	Power Budget Equation
Multimode	$P_B = P_T - P_R$ $P_B = -15 \text{ dBm} - (-28 \text{ dBm})$ $P_B = 13 \text{ dB}$
OC-12 single-mode	$P_B = P_T - P_R$ $P_B = -15 \text{ dBm} - (-28 \text{ dBm})$ $P_B = 13 \text{ dB}$
OC-48 single-mode	$P_B = P_T - P_R$ $P_B = -5 \text{ dBm} - (-18 \text{ dBm})$ $P_B = 13 \text{ dB}$

Power Margin Calculation

After calculating a link’s power budget (using the equation described in “Power Budget Calculation” on page 51), you can calculate the power margin (P_M), which estimates 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.

Table 16 lists the estimated amount of loss for factors that cause link loss.

Table 16: Estimating 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

In the following sample calculation for a 2 km-long multimode link with a power budget (P_B) of 13 dB, the link loss (LL) is the sum of the following factors:

- 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 is as follows:

$$\begin{aligned}
 P_M &= P_B - LL \\
 P_M &= 13 \text{ dB} - 2 \text{ km (1.0 dB/km)} - 5 (0.5 \text{ dB}) - 2 (0.5 \text{ dB}) - 0.5 \text{ dB [HOL]} - 1 \text{ dB [CRM]} \\
 P_M &= 13 \text{ dB} - 2 \text{ dB} - 2.5 \text{ dB} - 1 \text{ dB} - 0.5 \text{ dB} - 1 \text{ dB} \\
 P_M &= 6 \text{ dB}
 \end{aligned}$$

In the following sample calculation for an 8 km-long single-mode link with a power budget (P_B) of 13 dB, the link loss (LL) is 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:

$$\begin{aligned}
 P_M &= P_B - LL \\
 P_M &= 13 \text{ dB} - 8 \text{ km (0.5 dB/km)} - 7 (0.5 \text{ dB}) \\
 P_M &= 13 \text{ dB} - 4 \text{ dB} - 3.5 \text{ dB} \\
 P_M &= 5.5 \text{ dB}
 \end{aligned}$$

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 M40 router, see the *M20 and M40 Internet Routers PIC Guide*.

Routing Engine Interface Cable and Wire Specifications

For management and service operations, you connect the Routing Engine to an external console or management network through ports on the craft interface. You can also connect the router to external alarm-reporting devices through the alarm relay contacts on the craft interface. (For more information, see “Craft Interface” on page 17.)

Table 17 lists the specifications for the cables that connect to management ports and the wires that connect to the alarm relay contacts.

Table 17: Routing Engine Interface Cable and Wire Specifications

Cable Type	Cable Specification	Cable/Wire Supplied	Maximum Length	Router Receptacle
Routing Engine console or auxiliary interface	RS-232 (EIA-232) serial cable	One 6-ft (1.83-m) length with DB-9/DB-9 connectors	6 ft (1.83 m)	DB-9 male
Routing Engine Ethernet interface	Category 5 cable or equivalent suitable for 100BaseT operation	One 15-ft (4.92-m) length with RJ-45/RJ-45 connectors	328 ft (100 m)	RJ-45 autosensing
Alarm relay contacts	28-AWG to 14-AWG (0.09 to 2.09 mm ²) wire	No	None	—

Site Preparation Checklist

The checklist in Table 18 summarizes the tasks you need to perform when preparing a site for router installation.

Table 18: Site Preparation Checklist

Item or Task	Performed By	Date	Notes
Verify that environmental factors such as temperature and humidity do not exceed router tolerances.			
Measure distance between external power sources and router installation site.			
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

Regulatory Compliance and Safety Information

To install and use the router safely, follow proper safety procedures. This chapter provides the following safety and regulatory compliance information:

- Definition of Safety Warning Levels on page 55
- Safety Guidelines and Warnings on page 57
- Agency Approvals on page 84
- Compliance Statements for EMC Requirements on page 86

Definition of Safety Warning Levels

This manual uses the following three levels of safety warnings:



Note

You might find this information helpful in a particular situation, or might otherwise overlook it.



Caution

You need to observe the specified guidelines to avoid minor injury or discomfort to you, or severe damage to the router.



Warning

This symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents.

Waarschuwing Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van standaard maatregelen om ongelukken te voorkomen.

Varoitus Tämä varoitusmerkki merkitsee vaaraa. Olet tilanteessa, joka voi johtaa ruumiinvammaan. Ennen kuin työskentelet minkään laitteiston parissa, ota selvää sähkökytkentöihin liittyvistä vaaroista ja tavanomaisista onnettomuuksien ehkäisykeinoista.

Attention Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents.

Warnung Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an irgendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt.

Avvertenza Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti.

Advarsel Dette varselsymbolet betyr fare. Du befinner deg i en situasjon som kan føre til personskade. Før du utfører arbeid på utstyr, må du være oppmerksom på de faremomentene som elektriske kretser innebærer, samt gjøre deg kjent med vanlig praksis når det gjelder å unngå ulykker.

Aviso Este símbolo de aviso indica perigo. Encontra-se numa situação que lhe poderá causar danos físicos. Antes de começar a trabalhar com qualquer equipamento, familiarize-se com os perigos relacionados com circuitos eléctricos, e com quaisquer práticas comuns que possam prevenir possíveis acidentes.

¡Atención! Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes.

Varning! Denna varningssymbol signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanligt förfarande för att förebygga skador.

Safety Guidelines and Warnings

This section provides the safety guidelines and warnings for installing, operating, and maintaining the router:

- General Safety Guidelines and Warnings on page 57
- Electrical Safety Guidelines and Warnings on page 60
- Installation Safety Guidelines and Warnings on page 71
- Laser and LED Safety Guidelines and Warnings on page 76
- Maintenance and Operational Safety Guidelines and Warnings on page 79

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 judgement 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 when instructions are not 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.
- Observe the following warnings:
 - Qualified Personnel Warning on page 58
 - Restricted Access Area Warning on page 59

Qualified Personnel 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.

Avertissement Tout installation ou remplacement de l'appareil doit être réalisé par du personnel qualifié et compétent.

Achtung Gerät nur von geschultem, qualifiziertem Personal installieren oder auswechseln lassen.

Avvertenza Solo personale addestrato e qualificato deve essere autorizzato ad installare o sostituire questo apparecchio.

Advarsel Kun kvalifisert personell med riktig opplæring bør montere eller bytte ut dette utstyret.

Aviso Este equipamento deverá ser instalado ou substituído apenas por pessoal devidamente treinado e qualificado.

¡Atención! Estos equipos deben ser instalados y reemplazados exclusivamente por personal técnico adecuadamente preparado y capacitado.

Varning Denna utrustning ska endast installeras och bytas ut av utbildad och kvalificerad personal.

Restricted Access Area Warning

The router is intended for installation in restricted access areas. A restricted access area is an area to which access can be gained only by service personnel through the use of a special tool, lock and key, or other means of security, and which is controlled by the authority responsible for the location.

Waarschuwing Dit toestel is bedoeld voor installatie op plaatsen met beperkte toegang. Een plaats met beperkte toegang is een plaats waar toegang slechts door servicepersoneel verkregen kan worden door middel van een speciaal instrument, een slot en sleutel, of een ander veiligheidsmiddel, en welke beheerd wordt door de overheidsinstantie die verantwoordelijk is voor de locatie.

Varoitus Tämä laite on tarkoitettu asennettavaksi paikkaan, johon pääsy on rajoitettua. Paikka, johon pääsy on rajoitettua, tarkoittaa paikkaa, johon vain huoltohenkilöstö pääsee jonkin erikoistyökalun, lukkoon sopivan avaimen tai jonkin muun turvalaitteen avulla ja joka on paikasta vastuussa olevien toimivaltaisten henkilöiden valvoma.

Attention Cet appareil est à installer dans des zones d'accès réservé. Ces dernières sont des zones auxquelles seul le personnel de service peut accéder en utilisant un outil spécial, un mécanisme de verrouillage et une clé, ou tout autre moyen de sécurité. L'accès aux zones de sécurité est sous le contrôle de l'autorité responsable de l'emplacement.

Warnung Diese Einheit ist zur Installation in Bereichen mit beschränktem Zutritt vorgesehen. Ein Bereich mit beschränktem Zutritt ist ein Bereich, zu dem nur Wartungspersonal mit einem Spezialwerkzeugs, Schloß und Schlüssel oder anderer Sicherheitsvorkehrungen Zugang hat, und der von dem für die Anlage zuständigen Gremium kontrolliert wird.

Avvertenza Questa unità deve essere installata in un'area ad accesso limitato. Un'area ad accesso limitato è un'area accessibile solo a personale di assistenza tramite un'attrezzo speciale, lucchetto, o altri dispositivi di sicurezza, ed è controllata dall'autorità responsabile della zona.

Advarsel Denne enheten er laget for installasjon i områder med begrenset adgang. Et område med begrenset adgang gir kun adgang til servicepersonale som bruker et spesielt verktøy, lås og nøkkel, eller en annen sikkerhetsanordning, og det kontrolleres av den autoriteten som er ansvarlig for området.

Aviso Esta unidade foi concebida para instalação em áreas de acesso restrito. Uma área de acesso restrito é uma área à qual apenas tem acesso o pessoal de serviço autorizado, que possua uma ferramenta, chave e fechadura especial, ou qualquer outra forma de segurança. Esta área é controlada pela autoridade responsável pelo local.

¡Advertencia! 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.

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 60
- AC Power Electrical Safety Guidelines on page 61
- DC Power Electrical Safety Guidelines on page 61
- Copper Conductors Warning on page 63
- DC Power Disconnection Warning on page 64
- DC Power Grounding Requirements and Warning on page 65
- DC Power Wiring Sequence Warning on page 66
- DC Power Wiring Terminations Warning on page 67
- Grounded Equipment Warning on page 68
- In Case of Electrical Accident on page 68
- Backplane Energy Hazard Warning on page 68
- Multiple Power Supplies Disconnection Warning on page 69
- Power Disconnection Warning on page 70
- TN and IT Power Warning on page 71

General Electrical Safety Guidelines

- Install the router in compliance with the following local, national, or international electrical codes:
 - United States—National Fire Protection Association (NFPA70), 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 4. 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, 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 45 A @ 48 VDC. The 48 VDC facility DC source should be equipped with a circuit breaker rated at 45 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 45 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 grounding studs on each power supply. Use a hexagonal-head external drive socket wrench, with a minimum of 150 lb-in. (16 Nm) tightening torque, to connect the leads to the terminals.



Caution

If using a fixed-size nut driver or wrench to tighten and loosen the nuts, use only a 7/16-in. tool. Do not substitute a metric tool, because a tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

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.

¡Advertencia! Emplee sólo conductores de cobre.

Varning! Använd endast ledare av koppar.

DC Power Disconnection Warning

Before performing any of the following procedures, ensure that power is removed from the DC circuit. To ensure that all power is off, locate the circuit breaker on the panel board that services the DC circuit, switch the circuit breaker to the **OFF** position, and tape the switch handle of the circuit breaker in the **OFF** position.

Waarschuwing Voordat u een van de onderstaande procedures uitvoert, dient u te controleren of de stroom naar het gelijkstroom circuit uitgeschakeld is. Om u ervan te verzekeren dat alle stroom UIT is geschakeld, kiest u op het schakelbord de stroomverbreker die het gelijkstroom circuit bedient, draait de stroomverbreker naar de UIT positie en plakt de schakelaarhendel van de stroomverbreker met plakband in de UIT positie vast.

Varoitus Varmista, että tasavirtapiirissä ei ole virtaa ennen seuraavien toimenpiteiden suorittamista. Varmistaaksesi, että virta on KATKAISTU täysin, paikanna tasavirrasta huolehtivassa kojetaulussa sijaitseva suojakytkin, käännä suojakytkin KATKAISTU-asentoon ja teippaa suojakytkimen varsi niin, että se pysyy KATKAISTU-asennossa.

Attention Avant de pratiquer l'une quelconque des procédures ci-dessous, vérifiez 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.

¡Advertencia! 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 Power and Grounding Cable Specifications” on page 46.



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.

Varoitius 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.

¡Advertencia! Al instalar el equipo, conectar la tierra la primera y desconectarla la última.

Varning! Vid installation av enheten måste jordledningen alltid anslutas först och kopplas bort sist.

DC Power Wiring Sequence Warning

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 d'alimentation CC En utilisant les crochets appropriés à l'extrémité de câblage. En reliant la puissance, l'ordre approprié de câblage est rectifié pour rectifier, + RTN à + RTN, puis -48 V à -48 V. En débranchant la puissance, l'ordre approprié de câblage est -48 V à -48 V, + RTN à + RTN, a alors rectifié pour rectifier. Notez que le fil de masse devrait toujours être relié d'abord et débranché pour la dernière fois. Notez que le fil de masse devrait toujours être relié d'abord et débranché pour la dernière fois.

Warnung Verdrahten Sie die Gleichstrom-Versorgung mit den passenden Ansätzen am Verdrahtung Ende. Wenn man Energie anschließt, wird die korrekte Verdrahtung. Reihenfolge gerieben, um, + RTN zu + RTN, dann -48 V bis -48 V zu reiben. Wenn sie Energie trennt, ist die korrekte Verdrahtung Reihenfolge -48 V bis -48 V, + RTN zu + RTN, rieb dann, um zu reiben. Beachten Sie, daß der Erdungsdraht immer zuerst angeschlossen werden und zuletzt getrennt werden sollte.

Avvertenza Mostra la morsettiera dell alimentatore CC. Cablare l'alimentatore CC usando i connettori adatti all'estremità del cablaggio, come illustrato. La corretta sequenza di cablaggio è da massa a massa, da positivo a positivo (da linea ad L) e da negativo a negativo (da neutro a N). Tenere presente che il filo di massa deve sempre venire collegato per primo e scollegato per ultimo.

Advarsel Riktig tilkoples 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 molíó 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.

¡Advertencia! 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.

Varning! 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 johdinliitintä, esimerkiksi suljettua silmukkaa tai kourumaista liitintä, jossa on ylöspäin käännetty kiinnityskorvat. Tällaisten liitintöjen tulee olla kooltaan johtimiin sopivia ja niiden tulee puristaa yhteen sekä eristeen että johdinosan.

Attention Quand des fils torsadés sont nécessaires, utiliser des douilles terminales homologuées telles que celles à circuit fermé ou du type à plage ouverte avec cosses rebroussées. Ces douilles terminales doivent être de la taille qui convient aux fils et doivent être refermées sur la gaine isolante et sur le conducteur.

Warnung Wenn Litzenverdrahtung erforderlich ist, sind zugelassene Verdrahtungsabschlüsse, z.B. für einen geschlossenen Regelkreis oder gabelförmig, mit nach oben gerichteten Kabelschuhen zu verwenden. Diese Abschlüsse sollten die angemessene Größe für die Drähte haben und sowohl die Isolierung als auch den Leiter festklemmen.

Avvertenza Quando occorre usare trecce, usare connettori omologati, come quelli a occhiello o a forcilla con linguette rivolte verso l'alto. I connettori devono avere la misura adatta per il cablaggio e devono serrare sia l'isolante che il conduttore.

Advarsel Hvis det er nødvendig med flertrådede ledninger, brukes godkjente ledningsavslutninger, som for eksempel lukket sløyfe eller spadetype med oppoverbøyde kabelsko. Disse avslutningene skal ha riktig størrelse i forhold til ledningene, og skal klemme sammen både isolasjonen og ledaren.

Aviso Quando forem requeridas montagens de instalação elétrica 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.

¡Advertencia! Cuando se necesite hilo trenzado, utilizar terminales para cables homologados, tales como las de tipo "bucle cerrado" o "espada", con las lengüetas de conexión vueltas hacia arriba. Estos terminales deberán ser del tamaño apropiado para los cables que se utilicen, y tendrán que sujetar tanto el aislante como el conductor.

Varning! När flertrådiga ledningar krävs måste godkända ledningskontakter användas, t.ex. kabelsko av sluten eller öppen typ med uppåtvänd tapp. Storleken på dessa kontakter måste vara avpassad till ledningarna och måste kunna hålla både isoleringen och ledaren fastklämda.

Grounded Equipment 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.

¡Advertencia! Este equipo debe conectarse a tierra. Asegurarse de que el equipo principal esté conectado a tierra durante el uso normal.

Varning! 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.

Backplane Energy Hazard Warning



High levels of electrical energy are distributed across the router backplane. Be careful not to touch the backplane connectors, or any component connected to the backplane, with any metallic object while servicing components installed in the router.

Multiple Power Supplies Disconnection 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.

¡Advertencia! 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



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 virtälähteiden 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.

¡Advertencia! 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).

Varning! Innan du arbetar med ett chassi eller nära strömförsörjningsenheter skall du för växelströmsenheter dra ur nätsladden och för likströmsenheter bryta strømmen vid överspänningsskyddet.

TN and IT Power 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.

¡Advertencia! 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 72
- Installation Instructions Warning on page 72
- Rack-Mounting Requirements and Warnings on page 73
- Ramp Warning on page 76

Chassis Lifting Guidelines

A fully configured router weighs about 280 lb (127 kg). Observe the following guidelines for lifting and moving the router:

- Before moving the router, read the guidelines in “Prepare the Site” on page 39 to verify that the intended site meets the specified power, environmental, and clearance requirements.
- Do not attempt to lift a fully configured router by yourself. Using a mechanical lift to maneuver the router into a rack is recommended. If a lift cannot be used, a minimum of three people must lift the router, and you must remove components from the chassis before lifting (as described in “Remove Components from the Chassis” on page 100).
- 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 as you lift. Balance the load evenly and be sure that your footing is solid.



At least three people are required to lift the chassis. Before lifting the chassis, remove components and attach the installation lifting handle, as described in “Remove Components from the Chassis” on page 100 and “Install the Chassis into the Rack” on page 109. To prevent injury, keep your back straight and lift with your legs, not your back. Do not use the handles on the power supplies as hand holds for lifting the chassis.

Installation Instructions Warning



Read the installation instructions before you connect the router to a power source.

Waarschuwing Raadpleeg de installatie-aanwijzingen voordat u het systeem met de voeding verbindt.

Varoituis Lue asennusohjeet ennen järjestelmän yhdistämistä virtalähteeseen.

Attention Avant de brancher le système sur la source d'alimentation, consulter les directives d'installation.

Warnung Lesen Sie die Installationsanweisungen, bevor Sie das System an die Stromquelle anschließen.

Avvertenza Consultare le istruzioni di installazione prima di collegare il sistema all'alimentatore.

Advarsel Les installasjonsinstruksjonene før systemet kobles til strømkilden.

Aviso Leia as instruções de instalação antes de ligar o sistema à sua fonte de energia.

¡Atención! Ver las instrucciones de instalación antes de conectar el sistema a la red de alimentación.

Varning! Läs installationsanvisningarna innan du kopplar systemet till dess strömförsörjningsenhet.

Rack-Mounting Requirements and Warnings

Ensure that the equipment rack into which the router is installed is evenly and securely supported, to avoid the hazardous condition that could result from uneven mechanical loading.



Warning

To prevent bodily injury when mounting or servicing the router in a rack, take the following precautions to ensure that the system remains stable. The following directives help maintain your safety:

The router must be installed into a rack that is secured to the building structure.

The router should be mounted at the bottom of the rack if it is the only unit in the rack.

When mounting the router in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.

If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the router in the rack.

Waarschuwing Om lichamelijk letsel te voorkomen wanneer u dit toestel in een rek monteert of het daar een servicebeurt geeft, moet u speciale voorzorgsmaatregelen nemen om ervoor te zorgen dat het toestel stabiel blijft. De onderstaande richtlijnen worden verstrekt om uw veiligheid te verzekeren:

De Juniper Networks router moet in een stellage worden geïnstalleerd die aan een bouwswel is verankerd.

Dit toestel dient onderaan in het rek gemonteerd te worden als het toestel het enige in het rek is.

Wanneer u dit toestel in een gedeeltelijk gevuld rek monteert, dient u het rek van onderen naar boven te laden met het zwaarste onderdeel onderaan in het rek.

Als het rek voorzien is van stabiliseringshulpmiddelen, dient u de stabilisatoren te monteren voordat u het toestel in het rek monteert of het daar een servicebeurt geeft.

Varoituis Kun laite asetetaan telineeseen tai huolletaan sen ollessa telineessä, on noudatettava erityisiä varotoimia järjestelmän vakavuuden säilyttämiseksi, jotta vältetään loukkaantumista. 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 alaosaan kaikkein raskaimmalla esineellä ja siirry sitten sen yläosaan.

Jos telinettä varten on vakaimet, asenna ne ennen laitteen asettamista telineeseen tai sen huoltamista siinä.



Attention Pour éviter toute blessure corporelle pendant les opérations de montage ou de réparation de cette unité en casier, il convient de prendre des précautions spéciales afin de maintenir la stabilité du système. Les directives ci-dessous sont destinées à assurer la protection du personnel :

Le rack sur lequel est monté le Juniper Networks router doit être fixé à la structure du bâtiment.

Si cette unité constitue la seule unité montée en casier, elle doit être placée dans le bas.

Si cette unité est montée dans un casier partiellement rempli, charger le casier de bas en haut en plaçant l'élément le plus lourd dans le bas.

Si le casier est équipé de dispositifs stabilisateurs, installer les stabilisateurs avant de monter ou de réparer l'unité en casier.

Warnung Zur Vermeidung von Körperverletzung beim Anbringen oder Warten dieser Einheit in einem Gestell müssen Sie besondere Vorkehrungen treffen, um sicherzustellen, daß das System stabil bleibt. Die folgenden Richtlinien sollen zur Gewährleistung Ihrer Sicherheit dienen:

Der Juniper Networks router muß in einem Gestell installiert werden, das in der Gebäudestruktur verankert ist.

Wenn diese Einheit die einzige im Gestell ist, sollte sie unten im Gestell angebracht werden.

Bei Anbringung dieser Einheit in einem zum Teil gefüllten Gestell ist das Gestell von unten nach oben zu laden, wobei das schwerste Bauteil unten im Gestell anzubringen ist.

Wird das Gestell mit Stabilisierungszubehör geliefert, sind zuerst die Stabilisatoren zu installieren, bevor Sie die Einheit im Gestell anbringen oder sie warten.

Avvertenza Per evitare infortuni fisici durante il montaggio o la manutenzione di questa unità in un supporto, occorre osservare speciali precauzioni per garantire che il sistema rimanga stabile. Le seguenti direttive vengono fornite per garantire la sicurezza personale:

Il Juniper Networks router deve essere installato in un telaio, il quale deve essere fissato alla struttura dell'edificio.

Questa unità deve venire montata sul fondo del supporto, se si tratta dell'unica unità da montare nel supporto.

Quando questa unità viene montata in un supporto parzialmente pieno, caricare il supporto dal basso all'alto, con il componente più pesante sistemato sul fondo del supporto.

Se il supporto è dotato di dispositivi stabilizzanti, installare tali dispositivi prima di montare o di procedere alla manutenzione dell'unità nel supporto.



Advarsel Unngå fysiske skader under montering eller reparasjonsarbeid på denne enheten når den befinner seg i et kabinett. Vær nøye med at systemet er stabilt. Følgende retningslinjer er gitt for å verne om sikkerheten:

Juniper Networks router må installeres i et stativ som er forankret til bygningsstrukturen.

Denne enheten bør monteres nederst i kabinettet hvis dette er den eneste enheten i kabinettet.

Ved montering av denne enheten i et kabinett som er delvis fylt, skal kabinettet lastes fra bunnen og opp med den tyngste komponenten nederst i kabinettet.

Hvis kabinettet er utstyrt med stabiliseringsutstyr, skal stabilisatorene installeres før montering eller utføring av reparasjonsarbeid på enheten i kabinettet.

Aviso Para se prevenir contra danos corporais ao montar ou reparar esta unidade numa estante, deverá tomar precauções especiais para se certificar de que o sistema possui um suporte estável. As seguintes directrizes ajudá-lo-ão a efectuar o seu trabalho com segurança:

O Juniper Networks router deverá ser instalado numa prateleira fixa à estrutura do edifício.

Esta unidade deverá ser montada na parte inferior da estante, caso seja esta a única unidade a ser montada.

Ao montar esta unidade numa estante parcialmente ocupada, coloque os itens mais pesados na parte inferior da estante, arrumando-os de baixo para cima.

Se a estante possuir um dispositivo de estabilização, instale-o antes de montar ou reparar a unidade.

¡Advertencia! 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.



Warning

Varning! För att undvika kroppsskada när du installerar eller utför underhållsarbete på denna enhet på en ställning måste du vidta särskilda försiktighetsåtgärder för att försäkra dig om att systemet står stadigt. Följande riktlinjer ges för att trygga din säkerhet:

Juniper Networks router måste installeras i en ställning som är förankrad i byggnadens struktur.

Om denna enhet är den enda enheten på ställningen skall den installeras längst ned på ställningen.

Om denna enhet installeras på en delvis fylld ställning skall ställningen fyllas nedifrån och upp, med de tyngsta enheterna längst ned på ställningen.

Om ställningen är försedd med stabiliseringsdon skall dessa monteras fast innan enheten installeras eller underhålls på ställningen.

Ramp Warning



Warning

When installing the router, do not use a ramp inclined at more than 10 degrees.

Waarschuwing Gebruik een oprijplaat niet onder een hoek van meer dan 10 graden.

Varoitus Älä käyttää sellaista kaltevaa pintaa, jonka kaltevuus ylittää 10 astetta.

Attention Ne pas utiliser une rampe dont l'inclinaison est supérieure à 10 degrés.

Warnung Keine Rampen mit einer Neigung von mehr als 10 Grad verwenden.

Avvertenza Non usare una rampa con pendenza superiore a 10 gradi.

Advarsel Bruk aldri en rampe som heller mer enn 10 grader.

Aviso Não utilize uma rampa com uma inclinação superior a 10 graus.

¡Advertencia! No usar una rampa inclinada más de 10 grados.

Varning! Använd inte ramp med en lutning på mer än 10 grader.

Laser and LED Safety Guidelines and Warnings

Single-mode Physical Interface Cards (PICs) are equipped with laser transmitters, which are considered a Class 1 Laser Product by the U.S. Food and Drug Administration, and are evaluated as a Class 1 Laser Product per EN 60825 requirements.

Observe the following guidelines and warnings:

- General Laser Safety Guidelines on page 77
- Class 1 Laser Product Warning on page 77
- Class 1 LED Product Warning on page 78

- Laser Beam Warning on page 78
- Radiation From Open Port Apertures Warning on page 79

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.



Unterminated optical connectors can emit invisible laser radiation. The lens in the human eye focuses all the laser power on the retina, so even a low-power laser could permanently damage the eye if it is focused directly on the laser source.

Class 1 Laser Product Warning



Class 1 laser product.

Waarschuwing Klasse-1 laser produkt.

Varoituis Luokan 1 lasertuote.

Attention Produit laser de classe I.

Warnung Laserprodukt der Klasse 1.

Avvertenza Prodotto laser di Classe 1.

Advarsel Laserprodukt av klasse 1.

Aviso Produto laser de classe 1.

¡Advertencia! Producto láser Clase I.

Varning! Laserprodukt av klass 1.

Class 1 LED Product 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.

¡Advertencia! Aviso sobre producto LED de Clase 1.

Varning! Lysdiodprodukt av klass 1.

Laser Beam 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.

¡Advertencia! No mirar fijamente el haz ni observarlo directamente con instrumentos ópticos.

Varning! Rikta inte blicken in mot strålen och titta inte direkt på den genom optiska instrument.

Radiation From Open Port Apertures Warning



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.

Varoituis 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.

¡Advertencia! 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.

Varning! Osynlig strålning kan avges från en portöppning utan ansluten fiberkabel och du bör därför undvika att bli utsatt för strålning genom att inte stirra in i oskyddade öppningar.

Maintenance and Operational Safety Guidelines and Warnings

As you maintain the router, observe the following guidelines and warnings:

- Battery Handling Warning on page 80
- Jewelry Removal Warning on page 81
- Lightning Activity Warning on page 82
- Operating Temperature Warning on page 83
- Product Disposal Warning on page 84

Battery Handling Warning



Warning

Replacing the battery incorrectly might result in an explosion. Replace the battery only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

Waarschuwing Er is ontplofingsgevaar als de batterij verkeerd vervangen wordt. Vervang de batterij slechts met hetzelfde of een equivalent type dat door de fabrikant aanbevolen is. Gebruikte batterijen dienen overeenkomstig fabrieksvoorschriften weggeworpen te worden.

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.

¡Advertencia! Existe peligro de explosión si la batería se reemplaza de manera incorrecta. Reemplazar la batería exclusivamente con el mismo tipo o el equivalente recomendado por el fabricante. Desechar las baterías gastadas según las instrucciones del fabricante.

Varning! Explosionsfara vid felaktigt batteribyte. Ersätt endast batteriet med samma batterityp som rekommenderas av tillverkaren eller motsvarande. Följ tillverkarens anvisningar vid kassering av använda batterier.

