



M20™ Internet Router

Hardware Guide

Juniper Networks, Inc.

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About This Guide

This preface provides the following guidelines for using the *M20 Internet Router Hardware Guide*.

- Objectives on page xix
- Audience on page xix
- Documentation Conventions on page xix
- List of Technical Publications on page xxii
- Documentation Feedback on page xxix
- Requesting Technical Support on page xxix

Objectives

This manual describes hardware installation and basic troubleshooting procedures for the Juniper Networks M20 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, see the JUNOS software configuration guides for information about further JUNOS software configuration.



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

Audience

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

Documentation Conventions

Table 1 on page xx defines the notice icons used in this guide.

Table 1: Notice Icons





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

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

Table 2: Text and Syntax Conventions

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

Table 2: Text and Syntax Conventions *(continued)*

Convention	Description	Examples
(pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	broadcast multicast (string1 string2 string3)
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	rsvp { # Required for dynamic MPLS only
[] (square brackets)	Enclose a variable for which you can substitute one or more values.	community name members [community-ids]
Indentation and braces ({ })	Identify a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop address; retain; } } }
; (semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
J-Web GUI Conventions		
Bold text like this	Represents J-Web graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none">■ In the Logical Interfaces box, select All Interfaces.■ To cancel the configuration, click Cancel.
> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select Protocols > Ospf .

List of Technical Publications

Table 3 on page xxii lists the software and hardware guides and release notes for Juniper Networks J-series, M-series, MX-series, and T-series routing platforms and describes the contents of each document. Table 4 on page xxvi lists the books included in the *Network Operations Guide* series. Table 5 on page xxvii lists the manuals and release notes supporting JUNOS software with enhanced services. All documents are available at <http://www.juniper.net/techpubs/>.

Table 6 on page xxviii lists additional books on Juniper Networks solutions that you can order through your bookstore. A complete list of such books is available at <http://www.juniper.net/books>.

Table 3: Technical Documentation for Supported Routing Platforms

Book	Description
JUNOS Software for Supported Routing Platforms	
<i>Access Privilege</i>	Explains how to configure access privileges in user classes by using permission flags and regular expressions. Lists the permission flags along with their associated command-line interface (CLI) operational mode commands and configuration statements.
<i>Class of Service</i>	Provides an overview of the class-of-service (CoS) functions of the JUNOS software and describes how to configure CoS features, including configuring multiple forwarding classes for transmitting packets, defining which packets are placed into each output queue, scheduling the transmission service level for each queue, and managing congestion through the random early detection (RED) algorithm.
<i>CLI User Guide</i>	Describes how to use the JUNOS command-line interface (CLI) to configure, monitor, and manage Juniper Networks routing platforms. This material was formerly covered in the <i>JUNOS System Basics Configuration Guide</i> .
<i>Feature Guide</i>	Provides a detailed explanation and configuration examples for several of the most complex features in the JUNOS software.
<i>High Availability</i>	Provides an overview of hardware and software resources that ensure a high level of continuous routing platform operation and describes how to configure high availability (HA) features such as nonstop active routing (NSR) and graceful Routing Engine switchover (GRES).
<i>MPLS Applications</i>	Provides an overview of traffic engineering concepts and describes how to configure traffic engineering protocols.
<i>Multicast Protocols</i>	Provides an overview of multicast concepts and describes how to configure multicast routing protocols.
<i>Multiplay Solutions</i>	Describes how you can deploy IPTV and voice over IP (VoIP) services in your network.

Table 3: Technical Documentation for Supported Routing Platforms (*continued*)

Book	Description
<i>MX-series Solutions Guide</i>	Describes common configuration scenarios for the Layer 2 features supported on the MX-series routers, including basic bridged VLANs with normalized VLAN tags, aggregated Ethernet links, bridge domains, Multiple Spanning Tree Protocol (MSTP), and integrated routing and bridging (IRB).
<i>Network Interfaces</i>	Provides an overview of the network interface functions of the JUNOS software and describes how to configure the network interfaces on the routing platform.
<i>Network Management</i>	Provides an overview of network management concepts and describes how to configure various network management features, such as SNMP and accounting options.
<i>Policy Framework</i>	Provides an overview of policy concepts and describes how to configure routing policy, firewall filters, and forwarding options.
<i>Protected System Domain</i>	Provides an overview of the JCS 1200 platform and the concept of Protected System Domains (PSDs). The JCS 1200 platform, which contains up to six redundant pairs of Routing Engines running JUNOS software, is connected to a T320 router or to a T640 or T1600 routing node. To configure a PSD, you assign any number of Flexible PIC concentrators (FPCs) in the T-series routing platform to a pair of Routing Engines on the JCS 1200 platform. Each PSD has the same capabilities and functionality as a physical router, with its own control plane, forwarding plane, and administration.
<i>Routing Protocols</i>	Provides an overview of routing concepts and describes how to configure routing, routing instances, and unicast routing protocols.
<i>Secure Configuration Guide for Common Criteria and JUNOS-FIPS</i>	Provides an overview of secure Common Criteria and JUNOS-FIPS protocols for the JUNOS software and describes how to install and configure secure Common Criteria and JUNOS-FIPS on a routing platform.
<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>Software Installation and Upgrade Guide</i>	Describes the JUNOS software components and packaging and explains how to initially configure, reinstall, and upgrade the JUNOS system software. This material was formerly covered in the <i>JUNOS System Basics Configuration Guide</i> .
<i>Subscriber Access</i>	Provides an overview of the subscriber access features of the JUNOS software and describes how to configure subscriber access support on the router, including dynamic profiles, class of service, AAA, and access methods.
<i>System Basics</i>	Describes Juniper Networks routing platforms and explains how to configure basic system parameters, supported protocols and software processes, authentication, and a variety of utilities for managing your router on the network.

Table 3: Technical Documentation for Supported Routing Platforms (*continued*)

Book	Description
<i>VPNs</i>	Provides an overview and describes how to configure Layer 2 and Layer 3 virtual private networks (VPNs), virtual private LAN service (VPLS), and Layer 2 circuits. Provides configuration examples.
JUNOS References	
<i>Hierarchy and RFC Reference</i>	Describes the JUNOS configuration mode commands. Provides a hierarchy reference that displays each level of a configuration hierarchy, and includes all possible configuration statements that can be used at that level. This material was formerly covered in the <i>JUNOS System Basics Configuration Guide</i> .
<i>Interfaces Command Reference</i>	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot interfaces.
<i>Routing Protocols and Policies Command Reference</i>	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot routing policies and protocols, including firewall filters.
<i>System Basics and Services Command Reference</i>	Describes the JUNOS software operational mode commands you use to monitor and troubleshoot system basics, including commands for real-time monitoring and route (or path) tracing, system software management, and chassis management. Also describes commands for monitoring and troubleshooting services such as class of service (CoS), IP Security (IPsec), stateful firewalls, flow collection, and flow monitoring.
<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.
J-Web User Guide	
<i>J-Web Interface User Guide</i>	Describes how to use the J-Web graphical user interface (GUI) to configure, monitor, and manage Juniper Networks routing platforms.
JUNOS API and Scripting Documentation	
<i>JUNOScript API Guide</i>	Describes how to use the JUNOScript application programming interface (API) to monitor and configure Juniper Networks routing platforms.
<i>JUNOS XML API Configuration Reference</i>	Provides reference pages for the configuration tag elements in the JUNOS XML API.
<i>JUNOS XML API Operational Reference</i>	Provides reference pages for the operational tag elements in the JUNOS XML API.
<i>NETCONF API Guide</i>	Describes how to use the NETCONF API to monitor and configure Juniper Networks routing platforms.

Table 3: Technical Documentation for Supported Routing Platforms (*continued*)

Book	Description
<i>JUNOS Configuration and Diagnostic Automation Guide</i>	Describes how to use the commit script and self-diagnosis features of the JUNOS software. This guide explains how to enforce custom configuration rules defined in scripts, how to use commit script macros to provide simplified aliases for frequently used configuration statements, and how to configure diagnostic event policies.
Hardware Documentation	
<i>Hardware Guide</i>	Describes how to install, maintain, and troubleshoot routing platforms and components. Each platform has its own hardware guide.
<i>PIC Guide</i>	Describes the routing platform's Physical Interface Cards (PICs). Each platform has its own PIC guide.
<i>DPC Guide</i>	Describes the Dense Port Concentrators (DPCs) for all MX-series routers.
JUNOScope Documentation	
<i>JUNOScope Software User Guide</i>	Describes the JUNOScope software graphical user interface (GUI), how to install and administer the software, and how to use the software to manage routing platform configuration files and monitor routing platform operations.
Advanced Insight Solutions (AIS) Documentation	
<i>Advanced Insight Solutions Guide</i>	Describes the Advanced Insight Manager (AIM) application, which provides a gateway between JUNOS devices and Juniper Support Systems (JSS) for case management and intelligence updates. Explains how to run AI scripts on Juniper Networks devices.
J-series Routing Platform Documentation	
<i>Getting Started Guide</i>	Provides an overview, basic instructions, and specifications for J-series routing platforms. The guide explains how to prepare your site for installation, unpack and install the router and its components, install licenses, and establish basic connectivity. Use the <i>Getting Started Guide</i> for your router model.
<i>Basic LAN and WAN Access Configuration Guide</i>	Explains how to configure the interfaces on J-series Services Routers for basic IP routing with standard routing protocols, ISDN backup, and digital subscriber line (DSL) connections.
<i>Advanced WAN Access Configuration Guide</i>	Explains how to configure J-series Services Routers in virtual private networks (VPNs) and multicast networks, configure data link switching (DLSw) services, and apply routing techniques such as policies, stateless and stateful firewall filters, IP Security (IPsec) tunnels, and class-of-service (CoS) classification for safer, more efficient routing.
<i>Administration Guide</i>	Shows how to manage users and operations, monitor network performance, upgrade software, and diagnose common problems on J-series Services Routers.
Release Notes	

Table 3: Technical Documentation for Supported Routing Platforms (*continued*)

Book	Description
<i>JUNOS Release Notes</i>	Summarize new features and known problems for a particular software release, provide corrections and updates to published JUNOS, JUNOScript, and NETCONF 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 routing platform and summarize known problems with the hardware and accompanying software. Each platform has its own release notes.
<i>JUNOScope Release Notes</i>	Contain corrections and updates to the published JUNOScope manual, provide information that might have been omitted from the manual, and describe upgrade and downgrade procedures.
<i>AIS Release Notes</i>	Summarize AIS new features and guidelines, identify known and resolved problems, provide information that might have been omitted from the manuals, and provide initial setup, upgrade, and downgrade procedures.
<i>AIS AI-Scripts Release Notes</i>	Summarize AI-Scripts new features, identify known and resolved problems, provide information that might have been omitted from the manuals, and provide instructions for automatic and manual installation, including deleting and rolling back.
<i>J-series Services Router Release Notes</i>	Briefly describe Services Router features, identify known hardware problems, and provide upgrade and downgrade instructions.

Table 4: JUNOS Software Network Operations Guides

Book	Description
<i>Baseline</i>	Describes the most basic tasks for running a network using Juniper Networks products. Tasks include upgrading and reinstalling JUNOS software, gathering basic system management information, verifying your network topology, and searching log messages.
<i>Interfaces</i>	Describes tasks for monitoring interfaces. Tasks include using loopback testing and locating alarms.
<i>MPLS</i>	Describes tasks for configuring, monitoring, and troubleshooting an example MPLS network. Tasks include verifying the correct configuration of the MPLS and RSVP protocols, displaying the status and statistics of MPLS running on all routing platforms in the network, and using the layered MPLS troubleshooting model to investigate problems with an MPLS network.
<i>MPLS Log Reference</i>	Describes MPLS status and error messages that appear in the output of the <code>show mpls lsp extensive</code> command. The guide also describes how and when to configure Constrained Shortest Path First (CSPF) and RSVP trace options, and how to examine a CSPF or RSVP failure in a sample network.

Table 4: JUNOS Software Network Operations Guides (*continued*)

Book	Description
<i>MPLS Fast Reroute</i>	Describes operational information helpful in monitoring and troubleshooting an MPLS network configured with fast reroute (FRR) and load balancing.
<i>Hardware</i>	Describes tasks for monitoring M-series and T-series routing platforms.

To configure and operate a J-series Services Router or SRX-series services gateway running JUNOS software with enhanced services, you must also use the configuration statements and operational mode commands documented in JUNOS configuration guides and command references. To configure and operate a WX Integrated Services Module, you must also use WX documentation.

Table 5: JUNOS Software with Enhanced Services Documentation

Book	Description
All Platforms	
<i>JUNOS Software Interfaces and Routing Configuration Guide</i>	Explains how to configure J-series and SRX-series interfaces for basic IP routing with standard routing protocols, ISDN service, firewall filters (access control lists), and class-of-service (CoS) traffic classification.
<i>JUNOS Software Security Configuration Guide</i>	Explains how to configure and manage security services such as stateful firewall policies, IP Security (IPsec) virtual private networks (VPNs), firewall screens, Network Address Translation (NAT), Public Key Cryptography, and Application Layer Gateways (ALGs).
<i>JUNOS Software Administration Guide</i>	Shows how to monitor J-series and SRX-series devices and routing operations, firewall and security services, system alarms and events, and network performance. This guide also shows how to administer user authentication and access, upgrade software, and diagnose common problems.
<i>JUNOS Software CLI Reference</i>	Provides the complete JUNOS software with enhanced services configuration hierarchy and describes the configuration statements and operational mode commands not documented in the standard JUNOS manuals.
J-series Only	
<i>JUNOS Software with Enhanced Services Design and Implementation Guide</i>	Provides guidelines and examples for designing and implementing IPsec VPNs, firewalls, and routing on J-series Services Routers running JUNOS software with enhanced services.
<i>JUNOS Software with Enhanced Services Quick Start</i>	Explains how to quickly set up a J-series Services Router. This document contains router declarations of conformity.

Table 5: JUNOS Software with Enhanced Services Documentation (continued)

Book	Description
<i>JUNOS Software with Enhanced Services J-series Services Router Hardware Guide</i>	Provides an overview, basic instructions, and specifications for J-series Services Routers. This guide explains how to prepare a site, unpack and install the router, replace router hardware, and establish basic router connectivity. This guide contains hardware descriptions and specifications.
<i>JUNOS Software with Enhanced Services Migration Guide</i>	Provides instructions for migrating an SSG device running ScreenOS software or a J-series Services Router running the JUNOS software to JUNOS software with enhanced services.
<i>WXC Integrated Services Module Installation and Configuration Guide</i>	Explains how to install and initially configure a WXC Integrated Services Module in a J-series Services Router for application acceleration.
<i>JUNOS Software with Enhanced Services Release Notes</i>	Summarizes new features and known problems for a particular release of JUNOS software with enhanced services on J-series Services Routers, including J-Web interface features and problems. The release notes also contain corrections and updates to the manuals and software upgrade and downgrade instructions for JUNOS software with enhanced services.
SRX-series Only	
<i>JUNOS Software for SRX-series Services Gateway Release Notes</i>	Summarizes new features and known problems for a particular release of JUNOS software with enhanced services on SRX-series services gateways, including J-Web interface features and problems. The release notes also contain corrections and updates to the manuals and software upgrade and downgrade instructions for JUNOS software with enhanced services.

Table 6: Additional Books Available Through <http://www.juniper.net/books>

Book	Description
<i>Interdomain Multicast Routing</i>	Provides background and in-depth analysis of multicast routing using Protocol Independent Multicast sparse mode (PIM SM) and Multicast Source Discovery Protocol (MSDP); details any-source and source-specific multicast delivery models; explores multiprotocol BGP (MBGP) and multicast IS-IS; explains Internet Gateway Management Protocol (IGMP) versions 1, 2, and 3; lists packet formats for IGMP, PIM, and MSDP; and provides a complete glossary of multicast terms.
<i>JUNOS Cookbook</i>	Provides detailed examples of common JUNOS software configuration tasks, such as basic router configuration and file management, security and access control, logging, routing policy, firewalls, routing protocols, MPLS, and VPNs.
<i>MPLS-Enabled Applications</i>	Provides an overview of Multiprotocol Label Switching (MPLS) applications (such as Layer 3 virtual private networks [VPNs], Layer 2 VPNs, virtual private LAN service [VPLS], and pseudowires), explains how to apply MPLS, examines the scaling requirements of equipment at different points in the network, and covers the following topics: point-to-multipoint label switched paths (LSPs), DiffServ-aware traffic engineering, class of service, interdomain traffic engineering, path computation, route target filtering, multicast support for Layer 3 VPNs, and management and troubleshooting of MPLS networks.

Table 6: Additional Books Available Through <http://www.juniper.net/books> (continued)

Book	Description
<i>OSPF and IS-IS: Choosing an IGP for Large-Scale Networks</i>	Explores the full range of characteristics and capabilities for the two major link-state routing protocols: Open Shortest Path First (OSPF) and IS-IS. Explains architecture, packet types, and addressing; demonstrates how to improve scalability; shows how to design large-scale networks for maximum security and reliability; details protocol extensions for MPLS-based traffic engineering, IPv6, and multitopology routing; and covers troubleshooting for OSPF and IS-IS networks.
<i>Routing Policy and Protocols for Multivendor IP Networks</i>	Provides a brief history of the Internet, explains IP addressing and routing (Routing Information Protocol [RIP], OSPF, IS-IS, and Border Gateway Protocol [BGP]), explores ISP peering and routing policies, and displays configurations for both Juniper Networks and other vendors' routers.
<i>The Complete IS-IS Protocol</i>	Provides the insight and practical solutions necessary to understand the IS-IS protocol and how it works by using a multivendor, real-world approach.

Documentation Feedback

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

- Document name
- Document part number
- Page number
- Software release version (not required for *Network Operations Guides [NOGs]*)

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or JNASC support contract, or are covered under warranty, and need postsales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the JTAC User Guide located at <http://www.juniper.net/customers/support/downloads/710059.pdf>.
- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/>.
- JTAC Hours of Operation —The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>
- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base:
<http://kb.juniper.net/>
- Download the latest versions of software and review release notes:
<http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications:
<https://www.juniper.net/alerts/>
- Join and participate in the Juniper Networks Community Forum:
<http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Manager: <http://www.juniper.net/cm/>

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool located at <https://tools.juniper.net/SerialNumberEntitlementSearch/>.

Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Manager tool in the CSC at <http://www.juniper.net/cm/>.
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, visit us at <http://www.juniper.net/support/requesting-support.html>.

Part 1

Product Overview

- System Overview on page 3
- Hardware Component Overview on page 7
- JUNOS Software Overview on page 37
- System Architecture Overview on page 45

Chapter 1

System Overview

This chapter provides an overview of the Juniper Networks M20 Internet router, discussing the following topics:

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

System Description

The M20 Internet router is a complete routing system that provides SONET/SDH, ATM, Ethernet, and channelized interfaces for large networks and network applications, such as those supported by Internet service providers (ISPs). Application-specific integrated circuits (ASICs), a definitive part of the router design, enable the router to forward data at the high speeds demanded by current network media.

The router accommodates up to four Flexible PIC Concentrators (FPCs), which can each be configured with a variety of network media types, altogether providing up to 64 physical interface ports per system. The router height of 14 in. (36 cm) enables stacked installation of five M20 systems in a single floor-to-ceiling rack, for increased port density per unit of floor space.

The router's maximum aggregate throughput is 3.2 gigabits per second (Gbps) per FPC. Inserting a combination of PICs with an aggregate higher than the maximum throughput is supported, but constitutes oversubscription of the FPC.

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

Field-Replaceable Units (FRUs)

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

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

Table 7 on page 4 lists the FRUs for the M20 router.

Table 7: Field-Replaceable Units

Hot-Removable and Hot-Insertable FRUs	Hot-Pluggable FRUs	FRUs That Require Powering Off the Router
Fan tray (front or Routing Engine)	Routing Engine	Craft interface
Flexible PIC Concentrator (FPC)	System and Switch Board (SSB)	
Physical Interface Card (PIC)		
Power supply (AC or DC)		
Small form-factor pluggable (SFP)		

For FRU replacement instructions, see “Replacing Hardware Components” on page 117.

System Redundancy

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

- Cooling system—The cooling subsystems have redundant components, which are controlled by the SSB. If a fan fails, the remaining fans provide sufficient cooling for the unit indefinitely. For more information, see “Cooling System” on page 34.
- Routing Engine—The router can have one or two Routing Engines. If two Routing Engines are installed, one (the master) is active and the other is in standby mode. If the master Routing Engine is removed from the chassis, the standby Routing Engine becomes active. For more information, see “Routing Engine” on page 24.
- Power supply—The router has two load-sharing, fully redundant power supplies to distribute either AC or DC power to the other components. If one power supply

fails, the second power supply can provide full power to the router's components indefinitely. For more information, see “Power System” on page 30.

- **System and Switch Board (SSB)**—The router can have one or two SSBs. If two SSBs are installed, one is active and the other is in reset mode. If the active SSB is removed from the chassis, the other SSB becomes active. For more information, see “System and Switch Board (SSB)” on page 21.

In the base configuration, the router has one Routing Engine and SSB, and multiple power supplies and cooling system components.

Safety Requirements, Warnings, and Guidelines

To avoid harm to yourself or the router as you install and maintain it, follow the guidelines for working with and near electrical equipment, as well as the safety procedures for working with Internet routers. For a discussion of how to make the installation site a safe environment, see “Preparing for Router Installation” on page 53. For a list of safety warnings, see “Safety and Regulatory Compliance Information” on page 167 and particularly “Electrical Safety Guidelines and Warnings” on page 186. However, providing an exhaustive set of guidelines for working with electrical equipment is beyond the scope of this manual.

Chapter 2

Hardware Component Overview

This chapter provides an overview of the hardware components on the M20 Internet router:

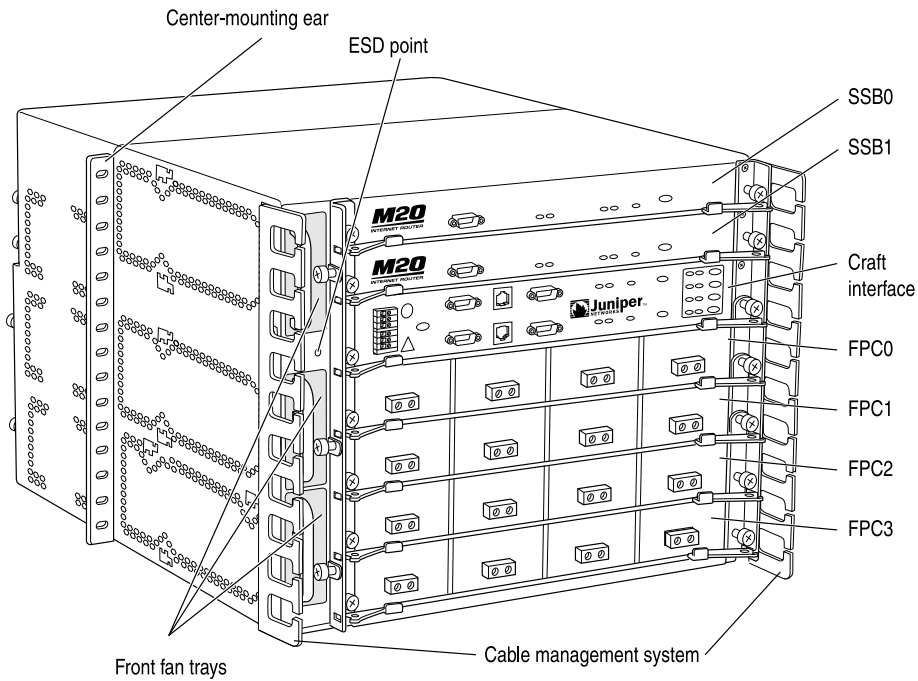
- Chassis on page 7
- Packet Forwarding Engine on page 9
- Routing Engine on page 24
- Craft Interface on page 28
- Power System on page 30
- Cooling System on page 34
- Cable Management System on page 35

Chassis

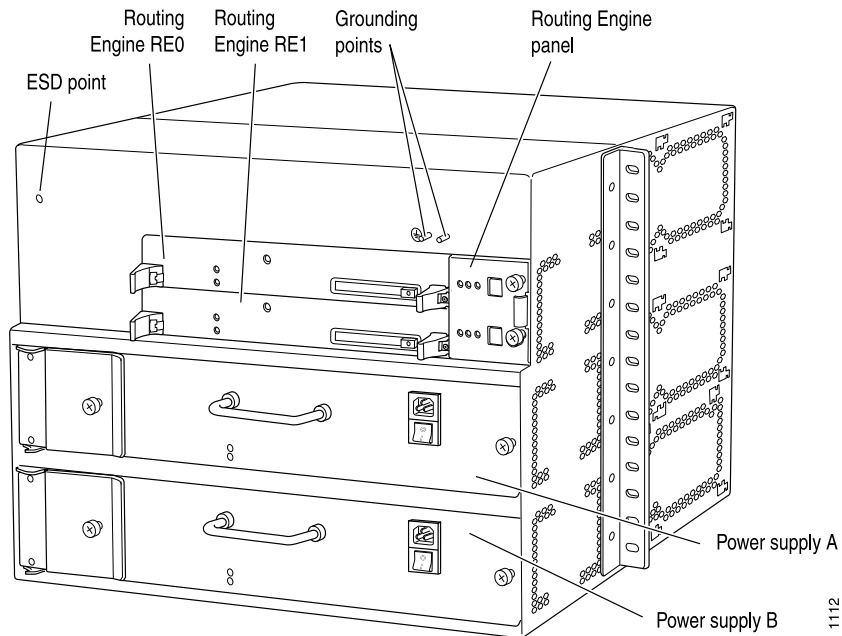
The router chassis is a rigid sheet metal structure that houses the other hardware components. The chassis is 17.5 in. (44.5 cm) wide and 21 in. (54 cm) deep. The chassis height of 14 in. (36 cm) enables stacked installation of five M20 routers in a single floor-to-ceiling rack. For more information, see “Rack Requirements” on page 54.

The two front-mounting brackets or center-mounting brackets (one on each side) extend the chassis width to 19 in. (48.3 cm).

Figure 1 on page 8 and Figure 2 on page 8 show front and rear views of the router chassis.

Figure 1: Front of Chassis

1111

Figure 2: Rear of Chassis

1112

The chassis includes the following electrical safety components:

- Two electrostatic discharge (ESD) points (banana plug receptacles), one front and one rear, as shown in Figure 1 on page 8 and Figure 2 on page 8

- 1/4–20 UNC grounding studs located above the Routing Engines, as shown in Figure 2 on page 8



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

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

For further safety information, see “Safety and Regulatory Compliance Information” on page 167.

Table 8 on page 9 summarizes physical specifications for the router chassis.

Table 8: Chassis Physical Specifications

Description	Value
Chassis height	14 in. (36 cm)
Chassis width	17.5 in. (44.5 cm) for sides of chassis 19 in. (48.3 cm) with front-mounting brackets or center-mounting brackets
Chassis depth	21 in. (54 cm)
Weight, maximum configuration	134 lb (61 kg)
Weight, minimum configuration	80 lb (36 kg)
Thermal output	3850 BTU/hour

Packet Forwarding Engine

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

The Packet Forwarding Engine has the following components:

- **Midplane**—Physically separates front and rear cavities inside the chassis, distributes power from the power supplies, and transfers packets and signals between router components, which plug into it.
- **Flexible PIC Concentrators (FPCs)**—Process incoming and outgoing packets. Up to four FPCs plug into the midplane from the front of the chassis. Each FPC accommodates up to four PICs.
- **Physical Interface Cards (PICs)**—Physically connect the router to network media such as OC12/STM4, OC48/STM16, Ethernet, and channelized interfaces. PICs are housed in Flexible PIC Concentrators (FPCs). (Quad-wide PICs, such as the 4-port Gigabit Ethernet and OC48/STM16 SONET/SDH PICs, are an exception. Such PICs occupy an entire FPC slot in the chassis and insert directly into the slot rather than into an FPC card carrier.)
- **System and Switch Board (SSB)**—Performs route lookup, filtering, and switching. One or two SSBs plug into the midplane from the front of the chassis.

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

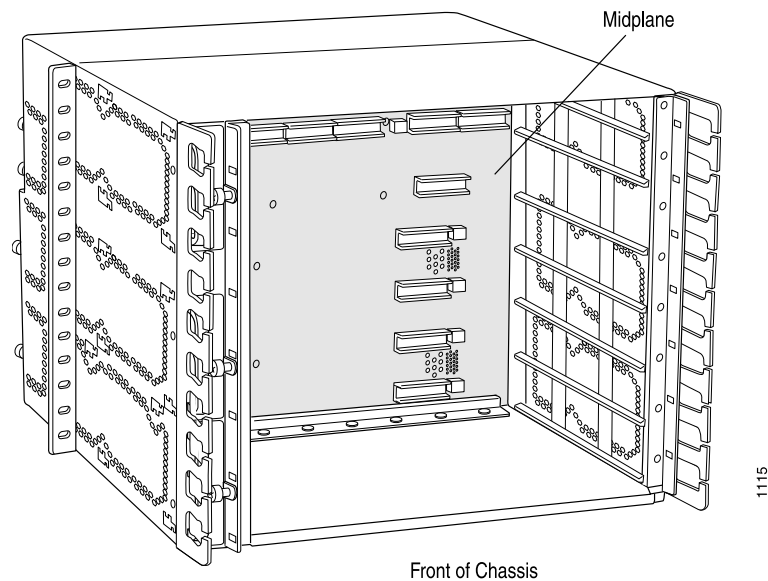
- Midplane on page 10
- Physical Interface Cards (PICs) on page 11
- Flexible PIC Concentrators (FPCs) on page 12
- System and Switch Board (SSB) on page 21

Midplane

The midplane is a panel located in the center of the chassis, running from side to side and forming the rear of the FPC card cage (see Figure 3 on page 11). All router components other than PICs plug directly into the midplane. The midplane contains an EEPROM that stores the serial number and revision level of the midplane.

The midplane performs the following functions:

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

Figure 3: Midplane

Physical Interface Cards (PICs)

Physical Interface Cards (PICs) physically connect the router to network media. They are housed in Flexible PIC Concentrators (FPCs); for more information about FPCs, see “Flexible PIC Concentrators (FPCs)” on page 12. (Quad-wide PICs, such as the 4-port Gigabit Ethernet and OC48/STM16 SONET/SDH PICs, are an exception. Such PICs occupy an entire FPC slot in the chassis and insert directly into the slot rather than into an FPC card carrier.)

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

The router supports various PICs, including ATM, Channelized, Gigabit Ethernet, IP Services, and SONET/SDH interfaces. For complete PIC specifications, see the *M20 PIC Guide*.

Some PICs, such as selected Gigabit Ethernet PICs, accept small form-factor pluggables (SFPs), which are fiber-optic transceivers that can be removed from the PIC. Various SFPs have different reach characteristics. You can mix them in a single PIC and change the combination dynamically. SFPs are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. For SFP replacement instructions, see “Replacing an SFP” on page 136. For information about PICs that use SFPs, see the *M20 PIC Guide*.

A regular PIC installs into one of the four slots in an FPC card carrier. The PIC slots are numbered from 0 (zero) through 3, right to left. The number of ports on a PIC depends on the type of PIC.

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.

Quad-wide PICs, such as the 4-port Gigabit Ethernet and OC48/STM16 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 “Replacing an FPC” on page 128.

For replacement instructions for regular PICs, see “Replacing a PIC” on page 133.

PIC Components

Most PICs supported on the M20 router have the following components. For complete specifications, see the *M20 PIC Guide*. For information about pinouts for PIC cable connectors, see “Cable Connector Pinouts” on page 229.

- 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 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 11). The main function of an FPC is to connect the PICs installed in it to the other router components. An I/O Manager ASIC on the FPC divides each incoming data packet into 64-byte cells and passes the cells through the midplane to the SSB, where another ASIC decides how to distribute them among the memory buffers located on and shared by all installed FPCs. After the SSB decides how to forward a packet, an I/O Manager ASIC on the FPC reassembles the corresponding data cells back into network-packet form and passes the packet to the appropriate PIC for transmission to the network. For more information, see “Data Flow Through the Packet Forwarding Engine” on page 46.

The M20 router supports the FPC in Table 9 on page 12.

Table 9: FPCs Supported by the M20 Router

FPC Name	FPC Model Number	Maximum Number of PICs Supported per FPC	Maximum Throughput per FPC	First JUNOS Release
Enhanced Plus FPC1	M20-FPC1-EP	4	3.2 Gbps	7.2

An Enhanced Plus FPC1 is labeled with an EP sticker on its faceplate.

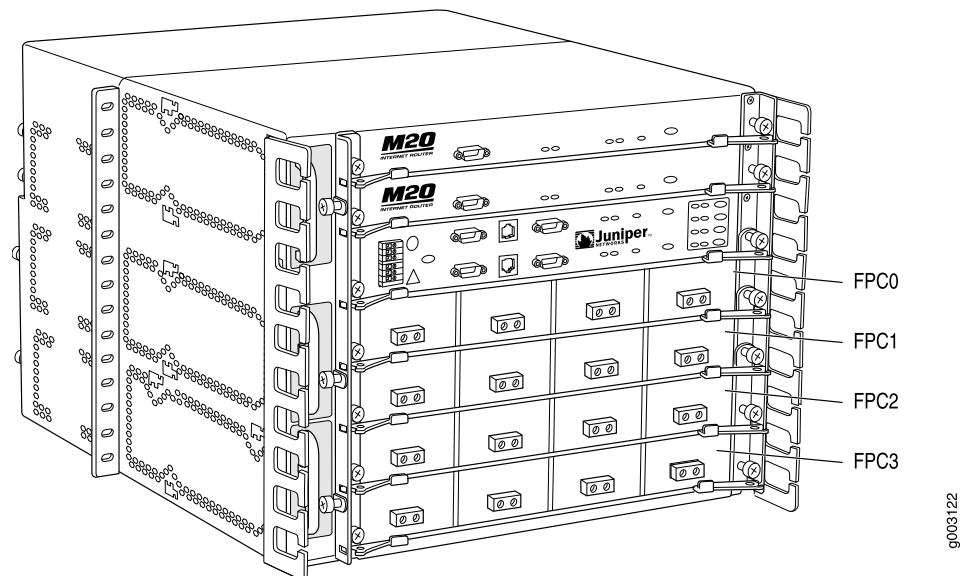
Enhanced FPCs provide more SRAM memory than the standard FPCs, which increases scalability, provides more granular class-of-service (CoS) capabilities, and enhances VPN scaling.

Up to four FPCs install horizontally into the midplane from the front of the chassis. The FPC slots are numbered top to bottom, from **FPC0** to **FPC3**. Each FPC accommodates up to four PICs. The PIC slots in each FPC are numbered from **0** (zero) through **3**, left to right. 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.

FPCs are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. When you remove or install an FPC, packet forwarding halts for about 200 ms while the Packet Forwarding Engine adjusts to the change in the amount of memory available in the pool located on and shared by all FPCs. When you install an FPC into a functioning router, the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs housed on the FPC are enabled. Forwarding continues uninterrupted during this process. For FPC replacement instructions, see “Replacing an FPC” on page 128.

Figure 4 on page 13 shows a chassis with FPCs installed in all four slots.

Figure 4: Front of Chassis with FPCs Installed



FPC Components

An FPC has the following components:

- FPC card carrier—Houses the ASICs, connectors, and processor subsystem.
- One I/O Manager ASIC—Parses Layer 2 and Layer 3 data and performs encapsulation and segmentation. The ASIC divides incoming packets into 64-byte

data cells for easier processing, and reassembles the cells for each packet after the forwarding decision is made for it.

- Two identical synchronous DRAM (SDRAM) dual inline memory modules (DIMMs)—Form the memory pool shared with the other FPCs installed in the router.
- Parity-protected synchronous SRAM (SSRAM)—Stores data structures used by the I/O Manager ASICs.
- Processor subsystem—Manages packet handling in the FPC and communication with the SSB. It is a PowerPC 603e-based CPU with parity-protected DRAM.
- EEPROM—Stores the serial number and revision level of the FPC.
- Two LEDs—Indicate FPC status. The LED labeled **OK** is green and the one labeled **FAIL** is amber. The LEDs for each FPC are located on the router craft interface. For more information, see “FPC LEDs and Offline Button” on page 30.
- Offline button—Prepares the FPC for removal from the router when pressed. Like the LEDs, an offline button is located on the craft interface. For more information, see “FPC LEDs and Offline Button” on page 30.
- Ejector levers—Control the locking system that secures the FPC in the card cage.

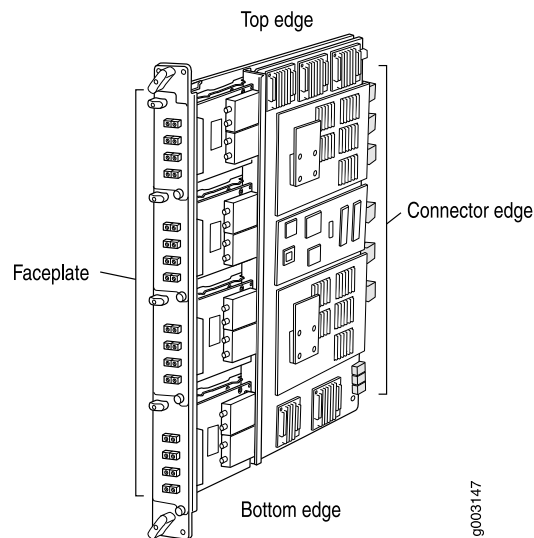


NOTE: For specific information about FPC components (for example, the amount of memory available), issue the **show chassis fpc** command.

FPC Edges

Regardless of whether you are holding an FPC vertically or horizontally, this document uses the same terms for all four edges of the FPC (see Figure 5 on page 15):

- Faceplate—Edge of the FPC that has slots into which you insert the PICs
- Connector edge—Edge opposite the faceplate; this edge has the connectors that attach to the midplane
- Top edge—Edge at the top of the FPC when it is vertical
- Bottom edge—Edge at the bottom of the FPC when it is vertical

Figure 5: FPC Edges

Handling and Storing FPCs

This section explains how to avoid damaging the FPCs that you install into routing platforms. The instructions in this section apply to all FPCs.



CAUTION: Many components on the FPC are fragile. Failure to handle FPCs as specified in this document can cause irreparable damage.

Holding an FPC



CAUTION: To prevent damage when handling or carrying FPCs, observe the following precautions.

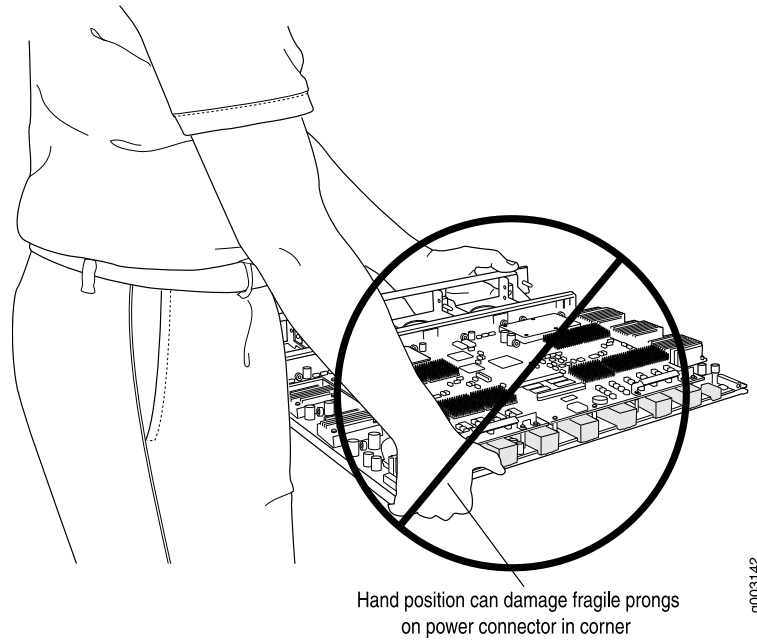


NOTE: An FPC configured with PICs installed can weigh as much as 7 lb (3.1 kg). Be prepared to accept the full weight of the FPC as you lift it.

As you carry the FPC, do not bump it against anything. FPC components are fragile.