Jewelry Removal Warning



Warning

Before working on equipment that is connected to power lines, remove jewelry, including rings, necklaces, and watches. Metal objects heat up when connected to power and ground and can cause serious burns or weld the metal object to the terminals.

Waarschuwing Alvorens aan apparatuur te werken die met elektrische leidingen is verbonden, sieraden (inclusief ringen, kettingen en horloges) verwijderen. Metalen voorwerpen worden warm wanneer ze met stroom en aarde zijn verbonden, en kunnen ernstige brandwonden veroorzaken of het metalen voorwerp aan de aansluitklemmen lassen.

Varoitus Ennen kuin työskentelet voimavirtajohtoihin kytkettyjen laitteiden parissa, ota pois kaikki korut (sormukset, kaulakorut ja kellot mukaan lukien). Metalliesineet 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.

¡Advertencia! Antes de operar sobre equipos conectados a líneas de alimentación, quitarse las joyas (incluidos anillos, collares y relojes). Los objetos de metal se calientan cuando se conectan a la alimentación y a tierra, lo que puede ocasionar quemaduras graves o que los objetos metálicos queden soldados a los bornes.

Varning! Tag av alla smycken (inklusive ringar, halsband och armbandsur) innan du arbetar på utrustning som är kopplad till kraftledningar. Metallobjekt hettas upp när de kopplas ihop med ström och jord och kan förorsaka allvarliga brannskador; metallobjekt kan också sammansvetsas med kontakterna.

Lightning Activity 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).

¡Advertencia! No operar el sistema ni conectar o desconectar cables durante el transcurso de descargas eléctricas en la atmósfera.

Varning! Vid åska skall du aldrig utföra arbete på systemet eller ansluta eller koppla loss kablar.

Operating Temperature Warning



Warning

To prevent the router from overheating, do not operate it in an area that exceeds the maximum recommended ambient temperature of 104°F (40°C). To prevent airflow restriction, allow at least 6 inches (15.2 cm) of clearance around the ventilation openings.

Waarschuwing Om te voorkomen dat welke router van de Juniper Networks router dan ook oververhit raakt, dient u deze niet te bedienen op een plaats waar de maximale aanbevolen omgevingstemperatuur van 40°C wordt overschreden. Om te voorkomen dat de luchtstroom wordt beperkt, dient er minstens 15,2 cm speling rond de ventilatie-openingen te zijn.

Varoitus Ettei Juniper Networks router-sarjan reititin ylikuumentuusi, sitä ei saa käyttää tilassa, jonka lämpötila ylittää korkeimman suositellun ympäristölämpötilan 40°C. Ettei ilmanvaihto estyisi, tuuletusaukkojen ympärille on jätettävä ainakin 15,2 cm tilaa.

Attention Pour éviter toute surchauffe des routeurs de la gamme Juniper Networks router, ne l'utilisez pas dans une zone où la température ambiante est supérieure à 40°C. Pour permettre un flot d'air constant, dégagez un espace d'au moins 15 cm autour des ouvertures de ventilations.

Warnung Um einen Router der router vor Überhitzung zu schützen, darf dieser nicht in einer Gegend betrieben werden, in der die Umgebungstemperatur das empfohlene Maximum von 40°C überschreitet. Um Lüftungsverschluß zu verhindern, achten Sie darauf, daß mindestens 15,2 cm lichter Raum um die Lüftungsöffnungen herum frei bleibt.

Avvertenza Per evitare il surriscaldamento dei router, non adoperateli in un locale che ecceda la temperatura ambientale massima di 40°C. Per evitare che la circolazione dell'aria sia impedita, lasciate uno spazio di almeno 15.2 cm di fronte alle aperture delle ventole.

Advarsel Unngå overoppheting av eventuelle rutere i Juniper Networks router Disse skal ikke brukes på steder der den anbefalte maksimale omgivelsestemperaturen overstiger 40°C (104°F). Sørg for at klaringen rundt lufteåpningene er minst 15,2 cm (6 tommer) for å forhindre nedsatt luftsirkulasjon.

Aviso Para evitar o sobreaquecimento do encaminhador Juniper Networks router, não utilize este equipamento numa área que exceda a temperatura máxima recomendada de 40°C. Para evitar a restrição à circulação de ar, deixe pelo menos um espaço de 15,2 cm à volta das aberturas de ventilação.

¡Advertencia! 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



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.

¡Advertencia! El desecho final de este producto debe realizarse según todas las leyes y regulaciones nacionales.

Varning! Slutlig kassering av denna produkt bör skötas i enlighet med landets alla lagar och föreskrifter.

Agency Approvals

The router complies with the following standards:

- Safety
 - CAN/CSA-22.2 No. 60950-00/UL 1950 Third Edition, Safety of Information Technology Equipment
 - EN 60825-1 Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
 - EN 60825-2 Safety of Laser Products - Part 2: Safety of Optical Fibre Communication Systems
 - EN 60950 Safety of Information Technology Equipment

■ 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 (designed to meet these standards)

- 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.

Chapter 7

Prepare to Install 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 the Site” on page 39 and review the safety information in “Regulatory Compliance and Safety Information” on page 55. This chapter discusses the following topics:

- Tools Required on page 89
- General Safety Guidelines and Warnings on page 90
- Prevent Electrostatic Discharge Damage on page 91
- Unpack the Router on page 92
- Rack-Mounting Brackets on page 94

Tools Required

To unpack and install the router, you need the following tools:

- Phillips (+) screwdrivers, numbers 1 and 2
- 9/16-in. open-end or socket wrench to remove bolts that secure the router to the shipping pallet; if 9/16-in. tool is not available, use pliers or an adjustable wrench rather than a fixed-size metric wrench

General Safety Guidelines and Warnings

This manual uses the following three levels of safety warnings. Pay careful attention to them as you install the router:



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

You are in a dangerous 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.

Before installing the router, review the following guidelines:

- Always follow all instructions and warnings marked on the router, router components, and accessories.
- Perform only those procedures explicitly described in this installation guide. Only authorized service personnel should perform other system procedures.
- For protection against shock hazard, verify that all power cords are disconnected before installing or servicing the router.
- Never install wiring during electrical storms.
- Never install electrical jacks in wet locations unless the jacks are specifically designed for wet environments.
- Operate a DC-powered router only when the grounding cable is connected.
- Do not open or remove chassis covers or sheet metal parts when instructions are not provided in this manual. Such an action could cause severe electrical shock.
- Do not push or force any objects through any of the openings 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.

**Note**

For a complete list of safety guidelines and warnings, see “Regulatory Compliance and Safety Information” on page 55.

Prevent Electrostatic Discharge Damage

Many router hardware components are sensitive to damage from static electricity. Some components can be impaired by as little as 30 V. You can easily generate potentially damaging static voltages when you handle plastic or foam packing material or if you move components across plastic or carpet. To prevent intermittent or complete component failures, always take ESD precautions:

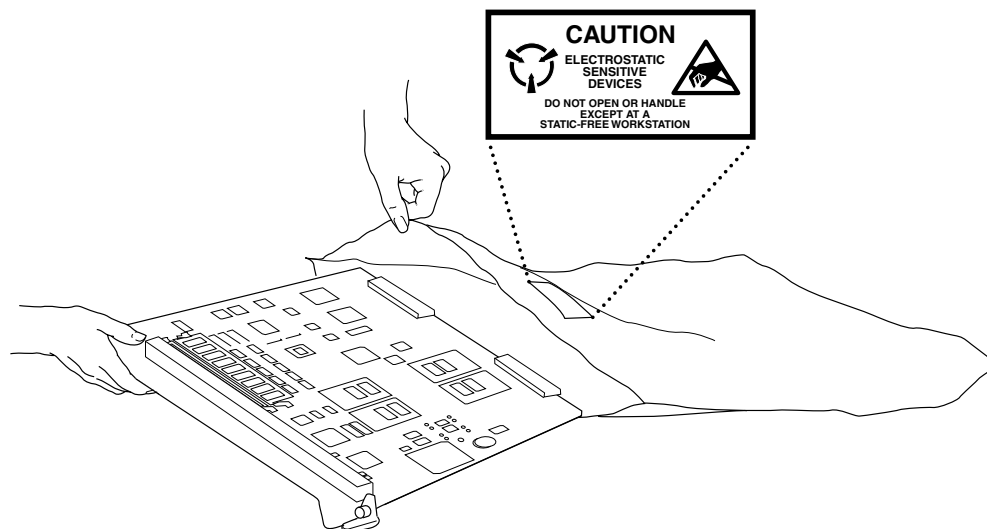
To minimize the potential for ESD damage, observe the following guidelines:

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

**Caution**

For equipment safety, periodically check the resistance value of the antistatic strap. The measurement should range from 1 to 10 Mohms.

- When handling any component that is removed from the chassis, make sure the equipment end of your ESD strap is attached to one of the electrostatic discharge points on the chassis, which are shown in Figure 1 and Figure 2.
- Avoid contact between the board and your clothing. ESD emitted from clothing can 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 21). If you are returning a component to the factory, immediately store the component in an electrostatic bag.

Figure 21: Place a Board Component into an Electrostatic Bag

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Unpack the Router

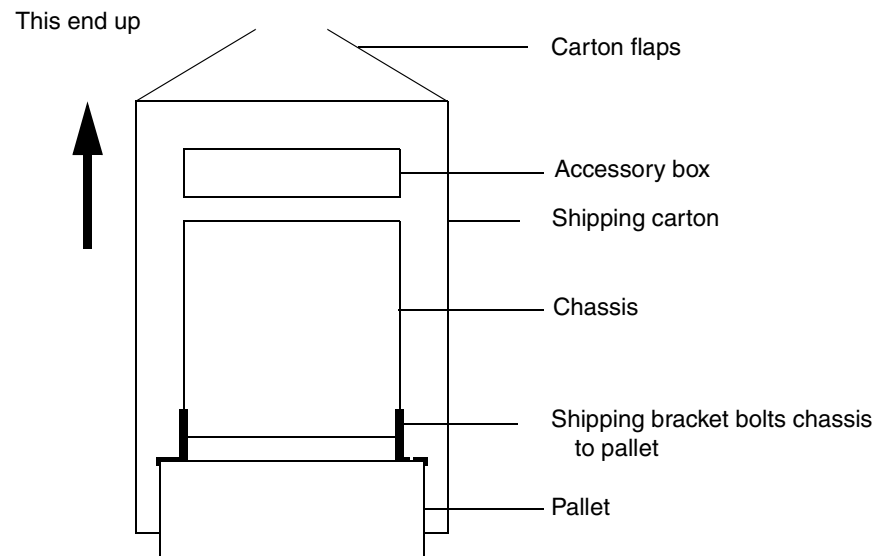
The router is shipped in a wooden crate and bolted to the pallet that forms the bottom of the crate. The crate also contains an accessory box, the handle used during manual router installation, and the *M40 Internet Router Installation Quick Start* poster.

**Note**

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

To unpack the system, follow these steps:

1. Move the shipping crate to a staging area as close to the installation site as possible, but where you have enough room to remove the system components. While the chassis is bolted to the pallet, you can use a forklift to move it.
2. Position the crate so that the arrows are pointing up.
3. Open the top flaps on the crate.
4. Remove the accessory box (see Figure 22).
5. Open the accessory box and verify the contents against the parts inventory on the label attached to the box.
6. Lift the crate off the pallet.

Figure 22: Contents of the Shipping Crate

7. Verify the chassis components received against the packing list included with the router. A generic parts inventory appears in Table 19. If any part is missing, contact a customer service representative.
8. Use a 9/16-in. open-end or socket wrench to loosen and remove the bolts on the brackets that attach the chassis to the pallet. If a 9/16-in. tool is not available, use pliers or an adjustable wrench rather than a fixed-size metric wrench.
9. Use a Phillips screwdriver to loosen the screws that secure the brackets to the sides of the chassis, and remove the brackets. Store the brackets, screws, and bolts inside the accessory box.
10. Save the shipping crate, packing materials, and pallet in case you later need to move or ship the router.
11. Proceed to "Install the Router and Configure Software" on page 97 to continue with the installation.

Table 19: Generic Inventory of Router Components Installed in Chassis

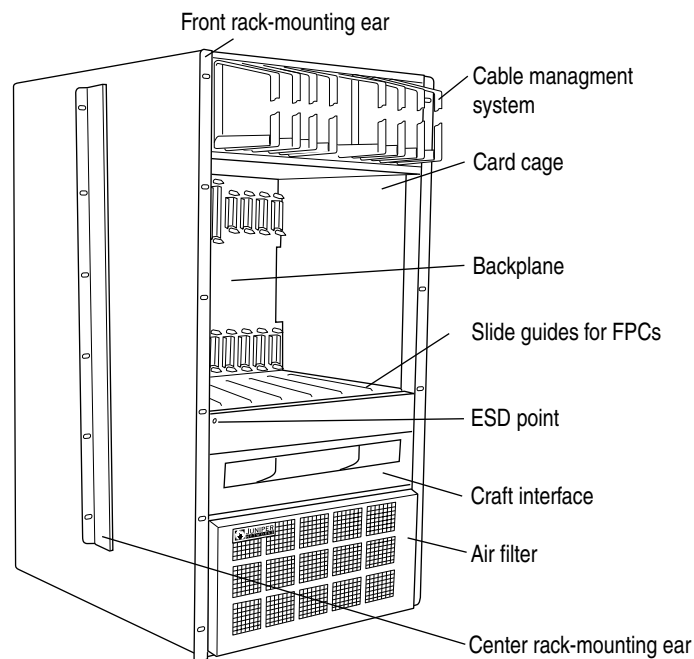
Component	Quantity Shipped
FPC with up to 4 PICs installed	Up to 8
PIC	Up to 4 per FPC
SCB	1
Lower impeller assembly and craft interface	1
Backplane	1
Upper impeller assembly	1
Fan tray with 3 fans	1

Component	Quantity Shipped
Routing Engine	1
Power supply with integrated fan	2

Rack-Mounting Brackets

Front rack-mounting ears are built into the chassis sides, as shown in Figure 23. If requested, a center rack-mounting kit can be shipped with the router (see Figure 24). You attach center rack-mounting ears along the middle of either side of the chassis with the screws provided.

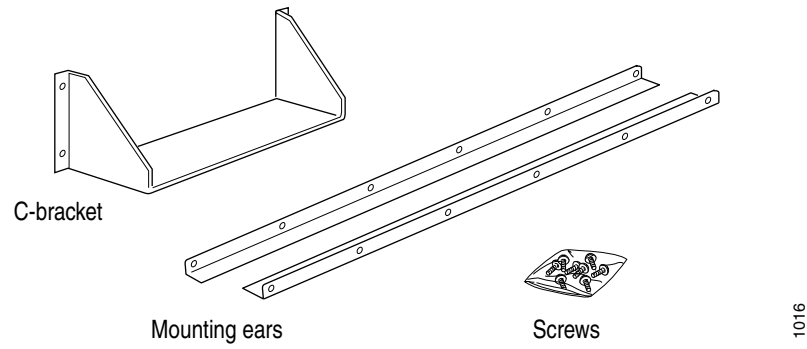
Figure 23: Chassis Showing Mounting Ears



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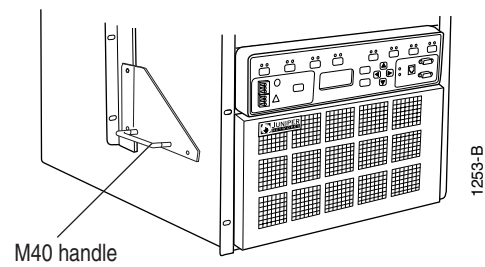
A C-bracket shelf can also be requested, to provide additional support when a router is mounted above another router (in the upper half of the rack). A router mounted in the lowest position in the rack is supported by the floor or by the bottom rack rail, so the C-bracket shelf is not required in that case. Figure 24 shows the C-bracket shelf.

Figure 24: Optional C-Bracket Shelf, Center-Mounting Ears, and Screws



Side handles can also be requested (see Figure 25), to make it easier to lift the chassis into the rack. They are recommended if a mechanical lift is not used.

Figure 25: Chassis Side Handles



Chapter 8

Install the Router and Configure Software

Before installing the router, prepare the site as described in “Prepare the Site” on page 39 and unpack the router from the shipping crate as described in “Unpack the Router” on page 92.

You can install the router into a rack either with or without the help of a mechanical lift. Because a fully configured router weighs approximately 280 lb (127 kg), using a mechanical lift is recommended. If you do not use a lift, you must remove most components from the chassis to reduce its weight before installation, then reinstall them before powering on the router.

This chapter describes both methods, and also describes how to connect management and alarm devices, PIC cables, and power cables:

- Tools and Parts Required on page 97
- Install the Router Using a Mechanical Lift on page 98
- Install the Router without Using a Mechanical Lift on page 99
- Connect the Router to Management and Alarm Devices on page 119
- Connect PIC Cables on page 121
- Provide Power to the Router on page 122
- Configure the JUNOS Internet Software on page 127

Tools and Parts Required

You need the following tools and parts to install the chassis and its components:

- Mechanical lift (recommended)
- Phillips (+) screwdrivers, numbers 1 and 2
- Flat-blade (–) screwdriver, 2.5 mm (for serial cable connector)
- Phillips (+) screwdriver, 2.5 mm (for alarm relay contacts)
- Electrostatic bags or antistatic mats, one for each electronic component removed during installation without a mechanical lift
- ESD grounding wrist strap

- Wire cutters
- Pliers

Install the Router Using a Mechanical Lift

Using a mechanical lift to maneuver the router into the rack is recommended because of the router's size and weight. The lift must be able to accommodate the router's weight—approximately 280 lb (127 kg) fully configured—and must fit between the support posts of the rack.



Note

If you are installing two routers in one rack, install the lower one first.

First, perform the following prerequisite procedures:

- 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 39.
- Read the information in “Installation Safety Guidelines and Warnings” on page 71, with particular attention to “Chassis Lifting Guidelines” on page 72.
- Remove the router from the shipping crate, as described in “Prepare to Install the Router” on page 89.

Then, perform the following procedures to install the router:

1. If you are installing the router in the upper half of the rack, install the C-bracket first (see “Rack-Mounting Brackets” on page 94). Follow this procedure:
 - a. Select the height in the rack at which to mount the C-bracket. The M40 router is 35 in. (89 cm or 20 U) high, so if you are mounting two routers in the rack leave at least that much distance between the C-bracket shelf and both the top and bottom cross-pieces of the rack.
 - b. As you stand in front of the rack, position the C-bracket so that the shelf is protruding toward you, and align the C-bracket mounting holes with holes in the rack rails. If you are front mounting the router, install the C-bracket into the rack from the rear. Make sure the mounting holes on both sides are parallel.
 - c. Insert and tighten the provided screws.
2. If you are center-mounting the router, attach a center-mounting ear to either side of the chassis. For information about the center-mounting ears, see “Rack-Mounting Brackets” on page 94.
3. Load the router onto the lift, making sure it rests securely on the lift platform.
4. Use the lift to position the router at the correct height in the rack.

5. Align the bottom hole in both front- or center-mounting ears with a hole in each rack rail, making sure the chassis is level.
6. Install one of the mounting screws provided (in the accessory box shipped with the router) into each of the two aligned holes.
7. Moving up each post or ear, install a screw in every mounting hole.
8. Verify that all the mounting screws on one side of the rack are aligned with the mounting screws on the opposite side and that the router is level.
9. Move the lift away from the rack.
10. To complete the installation, proceed to “Connect the Router to Management and Alarm Devices” on page 119.

Install the Router without Using a Mechanical Lift

If you cannot use a mechanical lift to lift the router into the rack, you can install it manually. First you need to reduce the weight by removing components from the chassis. The reduced chassis weight is approximately 180 lb (82 kg), so lifting it safely still requires three people to lift and one to insert the mounting screws.

Table 20 lists the weight of major components.

Table 20: Chassis Component Weights

Component	Approximate Weight (lb)	Approximate Weight (kg)
Air filter	0.5	0.2
Cable management system	2	1
Fan tray	5	2
FPC with 4 PICs installed	3	1
Lower impeller assembly with craft interface	9	4
Power supply	20	9
Routing Engine housing	17	8
Upper impeller assembly	10	4
System Control Board (SCB)	1	0.5

To install the router without a mechanical lift, perform the procedures described in the following sections:

- Remove Components from the Chassis on page 100
- Install the Chassis into the Rack on page 109
- Reinstall Components into the Chassis on page 111

Remove Components from the Chassis

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



The procedures in this section apply only to initial installation and assume that you have not yet connected power to the router. If power is connected, completely disconnect it before continuing. See “Disconnect AC Power from the Router” on page 140 or “Disconnect DC Power from the Router” on page 147.

If you are installing or replacing components in an operational router, see the appropriate chapters in Part 3.

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

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

Perform the procedures described in the following sections to remove components from the chassis:

- Remove the Power Supplies on page 101
- Remove the Routing Engine Housing on page 102
- Remove the Upper Impeller Assembly on page 102
- Remove the Fan Tray on page 103
- Remove the Cable Management System on page 104
- Remove the FPCs on page 105
- Remove the SCB on page 106
- Remove the Air Filter on page 107
- Remove the Lower Impeller Assembly on page 108

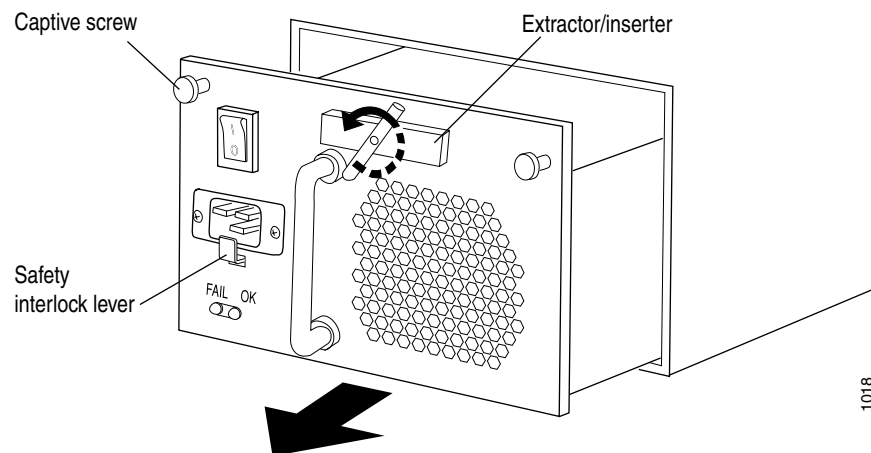
Remove the Power Supplies

The router has two power supplies (either AC or DC) located at the bottom rear of the chassis (see Figure 2). Each power supply weighs approximately 20 lb (9 kg).

To remove the power supplies, follow this procedure (see Figure 26, which shows an AC power supply):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Verify that the power switch on the faceplate of both power supplies is in the OFF (O) position.
3. Loosen the thumbscrew at each upper corner of the power supply faceplate, using a Phillips screwdriver if necessary.
4. Lift and hold up the safety interlock lever. (On an AC power supply, the lever is just below the appliance inlet. On a DC power supply, it is just below the power switch.)
5. While holding the safety interlock lever up, turn the extractor/insertor counterclockwise until the power supply disengages from the backplane.
6. Grasp the handle on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
7. Place one hand under the power supply to support it, then slide it completely out of the chassis.
8. Repeat Steps 3 through 7 to remove the second power supply.

Figure 26: Remove a Power Supply



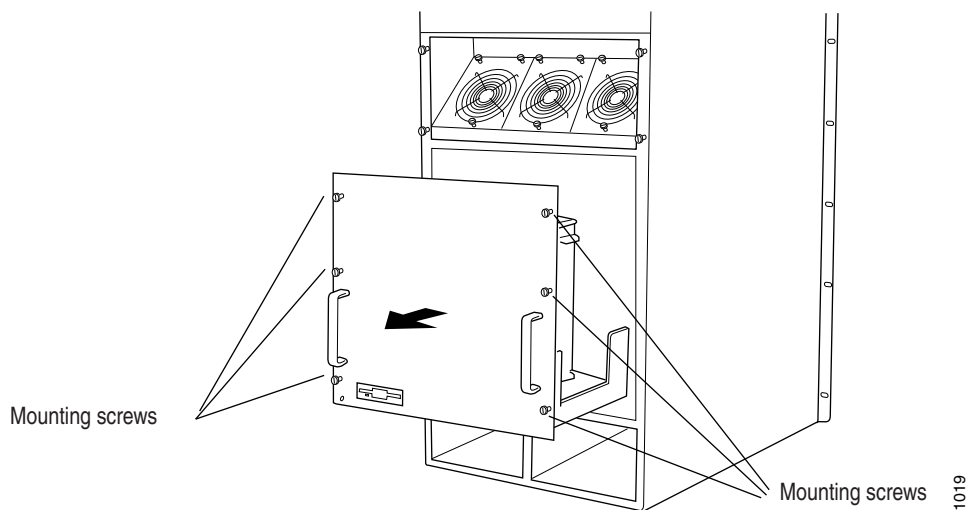
Remove the Routing Engine Housing

The Routing Engine resides in a metal housing in the rear of the chassis, below the fan tray (see Figure 2). The Routing Engine housing weighs approximately 17 lb (8 kg) and is about 16 in. (40.64 cm) deep.

To remove the Routing Engine housing, follow this procedure (see Figure 27):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the screws along the left and right edges of the Routing Engine housing (six in all), using a Phillips screwdriver if necessary.
3. Grasp the handles located at either side of the Routing Engine housing, and slide the unit about halfway out of the chassis.
4. Move one of your hands underneath the housing to support it, and slide it completely out of the chassis.

Figure 27: Remove the Routing Engine Housing



Remove the Upper Impeller Assembly

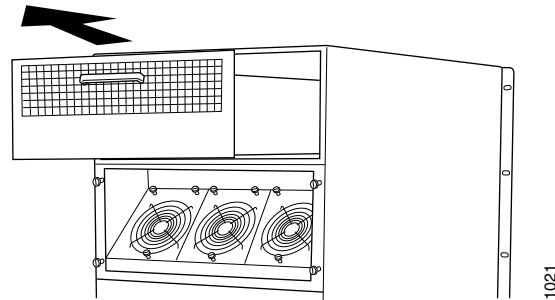
The upper impeller assembly is located at the top rear of the chassis, above the fan tray (see Figure 2). The assembly weighs approximately 10 lb (4 kg).

To remove the upper impeller assembly, follow this procedure (see Figure 28):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the captive screws at the bottom corners of the assembly, using a Phillips screwdriver if necessary.

3. Grasp the handle at the top of the assembly, and slide it about halfway out of the chassis.
4. Move one of your hands underneath the assembly to support it, and slide it completely out of the chassis.

Figure 28: Remove the Upper Impeller Assembly



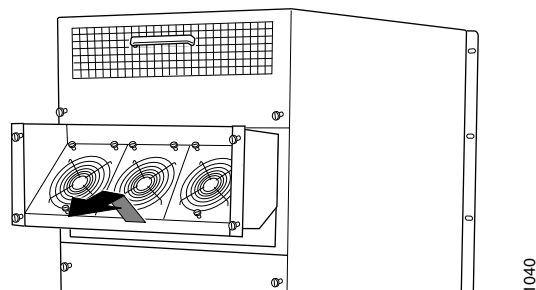
Remove the Fan Tray

The fan tray is located at the rear of the chassis, beneath the upper impeller assembly (see Figure 2). On some M40 routers, the tray is covered by a protective screen. You do not need to remove the screen before removing the fan tray from the chassis. The fan tray weighs approximately 5 lb (2 kg).

To remove the fan tray, follow this procedure (see Figure 29):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the screws at the outer corners of the fan tray (not the screws that attach the protective screen), using a Phillips screwdriver if necessary.
3. Grasp the sides of the fan tray and pull firmly to slide it out of the chassis.

Figure 29: Remove the Fan Tray



Remove the Cable Management System

The cable management system is located at the top front of the chassis, above the card cage (see Figure 1). It weighs only about 1 lb (0.5 kg), but you might want to remove it so that it does not interfere with your hand hold as you lift the chassis.

To remove the cable management system, follow this procedure:

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the two captive screws on top of the cable management system cover and remove the cover (see Figure 30).
3. Unscrew the four screws on the faceplate of the cable management system (see Figure 31).
4. Remove the unit from the chassis.