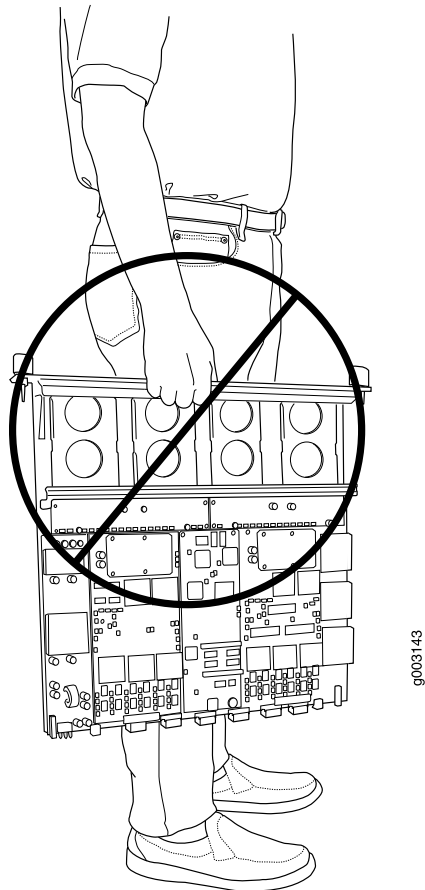
Do not grasp the FPC anywhere except places that this document indicates. In particular, never grasp the connector edge, especially at the power connector in the corner where the connector and bottom edges meet (see Figure 6 on page 16).

Figure 6: Do Not Grasp the Connector Edge



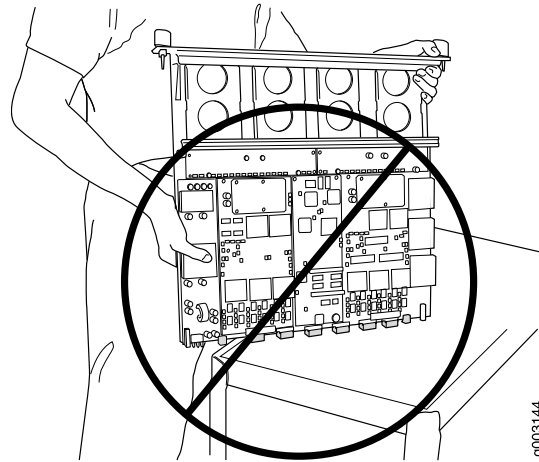
Do not carry the FPC by the faceplate with only one hand (see Figure 7 on page 17).

Figure 7: Do Not Carry an FPC with Only One Hand



Do not rest any edge of an FPC directly against a hard surface (see Figure 8 on page 18). If you must rest the FPC temporarily on an edge while changing its orientation between vertical and horizontal, use your hand as a cushion between the edge and the surface.

Figure 8: Do Not Rest the FPC on an Edge

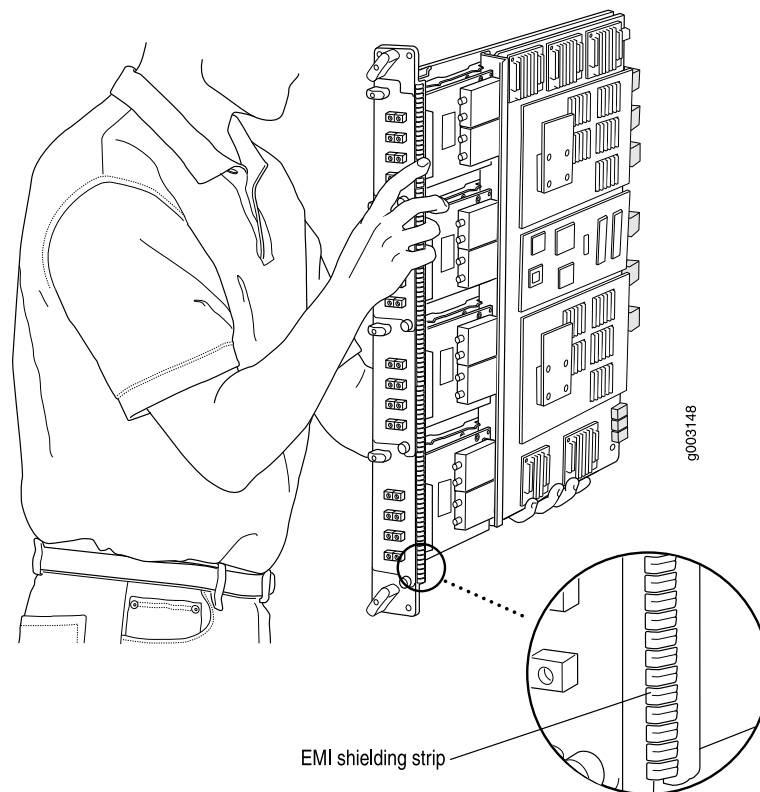


Holding an FPC Vertically

You hold an FPC horizontally when installing it into the chassis or an equipment rack. To hold an FPC vertically (see Figure 9 on page 19):

1. Orient the FPC so that the faceplate faces you.
2. Place one hand around the FPC faceplate about a quarter of the way down from the top edge. To avoid deforming the electromagnetic interference (EMI) shielding strip, do not press hard on it.
3. Place your other hand at the bottom edge of the FPC. If the FPC has heat sinks about midway between the faceplate and connector edge, place your other hand against the heat sinks.

Figure 9: Holding an FPC Vertically



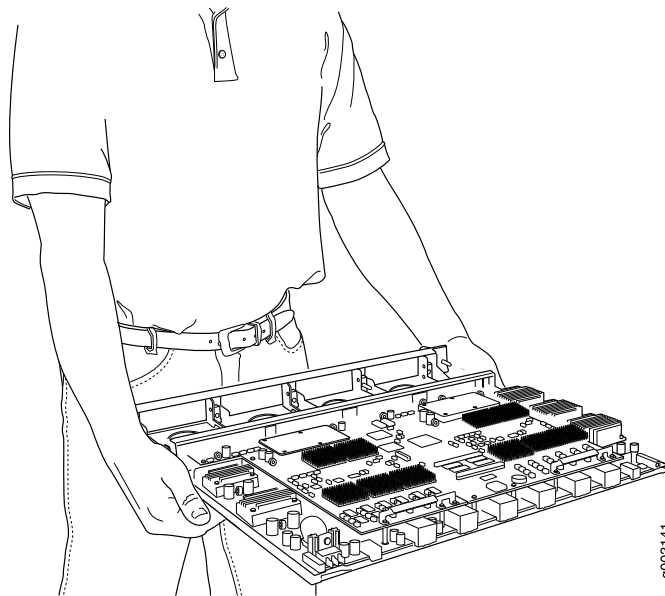
Holding an FPC Horizontally

If the FPC is horizontal before you grasp it, place your left hand around the faceplate and your right hand along the bottom edge. To hold an FPC horizontally (see Figure 10 on page 20):

1. Orient the FPC so that the faceplate faces you.
2. Grasp the top edge with your left hand and the bottom edge with your right hand. If the FPC has heat sinks about midway between the faceplate and connector edge, place your right hand against the heat sinks.

You can rest the faceplate of the FPC against your body as you carry it.

Figure 10: Holding an FPC Horizontally



Storing an FPC

When not installed in the routing platforms, FPCs must be either stored in the container in which a spare FPC is shipped or stored horizontally and component-side up on a flat, stable surface.

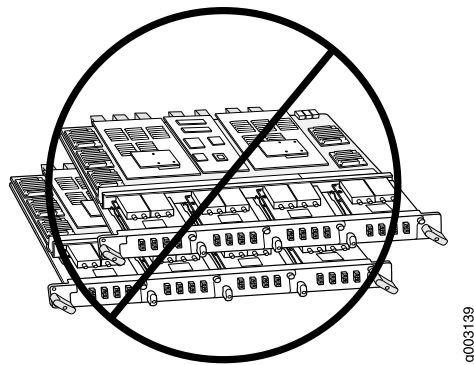
When you store an FPC on a horizontal surface or in the shipping container, always place it inside an antistatic bag. Because the FPC is heavy and because antistatic bags are fragile, inserting the FPC into the bag is easier with two people. To do this, one person holds the FPC in the horizontal position with the faceplate facing the body, and the other person slides the opening of the bag over the FPC connector edge. If you must insert the FPC into a bag by yourself, first lay the FPC horizontally on a flat, stable surface, component-side up. Orient the FPC with the faceplate facing you. Carefully insert the FPC connector edge into the opening of the bag, and pull the bag toward you to cover the FPC.



CAUTION: To prevent damage when storing FPCs, observe the following precautions:

- Never lay an FPC component-side down.
- Never stack an FPC under or on top of any other component (see Figure 11 on page 21).

Figure 11: Do Not Stack FPCs



System and Switch Board (SSB)

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

One or two SSBs can be installed into the uppermost slots in the front of the chassis, as shown in Figure 1 on page 8. Only one SSB is active at a time, with the optional second SSB in reset mode. SSBs are hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. Removing the standby SSB has no effect on router function. If the active SSB fails or is removed from the chassis, the effect depends on whether two SSBs are installed:

- If there is only one SSB, forwarding halts until the SSB is replaced and functioning again.
- If there are two SSBs, forwarding halts until the standby SSB boots and becomes active.

In both cases, all components in the Packet Forwarding Engine reset, and it takes approximately one minute for the new SSB to become active; synchronizing router configuration information can take additional time, depending on the complexity of the configuration.

For SSB replacement instructions, see “Replacing an SSB” on page 138.

The SSB communicates with the Routing Engine using a dedicated 100-Mbps Fast Ethernet link that transfers routing table data from the Routing Engine to the forwarding table in the Internet Processor II ASIC. The link is also used to transfer

from the SSB to the Routing Engine routing link-state updates and other packets destined for the router that have been received through the router interfaces.

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

- Route lookups—The Internet Processor II ASIC on each SSB performs route lookups using the forwarding table stored in SSRAM.
- Management of shared memory on the FPCs—One Distributed Buffer Manager ASIC receives the 64-byte data cells into which the I/O Manager ASIC on each FPC divides incoming packets, and uniformly allocates them throughout the shared memory buffers located on the FPCs.
- Transfer of outgoing data packets—The second Distributed Buffer Manager ASIC passes notification of the forwarding decision for each packet to an I/O Manager ASIC so that data cells for the outgoing packet can be reassembled for transmission to the network.
- Transfer of exception and control packets—The Internet Processor II ASIC passes exception packets to the microprocessor on the SSB, which processes almost all of them. The SSB sends any remaining exception packets to the Routing Engine for further processing. When the SSB detects an error originating in the Packet Forwarding Engine, it sends it to the Routing Engine using system logging (syslog) messages.
- Monitoring of system components—The SSB monitors other system components for failure and alarm conditions. It collects statistics from all sensors in the system and relays them to the Routing Engine, which sets alarms as appropriate. For example, if the temperature of a component exceeds the lower of two internally defined thresholds, the Routing Engine issues a “high temperature” alarm. If the temperature exceeds the higher threshold, the Routing Engine initiates a system shutdown.
- Controlling FPC resets—The SSB monitors the operation of the FPCs. If it detects errors in an FPC, the SSB attempts to reset the FPC. After three unsuccessful resets, the SSB takes the FPC offline and informs the Routing Engine. Other FPCs are unaffected, and normal system operation continues.
- Providing SONET/SDH clock source—The SSB generates a 19.44-MHz clock signal for use by SONET/SDH interfaces.

SSB Components

An SSB has the following components (see Figure 12 on page 23 and Figure 13 on page 23):

- Two Distributed Buffer Manager ASICs—Process incoming and outgoing packets: one distributes data cells (which the I/O Manager ASIC on each FPC derives from incoming packets) to the shared memory buffers on the FPCs, while the second forwards notification of routing decisions to the I/O Manager ASICs.
- One Internet Processor II ASIC—Performs route lookups and makes routing decisions.
- Parity-protected SSRAM—Stores the forwarding table.
- Processor subsystem—Manages SSB functions and handles exception packets. The processor has the following components:

- One PowerPC 603e processor
- Parity-protected Level 2 cache
- Parity-protected DRAM
- EEPROM—Stores the serial number and revision level.
- Offline button—Prepares the SSB for removal from the router when pressed.
- 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 SSB to a laptop or other monitoring device through an RS-232 (EIA-232) serial cable. It uses a DB-25 connector. See Figure 13 on page 23.
- Five LEDs—Indicate SSB status. There are two green ones labeled **STATUS**, an amber one labeled **OFFLINE**, a green one labeled **ONLINE**, and a green one labeled **MASTER**. Table 10 on page 24 describes the LED states.
- Ejector levers—Control the locking system that secures the SSB in the chassis.



NOTE: For specific information about SSB components (for example, the amount of DRAM), issue the `show chassis ssb` command.

Figure 12: System and Switch Board

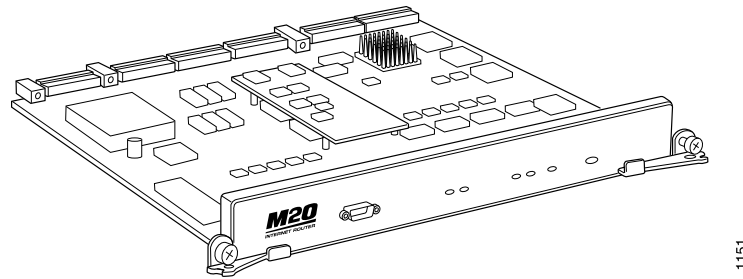


Figure 13: SSB Faceplate

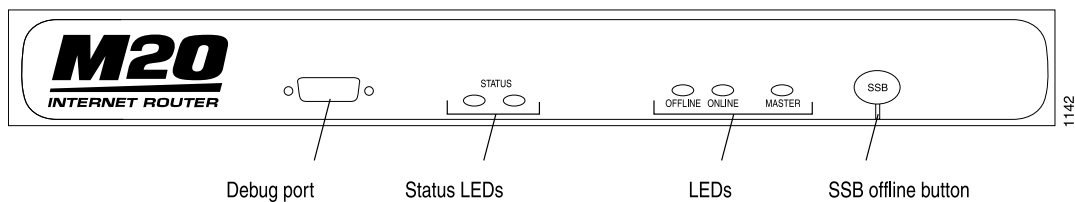


Table 10: States for SSB LEDs

Label	Color	State	Description
STATUS	Green	—	For debugging use by Juniper Networks Technical Support personnel.
OFFLINE	Amber	On steadily	SSB is not operational or is in reset mode.
ONLINE	Green	On steadily	SSB is running normally.
MASTER	Blue	On steadily	SSB is functioning as master.

Routing Engine

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

For a description of the Routing Engine's role in router architecture, see “Routing Engine Architecture” on page 47.

One or two Routing Engines can be installed into the midplane from the rear of the chassis, as shown in Figure 2 on page 8. If two Routing Engines are installed, they determine together which is the master and which is in standby mode (and so performs no functions). By default, the Routing Engine in the slot labeled **RE0** is the master. To change the default, include the appropriate `[edit chassis redundancy routing-engine]` statement in the configuration, as described in the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.

The Routing Engine is hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. Removal or failure of the standby Routing Engine does not affect router function. If the master Routing Engine is removed from the chassis, the effect depends on whether two Routing Engines are installed:

- If there is only one Routing Engine, packet forwarding halts until a Routing Engine is installed and functioning normally.
- If there are two Routing Engines, the effect depends on the software configuration:
 - If the Routing Engines are running JUNOS Release 6.0 or later and are configured for graceful switchover, the standby Routing Engine automatically assumes mastership without interruption of forwarding performance. For information about configuring graceful switchover, see the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.

If the Routing Engines are configured for graceful switchover and are running a JUNOS release that supports graceful switchover, the standby Routing Engine immediately assumes Routing Engine functions and there is no interruption to packet forwarding. For information about configuring graceful

switchover, see the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.

We recommend you run JUNOS Release 7.0 or later on the M20 router to support graceful switchover.

- Otherwise, forwarding halts while the standby Routing Engine becomes the master and resets the Packet Forwarding Engine.

For Routing Engine replacement instructions, see “Replacing a Routing Engine” on page 160.

Note that the effect of a hardware or software failure on the master Routing Engine differs from the effect of removing the master Routing Engine:

- With the default router configuration, in case of failure you must correct the problem manually. You can issue the appropriate **request chassis routing-engine master** command to switch mastership to the other Routing Engine, for example. For information about the command, see the *JUNOS System Basics and Services Command Reference*.
- On routers with two installed Routing Engines, you can configure graceful switchover of Routing Engines, as previously described for the case of Routing Engine removal. When the standby Routing Engine stops receiving keepalive signals from the master Routing Engine, it automatically assumes mastership without interruption of forwarding performance.

We recommend you run JUNOS Release 7.0 or later on the M20 router to support graceful switchover.

- On routers with two installed Routing Engines running any JUNOS release, you can configure automatic Routing Engine mastership failover. When the standby Routing Engine stops receiving keepalive signals from the master Routing Engine, it automatically assumes mastership. Packet forwarding halts while the Packet Forwarding Engine components reset and connect to the new master Routing Engine.

For information about configuring graceful switchover or automatic mastership failover, see the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.

Routing Engine Components

The Routing Engine (shown in Figure 14 on page 27) is a two-board system with the following components:

- CPU—Runs JUNOS software to maintain the router's routing tables and routing protocols. It has a Pentium-class processor.
- DRAM—Provides storage for the routing and forwarding tables and for other Routing Engine processes.
- Internal flash disk—Provides primary storage for software images, configuration files, and microcode. The drive is a fixed compact flask disk and is inaccessible from outside the router.

- Hard disk—Provides secondary storage for log files, memory dumps, and rebooting the system if the internal flash disk fails.
- PC card slots—Accept removable PC cards, which store software images for system upgrades.
- LED—Indicates disk activity for the internal IDE interface. It does not necessarily indicate routing-related activity.
- Interfaces for out-of-band management access—Provide information about Routing Engine status to devices (console, laptop, or terminal server) that can be attached to access ports located on the craft interface.

Each Routing Engine has one 10/100-Mbps Ethernet port for connecting to a management network, and two asynchronous serial ports—one for connecting to a console and one for connecting to a modem or other auxiliary device.

- EEPROM—Stores the serial number of the Routing Engine.
- Reset button—Reboots the Routing Engine when pressed.



NOTE: The LEDs that report Routing Engine status are on the Routing Engine panel and on the craft interface, rather than the Routing Engine faceplate. For more information, see “Routing Engine Panel and Fan Tray” on page 27.



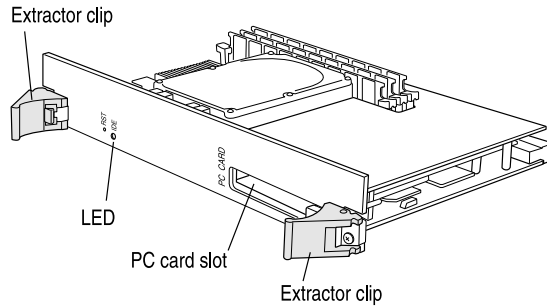
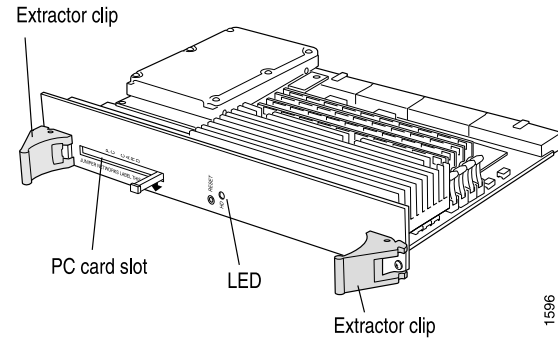
NOTE: The appearance and position of electronic components or the PC Card slot on your Routing Engine might differ from Figure 14 on page 27 and other figures in this document that depict the Routing Engine. These differences do not affect Routing Engine installation and removal or functionality.



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



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

Figure 14: Routing Engine**Routing Engine 333****Routing Engine 600**

1596

Routing Engine Panel and Fan Tray

The Routing Engine panel installs into the rear of the chassis, to the right of the Routing Engine slots (see Figure 2 on page 8). Behind the panel are two fans for cooling the Routing Engine. As shown in Figure 15 on page 27, LEDs on the left side of the panel faceplate report Routing Engine status. The upper set reports the status of the Routing Engine in the upper Routing Engine slot (**RE0**) and the lower set reports the status of the Routing Engine in the lower slot (**RE1**). Each set includes three LEDs—an amber one labeled **OFFLINE**, a green one labeled **ONLINE**, and a blue one labeled **MASTER**.

To the right of each **MASTER** LED is an offline button for the same Routing Engine as the LEDs. Press the button to take the Routing Engine offline for replacement as directed in this manual.

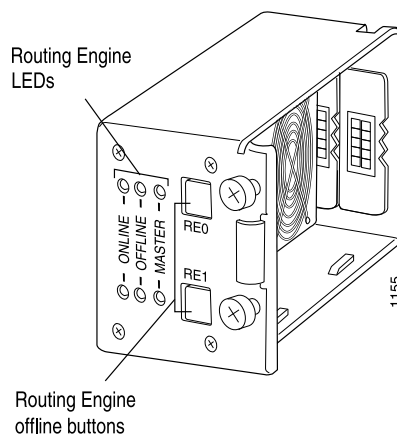
Figure 15: Routing Engine Panel

Table 11 on page 28 describes the Routing Engine LED states.

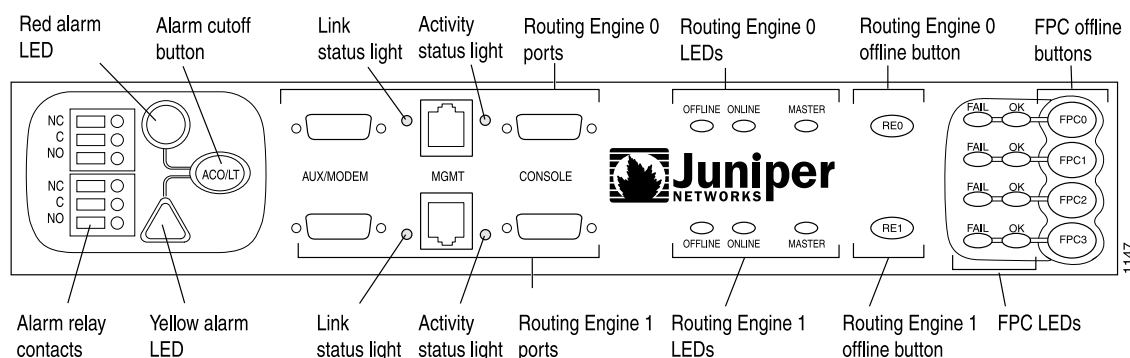
Table 11: States for Routing Engine LEDs

Label	Color	State	Description
OFFLINE	Amber	On steadily	Routing Engine is not operational or is in reset mode.
ONLINE	Green	On steadily	Routing Engine is running normally.
MASTER	Blue	On steadily	Routing Engine is functioning as master.

LEDs and offline buttons with the same function also appear on the craft interface. For more information, see “Routing Engine LEDs and Offline Buttons” on page 30.

Craft Interface

The craft interface provides status and troubleshooting information at a glance and has buttons for deactivating alarms and preparing FPCs for removal. The craft interface is located on the front of the chassis above the FPC card cage, as shown in Figure 1 on page 8. It includes the elements shown in Figure 16 on page 28.

Figure 16: Craft Interface

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

- SSB Components on page 22
- Power Supply LEDs on page 33

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

- Alarm Relay Contacts, LEDs, and Cutoff Button on page 29
- Routing Engine Interface Ports and Status Indicators on page 29

- Routing Engine LEDs and Offline Buttons on page 30
- FPC LEDs and Offline Button on page 30

Alarm Relay Contacts, LEDs, and Cutoff Button




At the far left side of the craft interface are two relay contacts for connecting the router to external alarm-reporting devices. The upper set is activated by a system red alarm and the lower set by a system yellow alarm. For instructions for attaching a device to the alarm relay contacts, see “Connecting to an External Alarm-Reporting Device” on page 85.

Immediately to the right of the alarm relay contacts are the two large alarm LEDs. The circular red LED lights to indicate a critical condition that can result in a system shutdown. The triangular yellow LED lights to indicate a less severe condition that requires monitoring or maintenance. Both LEDs can be lit simultaneously.

To deactivate red and yellow alarms, press the button labeled ACO/LT (for “alarm cutoff/lamp test”), 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, but does not correct the problem that caused the alarm.

Table 12 on page 29 describes the alarm LEDs and alarm cutoff button in more detail.

Table 12: Alarm LEDs and Alarm Cutoff/Lamp Test Button

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

Routing Engine Interface Ports and Status Indicators

To the right of the alarm LEDs on the craft interface are two sets of ports for connecting the Routing Engines to one or more external devices on which system administrators can issue JUNOS command-line interface (CLI) commands to manage the router (see Figure 16 on page 28). The upper set of ports connects to the Routing Engine in the upper Routing Engine slot (RE0), and the lower set connects to the Routing Engine in the lower Routing Engine slot (RE1).

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

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

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

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

For information about the pinouts for the connectors, see “Cable Connector Pinouts” on page 229.

Routing Engine LEDs and Offline Buttons

Above and below the Juniper Networks logo near the middle of the craft interface are status LEDs and offline buttons for the Routing Engines (see Figure 16 on page 28). They have the same function as the LEDs and buttons on the Routing Engine panel. For more information, see “Routing Engine Panel and Fan Tray” on page 27.

FPC LEDs and Offline Button

The FPC LEDs and offline buttons are located at the far right side of the craft interface, as shown in Figure 16 on page 28. The amber LED labeled **FAIL** and the green LED labeled **OK** indicate FPC status, as described in Table 13 on page 30.

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

Table 13: States for FPC LEDs

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

Power System

The router uses either AC or DC power. There are two load-sharing, isolated power supplies located at the bottom rear of the chassis, as shown in Figure 2 on page 8. The power supplies connect to the midplane, which distributes power to router

components according to their individual voltage requirements. When the power supplies are installed and operational, they automatically share the electrical load. If a power supply stops functioning for any reason, the remaining power supply instantly begins providing all the power the router needs for normal functioning and can provide full power indefinitely.



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

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

Power supplies are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. To avoid electrical injury, carefully follow the instructions in “Replacing an AC Power Supply” on page 141 and “Replacing a DC Power Supply” on page 147.



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 off 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 off the router again, first issue the CLI **request system halt** command. For more information, see “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

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

See the following sections for further information:

- AC Power Supply on page 31
- DC Power Supply on page 32
- Power Supply LEDs on page 33

AC Power Supply

An AC-powered router has two load-sharing, isolated AC power supplies, located at the bottom rear of the chassis, as shown in Figure 2 on page 8. For information about power supply redundancy and replaceability, see “Power System” on page 30.

Figure 17 on page 32 shows the power supply and Table 14 on page 32 lists electrical specifications. For information about the LEDs on the power supply, see “Power Supply LEDs” on page 33.

Figure 17: AC Power Supply

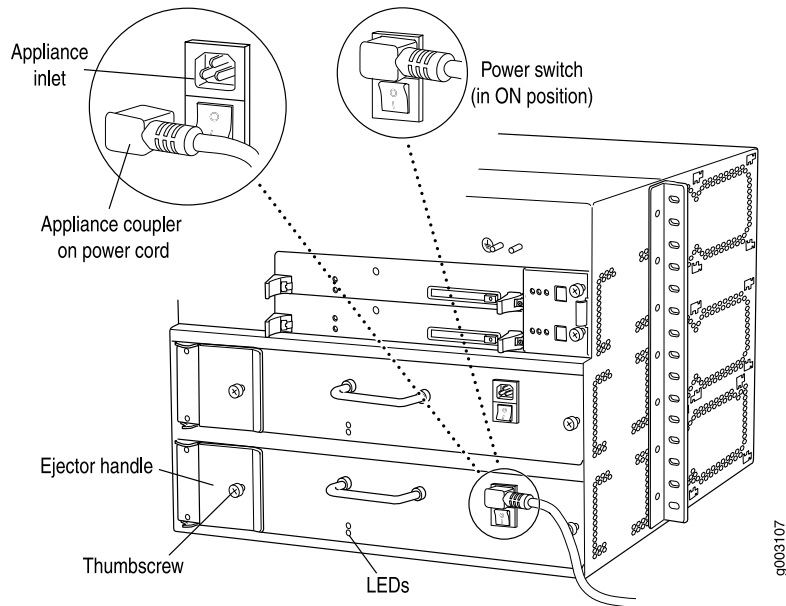


Table 14: Electrical Specifications for AC Power Supply

Description	Specification
Maximum power output	750 W; isolated
AC input voltage	Nominal: 100 - 240 VAC Operating range: 90–264 VAC
AC input line frequency	47 – 63 Hz
AC input current rating	12 - 6 A
Output voltages	+ 3.3 V @ 125 A, + 2.5 V @ 50 A, + 5 V @ 60 A, + 24 V @ 4 A, + 12 V @ 0.25 A, + 5 V aux. @ 0.25 A

DC Power Supply

A DC-powered router has two load-sharing, isolated DC power supplies, located at the bottom rear of the chassis, as shown in Figure 2 on page 8. Each DC power supply has an internal circuit breaker. For information about power supply redundancy and replaceability, see “Power System” on page 30.

Figure 18 on page 33 shows the power supply and Table 15 on page 33 lists electrical specifications. For information about the LEDs on the power supply, see “Power Supply LEDs” on page 33.

Figure 18: DC Power Supply

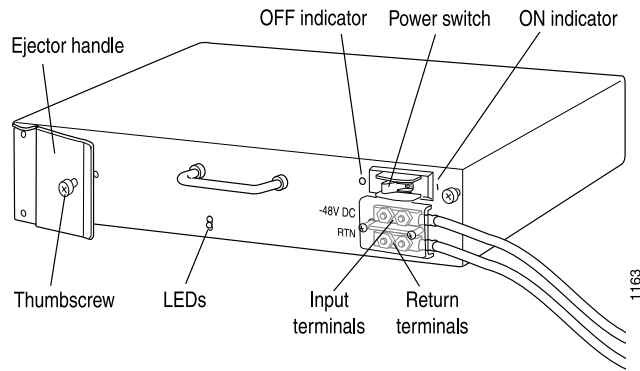


Table 15: Electrical Specifications for DC Power Supply

Description	Specification
Maximum power output	750 W; isolated
DC input voltage	Nominal: -48 VDC, -60 VDC Operating range: -40.5 to -72 VDC NOTE: If the input voltage from the DC power source drops below -40.5 VDC, the routing platform automatically shuts down. During automatic shutdown, the circuit remains active. When the input voltage returns to -42.75 VDC, the router automatically starts up again and the system returns to normal operation within 30 minutes. No operator intervention is required.
Input DC current rating	24 A @ -48 V
Output voltages	+ 2.5 V @ 50 A, + 3.3 V @ 12.5 A, + 5 V @ 60 A, + 24 V @ 4 A, + 12 V @ 0.25 A, + 5 V aux. @ 0.25 A



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

Power Supply LEDs

Table 16 on page 34 describes the LEDs on both AC and DC power supplies.

Table 16: 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.
FAULT	Amber	On steadily	Power supply has failed.

In addition, when one or both of the power supplies is operating outside the acceptable voltage range, the red alarm LED lights on the craft interface, and the red alarm relay contact on the craft interface is activated.

Cooling System

The cooling system includes several fan trays that draw room air into the chassis to keep its internal temperature below a maximum acceptable level. The cooling subsystems have redundant components, which are controlled by the SSB. If a fan fails, the remaining fans provide sufficient cooling for the unit indefinitely.

The router cooling system consists of the following components:

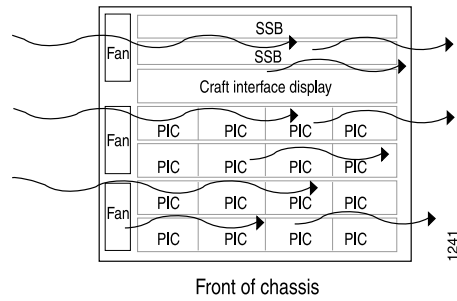
- Three front fan trays—Cool the FPCs and the SSB. The fan trays are located on the left front side of the chassis, as shown in Figure 1 on page 8. Each tray houses three fans.
- Routing Engine fan tray—Cools the Routing Engines. The fan tray is located behind the Routing Engine panel, as shown in Figure 2 on page 8. It houses two fans.
- Power supply integrated fan—Cools each power supply. It is built into the supply.

All cooling components are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. For instructions on replacing cooling system components, see “Replacing Cooling System Components” on page 123.



CAUTION: Do not remove a fan tray for more than a few minutes while the router is operating. The fans are powerful enough to draw in foreign material, such as bits of wire, into the chassis, which could damage router components.

The four fan trays plug directly into the router midplane and work together to provide side-to-side cooling, as shown in Figure 19 on page 35.

Figure 19: Airflow Through the Chassis

Cable Management System

The cable management system consists of racks that attach vertically to each side of the chassis at the front, as shown in Figure 1 on page 8. Pass PIC cables through the slots in the racks to keep the cables organized and securely in place, and to avoid bending optical cables beyond the proper bend radius. The cable management system evenly distributes the weight of a cable, so that it is not subjected to undue stress at the connector.

Chapter 3

JUNOS Software Overview

The JUNOS 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 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 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 software to monitor the protocol traffic passing through the router and to troubleshoot protocol and network connectivity problems.

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

This chapter discusses the following topics:

- Command-Line Interface on page 37
- Routing Engine Software Components on page 38
- Tools for Accessing and Configuring the Software on page 43
- Tools for Monitoring the Software on page 44
- Software Upgrades on page 44

Command-Line Interface

The JUNOS software command-line interface (CLI) is the primary tool for controlling and troubleshooting router hardware, the JUNOS software, routing protocols, and network connectivity. CLI commands display information from routing tables, information specific to routing protocols, and information about network connectivity derived from the `ping` and `traceroute` utilities.

You enter CLI commands on one or more external management devices connected to the Routing Engine through ports on the craft interface. The port labeled

AUX/MODEM attaches the Routing Engine to a laptop, modem, or other auxiliary device, the port labeled **CONSOLE** attaches to a system console, and the port labeled **MGMT** attaches to a management LAN. For more information, see “Routing Engine Interface Ports and Status Indicators” on page 29.

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 38
- VPNs on page 42
- Interface Process on page 42
- Chassis Process on page 43
- SNMP and MIB II Processes on page 43
- Management Process on page 43
- Routing Engine Kernel on page 43

Routing Protocol Process

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

This section discusses the following topics:

- IPv4 Routing Protocols on page 38
- IPv6 Routing Protocols on page 40
- Routing and Forwarding Tables on page 40
- Routing Policy on page 41

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

IPv4 Routing Protocols

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

- Unicast routing protocols
 - BGP—Border Gateway Protocol, version 4, is an Exterior Gateway Protocol (EGP) that guarantees loop-free exchange of routing information between routing domains (also called autonomous systems). BGP, in conjunction with JUNOS routing policy, provides a system of administrative checks and balances that can be used to implement peering and transit agreements.
 - ICMP—Internet Control Message Protocol router discovery is a method that hosts can use to discover the addresses of operational routers on a subnet.
 - IS-IS—Intermediate System-to-Intermediate System is a link-state interior gateway protocol (IGP) for IP networks that uses the shortest-path-first algorithm (SPF algorithm, also called the Dijkstra algorithm) to determine routes.
 - OSPF—Open Shortest Path First, version 2, is an IGP developed for IP networks by the Internet Engineering Task Force (IETF). OSPF is a link-state protocol that makes routing decisions based on the SPF algorithm.
 - RIP—Routing Information Protocol, version 2, is an IGP for IP networks based on the Bellman-Ford algorithm. RIP is a distance-vector protocol. RIP dynamically routes packets between a subscriber and a service provider without the subscriber having to configure BGP or to participate in the service provider's IGP discovery process.
- Multicast routing protocols
 - DVMRP—Distance Vector Multicast Routing Protocol is a dense-mode (flood-and-prune) multicast routing protocol.
 - IGMP—Internet Group Management Protocol, versions 1 and 2, is used to manage membership in multicast groups.
 - MSDP—Multicast Source Discovery Protocol enables multiple PIM sparse mode domains to be joined. A rendezvous point (RP) in a PIM sparse mode domain has a peering relationship with an RP in another domain, thereby discovering multicast sources from other domains.
 - PIM sparse mode and dense mode—Protocol-Independent Multicast is a multicast routing protocol used to route traffic to multicast groups that might span wide-area and interdomain internetworks. In PIM sparse mode, routers explicitly join and leave multicast groups. PIM dense mode is a flood-and-prune protocol.
 - SAP/SDP—Session Announcement Protocol and Session Description Protocol handle conference session announcements.
- MPLS application protocols
 - LDP—Label Distribution Protocol provides a mechanism for distributing labels in nontraffic-engineered applications. LDP allows routers to establish label-switched paths (LSPs) through a network by mapping network-layer routing information directly to data-link layer switched paths. LSPs created by LDP can also traverse LSPs created by Resource Reservation Protocol (RSVP).

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

IPv6 Routing Protocols

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

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

Routing and Forwarding Tables

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

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

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

In the unicast routing table, the routing protocol process designates routes with the lowest preference values as active. By default, a route's preference value is simply a function of how the routing protocol process learned about the route. You can modify the default preference value by setting routing policies and configuring other software parameters. See “Routing Policy” on page 41.

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

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

- **MPLS routing table**—Stores MPLS label information.

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

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

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

Routing Policy

By default, all routing protocols place their routes into the routing table. When advertising routes, the routing protocols, by default, advertise only a limited set of routes from the routing table. Specifically, each routing protocol exports only the active routes that were learned by that protocol. In addition, IGP (IS-IS, OSPF, and RIP) export the direct (interface) routes for the interfaces on which the protocol is explicitly configured.

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

Routing policies applied when the routing protocol places routes into the routing table are called *import policies* because the routes are being imported into the routing table. Policies applied when the routing protocol is advertising routes that are in the routing table are called *export policies* because the routes are being exported from

the routing table. In other words, the terms import and export are used with respect to the routing table.

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

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

VPNs

The JUNOS software supports several types of VPNs:

- **Layer 2 VPNs**—A Layer 2 VPN links a set of sites sharing common routing information, and whose connectivity is controlled by a collection of policies. A Layer 2 VPN is not aware of routes within a customer's network. It simply provides private links between a customer's sites over the service provider's existing public Internet backbone.
- **Layer 3 VPNs**—A Layer 3 VPN links a set of sites that share common routing information, and whose connectivity is controlled by a collection of policies. A Layer 3 VPN is aware of routes within a customer's network, requiring more configuration on the part of the service provider than a Layer 2 VPN. The sites that make up a Layer 3 VPN are connected over a service provider's existing public Internet backbone.
- **Interprovider VPNs**—An interprovider VPN supplies connectivity between two VPNs in separate autonomous systems (ASs). This functionality could be used by a VPN customer with connections to several various ISPs, or different connections to the same ISP in various geographic regions.
- **Carrier-of-Carrier VPNs**—Carrier-of-carrier VPNs allow a VPN service provider to supply VPN service to a customer who is also a service provider. The latter service provider supplies Internet or VPN service to an end customer.

Interface Process

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

properties. You can configure both interfaces that are currently active and interfaces that might be installed later.

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

Chassis Process

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

SNMP and MIB II Processes

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

Management Process

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

Routing Engine Kernel

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

Tools for Accessing and Configuring the Software

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

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

Tools for Monitoring the Software

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

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

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

Software Upgrades

The router is delivered with the JUNOS software preinstalled. To upgrade the software, you use CLI commands to copy a set of software images over the network to memory storage on the Routing Engine. The JUNOS 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 Software Installation and Upgrade Guide*.

Chapter 4

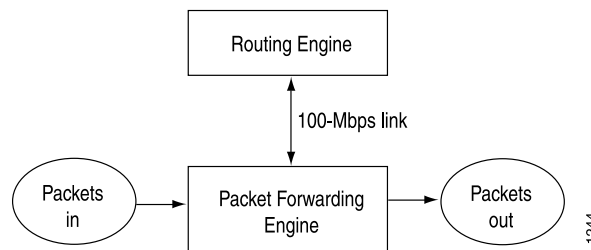
System Architecture Overview

The router architecture consists of two major components:

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

The Packet Forwarding Engine and the Routing Engine perform independently but communicate constantly through a 100-Mbps internal link. This arrangement provides streamlined forwarding and routing control and the ability to run Internet-scale networks at high speeds. Figure 20 on page 45 illustrates the relationship between the Packet Forwarding Engine and the Routing Engine.

Figure 20: System Architecture



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

- Packet Forwarding Engine Architecture on page 45
- Routing Engine Architecture on page 47

Packet Forwarding Engine Architecture

The Packet Forwarding Engine performs Layer 2 and Layer 3 packet switching. It can forward up to 40 Mpps for all packet sizes. The aggregate throughput is 3.2 gigabits per second (Gbps) per FPC. The Packet Forwarding Engine is implemented in application-specific integrated circuits (ASICs). It uses a centralized route lookup engine and shared memory.

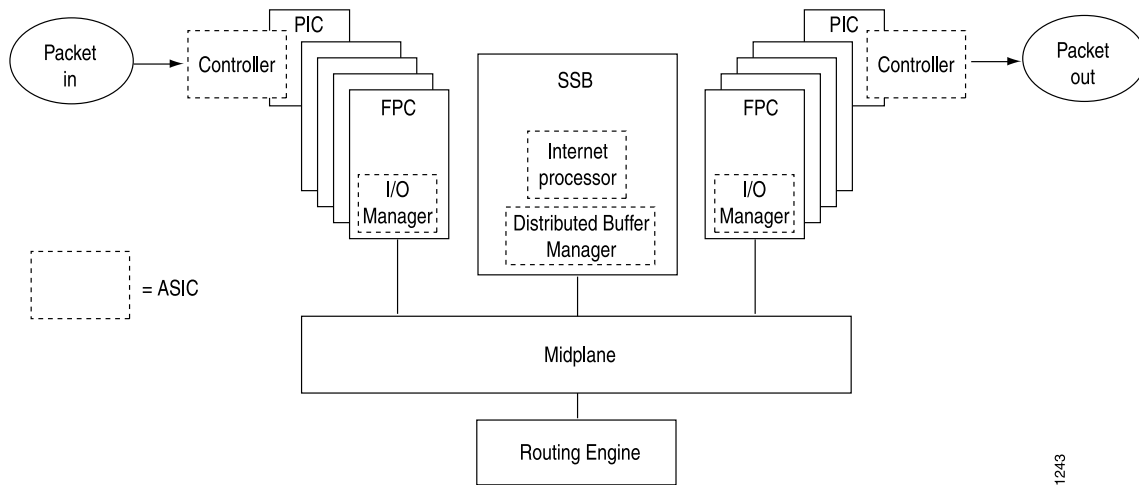
The Packet Forwarding Engine architecture includes the following components:

- Midplane—Transports packets, notifications, and other signals between the FPCs and the Packet Forwarding Engine (as well as other system components).
- Physical Interface Card (PIC)—Physically connects the router to fiber-optic or digital network media. A controller ASIC in each PIC performs control functions specific to the PIC media type.
- Flexible PIC 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.
- System and Switch Board (SSB)—Hosts an Internet Processor II ASIC, which makes forwarding decisions, and two Distributed Buffer Manager ASICs: one distributes data cells to the shared memory buffers on the FPCs and the other notifies the FPCs of forwarding decisions for outgoing packets.

Data Flow Through the Packet Forwarding Engine

Use of ASICs promotes efficient movement of data packets through the system. Packets flow through the Packet Forwarding Engine in the following sequence (see Figure 21 on page 47):

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

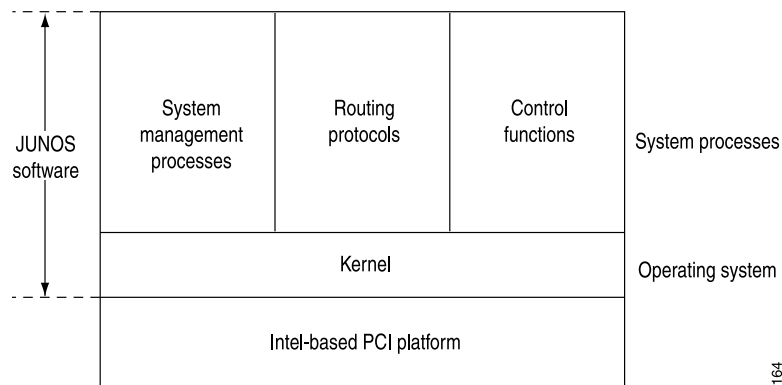
Figure 21: Packet Forwarding Engine Components and Data Flow

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Routing Engine Architecture

The Routing Engine is an Intel-based PCI platform running the JUNOS 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 22 on page 47).

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

Figure 22: Routing Engine Architecture

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Routing Engine Functions

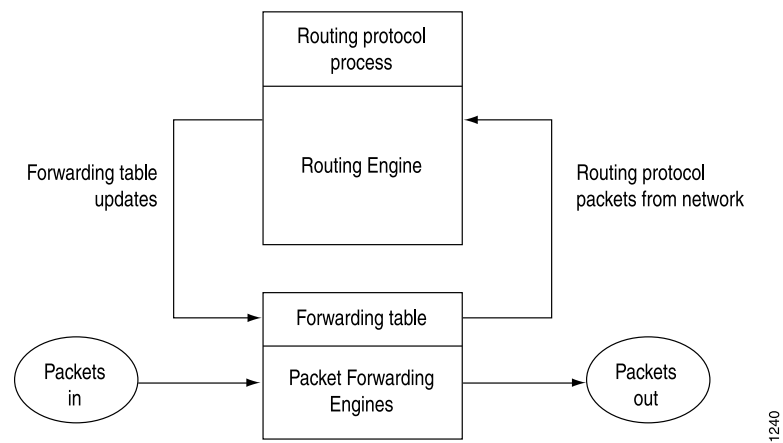
The Routing Engine handles all routing protocol processes, as well as the software processes that control the router's interfaces, the chassis components, system management, and user access to the router. These routing and software processes

run on top of a kernel that interacts with the Packet Forwarding Engine. For more information about the processes, see the *JUNOS System Basics and Services Command Reference*.

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

The Routing Engine constructs and maintains one or more routing tables (see Figure 23 on page 49). From the routing tables, the Routing Engine derives a table of active routes, called the forwarding table, which is then copied into the Packet Forwarding Engine. The design of the ASICs allow the forwarding table in the Packet Forwarding Engine to be updated without interrupting forwarding performance.

Figure 23: Control Packet Handling for Routing and Forwarding Table Updates

Part 2

Initial Installation

- Preparing for Router Installation on page 53
- Unpacking the Router on page 59
- Installing the Router Using a Mechanical Lift on page 63
- Installing the Router Without a Mechanical Lift on page 65
- Connecting the Router on page 83
- Grounding and Providing Power to the Router on page 89
- Configuring the Router on page 95

Chapter 5

Preparing for Router Installation

This chapter describes how to prepare your site for installation of the M20 Internet router. It discusses the following topics:

- Site Preparation Checklist on page 53
- Rack Requirements on page 54

Site Preparation Checklist

The checklist in Table 17 on page 53 summarizes the tasks you need to perform when preparing a site for router installation.

Table 17: Site Preparation Checklist

Item or Task	For More Information	Performed By	Date
Environment			
Verify that environmental factors such as temperature and humidity do not exceed router tolerances.	"Router Environmental Specifications" on page 203		
Power			
Measure distance between external power sources and router installation site.	"DC Power, Connection, and Cable Specifications" on page 209		
Locate sites for connection of system grounding.	"Chassis Grounding" on page 207		
Calculate the power consumption and requirements.	"Router Power Requirements" on page 206		
Hardware Configuration			
Choose the configuration.	"Hardware Component Overview" on page 7		
Rack			
Verify that your rack meets the minimum requirements for the installation of the router.	"Rack Requirements" on page 54		

Table 17: Site Preparation Checklist (continued)

Item or Task	For More Information	Performed By	Date
Plan rack location, including required space clearances.	“Clearance Requirements for Airflow and Hardware Maintenance” on page 56 “Rack Size and Strength” on page 54		
If a rack is used, secure rack to floor and building structure.	“Connection to Building Structure” on page 56		
Cables			
Acquire cables and connectors: <ul style="list-style-type: none"> ■ Determine the number of cables needed based on your planned configuration. ■ Review the maximum distance allowed for each cable. Choose the length of cable based on the distance between the hardware components being connected. 	“Calculating Power Budget for Fiber-Optic Cable” on page 215 “Calculating Power Margin for Fiber-Optic Cable” on page 215		
Plan the cable routing and management.	“Maintaining PICs and PIC Cables” on page 103		

Rack Requirements

The router must be installed in a rack. Many types of racks are acceptable, including front-mount racks, 4-post (telco) racks, and center-mount racks. An example of a center-mount rack appears in Figure 24 on page 55.

The following sections describe rack requirements:

- Rack Size and Strength on page 54
- Spacing of Mounting Holes on page 55
- Connection to Building Structure on page 56
- Clearance Requirements for Airflow and Hardware Maintenance on page 56

Rack Size and Strength

The router is designed for installation in 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>).

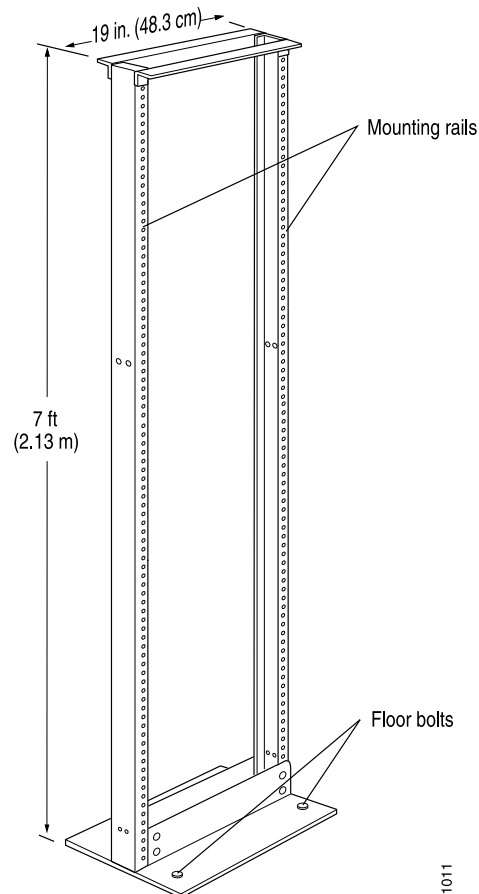
With the use of adapters, the router is designed to fit into a 600-mm-wide and 600-mm-deep rack, as defined in the four-part *Equipment Engineering (EE); European telecommunications standard for equipment practice* (document numbers ETS 300 119-1 through 119-4) published by the European Telecommunications Standards Institute (<http://www.etsi.org>). Use approved wing devices to narrow the opening between the rails.

The rack rails must be spaced widely enough to accommodate the router chassis's external dimensions: 14 in. (36 cm) high, 21 in. (54 cm) deep, and 17.5 in. (44.5 cm) wide. The outer edges of the front-mounting brackets or center-mounting brackets extend the width to 19 in. (48.3 cm). The spacing of rails and adjacent racks must also allow for the clearances around the router and rack that are specified in “Clearance Requirements for Airflow and Hardware Maintenance” on page 56.

The chassis height of 14 in. (36 cm) is approximately 8 U. A U is the standard rack unit defined in *Cabinets, Racks, Panels, and Associated Equipment* (document number EIA-310-D) published by the Electronics Industry Association. You can stack eight router 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 approximately 134 lb (61 kg). If you stack eight fully configured routers in one rack, it must be capable of supporting about 670 lb (305 kg).

Figure 24: Typical Center-Mount Rack



Spacing of Mounting Holes

The holes in both the front-mounting brackets and center-mounting brackets is the same, and is designed for maximum flexibility in vertical placement of the router in

the rack. Every other hole in the brackets is at a distance of 1 U (1.75 in. or 4.445 cm), so the router can be mounted in any rack that also provides holes spaced at that distance.

Connection to Building Structure

Always secure the rack to the structure of the building. If your geographical area is subject to earthquakes, bolt the rack to the floor. For maximum stability, also secure the rack to ceiling brackets. For more information, see “Rack-Mounting Requirements and Warnings” on page 175.

Clearance Requirements for Airflow and Hardware Maintenance

When planning the installation site, you must allow sufficient clearance around the rack (see Figure 25 on page 57):

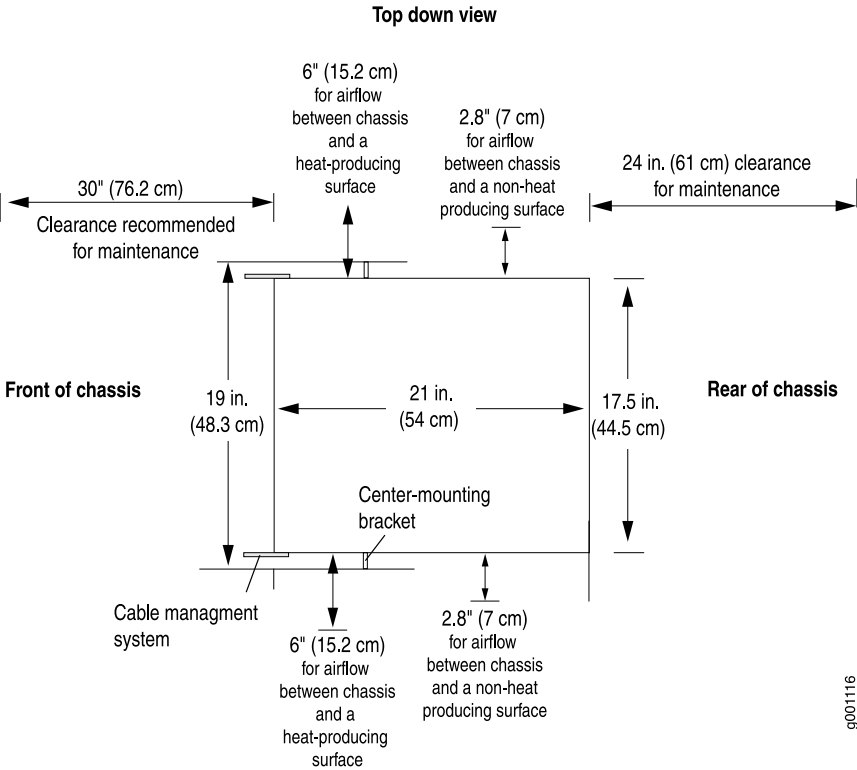
- For the cooling system to function properly, the airflow around the chassis must be unrestricted. Figure 19 on page 35 depicts the airflow in the router. Allow at least 6 in. (15.2 cm) of clearance between side-cooled routers. Allow 2.8 in. (7 cm) between the side of the chassis and any non-heat-producing surface such as a wall.



NOTE: We recommend that you do not install the router in a cabinet. If you mount the router in a cabinet, be sure that ventilation is sufficient to prevent overheating.

- For service personnel to remove and install hardware components, there must be adequate space at the front and back of the router. At least 24 in. (61 cm) is required both in front of and behind the router. NEBS GR-63 recommends that you allow at least 30 in. (76.2 cm) in front of the rack and 24 in. (61 cm) behind the rack.

Figure 25: Chassis Dimensions and Clearance Requirements



Chapter 6

Unpacking the Router

This chapter explains how to unpack the router and verify the parts received. Before beginning, prepare the installation site as described in “Preparing for Router Installation” on page 53 and review the safety information in “Safety and Regulatory Compliance Information” on page 167, especially “General Safety Guidelines and Warnings” on page 169 and “Installation Safety Guidelines and Warnings” on page 173. This chapter discusses the following topics:

- Tools and Parts Required on page 59
- Unpacking the Router on page 59
- Choosing Front-Mounting or Center-Mounting on page 61

Tools and Parts Required

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

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

Unpacking the Router

The router is shipped in a wooden crate and bolted to the pallet that forms the bottom of the crate. The crate also contains an accessory box and the *M20 Internet Router Installation Quick Start* poster.

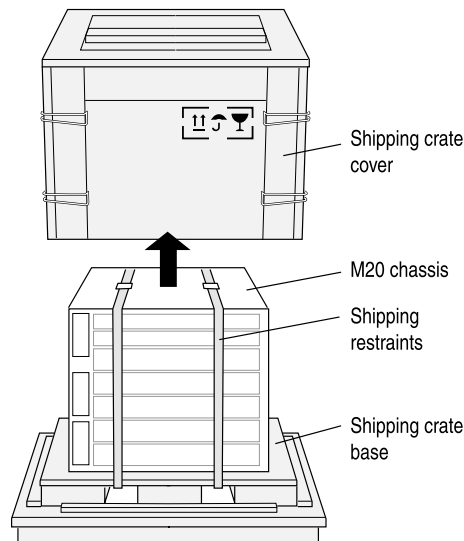


NOTE: The router is maximally protected inside the shipping crate. Do not unpack it until you are ready to begin installation.

To unpack the router, perform these steps:

1. Move the shipping crate to a staging area as close to the installation site as possible, but where you have enough room to remove the system components. While the chassis is bolted to the pallet, you can use a forklift or pallet jack to move it.
2. Position the crate so that the arrows are pointing up.

3. Twist open the locking tabs that secure the crate cover to the pallet.
4. Remove the cover from the crate. See Figure 26 on page 60.
5. Unfasten the shipping restraint straps.
6. Remove the accessory box from the top of the router.
7. Open the accessory box and verify the contents against the parts inventory on the label attached to the box.
8. Verify the chassis components received against the packing list included with the router. A generic parts inventory appears in Table 18 on page 60.
9. Use a 1/2-in. open-end or socket wrench to loosen and remove the bolts on the brackets that attach the chassis to the pallet. If a 1/2-in. tool is not available, use pliers or an adjustable wrench rather than a fixed-size metric wrench.
10. 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.
11. Save the shipping crate, packing materials, and pallet in case you later need to move or ship the router.

Figure 26: Unpacking the Router

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Table 18: Generic Inventory of Router Components Installed in Chassis

Component	Quantity
Craft interface	1
Front fan tray	3
FPC with one or more PICs installed	Up to 4
PIC	Up to 4 per FPC

Table 18: Generic Inventory of Router Components Installed in Chassis *(continued)*

Component	Quantity
Midplane	1
SSB	1 or 2
Routing Engine	1 or 2
Routing Engine panel and fan tray	1
Power supply	2
Center-mounting brackets	2
Blank panels for slots without components	Varies depending on router configuration

Choosing Front-Mounting or Center-Mounting

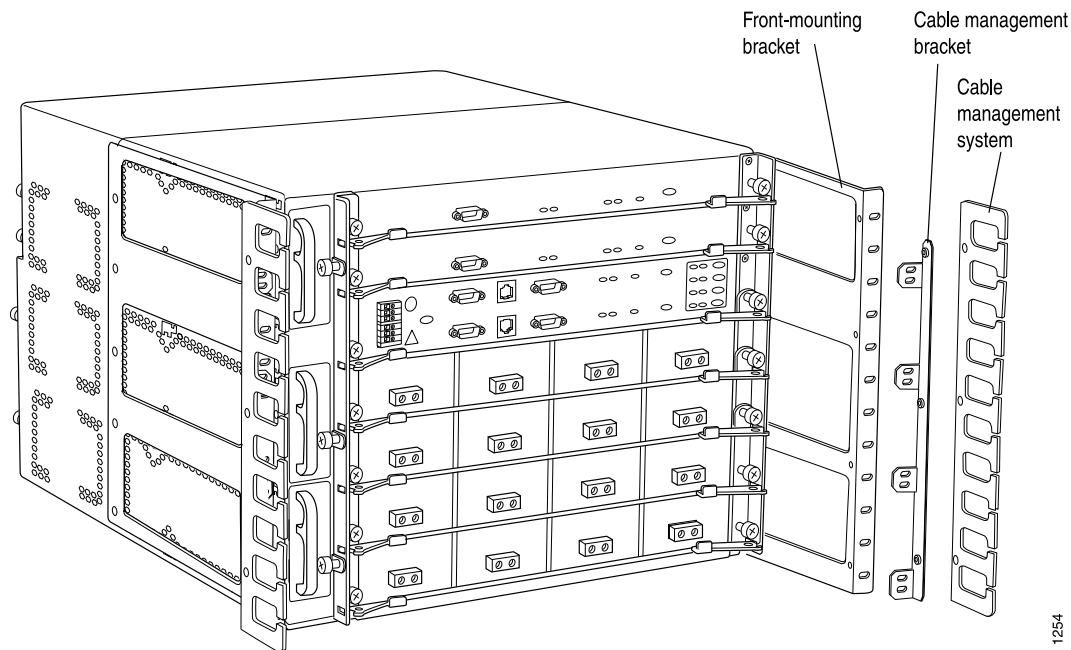
For an open-frame rack, center-mounting the router in the rack is preferable to front-mounting because the more even distribution of weight provides greater stability.

The router is shipped with the center-mounting brackets already installed, as shown in Figure 1 on page 8. The brackets have openings in their sides to allow for air flow into the chassis.

If you are front-mounting the router:

- We recommend that you support the back of the router with a shelf or other structure (not provided).
- Remove the center-mounting brackets from the chassis.
- Attach the front-mounting brackets provided in the shipping crate to the chassis before placing the chassis in the rack. Attach the brackets so that the front of the brackets extend outward. Secure the brackets to the chassis by installing screws along both the front and rear of the brackets. See Figure 27 on page 62.
- Remove the brackets to which the cable management system attaches on each side of the router, which are preinstalled on the router as shipped.
- Remove the cable management racks from the brackets and attach them to the front-mounting cable management brackets provided in the shipping crate. Attach the replacement brackets to the chassis as shown in Figure 27 on page 62.

Figure 27: Chassis with Front-Mounting Brackets and Cable Management System



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Chapter 7

Installing the Router Using a Mechanical Lift

Because the router weighs between 80 lb (36 kg) and about 134 lb (61 kg) depending on configuration, using a mechanical lift to install it is recommended. This chapter provides instructions. If you do not use a lift, see “Installing the Router Without a Mechanical Lift” on page 65. This chapter has the following sections:

- Tools and Parts Required on page 63
- Installing the Chassis Using a Mechanical Lift on page 63

Tools and Parts Required

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

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

Installing the Chassis Using a Mechanical Lift

Using a mechanical lift to maneuver the router into the rack is recommended because of the router's size and weight. The lift must be able to accommodate the router's weight—between 80 lb (36 kg) and about 134 lb (61 kg) depending on configuration—and must fit between the support posts of the rack.



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

First, perform the following prerequisite procedures:

- Verify that the router site meets the requirements described in “Preparing for Router Installation” on page 53.
- 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 54.

- Read the information in “Installation Safety Guidelines and Warnings” on page 173, with particular attention to “Chassis Lifting Guidelines” on page 174.
- Remove the router from the shipping carton, as described in “Unpacking the Router” on page 59.

Then, perform the following procedures to install the router:

1. If you are front-mounting the router, replace the center-mounting hardware on the chassis with front-mounting hardware as described in “Choosing Front-Mounting or Center-Mounting” on page 61.
2. Load the router onto the lift, making sure it rests securely on the lift platform.
3. Use the lift to position the router at the correct height in the rack.
4. Align the bottom hole in both front-mounting or center-mounting brackets with a hole in each rack rail, making sure the chassis is level.
5. Install one of the mounting screws provided (in the accessory box shipped with the router) into each of the two aligned holes. Use a Phillips screwdriver to tighten the screws.
6. Moving up each bracket, install three more screws in each front-mounting bracket or center-mounting bracket. The recommended installation pattern places the second screw a distance of 2 U (3.5 in. or 8.9 cm) above the first, the third screw 3 U (5.25 in. or 13.34 cm) above the second, and the fourth screw in the topmost hole in the bracket (2 U above the third screw).
7. Verify that all the mounting screws on one side of the rack are aligned with the mounting screws on the opposite side and that the router is level.
8. Move the lift away from the rack.
9. To continue the installation, proceed to “Connecting the Router” on page 83.

Chapter 8

Installing the Router Without a Mechanical Lift

You can install the router into a rack either with or without the help of a mechanical lift. Because the router weighs between 80 lb (36 kg) and about 134 lb (61 kg) depending on configuration, using a mechanical lift is recommended; for instructions, see “Installing the Router Using a Mechanical Lift” on page 63.

If you do not use a mechanical lift, you must remove components from the chassis to reduce its weight before lifting it into the rack. The reduced chassis weight is approximately 80 lb (36 kg), so installing it safely still requires two people to lift and an additional person to insert the mounting screws.

Table 19 on page 65 lists the weight of the chassis and major components.

Table 19: Router Component Weights

Component	Approximate Weight (lb)	Approximate Weight (kg)
Cable management system	1	0.5
FPC carrier with 4 installed PICs	3	1.4
Front fan tray	5	2.3
Power supply (AC or DC)	12	5.4
Routing Engine	1.5	0.7
Routing Engine panel and fan tray	2	0.9
System and Switch Board (SSB)	3	1.4

Before installing the chassis, perform the following prerequisite procedures:

- Verify that the router site meets the requirements described in “Preparing for Router Installation” on page 53.
- 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 54.

- Read the information in “Installation Safety Guidelines and Warnings” on page 173, with particular attention to “Chassis Lifting Guidelines” on page 174.
- Remove the router from the shipping carton, as described in “Unpacking the Router” on page 59.

The following sections describe installation requirements and procedures:

- Tools and Parts Required on page 66
- Removing Components from the Chassis on page 66
- Installing the Chassis into the Rack on page 74
- Reinstalling Components into the Chassis on page 75

Tools and Parts Required

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

- Phillips (+) screwdrivers, numbers 1 and 2
- Electrostatic bags or antistatic mats, one for each electronic component removed
- Electrostatic damage (ESD) grounding wrist strap

Removing Components from the Chassis

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



WARNING: The procedures in this section apply only to initial installation and assume that you have not yet connected power to the router. If power is connected, completely disconnect it before continuing. See “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

If you are installing or replacing components in an operational router, see “Replacing Hardware Components” on page 117.

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

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

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

- Removing the Power Supplies on page 67
- Removing the Routing Engines on page 68

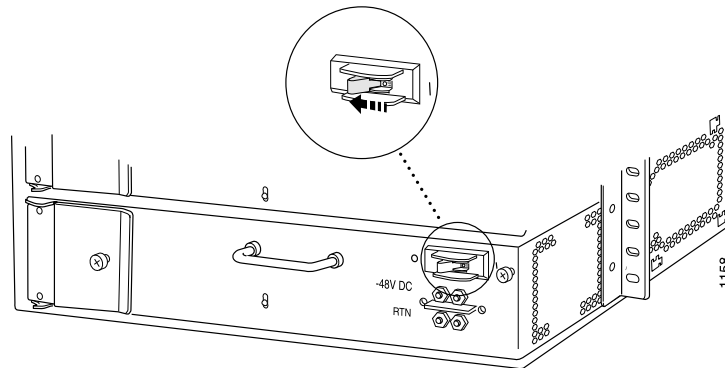
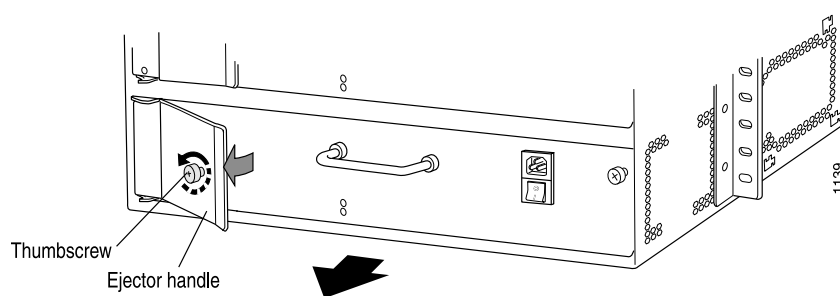
- Removing the Routing Engine Panel and Fan Tray on page 69
- Removing the SSBs on page 70
- Removing the Front Fan Trays on page 71
- Removing the FPCs on page 72

Removing the Power Supplies

The router has two power supplies (either AC or DC) located at the bottom rear of the chassis, as shown in Figure 2 on page 8. A power supply weighs approximately 12 lb (5.5 kg).

To remove the power supplies, follow this procedure (see Figure 28 on page 68, which shows the power switch in the **OFF [O]** position on a DC power supply, and Figure 29 on page 68, which shows removal of an AC power supply):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that the power switch for each power supply is in the **OFF (O)** position. On a DC power supply, the switch is located above the terminal studs on the power supply faceplate. On an AC power supply, the switch is just below the appliance inlet on the power supply faceplate.
3. Loosen the thumbscrew at each end of the power supply faceplate, using a Phillips screwdriver if necessary. Unscrew both thumbscrews simultaneously and at about the same rate (unscrewing the two screws alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
4. Pull the ejector handle away from the faceplate.
5. Grasp the handle on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
6. Place one hand under the power supply to support it, then slide it completely out of the chassis.
7. Repeat the procedure to remove the second power supply.

Figure 28: Power Switch in the Off Position on a DC Power Supply**Figure 29: Removing a Power Supply**

Removing the Routing Engines

The router can have a Routing Engine in each of the slots labeled RE 0 and RE 1 at the rear of the chassis, as shown in Figure 2 on page 8. Each Routing Engine weighs approximately 1.5 lb (0.7 kg).

The routing engine is hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. For a description of the effect of removing a routing engine, see “Routing Engine” on page 24.

To remove a Routing Engine, follow this procedure (see Figure 30 on page 69):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Using your thumbs, push and hold the red tab on each extractor clip toward the outer edge of the unit. Push the ends of the extractor clips outward to unseat the Routing Engine from the chassis.
4. Grasp the extractor clips and slide the unit about halfway out of the chassis.

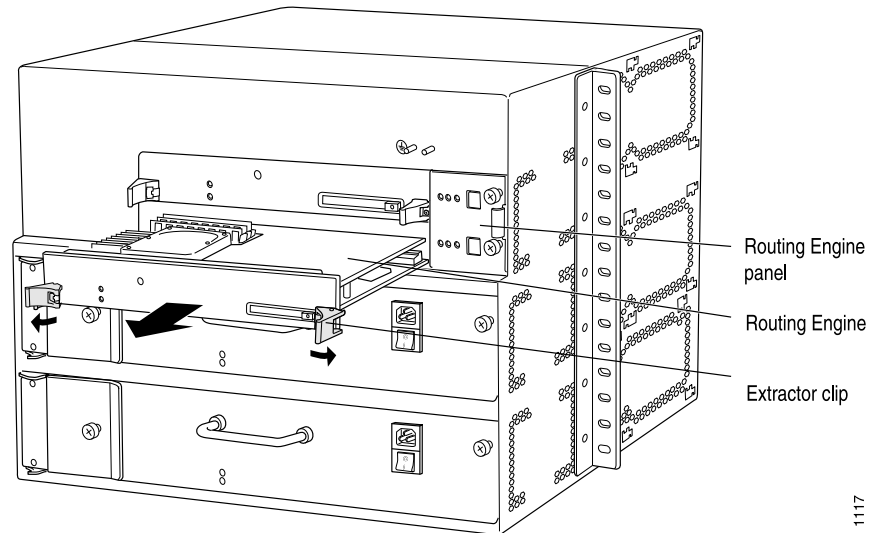


CAUTION: Slide the Routing Engine straight out of the chassis. Damage can result if the Routing Engine gets lodged because of uneven movement.

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

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

Figure 30: Removing a Routing Engine



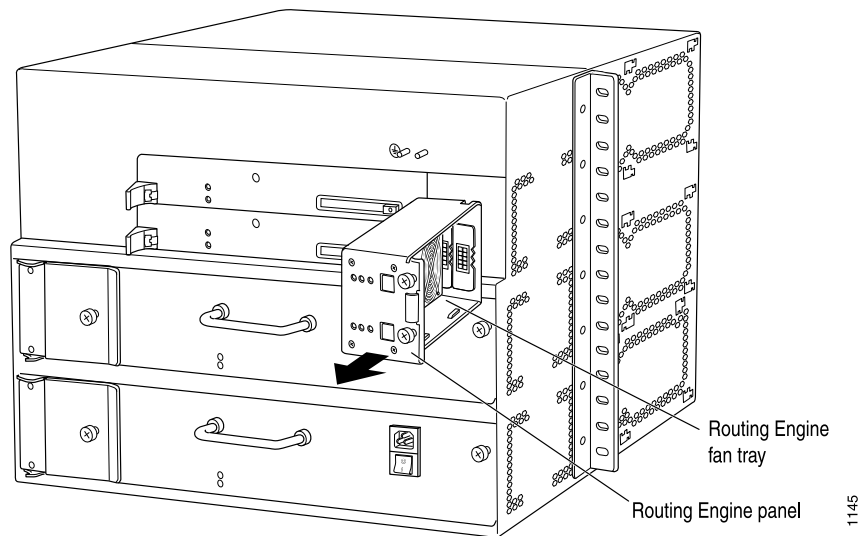
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Removing the Routing Engine Panel and Fan Tray

The Routing Engine panel and fan tray is located immediately to the right of the Routing Engines, as shown in Figure 2 on page 8. The unit weighs approximately 2 lb (1 kg).

To remove the Routing Engine panel and fan tray, follow this procedure (see Figure 31 on page 70):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Loosen the thumbscrews on the right side of the Routing Engine panel, using a Phillips screwdriver if necessary.
4. Grasp the handle between the thumbscrews and pull the unit halfway out of the chassis.
5. Place one hand under the unit to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

Figure 31: Removing the Routing Engine Panel and Fan Tray

Removing the SSBs

The router can have an SSB in each of the two uppermost slots in the front of the chassis, as shown in Figure 1 on page 8. Each SSB weighs approximately 3 lb (1.5 kg).

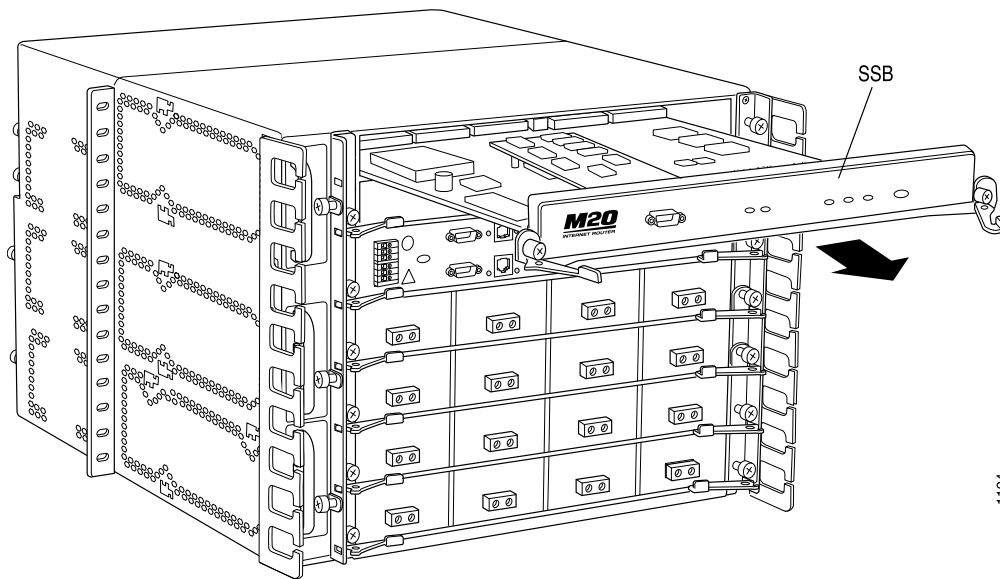
To remove the SSBs, follow this procedure (see Figure 32 on page 71):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Loosen the thumbscrew at each end of the SSB, using a Phillips screwdriver if necessary.
4. Pull the end of each ejector lever outward until it is nearly perpendicular to the SSB faceplate.
5. Grasp the ejector levers and pull firmly to slide the SSB about halfway out of the chassis.
6. Place one hand under the SSB to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.



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

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

Figure 32: Removing an SSB

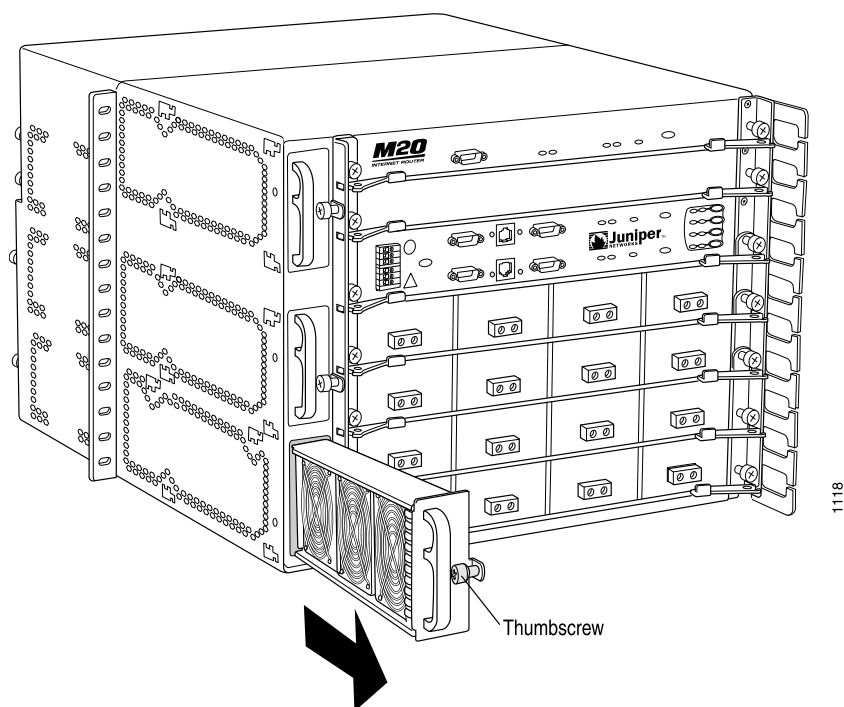
1124

Removing the Front Fan Trays

The three front fan trays are located in a column at the front left of the chassis, as shown in Figure 1 on page 8. Each fan tray houses three fans and weighs approximately 5 lb (2 kg).

To remove the fan trays, follow this procedure (see Figure 33 on page 72):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Loosen the thumbscrew near the middle of the fan tray faceplate, using a Phillips screwdriver if necessary.
3. Grasp the handle on the faceplate and slide the tray about halfway out of the chassis.
4. Place one hand under the fan tray to support it and slide it completely out of the chassis.
5. Repeat the procedure to remove the other two front fan trays.

Figure 33: Removing a Front Fan Tray

Removing the FPCs

The router can have up to four FPCs mounted horizontally in the FPC card cage on the front of the chassis, as shown in Figure 1 on page 8. 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 with the top slot (labeled FPC0) and working down. 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 20 on page 72.

Table 20: FPC Removal Checklist

Slot	Media Types	Date Removed	Date Reinstalled
0			
1			
2			
3			

To remove the FPCs, follow this procedure (see Figure 34 on page 74):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Locate the FPC or blank panel in the slot directly below the craft interface, which is labeled **FPC0**.
4. If the slot is covered by a blank panel, you can leave it in place. If the slot contains an FPC, perform the following steps:
 - a. Unscrew the thumbscrew at each end of the FPC, using a Phillips screwdriver if necessary.
 - b. Pull the ends of the ejector levers, which are adjacent to the thumbscrews, away from the face of the FPC.
 - c. Grasp the FPC with both hands and slide it about halfway out of the chassis.
 - d. Place one hand underneath the FPC to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.

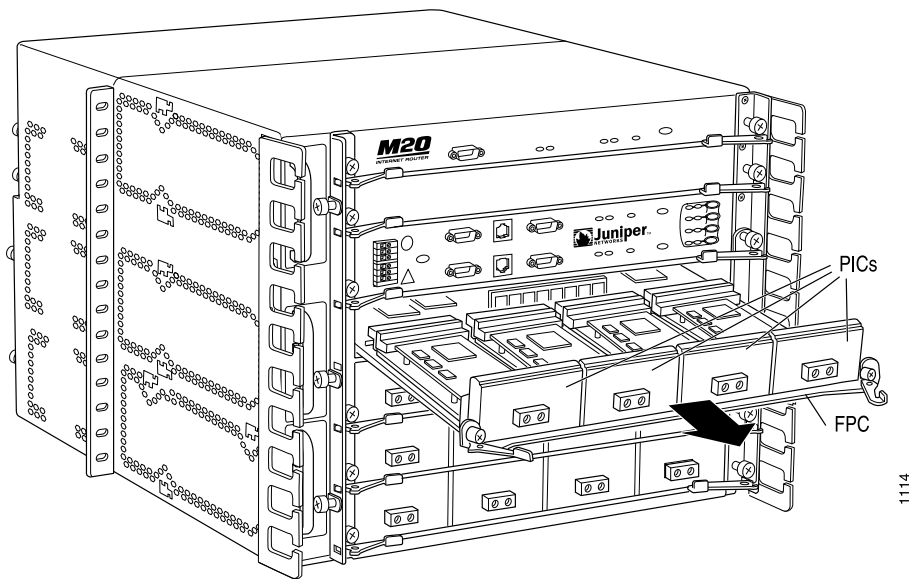


CAUTION: When the FPC is out of the chassis, do not hold it by the ejector levers. They cannot support its weight.