Figure 30: Remove the Cable Management System Cover

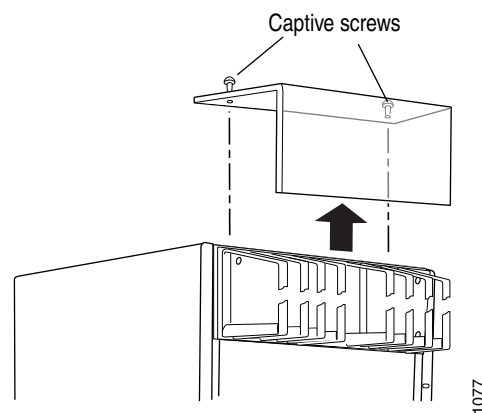
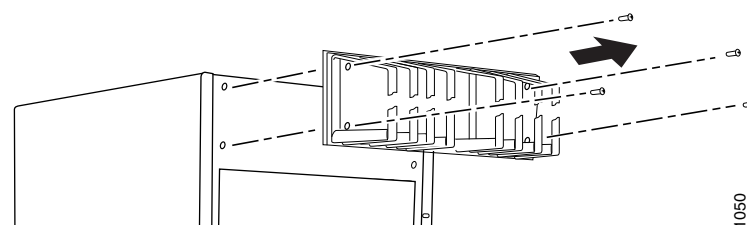


Figure 31: Remove the Cable Management System



Remove the FPCs

The router can have up to eight FPCs mounted vertically in the FPC card cage at the front of the chassis (see Figure 1). An FPC that houses four PICs weighs about 3 lb (1.5 kg).



Note

To help you work systematically, the following procedure directs you to remove FPCs starting at the left side of the card cage and working toward the right. You can remove FPCs in any order, however. As you remove each FPC, label it with its slot number and record the relevant information in the checklist in Table 21.

Table 21: FPC Removal Checklist

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

To remove the FPCs, follow this procedure:

1. Place an antistatic mat or electrostatic bag on a flat, stable surface to receive each FPC.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Locate the FPC or blank panel located in the leftmost slot of the card cage on the front of the chassis. It is directly above the offline button on the craft interface that is labeled **0** (zero).
4. If the slot is covered by a blank panel, you can leave it in place. If the slot contains an FPC, perform the following steps:
 - a. Loosen the thumbscrew at each end of the FPC, using a Phillips screwdriver if necessary.
 - b. Pull the ends of the extractor clips, which are adjacent to the thumbscrews, toward the outer edges of the FPC (see Figure 32).

- c. Grasp both sides of the card carrier and slide the FPC about halfway out of the card cage.
- d. Place one hand under the FPC to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag prepared in Step 1.

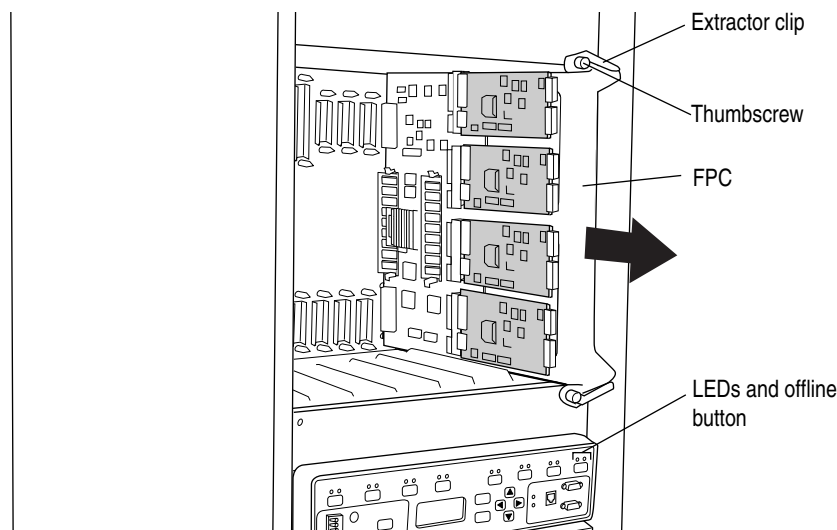


Caution

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

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

Figure 32: Remove an FPC



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Remove the SCB

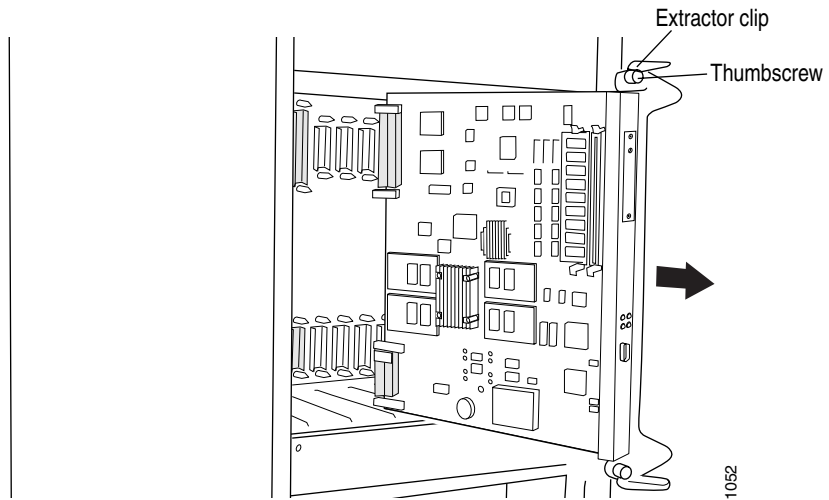
The SCB is located at the center of the card cage, at the front of the chassis (see Figure 1). It weighs approximately 1 lb (0.5 kg).

To remove the SCB, follow this procedure (see Figure 33):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the SCB.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Unscrew the thumbscrew at each end of the SCB, using a Phillips screwdriver if necessary.
4. Pull the ends of the extractor clips (which are adjacent to the thumbscrews) toward the outer edges of the SCB.

5. Grasp both sides of the SCB and slide it about halfway out of the chassis.
6. Place one hand under the SCB to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag prepared in Step 1.

Figure 33: Remove the SCB



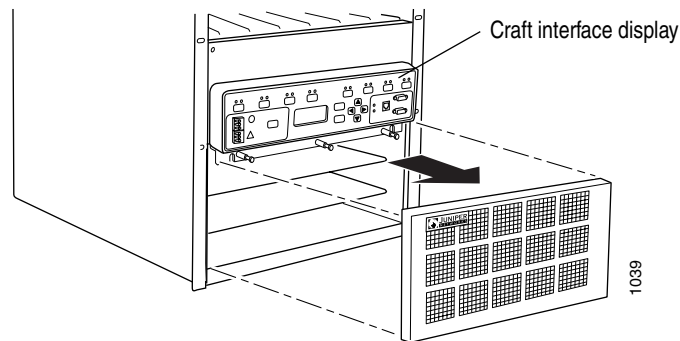
Remove the Air Filter

The air filter is located below the craft interface at the front of the chassis (see Figure 1). The air filter weighs less than 0.5 lb (0.2 kg), but you must remove it in order to remove the lower impeller assembly.

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

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the sides of the air filter and firmly pull it out from the chassis.

Figure 34: Remove the Air Filter



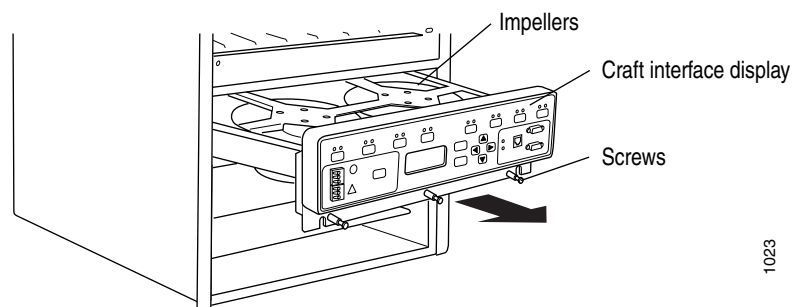
Remove the Lower Impeller Assembly

The lower impeller assembly is located just above the air intake on the front of the chassis, behind the craft interface (see Figure 1). The assembly weighs approximately 9 lb (4 kg).

To remove the lower impeller assembly, follow this procedure (see Figure 35):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the three screws at the bottom edge of the assembly, using a Phillips screwdriver if necessary.
3. Grasp the sides of the assembly, and slide it about halfway out of the chassis.
4. Move one of your hands underneath the assembly to support it, and slide it completely out of the chassis.

Figure 35: Remove the Lower Impeller Assembly



Install the Chassis into the Rack

After you have removed components as described in “Remove Components from the Chassis” on page 100, the chassis is light enough for a team of installers to lift into the rack.



Caution

Lifting the empty chassis and mounting it into a rack requires three people to lift and a fourth person to secure the mounting screws. The empty chassis weighs approximately 180 lb (82 kg).

If you are installing two routers in a rack, install the lower one first.

First, perform the following prerequisite procedures:

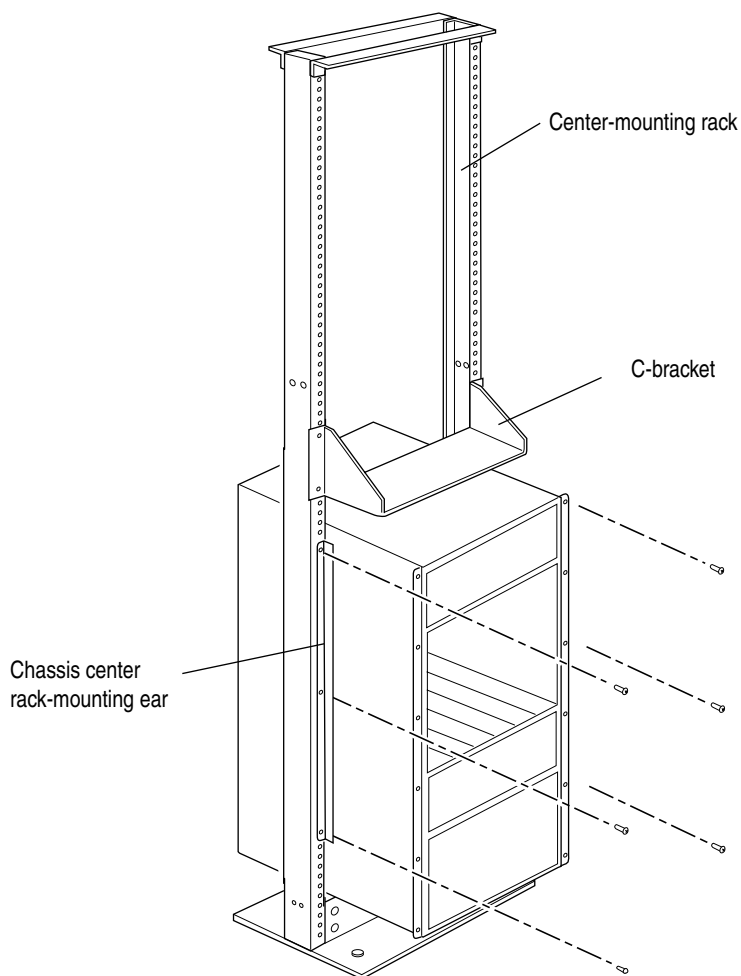
- Place the rack in its permanent location, allowing adequate clearance for airflow and maintenance, and secure it to the building structure. For details, see “Rack Requirements” on page 39.
- Read the information in “Installation Safety Guidelines and Warnings” on page 71, with particular attention to “Chassis Lifting Guidelines” on page 72.
- Remove the router from the shipping crate, as described in “Prepare to Install the Router” on page 89.
- Remove chassis components, as directed in “Remove Components from the Chassis” on page 100.

Then, perform the following procedures to install the router:

1. If you are installing the router in the upper half of the rack, install the C-bracket first (see “Rack-Mounting Brackets” on page 94). Follow this procedure:
 - a. Select the height in the rack at which to mount the C-bracket. The M40 router is 35 in. (89 cm or 20 U) high, so if you are mounting two routers in the rack leave at least that much distance between the C-bracket shelf and both the top and bottom cross-pieces of the rack.
 - b. As you stand in front of the rack, position the C-bracket so that the shelf is protruding toward you, and align the C-bracket mounting holes with holes in the rack rails. If you are front mounting the router, install the C-bracket into the rack from the rear. Make sure the mounting holes on both sides are parallel.
 - c. Insert and tighten the provided screws.
2. If you are center-mounting the router, attach a center-mounting ear to either side of the chassis. For information about the center-mounting ears, see “Rack-Mounting Brackets” on page 94.
3. If desired, attach a lifting handle on either side of the chassis (see “Rack-Mounting Brackets” on page 94).

4. Prepare to lift the router:
 - A person stands on either side of the chassis. Each grasps the side edge of the FPC card cage with one hand, and either grasps the lifting handle with the other hand or places the other hand under the chassis near the rear.
 - A third person stands behind the chassis and lifts from under it with both hands.
5. Lift the chassis and position it in the rack. If the C-bracket is installed, rest the router on it. Align the bottom hole in both front- or center-mounting ears with a hole in each rack rail, making sure the chassis is level. See Figure 36.

Figure 36: Install the Chassis in a Rack



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6. Install one of the mounting screws provided (in the accessory box shipped with the router) into each of the two aligned holes.
7. Moving up each post or ear, install a screw in every mounting hole.

8. Verify that all the mounting screws on one side of the rack are aligned with the mounting screws on the opposite side and that the router is level.
9. Proceed to the instructions in “Reinstall Components into the Chassis” on page 111.

Reinstall Components into the Chassis

After you have mounted the chassis in the rack as described in “Install the Chassis into the Rack” on page 109, reinstall the router components into the chassis.



The procedures in this section apply only to initial installation and assume that you have not yet connected power to the router. If power is connected, completely disconnect it before continuing. See “Disconnect AC Power from the Router” on page 140 or “Disconnect DC Power from the Router” on page 147.

If you are installing or replacing components in an operational router, see the appropriate chapters in Part 3.

Perform the procedures described in the following sections to reinstall components in the chassis:

- Reinstall the Lower Impeller Assembly on page 111
- Reinstall the Air Filter on page 112
- Reinstall the SCB on page 113
- Reinstall the FPCs on page 114
- Reinstall the Cable Management System on page 115
- Reinstall the Fan Tray on page 116
- Reinstall the Upper Impeller Assembly on page 117
- Reinstall the Routing Engine Housing on page 117
- Reinstall the Power Supplies on page 118

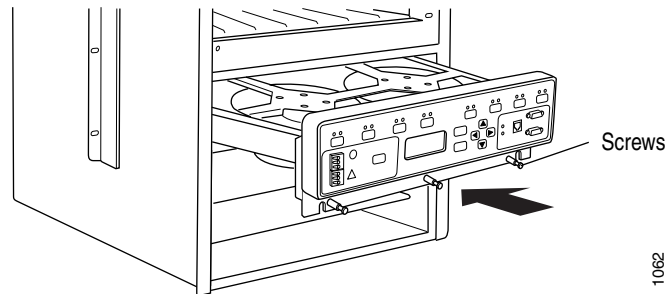
Reinstall the Lower Impeller Assembly

The lower impeller assembly is located just above the air intake on the front of the chassis, behind the craft interface (see Figure 1). To reinstall it, follow this procedure (see Figure 37):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the sides of the lower impeller assembly, and align the rear of the tray with the slider bars inside the chassis.

3. Slide the assembly all the way into the chassis.
4. Using a Phillips screwdriver, tighten the three captive screws at the bottom edge of the assembly to seat it firmly in the chassis.

Figure 37: Reinstall the Lower Impeller Assembly

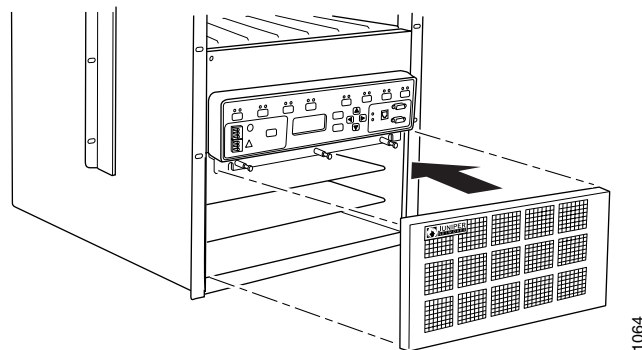


Reinstall the Air Filter

The air filter is located below the craft interface at the front of the chassis (see Figure 1). To reinstall it, follow this procedure (see Figure 38):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the sides of the air filter and push it firmly over the air intake, inserting its metal prongs into the chassis.

Figure 38: Reinstall the Air Filter

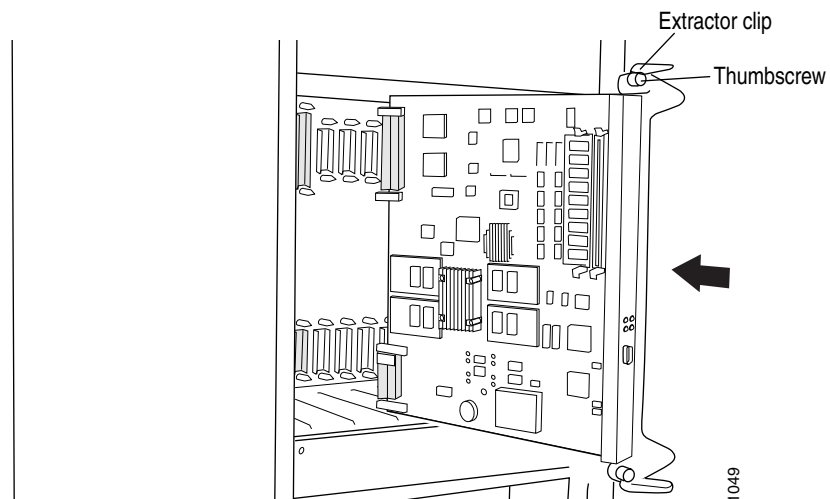


Reinstall the SCB

The SCB is located at the center of the card cage, at the front of the chassis (see Figure 1). To reinstall it, follow this procedure (see Figure 39):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the front of the SCB with both hands and align the rear of the card carrier with the slide guides in the card cage.
3. Slide the SCB all the way into the card cage until it contacts the backplane.
4. Push the ends of the extractor clips (which are located at each end of the SCB) towards each other to secure the SCB in the chassis.
5. Using a Phillips screwdriver, tighten the thumbscrew at each end of the SCB to seat the unit firmly in the chassis.

Figure 39: Reinstall the SCB



Reinstall the FPCs

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

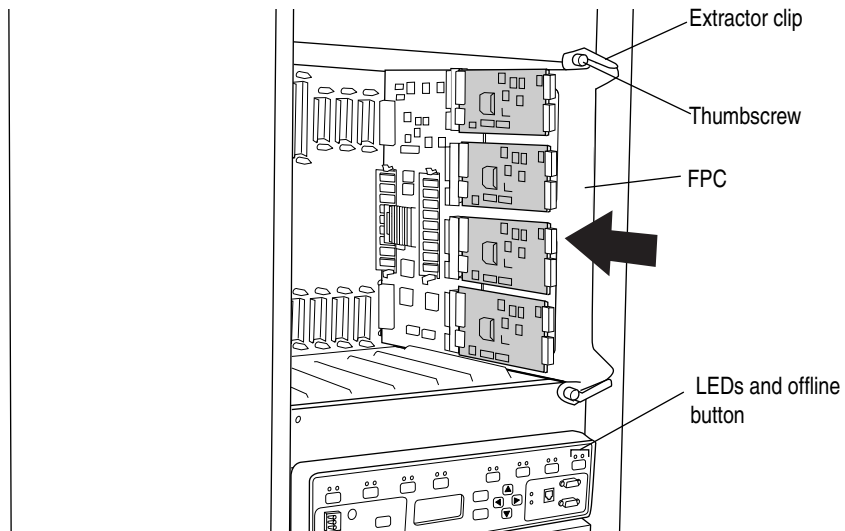


To help you work systematically, the following procedure directs you to reinstall FPCs starting at the left side of the card cage and working toward the right. You can install FPCs in any order, however.

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

To reinstall the FPCs, follow this procedure:

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Locate the leftmost slot in the FPC card cage on the front of the chassis. It is directly above the offline button on the craft interface that is labeled 0 (zero).
3. Locate the FPC that you labeled 0 during removal. Verify that the ends of the extractor clips, which are located at each end of the FPC, are pushed outward, toward the ends of the FPC.
4. Grasp the front of the FPC with both hands and align the rear of the card carrier with the slide guides in the card cage.
5. Slide the FPC all the way into the card cage until it contacts the backplane.
6. Push the ends of the extractor clips toward each other to secure the FPC in the chassis.
7. Using a Phillips screwdriver, tighten the thumbscrew at each end of the FPC to seat the unit firmly in the chassis.
8. Repeat Steps 4 through 7 for each FPC, proceeding from left to right through the remaining FPC slots.

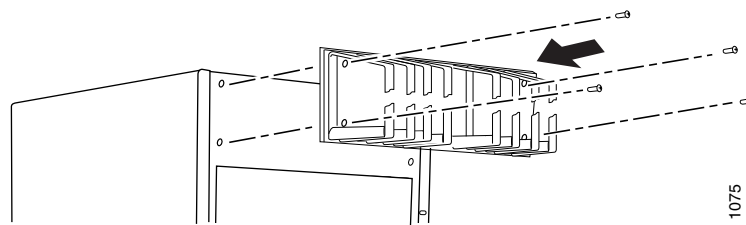
Figure 40: Reinstall an FPC

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Reinstall the Cable Management System

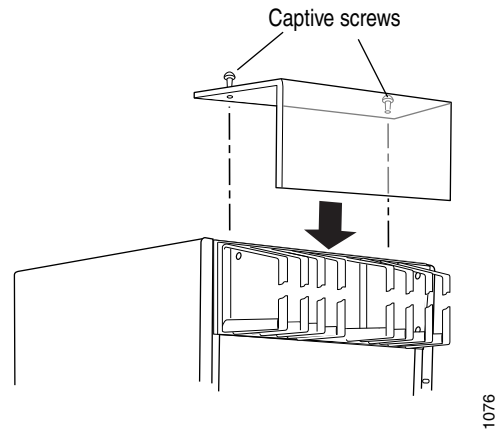
The cable management system is located at the top front of the chassis, above the card cage (see Figure 1). If you removed it in “Remove the Cable Management System” on page 104, follow this procedure to reinstall it:

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Place the cable management system on the chassis, aligning the screws on its faceplate with the mounting holes on the chassis (see Figure 41).
3. Using a Phillips screwdriver, tighten the screws.
4. Replace the cable management system cover and tighten its captive screws to the top of the metal prongs at either end of the cable management system (see Figure 42).

Figure 41: Reinstall the Cable Management System

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Figure 42: Reinstall the Cable Management System Cover

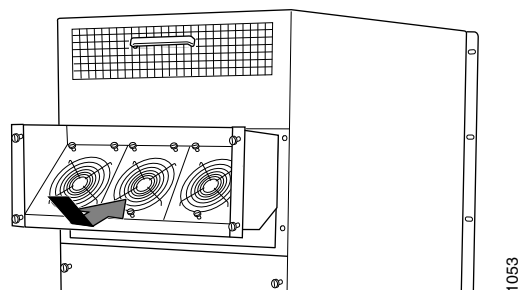


Reinstall the Fan Tray

The fan tray is located at the rear of the chassis, beneath the upper impeller assembly (see Figure 2). On some M40 routers, the tray is covered by a protective screen, which should already be in place on the tray. To reinstall the tray, follow this procedure (see Figure 43):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Slide the fan tray into the chassis.
3. Align the screws at the corners of the fan tray with the mounting holes at the edges of the opening and use a Phillips screwdriver to tighten the screws.

Figure 43: Reinstall the Fan Tray

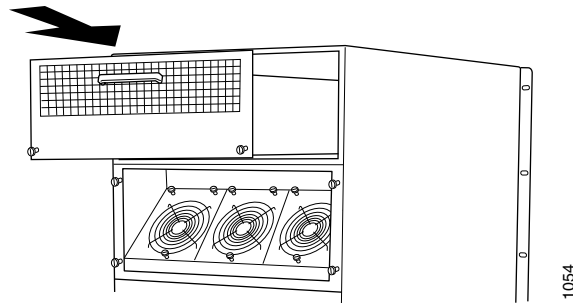


Reinstall the Upper Impeller Assembly

The upper impeller assembly is located at the top rear of the chassis, above the fan tray (see Figure 2). To reinstall it, follow this procedure (see Figure 44):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the handle at the top of the assembly and slide the assembly all the way into the chassis.
3. Using a Phillips screwdriver, tighten the thumbscrews at the lower corners of the assembly.

Figure 44: Reinstall the Upper Impeller Assembly

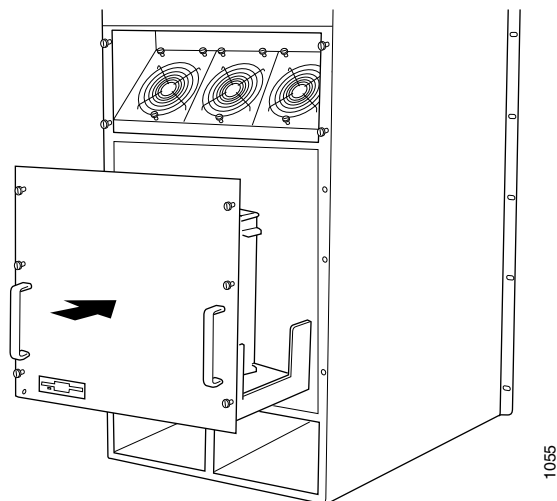


Reinstall the Routing Engine Housing

The Routing Engine resides in a metal housing in the rear of the chassis, below the fan tray (see Figure 2). To reinstall the Routing Engine housing, follow this procedure (see Figure 45):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Place one hand underneath the unit to support it and grasp a handle on the front of the unit with the other hand.
3. Align the rear of the unit with the slide guides in the chassis.
4. Slide the unit completely into the chassis.
5. Using a Phillips screwdriver, tighten the screws along the left and right edges of the Routing Engine housing (six in all).

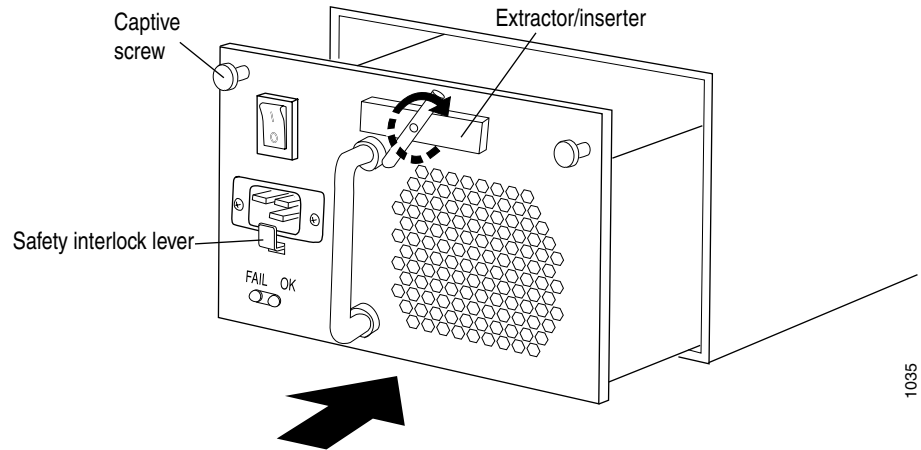
Figure 45: Reinstall the Routing Engine Housing



Reinstall the Power Supplies

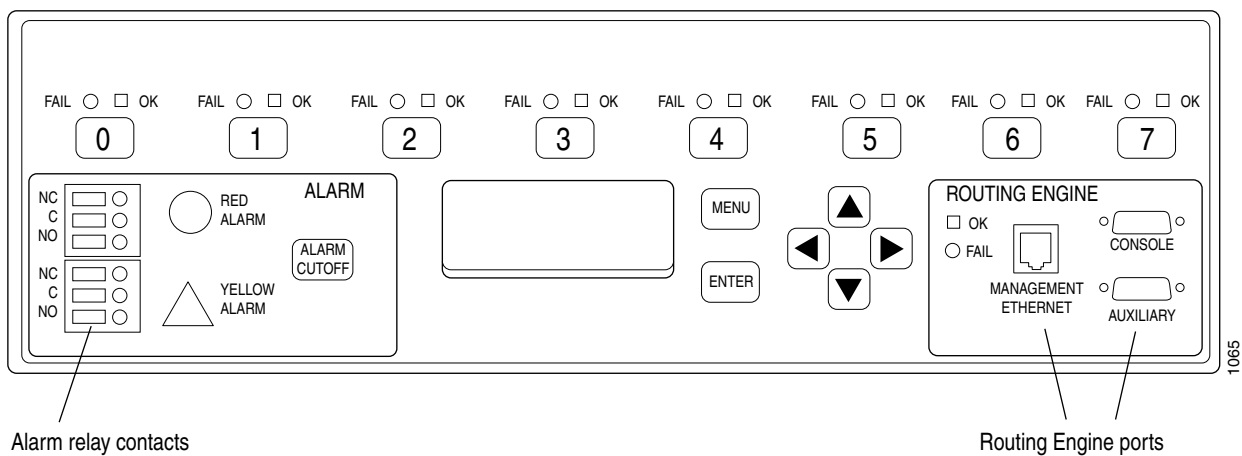
The router has two power supplies (either AC or DC) located at the bottom rear of the chassis (see Figure 2). To reinstall the power supplies, follow this procedure (see Figure 46, which shows an AC power supply):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Verify that the power switch on the faceplate of both power supplies is in the **OFF (0)** position.
3. Grasp the handle on the power supply faceplate with one hand and place the other hand under the unit to support it.
4. With a finger of the hand that is grasping the handle, lift and hold up the safety interlock lever. (On an AC power supply, the lever is just below the appliance inlet. On a DC power supply, it is just below the power switch.)
5. While holding the safety interlock lever up, slide the power supply into the chassis until it contacts the backplane.
6. Still holding the safety interlock lever up, turn the extractor/insertor clockwise until the power supply engages with the connectors on the backplane.
7. Push the safety interlock lever down.
8. Using a Phillips screwdriver, tighten (but do not overtighten) the thumbscrew at each upper corner of the power supply faceplate.
9. Repeat Steps 3 through 8 to reinstall the second power supply.

Figure 46: Reinstall a Power Supply

Connect the Router to Management and Alarm Devices

After you have installed the router into the rack, connect the Routing Engine to one or more external devices for management and service operations. Figure 47 shows the location of the Routing Engine interface ports and alarm relay contacts on the craft interface. For specifications for the cable and wire that inserts into the ports, see “Routing Engine Interface Cable and Wire Specifications” on page 53.

Figure 47: Routing Engine Interface Ports on the Craft Interface

To connect external devices, perform the procedures described in the following sections:

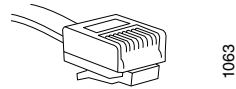
- Connect to a Network for Out-of-Band Management on page 120
- Connect to a Management Console or Auxiliary Device on page 120
- Connect to an External Alarm-Reporting Device on page 121

Connect to a Network for Out-of-Band Management

Connect the Routing Engine to a network for out-of-band management through the **MANAGEMENT ETHERNET** port on the craft interface. One cable with RJ-45/RJ-45 connectors is provided with the router, as detailed in “Routing Engine Interface Cable and Wire Specifications” on page 53. Follow this procedure:

1. Plug one end of the Ethernet cable (the connector is shown in Figure 48) into the **MANAGEMENT ETHERNET** port on the craft interface.
2. Plug the other end of the cable into the network device.

Figure 48: Routing Engine Ethernet Cable Connector



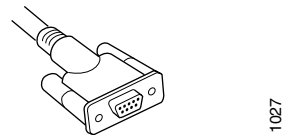
Connect to a Management Console or Auxiliary Device

You can configure and manage the router on a system console connected to the Routing Engine through the **CONSOLE** port on the craft interface, or on a laptop, modem, or other auxiliary device connected through the **AUXILIARY** port. One RS-232 (EIA-232) serial cable with DB-9/DB-9 connectors is provided with the router, as detailed in “Routing Engine Interface Cable and Wire Specifications” on page 53. (If you want to connect a device to both ports, you must supply another cable.)

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 49) of the provided console cable into the **CONSOLE** or **AUXILIARY** port.
3. Tighten the screws on the connector, using a 2.5-mm flat-blade screwdriver if necessary.
4. Attach the other end of the cable to the console or auxiliary device.

Figure 49: Console and Auxiliary Serial Port Connector



Connect to an External Alarm-Reporting Device

You can connect the router to external alarm-reporting devices through the relay contacts on the craft interface next to the LEDs labeled **RED ALARM** and **YELLOW ALARM** (see Figure 47). A system condition that triggers the red or yellow alarm LED on the craft interface also activates the corresponding alarm relay contact.

The alarm relay contacts accept wire of any gauge between 28-AWG and 14-AWG (0.09 and 2.09 mm²) wire, which is not provided. Use the gauge of wire appropriate for the external device that you are connecting to the contacts.

To connect an external device to an alarm relay contact, follow this procedure:

1. Prepare the required length of wire with gauge between 28-AWG and 14-AWG (0.09 and 2.09 mm²).
2. Use a 2.5 mm Phillips screwdriver to loosen the small screws on the faceplate of the appropriate alarm relay contact—the upper contact for a device that reports high priority (red) alarms, or the lower contact for the device that reports lower priority (yellow) alarms.
3. Insert wires into the appropriate slots in the front of the relay contact (**NC** means “normally closed,” **C** means “common,” and **NO** means “normally open”).
4. Attach the other end of the wires to the external device.

To attach a reporting device for the other kind of alarm, repeat Steps 1 through 4.

Connect PIC Cables

Now plug network cable into the PICs housed in the FPCs. For information about the cable used by the PICs supported on the M40 router, see the *M20 and M40 Internet Routers PIC Guide*.

To connect the PIC cables into the PIC cable connectors at the front of the chassis, follow this procedure:

1. Have ready a length of the type of cable used by the PIC.
2. If the PIC cable connector port is covered by a rubber safety plug, remove the plug.



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

Do not leave a transceiver uncovered except when removing or inserting the 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 (see Figure 50, which shows a fiber-optic connector).

4. Carefully thread the cable through the hooks in the cable management system at the upper front of the chassis (see Figure 1), 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.

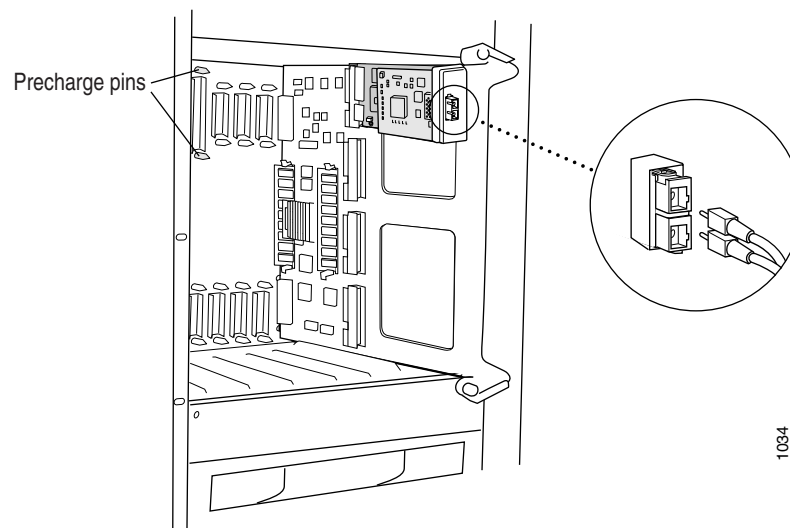


Caution

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.

Never 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 50: Connect Cable to a PIC



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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 123
- Connect Power to a DC-Powered Router on page 123
- Power On the Router on page 125

Connect Power to an AC-Powered Router

You connect power to an AC-powered 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.

To connect the AC power cords, follow this procedure:

1. Verify that the switch on each power supply faceplate is in the **OFF (O)** position.
2. Locate the power cords shipped with the router, which should have a plug appropriate for your geographical location (see “AC Power Cord Specifications” on page 45).
3. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
4. 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.
5. Repeat Step 4 for the other power supply.

Connect Power to a DC-Powered Router

Connect power to a DC-powered router by attaching power cables from external DC power sources to the terminal studs on each power supply. Power and grounding cables are not supplied with the router. For information about the required cable type, see “DC Power and Grounding Cable Specifications” on page 46.



Note

The router must be connected to two separate external DC power sources, one for each power supply.



Caution

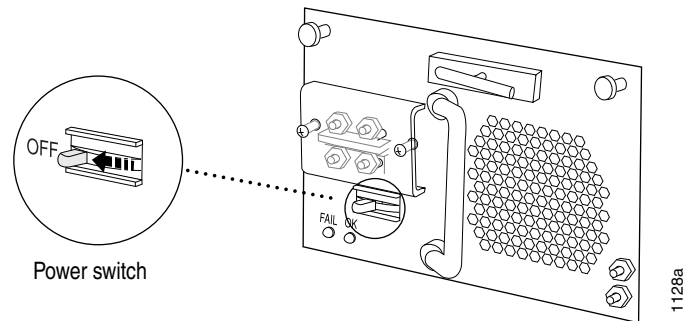
There is no standard color coding for DC power cables. The color coding used by the external DC power source at your site determines the color coding for the leads on the power cables that attach to the circuit breaker box. You must ensure that the connections at the circuit breaker box maintain the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

To connect DC power cables to the power supplies, follow this procedure:

1. Ensure that the voltage across the leads of the DC power cables that you are connecting to the circuit breaker box is 0 V and that there is no chance that the cable leads might become active during installation.
2. Verify that a licensed electrician has attached the cable lugs provided with the router to the grounding and power cables.

3. Verify that the power switch is in the **OFF (0)** position (see Figure 51).

Figure 51: DC Power Switch in the Off Position



4. Attach the grounding cable to a proper earth ground for both external DC power sources, if it is not already.
5. Remove the nuts and locking washers that are preinstalled on the grounding studs at the lower right corner of the power supply faceplate. Slide the grounding cable lug onto the studs and replace the washers and nuts. Using a 7/16-in. nut driver or wrench, tighten the nuts.

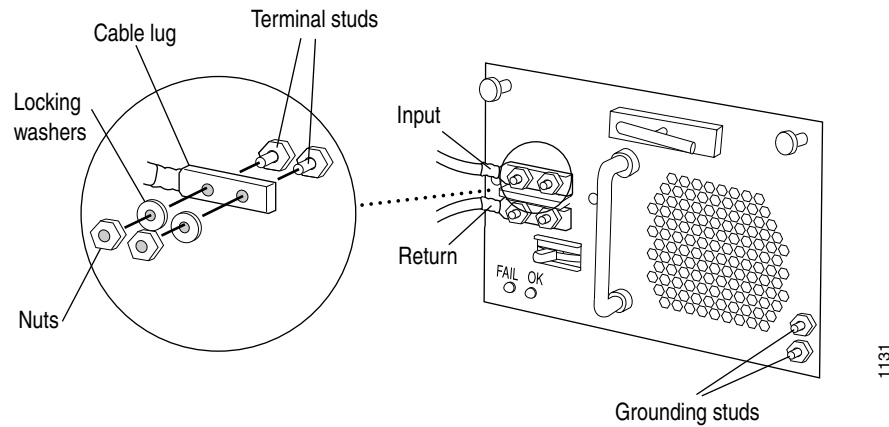


Caution

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

6. Using a Phillips screwdriver, loosen the screws securing the protective shield over the power terminal studs. Remove the shield. Remove the outer nut and washer that are preinstalled on each terminal stud.
7. Slide the power cable lugs onto the terminal studs on the power supply faceplate (see Figure 52):
 - Connect the positive (+) source cable lug to the return terminal, which is labeled RTN.
 - Connect the negative (–) source cable lug to the input terminal, which is labeled –48V.

Run the power cables to the left on the left power supply, and to the right on the right power supply. This arrangement enables you to replace a power supply without having to detach the cables from the other power supply.

Figure 52: Attach Cables to the DC Power Supply

8. Secure the power cable lugs to the terminal studs, first with a washer, then with a nut (the washers and nuts are provided with the router). Using a 7/16-in. nut driver or wrench, tighten the nuts.



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

9. Verify that the source power cabling and the grounding cabling are correct, that they are not touching or blocking access to router components, and that they do not drape where people could trip on them.
10. Replace the clear cover over the terminal studs and tighten the screws that secure it to the power supply.
11. Repeat Steps 3 through 10 to reinstall the second power supply.

Power On the Router

To power on the router, follow this procedure:

1. Make certain that the power supplies are fully inserted in the chassis and the thumbscrews on their faceplates are tightened.
2. For both power supplies on an AC-powered router, make certain 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 both power supplies on a DC-powered router, make certain that the positive (+) source DC power cable lug is connected to the return terminal (labeled RTN) and the negative (–) power cable lug is connected to the input terminal (labeled –48V).

3. Turn on the power to the management device that is connected to the Routing Engine through the craft interface port labeled **CONSOLE**, **AUXILIARY**, or **MANAGEMENT ETHERNET**. For more information on connecting management devices, see “Connect the Router to Management and Alarm Devices” on page 119.
4. Press the power switch on one power supply to the **ON (|)** position. Verify that the green LED labeled **OK** on the power supply faceplate eventually lights steadily.

**Note**

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

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 complete instructions, see “Disconnect AC Power from the Router” on page 140 or “Disconnect DC Power from the Router” on page 147.

If after powering on the power supply you must power it off, wait at least 60 seconds. After powering off a power supply, wait 60 seconds before turning it back on.

5. Press the power switch on other power supply to the **ON (|)** position and confirm that the **OK** LED lights as described in Step 4. If the LED is not lit after 60 seconds, repeat the power supply and cable installation procedures described in “Reinstall the Power Supplies” on page 118, and “Connect Power to an AC-Powered Router” on page 123 or “Connect Power to a DC-Powered Router” on page 123.
6. On the management device, 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 disk in the Routing Engine, one on a rotating hard disk in the Routing Engine, and one on an LS-120 disk that ships with the router.

When the router boots, it first attempts to start the image from an LS-120 disk if one is installed in the LS-120 drive. If an LS-120 disk is not installed or the attempt otherwise fails, the router next tries the flash disk, then finally the hard disk.

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 **MANAGEMENT ETHERNET** 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 125.
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-name# commit
```

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