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.

5. Repeat Step 4 for each FPC or blank cover, proceeding from top to bottom.

Figure 34: Removing an FPC

Installing the Chassis into the Rack

After you have removed components as described in “Removing Components from the Chassis” on page 66, the chassis is light enough for a team of installers to lift into the rack.



CAUTION: The reduced weight of the chassis is approximately 80 lb (36 kg). Installing it into the rack still requires two people to lift and an additional person to secure the mounting screws.

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

Perform the following procedures (see Figure 35 on page 75):

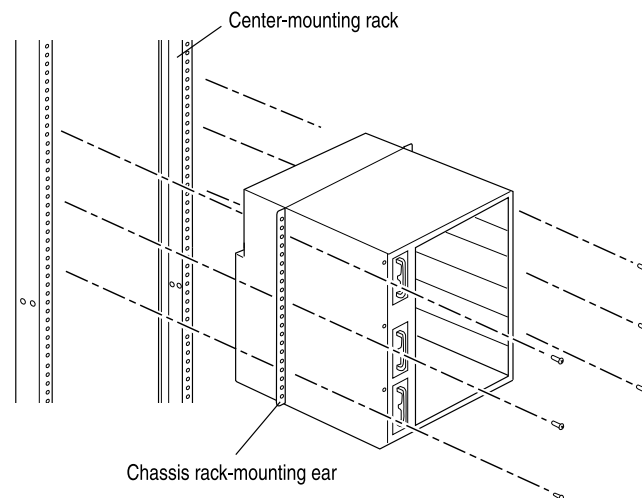
1. If you are front-mounting the router, replace the center-mounting hardware on the chassis with front-mounting hardware as described in “Choosing Front-Mounting or Center-Mounting” on page 61.
2. With one person at the front and one at the back of the chassis, grasp the chassis, lift it, and position it at the correct height in the rack.



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

3. Align the bottom hole in both front-mounting or center-mounting brackets with a hole in each rack rail, making sure the chassis is level.
4. Install one of the mounting screws provided (in the accessory box shipped with the router) into each of the two aligned holes. Use a Phillips screwdriver to tighten the screws.
5. Moving up each bracket, install three more screws in each front-mounting bracket or center-mounting bracket. The recommended installation pattern places the second screw a distance of 2 U (3.5 in. or 8.9 cm) above the first, the third screw 3 U (5.25 in. or 13.34 cm) above the second, and the fourth screw in the topmost hole in the bracket (2 U above the third screw).
6. 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.
7. Loosen the thumbscrews on the lifting handle and remove it from the chassis.
8. Proceed to the instructions in “Reinstalling Components into the Chassis” on page 75.

Figure 35: Installing the Chassis in a Rack



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Reinstalling Components into the Chassis

After you have mounted the chassis in the rack as described in “Installing the Chassis into the Rack” on page 74, reinstall the router components into the chassis.



WARNING: The procedures in this section apply only to initial installation and assume that you have not yet connected power to the router. If power is connected, completely disconnect it before continuing. See “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

If you are installing or replacing components in an operational router, see “Replacing Hardware Components” on page 117.

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

- Reinstalling the FPCs on page 76
- Reinstalling the SSBs on page 77
- Reinstalling the Front Fan Trays on page 78
- Reinstalling the Routing Engine Panel and Fan Tray on page 79
- Reinstalling the Routing Engines on page 80
- Reinstalling the Power Supplies on page 81

Reinstalling the FPCs

The FPCs install into the card cage at the front of the chassis, as shown in Figure 1 on page 8.



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

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

To reinstall the FPCs, follow this procedure (see Figure 36 on page 77):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Locate the slot directly below the craft interface, which is labeled **FPC0**, and the corresponding FPC.
3. Verify that the ends of the ejector levers, which are located at each end of the FPC, are pushed outward, nearly perpendicular to the face of the FPC.
4. Grasp the front of the FPC with one hand and place the other hand under the FPC to support it.

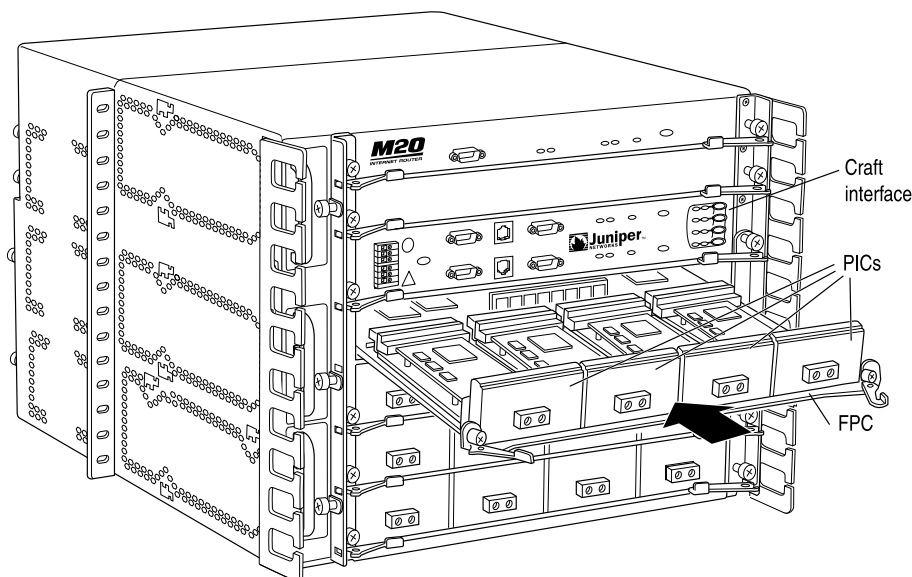


CAUTION: When the FPC is out of the chassis, do not hold it by the ejector levers. They cannot support its weight.

-
5. Align the rear bottom corners of the FPC with the guides at the bottom of the FPC slot. Slide the FPC into the card cage until it contacts the midplane.

6. Push the ends of the ejector levers inward until they are nearly flush with the face of the FPC.
7. Tighten the thumbscrew at each end of the FPC to seat the FPC securely in the chassis.
8. Repeat the procedure for each FPC, proceeding from top to bottom through the slots.

Figure 36: Reinstalling an FPC



1113

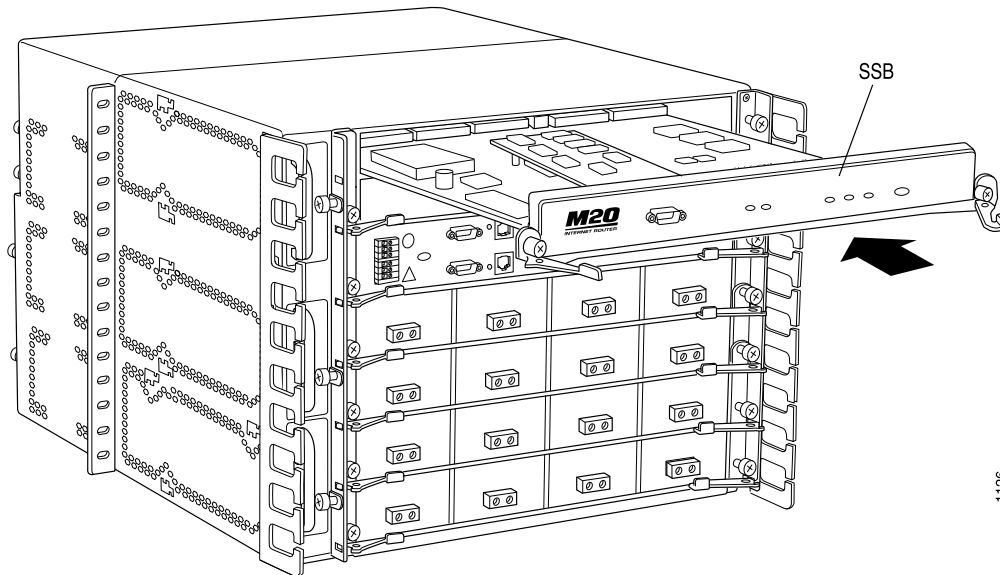
Reinstalling the SSBs

The SSBs install into the two uppermost slots in the front of the chassis, as shown in Figure 1 on page 8. To reinstall the SSB, follow this procedure (see Figure 37 on page 78):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that the ends of the ejector levers are pulled outward to a position nearly perpendicular to the faceplate of the SSB.
3. Place one hand under the SSB to support it and grasp one of the ejector levers at the front with the other hand.
4. Align the rear of the SSB with the guides inside the chassis and slide it in completely.
5. Press the ejector lever at each end of the SSB inward.
6. Tighten the thumbscrew at each end of the SSB to seat the SSB firmly in the chassis.

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

Figure 37: Reinstalling an SSB



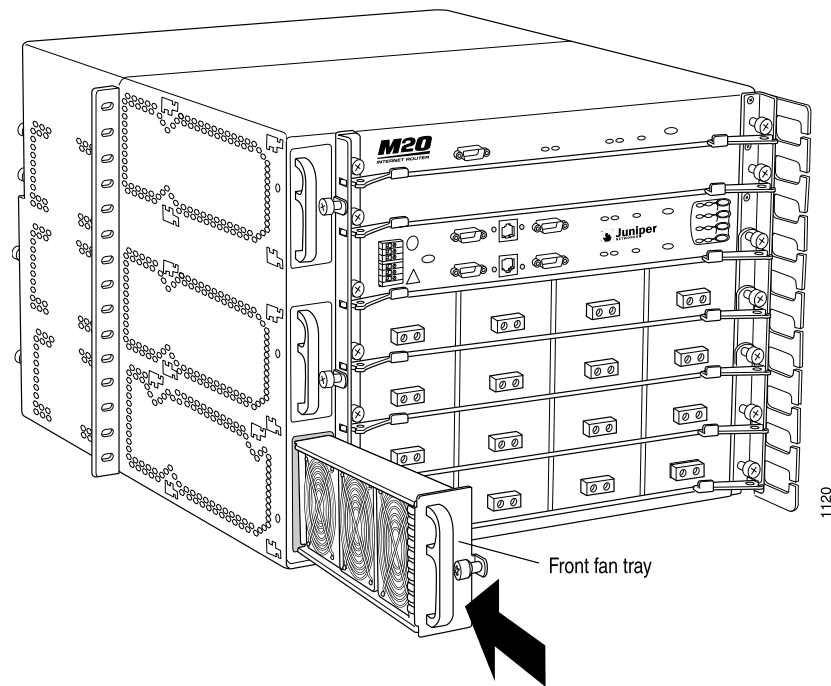
1126

Reinstalling the Front Fan Trays

The three front fan trays install in a column at the front left of the chassis, as shown in Figure 1 on page 8. To reinstall the fan trays, follow this procedure (see Figure 38 on page 79):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Grasp the handle on the faceplate of the fan tray with one hand and place the other hand under the unit to support it. Orient the tray so that the fans are on the left side.
3. Slide the tray into the slot.
4. Tighten the thumbscrew to seat the fan tray firmly in the chassis.

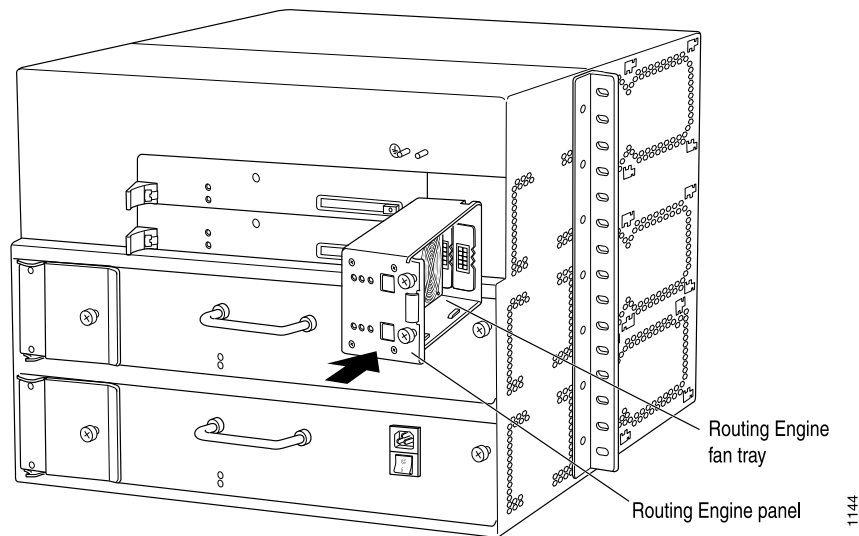
Repeat the procedure to reinstall the other two front fan trays.

Figure 38: Reinstalling a Front Fan Tray

Reinstalling the Routing Engine Panel and Fan Tray

The Routing Engine panel and fan tray installs immediately to the right of the Routing Engines, as shown in Figure 2 on page 8. To reinstall the unit, follow this procedure (see Figure 39 on page 80):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Grasp the handle on the faceplate of the unit with one hand and place the other hand under the unit to support it.
3. Slide the unit into the chassis.
4. Tighten the thumbscrews to seat the unit firmly in the chassis.

Figure 39: Reinstalling the Routing Engine Panel and Fan Tray

Reinstalling the Routing Engines

The router can have a Routing Engine in each of the slots labeled **RE 0** and **RE 1** at the rear of the chassis, as shown in Figure 2 on page 8.



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

To reinstall a Routing Engine, follow this procedure (see Figure 40 on page 81):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that the extractor clip at each end of the Routing Engine is flipped toward the outer edge of the unit. If necessary, use your thumbs to push and hold the red tab on each extractor clip toward the outer edge, then push the ends of the extractor clips outward.
3. Place one hand under the Routing Engine to support it and grasp one of the extractor clips on the faceplate with the other hand.
4. Align the rear of the Routing Engine with the guide rails inside the chassis and slide it in completely.

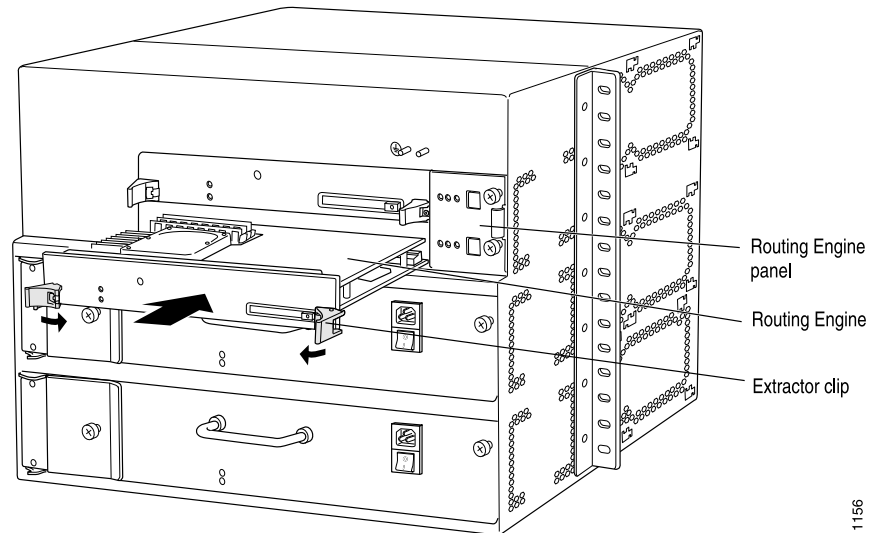


CAUTION: Align the Routing Engine carefully with the guide rails and push it in evenly. Damage can result if the Routing Engine gets lodged in the rails because of uneven movement.

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

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

Figure 40: Reinstalling a Routing Engine



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Reinstalling the Power Supplies

The two power supplies (AC or DC) are located at the bottom rear of the chassis, as shown in Figure 2 on page 8. To reinstall the power supplies, follow this procedure (see Figure 41 on page 82, which shows the power switch in the OFF [O] position on a DC power supply, and Figure 42 on page 82, which shows installation of an AC power supply):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that the power switch for each power supply is in the OFF (O) position. On a DC power supply, the switch is located above the terminal studs on the power supply faceplate. On an AC power supply, the switch is just below the appliance inlet on the power supply faceplate.
3. Grasp the handle on the power supply faceplate with one hand and place the other hand under the supply to support it.
4. Slide the power supply into the chassis until it contacts the midplane.
5. Press the ejector handle toward the faceplate to seat the power supply firmly in the chassis.
6. Tighten (but do not overtighten) the thumbscrews on the power supply faceplate. Turn both thumbscrews simultaneously and at about the same rate (turning them alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
7. Repeat the procedure to reinstall the second power supply.
8. To continue the installation, proceed to “Connecting the Router” on page 83.

Figure 41: Power Switch in the Off Position on a DC Power Supply

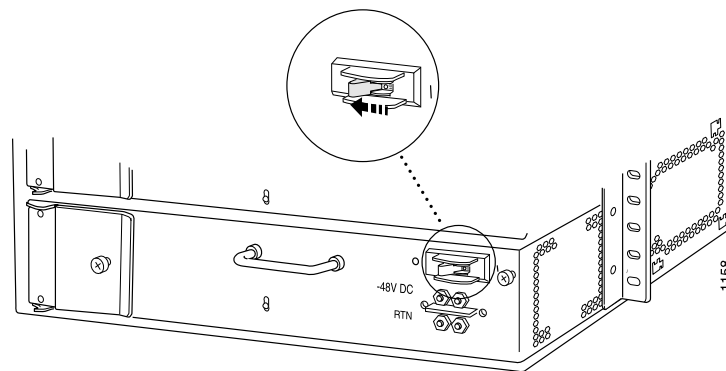
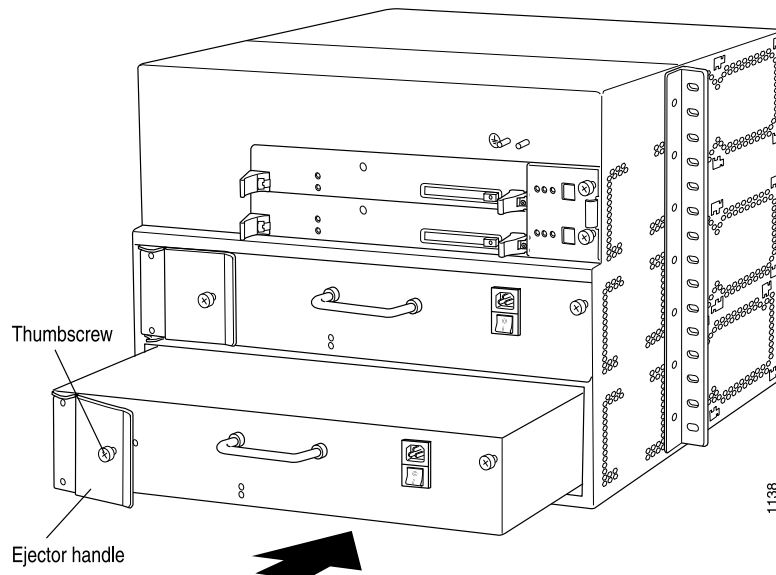


Figure 42: Reinstalling a Power Supply



Chapter 9

Connecting the Router

After installing the router into the rack as described in “Installing the Router Using a Mechanical Lift” on page 63 or “Installing the Router Without a Mechanical Lift” on page 65, complete the installation by connecting management and alarm devices, PICs, and power cables. This chapter has the following sections:

- Tools and Parts Required on page 83
- Connecting the Router to Management and Alarm Devices on page 83
- Connecting PIC Cables on page 86

Tools and Parts Required

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

- Phillips (+) screwdrivers, numbers 1 and 2
- 2.5-mm flat-blade (-) screwdriver
- 2.5-mm Phillips (+) screwdriver
- 7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a torque range between 23 lb-in. (2.6 Nm) and 25 lb-in. (2.8 Nm), for tightening nuts to terminal studs on the power supply faceplate on a DC-powered router.

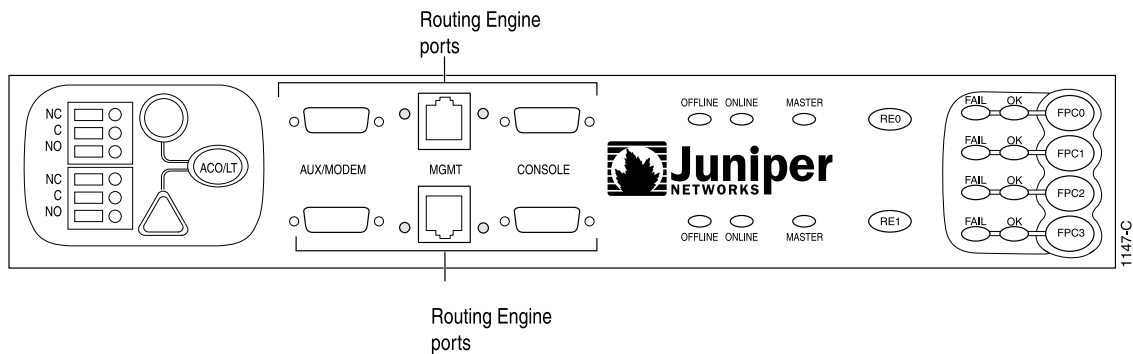


CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

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

Connecting the Router to Management and Alarm Devices

After you have installed the router into the rack, attach one or more external devices to the ports on the craft interface that connect to the Routing Engines for management and service operations (see Figure 43 on page 84). For specifications for the cable accepted by the Routing Engine management ports, see “Routing Engine Interface Cable and Wire Specifications” on page 217.

Figure 43: Routing Engine Management Ports and Alarm Relay Contacts

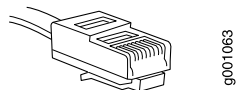
To connect external devices to the Routing Engine management ports, perform the procedures described in the following sections:

- Connecting to a Network for Out-of-Band Management on page 84
- Connecting to a Management Console or Auxiliary Device on page 84
- Connecting to an External Alarm-Reporting Device on page 85

Connecting to a Network for Out-of-Band Management

To connect the Routing Engine to a network for out-of-band management, connect an Ethernet cable with RJ-45/RJ-45 connectors to the **MGMT** port on the craft interface. One such cable is provided with the router. For cable specifications, see “Routing Engine Interface Cable and Wire Specifications” on page 217:

1. Turn off the power to the management device.
2. Plug one end of the Ethernet cable (Figure 44 on page 84 shows the connector) into the appropriate **MGMT** port on the craft interface. Figure 43 on page 84 shows the external device ports on the craft interface. The upper ports connect to the Routing Engine in the upper Routing Engine slot (**RE0**), and the lower ports connect to the Routing Engine in the lower Routing Engine slot (**RE1**).
3. Plug the other end of the cable into the network device.

Figure 44: Routing Engine Ethernet Cable Connector

Connecting to a Management Console or Auxiliary Device

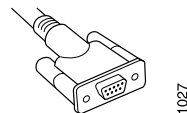
To use a system console to configure and manage the Routing Engine, connect it to the appropriate **CONSOLE** port on the craft interface. To use a laptop, modem, or other auxiliary device, connect it to the appropriate **AUX/MODEM** port on the craft interface. Both ports accept an RS-232 (EIA-232) serial cable with DB-9/DB-9 connectors. One such cable is provided with the router. If you want to connect a

device to both ports, you must supply another cable. For cable specifications, see “Routing Engine Interface Cable and Wire Specifications” on page 217.

To connect a management console or auxiliary device:

1. Turn off the power to the console or auxiliary device.
2. Plug the female end (shown in Figure 45 on page 85) of the provided serial cable into the appropriate **CONSOLE** or **AUX/MODEM** port. Figure 43 on page 84 shows the external device ports on the craft interface. The upper ports connect to the Routing Engine in the upper Routing Engine slot (**RE0**), and the lower ports connect to the Routing Engine in the lower Routing Engine slot (**RE1**).
3. Using a 2.5-mm flat-blade screwdriver, tighten the screws on the connector.
4. Attach the other end of the cable to the console or auxiliary device.

Figure 45: Console and Auxiliary Serial Port Connector



Connecting to an External Alarm-Reporting Device

To connect the router to external alarm-reporting devices, attach wires to the relay contacts on the craft interface located to the left of the red and yellow alarm LEDs. A system condition that triggers the red alarm LED on the craft interface also activates the upper alarm relay contact, whereas a less serious alarm condition activates the yellow alarm LED and lower alarm relay contact.

The alarm relay contacts accept wire of any gauge between 28-AWG and 14-AWG (0.08 and 2.08 mm²), which is not provided. Use the gauge of wire appropriate for the external device that you are connecting.

To connect an external device to an alarm relay contact, follow this procedure (see Figure 43 on page 84):

1. Prepare the required length of wire with gauge between 28-AWG and 14-AWG (0.08 and 2.08 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.

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

Connecting PIC Cables

Now connect PICs to the network by plugging in network cable. To connect cable to the PICs (see Figure 46 on page 87, which shows a fiber-optic PIC):

1. Have ready a length of the type of cable used by the PIC. For cable specifications, see the *M20 PIC Guide*.
2. If the PIC cable connector port is covered by a rubber safety plug, remove the plug.



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



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

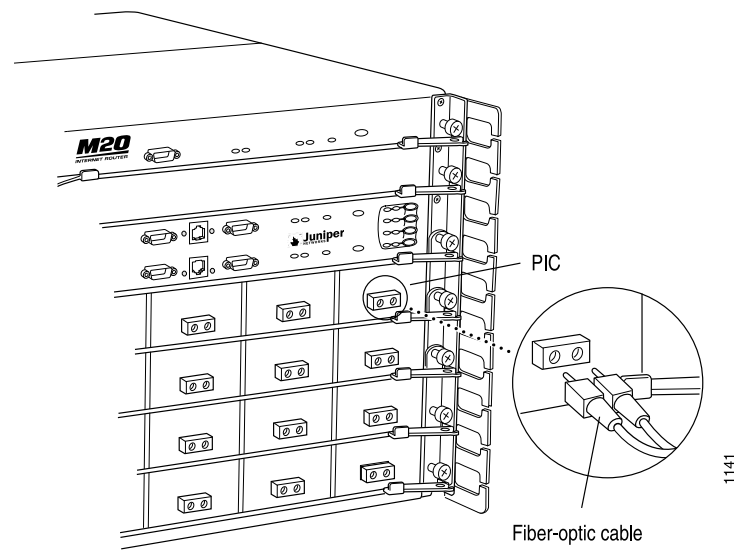
3. Insert the cable connector into the cable connector port on the PIC faceplate.
 4. Arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out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



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



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

Figure 46: Attaching Cable to a PIC

Chapter 10

Grounding and Providing Power to the Router

- Grounding the Router on page 89
- Connecting Power to an AC-Powered Router on page 89
- Powering On an AC-Powered Router on page 90
- Connecting Power to a DC-Powered Router on page 91
- Powering On a DC-Powered Router on page 92

Grounding the Router

To ground the router:

1. Verify that a licensed electrician has attached the cable lug provided with the router to the grounding cable.
2. Connect the grounding cable to a proper earth ground.
3. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
4. Using a number 2 Phillips screwdriver, remove the screws next to the grounding symbol above the power supplies on the chassis rear. Secure the grounding cable lug to the chosen grounding point by reinstalling and tightening the screws.
5. Verify that the grounding cabling is connected correctly, that it does not touch or block access to router components, and that it does not drape where people could trip on it.

Connecting Power to an AC-Powered Router

1. Locate the power cords shipped with the router, which should have a plug appropriate for your geographical location (see “AC Power, Connection, and Power Cord Specifications” on page 208).
2. Verify that the switch on each power supply faceplate is in the OFF (O) position.

3. For each power supply, insert the appliance coupler end of a power cord into the appliance inlet on a power supply faceplate. Verify that the power cord does not block access to router components or drape where people could trip on it.
4. Insert the plug into an AC power source receptacle.

Powering On an AC-Powered Router

To power on the router:

1. Verify that the power supplies are fully inserted in the chassis and the thumbscrews on their faceplates are tightened.
2. Verify that the ends of each power cord are firmly plugged into the appliance inlet on the power supply faceplate and the external power source receptacle.
3. Verify that an external management device is connected to one of the Routing Engine ports (**AUX/MODEM**, **CONSOLE**, or **MGMT**). For more information about connecting management devices, see “Connecting the Router to Management and Alarm Devices” on page 83.
4. Turn on the power to the external management device.
5. Press the power switch on the faceplate of the power supplies in slots **P/S 0** and **P/S 1** to the **ON (|)** position.



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



NOTE: If the LED does not light after 60 seconds, verify that the power supply is properly inserted into the chassis and repeat the cable installation procedures described in “Connecting Power to an AC-Powered Router” on page 89.

6. Verify that the **OUTPUT OK** LED on each power supply faceplate eventually lights steadily.
 7. Press the power switch for any additional power supplies to the **ON (|)** position and verify that the **OUTPUT OK** LED on each power supply faceplate lights steadily.
 8. On the external management device connected to the Routing Engine, monitor the startup process to verify that the system has booted properly.
-



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



NOTE: After powering off a power supply, wait at least 60 seconds before turning it back on. If the router is completely powered off 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 off the router again, first issue the CLI `request system halt` command. For more information, see “Disconnecting AC Power from the Router” on page 144.

Connecting Power to a DC-Powered Router

Connect DC power to the router by inserting power cables into the field-wiring terminals on the faceplate of each power supply. DC Power cables are not supplied with the router. For information about the required cable type, see “DC Power, Connection, and Cable Specifications” on page 209.

1. Verify that there is no power flowing from either external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. Verify that a licensed electrician has attached a listed power cable lug to each power source cable.
3. For each power supply, verify that the power switch on the power supply faceplate is in the **OFF (O)** position.
4. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
5. Loop the power cables through the hook located on the faceplate to the right of the field-wiring terminals.
6. Depending on the type of power cable lugs used, loosen or remove the screws on the field-wiring terminals.
7. Insert the power cable lugs into the appropriate field-wiring terminals. Using a number 1 Phillips screwdriver, turn the screw on each field-wiring terminal clockwise to secure the power cable lug. Apply between 8 lb-in. (.9 Nm) and 9 lb-in. (1.02 Nm) of torque to each screw.
 - a. Insert the positive (+) source cable into the return terminal, which is labeled RTN.
 - b. Insert the negative (–) source cable into the input terminal, which is labeled –48V.



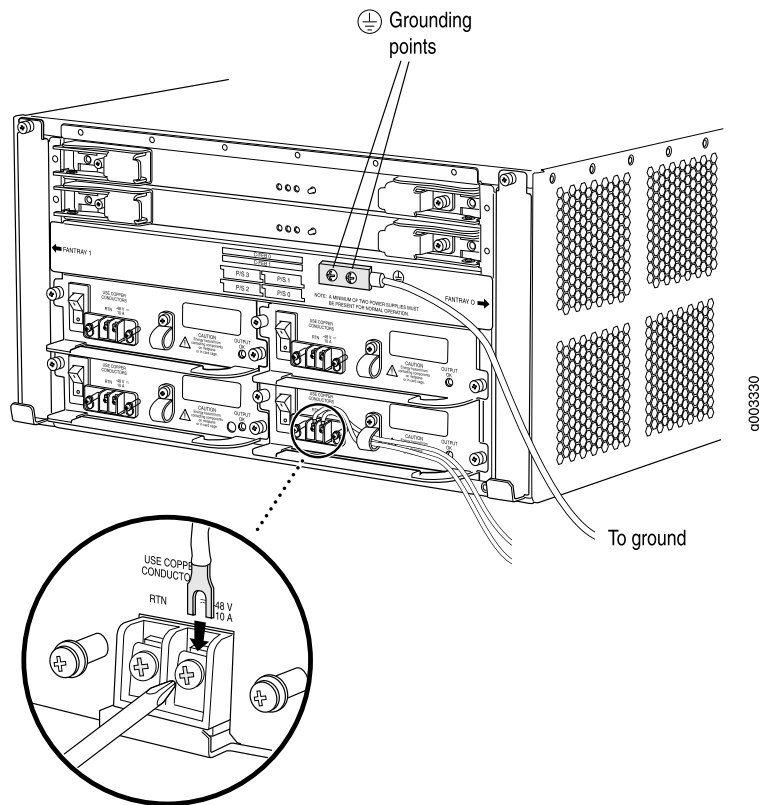
CAUTION: You must ensure that power connections maintain the proper polarity. The power source cables might be labeled (+) and (–) to indicate their polarity. There is no standard color coding for DC power cables. The color coding used by the external DC power source at your site determines the color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



NOTE: The DC power supplies in slots P/S 0 and P/S 1 must be powered by dedicated power feeds derived from feed A, and the DC power supplies in slots P/S 2 and P/S 3 must be powered by dedicated power feeds derived from feed B. This configuration provides the commonly deployed A/B feed redundancy for the system. For information about connecting to DC power sources, see “DC Power, Connection, and Cable Specifications” on page 209.

8. Verify that the DC source power cabling is correct, that the DC cables are not touching or blocking access to router components, and that they do not drape where people could trip on them.

Figure 47: Connecting DC Power and Grounding Cables



Powering On a DC-Powered Router

To power on the router:

1. Verify that the power supplies are fully inserted in the chassis and the thumbscrews on their faceplates are tightened.
2. For each power supply on a DC-powered router, verify that the source DC power cables are connected to the appropriate terminal on the power supply faceplate:

the positive (+) source cable to the return terminal (labeled RTN) and the negative (–) source cable to the input terminal (labeled –48V).

3. Verify that an external management device is connected to one of the Routing Engine ports on the craft interface (AUX/MODEM, CONSOLE, or MGMT). For more information about connecting management devices, see “Connecting the Router to Management and Alarm Devices” on page 83.
4. Turn on the power to the external management device.
5. Press the power switch for the power supplies in slots P/S 0 and P/S 1 to the ON (|) position. The power switch is located on the power supply faceplate.



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



NOTE: If the LED does not light after 60 seconds, verify that the power supply is properly inserted into the chassis and repeat the cable installation procedures described in “Connecting Power to a DC-Powered Router” on page 91.

6. Verify that the **OUTPUT OK** LED on each power supply faceplate eventually lights steadily.
7. Press the power switch for any additional power supplies to the ON (|) position and verify that the **OUTPUT OK** LED on each power supply faceplate lights steadily.
8. On the external management device connected to the Routing Engine, monitor the startup process to verify that the system has booted properly.



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



NOTE: After powering off a power supply, wait at least 60 seconds before turning it back on. If the router is completely powered off 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 off the router again, first issue the CLI `request system halt` command. For more information, see “Disconnecting DC Power from the Router” on page 153.

Chapter 11

Configuring the Router

- Configuring the JUNOS Software on page 95

Configuring the JUNOS Software

The router is shipped with the JUNOS software preinstalled and ready to be configured when the router is powered on. There are three copies of the software: one on a CompactFlash card (if installed) in the Routing Engine, one on the hard disk in the Routing Engine, and one on a PC card that can be inserted into the slot in the Routing Engine faceplate.

When the router boots, it first attempts to start the image on the PC card. If a PC card is not inserted into the Routing Engine or the attempt otherwise fails, the router next tries the CompactFlash card (if installed), and 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 **MGMT** port on the craft interface.

Gather the following information before configuring the router:

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

This procedure connects the router to the network but does not enable it to forward traffic. For complete information about enabling the router to forward traffic, including examples, see the JUNOS software configuration guides.

To configure the software:

1. Verify that the router is powered on, as described in “Powering On an AC-Powered Router” on page 90.
2. Log in as the root user. There is no password.

3. Start the CLI.

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

4. Enter configuration mode.

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

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

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

6. Configure the router's domain name.

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

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

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

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

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

9. Configure the IP address of a DNS server.

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

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

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

or

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

or

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

or

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

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

```
[edit]
root@# show
system {
  host-name host-name;
  domain-name domain-name;
  backup-router address;
  root-authentication {
    authentication-method (password | public-key);
  }
  name-server {
    address;
  }
}
interfaces {
  fxp0 {
    unit 0 {
      family inet {
        address address/prefix-length;
      }
    }
  }
}
```

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

```
[edit]
root@# commit
```

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

```
[edit]
root@host# commit
```

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

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


Part 3

Hardware Maintenance, Troubleshooting, and Replacement Procedures

- Maintaining Hardware Components on page 101
- Troubleshooting Hardware Components on page 109
- Replacing Hardware Components on page 117

Chapter 12

Maintaining Hardware Components

This chapter describes how to maintain hardware components installed in the router. For information about returning a part to Juniper Networks for repair or replacement, see “Contacting Customer Support and Returning Hardware” on page 219.

- Routine Maintenance Procedures on page 101
- Maintaining Cooling System Components on page 101
- Maintaining Packet Forwarding Engine Components on page 102
- Maintaining the Routing Engines on page 105
- Maintaining the Power Supplies on page 106

Routine Maintenance Procedures

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

- Inspect the installation site for potential problems caused by moisture, loose wires or cables, and excessive dust. Make sure that airflow around the router is unobstructed.
- Check the LEDs on the craft interface and on hardware components. See “Craft Interface” on page 28.

Maintaining Cooling System Components

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

```
user@host> show chassis environment
```

Class	Item	Status	Measurement
...			
Fans	Rear Fan	OK	Spinning at normal speed
	Front Upper Fan	OK	Spinning at normal speed
	Front Middle Fan	OK	Spinning at normal speed
	Front Bottom Fan	OK	Spinning at normal speed
...			

The row labeled **Rear Fan** reports the status of the Routing Engine fan tray and the other three rows report the status of the front fan trays. For further description of the output from the command, see the *JUNOS System Basics and Services Command Reference*.

Maintaining Packet Forwarding Engine Components

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

- Maintaining the FPCs on page 102
- Maintaining PICs and PIC Cables on page 103
- Maintaining the SSBs on page 104

Maintaining the FPCs

The router can have up to four Flexible PIC Concentrators (FPCs) mounted horizontally in the front of the chassis, as shown in Figure 1 on page 8. To maintain FPCs, perform the following procedures on a regular basis:

- Check the FPC LEDs on the craft interface. The green LED labeled **OK** lights steadily when an FPC is functioning normally. For more information, see “FPC LEDs and Offline Button” on page 30.
- 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 (%)		Memory DRAM (MB)	Utilization (%)	
			Total	Interrupt		Heap	Buffer
0	Online	37	4	0	32	1	39
1	Online	39	4	0	32	1	39
2	Empty						
3	Online	34	4	0	32	1	39

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

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

```
Slot 0 information:
State                Online
Temperature          37 degrees C / 98 degrees F
Total CPU DRAM       32 MB
Total SRAM           4 MB
Total SDRAM          128 MB
I/O Manager ASIC information  Version 3.0, Foundry IBM, Part number
0
```

```

I/O Manager ASIC information      Version 3.0, Foundry IBM, Part number
0
Start time:                      2003-03-31 20:54:30 PDT
Uptime:                          25 days, 8 hours, 5 minutes, 32 seconds

```

For further description of the output from the commands, see the *JUNOS System Basics and Services Command Reference*.

Maintaining PICs and PIC Cables

To maintain PICs and PIC cables:

- 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 PIC Guide*. If the FPC that houses the PIC detects a PIC failure, the FPC generates an alarm message to be sent to the Routing Engine.
- Issue the CLI **show chassis fpc pic-status** command. The PIC slots in an FPC are numbered from 0 through 3, right to left:

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

```

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

```

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

- Use the cable management system (shown in Figure 1 on page 8) to support cables and prevent cables from dislodging or developing stress points.
- Place excess cable out of the way in the cable management system. Do not allow fastened loops of cable to dangle from the connector or cable management system, because this stresses the cable at the fastening point. Putting fasteners on the loops helps to maintain their shape.
- Keep the cable connections clean and free of dust and other particles, which can cause drops in the received power level. Always inspect cables and clean them if necessary before connecting an interface.
- Label both ends of PIC cables to identify them.

The following guidelines apply specifically to fiber-optic cable:

- When you unplug a fiber-optic cable from a PIC, always place a rubber safety plug over the transceiver on the PIC faceplate and on the end of the cable.
- Anchor fiber-optic cable to avoid stress on the connectors. When attaching fiber to a PIC, be sure to secure the fiber so it is not supporting its own weight as it hangs to the floor. Never let fiber-optic cable hang free from the connector.

- Avoid bending fiber-optic cable beyond its bend radius. An arc smaller than a few inches can damage the cable and cause problems that are difficult to diagnose.
- Frequent plugging and unplugging of fiber-optic cable into and out of optical instruments, such as ATM or SONET/SDH analyzers, can cause damage to the instruments that is expensive to repair. Instead, attach a short fiber extension to the optical equipment. Any wear and tear due to frequent plugging and unplugging is then absorbed by the short fiber extension, which is easy and inexpensive to replace.
- Keep fiber-optic cable connections clean. Small micro-deposits of oil and dust in the canal of the transceiver or cable connector could cause loss of light, reducing signal power and possibly causing intermittent problems with the optical connection.