```
[edit]
root@host-name# exit
root@host-name>
```

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 and Replacement Procedures

- Hardware Maintenance Overview on page 133
- Maintain and Replace the Power Supplies on page 135
- Maintain and Replace Cooling System Components on page 153
- Maintain and Replace Packet Forwarding Engine Components on page 161
- Maintain and Replace Routing Engine Components on page 173
- Maintain and Replace Cables and Connectors on page 181

Chapter 9

Hardware Maintenance Overview

This chapter discusses the following procedures for maintaining the router:

- Routine Maintenance Procedures on page 133
- Replacing FRUs on page 133

For information about returning a part to Juniper Networks for repair or replacement, see “Return the Router or Its Components” on page 215.

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 and into the air intake vent at the bottom of the chassis front is unobstructed.
- Check the status-reporting devices on the craft interface: system alarms, LEDs, and LCD. See “Craft Interface” on page 17.
- Inspect the air filter at the bottom front of the router, replacing it as needed for optimum cooling system performance. Do not run the router for more than a few minutes without the air filter in place. For replacement instructions, see “Maintain and Replace the Air Filter” on page 154.

Replacing FRUs

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 part. For instructions, see “Return the Router or Its Components” on page 215.

The subsequent chapters in this part describe how to replace FRUs. For a list of the FRUs on the M40 router, see “Field-Replaceable Units (FRUs)” on page 4.

Chapter 10

Maintain and Replace the Power Supplies

This chapter discusses the following topics related to maintaining and replacing the power supplies:

- Tools and Parts Required on page 135
- Maintain the Power Supplies on page 135
- Replace an AC Power Supply on page 136
- Disconnect and Connect AC Power on page 140
- Replace a DC Power Supply on page 141
- Disconnect and Connect DC Power on page 147

Tools and Parts Required

To replace DC or AC power supplies, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- ESD grounding wrist strap
- 7/16-in. nut driver or wrench for tightening nuts to grounding and terminal studs on a DC power supply; if 7/16-in. tool is not available, use pliers or an adjustable wrench rather than a metric nut driver or wrench

Maintain the Power Supplies

To maintain the power supplies, follow these guidelines:

- Make sure that the power and ground cables on each DC power supply are arranged so that they do not obstruct access to the other power supply or to the Routing Engine.
- Routinely check the LEDs on the power supply faceplate. The green **OK** LED indicates that the power supply is functioning normally; the red **FAIL** LED indicates a power supply fault. For more information about the power supply LEDs, refer to “Power Supply LEDs” on page 22.

- 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 and the LCD on the craft interface. Power supply failure or removal triggers an alarm that causes one or both of the LEDs to light and an error message to appear on the LCD. You can display the error messages remotely 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 235.

- Verify that the airflow to each supply is unobstructed.
- 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.

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 4. When one power supply fails or is powered down, the other power supply automatically assumes the entire electrical load for the router.

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

- Remove an AC Power Supply on page 137
- Install an AC Power Supply on page 138

Remove an AC Power Supply

The AC power supplies are located at the bottom rear of the chassis (see Figure 2). Each AC power supply weighs approximately 20 lb (9 kg).



Caution

Do not leave a power supply slot empty for more than a short time while the router is operational. The power supply must remain in the chassis for proper airflow.

To remove an AC power supply, follow this procedure (see Figure 53):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Press the power switch on the power supply faceplate to the OFF (O) position.

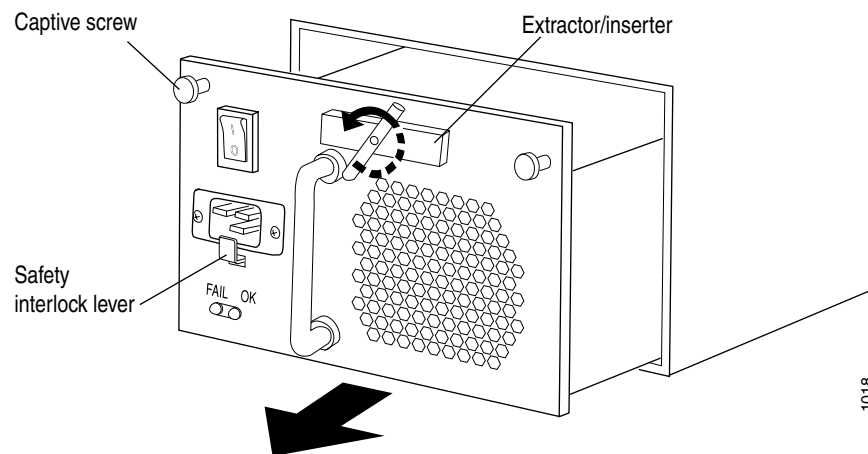


Note

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.

3. Unplug the power cord from the appliance inlet on the faceplate.
4. Loosen the thumbscrew at each upper corner of the power supply faceplate, using a Phillips screwdriver if necessary.
5. Lift and hold up the safety interlock lever, which is directly below the appliance inlet.
6. While holding the safety interlock lever up, turn the extractor/insertor counterclockwise until the power supply disengages from the backplane.
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 53: Remove an AC Power Supply



Install an AC Power Supply

To install an AC power supply, follow this procedure:

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 Power Cord Specifications” on page 45).
3. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
4. Grasp the handle on the power supply faceplate with one hand and place the other hand under the unit to support it.
5. With a finger of the hand that is grasping the handle, lift and hold up the safety interlock lever, which is just below the appliance inlet.
6. While holding the safety interlock lever up, slide the power supply into the chassis until it contacts the backplane.
7. Still holding the safety interlock lever up, turn the extractor/insertor clockwise until the power supply engages with the connectors on the backplane.
8. Push the safety interlock lever down.
9. Using a Phillips screwdriver, tighten (but do not overtighten) the thumbscrew at each upper corner of the power supply faceplate.

10. 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.
11. Press the power switch on the power supply to the ON (|) position. Verify that the green LED labeled **OK** on the power supply faceplate eventually lights steadily.

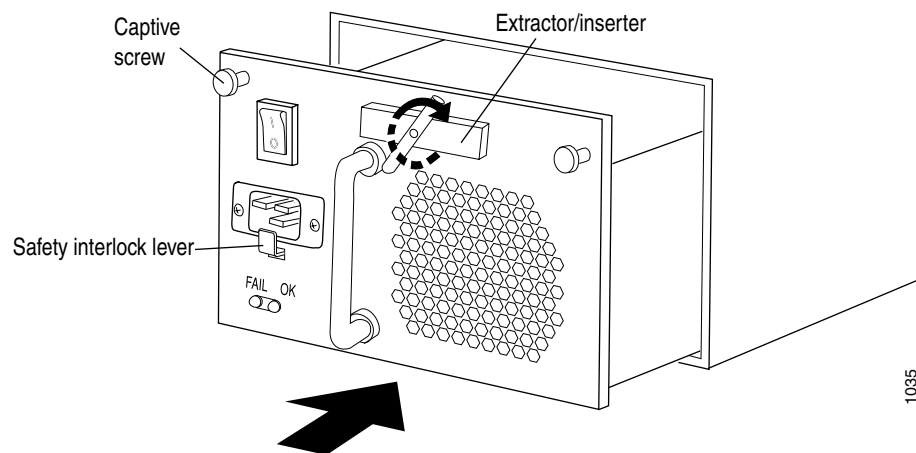
**Note**

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

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 complete instructions, see “Disconnect AC Power from the Router” on page 140.

If after powering on the power supply you must power it off, wait at least 60 seconds. After powering off a power supply, wait 60 seconds before turning it back on.

Figure 54: 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 140
- Connect AC Power to the Router on page 140

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

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

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

2. Press the power switch on both power supply faceplates to the OFF (O) position.
3. Unplug the power cord from both power supplies.



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

Connect AC Power to the Router

1. Verify that the power supplies are fully inserted in the chassis, that the thumbscrews and extractor/inserters on their faceplates are tightened, and that the power switches on both faceplates are in the OFF (O) position.
2. For both power supplies, 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. Turn on the power to the management device that is connected to the Routing Engine through the craft interface port labeled **CONSOLE**, **AUXILIARY**, or **MANAGEMENT ETHERNET**. For more information on connecting management devices, see “Connect the Router to Management and Alarm Devices” on page 119.

4. Press the power switch on the faceplate of one power supply to the **ON** (|) position. The green **OK** LED on the power supply faceplate blinks rapidly for a short time, then lights steadily.



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

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 complete instructions, see “Disconnect AC Power from the Router” on page 140.

If after powering on the power supply you must power it off, wait at least 60 seconds. After powering off a power supply, wait 60 seconds before turning it back on.

5. Press the second power switch to the **ON** (|) position and observe the LEDs on the second power supply faceplate. They should light as described in Step 4.

If the LEDs are not lit in the appropriate pattern after 60 seconds, repeat the power supply installation procedures described in “Install an AC Power Supply” on page 138, and the previous steps in this procedure.

6. On the management device, monitor the startup process to verify that the system has booted properly.

Replace a DC Power Supply

A DC-powered router has two load-sharing, redundant DC power supplies. Each power supply is hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. When one power supply fails or is powered down, the other power supply automatically assumes the entire electrical load for the router.

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

- Remove a DC Power Supply on page 142
- Install a DC Power Supply on page 144

Remove a DC Power Supply

The DC power supplies are located at the bottom rear of the chassis (see Figure 2). Each DC power supply weighs approximately 20 lb (9 kg).



Caution

Do not leave a power supply slot empty for more than a short time while the router is operational. The power supply must remain in the chassis for proper airflow.

To remove a DC power supply, follow this procedure:

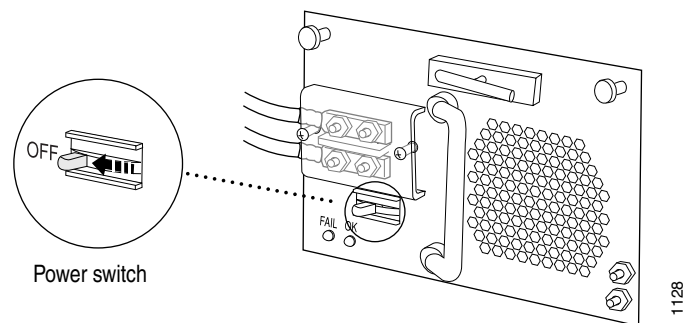
1. Turn off the power flowing from the DC power source to the power supply. Ensure that the voltage across the leads of the DC power cables that you are disconnecting is 0 V and that there is no chance that the cable leads might become active during removal.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Flip the power switch on the power supply faceplate to the **OFF (O)** position. See Figure 55



Note

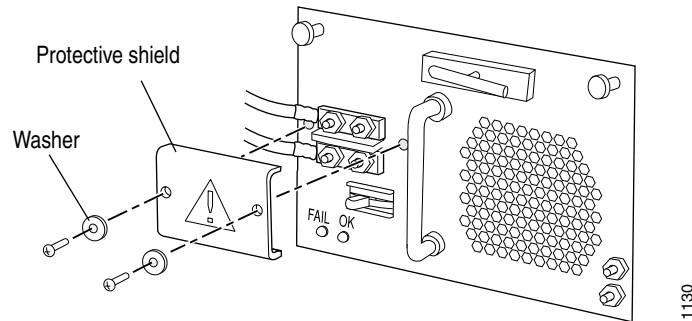
If you are not removing the power supply, but simply powering it off, wait at least 60 seconds before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

Figure 55: Flip the Power Switch on a DC Power Supply to the OFF Position

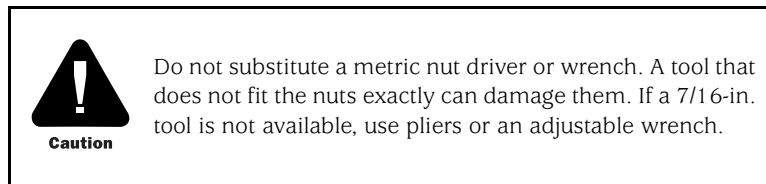


4. Using a Phillips screwdriver, loosen the screws securing the protective shield over the power terminal studs and remove the shield. See Figure 56.

Figure 56: Remove the Protective Shield from the Terminal Studs

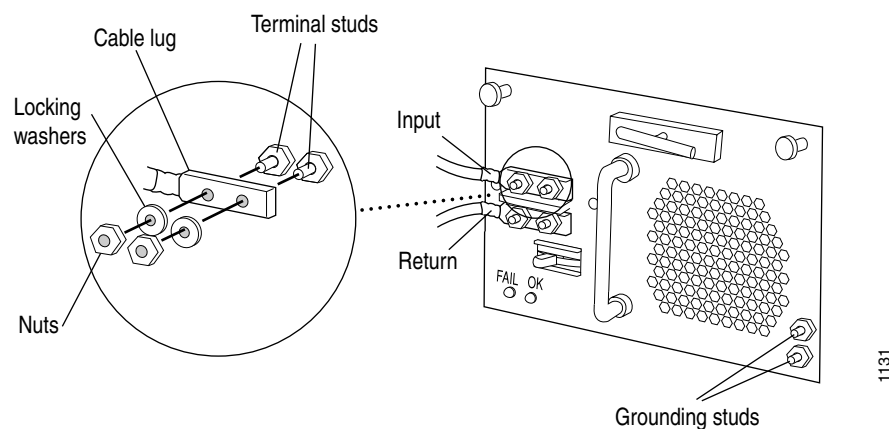


5. Using a 7/16-in. nut driver or wrench, loosen the nuts that secure the power cable lugs to the terminal studs. Remove the nuts, washers, and lug from each set of terminal studs. See Figure 57.



6. Using a 7/16-in. nut driver or wrench, loosen the nuts that secure the grounding cable lug to the grounding studs. Remove the nuts, washers, and lug from the grounding studs.

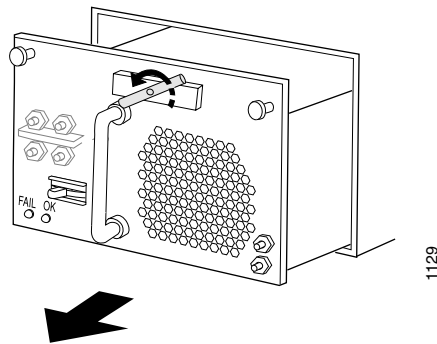
Figure 57: Remove Cables from a DC Power Supply



7. Loosen the thumbscrew at each upper corner of the power supply faceplate, using a Phillips screwdriver if necessary.
8. Lift and hold up the safety interlock lever, which is just below the power switch.

9. While holding the safety interlock lever up, turn the extractor/inserter counterclockwise until the power supply disengages from the backplane. See Figure 58.
10. Grasp the handle on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
11. Place one hand under the power supply to support it, then slide it completely out of the chassis.

Figure 58: Remove a DC Power Supply



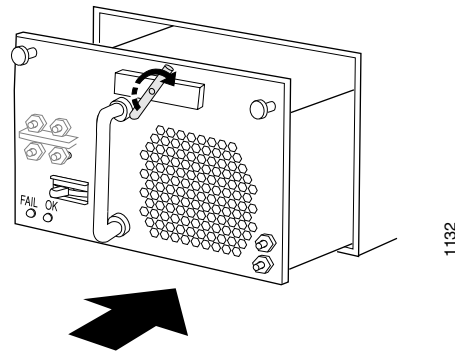
Install a DC Power Supply

To install a DC power supply, follow this procedure:

1. Verify that the power from the DC power source is shut off. Ensure that the voltage across the leads of the DC power cables that you are connecting is 0 V and that there is no chance that the cable leads might become active during connection.
2. Verify that the power switch on the power supply faceplate is in the **OFF (O)** position.
3. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
4. Grasp the handle on the power supply faceplate with one hand and place the other hand under the unit to support it.
5. With a finger of the hand that is grasping the handle, lift and hold up the safety interlock lever, which is just below the power switch.
6. While holding the safety interlock lever up, slide the power supply into the chassis until it contacts the backplane.
7. Still holding the safety interlock lever up, turn the extractor/insertor clockwise until the power supply engages with the connectors on the backplane. See Figure 59.
8. Push the safety interlock lever down.

9. Using a Phillips screwdriver, tighten (but do not overtighten) the thumbscrew at each upper corner of the power supply faceplate.

Figure 59: Install a DC Power Supply



10. Slide the grounding cable lug onto the grounding studs at the lower right corner of the power supply faceplate. Secure the lug, first with locking washers, then with nuts. Using a 7/16-in. nut driver or wrench, tighten the nuts.

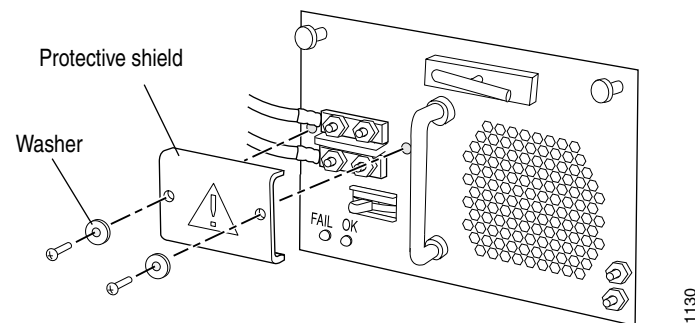


Caution

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

11. If the protective shield is installed over the power supply terminals, use a Phillips screwdriver to loosen and remove the screws that secure the shield to the power supply (see Figure 60).

Figure 60: Remove the Protective Shield from the Terminal Studs



12. Slide the power cable lugs onto the terminal studs on the power supply faceplate (see Figure 61):

- Connect the positive (+) source cable lug to the return terminal, which is labeled RTN.
- Connect the negative (–) source cable lug to the input terminal, which is labeled –48V.

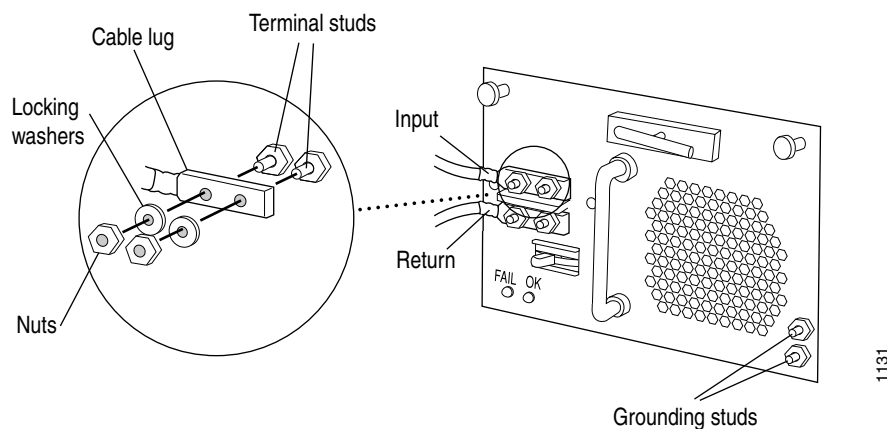
Run the power cables to the left on the left power supply, and to the right on the right power supply. This arrangement enables you to replace a power supply without having to detach the cables from the other power supply.



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

Figure 61: Attach Cables to a DC Power Supply



13. Secure the cable lug to the terminal studs, first with locking washers, then nuts. Using a 7/16-in. nut driver or wrench, tighten the nuts.



Caution

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

14. Verify that the power cabling from the source DC breaker to the power supply is correct.

15. Reinstall the protective shield covering the terminal studs.
16. Press the power switch on the power supply to the ON (|) position. Verify that the green LED labeled OK on the power supply faceplate eventually lights steadily.

**Note**

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

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 complete instructions, see “Disconnect DC Power from the Router” on page 147.

If after powering on the power supply you must power it off, wait at least 60 seconds. After powering off a power supply, wait 60 seconds before turning it back on.

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:

- Disconnect DC Power from the Router on page 147
- Connect DC Power to the Router on page 149

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

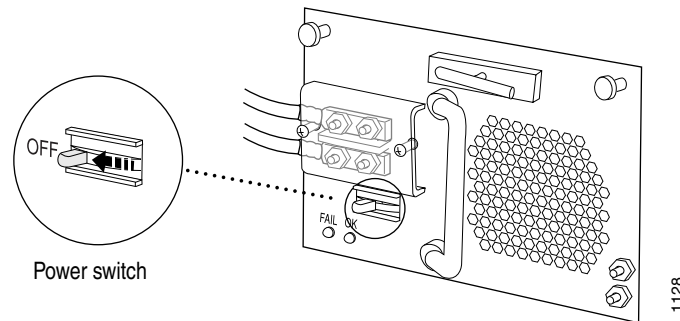
```
user@host> request system halt
```

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

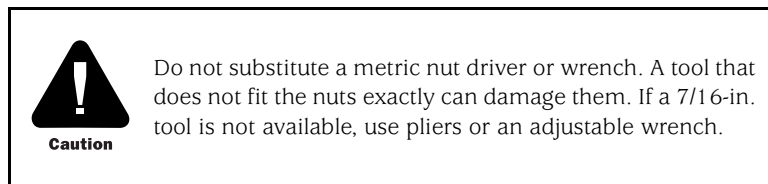
2. Turn off the power flowing from each DC power source to a power supply. Ensure that the voltage across the leads of the DC power cables is 0 V and that there is no chance that they might become active during removal.

3. Flip the power switch on both power supplies to the **OFF (O)** position. See Figure 62.

Figure 62: Flip the Power Switch on a DC Power Supply to the OFF Position

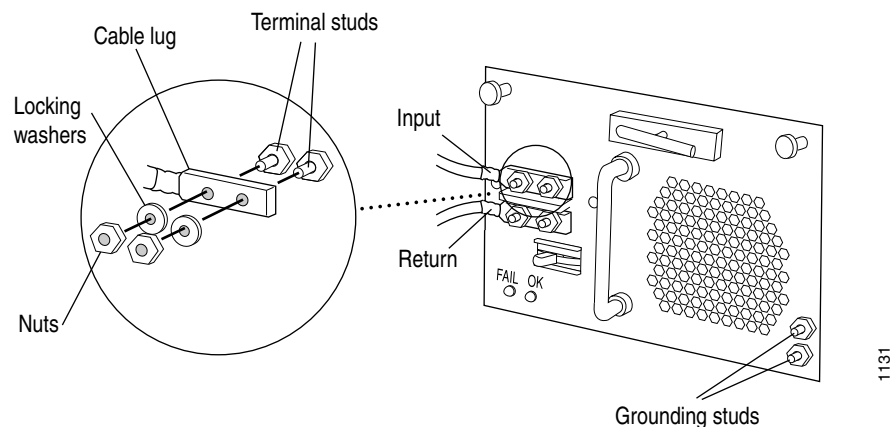


4. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on one power supply. Remove the shield.
5. Using a 7/16-in. nut driver or wrench, loosen the nuts securing the cable lugs to the terminal studs on the power supply, then remove the nut and washer from each terminal stud (see Figure 63).



6. Remove the cable lugs from the terminal studs.

Figure 63: Remove Cables from a DC Power Supply



7. If you are decommissioning the router, loosen and remove the nuts and washers that secure the grounding lug to the power supply and remove the grounding lug.

8. If not immediately attaching replacement cables, replace the protective shield over the terminal studs and tighten the screws that secure it to the box.
9. Verify that the removed cables are not touching or blocking access to any router components.
10. Repeats Steps 4 through 9 for the other power supply.

Connect DC Power to the Router

Connect DC power to the router by attaching power cables from external DC power sources to the terminal studs on the power supplies. Power and grounding cables are not supplied with the router. For information about the required cable type, see “DC Power and Grounding Cable Specifications” on page 46.



Note

The router must be connected to two separate external DC power sources, one for each set of terminal studs on the circuit breaker box.



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

To connect DC power to the router, follow this procedure:

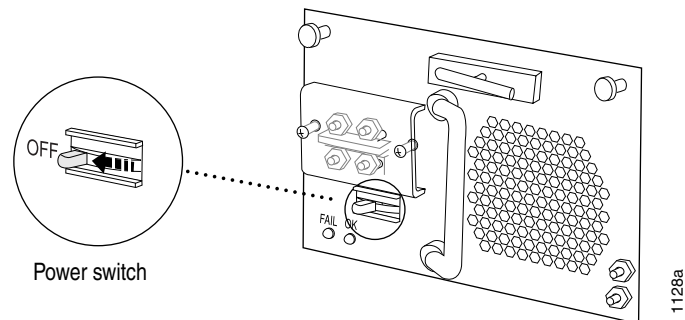
1. Ensure that the voltage across the leads of the DC power source cables that you are connecting is 0 V and that there is no chance that the cable leads might become active during installation.
2. Verify that the power supplies are fully inserted in the chassis, that the thumbscrews and extractor/inserters on their faceplates are tightened, and that the power switches on both faceplates are in the OFF (O) position. See Figure 64.
3. Attach the grounding cable to a proper earth ground, if it is not already.
4. Slide the grounding cable lug onto the grounding studs at the lower right corner of the power supply faceplate. Secure the lug, first with locking washers, then with nuts. Using a 7/16-in. nut driver or wrench, tighten the nuts.



Caution

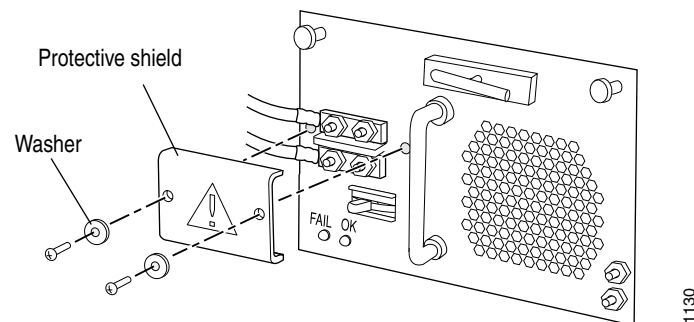
Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them. If a 7/16-in. tool is not available, use pliers or an adjustable wrench.

Figure 64: Power Switch on a DC Power Supply in the OFF Position



5. If the protective shield is installed over the power supply terminals, use a Phillips screwdriver to loosen and remove the screws that secure the shield to the power supply (see Figure 65).

Figure 65: Remove the Protective Shield from the Terminal Studs



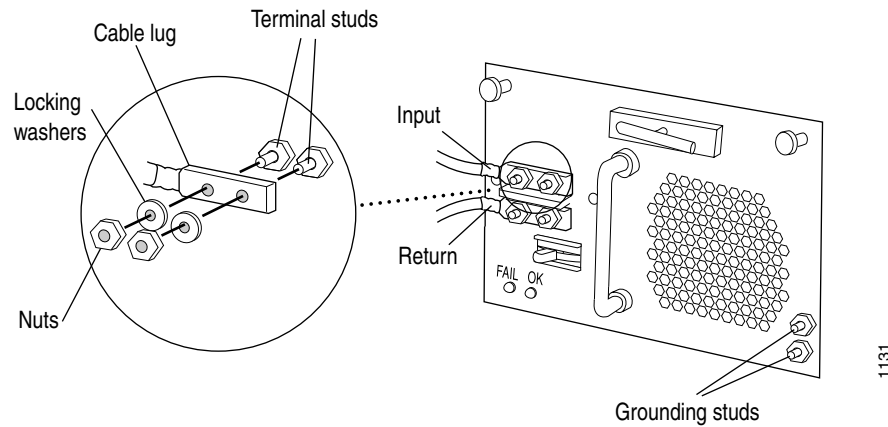
6. Slide the power cable lugs onto the terminal studs on the power supply faceplate (see Figure 66):
 - Connect the positive (+) source cable lug to the return terminal, which is labeled RTN.
 - Connect the negative (-) source cable lug to the input terminal, which is labeled -48V.

Run the power cables to the left on the left power supply, and to the right on the right power supply. This arrangement enables you to replace a power supply without having to detach the cables from the other power supply.



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

Figure 66: Attach Cables to a DC Power Supply

7. Secure the cable lugs to the terminal studs, first with locking washers, then nuts.
8. Verify that the DC power source wiring from the source DC breaker to the power supply is correct.
9. Reinstall the protective shield covering the terminal studs.
10. Repeat Steps 4 through 9 for the other power supply.
11. Turn on the power to the management device that is connected to the Routing Engine through the craft interface port labeled **CONSOLE**, **AUXILIARY**, or **MANAGEMENT ETHERNET**. For more information on connecting management devices, see “Connect the Router to Management and Alarm Devices” on page 119.
12. Press the power switch on the power supply to the **ON** (|) position. Verify that the green LED labeled **OK** on the power supply faceplate eventually lights steadily.

**Note**

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

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 complete instructions, see “Disconnect DC Power from the Router” on page 147.

If after powering on the power supply you must power it off, wait at least 60 seconds. After powering off a power supply, wait 60 seconds before turning it back on.

13. Press the power switch on other power supply to the **ON** (|) position and confirm that the **OK** LED lights as described in Step 4. If the LED is not lit after 60 seconds, repeat the power supply installation procedures described in “Install a DC Power Supply” on page 144 and the previous steps in this procedure.
14. On the management device, monitor the startup process to verify that the system has booted properly.

Chapter 11

Maintain and Replace Cooling System Components

This chapter describes how to maintain and replace cooling system components:

- Tools and Parts Required on page 153
- Maintain and Replace the Air Filter on page 154
- Maintain and Replace the Fan Tray on page 155
- Maintain the Impeller Assemblies on page 157
- Replace the Lower Impeller Assembly on page 158
- Replace the Upper Impeller Assembly on page 159

Tools and Parts Required

You need the following tools and parts to replace cooling system components:

- Phillips (+) screwdrivers, numbers 1 and 2
- ESD grounding wrist strap
- Electrostatic bag or antistatic mat for each component removed

Maintain and Replace the Air Filter

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



Caution

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

See the following sections:

- Remove the Air Filter on page 154
- Install the Air Filter on page 155

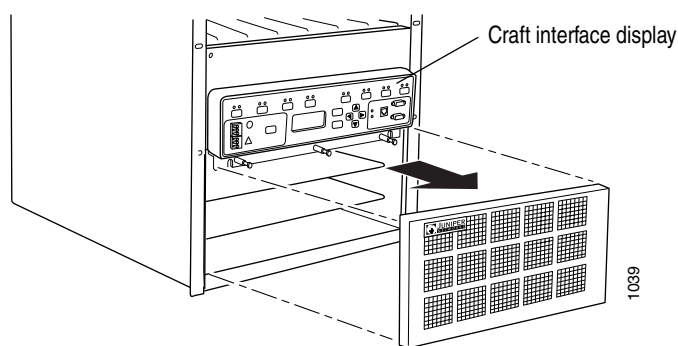
Remove the Air Filter

The air filter is located below the craft interface at the front of the chassis (see Figure 1). The air filter weighs less than 0.5 lb (0.2 kg), and you must remove it in order to remove the lower impeller assembly.

To remove the air filter, use the following procedure (see Figure 67):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Grasp the sides of the air filter and firmly pull it out from the chassis.

Figure 67: Remove the Air Filter

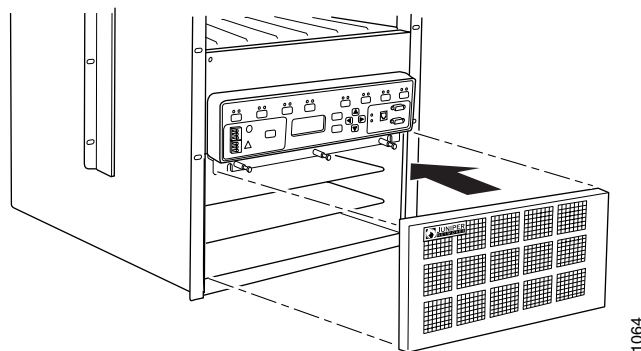


Install the Air Filter

To install the air filter, follow this procedure (see Figure 68):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Grasp the sides of the air filter and push it firmly over the air intake, inserting its metal prongs into the chassis.

Figure 68: Install the Air Filter



Maintain and Replace the Fan Tray

The fan tray is located at the rear of the chassis, beneath the upper impeller assembly (see Figure 2). To check the status of the fans in the fan tray, issue the **show chassis environment** command. The output refers to the individual fans in the fan tray as the Rear Left Fan, Rear Center Fan, and Rear Right Fan:

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

To replace the fan tray, perform the following procedures:

- Remove the Fan Tray on page 156
- Install the Fan Tray on page 156

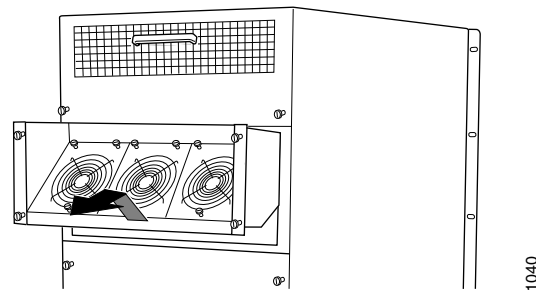
Remove the Fan Tray

The fan tray is located at the rear of the chassis, beneath the upper impeller assembly (see Figure 2). On some M40 routers, the tray is covered by a protective screen. You do not need to remove the screen before removing the fan tray from the chassis. The fan tray weighs approximately 5 lb (2 kg).

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

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the screws at the outer corners of the fan tray (not the screws that attach the protective screen), using a Phillips screwdriver if necessary.
3. Grasp the sides of the fan tray and pull firmly to slide it out of the chassis.

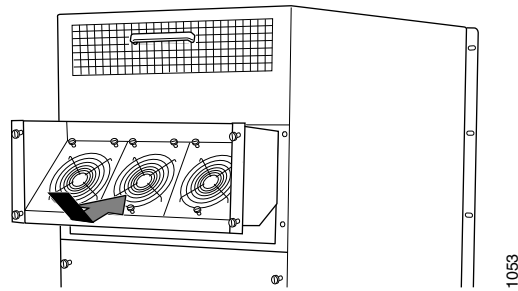
Figure 69: Remove the Fan Tray



Install the Fan Tray

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

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Slide the fan tray into the chassis.
3. Align the screws at the corners of the fan tray with the mounting holes at the edges of the opening and use a Phillips screwdriver to tighten the screws.

Figure 70: Install the Fan Tray

Maintain the Impeller Assemblies

The router has two non-interchangeable impeller assemblies. The lower impeller is located behind the craft interface at the front the chassis (see Figure 1), and the upper assembly is located above the fan tray at the rear of the chassis (see Figure 2). They work together to cool the Packet Forwarding Engine components.

During normal operation, the impellers run at less than full speed. The following conditions automatically cause the impellers to run at full speed and trigger the indicated alarm:

- One of the impellers fails (red alarm).
- One of the impellers is removed (yellow alarm). For removal instructions, see the following sections:
 - Remove the Lower Impeller Assembly on page 158
 - Remove the Upper Impeller Assembly on page 159
- The router temperature exceeds the “temperature warm” threshold (yellow alarm).
- The temperature of the router exceeds the maximum (“temperature hot”) threshold (red alarm and automatic shutdown of the power supplies).

For more information about impeller-related alarms, see “Hardware and Interface Alarm Messages” on page 192.

To check the status of the impeller assemblies, issue the **show chassis environment** command. The output refers to the **Top** and **Bottom** impellers, as shown in this example:

```
user@host> show chassis environment
Class Item                               Status      Measurement
...
Fans   Top Impeller                       OK          Spinning at normal speed
       Bottom impeller                   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*.

Replace the Lower Impeller Assembly

The lower impeller assembly is located behind the craft interface at the front the chassis (see Figure 1) and works together with the upper assembly to cool the Packet Forwarding Engine components. It is hot-removable and hot-insertable.

To replace the fan tray, perform the following procedures:

- Remove the Lower Impeller Assembly on page 158
- Install the Lower Impeller Assembly on page 159

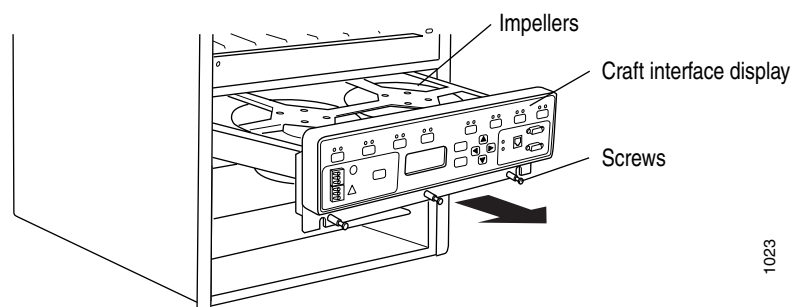
Remove the Lower Impeller Assembly

The lower impeller assembly is located behind the craft interface at the front the chassis (see Figure 1). It weighs approximately 9 lb (4 kg).

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

1. Remove the air filter, if it is installed on the chassis. For instructions, see “Remove the Air Filter” on page 154.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Unscrew the three screws at the bottom edge of the assembly, using a Phillips screwdriver if necessary.
4. Grasp the sides of the assembly, and slide it about halfway out of the chassis.
5. Move one of your hands underneath the assembly to support it, and slide it completely out of the chassis.

Figure 71: Remove the Lower Impeller Assembly



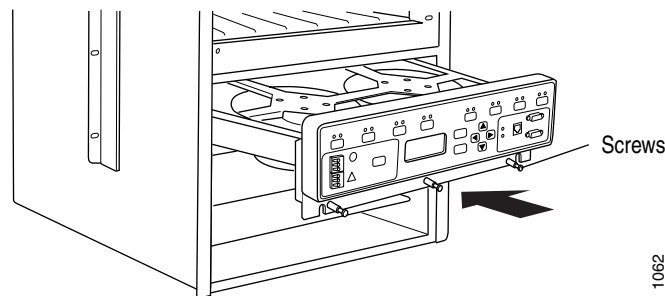
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Install the Lower Impeller Assembly

The lower impeller assembly is located behind the craft interface at the front the chassis (see Figure 1). To install it, follow this procedure (see Figure 72):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the sides of the assembly, and align the rear with the slide guides in the chassis.
3. Slide the assembly all the way into the chassis until it contacts the backplane.
4. Using a Phillips screwdriver, tighten the three captive screws at the bottom edge of the assembly to seat it firmly in the chassis.
5. Install the air filter as described in “Install the Air Filter” on page 155.

Figure 72: Install the Lower Impeller Assembly



Replace the Upper Impeller Assembly

The upper impeller assembly is located at the top rear of the chassis, above the fan tray (see Figure 2), and works together with the lower assembly to cool the Packet Forwarding Engine components. It is hot-removable and hot-insertable.

To replace the upper impeller assembly, perform the following procedures:

- Remove the Upper Impeller Assembly on page 159
- Install the Upper Impeller Assembly on page 160

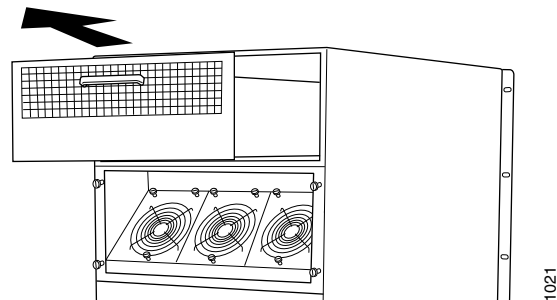
Remove the Upper Impeller Assembly

The upper impeller assembly is located at the top rear of the chassis, above the fan tray (see Figure 2). It weighs approximately 10 lb (4 kg).

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Unscrew the captive screws at the bottom corners of the assembly, using a Phillips screwdriver if necessary.

3. Grasp the handle at the top of the assembly, and slide it about halfway out of the chassis.
4. Move one of your hands underneath the assembly to support it, and slide it completely out of the chassis.

Figure 73: Remove the Upper Impeller Assembly

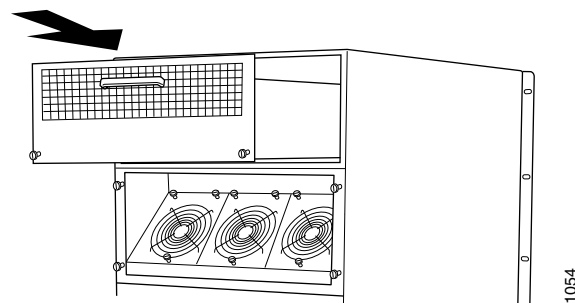


Install the Upper Impeller Assembly

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

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Grasp the handle at the top of the assembly and slide the assembly all the way into the chassis.
3. Using a Phillips screwdriver, tighten the thumbscrews at the lower corners of the assembly.

Figure 74: Install the Upper Impeller Assembly



Chapter 12

Maintain and Replace Packet Forwarding Engine Components

This chapter discusses the following topics about maintaining and replacing Packet Forwarding Engine components:

- Tools and Parts Required on page 161
- Maintain FPCs and PICs on page 162
- Replace an FPC or Quad-wide PIC on page 163
- Replace a PIC on page 167
- Maintain the SCB on page 169
- Replace the SCB on page 169

Tools and Parts Required

You need the following the tools and parts to replace Packet Forwarding Engine components:

- Phillips (+) screwdrivers, numbers 1 and 2
- Electrostatic bags or antistatic mats, one for each component removed
- ESD grounding wrist strap
- Replacement components or blank panels for each component removed
- Rubber safety caps to cover each transceiver on a PIC that connects to fiber-optic cable

Maintain FPCs and PICs

The router can have up to eight Flexible PIC Concentrators (FPCs) mounted vertically in the FPC card cage at the front of the chassis (see Figure 1). To maintain FPCs and the Physical Interface Cards (PICs) housed in them, perform the following procedures on a regular basis:

- Check the LCD on the craft interface and the LEDs on the craft interface directly below each FPC slot. The green LED labeled **OK** lights steadily when an FPC is functioning normally. For more information, see “FPC LEDs and Offline Button” on page 18.
- 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 *M20 and M40 Internet Routers PIC Guide*. If the FPC that houses the PIC detects a PIC failure, the FPC informs the SCB, which in turn sends an alarm to the Routing Engine.
- Issue the CLI **show chassis fpc** command to check the status of installed FPCs. As shown in the sample output, the value **Online** in the column labeled **State** indicates that the FPC is functioning normally:

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

Slot	State	Temp (C)	CPU Utilization (%) Total Interrupt	Memory DRAM (MB)	Utilization (%) Heap Buffer
0	Online	28	1 0	8	9 15
1	Online	27	1 0	8	9 15
2	Online	29	1 0	8	12 14
3	Empty				
4	Empty				
5	Online	25	0 0	8	8 14
6	Online	29	1 0	8	9 14
7	Online	26	1 0	8	8 13

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

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

Slot 0 information:

State	Online
Logical slot	0
Temperature	28 degrees C / 82 degrees F
Total CPU DRAM	8 MB
Total SRAM	1 MB
Total SDRAM	128 MB
Total notification SDRAM	24 MB
I/O Manager ASIC information	Version 1.1, Foundry IBM, Part number 0
Start time:	2003-05-23 18:14:31 PDT
Uptime:	34 days, 6 hours, 9 minutes, 5 seconds

- To check the status of a PIC, issue the CLI **show chassis fpc pic-status** command. The following example specifies an FPC slot number (5), which is optional. The PIC slots in an FPC are numbered from 0 (zero) through 3, top to bottom:

```
user@host> show chassis fpc pic-status 5
```

Slot 5 Online

PIC 0	1x OC-12 SONET, SMIR
PIC 1	1x OC-12 ATM, MM
PIC 2	1x OC-12 SONET, SMIR
PIC 3	1x Tunnel

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

Replace an FPC or Quad-wide PIC

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

To replace an FPC or quad-wide PIC, perform the following procedures:

- Remove an FPC or Quad-wide PIC on page 163
- Install an FPC or Quad-wide PIC on page 165

Remove an FPC or Quad-wide PIC

The router can have up to eight FPCs or quad-wide PICs mounted vertically in the FPC card cage on the front of the chassis (see Figure 1). An FPC that houses four PICs weighs about 3 lb (1.5 kg).

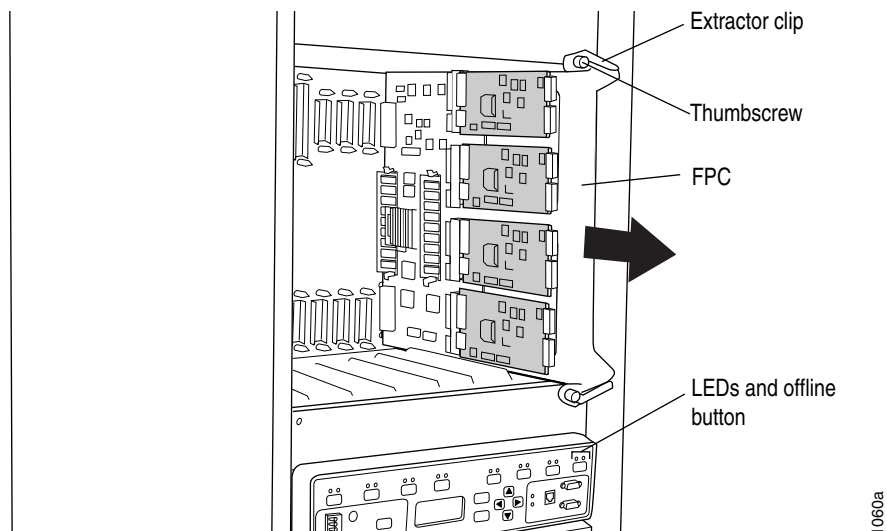
To remove an FPC or quad-wide PIC, follow this procedure (for brevity, the instructions refer to FPCs only):

1. Place an antistatic mat or electrostatic bag on a flat, stable surface to receive the FPC. If any of the PICs on the FPC use fiber-optic cable, also have ready a rubber safety cap for each transceiver and cable.

If you are removing PICs from the FPC, use a foam antistatic mat instead. If a foam mat is not available, substitute a standard flat antistatic mat but use extra care when laying the FPC component side down on it, to avoid damaging the electrical components.

2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Label the cables connected to each PIC on the FPC so that you can reconnect the cables to the correct PICs.
4. Take the FPC offline by pressing and holding its offline button for 5 seconds or until the red **FAIL** LED next to the button goes out. The offline button for each FPC is located just below it on the craft interface (see Figure 75).

Figure 75: Remove an FPC



5. Disconnect the cables from the PICs on the FPC. If a PIC uses fiber-optic cable, immediately cover each transceiver and the end of each cable with a rubber safety cap. Carefully thread each disconnected cable through the hooks in the cable management system, to prevent the cables from developing stress points.



Warning

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

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

6. Unscrew the thumbscrew at each end of the FPC, using a Phillips screwdriver if necessary.
7. Pull the ends of the extractor clips, which are adjacent to the thumbscrews, outward toward the ends of the FPC (see Figure 75).
8. Grasp the FPC with both hands and slide it about halfway out of the chassis.
9. Place one hand underneath the FPC to support it, and slide it completely out of the chassis. Set the FPC on the antistatic foam mat prepared in Step 1.



Caution

To avoid damaging any components, use extra care when laying the FPC on the antistatic mat, particularly if the mat is not made of foam.

Do not stack the FPC on top of or under any other component.

10. If you are removing or replacing PICs on the FPC, see “Replace a PIC” on page 167.
11. If you are not immediately reinstalling an FPC into the slot, cover the slot with a blank panel so that cooling air can circulate properly through the FPC card cage.

Install an FPC or Quad-wide PIC

To install an FPC or quad-wide PIC, follow this procedure (for brevity, the instructions refer to FPCs only):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Install or remove PICs as desired by following the instructions in “Replace a PIC” on page 167. You must install or remove PICs before installing the FPC into the chassis. If any PICs use fiber-optic cable, make sure that each transceiver is covered with a rubber safety cap.
3. Verify that the ends of the extractor clips are pointing outward toward the ends of the FPC.
4. Grasp the front of the FPC with both hands and align the rear with the guides at the sides of the FPC slot in the chassis.
5. Slide the FPC straight into the card cage until it contacts the backplane.



Caution

When about 1 in. (2.5 cm) of the FPC remains outside the slot, adjust the insertion speed so that it takes between 1 and 15 seconds for the FPC to contact the backplane. Completing the insertion too quickly or too slowly can cause the router to reset.

6. Push the ends of the extractor clips, located at each end of the FPC, inward toward the center of the FPC (see Figure 76).
7. Tighten the thumbscrew at each end of the FPC.
8. If any of the PICs on the FPC use 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 PIC faceplate. Single-mode fiber-optic cable and the PICs that use it (such as ATM and SONET/SDH interfaces) emit laser light that can damage your eyes.

9. Insert the appropriate cables into the cable connector ports on each PIC on the FPC. Secure the cables so that they are not supporting their own weight. Place excess cable out of the way in a neatly coiled loop, using the cable management system. Placing fasteners on a loop helps to maintain its shape.



Caution

Do not let cable hang free from the connector. Do not allow fastened loops of cable to dangle from the ladder rack, because this stresses the cable at the fastening point.

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

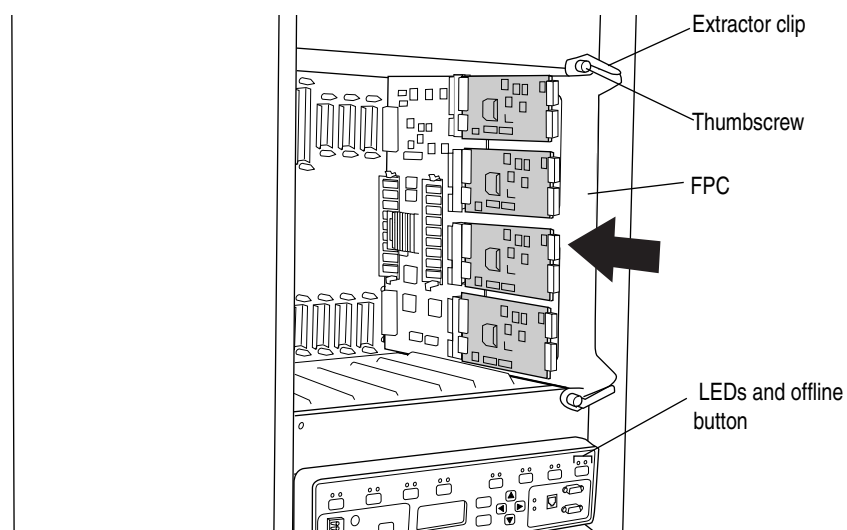
10. Press and hold the FPC offline button on the craft interface.

The green LED labeled **OK** blinks for about 5 seconds while the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs housed in the FPC are enabled. Router forwarding operations then halt for about 200 ms while the Packet Forwarding Engine incorporates the memory on the new FPC into the memory buffers shared by all FPCs. When the FPC is online, the **OK** LED lights steadily and you can release the offline button.

You can also verify correct PIC and FPC functioning by issuing the `show chassis fpc` commands described in “Maintain FPCs and PICs” on page 162.

11. If you are installing multiple FPCs, repeat Steps 2 through 10 for each one. Wait 30 seconds after installing each FPC to allow the FPC and PICs to come online.

Figure 76: Install an FPC



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Replace a PIC

PICs are housed in the FPCs installed in the front of the router, as shown in Figure 4. Quad-wide PICs, such as the OC-48/STM-16 SONET/SDH PIC, occupy an entire FPC slot and are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. For replacement instructions, see “Replace an FPC or Quad-wide PIC” on page 163.

A regular PIC, which installs into a four-slot FPC card carrier, is hot-removable and hot-insertable in the sense that removing it does not disrupt routing functions; however, you must completely remove its host FPC from the chassis before removing the PIC, which affects all PICs on the FPC.

To replace a PIC, perform the following procedures:

- Remove a PIC on page 167
- Install a PIC on page 168

Remove a PIC

To remove a PIC from an FPC, follow this procedure (see Figure 77):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the PIC.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Follow the instructions in “Remove an FPC or Quad-wide PIC” on page 163 to remove the PIC’s host FPC from the chassis. Lay the FPC on an antistatic foam mat on a flat, stable surface. If a foam mat is not available, substitute a standard flat antistatic mat but use extra care when laying the FPC component side down on it, to avoid damaging the electrical components.
4. With the FPC lying component side down and the PIC faceplates facing you, use a Phillips screwdriver to loosen the two screws that secure the PIC to the FPC.
5. Carefully turn over the FPC and lay it on the mat component side up with the PIC faceplates facing you.
6. Pull the PIC straight out of the FPC slot.

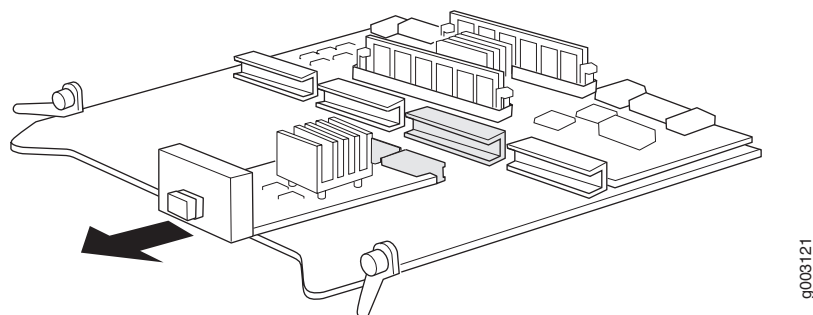


Caution

You might need to rock the PIC back and forth to loosen it from the connector in the FPC slot. To avoid bending the pins on the connector, use the smallest and gentlest motion possible.

7. Place the PIC in the electrostatic bag or on the antistatic mat prepared in Step 1.

Figure 77: Remove a PIC



Install a PIC

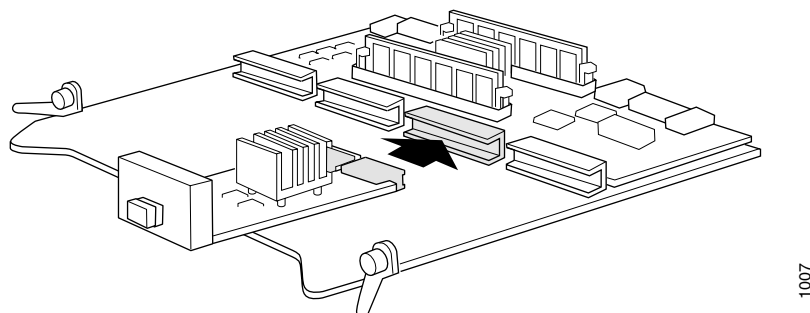
To install a PIC, follow this procedure (see Figure 78):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Place the FPC into which you are installing the PIC on an antistatic foam mat, component side up and with its faceplate facing you. If a foam mat is not available, substitute a standard flat antistatic mat but use extra care when laying the FPC on it to avoid damaging the electrical components.
3. Push the PIC part way into the FPC slot. Carefully align the tabs on the PIC connector with the notches in the connector at the rear of the FPC slot. Push the PIC in until the connectors join.



If the pins on the FPC connector are not aligned properly with the holes in the PIC connector, the pins might be bent or the holes damaged. Either kind of damage can prevent the PIC and FPC from functioning correctly.

4. Carefully turn over the FPC and lay it component side down on the mat with the PIC faceplates facing you.
5. Using a Phillips screwdriver, tighten the two screws that secure the PIC in the FPC.
6. Using a screwdriver, tighten the two screws on the noncomponent side that fasten each PIC to the FPC.

Figure 78: Install a PIC

Maintain the SCB

The System Control Board (SCB) occupies the center slot of the card cage, installing into the backplane from the front of the chassis (see Figure 1). To maintain the SCB, follow these guidelines:

- Check the LEDs on the SCB faceplate. The green LEDs labeled **ACTIVE** and **RUN** blink periodically when it is functioning normally. For more information, see “SCB Components” on page 13.
- Issue the CLI **show chassis scb** command to check the status of the SCB. As shown in the sample output, the **Uptime** field reports how long the SCB has been functioning:

```
user@host> show chassis scb
SCB status:
  Temperature           26 degrees C / 78 degrees F
  CPU utilization        2 percent
  Interrupt utilization  0 percent
  Heap utilization       16 percent
  Buffer utilization      44 percent
  Total CPU DRAM         64 MB
  Internet Processor II  Version 1, Foundry IBM, Part number 9
  Start time:           2003-05-22 11:43:46 PDT
  Uptime:               4 days, 4 hours, 11 minutes, 15 seconds
```

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*.

Replace the SCB

The SCB is hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. When the SCB fails or is removed from the chassis, forwarding halts until it is replaced and functioning again.

To replace the SCB, perform the following procedures:

- Remove the SCB on page 170
- Install the SCB on page 171

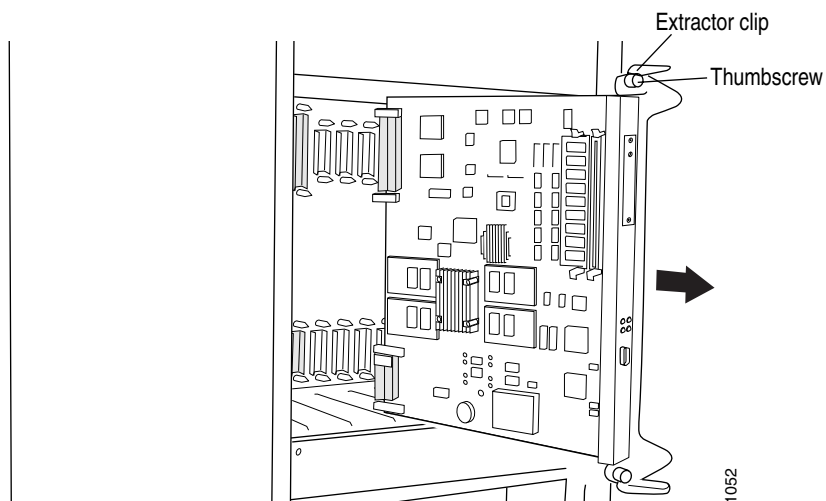
Remove the SCB

The SCB is located at the center of the card cage, at the front of the chassis (see Figure 1). It weighs approximately 1 lb (0.5 kg).

To remove the SCB, follow this procedure (see Figure 79):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the SCB.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Unscrew the thumbscrew at each end of the SCB, using a Phillips screwdriver if necessary.
4. Pull the ends of the extractor clips (which are adjacent to the thumbscrews) outward, toward the ends of the SCB.
5. Grasp both sides of the SCB and slide it about halfway out of the chassis.
6. Place one hand under the SCB to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag prepared in Step 1.

Figure 79: Remove the SCB

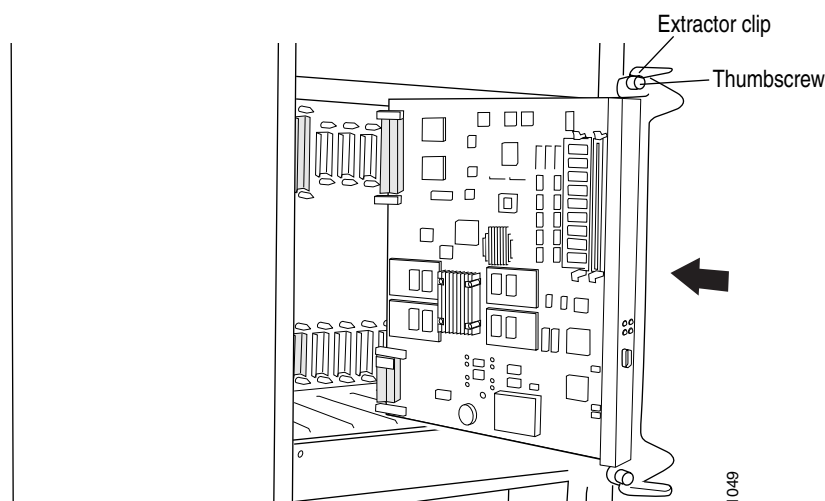


Install the SCB

To install the SCB, follow this procedure (see Figure 80):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Verify that the ends of the extractor clips are pointing outward toward the ends of the SCB.
3. Grasp the front of the SCB with both hands and align the rear of the card carrier with the slide guides in the card cage.
4. Slide the SCB all the way into the card cage until it contacts the backplane.
5. Push the ends of the extractor clips (which are located at each end of the SCB) towards each other to secure the SCB in the chassis.
6. Using a Phillips screwdriver, tighten the thumbscrew at each end of the SCB to seat the unit firmly in the chassis.
7. Verify that the green LEDs labeled **ACTIVE** and **RUN** blink periodically on the SCB faceplate. You can also verify SCB functioning by issuing the `show chassis scb` command, as described in “Maintain the SCB” on page 169.

Figure 80: Install the SCB



Chapter 13

Maintain and Replace Routing Engine Components

This chapter discusses the following topics about maintaining and replacing Routing Engine components:

- Tools and Parts Required on page 173
- Maintain the Routing Engine on page 174
- Replace the Routing Engine Housing on page 174
- Replace the Routing Engine on page 176
- Replace the LS-120 Drive on page 180

Tools and Parts Required

To replace Routing Engine components, you need the following the tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- Electrostatic bags or antistatic mats, one for each component removed
- ESD grounding wrist strap
- Replacement components or blank panels, one for each component that you are removing

Maintain the Routing Engine

To maintain the Routing Engine, perform the following procedures on a regular basis:

- Check the LCD and the Routing Engine LEDs on the craft interface. The LCD reports Routing Engine status during normal operation and describes the cause of failures when they occur. The green LED labeled **OK** lights steadily when the Routing Engine is functioning normally. For more information about the LEDs and LCD, see “Craft Interface” on page 17.
- Issue the CLI `show chassis routing-engine` command to check the status of the Routing Engine:

```
user@host> show chassis routing-engine
Routing Engine status:
  Temperature                25 degrees C / 77 degrees F
  DRAM                       256 MB
  Memory utilization         32 percent
  CPU utilization:
    User                     0 percent
    Background               0 percent
    Kernel                   0 percent
    Interrupt                 0 percent
    Idle                     99 percent
  Model                      RE-1.0
  Start time                  2003-05-22 11:40:03 PDT
  Uptime                     21 hours, 15 minutes, 39 seconds
  Load averages:             1 minute   5 minute  15 minute
                              0.00       0.00    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*.

Replace the Routing Engine Housing

The Routing Engine resides in a metal housing in the rear of the chassis, below the fan tray (see Figure 2). The housing is not a FRU, but you must remove it from the chassis to access the Routing Engine and LS-120 drive. The Routing Engine housing weighs approximately 17 lb (8 kg).

To remove and install the Routing Engine housing, perform the following procedures:

- Remove the Routing Engine Housing on page 175
- Install the Routing Engine Housing on page 175

Remove the Routing Engine Housing

To remove the Routing Engine housing, use the following procedure (see Figure 81):

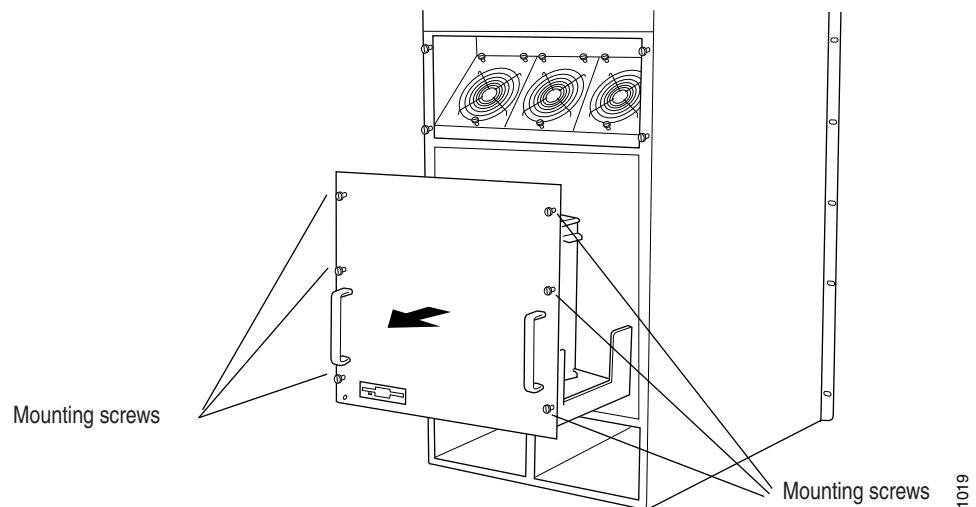
1. On the console or other management device connected to the Routing Engine, enter CLI operational mode and issue the following command. The command shuts down the Routing Engine cleanly, so that its state information is preserved:

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

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

2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Unscrew the screws along the left and right edges of the Routing Engine housing (six in all), using a Phillips screwdriver if necessary.
4. Grasp the handles located at either side of the Routing Engine housing, and slide the unit about halfway out of the chassis.
5. Move one of your hands underneath the housing to support it, and slide it completely out of the chassis.

Figure 81: Remove the Routing Engine Housing



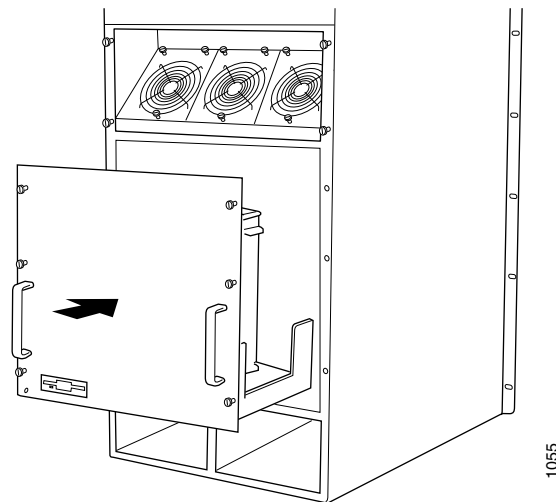
Install the Routing Engine Housing

To return the Routing Engine housing to the chassis, follow this procedure (see Figure 82):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Place one hand underneath the unit to support it and grasp a handle on the front of the unit with the other hand.

3. Align the rear of the unit with the slide guides in the chassis.
4. Slide the unit completely into the chassis.
5. Using a Phillips screwdriver, tighten the screws along the left and right edges of the Routing Engine housing (six in all).

Figure 82: Install the Routing Engine Housing



Replace the Routing Engine

The Routing Engine is hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. When it fails or is removed from the chassis, forwarding halts until it is replaced and functioning again.

To replace the Routing Engine, perform the following procedures:

- Remove the Routing Engine on page 177
- Install the Routing Engine on page 178



Note

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

Remove the Routing Engine

The Routing Engine is housed in the Routing Engine housing. It weighs approximately 1.5 lb (0.7 kg).

To remove the Routing Engine, follow this procedure:

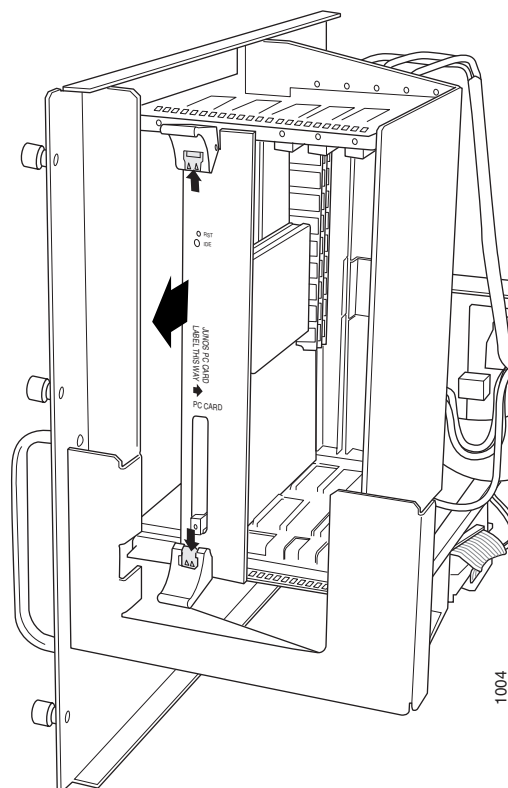
1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the Routing Engine.
2. Attach an ESD wrist strap to your bare wrist and connect the wrist strap to one of the two ESD points on the chassis.
3. Remove the Routing Engine housing from the chassis, if it is not already. For instructions, see "Remove the Routing Engine Housing" on page 175.
4. If screws are installed in the extractor clips located at each end of the Routing Engine faceplate, use a Phillips screwdriver to loosen them until the Routing Engine is no longer seated in the housing.
5. 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 (see Figure 83).
6. Grasp the extractor clips and slide the unit about halfway out of the chassis.



Be careful to slide the Routing Engine straight out of the chassis. Damage can result if it gets lodged because of uneven movement.

7. 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 prepared in Step 1.

Figure 83: Remove the Routing Engine



Install the Routing Engine

To install the Routing Engine in the Routing Engine housing, follow this procedure (see Figure 82):

1. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
2. Verify that the extractor clip at each end of the Routing Engine is flipped toward the outer edge of the unit. If necessary, use your thumbs to push and hold the red tab on each extractor clip toward the outer edge, then push the ends of the extractor clips outward.
3. Place one hand under the Routing Engine to support it and grasp one of the extractor clips on the faceplate with the other hand.
4. Align the rear of the Routing Engine with the guide rails in the Routing Engine housing and slide it in completely. See Figure 84.



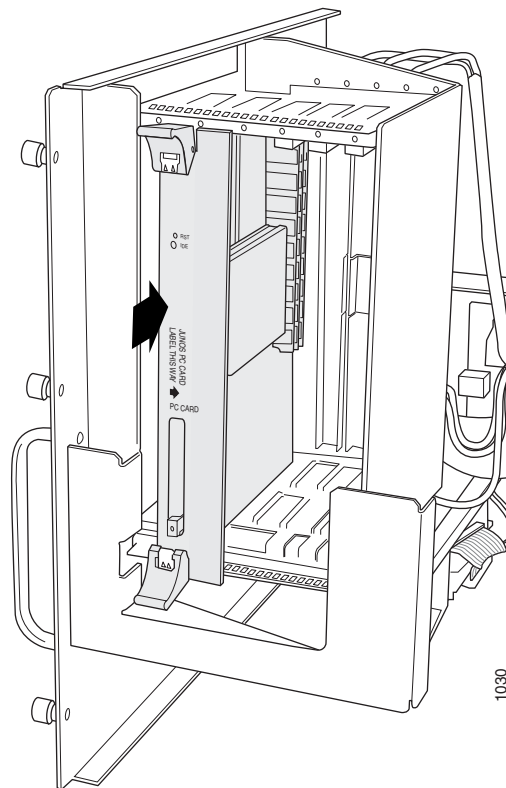
Caution

Be careful to align the Routing Engine correctly with the guide rails and push it in evenly. Damage can result if it gets lodged because of uneven movement.

5. Press the extractor clip at each end of the Routing Engine inward to seat the unit firmly in the chassis.
6. If screws are installed in the extractor clips, use a Phillips screwdriver to tighten them.
7. Return the Routing Engine housing to the chassis. For instructions, see “Install the Routing Engine Housing” on page 175.
8. After the Routing Engine restarts, check the Routing Engine LEDs on the craft interface to verify that the green LED labeled **OK** is lit (see Figure 7).

You can also verify correct Routing Engine functioning by issuing the `show chassis routing-engine` command described in “Maintain the Routing Engine” on page 174.

Figure 84: Install the Routing Engine

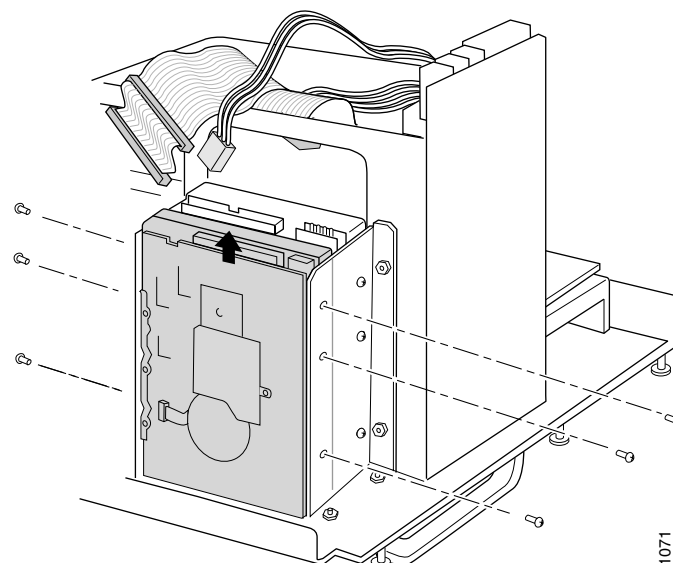


Replace the LS-120 Drive

To replace the LS-120 drive, use the following procedure (see Figure 85). You can perform this procedure without powering down the router.

1. Remove the Routing Engine housing from the chassis, if it is not already. For instructions, see “Remove the Routing Engine Housing” on page 175.
2. Attach an ESD strap to your bare wrist and connect the strap to one of the ESD points on the chassis.
3. Locate the LS-120 drive module inside the Routing Engine housing. The drive resides in a metal housing in front of an equally sized hard drive.
4. Detach the exposed power connector plug and the Routing Engine connector from the top of the drive. You might need a small pair of pliers to grip the Routing Engine connector.
5. Using a Phillips screwdriver, unscrew the screws on the metal housing (three on each side).
6. Slide the LS-120 drive out of its bay.
7. Slide the replacement LS-120 drive into the empty bay.
8. Reattach the power connector and the Routing Engine connector.
9. Using a Phillips screwdriver, tighten the screws along both sides of the metal housing.
10. Return the Routing Engine housing to the chassis. For instructions, see “Install the Routing Engine Housing” on page 175.

Figure 85: Remove the LS-120 Drive from the Routing Engine Housing



Chapter 14

Maintain and Replace Cables and Connectors

This chapter describes how to maintain and replace cables and connectors:

- Tools and Parts Required on page 181
- Cable Specifications on page 182
- Maintain PIC Cables on page 182
- Replace PIC Cables on page 183
- Replace Power Supply Cables on page 185
- Replace Cables and Wire Connecting to Routing Engine Interface Ports on page 186

Tools and Parts Required

To replace network and power cords, cables, and wiring, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- Phillips (+) screwdriver, 2.5 mm (for alarm relay contacts)
- Flat-blade (–) screwdriver, 2.5 mm (for serial cable connector)
- ESD grounding wrist strap
- Wire cutters
- 7/16-in. nut driver or wrench for tightening nuts to terminal studs on a DC power supply; if 7/16-in. tool is not available, use pliers or an adjustable wrench rather than a metric nut driver or wrench
- Rubber safety cap to cover the PIC cable connector for each PIC fiber-optic cable removed

Cable Specifications

See the following sections for specifications for the indicated type of cable. For information about the cable used by the PICs supported on the M40 router, see the *M20 and M40 Internet Routers PIC Guide*.

- AC Power Cord Specifications on page 45
- DC Power and Grounding Cable Specifications on page 46
- Routing Engine Interface Cable and Wire Specifications on page 53

Maintain PIC Cables

To maintain PIC cables, follow these guidelines:

- Use the cable management system (shown in Figure 1) 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 because this stresses the cable at the fastening point. Putting fasteners on the loops help 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 all PIC cables to identify them, labeling each end of the cable the same.

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.
- Keep fiber-optic cable connections clean using an appropriate fiber-cleaning device, such as RIFOCS 945/946 Fiber Optic Connector Cleaning System. See “Fiber-Optic Connector Cleaning” on page 213.
- 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.

Replace PIC Cables

Removing and installing PIC cables does not affect router function, except that the PIC does not receive or transmit data while the cable is disconnected. To replace a PIC cable, perform the following procedures:

- Remove a PIC Cable on page 183
- Install a PIC Cable on page 184

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 you are removing and the transceiver into which it plugs.
2. Unplug the cable from the cable connector port and immediately place a rubber safety cap over the port if it connects to fiber-optic cable.



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

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

3. Carefully thread the cable through the cable management system, to prevent the cable from dislodging or developing stress points. 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.



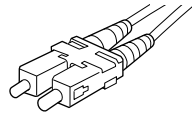
Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

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.

Install a PIC Cable

1. Have ready a length of the type of cable used by the PIC, as specified in the *M20 and M40 Internet Routers PIC Guide*. Figure 86 depicts the connector on fiber-optic cable.

Figure 86: PIC Fiber-Optic Cable Connector



2. Remove the rubber safety plug from the PIC cable connector port.



Warning

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

Do not leave a transceiver uncovered except when removing or inserting the 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 (see Figure 87, which shows a fiber-optic connector).
4. Carefully thread the cable through 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 from the connector. 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.



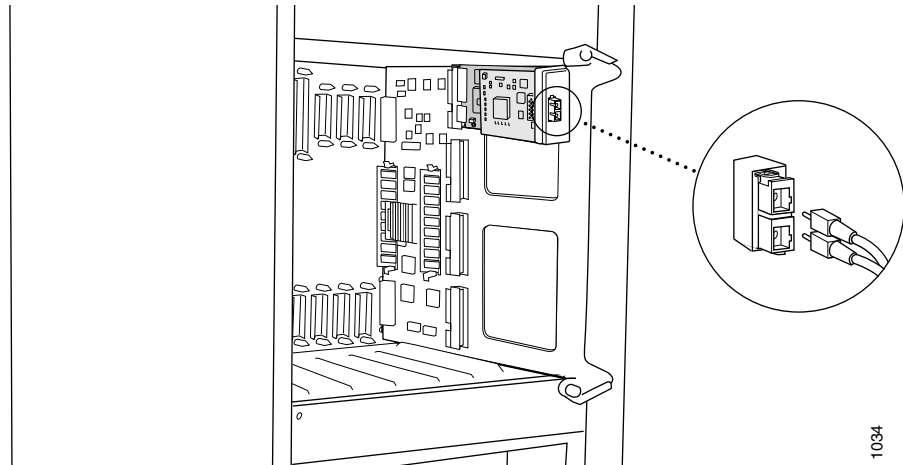
Caution

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.

Never 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. Verify that the PIC is functioning correctly by noting whether the normal function indicator LED is lit. The normal function indicator LED is usually green; for more information, see the *M20 and M40 Internet Routers PIC Guide*.

You can also verify correct PIC functioning by issuing the `show chassis fpc pic-status` command, described in “Maintain FPCs and PICs” on page 162.

Figure 87: Connect Fiber-Optic Cable to a PIC

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Replace Power Supply Cables

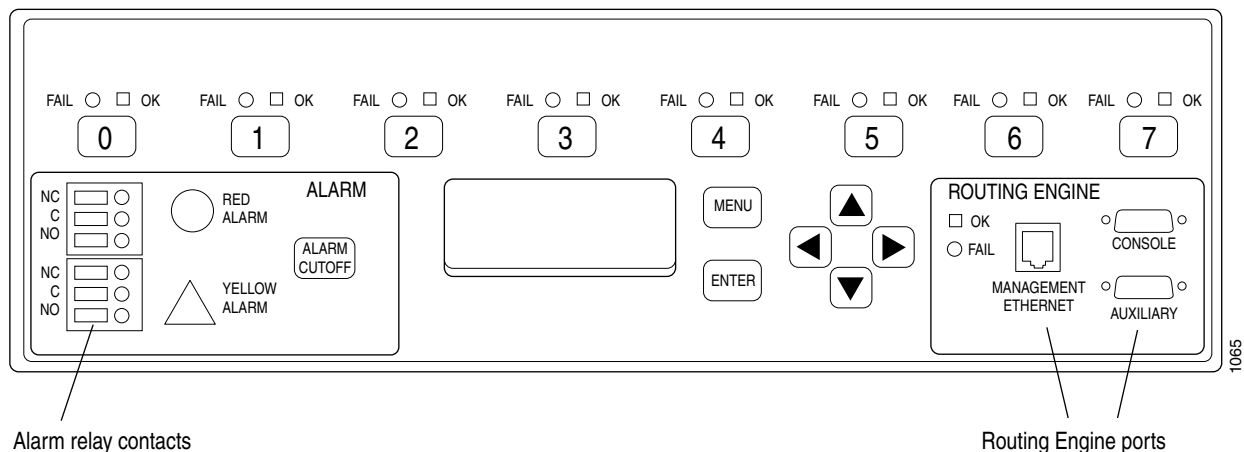
For instructions for replacing AC or DC power cables, see “Disconnect and Connect AC Power” on page 140 and “Disconnect and Connect DC Power” on page 147.

Replace Cables and Wire Connecting to Routing Engine Interface Ports

To replace the cables and wires that connect external management devices to the craft interface (see Figure 88), perform the procedures described in the following sections:

- Replace the Management Ethernet Cable on page 186
- Replace the Console or Auxiliary Cable on page 187
- Replace Alarm Relay Wire on page 188

Figure 88: Routing Engine Interface Ports on the Craft Interface



Alarm relay contacts

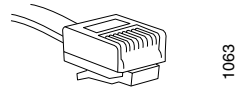
Routing Engine ports

Replace the Management Ethernet Cable

The cable that plugs into the port labeled **MANAGEMENT ETHERNET** on the craft interface connects the Routing Engine to a network for out-of-band management (see Figure 88). The port accepts a cable with RJ-45/RJ-45 connectors, which is provided with the router as detailed in “Routing Engine Interface Cable and Wire Specifications” on page 53.

To replace the cable connecting to a management network, follow this procedure:

1. If a cable is already installed in the **MANAGEMENT ETHERNET** port, perform the following steps:
 - a. Press the tab on the connector and pull the connector straight out of the port. Figure 89 shows the connector.
 - b. Repeat to disconnect the cable from the network device.
2. Plug one end of the replacement Ethernet cable into the **MANAGEMENT ETHERNET** port.
3. Plug the other end of the cable into the network device.

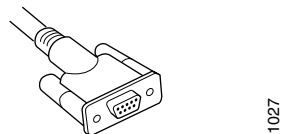
Figure 89: Management Port Ethernet Connector

Replace the Console or Auxiliary Cable

The cable that plugs into the port labeled **CONSOLE** on the craft interface connects the Routing Engine to a system console. The cable that plugs into the port labeled **AUXILIARY** connects the Routing Engine to a laptop, modem, or other auxiliary device (see Figure 88). Both ports accept an RS-232 (EIA-232) serial cable with DB-9/DB-9 connectors. One such cable is provided with the router, as detailed in “Routing Engine Interface Cable and Wire Specifications” on page 52. If you want to connect devices to both ports, you must supply another cable.

To replace the cable connecting to a management console or auxiliary device, follow this procedure:

1. If a cable is already installed in the **CONSOLE** or **AUXILIARY** port, perform the following steps:
 - a. Turn off the power to the console or auxiliary device.
 - b. Unscrew the screws that secure the cable connector to the port, using a 2.5-mm flat-blade screwdriver if necessary. Figure 90 shows the cable connector.
 - 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 **CONSOLE** or **AUXILIARY** port and the other end into the device.
3. Tighten the screws on the connectors at both ends, using a 2.5-mm flat-blade screwdriver if necessary.
4. Power on the auxiliary or console device.

Figure 90: Console and Auxiliary Serial Port Connector

Replace Alarm Relay Wire

The alarm relay contacts located on the craft interface to the left of the red and yellow alarm LEDs connect to external alarm devices that report conditions that trigger a red or yellow alarm (see Figure 88). The alarm relay contacts accept wire of any gauge between 28-AWG and 14-AWG (0.09 and 2.09 mm²), which is not provided. Use the gauge of wire appropriate for the external device that you are connecting to the relay contact.

To replace the wires connecting to an alarm-reporting device, follow this procedure:

1. Prepare the required lengths of replacement wire with gauge between 28-AWG and 14-AWG (0.09 and 2.09 mm²).
2. Disconnect the existing wires at the external device.
3. Use a 2.5 mm Phillips screwdriver to loosen the small screws on the faceplate of the appropriate alarm relay contact—the upper contact for a device that reports high priority (red) alarms, or the lower contact for the device that reports lower priority (yellow) alarms.
4. Remove existing wires from the alarm relay contact and insert replacement wires (the NC label on one contact means “normally closed,” C means “common,” and NO means “normally open”). Tighten the screws to secure the wire.
5. Attach the other end of the replacement wires to the external device.

Part 4

Troubleshooting

- Troubleshooting Overview on page 191
- Troubleshoot the Power Supplies on page 195
- Troubleshoot the Cooling System on page 197
- Troubleshoot the Packet Forwarding Engine Components on page 201

Chapter 15

Troubleshooting Overview

This chapter provides an overview of the resources you can use while troubleshooting problems with the router:

- Command-Line Interface on page 191
- LEDs on page 192
- Hardware and Interface Alarm Messages on page 192
- Juniper Networks Technical Assistance Center on page 194

For information about troubleshooting problems with specific hardware components—including the cooling system, power supplies, and the Packet Forwarding Engine—see the subsequent chapters in this document. If you encounter problems with other router components, including the Routing Engine, contact the Juniper Networks Technical Assistance Center (JTAC) as described in “Juniper Networks Technical Assistance Center” on page 194.

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. There is a port labeled **CONSOLE** for attaching a system console, a port labeled **AUXILIARY** for attaching a laptop, modem, or other auxiliary device, and a port labeled **MANAGEMENT ETHERNET** for attaching to a management LAN. For more information, see “Routing Engine LEDs and Interface Ports” on page 19.

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 192.

LEDs

The LEDs described in the following sections indicate the basic status of hardware components:

- LEDs on the Craft Interface on page 192
- LEDs on Hardware Components on page 192

LEDs on the Craft Interface

The craft interface hosts LEDs and an LCD that provide status and troubleshooting information at a glance. It is located on the front of the chassis below the FPC card cage (see Figure 1). The LEDs on the craft interface include the following:

- **Alarm**—The circular red alarm LED at the left of the craft interface indicates a critical condition that can result in a system shutdown. The triangular yellow alarm next to it indicates a less severe condition that requires monitoring or maintenance. Both alarms can occur simultaneously. When an alarm LED is lit, the LCD describes the cause of the alarm. For more information about the alarm LEDs, see “Alarm Relay Contacts, LEDs, and Cutoff Button” on page 18. For more information about the causes of alarms, see “Hardware and Interface Alarm Messages” on page 192.
- **FPC**—For each of the eight FPC slots in the router, there are two LEDs and an offline button located on the craft interface directly below the slot. The green LED labeled **OK** and red LED labeled **FAIL** indicate FPC status. For more information, see “FPC LEDs and Offline Button” on page 18.
- **Routing Engine**—LEDs at the right side of the craft interface indicate the status of the Routing Engine—a green one labeled **OK** and a red one labeled **FAIL**. For more information, see “Routing Engine LEDs and Interface Ports” on page 19.

LEDs on Hardware Components

LEDs on the faceplates of many hardware components report component status:

- **PIC**—Most PICs have an LED labeled **STATUS** on the PIC faceplate. Some PICs have additional LEDs, often one per port. The meaning of the LED states differs for various PICs. For more information, see the *M20 and M40 Internet Routers PIC Guide*.
- **Power supply**—A red **FAIL** LED and a green **OK** LED are located on each power supply faceplate and indicate the status of the power supply. See “Power Supply LEDs” on page 22.
- **SCB**—Four LEDs on the faceplate of the SCB indicate its status. See “SCB Components” on page 13.

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, trips the corresponding alarm relay contact on the craft interface, and reports the cause of the alarm in the craft interface LCD. To view a more detailed description of the alarm cause, issue the **show chassis alarms** CLI command:

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

There are two classes of alarm messages:

- Chassis alarms—Indicate a problem with a chassis component such as the cooling system or power supplies, as described in Table 22. The text in the column labeled “LCD Message” appears in the LCD. The text in the column labeled “CLI Message” appears in the output from the `show chassis alarms` command.
- Interface alarms—Indicate a problem with a specific network interface, as described in Table 23.

Table 22: Chassis Alarm Messages

Component	LCD Message	CLI Message
Fans	<i>fan-name</i> FAIL	<i>fan-name</i> stopped spinning
	<i>fan-name</i> RMVD	<i>fan-name</i> removed
	Too few fans	Too few fans installed or working
Temperature sensors	<i>temperature-sensor</i> FAIL	<i>temperature-sensor</i> temperature sensor failed
	System too warm	A temperature sensor exceeds 54 degrees C
Power supplies	Supply x FAIL	Power supply x not providing power
	Supply x 3V FAIL	Power supply x 3.3V failed
	Supply x 5V FAIL	Power supply x 5V failed
	Supply x 2V FAIL	Power supply x 2.5V failed
FPCs	Slot x: errors	Too many unrecoverable errors
	Slot x: errors	Too many recoverable errors
Craft Interface	Craft IF FAIL	Craft interface not responding

Table 23: SONET Interface Alarm Messages

LCD Message	CLI Message
<i>interface-name so-x/x/x LOL</i>	<i>interface-name so-x/x/x - SONET loss of light</i>
<i>interface-name so-x/x/x PLL</i>	<i>interface-name so-x/x/x - SONET PLL lock</i>
<i>interface-name so-x/x/x LOF</i>	<i>interface-name so-x/x/x - SONET loss of frame</i>
<i>interface-name so-x/x/x LOS</i>	<i>interface-name so-x/x/x - SONET loss of signal</i>
<i>interface-name so-x/x/x SEF</i>	<i>interface-name so-x/x/x - SONET severely errored frame</i>
<i>interface-name so-x/x/x LAIS</i>	<i>interface-name so-x/x/x - SONET line AIS</i>
<i>interface-name so-x/x/x PAIS</i>	<i>interface-name so-x/x/x - SONET path AIS</i>
<i>interface-name so-x/x/x LOP</i>	<i>interface-name so-x/x/x - SONET loss of pointer</i>
<i>interface-name so-x/x/x BERR-SD</i>	<i>interface-name so-x/x/x - SONET bit error rate defect</i>
<i>interface-name so-x/x/x BERR-SF</i>	<i>interface-name so-x/x/x - SONET bit error rate fault</i>
<i>interface-name so-x/x/x LRDI</i>	<i>interface-name so-x/x/x - SONET line remote defect indicator</i>
<i>interface-name so-x/x/x PRDI</i>	<i>interface-name so-x/x/x - SONET path remote defect indicator</i>
<i>interface-name so-x/x/x REI</i>	<i>interface-name so-x/x/x - SONET remote error indicator</i>
<i>interface-name so-x/x/x UNEQ</i>	<i>interface-name so-x/x/x - SONET unequipped</i>
<i>interface-name so-x/x/x PMIS</i>	<i>interface-name so-x/x/x - SONET path mismatch</i>

Juniper Networks Technical Assistance Center

If you need assistance during troubleshooting, you can contact the Juniper Networks Technical Assistance Center (JTAC) by e-mail at support@juniper.net or by telephone at 1-888-314-JTAC (within the United States) or (+ 1) 408-745-9500 (from outside the United States).

Chapter 16

Troubleshoot the Power Supplies

When a power supply is functioning correctly, the green LED labeled **OK** is lit steadily and the red LED labeled **FAIL** is not lit.

If the LEDs are in any other states, consult the following sections:

- All LEDs on Both Supplies are Off on page 195
- All LEDs on One Supply are Off or LED States are not Correct on page 195

All LEDs on Both Supplies are Off

If all LEDs are off on both power supply faceplates, either someone has switched off power to the router or the system temperature has exceeded the acceptable maximum. In the latter case, the Routing Engine shuts down both power supplies. There is no power to the router, so the alarm LEDs on the craft interface are not lit.

Excessive system temperature is almost always caused by excessive environmental temperature. Correct the environmental temperature before powering the router on again.

All LEDs on One Supply are Off or LED States are not Correct

If either of the following conditions apply, perform the diagnostic procedure that follows:

- The LEDs on one power supply are all off, but the LEDs on the other supply indicate that it is functioning properly.
- The LED states on one or both supplies indicate a problem: the green LED labeled **OK** is not lit and the red LED labeled **FAIL** is lit.

Perform the following steps to diagnose and correct the problem:

1. Check the red alarm LED on the craft interface:

- If it is lit, issue the following CLI command for more information about the source of an alarm condition:

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

For a list of messages that can appear, see “Hardware and Interface Alarm Messages” on page 192.

A common cause of power supply shutdown is that the temperature of the power supply or another router component has exceed the maximum temperature.

- 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 136 and “Replace a DC Power Supply” on page 141. If the LEDs light 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 215.
 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 “Disconnect and Connect AC Power” on page 140 and “Disconnect and Connect DC Power” on page 147.

If you cannot determine the cause of the problem or need additional assistance, see “Juniper Networks Technical Assistance Center” on page 194.

Chapter 17

Troubleshoot the Cooling System

The router's cooling system comprises two separate subsystems:

- Upper and lower impeller assemblies—Cool the Packet Forwarding Engine components (backplane, SCB, FPCs, and PICs). The lower impeller assembly is located behind the craft interface at the front the chassis (see Figure 1), and the upper assembly is located above the fan tray at the rear of the chassis (see Figure 2). Each assembly houses two impellers for redundancy. The assemblies are not interchangeable.
- Fan tray—Cools the Routing Engine and backplane. The tray houses three fans for redundancy and is located above the Routing Engine at the upper rear of the chassis (see Figure 2).

The cooling system draws in room air through the air intake vent located at the front of the chassis below the craft interface. After entering the chassis, the air stream separates into separate flows for the front and rear subsystems, and the temperature of each flow is monitored independently. For a graphic depiction of the airflow, see Figure 10.

For the cooling system to function properly, the clearance around the chassis must be sufficient for unobstructed airflow. See “Clearance Requirements for Airflow and Hardware Maintenance” on page 42.

During normal operation, the impellers and fans in the fan tray function at less than full speed. Sensors on the backplane and router components constantly monitor their temperature, and the speed of the fans and impellers is adjusted as necessary. If the router temperature exceeds the acceptable maximum, the JUNOS software shuts down the router by turning off the power supplies.

To troubleshoot the cooling subsystems, follow these procedures:

- Troubleshoot the Fan Tray and Impeller Assemblies on page 198
- Troubleshoot the Power Supply Fans on page 199

Troubleshoot the Fan Tray and Impeller Assemblies

To troubleshoot the fan tray and impeller assemblies, follow these guidelines:

- If the red alarm LED on the craft interface lights, check the LCD on the craft interface for the source of the problem. The display reports the number of alarm conditions and the source of each alarm. For a list of messages, see “Hardware and Interface Alarm Messages” on page 192.
- Issue the following CLI command for more information about the source of an alarm condition:

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

- Issue the following command to check the status of the fans and impellers:
- To check the status of the impellers and fans, issue the **show chassis environment** command. The output refers to the **Top** and **Bottom** impellers and to the individual fans in the fan tray as the **Rear Left Fan**, **Rear Center Fan**, and **Rear Right Fan**:

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

- Place your hand near the exhaust at the upper rear of the chassis to determine whether the impellers and fans are expelling air.
- If both power supplies have failed, the system temperature might have exceeded the threshold, causing the system to shut down. See “All LEDs on Both Supplies are Off” on page 205.
- If the LCD on the craft interface reports failure of only one impeller and the other impellers are functioning normally, the impeller is probably faulty and needs to be replaced. For replacement instructions, see “Maintain and Replace Cooling System Components” on page 153. For instructions about returning a faulty component to Juniper Networks, see “Return the Router or Its Components” on page 215.
- If one of the fan assemblies fails, look at the fan to determine whether the blades of the fan are rotating. Individual blades are not distinguishable when the fan is rotating at normal speeds.

Troubleshoot the Power Supply Fans

Two LEDs on each power supply faceplate report power supply status: a green LED labeled **OK** and a red LED labeled **FAIL**. In addition, a fail condition triggers the red alarm LED on the craft interface.

Issue the following CLI command to check the status of the power supplies and their fans. 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*.

Chapter 18

Troubleshoot the Packet Forwarding Engine Components

This chapter discusses the following topics related to troubleshooting components of the Packet Forwarding Engine:

- Troubleshoot FPCs on page 201
- Troubleshoot PICs on page 202
- Troubleshoot the SCB on page 202

Troubleshoot FPCs

As soon as an FPC is seated on an operating router, the Routing Engine downloads the FPC software to it. The FPC then runs diagnostics and enables the PICs that it houses. During this time, the green FPC LED labeled OK on the craft interface is blinking. When the FPC is online and functioning normally, the OK LED lights steadily.

To troubleshoot FPCs, follow these guidelines:

- If the red FPC LED labeled FAIL lights steadily, make sure the FPC is properly seated in the backplane—use a Phillips screwdriver to check that the screws at the top and bottom of the card carrier are tight.
- Issue the CLI `show chassis fpc` command to check the status of installed FPCs. As shown in the sample output, the value `Online` in the column labeled `State` indicates that the FPC is functioning normally:

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

Slot	State	Temp	CPU Utilization (%)		Memory		Utilization (%)	
		(C)	Total	Interrupt	DRAM (MB)	Heap	Buffer	
0	Online	28	1	0	8	9	15	
1	Online	27	1	0	8	9	15	
2	Online	29	1	0	8	12	14	
3	Empty							
4	Empty							
5	Online	25	0	0	8	8	14	
6	Online	29	1	0	8	9	14	
7	Online	26	1	0	8	8	13	

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

```
user@host> show chassis fpc detail 0
Slot 0 information:
  State                               Online
  Logical slot                        0
  Temperature                         28 degrees C / 82 degrees F
  Total CPU DRAM                      8 MB
  Total SRAM                          1 MB
  Total SDRAM                         128 MB
  Total notification SDRAM            24 MB
  I/O Manager ASIC information        Version 1.1, Foundry IBM, Part number 0
  Start time:                        2003-05-23 18:14:31 PDT
  Uptime:                             34 days, 6 hours, 9 minutes, 5 seconds
```

Troubleshoot PICs

To troubleshoot 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 *M20 and M40 Internet Routers PIC Guide*.
- To check the status of a PIC, issue the following CLI command. The following example specifies an FPC slot number (3), which is optional. The PIC slots in the FPC are numbered from 0 (zero) through 3, top to bottom:

```
user@host> show chassis fpc pic-status 3
Slot 3 Online
  PIC 0    4x OC-3 SONET, MM
  PIC 1    4x OC-3 SONET, SMIR
  PIC 2    1x OC-12 SONET, SMIR
  PIC 3    1x G/E, 1000 BASE-SX
```

Troubleshoot the SCB

To troubleshoot the SCB, follow these guidelines:

- Periodically check the alarm LEDs and the LCD on the craft interface. If the SCB is not functioning properly, it might send spurious error messages to the Routing Engine (indicating incorrectly that system components are malfunctioning, for example). These messages can appear on the LCD.
- If all four LEDs on the SCB faceplate are on, but dimly lit, the SCB is probably not seated properly. Tighten the captive screws at the top and bottom of the SCB card carrier. For more information about the LEDs, see “SCB Components” on page 13.

- If the green RUN LED on the SCB is not blinking, the SCB processor is not functioning normally. The SCB might not be connected properly to the backplane. Try tightening the screws at the top and bottom of the SCB card carrier. If that does not work, try reinstalling the SCB.
- When the Routing Engine is removed, the SCB enters a warm shutdown mode and continues forwarding data for a limited time using a frozen forwarding table. (The default time limit is determined by a timer in the SCB.) If the Routing Engine is replaced during the warm shutdown period, the SCB unfreezes its forwarding tables and resumes normal functioning. Otherwise, the SCB shuts itself down after the time limit expires.

Part 5

Appendixes

- Cable Connectors and Pinouts on page 207
- Fiber-Optic Connector Cleaning on page 213
- Return the Router or Its Components on page 215
- Glossary on page 223

Appendix A

Cable Connectors and Pinouts

This chapter contains tables that list the pinouts for the following cable connectors on the router:

- RJ-45 Connector Pinouts for the Ethernet Management Port on page 207
- DB-9 Connector Pinouts for the Routing Engine Console and Auxiliary Ports on page 208
- E1 and T1 RJ-48 Cable Pinouts on page 208
- Fast Ethernet 12-port Cable Pinouts on page 211

RJ-45 Connector Pinouts for the Ethernet Management Port

The port on the craft interface labeled **MANAGEMENT ETHERNET** is an autosensing 10/100-Mbps Ethernet RJ-45 receptacle that accepts an Ethernet cable for connecting the Routing Engine to a management LAN (or other device that supports out-of-band management). For more information, see “Routing Engine LEDs and Interface Ports” on page 19. Table 24 describes the RJ-45 connector pinout.

Table 24: 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 Console and Auxiliary Ports

The ports on the craft interface labeled **AUXILIARY** and **CONSOLE** are DB-9 receptacles that accept RS-232 (EIA-232) cable. The **AUXILIARY** port connects the Routing Engine to a laptop, modem, or other auxiliary unit, and the **CONSOLE** port connects it to a management console. The ports are configured as data terminal equipment (DTE). For more information, see “Routing Engine LEDs and Interface Ports” on page 19. Table 25 describes the DB-9 connector pinouts.

Table 25: 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	– >	Ready to Send
8	CTS	< –	Clear to Send
9	RING	< –	Ring Indicator

E1 and T1 RJ-48 Cable Pinouts

The E1 and T1 PICs use an RJ-48 cable, which is not supplied with the PIC.



Note

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

The following tables describe the RJ-48 connector pinouts:

- Table 26, “RJ-48 Connector to RJ-48 Connector (Straight) Pinout” on page 209
- Table 27, “RJ-48 Connector to RJ-48 Connector (Crossover) Pinout” on page 209
- Table 28, “RJ-48 Connector to DB-15 Connector (Straight) Pinout” on page 210
- Table 29, “RJ-48 Connector to DB-15 Connector (Crossover) Pinout” on page 210

Table 26: 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, +
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 27: 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 28: 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 29: 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
14	No connect	No connect
15	No connect	No connect

Fast Ethernet 12-port Cable Pinouts

The Fast Ethernet 12-port PIC has one VHDCI connector port on its faceplate (see Figure 91), which accepts the RJ-21 cable supplied with the PIC (see Figure 92).

Figure 91: Fast Ethernet 12-port PIC

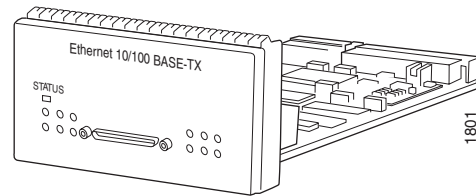


Figure 92: VHDCI to RJ-21 Cable

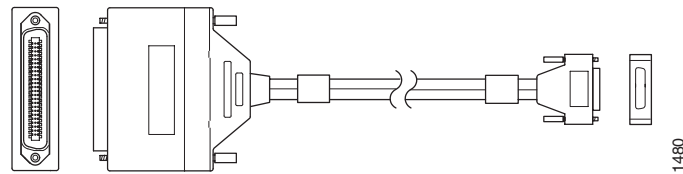


Table 30 describes the RJ-21 cable pinouts.



Note

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

Table 30: 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

Ethernet Port Numbers	RJ-21 Pin Assignment			
9	20	45	19	44
10	22	47	21	46
11	24	49	23	48

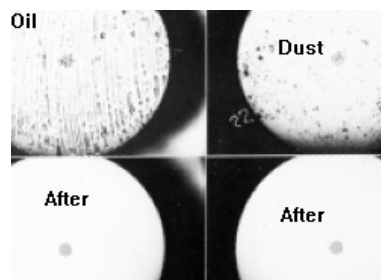
Appendix B

Fiber-Optic Connector Cleaning

For proper performance of PICs that use SC fiber-optic cable, you must clean the fiber-optic transceivers before inserting SC cable.

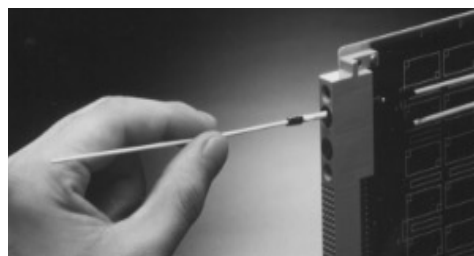
Because of the high sensitivity of fiber-optic PIC receivers, you must keep the PIC connectors clean and free of dust. Small micro-deposits of oil and dust in the canal of the SC connector could cause loss of light, reducing signal power and possibly causing intermittent problems with the optical connection. Figure 93 shows the oil and dust that collects in the SC connector canals.

Figure 93: Microdeposits in the SC Connector Canal



Keep the connectors clean using 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. Figure 94 shows the proper cleaning procedure.

Figure 94: Clean the Connectors



After you have cleaned the optical transceiver area of the fiber-optic PIC, make sure that the SC connector tip of the fiber-optic cable is clean.

To clean the fiber-optic cable SC connection, use only an approved alcohol-free fiber-optic cable cleaning kit such as the Opptex Cletop-S Fiber Cleaner. Follow the directions for the cleaning kit you use. Figure 95 shows a cable cleaning kit.

Figure 95: Fiber-optic Cable Cleaning Kit



Appendix C

Return the Router or Its Components

This chapter discusses the following topics related to returning parts for repair or replacement:

- Return Procedure on page 215
- Locate Component Serial Numbers on page 216
- Pack the Router for Shipment on page 220
- Pack Components for Shipment on page 221

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 216.
2. Obtain a Return Materials Authorization (RMA) number from the Juniper Networks Technical Assistance Center (JTAC). You can send e-mail to support@juniper.net, or call 1-888-314-JTAC (within the United States) or (+ 1) 408-745-9500 (from outside the United States).

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 220 or “Pack Components for Shipment” on page 221.

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                               00126         M40
Backplane          REV 06    710-000073   AA2097
Power Supply A     Rev      740-000234   000001        AC
Power Supply B     Rev A1    740-000234   000132        AC
Maxicab            REV 05    710-000229   AA4390
Minicab            REV 02    710-000482   AA4423
Display            REV 07    710-000150   AA4352
Routing Engine                               RE-1.0
...
```

Most components also have a small rectangular serial number ID label (see Figure 96) attached to the component body.