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

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

Maintaining the SSBs

The router can have a System and Switch Board (SSB) in each of the two uppermost slots on the front of the chassis, as shown in Figure 1 on page 8. To maintain the SSBs, perform the following procedures on a regular basis:

- Check the LEDs on the SSB faceplates. The green LED labeled **ONLINE** and blue LED labeled **MASTER** light steadily on the master SSB when it is functioning normally. For more information, see “SSB Components” on page 22.
- Issue the CLI **show chassis ssb** command to check the status of the SSBs. As shown in the sample output, when two SSBs are installed the master SSB is marked as **Master**, and the other SSB as **Backup**:

```
user@host> show chassis ssb
```

```
SSB status:
Slot 0 information:
  State                Master
  Temperature          28 degrees C / 82 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:          2003-04-21 14:28:06 PDT
  Uptime:              14 days, 8 hours, 6 minutes, 9 seconds
Slot 1 information:
  State                Backup
```

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

Maintaining the Routing Engines

The router can have a Routing Engine in each of the slots labeled RE0 and RE1 at the rear of the chassis, as shown in Figure 2 on page 8. To maintain the Routing Engines, perform the following procedures on a regular basis:

- Check the Routing Engine LEDs on the Routing Engine panel or on the craft interface. The green LED labeled **ONLINE** and blue LED labeled **MASTER** light steadily for the master Routing Engine when it is functioning normally. (The **ONLINE** LED also lights for the standby Routing Engine if it is installed). For more information about the LEDs, see “Routing Engine Panel and Fan Tray” on page 27.
- Issue the CLI `show chassis routing-engine` command to check the status of the Routing Engines. As shown in the sample output, the master Routing Engine is marked as **Master** in the **Current state** field:

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

```
Routing Engine status:
```

```
Slot 0:
```

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

```
Routing Engine status:
```

```
Slot 1:
```

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

```

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

```

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

Maintaining the Power Supplies

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

- Check the LEDs on the faceplate of both power supplies. The green **OK** LED indicates that the power supply is functioning normally; the amber **FAULT** LED indicates a power supply fault. For more information, see “Power Supply LEDs” on page 33.
- 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 System Basics and Services Command Reference*.

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

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

For a list of possible alarm messages, see “Hardware and Interface Alarm Messages” on page 110.

- Verify that the power source has the proper current rating and that each power supply is connected to a separate power source.
- Verify that the cable or cord connecting the power supply to the external power source is securely in place and that there is no moisture accumulating near the router.
- Verify that the cable or cord from the power source to the router is not damaged. If the insulation is cracked or broken, replace the cable or cord immediately.

- Verify that the power cables or cord do not touch or obstruct access to other router components, and that they do not drape where people could trip on them.
- Verify that the air flow in and out of cooling system components is not obstructed.

Chapter 13

Troubleshooting Hardware Components

This chapter describes how to troubleshoot problems with hardware components installed in the router. If you encounter software problems, or problems with hardware components not discussed here, contact the Juniper Networks Technical Assistance Center (JTAC) as described in “Requesting Technical Support” on page xxix.

- Overview of Troubleshooting Resources on page 109
- Troubleshooting the Cooling System on page 111
- Troubleshooting Packet Forwarding Engine Components on page 113
- Troubleshooting the Power System on page 115

Overview of Troubleshooting Resources

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

- LEDs on page 109
- Hardware and Interface Alarm Messages on page 110
- Juniper Networks Technical Assistance Center on page 111

LEDs

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

LEDs on the Craft Interface

The craft interface provides status and troubleshooting information at a glance. It is located on the front of the chassis above the FPCs, as shown in Figure 1 on page 8. The LEDs on the craft interface include the following:

- Alarm—The circular red alarm LED at the upper left of the craft interface indicates a critical condition that can result in a system shutdown. The triangular yellow alarm below it indicates a less severe condition that requires monitoring or maintenance. Both alarms can occur simultaneously. For more information about the alarm LEDs, see “Alarm Relay Contacts, LEDs, and Cutoff Button” on page 29. For more information about the causes of alarms, see “Hardware and Interface Alarm Messages” on page 110.

- **FPC**—For each of the FPC slots in the router, there are two LEDs and an offline button located on the craft interface. The green LED labeled **OK** and the amber LED labeled **FAIL** indicate FPC status. For more information, see “FPC LEDs and Offline Button” on page 30.
- **Routing Engine**—Two sets of LEDs in the middle of the craft interface near the Juniper Networks logo indicate the status of the two Routing Engines. Each set includes three LEDs—a blue one labeled **MASTER**, a green one labeled **ONLINE**, and an amber one labeled **OFFLINE**. The LEDs on the Routing Engine panel display the same information; see “Routing Engine LEDs and Offline Buttons” on page 30.

LEDs on Hardware Components

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

- **PIC**—Most PICs have an LED labeled **STATUS** on 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 PIC Guide*.
- **Power supply**—A green LED labeled **OK** and an amber LED labeled **FAULT** report the status of the power supply. For more information, see “Power Supply LEDs” on page 33.
- **Routing Engine panel**—Sets of LEDs on the Routing Engine panel indicate the status of the two Routing Engines. Each set includes three LEDs—a blue one labeled **MASTER**, a green one labeled **ONLINE**, and an amber one labeled **OFFLINE**. For more information, see “Routing Engine Panel and Fan Tray” on page 27.
- **SSB**—An amber LED labeled **OFFLINE**, a green LED labeled **ONLINE**, and a blue LED labeled **MASTER** report the status of the SSB. For more information, see “SSB Components” on page 22.

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, and trips the corresponding alarm relay contact on the craft interface. 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 21 on page 111.
- **Interface alarms**—Indicate a problem with a specific network interface, as described in Table 22 on page 115.

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

Table 21: Chassis Alarm Messages

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

Juniper Networks Technical Assistance Center

If you need assistance during troubleshooting, you can contact the Juniper Networks Technical Assistance Center (JTAC) by using the Web or telephone. See “Requesting Technical Support” on page xxix.

Troubleshooting the Cooling System

The router has two separate cooling subsystems, one for the power supplies and one for the other router components. Each subsystem maintains a separate air flow and is monitored independently. For a graphic depiction of the airflow, see Figure 19 on page 35.

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 56.

To troubleshoot the cooling subsystems, follow these guidelines:

- Troubleshooting the Power Supply Fan on page 112
- Troubleshooting the Front and Routing Engine Fan Trays on page 112

Troubleshooting the Power Supply Fan

To check the status of the power supply fans, perform the following procedures:

- Check LEDs. Two LEDs on the power supply faceplate report the supply's status, including the status of the fan. If the amber LED labeled **FAULT** is lit, the power supply fan might have failed. For more information, see “Power Supply LEDs” on page 33. Power supply failure also triggers the red alarm LED on the craft interface. For more information about alarm LEDs, see “Alarm Relay Contacts, LEDs, and Cutoff Button” on page 29
- 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, implying that its internal fan is maintaining an acceptable temperature:

```
user@host> show chassis environment
```

Class	Item	Status	Measurement	Power Supply A	Power Supply B
	OK	Power	OK ...		

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

Troubleshooting the Front and Routing Engine Fan Trays

The three fan trays in the front of the router and the fans behind the Routing Engine panel at the rear of the router draw in room air to cool router components. Temperature sensors on the components detect temperatures above the acceptable range. Fan failure or an excessive temperature condition triggers the red alarm LED and the corresponding alarm relay contact on the craft interface. If the temperature passes the acceptable maximum, the Routing Engine turns off the power supplies.

To troubleshoot the fan trays, follow these guidelines:

- To check the status of the fans in a fan tray, issue the **show chassis environment** command. The output includes an entry for each fan tray, as shown in this example:

```
user@host> show chassis environment
```

Class	Item	Status	Measurement
...			
Fans	Rear Fan	OK	Spinning at normal speed
	Front Upper Fan	OK	Spinning at normal speed
	Front Middle Fan	OK	Spinning at normal speed
	Front Bottom Fan	OK	Spinning at normal speed
...			

The row labeled **Rear Fan** reports the status of the Routing Engine fan tray and the other three rows report the status of the front fan trays. For further description

of the output from the command, see the *JUNOS System Basics and Services Command Reference*.

- If one of the fan trays fails, determine whether you can distinguish individual blades in a fan—this is not possible when the fans are rotating at normal speed.
- If a front fan tray seems to have failed, move it to another bay. For information about replacing a front fan tray, see “Replacing a Front Fan Tray” on page 124.
 - If the fan tray does not work in the other bay, it is probably faulty and needs to be replaced. For instructions about returning a faulty component to Juniper Networks, see “Contacting Customer Support and Returning Hardware” on page 219.
 - If the fan tray works in another bay, there is probably a problem with power connectivity from the midplane. Contact JTAC for assistance.

Troubleshooting Packet Forwarding Engine Components

The following sections describe how to troubleshoot FPCs and PICs:

- Troubleshooting FPCs on page 113
- Troubleshooting PICs on page 114

Troubleshooting 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 housed on it. 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 the FPCs, follow these guidelines:

- If the amber FPC LED labeled **FAIL** on the craft interface lights steadily, make sure the FPC is properly seated in the midplane. Use a Phillips screwdriver to check that the screws at the top and bottom of the card carrier are tight.
- To check the status of an FPC, issue the CLI **show chassis fpc** command. 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	37	4	0	32	1	39
1	Online	39	4	0	32	1	39
2	Empty						
3	Online	34	4	0	32	1	39

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

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

```
Slot 0 information:
  State                               Online
  Temperature                         37 degrees C / 98 degrees F
  Total CPU DRAM                      32 MB
  Total SRAM                          4 MB
  Total SDRAM                         128 MB
  I/O Manager ASIC information        Version 3.0, Foundry IBM, Part number
0
  I/O Manager ASIC information        Version 3.0, Foundry IBM, Part number
0
  Start time:                        2003-03-31 20:54:30 PDT
  Uptime:                            25 days, 8 hours, 5 minutes, 32 seconds
```

Troubleshooting PICs

To troubleshoot the PICs:

1. Check the status of the LEDs located on the PIC faceplate. Many PICs have an LED labeled **STATUS** on their faceplate. Some PICs have additional LEDs, often one per port. For information about the LEDs on each PICs, see the *M20 PIC Guide*.
2. Issue the following CLI command to check the status of a PIC:

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

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

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

The PIC slots are numbered from 0 through 3, right to left

3. If an LED is lit indicating a problem with the PIC, issue the **show chassis alarms** CLI command to view a more detailed description of the alarm cause:

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

For a list of messages that can appear in the output, see Table 22 on page 115.

4. If you are unable to correct the problem, replace the PIC with a spare. For instructions, see “Replacing a PIC” on page 133. If the LEDs light correctly on the spare, the original PIC is faulty. Return it to Juniper Networks for replacement, as described in “Contacting Customer Support and Returning Hardware” on page 219.

Table 22: SONET/SDH Interface Alarm Messages

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

Troubleshooting the Power System

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

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

- All LEDs on Both Supplies Are Off on page 115
- All LEDs on One Supply Are Off or LED States Are not Correct on page 116

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 no LEDs are lit, including the alarm LEDs on the craft interface.

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

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

If either of the following conditions applies, perform the diagnostic procedure described following the list of conditions:

- The LEDs on one power supply are all off, but the LEDs on the other supply indicate that it is functioning properly.
- The LED states on one or both supplies indicate a problem: the green LED labeled **OUTPUT OK** is not lit and the amber LED labeled **FAULT** 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 information about the cause of an alarm condition:

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

For a list of messages that can appear in the output, see “Hardware and Interface Alarm Messages” on page 110. A common cause of power supply shutdown is that the temperature of the power supply or another router component has exceed the maximum limit.

- If the red alarm LED is not lit, check that the power switch is in the **ON** position on the power supply faceplate.
2. Replace the faulty power supply with a spare. For instructions, see “Replacing an AC Power Supply” on page 141 and “Replacing a DC Power Supply” on page 147. If the LEDs light correctly on the spare, the original power supply is faulty. Return it to Juniper Networks for replacement, as described in “Contacting Customer Support and Returning Hardware” on page 219.
 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 “Replacing an AC Power Cord” on page 146 and “Disconnecting and Connecting DC Power” on page 153 (you do not need to disconnect and reconnect the grounding cable on a DC-powered router).
 4. If you cannot determine the cause of the problem or need additional assistance, see “Juniper Networks Technical Assistance Center” on page 111.

Chapter 14

Replacing Hardware Components

Most of the router's hardware components are field-replaceable units (FRUs), which means that you can remove and replace them yourself. When you need to replace a router component, contact your customer support or sales representative to order the field-replaceable unit (FRU) that contains the component. For instructions, see “Contacting Customer Support and Returning Hardware” on page 219. For a list of the FRUs on the M20 router, see “Field-Replaceable Units (FRUs)” on page 4.

- Tools and Parts Required on page 117
- Replacing the Craft Interface and Routing Engine Interface Port Cables on page 118
- Replacing Cooling System Components on page 123
- Replacing Packet Forwarding Engine Components on page 128
- Replacing Power System Components on page 141
- Replacing Routing Engine Components on page 158

Tools and Parts Required

To replace hardware components, you need the tools and parts listed in Table 23 on page 117.

Table 23: Tools and Parts Required

Tool or part	Components
Electrostatic bag or antistatic mat	Craft interface
	FPC
	PIC
	Routing Engine
	Routing Engine panel and fan tray
	SSB
Electrostatic discharge (ESD) grounding wrist strap	All
Flat-blade (–) screwdriver, 2.5-mm	Console or auxiliary cable

Table 23: Tools and Parts Required *(continued)*

Tool or part	Components
Phillips (+) screwdriver, 2.5-mm	Alarm relay contacts
Phillips (+) screwdrivers, numbers 1 and 2	Craft interface DC power cables (to remove protective shield) Front fan tray PIC Power supply (AC or DC) Routing Engine Routing Engine panel and fan tray SSB
7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a torque range between 23 lb-in. (2.6 Nm) and 25 lb-in. (2.8 Nm) (See following note.)	DC power supply (to remove or install power cables) DC power cables
Wire cutters	Alarm relay contacts
Rubber safety cap	Fiber-optic PIC or PIC cable



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

Replacing the Craft Interface and Routing Engine Interface Port Cables

The craft interface is located on the front of the chassis above the FPC card cage, as shown in Figure 1 on page 8. It houses the Routing Engine interface ports, which accept connections to external management and alarm-reporting devices.

The craft interface is field-replaceable, but is not hot-removable, hot-insertable, or hot-pluggable. You must power off the router before removing or installing it, as specified in “Field-Replaceable Units (FRUs)” on page 4. The cables and wire that connect to the Routing Engine interface ports are hot-removable and hot-insertable.

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

- Removing the Craft Interface on page 119
- Installing the Craft Interface on page 120
- Replacing Connections to Routing Engine Interface Ports on page 121

Removing the Craft Interface

To remove the craft interface, follow this procedure (see Figure 48 on page 120):

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

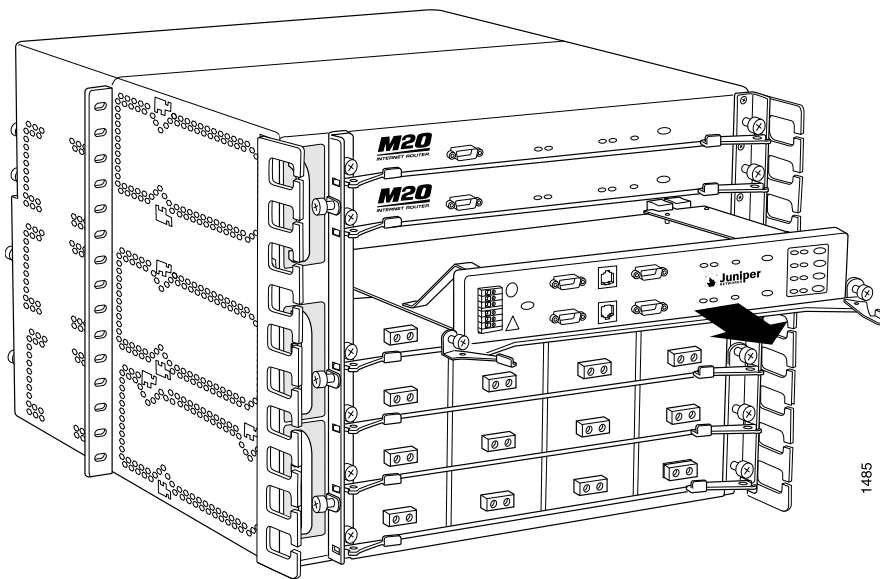
```
user@host> request system halt
```



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

For more information about the command, see the *JUNOS System Basics and Services Command Reference*.

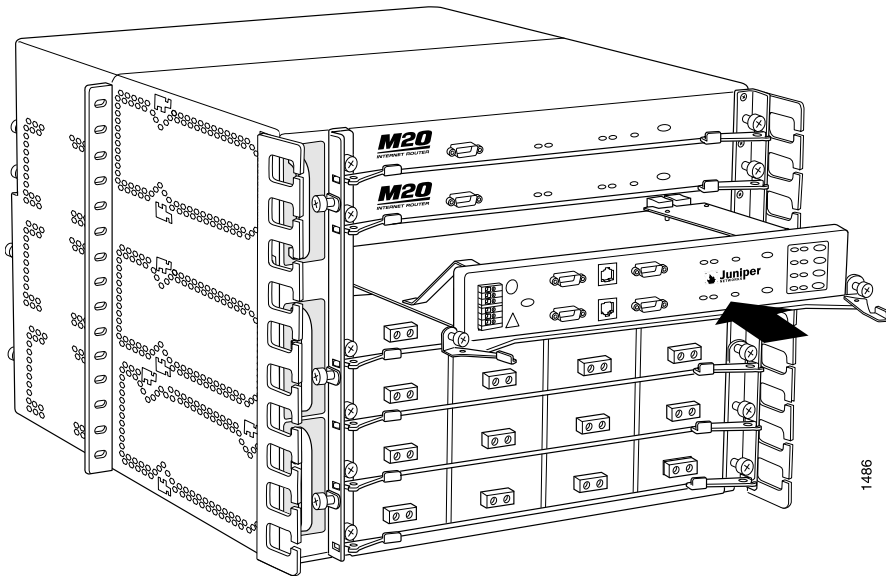
3. Power off the router by pressing the power switch for both power supplies to the OFF (O) position. On a DC power supply, the switch is located above the terminal studs on the power supply faceplate. On an AC power supply, the switch is just below the appliance inlet on the power supply faceplate.
4. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
5. Disconnect any external devices connected to the craft interface. For instructions, see “Replacing Connections to Routing Engine Interface Ports” on page 121.
6. Unscrew the thumbscrew at each end of the craft interface, using a Phillips screwdriver if necessary.
7. Pull the ends of the ejector levers, which are adjacent to the thumbscrews, away from the face of the craft interface.
8. Grasp the craft interface with both hands and slide it about halfway out of the chassis.
9. Place one hand underneath the craft interface to support it, slide it completely out of the chassis, and set it on the antistatic mat or in the electrostatic bag.

Figure 48: Removing the Craft Interface

Installing the Craft Interface

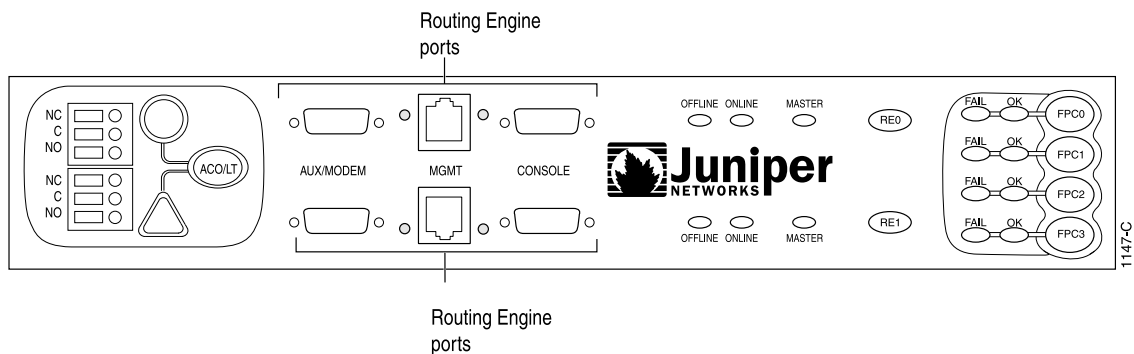
To install the craft interface, follow this procedure (see Figure 49 on page 121):

1. Verify that the router is powered off. If necessary, halt the Routing Engine software and power off the power supplies as described in “Removing the Craft Interface” on page 119.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Place one hand under the craft interface to support it and grasp one of the ejector levers at the front with the other hand.
4. Align the rear of the craft interface with the guides inside the chassis and slide it in completely.
5. Press the ejector lever at each end of the craft interface inward toward the faceplate.
6. Tighten the thumbscrew at each end of the craft interface faceplate until the craft interface is seated firmly in the chassis.
7. Reattach an external management device to one of the Routing Engine ports on the craft interface (**AUX/MODEM, CONSOLE, or MGMT**). If two Routing Engines are installed, connect to the Routing Engine that is configured to become the master, which by default is the Routing Engine in slot **RE0**. For more information, see “Routing Engine” on page 24. Also reattach alarm relay contacts if desired. For instructions, see “Replacing Connections to Routing Engine Interface Ports” on page 121.

Figure 49: Installing the Craft Interface

Replacing Connections to Routing Engine Interface Ports

The ports on the craft interface connect the Routing Engine to external management devices (see Figure 50 on page 121).

Figure 50: Routing Engine Interface Ports and Alarm Relay Contacts

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

- Replacing the Management Ethernet Cable on page 121
- Replacing the Console or Auxiliary Cable on page 122
- Replacing Alarm Relay Wire on page 123

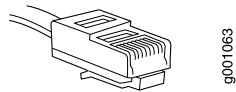
Replacing the Management Ethernet Cable

To connect the Routing Engine to a network for out-of-band management, connect an Ethernet cable with RJ-45/RJ-45 connectors to the MGMT port on the craft interface.

One such cable is provided with the router. For cable specifications, see “Routing Engine Interface Cable and Wire Specifications” on page 217:

1. If a cable is already installed in the **MGMT** port for the relevant Routing Engine, perform the following steps:
 - a. Press the tab on the connector and pull the connector straight out of the port. Figure 51 on page 122 shows the connector.
 - b. Disconnect the cable from the network device.
2. Plug one end of the replacement Ethernet cable into the appropriate **MGMT** port. Figure 50 on page 121 Figure 43 on page 84 shows the external device ports on the craft interface. The upper ports connect to the Routing Engine in the upper Routing Engine slot (**RE0**), and the lower ports connect to the Routing Engine in the lower Routing Engine slot (**RE1**).
3. Plug the other end of the cable into the network device.

Figure 51: Ethernet Cable Connector



Replacing the Console or Auxiliary Cable

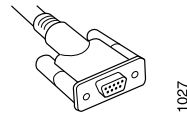
To use a system console to configure and manage the Routing Engine, connect it to the appropriate **CONSOLE** port on the craft interface. To use a laptop, modem, or other auxiliary device, connect it to the appropriate **AUX/MODEM** port on the craft interface. Both ports accept an RS-232 (EIA-232) serial cable with DB-9/DB-9 connectors. One such cable is provided with the router. If you want to connect a device to both ports, you must supply another cable. For cable specifications, see “Routing Engine Interface Cable and Wire Specifications” on page 217.

To connect a management console or auxiliary device:

1. If a cable is already installed in the **CONSOLE** or **AUX/MODEM** port, perform the following steps:
 - a. Turn off the power to the console or auxiliary device.
 - b. Unscrew the screws that secure the cable connector to the port, using a 2.5-mm flat-blade screwdriver if necessary.
 - c. Pull the cable connector straight out of the port.
 - d. Disconnect the cable from the console or auxiliary device.
2. Plug the female end of the replacement serial cable into the appropriate **CONSOLE** or **AUX/MODEM** port. Figure 50 on page 121 Figure 43 on page 84 shows the external device ports on the craft interface. The upper ports connect to the Routing Engine in the upper Routing Engine slot (**RE0**), and the lower ports connect to the Routing Engine in the lower Routing Engine slot (**RE1**).

3. Tighten the screws on the connector, using a 2.5-mm flat-blade screwdriver if necessary.
4. Power on the auxiliary or console device.

Figure 52: Serial Port Connector



Replacing Alarm Relay Wire

To connect the router to external alarm-reporting devices, attach wires to the relay contacts on the craft interface located to the left of the red and yellow alarm LEDs. A system condition that triggers the red alarm LED on the craft interface also activates the upper alarm relay contact, whereas a less serious alarm condition activates the yellow alarm LED and lower alarm relay contact.

The alarm relay contacts accept wire of any gauge between 28-AWG and 14-AWG (0.08 and 2.08 mm²), which is not provided. Use the gauge of wire appropriate for the external device that you are connecting.

To replace the wires connecting to an alarm-reporting device, follow this procedure (see Figure 50 on page 121):

1. Disconnect the existing wire at the external device.
2. Prepare the required length of replacement wire with gauge between 28-AWG and 14-AWG (0.08 and 2.08 mm²).
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.

Replacing Cooling System Components

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

- Replacing a Front Fan Tray on page 124
- Replacing the Routing Engine Panel and Fan Tray on page 126

Replacing a Front Fan Tray

Three fan trays install in a column at the left front of the chassis, as shown in Figure 1 on page 8. Each fan tray houses three fans and weighs approximately 5 lb (2 kg). To replace a front fan tray, perform the following procedures:

- Removing a Front Fan Tray on page 124
- Installing a Front Fan Tray on page 125

Removing a Front Fan Tray

To remove a fan tray, follow this procedure:

1. If any PIC cables draped between a PIC and the cable management system are blocking the fan tray you are removing, remove the cables from the slots in the cable management system. Arrange the cables so that they do not block the front of the fan tray, and secure them with temporary fasteners so that they are not supporting their own weight as they hang from the connector. (To make it easier to see the fan trays, Figure 53 on page 125 does not depict the cable management system on the left side of the router.)



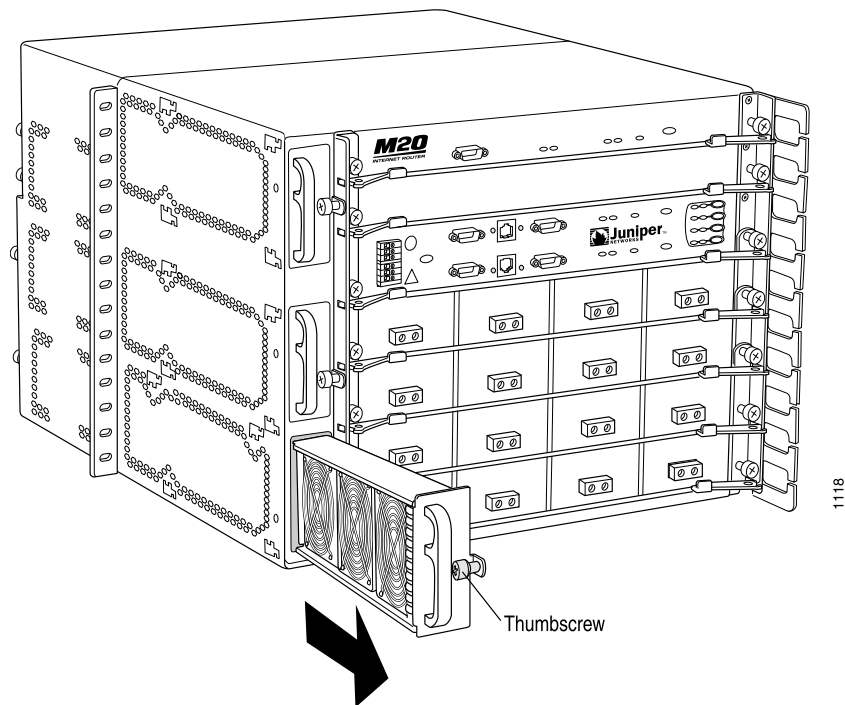
CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.

2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Loosen the thumbscrew near the middle of the fan tray faceplate, using a Phillips screwdriver if necessary.
4. Grasp the handle on the faceplate and slowly slide the fan tray out of the chassis just enough to disengage the fan tray connector from the midplane. Do not slide out the fan tray more than 0.5 in. (1.27 cm).



CAUTION: To avoid injury and damaging the fan tray, wait until the fans have completely stopped before you continue removing the fan tray from the chassis.

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

Figure 53: Removing a Front Fan Tray

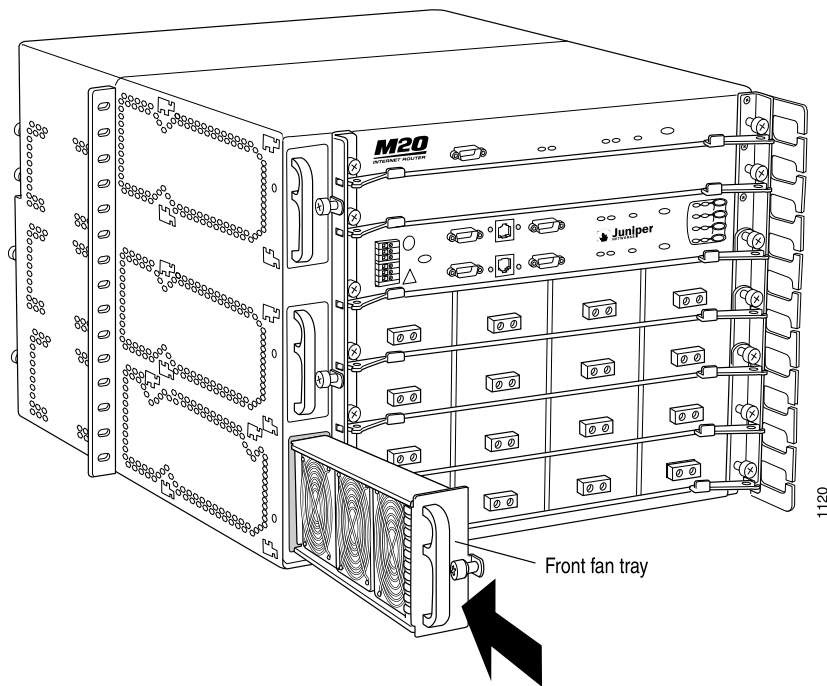
Installing a Front Fan Tray

To install a front fan tray, follow this procedure (see Figure 54 on page 126):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Grasp the handle on the faceplate of the fan tray with one hand and place the other hand under the unit to support it. Orient the tray so that the fans are on the left side.
3. Slide the tray into the slot.
4. Tighten the thumbscrew to seat the fan tray firmly in the chassis.
5. If you removed any PIC cables from slots in the cable management system while removing the fan tray, replace them. (To make it easier to see the fan trays, Figure 54 on page 126 does not depict the cable management system on the left side of the router.)



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

Figure 54: Installing a Front Fan Tray

Replacing the Routing Engine Panel and Fan Tray

The Routing Engine panel and fan tray is located immediately to the right of the Routing Engines, as shown in Figure 2 on page 8. The unit weighs approximately 2 lb (1 kg). To replace the Routing Engine panel and fan tray, perform the following procedures:

- Removing the Routing Engine Panel and Fan Tray on page 126
- Installing the Routing Engine Panel and Fan Tray on page 127

Removing the Routing Engine Panel and Fan Tray

To remove the Routing Engine panel and fan tray, follow this procedure (see Figure 55 on page 127):

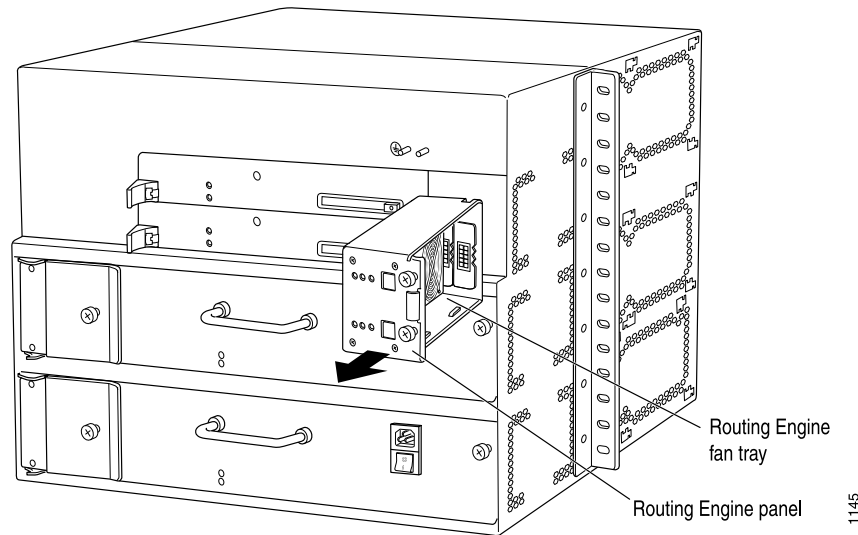
1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Loosen the thumbscrews on the right side of the Routing Engine panel, using a Phillips screwdriver if necessary.
4. Grasp the handle between the thumbscrews and pull the unit halfway out of the chassis.



CAUTION: To avoid injury, do not touch the fans with your fingers or any tool as you slide the fan tray out of the chassis—they might still be spinning.

5. Place one hand under the fan tray to support it, slide the tray completely out of the chassis after the fans stop spinning, and place it on the antistatic mat or in the electrostatic bag.

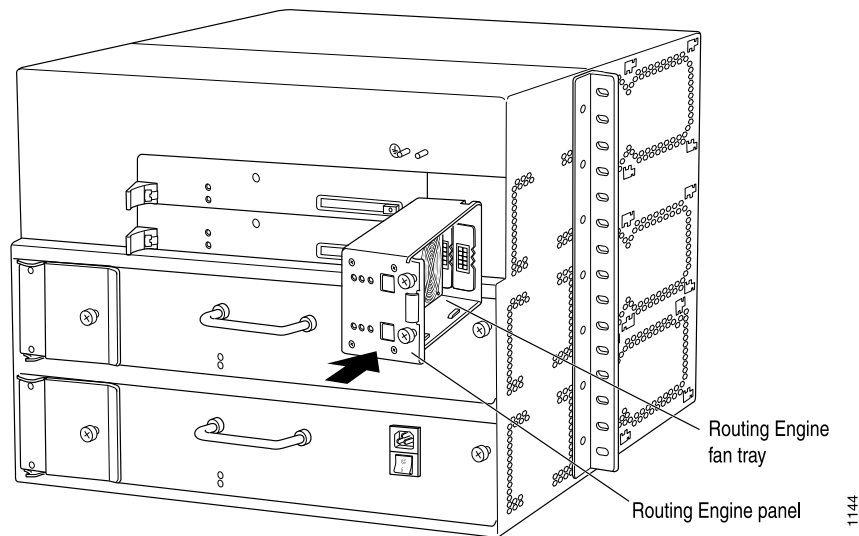
Figure 55: Removing the Routing Engine Panel and Fan Tray



Installing the Routing Engine Panel and Fan Tray

To install the Routing Engine panel and fan tray, follow this procedure (see Figure 56 on page 128):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Grasp the handle on the faceplate of the unit with one hand and place the other hand under the unit to support it.
3. Slide the unit into the chassis.
4. Tighten the thumbscrews to seat the unit firmly in the chassis.

Figure 56: Installing the Routing Engine Panel and Fan Tray

Replacing Packet Forwarding Engine Components

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

- Replacing an FPC on page 128
- Replacing a PIC on page 133
- Replacing an SFP on page 136
- Replacing an SSB on page 138

Replacing an FPC

The router can have up to four FPCs installed horizontally in the front of the chassis, as shown in Figure 1 on page 8. An FPC that houses four PICs weighs about 3 lb (1.5 kg). FPCs are hot-removable and hot-insertable, as described in “Field-Replaceable Units (FRUs)” on page 4. When you remove an FPC, forwarding operations halt for about 200 ms while the Packet Forwarding Engine flushes the shared memory buffers on the remaining FPCs.

To replace an FPC, perform the following procedures:

- Removing an FPC on page 128
- Installing an FPC on page 131

Removing an FPC

To remove an FPC, follow this procedure (see Figure 57 on page 130):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the FPC. If you are removing PICs from the FPC, substitute an antistatic foam mat, which provides extra cushioning for the electrical components on the FPC and PICs. If you are removing PICs from the FPC, prepare an antistatic mat or electrostatic bag for each one. If any of the PICs on the FPC use fiber-optic cable, also have ready a rubber safety cap for each transceiver and cable.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Label the cables connected to each PIC on the FPC so that you can later reconnect the cables to the correct PICs.
4. Use one of the following methods to take the FPC offline:
 - Press and hold the FPC offline button. The green OK LED next to the button begins to blink. Hold the button down until the LED goes out. The FPC LEDs and offline buttons are located at the far right side of the craft interface.
 - Issue the following CLI command:

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

For more information about the command, see the *JUNOS System Basics and Services Command Reference*.

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



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



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



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

6. Unscrew the thumbscrew at each end of the FPC, using a Phillips screwdriver if necessary.

7. Pull the ends of the ejector levers, which are adjacent to the thumbscrews, away from the face of the FPC.
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, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.



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

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.

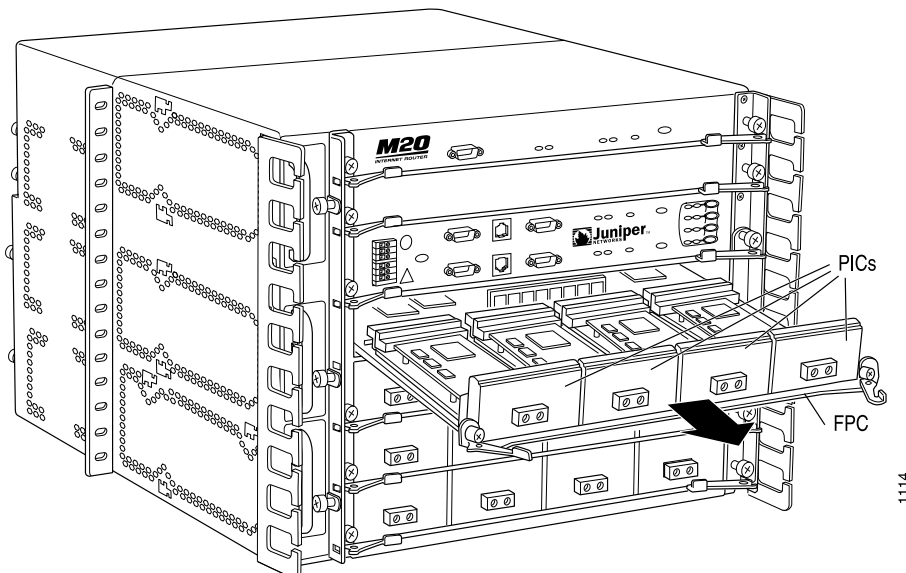
Do not stack the FPC on top of or under any other component.

10. If you are removing or replacing PICs on the FPC, see “Replacing a PIC” on page 133.
11. If you are not reinstalling an FPC into the emptied slot within a short time, install a blank FPC panel over the slot to maintain proper airflow in the FPC card cage.



CAUTION: After removing an FPC from the chassis, wait at least 30 seconds before reinserting it, removing an FPC from a different slot, or inserting an FPC into a different slot.

Figure 57: Removing an FPC



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Installing an FPC

To install an FPC, follow this procedure (see Figure 58 on page 133 and Figure 59 on page 133):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Install or remove PICs as desired by following the instructions in “Replacing a PIC” on page 133. 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 ejector levers, which are located at each end of the FPC, are pushed outward, nearly perpendicular to the face of the FPC.
4. Grasp the front of the FPC with one hand and place the other hand under the FPC to support it.



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

5. Align the rear bottom corners of the FPC with the guides at the bottom of the FPC slot. Slide the FPC into the card cage until it contacts the midplane.



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 midplane. Completing the insertion too quickly or too slowly can cause the router to reset.

As the FPC comes online, the green FPC LED labeled **OK** begins to blink. It continues to blink while the Routing Engine downloads software to the FPC, the FPC runs its diagnostics, and the PICs housed in the FPC are enabled. Packet forwarding then halts for about 200 ms while the Packet Forwarding Engine incorporates the memory on the new FPC into the memory buffers shared by all FPCs. When the FPC is online, the **OK** LED lights steadily.



CAUTION: After the **OK** LED lights steadily, wait at least 30 seconds before removing the FPC again, removing a FPC from a different slot, or inserting an FPC in a different slot.

6. Push the ends of the ejector levers inward until they are nearly flush with the face of the FPC.
7. Tighten the thumbscrew at each end of the FPC to seat the FPC securely in the chassis.

8. If any of the PICs on the FPC connect to fiber-optic cable, remove the rubber safety cap from each transceiver and cable.



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



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

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

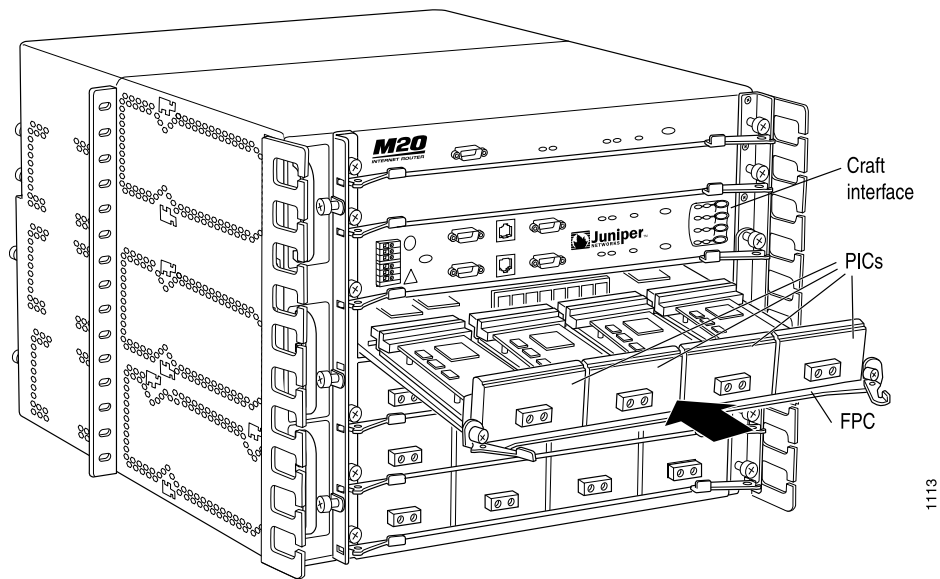
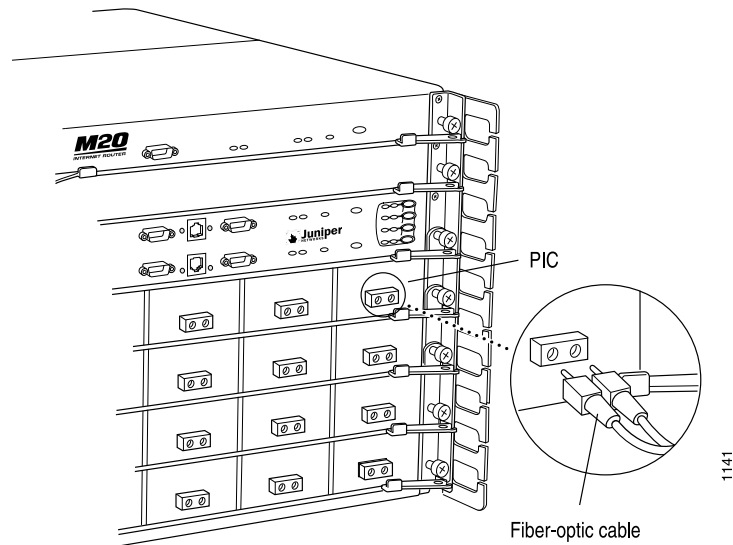


CAUTION: Do not let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, which stresses the cable at the fastening point.



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

10. To verify correct PIC and FPC functioning, issue the **show chassis fpc** commands described in “Maintaining the FPCs” on page 102 and “Maintaining PICs and PIC Cables” on page 103.

Figure 58: Installing an FPC**Figure 59: Connecting Fiber-Optic Cable to a PIC**

Replacing a PIC

Regular PICs are housed in the FPCs installed in the front of the router, as shown in Figure 1 on page 8.

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.

Quad-wide PICs, such as the 4-port Gigabit Ethernet and OC48/STM16 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 “Replacing an FPC” on page 128.

To replace a regular PIC, perform the following procedures:

- Removing a PIC on page 134
- Installing a PIC on page 135

Removing a PIC

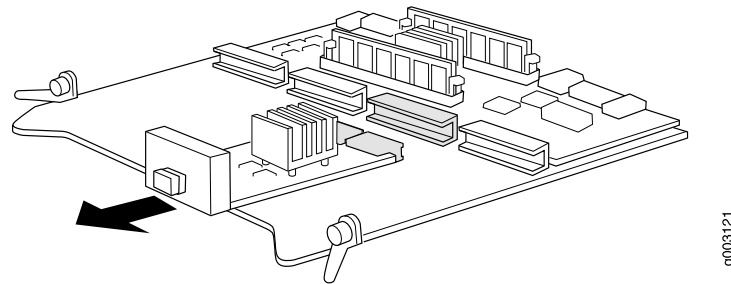
To remove a PIC, follow this procedure (see Figure 60 on page 135):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the PIC. If the PIC connects to fiber-optic cable, have ready a rubber safety cap for each transceiver and cable.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Follow the instructions in “Removing an FPC” on page 128 to remove the PIC's host FPC from the chassis. Lay the FPC component side down 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 on it to avoid damaging the electrical components on the FPC and PICs.
4. With the FPC lying component side down, 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 and 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.
8. If you are not reinstalling a PIC into the emptied slot, install a blank PIC panel over the slot before reinstalling the FPC, to maintain proper airflow in the FPC card cage.

Figure 60: Removing a PIC**Installing a PIC**

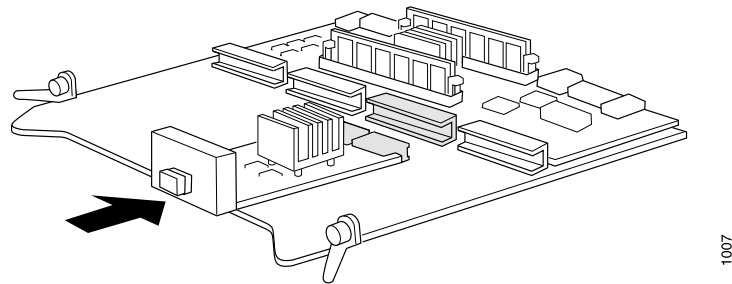
To install a PIC, follow this procedure (see Figure 61 on page 136):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. If the PIC uses fiber-optic cable, verify that there is a rubber safety cap over each transceiver on the faceplate. Install a cap if necessary.
3. 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 on the FPC and PICs.
4. Push the PIC part way into the FPC slot. Carefully align the tabs on the back of the PIC with the notches in the connector at the rear of the FPC slot. Push the PIC in until the connectors join.



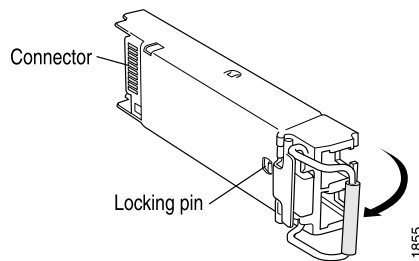
CAUTION: Be careful to insert the PIC straight into the FPC slot. If the pins on the FPC connector are not aligned properly with the holes in the PIC connector, the pins might be bent or the holes damaged. Either kind of damage can prevent the PIC and FPC from functioning correctly.

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

Figure 61: Installing a PIC

Replacing an SFP

Small form-factor pluggables (SFPs) are optical transceivers that can be removed from a PIC (for more information, see “Physical Interface Cards (PICs)” on page 11).

Figure 62: Small Form-Factor Pluggable (SFP)

SFPs are hot-insertable and hot-removable. Removing an SFP does not interrupt PIC functioning, but the removed SFP no longer receives or transmits data. To replace an SFP, perform the following procedures:

- Removing an SFP on page 136
- Installing an SFP on page 137

Removing an SFP



WARNING: Do not look directly into transceivers or into the ends of fiber-optic cables connected to a transceiver. Fiber-optic transceivers emit laser light that can damage your eyes.



CAUTION: When handling fiber-optic transceivers and fiber-optic cable, observe the following precautions:

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

- Do not bend 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.

To remove an SFP (see Figure 62 on page 136):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface to receive the SFP. Have ready a rubber safety cap for the SFP transceiver and the cable.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Label the cable connected to the SFP so that you can later reconnect it to the correct SFP.
4. Disconnect the cable from the SFP. Immediately cover the transceiver and the end of the cable with a rubber safety cap.
5. Arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
6. Pull the ejector handle away from the SFP faceplate to unseat the SFP from the PIC. Pull the SFP out of the PIC and place it on the antistatic mat or in the electrostatic bag.

Installing an SFP



WARNING: Do not look directly into transceivers or into the ends of fiber-optic cables connected to a transceiver. Fiber-optic transceivers emit laser light that can damage your eyes.



CAUTION: When handling fiber-optic transceivers and fiber-optic cable, observe the following precautions:

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

To install a replacement SFP (see Figure 62 on page 136):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that a rubber safety cap covers the SFP transceiver, installing one if necessary.
3. Orient the SFP over the port in the PIC so that the connector end will enter the slot first and the SFP connector faces the appropriate direction:
 - If the PIC has ten SFP ports, the ports are arranged in two columns. The SFP connector faces to the right for ports in the left column, and to the left for ports in the right column.
 - If the PIC has one or two SFP ports, the SFP connector faces to the left on platforms in which FPCs install vertically in the chassis, and faces upward on platforms in which FPCs install horizontally in the chassis.
4. Slide the SFP into the slot. If there is resistance, remove the SFP and flip it so that the connector faces the other direction.
5. Remove the rubber safety cap from the transceiver and the end of the cable, and insert the cable into the transceiver.
6. Arrange the cable in the cable management system to prevent the cable from dislodging or developing stress points. Secure the cable so that it is not supporting its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
7. Verify that the status LEDs on the PIC faceplate indicate that the SFP is functioning correctly (there is an LED for each SFP port). For more information about the PIC LEDs, see the *M20 PIC Guide*. You can also verify PIC functioning by issuing the `show chassis fpc pic-status` command described in “Maintaining PICs and PIC Cables” on page 103.

Replacing an SSB

One or two SSBs can be installed into the uppermost slots in the front of the chassis, as shown in Figure 1 on page 8. Only one SSB is active at a time, with the optional second SSB in reset mode. SSBs are hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. Removing the standby SSB has no effect on router function. If the active SSB fails or is removed from the chassis, the effect depends on whether two SSBs are installed:

- If there is only one SSB, forwarding halts until the SSB is replaced and functioning again.

- If there are two SSBs, forwarding halts until the standby SSB boots and becomes active.

In both cases, all components in the Packet Forwarding Engine reset, and it takes approximately one minute for the new SSB to become active; synchronizing router configuration information can take additional time, depending on the complexity of the configuration.

To replace an SSB, perform the following procedures:

- Removing an SSB on page 139
- Installing an SSB on page 140

Removing an SSB

To remove an SSB, follow this procedure (see Figure 63 on page 140):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. If you are removing the active SSB, press and hold the offline button on the faceplate until the yellow LED labeled **FAIL** lights, which takes about 5 seconds.

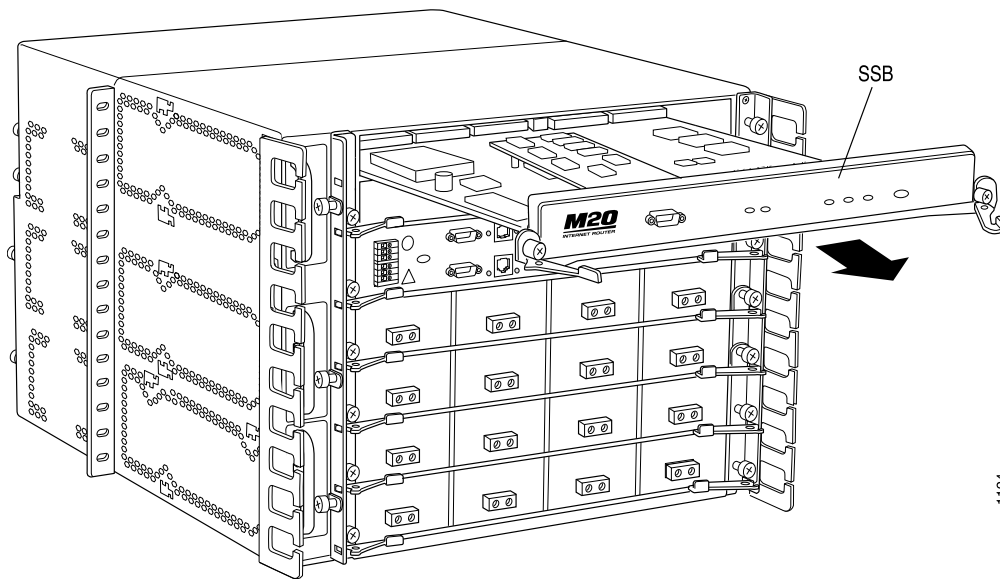
(The effect of removing the active SSB depends on whether a second SSB is installed. For more information, see “Replacing an SSB” on page 138.)

4. Loosen the thumbscrew at each end of the SSB, using a Phillips screwdriver if necessary.
5. Pull the end of each ejector lever outward until it is nearly perpendicular to the SSB faceplate.
6. Grasp the ejector levers and pull firmly to slide the SSB about halfway out of the chassis.
7. Place one hand under the SSB to support it, slide it completely out of the chassis, and place it on the antistatic mat or in the electrostatic bag.



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

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

Figure 63: Removing an SSB

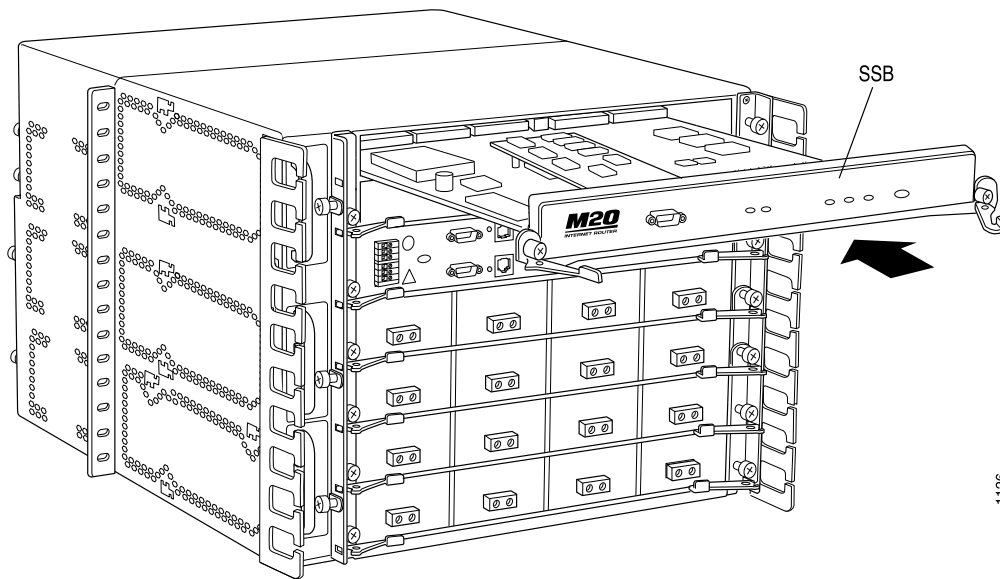
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Installing an SSB

To install an SSB, follow this procedure (see Figure 64 on page 141):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that the ends of the ejector levers are pulled outward to a position nearly perpendicular to the faceplate of the SSB.
3. Place one hand under the SSB to support it and grasp one of the ejector levers at the front with the other hand.
4. Align the rear of the SSB with the guides inside the chassis and slide it in completely.
5. Press the ejector lever at each end of the SSB inward.
6. Tighten the thumbscrew at each end of the SSB to seat the SSB firmly in the chassis.
7. Press the offline button on the SSB faceplate and hold it down until the green LED labeled **ONLINE** lights steadily, in about 5 seconds.

You can also verify correct SSB functioning by issuing the `show chassis ssb` commands described in “Maintaining the SSBs” on page 104.

Figure 64: Installing an SSB

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Replacing Power System Components

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

- Replacing an AC Power Supply on page 141
- Disconnecting and Connecting AC Power on page 144
- Replacing an AC Power Cord on page 146
- Replacing a DC Power Supply on page 147
- Disconnecting and Connecting DC Power on page 153

Replacing 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 off, the other power supply automatically assumes the entire electrical load for the router.

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

- Removing an AC Power Supply on page 141
- Installing an AC Power Supply on page 143

Removing an AC Power Supply

The AC power supplies are located at the bottom rear of the chassis, as shown in Figure 2 on page 8. Each AC power supply weighs approximately 12 lb (5.5 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 65 on page 142):

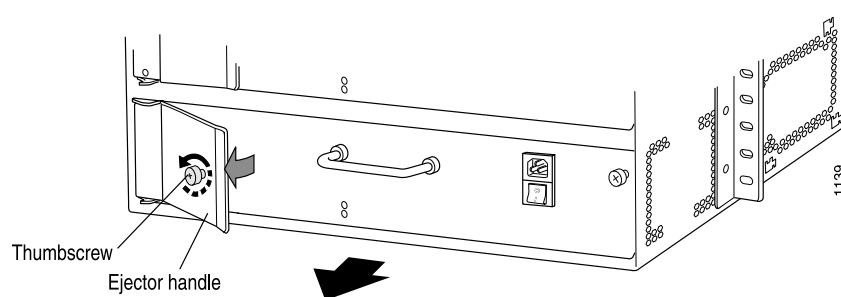
1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Press 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 end of the power supply faceplate, using a Phillips screwdriver if necessary. Unscrew both thumbscrews simultaneously and at about the same rate (unscrewing the two screws alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
5. Pull the ejector handle away from the faceplate.
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.

Figure 65: Removing an AC Power Supply



Installing an AC Power Supply

To install an AC power supply, follow this procedure (see Figure 66 on page 144):

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, Connection, and Power Cord Specifications” on page 208).
3. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
4. Grasp the handle on the power supply faceplate with one hand and place the other hand under the supply to support it.
5. Slide the power supply into the chassis until it contacts the midplane.
6. Press the ejector handle toward the faceplate to seat the power supply firmly in the chassis.
7. Tighten (but do not overtighten) the thumbscrews on the power supply faceplate. Turn both thumbscrews simultaneously and at about the same rate (turning them alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
8. 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.
9. Press the power switch on the faceplate to the **ON (I)** position. Verify that the green **OK** LED eventually lights steadily and the amber **FAULT** LED does not light.



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

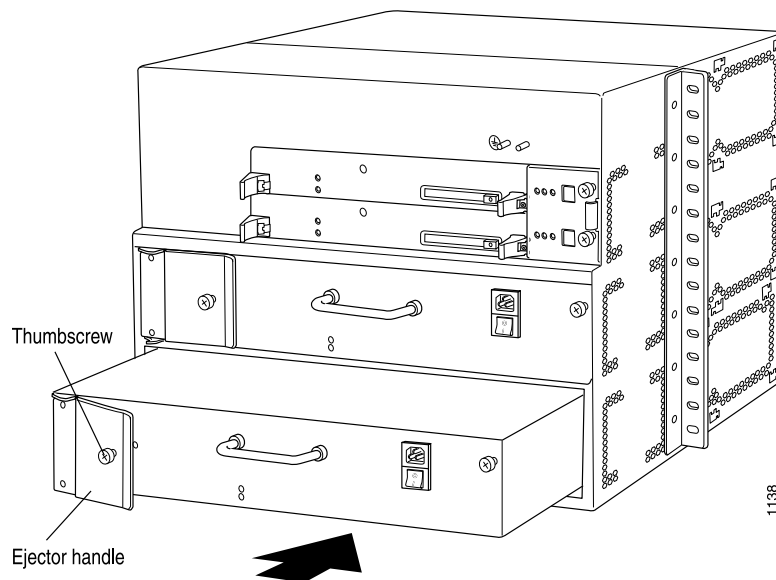
If the router is completely powered off when you power on the power supply, the Routing Engine boots as the power supply completes its startup sequence. If the Routing Engine finishes booting and you need to power off the router again, first issue the CLI **request system halt** command. For more information, see “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

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



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

Figure 66: Installing an AC Power Supply



Disconnecting and Connecting 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:

- Disconnecting AC Power from the Router on page 144
- Connecting AC Power to the Router on page 145

Disconnecting 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 master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

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



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

For more information about the command, see the *JUNOS System Basics and Services Command Reference*.

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



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

Connecting AC Power to the Router

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

1. Verify that the power supplies are fully inserted in the chassis and the thumbscrews on their faceplates are tightened.
2. For each power supply, verify that the ends of the power cord are firmly plugged into the appliance inlet on the power supply faceplate and the external power source receptacle.
3. Connect a management device to one of the ports on the craft interface (**AUX/MODEM**, **CONSOLE**, or **MGMT**) for the Routing Engine that is configured to become the master. For more information on connecting management devices, see “Replacing Connections to Routing Engine Interface Ports” on page 121.
4. Turn on the management device.
5. Press the power switch on the faceplate of one power supply to the **ON (|)** position. Verify that the green **OK** LED eventually lights steadily and the amber **FAULT** LED does not light.



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

If the system is completely powered off 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 off the system again, first issue the CLI **request system halt** command. For more information, see “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

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

6. Press the power switch on the other power supply to the **ON (|)** position and observe the LEDs on the power supply faceplate. They should light as described in the previous step.

If the LEDs are not lit in the appropriate pattern after 60 seconds, repeat the procedures in “Installing an AC Power Supply” on page 143 and the previous steps in this procedure.



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

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

Replacing an AC Power Cord

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

1. Locate a replacement power cord with the type of plug appropriate for your geographical location (see “AC Power, Connection, and Power Cord Specifications” on page 208).
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. Press the power switch on the power supply faceplate to the **OFF (O)** position.
4. Unplug the power cord from the appliance inlet on the faceplate and from the power source receptacle.

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



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

Replacing 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 off, the other power supply automatically assumes the entire electrical load for the router.

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

- Removing a DC Power Supply on page 147
- Installing a DC Power Supply on page 149

Removing a DC Power Supply

The DC power supplies are located at the bottom rear of the chassis, as shown in Figure 2 on page 8. Each DC power supply weighs approximately 12 lb (5.5 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 (see Figure 67 on page 148, Figure 68 on page 149, and Figure 69 on page 149):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Press the power switch for the power supply (located on the power supply faceplate) to the **OFF** (O) position.



NOTE: If you are power cycling the power supply rather than shutting it off for a time, wait at least 60 seconds after turning it off before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

3. Shut off the power flowing to the power supply from the external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
4. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the power supply faceplate. Remove the cover.
5. Using a 7/16-in. nut driver or wrench, loosen the outer nut on each power supply terminal stud. Remove the outer nut and locking washer from each stud and slide the power cable lugs off the studs.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

6. Loosen the thumbscrew at each end of the power supply faceplate, using a Phillips screwdriver if necessary. Unscrew both thumbscrews simultaneously and at about the same rate (unscrewing the two screws alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
7. Pull the ejector handle away from the faceplate.
8. Grasp the handle on the power supply faceplate and pull firmly to slide the unit about halfway out of the chassis.
9. Place one hand under the power supply to support it, then slide it completely out of the chassis.

Figure 67: Press the Power Switch to the Off Position on a DC Power Supply

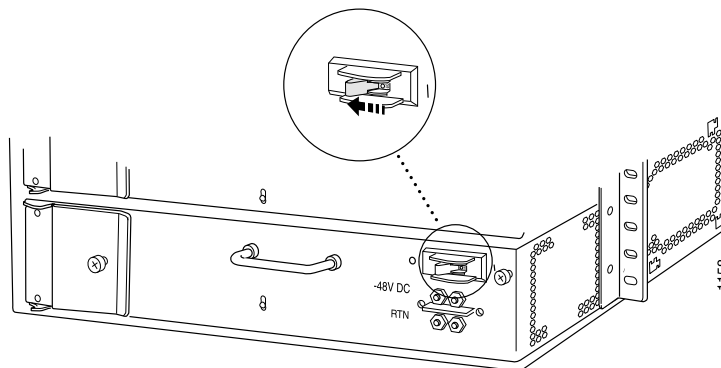
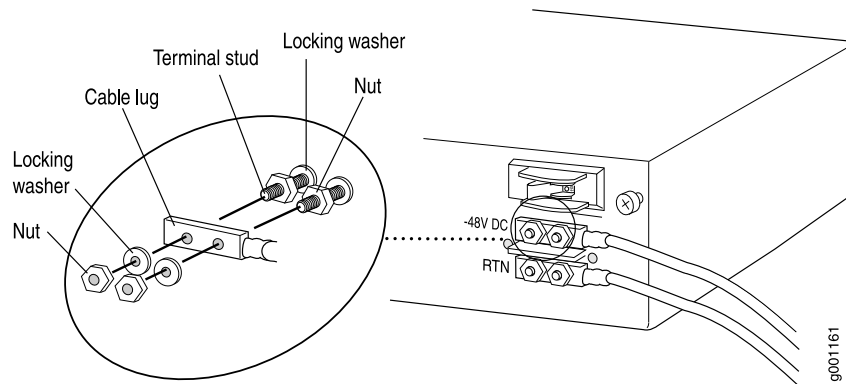
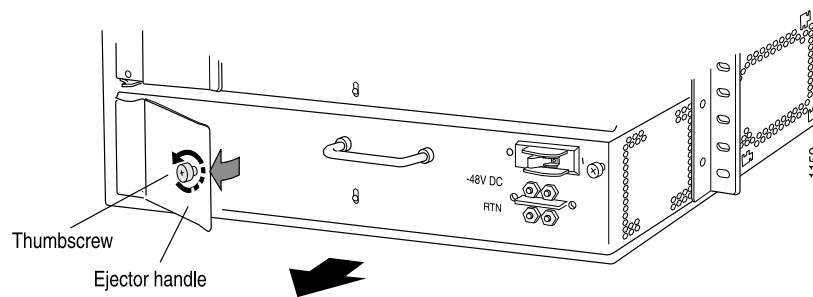


Figure 68: Disconnecting Power Cables from a DC Power Supply**Figure 69: Removing a DC Power Supply**

Installing a DC Power Supply

To install a DC power supply, follow this procedure (see Figure 70 on page 151, Figure 71 on page 152, Figure 72 on page 152, and Figure 73 on page 153):

1. Verify that there is no power flowing to the power supply from the external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. Verify that the power switch for the power supply (located on the power supply faceplate) is in the **OFF (O)** position.
3. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
4. Grasp the handle on the power supply faceplate with one hand and place the other hand under the supply to support it.
5. Slide the power supply into the chassis until it contacts the midplane.

6. Press the ejector handle toward the faceplate to seat the power supply firmly in the chassis.
7. Tighten (but do not overtighten) the thumbscrews on the power supply faceplate. Turn both thumbscrews simultaneously and at about the same rate (turning them alternately or at very different rates can cause the power supply to become lodged in the slot, making it difficult to turn the screws).
8. If a protective shield is installed over the terminal studs on the power supply, loosen the screws that secure it to the power supply and remove the shield.
9. If nuts and washers are installed on the power supply terminal studs, use a 7/16-in. nut driver or wrench to loosen the outer nut on each stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

10. Slide the power cable lugs onto the terminals on the power supply. Replace the outer washers and nuts (in that order) to secure the power cable lugs to the terminal studs.
 - a. Connect the positive (+) source cable lug to the return terminal on the power supply, which is labeled **RTN**.
 - b. Connect the negative (–) source cable lug to the input terminal on the power supply, which is labeled **–48V**.

Using a 7/16-in. nut driver or wrench, tighten each nut. Apply between 23 lb-in. (2.6 Nm) and 25 lb-in. (2.8 Nm) of torque to each nut.

11. Verify that the DC source power cabling and the grounding cabling are correct, that they are not touching or blocking access to router components, and that they do not drape where people could trip on them.
12. Replace the protective shield over the terminals and tighten the screws that secure it to the power supply.
13. Turn on the DC power source so that voltage flows to the power supply.
14. Press the switch on the power supply faceplate to the **ON** (|) position. Verify that the green **OK** LED eventually lights steadily and the amber **FAULT** LED does not light.



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

If the router is completely powered off 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 off the router again, first issue the CLI **request system halt** command. For more information, see “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

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



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

Figure 70: Power Switch in the Off Position on a DC Power Supply

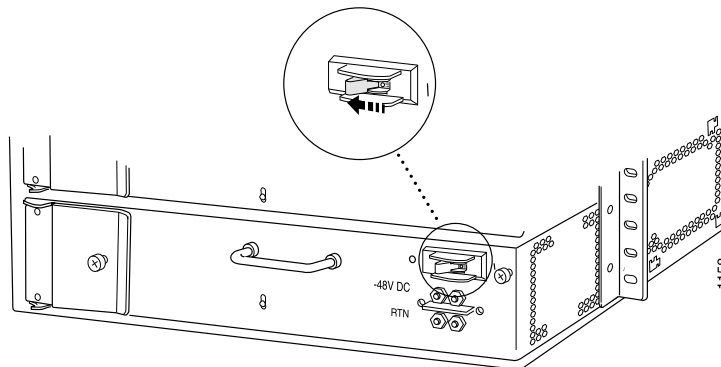


Figure 71: Installing a DC Power Supply

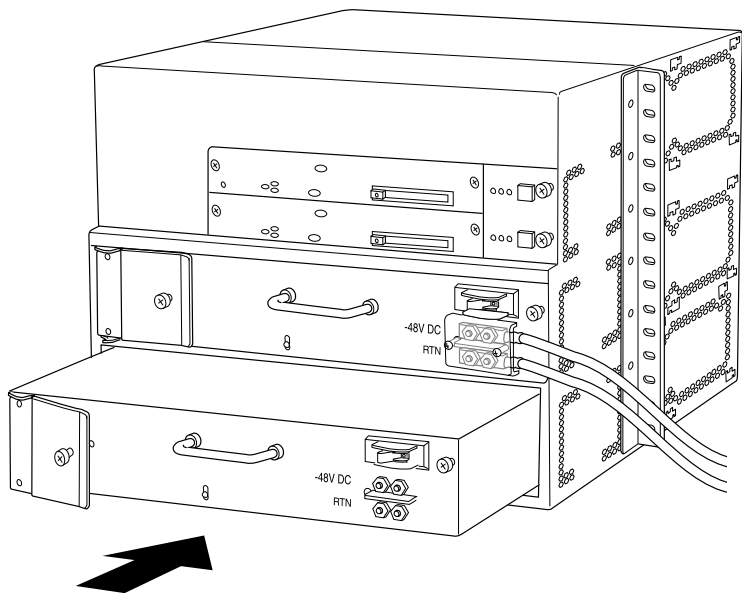


Figure 72: Connecting Power Cables to a DC Power Supply

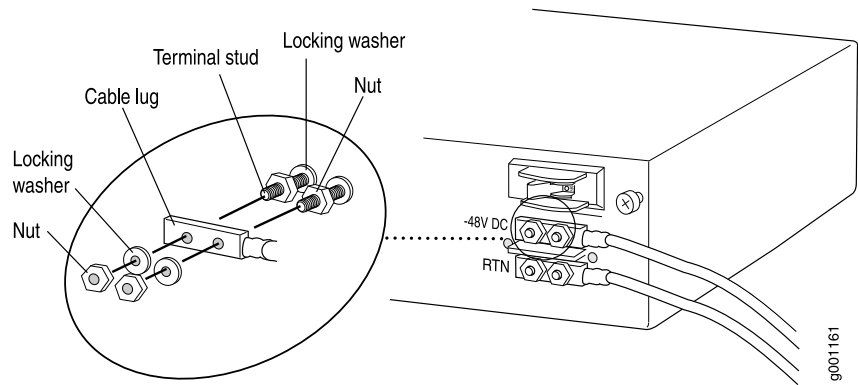
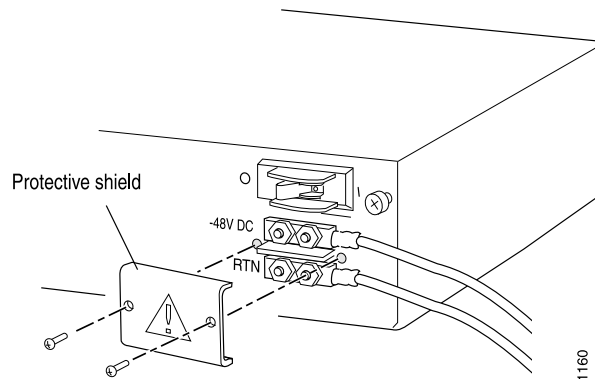


Figure 73: Installing the Protective Shield on a DC Power Supply

Disconnecting and Connecting DC Power

On a DC-powered router, the power cables from the external DC power sources connect to terminal studs on each power supply. To disconnect or connect power to the router, perform the following procedures. Also follow these procedures when replacing the power cables, the grounding cable, or both:

- Disconnecting DC Power from the Router on page 153
- Connecting DC Power to the Router on page 155

Disconnecting DC Power from the Router

To disconnect DC power from the router, follow this procedure (see Figure 74 on page 154):

1. On the console or other management device connected to the master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

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



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

For more information about the command, see the *JUNOS System Basics and Services Command Reference*.

2. For each power supply, press the power switch on the power supply faceplate to the **OFF (O)** position.



NOTE: If you are power cycling the power supply rather than shutting it off for a time, wait at least 60 seconds after turning it off before turning it back on. If you need to power it off again, wait for at least 60 seconds after powering it on.

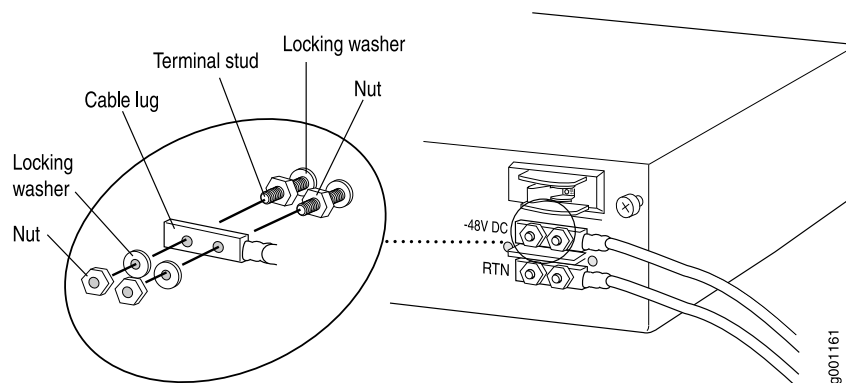
3. Shut off the power flowing from both external power sources, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
4. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the power supply faceplate. Remove the cover.
5. Using a 7/16-in. nut driver or wrench, loosen the outer nut securing the cable lug to each terminal stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

6. Slide the cable lug off of each terminal stud. Leave the inner washer and nut on each stud.
7. If you are decommissioning the router, loosen and remove the nuts and washers that secure the grounding lug to the chassis and remove the grounding lug.
8. If not immediately attaching replacement cables, replace the protective shield on each power supply and tighten the screws that secure it to the supply.
9. Verify that the removed cables are not touching or blocking access to any router components.

Figure 74: Disconnecting DC Power Cables



Connecting DC Power to the Router

Connect DC power to the router by attaching a grounding cable to the chassis grounding points and attaching power cables from external power sources to the terminal studs on the power supply faceplate. Power and grounding cables are not supplied with the router. For cable specifications, see “Chassis Grounding” on page 207.



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



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

To connect DC power to the router, follow this procedure (see Figure 75 on page 158):

1. Verify that there is no power flowing from either external power source, so that the voltage across the leads of the power cables is 0 V. Ensure that there is no chance that the cable leads might become active during the procedure.
2. For each power supply, verify that the power switch on the power supply faceplate is in the **OFF (O)** position.
3. Connect the grounding cable to a proper earth ground.
4. Verify that a licensed electrician has attached the cable lug provided with the router to the grounding cable.
5. Make sure that grounding surfaces are clean and brought to a bright finish before grounding connections are made.
6. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
7. Place the grounding cable lug over the grounding points. The grounding points are sized for 1/4-20 UNC screws.
8. Secure the grounding cable lug to the grounding points, first with the washers, then with the screws.
9. Verify that the grounding cabling is correct, that the grounding cable does not touch or block access to router components, and that it does not drape where people could trip on it.
10. Using a Phillips screwdriver, loosen and remove the screws securing the protective shield over the terminal studs on the power supply faceplate. Remove the cover.
11. Install one flat washer and one nut (in that order) on each power terminal stud:
 - If no washers and nuts are already installed, they should be in the accessory box.

- If two pairs of nuts and washers are installed on the studs, use a 7/16-in. nut driver or wrench to loosen the outer nut on each stud. Remove the outer nuts and washers, leaving the inner nut and washer on each stud.



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.



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

12. Slide the power cable lugs onto the terminal studs. Install another washer and nut (in that order) on each terminal stud to secure each power cable lug.
 - a. Connect the positive (+) source cable lugs to the return terminals, which are labeled RTN.
 - b. Connect the negative (–) source cable lugs to the input terminals, which are labeled –48V.

Using a 7/16-in. nut driver or wrench, tighten the nuts. Apply between 23 lb-in. (2.6 Nm) and 25 lb-in. (2.8 Nm) of torque to each nut.

13. Bend the power cables at a radius appropriate for the AWG being used and tie them together to ensure that the power cables do not obstruct any other components. To identify the minimum bend radius for each type of power cable types, see published industry standards, such as the National Electrical Code (NEC) and Insulated Cable Engineers Association (ICEA). Do not bend a power cable beyond the specified minimum bend radius.
14. 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.
15. Replace the protective shield over the terminal studs and use a Phillips screwdriver to tighten the screws.
16. Turn on the DC power source so that voltage flows to the router.
17. Turn on the power to a management device that is connected to the master Routing Engine (through the craft interface port labeled AUX/MODEM, CONSOLE, or MGMT). For more information on connecting management devices, see “Connecting the Router to Management and Alarm Devices” on page 83.
18. Press the power switch on one power supply faceplate to the ON position. Verify that the green OK LED eventually lights steadily and the amber FAULT LED does not light.



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

If the router is completely powered off 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 off the router again, first issue the CLI **request system halt** command. For more information, see “Disconnecting AC Power from the Router” on page 144 or “Disconnecting DC Power from the Router” on page 153.

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

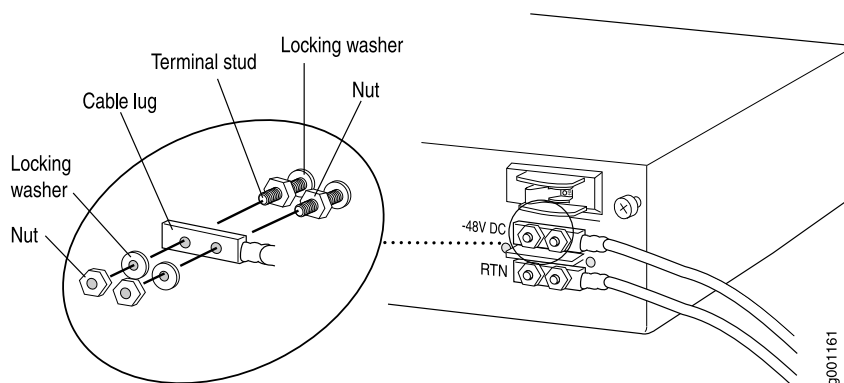
-
19. Press the power switch for the second power supply to the ON (|) position and observe the LEDs on the second power supply faceplate. They should light as described in the previous step.

If the LEDs are not lit in the appropriate pattern after 60 seconds, repeat the power supply installation procedures in “Installing a DC Power Supply” on page 149 and the cable attachment steps in this section.