Figure 96: Serial Number ID Label



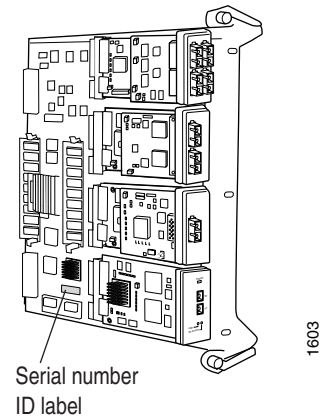
The following sections describe the tag location on each type of component:

- FPC Serial Number ID Label on page 217
- PIC Serial Number ID Label on page 217
- Power Supply Serial Number ID Label on page 218
- Routing Engine Serial Number Label on page 218
- SCB Serial Number ID Label on page 219

FPC Serial Number ID Label

The serial number ID label on an FPC is located near the rear on the left side when the FPC is vertical, as it is when installed in the router (see Figure 97).

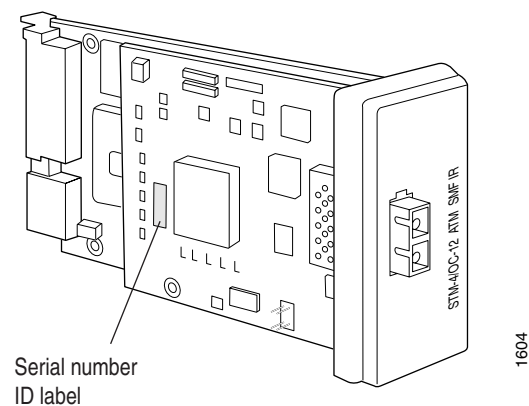
Figure 97: FPC Serial Number ID Label



PIC Serial Number ID Label

The serial number ID label on a PIC is located on the left side when the PIC is vertical, as it is when installed in the router (see Figure 98).

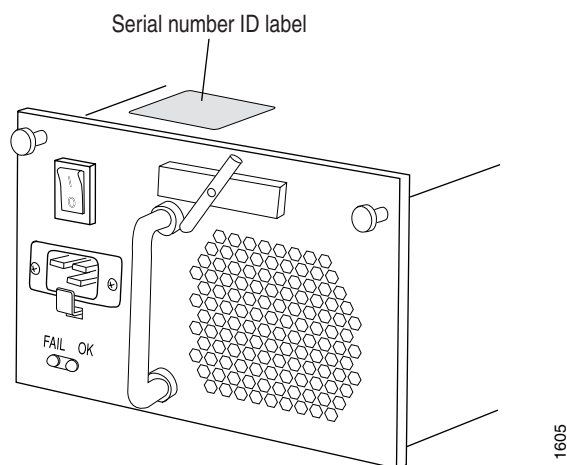
Figure 98: PIC Serial Number ID Label



Power Supply Serial Number ID Label

The serial number ID label on a power supply is located on the top (see Figure 99).

Figure 99: Power Supply Serial Number ID Label



Routing Engine Serial Number Label

The location of the serial number label depends on the type of Routing Engine (see Figure 100 and Figure 101). Some Routing Engines might have more than one serial number. Contact your Juniper support representative if you need assistance in determining which serial number to provide.

Figure 100: Routing Engine 333 Serial Number ID Label

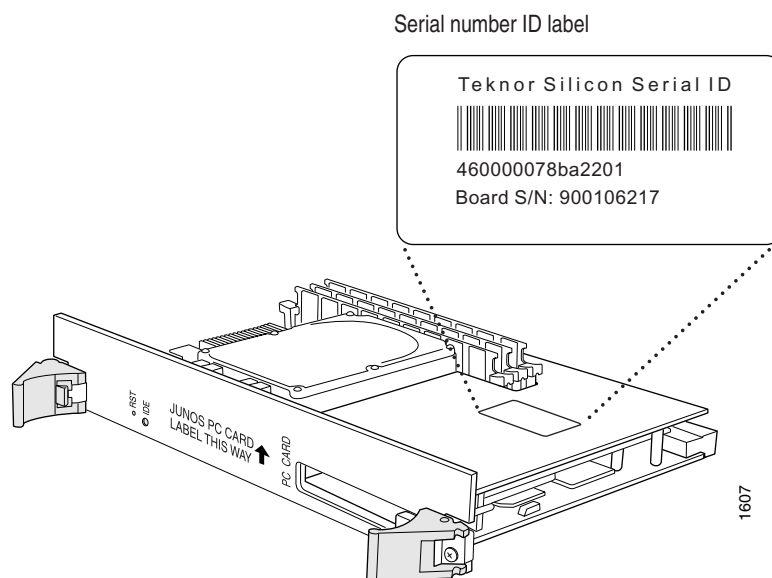
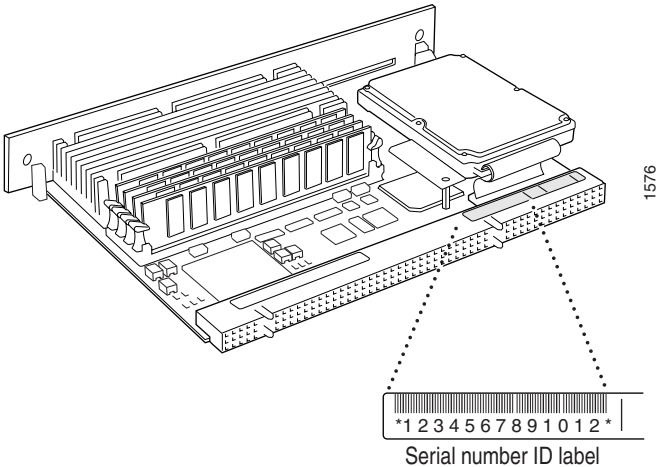


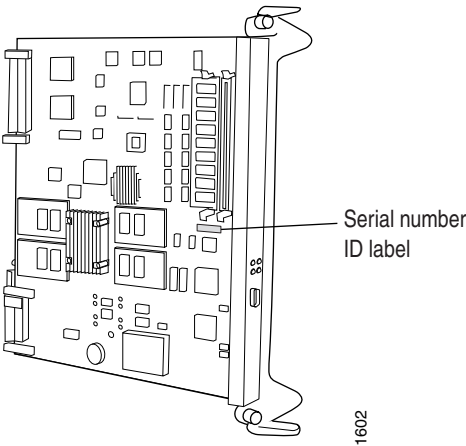
Figure 101: Routing Engine 600 Serial Number ID Label



SCB Serial Number ID Label

The serial number ID label on an SCB is located at the center front of the board panel (see Figure 102).

Figure 102: Serial Number Label on the System Control Board



4.

Pack the Router for Shipment

To pack the router for shipment, follow this procedure:

1. Retrieve the crate with bottom pallet 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. For more information, see the *JUNOS Internet Software Operational Mode Command Reference: Protocols, Class of Service, Chassis, and Management*.

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

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

3. Shut down power to the router by pressing the power switch on the faceplate of both power supplies to the OFF (O) position.
4. Disconnect the power cords or cables. For instructions, see “Disconnect AC Power from the Router” on page 140 and “Disconnect DC Power from the Router” on page 147.
5. Remove the cables from all PICs and external management and alarm devices. For instructions, see “Maintain and Replace Cables and Connectors” on page 181.
6. Remove the chassis from the rack.
 - If you are using a mechanical lift, place the lift under the chassis, unscrew and remove the mounting screws from the rack, and move the router to the pallet.
 - If you are moving the router manually, first remove components as described in “Remove Components from the Chassis” on page 100. Unscrew and remove the mounting screws from the rack, move the router to the pallet, then reinstall the components as described in “Reinstall Components into the Chassis” on page 111.
7. Place the chassis on the pallet and bolt it to the pallet.
8. Replace the packing foam on top of the chassis.
9. Place the crate cover over the chassis and foam.

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.



Do not stack any of the Packet Forwarding Engine components.

Appendix D

Glossary

A

AAL	ATM adaptation layer. A series of protocols enabling various types of traffic, including voice, data, image, and video, to run over an ATM network.
ADM	Add/drop multiplexer. SONET functionality that allows lower-level signals to be dropped from a high-speed optical connection.
ANSI	American National Standards Institute. The United States' representative to the ISO.
ARP	Address Resolution Protocol. Protocol for mapping IP addresses to MAC addresses.
AS	Autonomous system. Set of routers under a single technical administration. Each AS normally uses a single interior gateway protocol (IGP) and metrics to propagate routing information within the set of routers. Also called <i>routing domain</i> .
ASIC	Application-specific integrated circuit. Specialized processors that perform specific functions on the router.
ATM	Asynchronous Transfer Mode. A high-speed multiplexing and switching method utilizing fixed-length cells of 53 octets to support multiple types of traffic.
autonomous system	<i>See AS.</i>

B

backplane	Forms the rear of the FPC card cage. Provides data transfer, power distribution, and signal connectivity.
bandwidth	The range of transmission frequencies a network can use, expressed as the difference between the highest and lowest frequencies of a transmission channel. In computer networks, greater bandwidth indicates faster data-transfer rate capacity.
Bellcore	Bell Communications Research. Research and development organization created after the divestiture of the Bell System. It is supported by the regional Bell holding companies (RBHCs), which own the regional Bell operating companies (RBOCs).
BERT	Bit error rate test. A test that can be run on a T3 interface to determine whether it is operating properly.
BGP	Border Gateway Protocol. Exterior gateway protocol used to exchange routing information among routers in different autonomous systems.
bit error rate test	<i>See BERT.</i>

BITS	Building Integrated Timing Source. Dedicated timing source that synchronizes all equipment in a particular building.
Border Gateway Protocol	<i>See BGP.</i>
broadcast	Operation of sending network traffic from one network node to all other network nodes.
bundle	Collection of software that makes up a JUNOS software release.
C	
CE device	Customer edge device. Router or switch in the customer's network that is connected to a service provider's provider edge (PE) router and participates in a Layer 3 VPN.
CFM	Cubic feet per minute. Measure of air flow in volume per minute.
channel service unit	<i>See CSU/DSU.</i>
CIDR	Classless interdomain routing. A method of specifying Internet addresses in which you explicitly specify the bits of the address to represent the network address instead of determining this information from the first octet of the address.
class of service	<i>See CoS.</i>
CLEC	(Pronounced "see-lek") Competitive Local Exchange Carrier. Company that competes with the already established local telecommunications business by providing its own network and switching.
CLEI	Common language equipment identifier. Inventory code used to identify and track telecommunications equipment.
CLI	Command-line interface. Interface provided for configuring and monitoring the routing protocol software.
community	In BGP, a group of destinations that share a common property. Community information is included as one of the path attributes in BGP update messages.
confederation	In BGP, a group of systems that appears to external autonomous systems to be a single autonomous system.
constrained path	In traffic engineering, a path determined using RSVP signaling and constrained using CSPF. The ERO carried in the packets contains the constrained path information.
core	The central backbone of the network.
CoS	Class of service. A group of privileges and features assigned to a particular service.
CPE	Customer premises equipment. Telephone or other service provider equipment located at a customer site.
craft interface	Mechanisms used by a Communication Workers of America craftsman to operate, administer, and maintain equipment or provision data communications. On a Juniper Networks router, the craft interface allows you to view status and troubleshooting information and perform system control functions.

CSU/DSU	Channel service unit/data service unit. Channel service unit connects a digital phone line to a multiplexer or other digital signal device. Data service unit connects a DTE to a digital phone line.
customer edge device	<i>See CE device.</i>
D	
daemon	Background process that performs operations on behalf of the system software and hardware. Daemons normally start when the system software is booted, and they run as long as the software is running. In the JUNOS software, daemons are also referred to as processes.
data circuit-terminating equipment	<i>See DCE.</i>
data-link connection identifier	<i>See DLCI.</i>
data service unit	<i>See CSU/DSU.</i>
Data Terminal Equipment	<i>See DTE.</i>
dcd	The JUNOS software interface process (daemon).
DCE	Data circuit-terminating equipment. RS-232-C device, typically used for a modem or printer, or a network access and packet switching node.
default address	Router address that is used as the source address on unnumbered interfaces.
denial of service	<i>See DoS.</i>
dense wavelength-division multiplexing	<i>See DWDM.</i>
DHCP	Dynamic Host Configuration Protocol. Allocates IP addresses dynamically so that they can be reused when they are no longer needed.
Dijkstra algorithm	<i>See SPF.</i>
DIMM	Dual inline memory module. 168-pin memory module that supports 64-bit data transfer.
direct routes	<i>See interface routes.</i>
DLCI	Data-link connection identifier. Identifier for a Frame Relay virtual connection (also called a logical interface).
DoS	Denial of service. System security breach in which network services become unavailable to users.
DRAM	Dynamic random-access memory. Storage source on the router that can be accessed quickly by a process.
drop profile	Drop probabilities for different levels of buffer fullness that are used by RED to determine from which queue to drop packets.

DSU Data service unit. A device used to connect a DTE to a digital phone line. Converts digital data from a router to voltages and encoding required by the phone line. *See also CSU/DSU.*

DTE Data Terminal Equipment. RS-232-C interface that a computer uses to exchange information with a serial device.

DVMRP Distance Vector Multicast Routing Protocol. Distributed multicast routing protocol that dynamically generates IP multicast delivery trees using a technique called reverse path multicasting (RPM) to forward multicast traffic to downstream interfaces.

DWDM Dense wavelength-division multiplexing. Technology that enables data from different sources to be carried together on an optical fiber, with each signal carried on its own separate wavelength.

**Dynamic Host
Configuration Protocol** *See DHCP.*

E

ECSA Exchange Carriers Standards Association. A standards organization created after the divestiture of the Bell System to represent the interests of interexchange carriers.

EGP Exterior gateway protocol, such as BGP.

EIA Electronic Industries Association. A United States trade group that represents manufacturers of electronics devices and sets standards and specifications.

EMI Electromagnetic interference. Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics or electrical equipment.

explicit path *See signaled path.*

export To place routes from the routing table into a routing protocol.

F

FEAC Far-end alarm and control. T3 signal used to send alarm or status information from the far-end terminal back to the near-end terminal and to initiate T3 loopbacks at the far-end terminal from the near-end terminal.

**Flexible PIC
Concentrator** *See FPC.*

**forwarding information
base** *See forwarding table.*

forwarding table JUNOS software forwarding information base (FIB). The JUNOS routing protocol process installs active routes from its routing tables into the Routing Engine forwarding table. The kernel copies this forwarding table into the Packet Forwarding Engine, which is responsible for determining which interface transmits the packets.

FPC Flexible PIC Concentrator. An interface concentrator on which PICs are mounted. An FPC inserts into a slot in a Juniper Networks router. *See also PIC.*

FRU Field-replaceable unit. Router component that customers can replace onsite.

H

- HDLC** High-level data link control. An International Telecommunication Union (ITU) standard for a bit-oriented data link layer protocol on which most other bit-oriented protocols are based.
- hold time** Maximum number of seconds allowed to elapse between the time a BGP system receives successive keepalive or update messages from a peer.
- host subsystem** Provides routing and system-management functions of the router. Consists of a Routing Engine and an adjacent Control Board (CB).
- IANA** Internet Assigned Numbers Authority. Regulatory group that maintains all assigned and registered Internet numbers, such as IP and multicast addresses. *See also NIC.*
- ICMP** Internet Control Message Protocol. Used in router discovery, ICMP allows router advertisements that enable a host to discover addresses of operating routers on the subnet.
- IDE** Integrated Drive Electronics. Type of hard disk on the Routing Engine.
- IEC** International Electrotechnical Commission. *See ISO.*
- IEEE** Institute of Electronic and Electrical Engineers. International professional society for electrical engineers.
- IETF** Internet Engineering Task Force. International community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.
- IGMP** Internet Group Membership Protocol. Used with multicast protocols to determine whether group members are present.
- IGP** Interior gateway protocol, such as IS-IS, OSPF, and RIP.
- import** To install routes from the routing protocols into a routing table.
- interface routes** Routes that are in the routing table because an interface has been configured with an IP address. Also called *direct routes*.
- IP** Internet Protocol. The protocol used for sending data from one point to another on the Internet.
- IS-IS** Intermediate System-to-Intermediate System protocol. Link-state, interior gateway routing protocol for IP networks that also uses the shortest-path first (SPF) algorithm to determine routes.
- ISO** International Organization for Standardization. Worldwide federation of standards bodies that promotes international standardization and publishes international agreements as International Standards.
- ISP** Internet service provider. Company that provides access to the Internet and related services.
- ITU** International Telecommunications Union (formerly known as the CCITT). Group supported by the United Nations that makes recommendations and coordinates the development of telecommunications standards for the entire world.

J

jitter Small random variation introduced into the value of a timer to prevent multiple timer expirations from becoming synchronized.

K

kernel forwarding table *See forwarding table.*

L

label-switched path (LSP) Sequence of routers that cooperatively perform MPLS operations for a packet stream. The first router in an LSP is called the *ingress router*, and the last router in the path is called the *egress router*. An LSP is a point-to-point, half-duplex connection from the ingress router to the egress router. (The ingress and egress routers cannot be the same router.)

label switching *See MPLS.*

label-switching router *See LSR.*

link Communication path between two neighbors. A link is *up* when communication is possible between the two end points.

link-state PDU (LSP) Packets that contain information about the state of adjacencies to neighboring systems.

LSP *See label-switched path (LSP) and link-state PDU (LSP).*

LSR Label-switching router. A router on which MPLS and RSVP are enabled and is thus capable of processing label-switched packets.

M

mask *See subnet mask.*

MBone Internet multicast backbone. An interconnected set of subnetworks and routers that support the delivery of IP multicast traffic. The MBone is a virtual network that is layered on top of sections of the physical Internet.

MED Multiple exit discriminator. Optional BGP path attribute consisting of a metric value that is used to determine the exit point to a destination when all other factors in determining the exit point are equal.

mesh Network topology in which devices are organized in a manageable, segmented manner with many, often redundant, interconnections between network nodes.

MIB Management Information Base. Definition of an object that can be managed by SNMP.

MPLS Multiprotocol Label Switching. Mechanism for engineering network traffic patterns that functions by assigning to network packets short labels that describe how to forward them through the network. Also called *label switching*. *See also traffic engineering.*

MTBF Mean time between failure. Measure of hardware component reliability.

MTU Maximum transfer unit. Limit on packet size for a network.

multicast Operation of sending network traffic from one network node to multiple network nodes.

Multiprotocol Label Switching *See MPLS.*

N

neighbor Adjacent system reachable by traversing a single subnetwork. An immediately adjacent router. Also called a *peer*.

NET Network entity title. Network address defined by the ISO network architecture and used in CLNS-based networks.

Network Time Protocol *See NTP.*

NIC Network Information Center. Internet authority responsible for assigning Internet-related numbers, such as IP addresses and autonomous system numbers. *See also IANA.*

NSAP Network service access point. Connection to a network that is identified by a network address.

n-selector Last byte of a nonclient peer address.

NTP Network Time Protocol. Protocol used to synchronize computer clock times on a network.

O

OC Optical Carrier. In SONET, Optical Carrier levels indicate the transmission rate of digital signals on optical fiber.

OSI Open System Interconnection. Standard reference model for how messages are transmitted between two points on a network.

OSPF Open Shortest Path First. A link-state IGP that makes routing decisions based on the shortest-path-first (SPF) algorithm (also referred to as the *Dijkstra algorithm*).

P

package A collection of files that make up a JUNOS software component.

Packet Forwarding Engine The architectural portion of the router that processes packets by forwarding them between input and output interfaces.

PCI Peripheral Component Interconnect. Standard, high-speed bus for connecting computer peripherals. Used on the Routing Engine.

PCMCIA Personal Computer Memory Card International Association. Industry group that promotes standards for credit card-size memory or I/O devices.

PDU Protocol data unit. IS-IS packets.

PE router Provider edge router. A router in the service provider's network that is connected to a customer edge (CE) device and that participates in a Virtual Private Network (VPN).

peer An immediately adjacent router with which a protocol relationship has been established. Also called a *neighbor*.

PFE *See Packet Forwarding Engine.*

Physical Interface Card *See PIC.*

PIC Physical Interface Card. A network interface-specific card that can be installed on an FPC in the router.

PIM	Protocol Independent Multicast. A protocol-independent multicast routing protocol. PIM Sparse Mode routes to multicast groups that might span wide-area and interdomain internets. PIM Dense Mode is a flood-and-prune protocol.
PLP	Packet Loss Priority.
policing	Applying rate limits on bandwidth and burst size for traffic on a particular interface.
PPP	Point-to-Point Protocol. Link-layer protocol that provides multiprotocol encapsulation. It is used for link-layer and network-layer configuration.
preference	Desirability of a route to become the active route. A route with a lower preference value is more likely to become the active route. The preference is an arbitrary value in the range 0 through 255 that the routing protocol process uses to rank routes received from different protocols, interfaces, or remote systems.
primary interface	Router interface that packets go out when no interface name is specified and when the destination address does not imply a particular outgoing interface.
Protocol-Independent Multicast	<i>See PIM.</i>
provider edge router	<i>See PE router.</i>
provider router	Router in the service provider's network that does not attach to a customer edge (CE) device.
Q	
QoS	Quality of service. Performance, such as transmission rates and error rates, of a communications channel or system.
quality of service	<i>See QoS.</i>
R	
RADIUS	Remote Authentication Dial-In User Service. Authentication method for validating users who attempt to access the router using Telnet.
Random Early Detection	<i>See RED.</i>
rate limiting	<i>See policing.</i>
RBOC	(Pronounced "are-bock") Regional Bell operating company. Regional telephone companies formed as a result of the divestiture of the Bell System.
RDRAM	RAMBUS dynamic random access memory.
RED	(Pronounced "red") Random Early Detection. Gradual drop profile for a given class that is used for congestion avoidance. RED tries to anticipate incipient congestion and reacts by dropping a small percentage of packets from the head of the queue to ensure that a queue never actually becomes congested.
Resource Reservation Protocol	<i>See RSVP.</i>
RFC	Request for Comments. Internet standard specifications published by the Internet Engineering Task Force.

RFI	Radio frequency interference. Interference from high-frequency electromagnetic waves emanating from electronic devices.
RIP	Routing Information Protocol. Distance-vector interior gateway protocol that makes routing decisions based on hop count.
routing domain	<i>See AS.</i>
Routing Engine	Architectural portion of the router that handles all routing protocol processes, as well as other software processes that control the router's interfaces, some of the chassis components, system management, and user access to the router.
routing table	Common database of routes learned from one or more routing protocols. All routes are maintained by the JUNOS routing protocol process.
rpd	JUNOS software routing protocol process (daemon). User-level background process responsible for starting, managing, and stopping the routing protocols on a Juniper Networks router.
RPM	Reverse path multicasting. Routing algorithm used by DVMRP to forward multicast traffic.
RSVP	Resource Reservation Protocol. Resource reservation setup protocol designed to interact with integrated services on the Internet.
S	SAP Session Announcement Protocol. Used with multicast protocols to handle session conference announcements.
	SAR Segmentation and reassembly. Buffering used with ATM.
	SDH Synchronous Digital Hierarchy. CCITT variation of SONET standard.
	SDP Session Description Protocol. Used with multicast protocols to handle session conference announcements.
	SDRAM Synchronous dynamic random access memory.
	secure shell <i>See SSH.</i>
	shortest-path-first algorithm <i>See SPF.</i>
	simplex interface An interface that assumes that packets it receives from itself are the result of a software loopback process. The interface does not consider these packets when determining whether the interface is functional.
	SNMP Simple Network Management Protocol. Protocol governing network management and the monitoring of network devices and their functions.
	SONET Synchronous Optical Network. High-speed (up to 2.5 Gbps) synchronous network specification developed by Bellcore and designed to run on optical fiber. STS-1 is the basic building block of SONET. Approved as an international standard in 1988. <i>See also SDH.</i>
	SPF Shortest-path first, an algorithm used by IS-IS and OSPF to make routing decisions based on the state of network links. Also called the <i>Dijkstra algorithm</i> .

SSH Secure shell. Software that provides a secured method of logging in to a remote network system.

SSRAM Synchronous Static Random Access Memory.

STM Synchronous Transport Module. CCITT specification for SONET at 155.52 Mbps.

STS Synchronous Transport Signal. Synchronous Transport Signal level 1. Basic building block signal of SONET, operating at 51.84 Mbps. Faster SONET rates are defined as STS-*n*, where *n* is a multiple of 51.84 Mbps. *See also* SONET.

subnet mask Number of bits of the network address used for host portion of a Class A, Class B, or Class C IP address.

Switch Interface Board *See* SIB.

sysid System identifier. Portion of the ISO nonclient peer. The sysid can be any 6 bytes that are unique throughout a domain.

T

TCP Transmission Control Protocol. Works in conjunction with Internet Protocol (IP) to send data over the Internet. Divides a message into packets and tracks the packets from point of origin to destination.

ToS Type of service.

traffic engineering Process of selecting the paths chosen by data traffic in order to balance the traffic load on the various links, routers, and switches in the network. (Definition from <http://www.ietf.org/internet-drafts/draft-ietf-mpls-framework-04.txt>.) *See also* MPLS.

tunnel Private, secure path through an otherwise public network.

type of service *See* ToS.

U

unicast Operation of sending network traffic from one network node to another individual network node.

UPS Uninterruptible power supply. Device that sits between a power supply and a router (or other piece of equipment) that prevents undesired power-source events, such as outages and surges, from affecting or damaging the device.

V

vapor corrosion inhibitor *See* VCI.

VCI Vapor corrosion inhibitor. Small cylinder packed with the router that prevents corrosion of the chassis and components during shipment.

VCI Virtual circuit identifier. 16-bit field in the header of an ATM cell that indicates the particular virtual circuit the cell takes through a virtual path. Also called a *logical interface*. *See also* VPI.

virtual circuit identifier *See* VCI.

virtual path identifier *See VPI.*

**Virtual Router
Redundancy Protocol** *See VRRP.*

VPI virtual path identifier. 8-bit field in the header of an ATM cell that indicates the virtual path the cell takes. *See also VCI.*

VRRP Virtual Router Redundancy Protocol. On Fast Ethernet and Gigabit Ethernet interfaces, allows you to configure virtual default routers.

**wavelength-division
multiplexing** *See WDM.*

WDM Wavelength-division multiplexing. Technique for transmitting a mix of voice, data, and video over various wavelengths (colors) of light.

weighted round-robin *See WRR.*

WRR Weighted round-robin. Scheme used to decide the queue from which the next packet should be transmitted.

Part 6

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