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

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

Figure 75: Connecting DC Power and Grounding Cables

Replacing Routing Engine Components

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

- Removing and Inserting the PC Card on page 158
- Replacing a Routing Engine on page 160
- Replacing the Routing Engine Panel on page 163

Removing and Inserting the PC Card

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



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



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

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

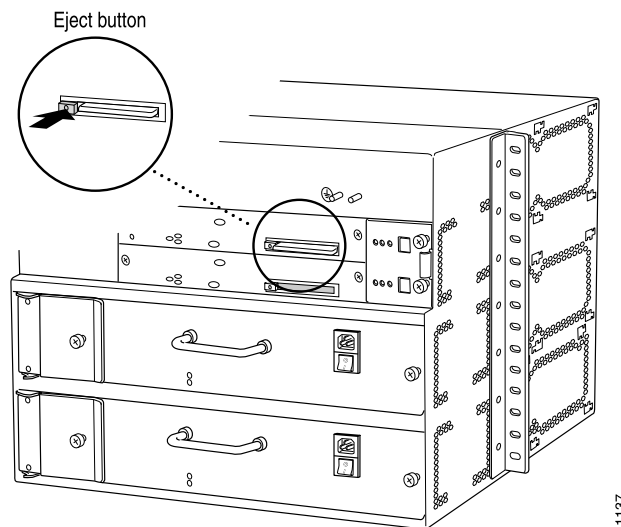
- Removing the PC Card on page 159
- Inserting the PC Card on page 159

Removing the PC Card

The PC Card is inserted in the slot labeled **PC CARD** in the Routing Engine faceplate. To remove the PC Card (see Figure 76 on page 159):

1. Press the eject button located next to the PC Card slot in the Routing Engine faceplate. Note that the PC Card slot might be located in a different position from that shown in Figure 76 on page 159.
2. When the PC Card pops partially out of the slot, grasp the card and pull it straight out of the slot.

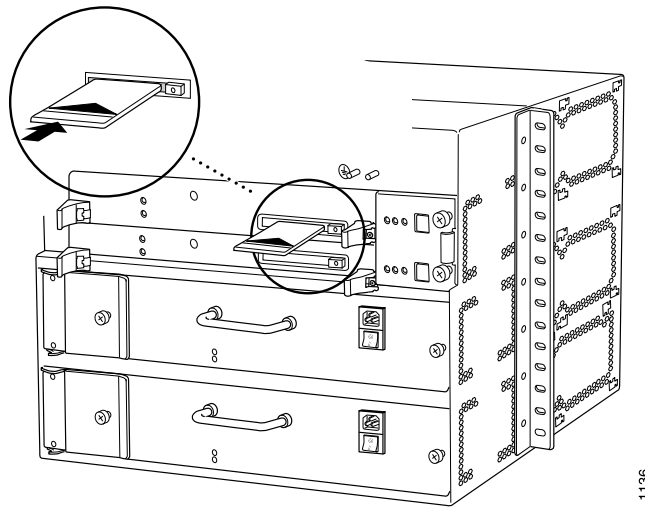
Figure 76: Removing the PC Card



Inserting the PC Card

To insert the PC Card (see Figure 77 on page 160):

1. Orient the PC Card with the Juniper Networks logo facing in the direction specified on the Routing Engine faceplate. Insert the card into the slot.
2. Press the card firmly all the way into the slot. Note that the PC Card slot might be located in a different position from that shown in Figure 77 on page 160.

Figure 77: Inserting the PC Card

Replacing a Routing Engine

The router can have a Routing Engine in each of the slots labeled RE0 and RE1 at the rear of the chassis, as shown in Figure 2 on page 8. Each Routing Engine weighs approximately 3 lb (1.5 kg). The Routing Engines are hot-pluggable, as described in “Field-Replaceable Units (FRUs)” on page 4. For a description of the effect of removing a Routing Engine, see “Routing Engine” on page 24. To replace a Routing Engine, perform the following procedures:

- Removing a Routing Engine on page 160
- Installing a Routing Engine on page 162

Removing a Routing Engine

To remove a Routing Engine, follow this procedure (see Figure 78 on page 162):

1. Place an electrostatic bag or antistatic mat on a flat, stable surface.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. If two Routing Engines are installed, use one of the following two methods to determine which is functioning as master:
 - Note which of the blue Routing Engine **MASTER** LEDs is lit on the Routing Engine panel or craft interface.
 - Issue the following CLI command. The master Routing Engine is designated **Master** in the **Current state** field:

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

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

4. If the Routing Engine you are removing is the master and a second Routing Engine is installed, issue the following CLI command to switch mastership to the standby Routing Engine:

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

The backup Routing Engine immediately assumes Routing Engine functions. If graceful switchover and nonstop routing are configured, packet forwarding and routing are continued without interruption. If the Routing Engines are configured for graceful switchover, but nonstop routing is not configured, there is no interruption to packet forwarding, but routing is interrupted momentarily. If neither graceful switchover nor nonstop routing is configured, packet forwarding halts while the backup Routing Engine becomes the master and the Packet Forwarding Engine components reset and connect to the new master Routing Engine. For information about configuring graceful switchover and nonstop routing, see the section about Routing Engine redundancy in the *JUNOS System Basics Configuration Guide*.

We recommend you run JUNOS Release 7.0 or later on the M20 router to support graceful switchover.



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

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

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

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



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

For more information about the command, see the *JUNOS System Basics and Services Command Reference*.

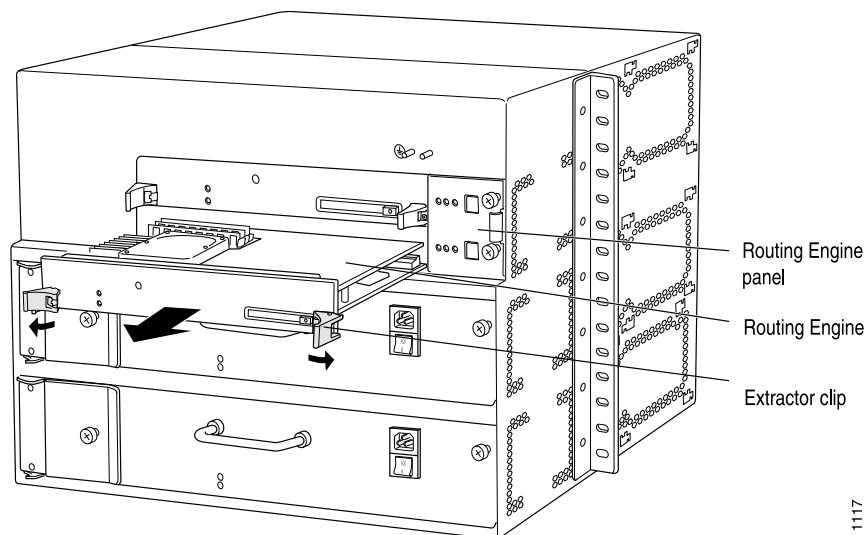
6. Using your thumbs, push and hold the red tab on each extractor clip toward the outer edge of the unit. Push the ends of the extractor clips outward to unseat the Routing Engine from the chassis.
7. Grasp the extractor clips and slide the unit about halfway out of the chassis.



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

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

Figure 78: Removing a Routing Engine



Installing a Routing Engine



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

To install a Routing Engine, follow this procedure (see Figure 79 on page 163):

1. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
2. Verify that the extractor clip at each end of the Routing Engine is flipped toward the outer edge of the unit. If necessary, use your thumbs to push and hold the red tab on each extractor clip toward the outer edge, then push the ends of the extractor clips outward.

3. Place one hand under the Routing Engine to support it and grasp one of the extractor clips on the faceplate with the other hand.
4. Align the rear of the Routing Engine with the guide rails inside the chassis and slide it in completely.

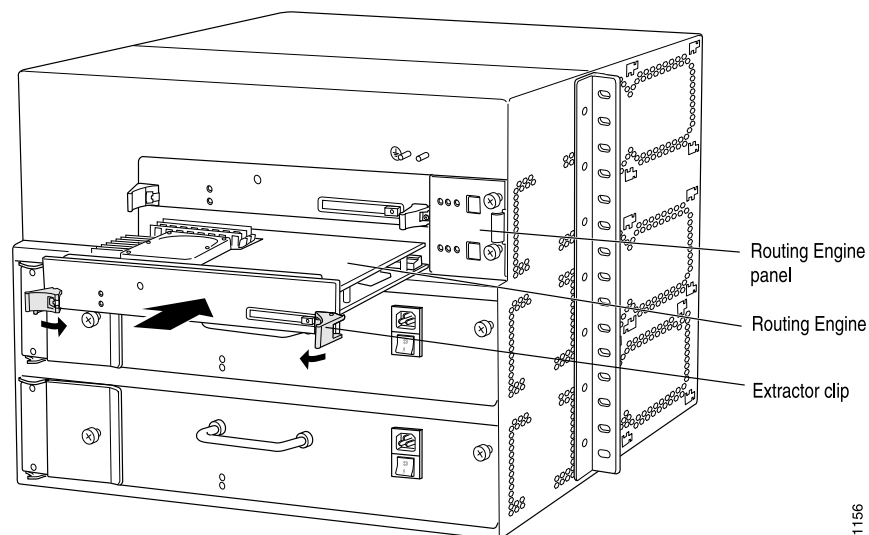


CAUTION: Align the Routing Engine carefully with the guide rails and push it in evenly. Damage can result if the Routing Engine gets lodged in the rails because of uneven movement.

5. Press the extractor clip at each end of the Routing Engine inward to seat the unit firmly in the chassis.
6. Check the Routing Engine LEDs on the Routing Engine panel or craft interface to verify that the green LED labeled **ONLINE** is lit (Figure 15 on page 27 shows the LEDs).

You can also verify correct Routing Engine functioning by issuing the `show chassis routing-engine` command described in “Maintaining the Routing Engines” on page 105.

Figure 79: Installing a Routing Engine



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Replacing the Routing Engine Panel

For instructions for replacing the Routing Engine panel and fan tray, see “Replacing the Routing Engine Panel and Fan Tray” on page 126.

Part 4

Appendixes

- Safety and Regulatory Compliance Information on page 167
- Environmental Specifications on page 203
- Power Requirements, Guidelines, and Specifications on page 205
- Cable Specifications on page 213
- Contacting Customer Support and Returning Hardware on page 219
- Cable Connector Pinouts on page 229

Appendix A

Safety and Regulatory Compliance Information

To install and use the router safely, follow proper safety procedures.

- Definition of Safety Warning Levels on page 167
- Safety Guidelines and Warnings on page 168
- Agency Approvals and Compliance Statements on page 197

Definition of Safety Warning Levels

This manual uses the following three levels of safety warnings:



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



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



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

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

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

Attention Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de

travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents.

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

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

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

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

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

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

Safety Guidelines and Warnings

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

- General Safety Guidelines and Warnings on page 169
- Fire Safety Requirements on page 172
- Installation Safety Guidelines and Warnings on page 173
- Laser and LED Safety Guidelines and Warnings on page 178
- Maintenance and Operational Safety Guidelines and Warnings on page 181
- Electrical Safety Guidelines and Warnings on page 186

General Safety Guidelines and Warnings

The following guidelines help ensure your safety and protect the router from damage. The list of guidelines might not address all potentially hazardous situations in your working environment, so be alert and exercise good judgment at all times.

- Perform only the procedures explicitly described in this manual. Make sure that only authorized service personnel perform other system services.
- Keep the area around the chassis clear and free from dust before, during, and after installation.
- Keep tools away from areas where people could trip over them while walking.
- Do not wear loose clothing or jewelry, such as rings, bracelets, or chains, which could become caught in the chassis.
- Wear safety glasses if you are working under any conditions that could be hazardous to your eyes.
- Do not perform any actions that create a potential hazard to people or make the equipment unsafe.
- Never attempt to lift an object that is too heavy for one person to handle.
- Never install or manipulate wiring during electrical storms.
- Never install electrical jacks in wet locations unless the jacks are specifically designed for wet environments.
- Operate the router only when it is properly grounded.
- Replace fuses only with fuses of the same type and rating.
- Do not open or remove chassis covers or sheet metal parts unless instructions are provided in this manual. Such an action could cause severe electrical shock.
- Do not push or force any objects through any opening in the chassis frame. Such an action could result in electrical shock or fire.
- Avoid spilling liquid onto the router chassis or onto any router component. Such an action could cause electrical shock or damage the router.
- Avoid touching uninsulated electrical wires or terminals that have not been disconnected from their power source. Such an action could cause electrical shock.

In addition, observe the following warnings and guidelines:

- Qualified Personnel Warning on page 169
- Restricted Access Area Warning on page 170
- Preventing Electrostatic Discharge Damage on page 172

Qualified Personnel Warning



WARNING: Only trained and qualified personnel should install or replace the router.

Waarschuwing Installatie en reparaties mogen uitsluitend door getraind en bevoegd personeel uitgevoerd worden.

Varoitus Ainoastaan koulutettu ja pätevä henkilökunta saa asentaa tai vaihtaa tämän laitteen.

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

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

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

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

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

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

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

Restricted Access Area Warning



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

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

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

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

sécurité. L'accès aux zones de sécurité est sous le contrôle de l'autorité responsable de l'emplacement.

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

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

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

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

¡Atención! Esta unidad ha sido diseñada para instalarse en áreas de acceso restringido. Área de acceso restringido significa un área a la que solamente tiene acceso el personal de servicio mediante la utilización de una herramienta especial, cerradura con llave, o algún otro medio de seguridad, y que está bajo el control de la autoridad responsable del local.

Varning! Denna enhet är avsedd för installation i områden med begränsat tillträde. Ett område med begränsat tillträde får endast tillträdas av servicepersonal med ett speciellt verktyg, lås och nyckel, eller annan säkerhetsanordning, och kontrolleras av den auktoritet som ansvarar för området.

Preventing Electrostatic Discharge Damage

Many router hardware components are sensitive to damage from static electricity. Some components can be impaired by voltages as low as 30 V. You can easily generate potentially damaging static voltages whenever you handle plastic or foam packing material or if you move components across plastic or carpets. Observe the following guidelines to minimize the potential for electrostatic discharge (ESD) damage, which can cause intermittent or complete component failures:

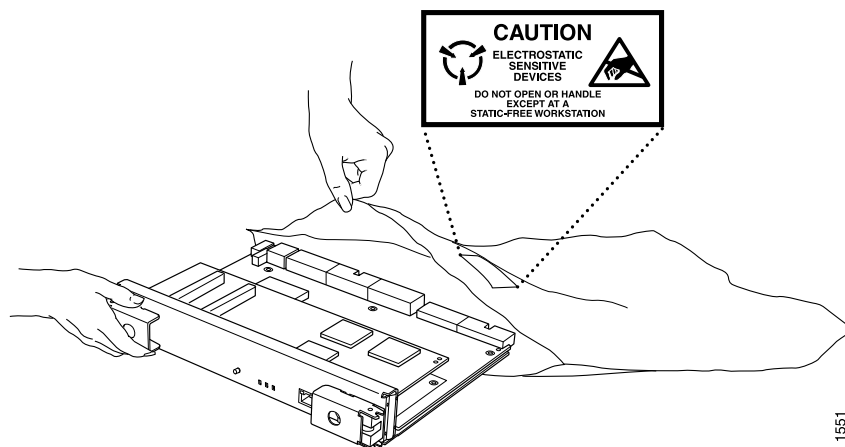
- Always use an ESD wrist strap or ankle strap, and verify that it is in direct contact with your skin.



CAUTION: For safety, periodically check the resistance value of the ESD strap. The measurement should be in the range of 1 to 10 Mohms.

- When handling any component that is removed from the chassis, verify that the equipment end of your ESD strap is attached to one of the ESD points on the chassis, which are shown in Figure 1 on page 8 and Figure 2 on page 8.
- Avoid contact between the component and your clothing. ESD voltages emitted from clothing can still damage components.
- When removing or installing a component, always place it component-side up on an antistatic surface, in an antistatic card rack, or in an electrostatic bag (see Figure 80 on page 172). If you are returning a component, place it in an electrostatic bag before packing it.

Figure 80: Placing a Component into an Electrostatic Bag



Fire Safety Requirements

In the event of a fire emergency involving routers and other network equipment, the safety of people is the primary concern. 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, 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, 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 173.

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, 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.

Installation Safety Guidelines and Warnings

Observe the following guidelines and warnings before and during router installation:

- Chassis Lifting Guidelines on page 174
- Installation Instructions Warning on page 174
- Rack-Mounting Requirements and Warnings on page 175
- Ramp Warning on page 178

Chassis Lifting Guidelines

The weight of a fully configured chassis is about 134 lb (61 kg). Observe the following guidelines for lifting and moving the router:

- Before moving the router, read the guidelines in “Preparing for Router Installation” on page 53 to verify that the intended site meets the specified power, environmental, and clearance requirements.
- Do not attempt to lift a fully configured router by yourself. Using a mechanical lift to maneuver the router into a rack is recommended. If a lift cannot be used, a minimum of two people must lift the router, and you must remove components from the chassis before lifting. For lifting and component removal instructions, see “Initial Installation” on page 51.
- Before lifting or moving the router, disconnect all external cables.
- As when lifting any heavy object, lift most of the weight with your legs rather than your back. Keep your knees bent and your back relatively straight and avoid twisting your body as you lift. Balance the load evenly and be sure that your footing is solid.

Installation Instructions Warning



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

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

Varoitus Lue asennusohjeet ennen järjestelmän yhdistämistä virtälähteeseen.

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

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

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

Advarsel Les installasjonsinstruksjonene før systemet kobles til strømkilden.

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

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

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

Rack-Mounting Requirements and Warnings

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



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

- The router must be installed into a rack that is secured to the building structure.
- The router should be mounted at the bottom of the rack if it is the only unit in the rack.
- When mounting the router in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.
- If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the router in the rack.

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

- De Juniper Networks router moet in een stellage worden geïnstalleerd die aan een bouwsel is verankerd.
- Dit toestel dient onderaan in het rek gemonteerd te worden als het toestel het enige in het rek is.
- Wanneer u dit toestel in een gedeeltelijk gevuld rek monteert, dient u het rek van onderen naar boven te laden met het zwaarste onderdeel onderaan in het rek.
- Als het rek voorzien is van stabiliseringshulpmiddelen, dient u de stabilisatoren te monteren voordat u het toestel in het rek monteert of het daar een servicebeurt geeft.

Varoitus Kun laite asetetaan telineeseen tai huolletaan sen ollessa telineessä, on noudatettava erityisiä varotoimia järjestelmän vakavuuden säilyttämiseksi, jotta vältetään loukkaantumiselta. Noudata seuraavia turvallisuusohjeita:

- Juniper Networks router on asennettava telineeseen, joka on kiinnitetty rakennukseen.
- Jos telineessä ei ole muita laitteita, aseta laite telineen alaosaan.
- Jos laite asetetaan osaksi täytettyyn telineeseen, aloita kuormittaminen sen alaosasta kaikkein raskaimmalla esineellä ja siirry sitten sen yläosaan.
- Jos telinettä varten on vakaimet, asenna ne ennen laitteen asettamista telineeseen tai sen huoltamista siinä.

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

- Le rack sur lequel est monté le Juniper Networks router doit être fixé à la structure du bâtiment.
- Si cette unité constitue la seule unité montée en casier, elle doit être placée dans le bas.
- Si cette unité est montée dans un casier partiellement rempli, charger le casier de bas en haut en plaçant l'élément le plus lourd dans le bas.
- Si le casier est équipé de dispositifs stabilisateurs, installer les stabilisateurs avant de monter ou de réparer l'unité en casier.

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

- Der Juniper Networks router muß in einem Gestell installiert werden, das in der Gebäudestruktur verankert ist.
- Wenn diese Einheit die einzige im Gestell ist, sollte sie unten im Gestell angebracht werden.
- Bei Anbringung dieser Einheit in einem zum Teil gefüllten Gestell ist das Gestell von unten nach oben zu laden, wobei das schwerste Bauteil unten im Gestell anzubringen ist.
- Wird das Gestell mit Stabilisierungszubehör geliefert, sind zuerst die Stabilisatoren zu installieren, bevor Sie die Einheit im Gestell anbringen oder sie warten.

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

- Il Juniper Networks router deve essere installato in un telaio, il quale deve essere fissato alla struttura dell'edificio.
- Questa unità deve venire montata sul fondo del supporto, se si tratta dell'unica unità da montare nel supporto.
- Quando questa unità viene montata in un supporto parzialmente pieno, caricare il supporto dal basso all'alto, con il componente più pesante sistemato sul fondo del supporto.
- Se il supporto è dotato di dispositivi stabilizzanti, installare tali dispositivi prima di montare o di procedere alla manutenzione dell'unità nel supporto.

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

- Juniper Networks router må installeres i et stativ som er forankret til bygningsstrukturen.
- Denne enheten bør monteres nederst i kabinettet hvis dette er den eneste enheten i kabinettet.
- Ved montering av denne enheten i et kabinett som er delvis fylt, skal kabinettet lastes fra bunnen og opp med den tyngste komponenten nederst i kabinettet.
- Hvis kabinettet er utstyrt med stabiliseringsutstyr, skal stabilisatorene installeres før montering eller utføring av reparasjonsarbeid på enheten i kabinettet.

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

- O Juniper Networks router deverá ser instalado numa prateleira fixa à estrutura do edifício.
- Esta unidade deverá ser montada na parte inferior da estante, caso seja esta a única unidade a ser montada.
- Ao montar esta unidade numa estante parcialmente ocupada, coloque os itens mais pesados na parte inferior da estante, arrumando-os de baixo para cima.
- Se a estante possuir um dispositivo de estabilização, instale-o antes de montar ou reparar a unidade.

¡Atención! Para evitar lesiones durante el montaje de este equipo sobre un bastidor, o posteriormente durante su mantenimiento, se debe poner mucho cuidado en que el sistema quede bien estable. Para garantizar su seguridad, proceda según las siguientes instrucciones:

- El Juniper Networks router debe instalarse en un bastidor fijado a la estructura del edificio.
- Colocar el equipo en la parte inferior del bastidor, cuando sea la única unidad en el mismo.
- Cuando este equipo se vaya a instalar en un bastidor parcialmente ocupado, comenzar la instalación desde la parte inferior hacia la superior colocando el equipo más pesado en la parte inferior.
- Si el bastidor dispone de dispositivos estabilizadores, instalar éstos antes de montar o proceder al mantenimiento del equipo instalado en el bastidor.

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

- Juniper Networks router måste installeras i en ställning som är förankrad i byggnadens struktur.
- Om denna enhet är den enda enheten på ställningen skall den installeras längst ned på ställningen.
- Om denna enhet installeras på en delvis fylld ställning skall ställningen fyllas nedifrån och upp, med de tyngsta enheterna längst ned på ställningen.
- Om ställningen är försedd med stabiliseringsdon skall dessa monteras fast innan enheten installeras eller underhålls på ställningen.

Ramp Warning



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

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

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

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

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

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

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

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

¡Atención! No usar una rampa inclinada más de 10 grados

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

Laser and LED Safety Guidelines and Warnings

Single-mode Physical Interface Cards (PICs) are equipped with laser transmitters, which are considered a Class 1 Laser Product by the U.S. Food and Drug Administration, and are evaluated as a Class 1 Laser Product per EN 60825-1 + A11 + A2 requirements.

Observe the following guidelines and warnings:

- General Laser Safety Guidelines on page 179
- Class 1 Laser Product Warning on page 179
- Class 1 LED Product Warning on page 179

- Laser Beam Warning on page 180
- Radiation from Open Port Apertures Warning on page 181

General Laser Safety Guidelines

When working around PICs, observe the following safety guidelines to prevent eye injury:

- Do not look into unterminated ports or at fibers that connect to unknown sources.
- Do not examine unterminated optical ports with optical instruments.
- Avoid direct exposure to the beam.



WARNING: Unterminated optical connectors can emit invisible laser radiation. The lens in the human eye focuses all the laser power on the retina, so focusing the eye directly on a laser source—even a low-power laser—could permanently damage the eye.

Class 1 Laser Product Warning



WARNING: Class 1 laser product.

Waarschuwing Klasse-1 laser produkt.

Varoitus Luokan 1 lasertuote.

Attention Produit laser de classe I.

Warnung Laserprodukt der Klasse 1.

Avvertenza Prodotto laser di Classe 1.

Advarsel Laserprodukt av klasse 1.

Aviso Produto laser de classe 1.

¡Atención! Producto láser Clase I.

Varning! Laserprodukt av klass 1.

Class 1 LED Product Warning



WARNING: Class 1 LED product.

Waarschuwing Klasse 1 LED-product.

Varoitus Luokan 1 valodiodituote.

Attention Alarme de produit LED Class I.

Warnung Class 1 LED-Produktwarnung.

Avvertenza Avvertenza prodotto LED di Classe 1.

Advarsel LED-produkt i klasse 1.

Aviso Produto de classe 1 com LED.

¡Atención! Aviso sobre producto LED de Clase 1.

Varning! Lysdiodprodukt av klass 1.

Laser Beam Warning



WARNING: Do not stare into the laser beam or view it directly with optical instruments.

Waarschuwing Niet in de straal staren of hem rechtstreeks bekijken met optische instrumenten.

Varoitus Älä katso säteeseen äläkä tarkastele sitä suoraan optisen laitteen avulla.

Attention Ne pas fixer le faisceau des yeux, ni l'observer directement à l'aide d'instruments optiques.

Warnung Nicht direkt in den Strahl blicken und ihn nicht direkt mit optischen Geräten prüfen.

Avvertenza Non fissare il raggio con gli occhi né usare strumenti ottici per osservarlo direttamente.

Advarsel Stirr eller se ikke direkte p strlen med optiske instrumenter.

Aviso Não olhe fixamente para o raio, nem olhe para ele directamente com instrumentos ópticos.

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

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

Radiation from Open Port Apertures Warning



WARNING: Because invisible radiation may be emitted from the aperture of the port when no fiber cable is connected, avoid exposure to radiation and do not stare into open apertures.

Waarschuwing Aangezien onzichtbare straling vanuit de opening van de poort kan komen als er geen fiberkabel aangesloten is, dient blootstelling aan straling en het kijken in open openingen vermeden te worden.

Varoitus Koska portin aukosta voi emittoitua näkymätöntä säteilyä, kun kuitukaapelia ei ole kytkettynä, vältä säteilylle altistumista äläkä katso avoimiin aukkoihin.

Attention Des radiations invisibles à l'il nu pouvant traverser l'ouverture du port lorsqu'aucun câble en fibre optique n'y est connecté, il est recommandé de ne pas regarder fixement l'intérieur de ces ouvertures.

Warnung Aus der Port-Öffnung können unsichtbare Strahlen emittieren, wenn kein Glasfaserkabel angeschlossen ist. Vermeiden Sie es, sich den Strahlungen auszusetzen, und starren Sie nicht in die Öffnungen!

Avvertenza Quando i cavi in fibra non sono inseriti, radiazioni invisibili possono essere emesse attraverso l'apertura della porta. Evitate di esporvi alle radiazioni e non guardate direttamente nelle aperture.

Advarsel Unngå utsettelse for stråling, og stirr ikke inn i åpninger som er åpne, fordi usynlig stråling kan emitteres fra portens åpning når det ikke er tilkoblet en fiberkabel.

Aviso Dada a possibilidade de emissão de radiação invisível através do orifício da via de acesso, quando esta não tiver nenhum cabo de fibra conectado, deverá evitar a exposição à radiação e não deverá olhar fixamente para orifícios que se encontrarem a descoberto.

¡Atención! Debido a que la apertura del puerto puede emitir radiación invisible cuando no existe un cable de fibra conectado, evite mirar directamente a las aperturas para no exponerse a la radiación.

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 182
- Jewelry Removal Warning on page 183
- Lightning Activity Warning on page 184

- Operating Temperature Warning on page 184
- Product Disposal Warning on page 186

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.

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

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

Jewelry Removal Warning



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

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

Varoitus Ennen kuin työskentelet voimavirtajohtoihin kytkettyjen laitteiden parissa, ota pois kaikki korut (sormukset, kaulakorut ja kellot mukaan lukien). Metalliesineet kuumenevat, kun ne ovat yhteydessä sähkövirran ja maan kanssa, ja ne voivat aiheuttaa vakavia palovammoja tai hitsata metalliesineet kiinni liitäntänapoihin.

Attention Avant d'accéder à cet équipement connecté aux lignes électriques, ôter tout bijou (anneaux, colliers et montres compris). Lorsqu'ils sont branchés à l'alimentation et reliés à la terre, les objets métalliques chauffent, ce qui peut provoquer des blessures graves ou souder l'objet métallique aux bornes.

Warnung Vor der Arbeit an Geräten, die an das Netz angeschlossen sind, jeglichen Schmuck (einschließlich Ringe, Ketten und Uhren) abnehmen. Metallgegenstände erhitzen sich, wenn sie an das Netz und die Erde angeschlossen werden, und können schwere Verbrennungen verursachen oder an die Anschlußklemmen angeschweißt werden.

Avvertenza Prima di intervenire su apparecchiature collegate alle linee di alimentazione, togliersi qualsiasi monile (inclusi anelli, collane, braccialetti ed orologi). Gli oggetti metallici si riscaldano quando sono collegati tra punti di alimentazione e massa: possono causare ustioni gravi oppure il metallo può saldarsi ai terminali.

Advarsel Fjern alle smykker (inkludert ringer, halskjeder og klokker) før du skal arbeide på utstyr som er koblet til kraftledninger. Metallgjenstander som er koblet til kraftledninger og jord blir svært varme og kan forårsake alvorlige brannskader eller smelte fast til polene.

Aviso Antes de trabalhar em equipamento que esteja ligado a linhas de corrente, retire todas as jóias que estiver a usar (incluindo anéis, fios e relógios). Os objectos metálicos aquecerão em contacto com a corrente e em contacto com a ligação à terra, podendo causar queimaduras graves ou ficarem soldados aos terminais.

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

Varning! Tag av alla smycken (inklusive ringar, halsband och armbandsur) innan du arbetar på utrustning som är kopplad till kraftledningar. Metallobjekt hettas upp när

de kopplas ihop med ström och jord och kan förorsaka allvarliga brännskador; metallobjekt kan också sammansvetsas med kontakterna.

Lightning Activity Warning



WARNING: Do not work on the system or connect or disconnect cables during periods of lightning activity.

Waarschuwing Tijdens onweer dat gepaard gaat met bliksem, dient u niet aan het systeem te werken of kabels aan te sluiten of te ontkoppelen.

Varoitus Älä työskentele järjestelmän parissa äläkä yhdistä tai irrota kaapeleita ukkosilmalla.

Attention Ne pas travailler sur le système ni brancher ou débrancher les câbles pendant un orage.

Warnung Arbeiten Sie nicht am System und schließen Sie keine Kabel an bzw. trennen Sie keine ab, wenn es gewittert.

Avvertenza Non lavorare sul sistema o collegare oppure scollegare i cavi durante un temporale con fulmini.

Advarsel Utfør aldri arbeid på systemet, eller koble kabler til eller fra systemet når det tordner eller lyner.

Aviso Não trabalhe no sistema ou ligue e desligue cabos durante períodos de mau tempo (trovoada).

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

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

Operating Temperature Warning



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

Waarschuwing Om te voorkomen dat welke router van de Juniper Networks router dan ook oververhit raakt, dient u deze niet te bedienen op een plaats waar de maximale aanbevolen omgevingstemperatuur van 40°C wordt overschreden. Om

te voorkomen dat de luchtstroom wordt beperkt, dient er minstens 15,2 cm speling rond de ventilatie-openingen te zijn.

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

Attention Pour éviter toute surchauffe des routeurs de la gamme Juniper Networks router, ne l'utilisez pas dans une zone où la température ambiante est supérieure à 40°C. Pour permettre un flot d'air constant, dégagez un espace d'au moins 15,2 cm autour des ouvertures de ventilations.

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

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

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

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

¡Atención! Para impedir que un encaminhador de la serie Juniper Networks router se recaliente, no lo haga funcionar en un área en la que se supere la temperatura ambiente máxima recomendada de 40°C. Para impedir la restricción de la entrada de aire, deje un espacio mínimo de 15,2 cm alrededor de las aperturas para ventilación.

Varning! Förhindra att en Juniper Networks router överhettas genom att inte använda den i ett område där den maximalt rekommenderade omgivningstemperaturen på 40°C överskrids. Förhindra att luftcirkulationen inskränks genom att se till att det finns fritt utrymme på minst 15,2 cm omkring ventilationsöppningarna.

Product Disposal Warning



WARNING: Disposal of this product must be handled according to all national laws and regulations.

Waarschuwing Dit produkt dient volgens alle landelijke wetten en voorschriften te worden afgedankt.

Varoitus Tämän tuotteen lopullisesta hävittämisestä tulee huolehtia kaikkia valtakunnallisia lakeja ja säännöksiä noudattaen.

Attention La mise au rebut définitive de ce produit doit être effectuée conformément à toutes les lois et réglementations en vigueur.

Warnung Dieses Produkt muß den geltenden Gesetzen und Vorschriften entsprechend entsorgt werden.

Avvertenza L'eliminazione finale di questo prodotto deve essere eseguita osservando le normative italiane vigenti in materia

Advarsel Endelig disponering av dette produktet må skje i henhold til nasjonale lover og forskrifter.

Aviso A descartagem final deste produto deverá ser efectuada de acordo com os regulamentos e a legislação nacional.

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

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

Electrical Safety Guidelines and Warnings

When working on equipment powered by electricity, follow the guidelines described in the following sections:

- In Case of Electrical Accident on page 186
- General Electrical Safety Guidelines and Warnings on page 187
- AC Power Electrical Safety Guidelines on page 191
- Power Cable Warning (Japanese) on page 192
- DC Power Electrical Safety Guidelines and Warnings on page 192

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.

General Electrical Safety Guidelines and Warnings

- Install the router in compliance with the following local, national, or international electrical codes:
 - United States—National Fire Protection Association (NFPA 70), United States National Electrical Code.
 - Canada—Canadian Electrical Code, Part 1, CSA C22.1.
 - Other countries—International Electromechanical Commission (IEC) 60364, Part 1 through Part 7.
 - Evaluated to the TN power system.
- Locate the emergency power-off switch for the room in which you are working so that if an electrical accident occurs, you can quickly turn off the power.
- Do not work alone if potentially hazardous conditions exist anywhere in your workspace.
- Never assume that power is disconnected from a circuit. Always check the circuit before starting to work.
- Carefully look for possible hazards in your work area, such as moist floors, ungrounded power extension cords, and missing safety grounds.
- Operate the router within marked electrical ratings and product usage instructions.
- For the router and peripheral equipment to function safely and correctly, use the cables and connectors specified for the attached peripheral equipment, and make certain they are in good condition.

Many router components can be removed and replaced without powering off or disconnecting power to the router, as detailed in “Field-Replaceable Units (FRUs)” on page 4. Never install equipment if it appears damaged.

Grounded Equipment Warning



WARNING: The router is intended to be grounded. Ensure that the router is connected to earth ground during normal use.

Waarschuwing Deze apparatuur hoort geaard te worden. Zorg dat de host-computer tijdens normaal gebruik met aarde is verbonden.

Varoitus Tämä laitteisto on tarkoitettu maadoitettavaksi. Varmista, että isäntälaitte on yhdistetty maahan normaalikäytön aikana.

Attention Cet équipement doit être relié à la terre. S'assurer que l'appareil hôte est relié à la terre lors de l'utilisation normale.

Warnung Dieses Gerät muß geerdet werden. Stellen Sie sicher, daß das Host-Gerät während des normalen Betriebs an Erde gelegt ist.

Avvertenza Questa apparecchiatura deve essere collegata a massa. Accertarsi che il dispositivo host sia collegato alla massa di terra durante il normale utilizzo.

Advarsel Dette utstyret skal jordes. Forviss deg om vertsterminalen er jordet ved normalt bruk.

Aviso Este equipamento deverá estar ligado à terra. Certifique-se que o host se encontra ligado à terra durante a sua utilização normal.

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

Varning! Denna utrustning är avsedd att jordas. Se till att värdenheten är jordad vid normal användning.

Midplane Energy Hazard Warning



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

Multiple Power Supplies Disconnection Warning



WARNING: The router has more than one power supply connection. All connections must be removed completely to remove power from the unit completely.

Waarschuwing Deze eenheid heeft meer dan één stroomtoevoerverbinding; alle verbindingen moeten volledig worden verwijderd om de stroom van deze eenheid volledig te verwijderen.

Varoitus Tässä laitteessa on useampia virtalähdekytkentöjä. Kaikki kytkennät on irrotettava kokonaan, jotta virta poistettaisiin täysin laitteesta.

Attention Cette unité est équipée de plusieurs raccordements d'alimentation. Pour supprimer tout courant électrique de l'unité, tous les cordons d'alimentation doivent être débranchés.

Warnung Diese Einheit verfügt über mehr als einen Stromanschluß; um Strom gänzlich von der Einheit fernzuhalten, müssen alle Stromzufuhren abgetrennt sein.

Avvertenza Questa unità ha più di una connessione per alimentatore elettrico; tutte le connessioni devono essere completamente rimosse per togliere l'elettricità dall'unità.

Advarsel Denne enheten har mer enn én strømtilkobling. Alle tilkoblinger må kobles helt fra for å eliminere strøm fra enheten.

Aviso Este dispositivo possui mais do que uma conexão de fonte de alimentação de energia; para poder remover a fonte de alimentação de energia, deverão ser desconectadas todas as conexões existentes.

¡Atención! Esta unidad tiene más de una conexión de suministros de alimentación; para eliminar la alimentación por completo, deben desconectarse completamente todas las conexiones.

Warning! Denna enhet har mer än en strömförsörjningsanslutning; alla anslutningar måste vara helt avlägsnade innan strömtillförseln till enheten är fullständigt bruten.

Power Disconnection Warning



WARNING: Before working on the router or near power supplies, unplug the power cord from an AC router; switch off the power at the circuit breaker on a DC router.

Waarschuwing Voordat u aan een frame of in de nabijheid van voedingen werkt, dient u bij wisselstroom toestellen de stekker van het netsnoer uit het stopcontact te halen; voor gelijkstroom toestellen dient u de stroom uit te schakelen bij de stroomverbreker.

Varoitus Kytke irti vaihtovirtalaitteiden virtajohto ja katkaise tasavirtalaitteiden virta suojakytkimellä, ennen kuin teet mitään asennuspohjalle tai työskentelet virtalähteiden läheisyydessä.

Attention Avant de travailler sur un châssis ou à proximité d'une alimentation électrique, débrancher le cordon d'alimentation des unités en courant alternatif; couper l'alimentation des unités en courant continu au niveau du disjoncteur.

Warnung Bevor Sie an einem Chassis oder in der Nähe von Netzgeräten arbeiten, ziehen Sie bei Wechselstromeinheiten das Netzkabel ab bzw. schalten Sie bei Gleichstromeinheiten den Strom am Unterbrecher ab.

Avvertenza Prima di lavorare su un telaio o intorno ad alimentatori, scollegare il cavo di alimentazione sulle unità CA; scollegare l'alimentazione all'interruttore automatico sulle unità CC.

Advarsel Før det utføres arbeid på kabinettet eller det arbeides i nærheten av strømforsyningsenheter, skal strømledningen trekkes ut p vekselstrømsenheter og strømmen kobles fra ved strømbryteren på likestrømsenheter.

Aviso Antes de trabalhar num chassis, ou antes de trabalhar perto de unidades de fornecimento de energia, desligue o cabo de alimentação nas unidades de corrente alternada; desligue a corrente no disjuntor nas unidades de corrente contínua.

¡Atención! Antes de manipular el chasis de un equipo o trabajar cerca de una fuente de alimentación, desenchufar el cable de alimentación en los equipos de corriente alterna (CA); cortar la alimentación desde el interruptor automático en los equipos de corriente continua (CC).

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

TN Power Warning



WARNING: The router is designed to work with TN power systems.

Waarschuwing Het apparaat is ontworpen om te functioneren met TN energiesystemen.

Varoituis Koje on suunniteltu toimimaan TN-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-Stromsystemen ausgelegt.

Avvertenza Il dispositivo è stato progettato per l'uso con sistemi di alimentazione TN.

Advarsel Utstyret er utfomet til bruk med TN-strømsystemer.

Aviso O dispositivo foi criado para operar com sistemas de corrente TN.

¡Atención! El equipo está diseñado para trabajar con sistemas de alimentación tipo TN.

Warning! Enheten är konstruerad för användning tillsammans med elkraftssystem av TN-typ.

Copper Conductors Warning



WARNING: Use copper conductors only.

Waarschuwing Gebruik alleen koperen geleiders.

Varoitus Käytä vain kuparijohtimia.

Attention Utilisez uniquement des conducteurs en cuivre.

Warnung Verwenden Sie ausschließlich Kupferleiter.

Avvertenza Usate unicamente dei conduttori di rame.

Advarsel Bruk bare kobberledninger.

Aviso Utilize apenas fios condutores de cobre.

¡Atención! Emplee sólo conductores de cobre.

Varning! Använd endast ledare av koppar.

AC Power Electrical Safety Guidelines

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

- AC-powered routers are shipped with a three-wire electrical cord with a grounding-type plug that fits only a grounding-type power outlet. Do not circumvent this safety feature. Equipment grounding should comply with local and national electrical codes.
- You must provide an external circuit breaker rated minimum 20 A, 125/250 VAC in the building installation.
- The power cord serves as the main disconnecting device. The socket outlet must be near the router and be easily accessible.
- The cores in the mains lead are colored in accordance with the following code:
 - Green and yellow—Earth
 - Blue—Neutral
 - Brown—Live
- When a router is equipped with two AC power supplies, both power cords (one for each power supply) must be unplugged to completely disconnect power to the router.

Power Cable Warning (Japanese)



WARNING: The attached power cable is only for this product. Do not use the cable for another product.

注意

附属の電源コードセットはこの製品専用です。
他の電気機器には使用しないでください。

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DC Power Electrical Safety Guidelines and Warnings

When working with DC-powered equipment, observe the following guidelines and warnings:

- DC Power Electrical Safety Guidelines on page 192
- DC Power Disconnection Warning on page 193
- DC Power Grounding Requirements and Warning on page 194
- DC Power Wiring Sequence Warning on page 195
- DC Power Wiring Terminations Warning on page 196

DC Power Electrical Safety Guidelines

The following electrical safety guidelines apply to a DC-powered router:

- A DC-powered router is 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 24 A. We recommend that the 48 VDC facility DC source be equipped with a circuit breaker rated at 30 A minimum, or as required by local code. Incorporate an easily accessible disconnect device into the facility wiring. In the United States and Canada, the –48 VDC facility should be equipped with a circuit breaker rated a minimum of 125 % of the power provisioned for the input in accordance with the National Electrical Code in the US and the Canadian Electrical Code in Canada. 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 60 A.
- 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 a DC-powered router is the nominal voltage associated with the battery circuit, and any higher voltages are only to be associated with float voltages for the charging function.
- Because the router is a positive ground system, you must connect the positive lead to the terminal labeled **RTN**, the negative lead to the terminal labeled **–48V**, and the earth ground to the chassis grounding points.

DC Power Disconnection Warning



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

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

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

Attention Avant de pratiquer l'une quelconque des procédures ci-dessous, vérifier que le circuit en courant continu n'est plus sous tension. Pour en être sûr, localiser le disjoncteur situé sur le panneau de service du circuit en courant continu, placer le disjoncteur en position fermée (**OFF**) et, à l'aide d'un ruban adhésif, bloquer la poignée du disjoncteur en position **OFF**.

Warnung Vor Ausführung der folgenden Vorgänge ist sicherzustellen, daß die Gleichstromschaltung keinen Strom erhält. Um sicherzustellen, daß sämtlicher Strom abgestellt ist, machen Sie auf der Schalttafel den Unterbrecher für die Gleichstromschaltung ausfindig, stellen Sie den Unterbrecher auf **AUS**, und kleben Sie den Schaltergriff des Unterbrechers mit Klebeband in der **AUS**-Stellung fest.

Avvertenza Prima di svolgere una qualsiasi delle procedure seguenti, verificare che il circuito CC non sia alimentato. Per verificare che tutta l'alimentazione sia scollegata (OFF), individuare l'interruttore automatico sul quadro strumenti che alimenta il circuito CC, mettere l'interruttore in posizione OFF e fissarlo con nastro adesivo in tale posizione.

Advarsel Før noen av disse prosedyrene utføres, kontroller at strømmen er frakoblet likestrømkretsen. Sørg for at all strøm er slått AV. Dette gjøres ved å lokalisere strømbryteren på brytertavlen som betjener likestrømkretsen, slå strømbryteren AV og teipe bryterhåndtaket på strømbryteren i AV-stilling.

Aviso Antes de executar um dos seguintes procedimentos, certifique-se que desligou a fonte de alimentação de energia do circuito de corrente contínua. Para se assegurar que toda a corrente foi DESLIGADA, localize o disjuntor no painel que serve o circuito de corrente contínua e coloque-o na posição OFF (Desligado), segurando nessa posição a manivela do interruptor do disjuntor com fita isoladora.

¡Atención! Antes de proceder con los siguientes pasos, comprobar que la alimentación del circuito de corriente continua (CC) esté cortada (OFF). Para asegurarse de que toda la alimentación esté cortada (OFF), localizar el interruptor automático en el panel que alimenta al circuito de corriente continua, cambiar el interruptor automático a la posición de Apagado (OFF), y sujetar con cinta la palanca del interruptor automático en posición de Apagado (OFF).

Varning! Innan du utför någon av följande procedurer måste du kontrollera att strömförsörjningen till likströmskretsen är bruten. Kontrollera att all strömförsörjning är BRUTEN genom att slå AV det överspänningsskydd som skyddar likströmskretsen och tejpa fast överspänningsskyddets omkopplare i FRÅN-läget.

DC Power Grounding Requirements and Warning

An insulated grounding conductor that is identical in size to the grounded and ungrounded branch circuit supply conductors, but is identifiable by green and yellow stripes, is installed as part of the branch circuit that supplies the unit. The grounding conductor is a separately derived system at the supply transformer or motor generator set.

For further information, see “DC Power, Connection, and Cable Specifications” on page 209.



WARNING: When installing the router, the ground connection must always be made first and disconnected last.

Waarschuwing Bij de installatie van het toestel moet de aardverbinding altijd het eerste worden gemaakt en het laatste worden losgemaakt.

Varoitus Laitetta asennettaessa on maahan yhdistäminen aina tehtävä ensiksi ja maadoituksen irti kytkeminen viimeiseksi.

Attention Lors de l'installation de l'appareil, la mise à la terre doit toujours être connectée en premier et déconnectée en dernier.

Warnung Der Erdanschluß muß bei der Installation der Einheit immer zuerst hergestellt und zuletzt abgetrennt werden.

Avvertenza In fase di installazione dell'unità, eseguire sempre per primo il collegamento a massa e disconnetterlo per ultimo.

Advarsel Når enheten installeres, må jordledningen alltid tilkobles først og frakobles sist.

Aviso Ao instalar a unidade, a ligação à terra deverá ser sempre a primeira a ser ligada, e a última a ser desligada.

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

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

DC Power Wiring Sequence Warning



WARNING: Wire the DC power supply using the appropriate lugs. When connecting power, the proper wiring sequence is ground to ground, + RTN to + RTN, then –48 V to –48 V. When disconnecting power, the proper wiring sequence is –48 V to –48 V, + RTN to + RTN, then ground to ground. Note that the ground wire should always be connected first and disconnected last.

Waarschuwing De juiste bedradingsvolgorde verbonden is aarde naar aarde, + RTN naar + RTN, en –48 V naar – 48 V. De juiste bedradingsvolgorde losgemaakt is en –48 V naar – 48 V, + RTN naar + RTN, aarde naar aarde.

Varoitus Oikea yhdistettävä kytkentäjäjestys on maajohto maajohtoon, + RTN varten + RTN, –48 V varten – 48 V. Oikea irrotettava kytkentäjäjestys on –48 V varten – 48 V, + RTN varten + RTN, maajohto maajohtoon.

Attention Câblez l'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 Die Stromzufuhr ist nur mit geeigneten Ringösen an das DC Netzteil anzuschliessen. Die richtige Anschlusssequenz ist: Erdanschluss zu Erdanschluss, + RTN zu + RTN und dann –48V zu –48V. Die richtige Sequenz zum Abtrennen der Stromversorgung ist –48V zu –48V, + RTN zu + RTN und dann Erdanschluss zu

Erdanschluss. Es ist zu beachten dass der Erdanschluss immer zuerst angeschlossen und als letztes abgetrennt wird.

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

Advarsel Riktig tilkoples tilkoplingssekvens er jord til jord, + RTN til + RTN, -48 V til - 48 V. Riktig frakoples tilkoplingssekvens er -48 V til - 48 V, + RTN til + RTN, jord til jord.

Aviso Ate con alambre la fuente de potencia cc Usando los terminales apropiados en el extremo del cableado. Al conectar potencia, la secuencia apropiada del cableado se muele para moler, + RTN a + RTN, entonces -48 V a -48 V. Al desconectar potencia, la secuencia apropiada del cableado es -48 V a -48 V, + RTN a + RTN, entonces molió para moler. Observe que el alambre de tierra se debe conectar siempre primero y desconectar por último. Observe que el alambre de tierra se debe conectar siempre primero y desconectar por último.

¡Atención! Wire a fonte de alimentação de DC Usando os talões apropriados na extremidade da fiação. Ao conectar a potência, a sequência apropriada da fiação é moída para moer, + RTN a + RTN, então -48 V a -48 V. Ao desconectar a potência, a sequência apropriada da fiação é -48 V a -48 V, + RTN a + RTN, moeu então para moer. Anote que o fio à terra deve sempre ser conectado primeiramente e desconectado por último. Anote que o fio à terra deve sempre ser conectado primeiramente e desconectado por último.

Warning! Korrekt kopplingssekvens ar jord till jord, + RTN till + RTN, -48 V till - 48 V. Korrekt kopplas kopplingssekvens ar -48 V till -48 V, + RTN till + RTN, jord till jord.

DC Power Wiring Terminations Warning



WARNING: When stranded wiring is required, use approved wiring terminations, such as closed-loop or spade-type with upturned lugs. These terminations should be the appropriate size for the wires and should clamp both the insulation and conductor.

Waarschuwing Wanneer geslagen bedrading vereist is, dient u bedrading te gebruiken die voorzien is van goedgekeurde aansluitingspunten, zoals het gesloten-lus type of het grijperschop type waarbij de aansluitpunten omhoog wijzen. Deze aansluitpunten dienen de juiste maat voor de draden te hebben en dienen zowel de isolatie als de geleider vast te klemmen.

Varoitus Jos säikeellinen johdin on tarpeen, käytä hyväksyttyä johdinliitintä, esimerkiksi suljettua silmukkaa tai kourumaista liitintä, jossa on ylöspäin käännetyt kiinnityskorvat. Tällaisten liitäntöjen tulee olla kooltaan johtimiin sopivia ja niiden tulee puristaa yhteen sekä eristeen että johdinosan.

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

Warnung Wenn Litzenverdrahtung erforderlich ist, sind zugelassene Verdrahtungsabschlüsse, sind zugelassene Verdrahtungsabschlüsse, sind zugelassene Verdrahtungsanschlüsse, z.B. Ringoesen oder gabelförmige Kabelschuhe mit nach oben gerichteten Enden 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 occhio o a forcina con linguette rivolte verso l'alto. I connettori devono avere la misura adatta per il cablaggio e devono serrare sia l'isolante che il conduttore.

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

Aviso Quando forem requeridas montagens de instalação eléctrica de cabo torcido, use terminações de cabo aprovadas, tais como, terminações de cabo em circuito fechado e planas com terminais de orelha voltados para cima. Estas terminações de cabo deverão ser do tamanho apropriado para os respectivos cabos, e deverão prender simultaneamente o isolamento e o fio condutor.

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

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

Agency Approvals and Compliance Statements

This appendix discusses the following regulatory compliance information

- Agency Approvals on page 198
- Compliance Statements for EMC Requirements on page 199
- Compliance Statements for Environmental Requirements on page 201
- Compliance Statements for Acoustic Noise on page 201

Agency Approvals

The router complies with the following standards:

- Safety
 - CAN/CSA-22.2 No. 60950-00/UL 1950 Third Edition, Safety of Information Technology Equipment
 - EN 60825-1 Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
 - EN 60950 Safety of Information Technology Equipment
- EMC
 - AS/NZS 3548 Class A (Australia/New Zealand)
 - EN55022 Class A (Europe)
 - FCC Part 15 Class A (USA)
 - VCCI Class A (Japan)
- Immunity
 - EN-61000-3-2 Power Line Harmonics
 - EN-61000-3-3 Voltage Fluctuations and Flicker
 - 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-61000-4-11 Voltage Dips and Sags
- ETSI
 - ETSI EN-300386-2 Telecommunication Network Equipment. Electromagnetic Compatibility Requirements
- NEBS
 - GR-1089-Core: EMC and Electrical Safety for Network Telecommunications Equipment
 - SR-3580 NEBS Criteria Levels (Level 3 Compliance)
 - GR-63-Core: NEBS, Physical Protection
 - The equipment is suitable for installation as part of the Common Bonding Network (CBN).
 - The equipment is suitable for installation in locations where the National Electrical Code (NEC) applies.

- The battery return connection is to be treated as a Common DC return (i.e. DC-C), as defined in GR-1089-CORE.

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.

Declaration of Conformity



DOC 0003

Declaration of Conformity

**Juniper Networks, Inc.
1194 North Mathilda Ave
Sunnyvale, CA 94089**

declares that under our sole responsibility the product(s)

**Internet Backbone Router
Models M20-AC, M20-DC**

are in conformity with the provisions of the following EC Directives, including all amendments,
and with national legislation implementing these directives:

**Low Voltage Directive 73/23/EEC
EMC Directive 89/336/EEC**

and that the following harmonized standards have been applied

**EN 60950-1:2001+A11
EN 60825-1:1994+A11
EN 60825-2:1994**

**EN 300 386 V1.3.1:2001
EN 55024:1998
EN 55022:1991+A1+A2, Class A
EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5,
EN 61000-4-6, EN 61000-4-11**

A handwritten signature in black ink that reads "John Lockwood".

Place
Mountain View, CA

Signature
John Lockwood

Date
12/19/2005

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

Translation:

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
VCCI-A

United States

The router has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Compliance Statements for Environmental Requirements

Lithium Battery

Batteries in this product are not based on mercury, lead, or cadmium substances. The batteries used in this product are in compliance with EU Directives 91/157/EEC, 93/86/EEC, and 98/101/EEC. The product documentation includes instructional information about the proper method of reclamation and recycling.

Compliance Statements for Acoustic Noise

Maschinenlärminformations-Verordnung - 3. GPSGV, der höchste Schalldruckpegel beträgt 71.2 dB(A) oder weniger gemäss EN ISO 7779

Translation:

The emitted sound pressure resulted in 71.2 dB(A) per EN ISO 7779.

Appendix B

Environmental Specifications

- Router Environmental Specifications on page 203

Router Environmental Specifications

Table 24 on page 203 specifies the environmental specifications required for normal router operation. In addition, the site should be as dust-free as possible. For more information, see “Maintaining Hardware Components” on page 101.

Table 24: Router Environmental Specifications

Description	Value
Altitude	No performance degradation to 10,000 ft (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5 % to 90 %, noncondensing
Temperature	Normal operation ensured in temperature range of 32°F (0°C) to 104°F (40°C) Nonoperating storage temperature in shipping crate: –40°F (–40°C) to 158°F (70°C)
Seismic	Tested to meet Telcordia Technologies Zone 4 earthquake requirements
Maximum thermal output	3850 BTU/hour



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

For additional safety guidelines and requirements, see “Safety and Regulatory Compliance Information” on page 167.

Appendix C

Power Requirements, Guidelines, and Specifications

- Power Guidelines, Requirements, and Specifications on page 205

Power Guidelines, Requirements, and Specifications

The router uses either AC or DC power. There are two load-sharing, isolated power supplies located at the bottom rear of the chassis, as shown in Figure 2 on page 8. The power supplies connect to the midplane, which distributes power to router components according to their individual voltage requirements. When the power supplies are installed and operational, they automatically share the electrical load. If a power supply stops functioning for any reason, the remaining power supply instantly begins providing all the power the router needs for normal functioning and can provide full power indefinitely.



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

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

- Site Electrical Wiring Guidelines on page 205
- Router Power Requirements on page 206
- Chassis Grounding on page 207
- AC Power, Connection, and Power Cord Specifications on page 208
- DC Power, Connection, and Cable Specifications on page 209

Site Electrical Wiring Guidelines

Distance Limitations for Signaling

Improperly installed wires can emit radio interference. In addition, the potential for damage from lightning strikes increases if wires exceed recommended distances, or if wires pass between buildings. The electromagnetic pulse (EMP) caused by lightning can damage unshielded conductors and destroy electronic devices. If your site has

previously experienced such problems, you might want to consult experts in electrical surge suppression and shielding.

Radio Frequency Interference

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

Electromagnetic Compatibility

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



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

Router Power Requirements

Table 25 on page 206 lists the power requirements for various hardware components when the router is operating under typical voltage conditions. For PIC power requirements, see the *M20 PIC Guide*.

Table 25: Component Power Requirements

Component	Power Requirement (Watts)	Power Requirement (Amps)
Base system (all components except FPCs and PICs)	170 (approximate)	4 A @ 48 V (approximate)
Fan (front and Routing Engine)	30	0.625 A @ 48 V
FPC	25.5	0.03 A @ 48 V
Routing Engine	17	0.2 A @ 48 V
SSB	50.5	1.05 A @ 48 V

You can use the information in Table 25 on page 206 and the *M20 PIC Guide* to calculate power consumption for various hardware configurations, input current from a different

source voltage, and thermal output, as shown in the following examples. (These examples use a generalized value for PICs of 0.625 A @ 48 V each.)

- Power consumption for minimum configuration:

$$\begin{aligned} &\text{Base system} + 1 \text{ FPC} + 1 \text{ SSB} + 1 \text{ Routing Engine} + 4 \text{ fans} + 4 \text{ PICs} = \\ &4 \text{ A} + 0.03 \text{ A} + 1.05 \text{ A} + 0.2 \text{ A} + 4(0.625 \text{ A}) + 4(0.625 \text{ A}) = \\ &4 \text{ A} + 0.03 \text{ A} + 1.05 \text{ A} + 0.2 \text{ A} + 2.5 \text{ A} + 2.5 \text{ A} = 10.3 \text{ A @ } 48 \text{ V} = 495 \text{ W} \\ &\text{DC} \end{aligned}$$

- Power consumption for maximum configuration:

$$\begin{aligned} &\text{Base system} + 4 \text{ FPCs} + 2 \text{ SSBs} + 2 \text{ Routing Engines} + 4 \text{ fans} + 16 \text{ PICs} \\ &= \\ &4 \text{ A} + 4(0.03 \text{ A}) + 2(1.05 \text{ A}) + 2(0.2 \text{ A}) + 4(0.625 \text{ A}) + 16(0.625 \text{ A}) = \\ &4 \text{ A} + 0.12 \text{ A} + 2.1 \text{ A} + 0.4 \text{ A} + 2.5 \text{ A} + 10 \text{ A} = 19.1 \text{ A @ } 48 \text{ V} = 917 \text{ W} \\ &\text{DC} \end{aligned}$$

- Input current from a DC source other than 48 V (based on maximum configuration; applies to DC power supply only):

$$\begin{aligned} &(54 \text{ VDC input}) \times (\text{input current } X) = (48 \text{ VDC input}) \times (\text{input current } Y) \\ &54 \times X = 48 \times 19.1 \text{ A} \\ &X = 48 \times 19.1 \text{ A} / 54 = 17.0 \text{ A} \end{aligned}$$

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

$$\begin{aligned} &\text{Watts DC} / 85\% \text{ AC PEM efficiency} / 0.293 = \text{BTU/hr} \\ &917 / 0.85 / 0.293 = 3682 \text{ BTU/hr} \end{aligned}$$

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

$$\begin{aligned} &\text{Watts DC} / 0.293 = \text{BTU/hr} \\ &917 / 0.293 = 3130 \text{ BTU/hr} \end{aligned}$$



NOTE: If you plan to operate a maximally configured DC-powered router, we recommend that you provision at least 24 A @ 48 VDC and use a facility circuit breaker rated for 30 A minimum. Doing so enables you to operate the router in any configuration without upgrading the power infrastructure, and allows the router to function at full capacity using one power supply.

If you plan to operate a DC-powered router at less than the maximum configuration and do not provision a 30 A circuit breaker, we recommend that you provision a circuit breaker rated for at least 125% of the continuous current that the system draws at 48 V.

Chassis Grounding

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



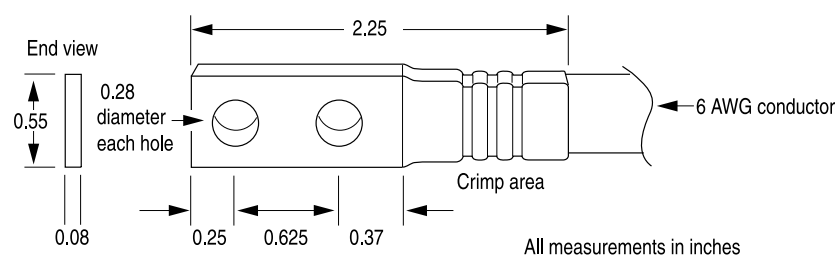
CAUTION: Before router installation begins, a licensed electrician must attach a cable lug to the grounding and power cables that you supply. A cable with an incorrectly attached lug can damage the router.

To ground AC-powered and DC-powered routers, connect a grounding cable to earth ground and then attach it to the chassis grounding points. The grounding points are spaced at 0.625-in. (15.86-mm) centers. The accessory box shipped with the router includes the cable lug that attaches to the grounding cable (see Figure 81 on page 208). The grounding cable must be 6-AWG (13.3 m²), minimum 75°C wire, or as permitted by the local code.



NOTE: Additional grounding is provided to an AC-powered router when you plug its power supplies into grounded AC power receptacles.

Figure 81: DC Power and Grounding Cable Lug



1188

AC Power, Connection, and Power Cord Specifications

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



WARNING: The AC power cord for the router is intended for use with the router only and not for any other use.

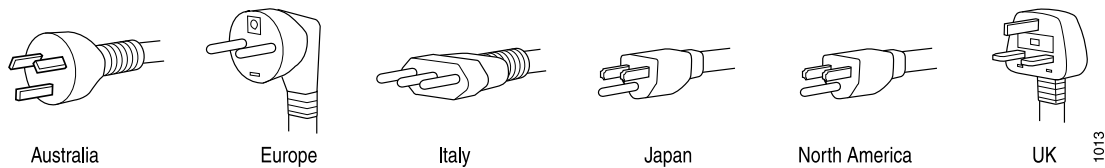


NOTE: In North America, AC power cords must not exceed 4.5 m (approximately 14.75 ft) in length, to comply with National Electrical Code (NEC) Sections 400-8 (NFPA 75, 5-2.2) and 210-52, and Canadian Electrical Code (CEC) Section 4-010(3). The cords supplied with the router are in compliance.

Table 26 on page 209 provides specifications and Figure 82 on page 209 depicts the plug on the AC power cord provided for each country or region.

Table 26: AC Power Cord Specifications

Country	Electrical Specification	Plug Type
Australia	240 VAC, 50 Hz AC	SAA/3
Europe (except Italy and United Kingdom)	220 or 230 VAC, 50 Hz AC	CEE 7/7
Italy	230 VAC, 50 Hz AC	CEI 23-16
Japan	110 VAC, 50 or 60 Hz AC	JIS 8303
North America	120 VAC, 60 Hz AC	NEMA 5-15P
United Kingdom	240 VAC, 50 Hz AC	BS89/10

Figure 82: AC Plug Types

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

For information about the AC power supply, including a description of components, see “AC Power Supply” on page 31. For instructions on connecting the power cord during initial installation, see “Connecting Power to an AC-Powered Router” on page 89. For instructions on replacing the AC power cord, see “Disconnecting and Connecting AC Power” on page 144.

DC Power, Connection, and Cable Specifications

To supply power to the router, connect power cables to a separate, dedicated DC power source for each power supply and attach the cables to the terminal studs on the power supply faceplate. 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 set of terminal studs to the power distribution panel.

The accessory box shipped with the router includes the cable lugs that attach to the terminal studs of the power supply faceplate (see Figure 81 on page 208). (The cable lug shown in Figure 81 on page 208 is also used for grounding the chassis.)



CAUTION: Before router installation begins, a licensed electrician must attach a cable lug to the grounding and power cables that you supply. A cable with an incorrectly attached lug can damage the router.

Table 27 on page 210 summarizes the specifications for the power cables, which you must supply.

Table 27: Power and Grounding Cable Specifications

Cable Type	Quantity and Specification	Connector Specification
Power	Eight 4-AWG (21.2 mm ²) (minimum) copper conductor, or as permitted by the local code.	Cable lug; dual hole, sized to fit 1/4-20 UNC terminal studs at 15.86-mm (0.625-in.) center line.



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



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

For other electrical safety information, see “Electrical Safety Guidelines and Warnings” on page 186.



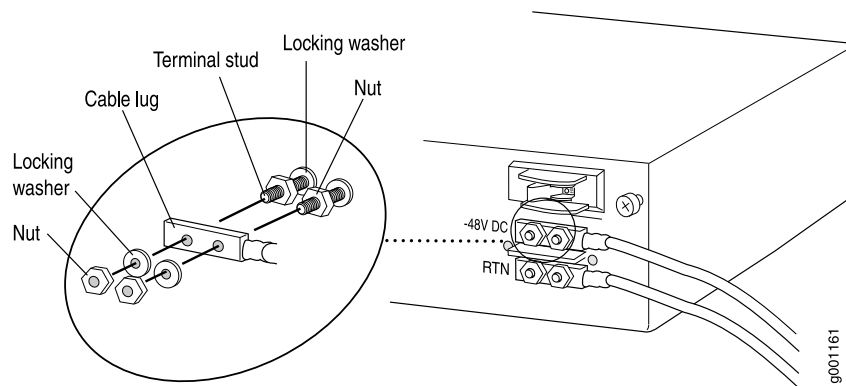
CAUTION: Power cords and cables must not block access to router components or drape where people could trip on them.

Figure 83 on page 211 shows how to attach the power cables. The power cables attach to the 1/4–20 UNC terminal studs located on the power supply faceplate— the input set of studs is labeled **–48V** and the return set is labeled **RTN**. The nuts and locking washers used to secure the power cable lugs on the terminal studs are preinstalled on the studs.

The tool for loosening or tightening the nuts on the terminal studs is a 7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a torque range between 23 lb-in. (2.6 Nm) and 25 lb-in. (2.8 Nm).



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

Figure 83: DC Power and Grounding Cable Connections

For a description of the DC power supply, see “DC Power Supply” on page 32. For instructions on connecting the DC power and grounding cables during initial installation, see “Connecting Power to a DC-Powered Router” on page 91. For instructions on replacing a DC power cable, see “Disconnecting and Connecting DC Power” on page 153.

Appendix D

Cable Specifications

- Network Cable Specifications and Guidelines on page 213
- Routing Engine Interface Cable and Wire Specifications on page 217

Network Cable Specifications and Guidelines

The various PICs supported on the router accept different kinds of network cable, including multimode and single-mode fiber-optic cable.

- Fiber-Optic and Network Cable Specifications on page 213
- Signal Loss in Multimode and Single-Mode Fiber-Optic Cable on page 213
- Attenuation and Dispersion in Fiber-Optic Cable on page 214
- Attenuation in SONET/SDH PICs on page 214
- Calculating Power Budget for Fiber-Optic Cable on page 215
- Calculating Power Margin for Fiber-Optic Cable on page 215

Fiber-Optic and Network Cable Specifications

The router supports PICs that use various kinds of network cable, including multimode and single-mode fiber-optic cable. For information about the type of cable used by each PIC, see the *M20 PIC Guide*.

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

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

Single-mode fiber is so small in diameter that rays of light can reflect internally through one layer only. Interfaces with single-mode optics use lasers as light sources. Lasers generate a single wavelength of light, which travels in a straight line through the single-mode fiber. Compared with multimode fiber, single-mode fiber has higher

bandwidth and can carry signals for longer distances. It is consequently more expensive.

For information about the maximum transmission distance and supported wavelength range for the types of single-mode and multimode fiber-optic cable used by PICs on the M20 router, see the *M20 PIC Guide*. Exceeding the maximum transmission distances can result in significant signal loss, which causes unreliable transmission.

Attenuation and Dispersion in Fiber-Optic Cable

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

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

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

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

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

When chromatic dispersion is at the maximum allowed, its effect can be considered as a power penalty in the power budget. The optical power budget must allow for the sum of component attenuation, power penalties (including those from dispersion), and a safety margin for unexpected losses. For more information about power budget, see “Calculating Power Budget for Fiber-Optic Cable” on page 215.

Attenuation in SONET/SDH PICs

SONET/SDH transceivers in the different reach classes—such as short reach (SR), intermediate reach (IR), or long reach (LR)—generate different output power levels and tolerate different input power levels. Transceivers that have a longer reach can transmit enough power to saturate the receivers on PICs that have a shorter reach. Specifically, LR transceivers can saturate IR PICs, and both IR and LR transceivers

can saturate SR PICs. Transceivers in the same reach class can also saturate one another.

To prevent saturation, you might need to attenuate power at the PIC receiver, particularly if you know that it has a shorter reach than the transceiver 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 M20 router, see the *M20 PIC Guide*.

Calculating Power Budget for Fiber-Optic Cable

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

$$P_B = P_T - P_R$$

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

$$P_B = P_T - P_R$$

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

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

Calculating Power Margin for Fiber-Optic Cable

After calculating a link's power budget (using the equation described in “Calculating Power Budget for Fiber-Optic Cable” on page 215), you can calculate the power margin (P_M), which represents the amount of power available after subtracting attenuation or link loss (LL) from the power budget (P_B). A worst-case estimate of P_M assumes maximum LL:

$$P_M = P_B - LL$$

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

Factors that can cause link loss include higher-order mode losses, modal and chromatic dispersion, connectors, splices, and fiber attenuation. Table 28 on page 216 lists an estimated amount of loss for the factors used in the following sample

calculations. For information about the actual amount of signal loss caused by equipment and other factors, refer to vendor documentation.

Table 28: Estimated Values for Factors Causing Link Loss

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

The following example uses the estimated values in Table 28 on page 216 to calculate link loss (LL) for a 2 km-long multimode link with a power budget (P_B) of 13 dB:

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

The power margin (P_M) is calculated as follows:

$$P_M = P_B - LL$$

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

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

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

The following sample calculation for an 8 km-long single-mode link with a power budget (P_B) of 13 dB uses the estimated values from Table 28 on page 216 to calculate link loss (LL) as the sum of fiber attenuation (8 km @ 0.5 dB/km, or 4 dB) and loss for seven connectors (0.5 dB per connector, or 3.5 dB). The power margin (P_M) is calculated as follows:

$$P_M = P_B - LL$$

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

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

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

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

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 28.)

Table 29 on page 217 lists the specifications for the cables that connect to management ports and the wires that connect to the alarm relay contacts.

Table 29: Cable and Wire Specifications for Routing Engine Management and Alarm Interfaces

Port	Cable Specification	Cable/Wire Supplied	Maximum Length	Router Receptacle
Routing Engine console or auxiliary interface	RS-232 (EIA-232) serial cable	One 6-ft (1.83-m) length with DB-9/DB-9 connectors	6 ft (1.83 m)	DB-9 male
Routing Engine Ethernet interface	Category 5 cable or equivalent suitable for 100BaseT operation	One 15-ft (4.57-m) length with RJ-45/RJ-45 connectors	328 ft (100 m)	RJ-45 autosensing
Alarm relay contacts	Wire with gauge between 28-AWG and 14-AWG (0.08 and 2.08 mm ²)	No	None	—

Appendix E

Contacting Customer Support and Returning Hardware

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

- Locating Component Serial Numbers on page 219
- Contacting Customer Support on page 225
- Return Procedure on page 226
- Tools and Parts Required on page 226
- Packing the Router for Shipment on page 227
- Packing Components for Shipment on page 228

Locating Component Serial Numbers

Before contacting Juniper Networks, Inc. to request a Return Materials Authorization (RMA), you must find the serial number on the router or component. To list all of the router components and their serial numbers, enter the following command-line interface (CLI) command:

```
user@host> show chassis hardware
Hardware inventory:
Item          Version  Part number  Serial number  Description
Chassis                               JN1090E5DAHA  T1600
Midplane      REV 02   710-017247   RC0094         T-series Backplane
FPM GBUS      REV 09   710-002901   WE0156         T640 FPM Board
FPM Display   REV 05   710-021387   DE4543         T1600 FPM Display
CIP           REV 06   710-002895   WD8691         T-series CIP
PEM 0         Rev 06   740-017906   TE27790        Power Entry Module 3x80
PEM 1         Rev 06   740-017906   TE27779        Power Entry Module 3x80
SCG 0         REV 14   710-003423   WF1874         T640 Sonet Clock Gen.
SCG 1         REV 14   710-003423   WF1881         T640 Sonet Clock Gen.
Routing Engine 0 REV 06   740-014082   1000688671     RE-A-2000
Routing Engine 1 REV 06   740-014082   1000688739     RE-A-2000
CB 0          REV 06   710-007655   KB9648         Control Board (CB-T)
CB 1          REV 15   710-002728   HR8130         T-series Control Board
FPC 0         REV 10   710-010845   JZ2728         FPC Type 4
CPU           REV 04   710-011481   JT8139         FPC CPU-Enhanced
PIC 0         REV 05   750-017405   DF3515         4x 10GE (LAN/WAN) XFP
  Xcvr 0       REV 01   740-014279   KB405P1        XFP-10G-LR
  Xcvr 1       REV 01   740-014289   C701XU05U      XFP-10G-SR
MMB 0         REV 01   710-016606   JW7943         ST-MMB
```

FPC 1 CPU	REV 03	710-013035	DF5574	FPC Type 3-ES
FPC 2 CPU	REV 04	710-013560	WF7206	E2-FPC Type 3
PIC 0	REV 03	710-013563	WE9007	FPC CPU-Enhanced
	REV 16	750-007141	NF5528	10x 1GE(LAN), 1000 BASE
Xcvr 0	REV 01	740-011782	P8P085F	SFP-SX
PIC 1	REV 12	750-009567	WF3566	1x 10GE(LAN), XENPAK
Xcvr 0	REV 02	740-013170	T07C94489	XENPAK-LR
PIC 2	REV 11	750-009567	CW9479	1x 10GE(LAN), XENPAK
Xcvr 0	REV 02	740-013170	T06F90331	XENPAK-LR
PIC 3	REV 07	750-012793	WF5106	1x 10GE(LAN/WAN) IQ2
Xcvr 0	REV 01	740-014279	KB405Q8	XFP-10G-LR
MMB 0	REV 06	710-010171	WF6759	MMB-5M3-288mbit
MMB 1	REV 06	710-010171	WF6800	MMB-5M3-288mbit
FPC 3 CPU	REV 04	710-013553	JW1482	E2-FPC Type 1
PIC 0	REV 02	710-013563	JY4119	FPC CPU-Enhanced
	REV 10	750-012266	JX5515	4x 1GE(LAN), IQ2
Xcvr 0	REV 01	740-011613	PAM2Y9H	SFP-SX
Xcvr 1	REV 01	740-011613	PAM2Y99	SFP-SX
Xcvr 2	0	NON-JNPR	AM07287E42	SFP-SX
Xcvr 3	REV 01	740-011613	PAJ4SQL	SFP-SX
PIC 1	REV 04	750-011209	HY3332	Adaptive Services-II
PIC 2	REV 03	750-011750	JH4537	Adaptive Services-II
FIPS				
MMB 1	REV 05	710-008923	JS8106	MMB 3M 288-bit
FPC 4 CPU	REV 04	710-013558	JX5622	E2-FPC Type 2
PIC 3	REV 02	710-013563	JT5841	FPC CPU-Enhanced
MMB 1	REV 21	750-001901	HZ6258	4x OC-12 SONET, SMIR
	REV 05	710-010171	JY3756	MMB-5M3-288mbit
FPC 5 CPU	REV 02	710-013037	DE3410	FPC Type 4-ES
PIC 0	REV 04	710-016744	DA2119	ST-PMB2
	REV 01	750-010850	JA0329	1x OC-768 SONET SR
PIC 1	REV 14	750-012518	JY9922	4x OC-192 SONET XFP
Xcvr 0		NON-JNPR	K9J02R8	XFP-OC192-SR
Xcvr 1	REV 01	740-014279	753019A00347	XFP-OC192-SR
Xcvr 2		NON-JNPR	AGL052700CN	UNKNOWN
Xcvr 3		NON-JNPR	AGL0527008J	UNKNOWN
MMB 0	REV 04	710-016036	DE9582	ST-MMB2
MMB 1	REV 04	710-016036	DE9580	ST-MMB2
FPC 7 CPU	REV 05	710-013558	WF4779	E2-FPC Type 2
PIC 0	REV 03	710-013563	WF4663	FPC CPU-Enhanced
	REV 09	750-011800	KA2397	8x 1GE(LAN), IQ2
Xcvr 0	REV 01	740-007326	P5S0PD9	SFP-SX
Xcvr 1	REV 01	740-007326	P5S0PD6	SFP-SX
Xcvr 2	REV 01	740-011613	PAJ4SQV	SFP-SX
Xcvr 3	REV 01	740-011613	PAM2Y94	SFP-SX
Xcvr 5		NON-JNPR	P9R0AJV	UNKNOWN
Xcvr 7	REV 01	740-013111	70191002	SFP-T
MMB 1	REV 06	710-010171	WF4050	MMB-5M3-288mbit
SPMB 0	REV 10	710-003229	JZ1095	T-series Switch CPU
SPMB 1	REV 09	710-003229	HR8670	T-series Switch CPU
SIB 0	REV 05	710-013074	DE7894	SIB-I8-SF
SIB 1	REV 05	710-013074	DE7916	SIB-I8-SF
SIB 2	REV 05	710-013074	DE7890	SIB-I8-SF
SIB 3	REV 05	710-013074	DE7883	SIB-I8-SF
SIB 4	REV 05	710-013074	DE7913	SIB-I8-SF

Most components also have a small rectangular serial number ID label (see Figure 84 on page 221) attached to the component body.

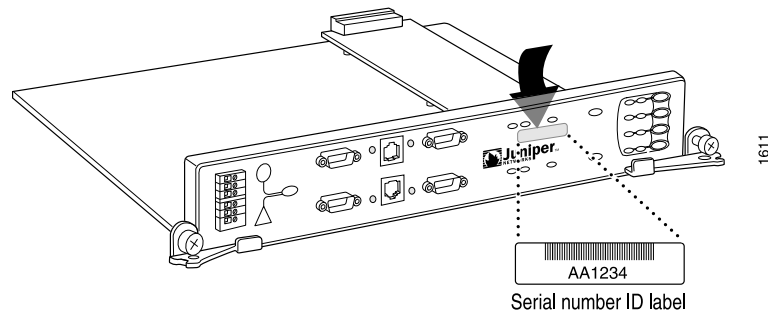
Figure 84: Serial Number ID Label

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

- Craft Interface Serial Number ID Label on page 221
- FPC Serial Number ID Label on page 222
- PIC Serial Number ID Label on page 222
- Power Supply Serial Number ID Label on page 223
- Routing Engine Serial Number ID Label on page 223
- SSB Serial Number ID Label on page 225

Craft Interface Serial Number ID Label

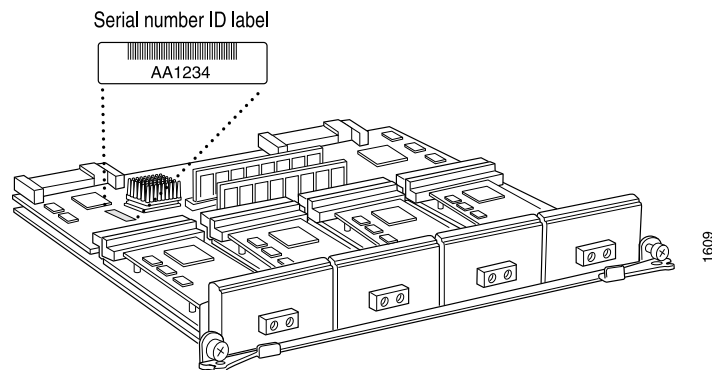
The serial number on the craft interface is located on the back of the panel, behind the alarm LEDs, as shown in Figure 85 on page 221.

Figure 85: Craft Interface Serial Number ID Label

FPC Serial Number ID Label

The serial number ID label on an FPC is located near the rear of the left side, as shown in Figure 86 on page 222.

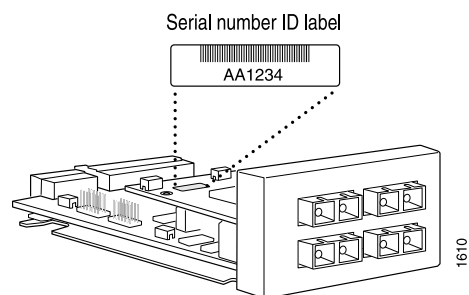
Figure 86: FPC Serial Number ID Label



PIC Serial Number ID Label

The serial number ID label on a PIC is located on the left side when the PIC is horizontal, as it is when installed in the router. See Figure 87 on page 222.

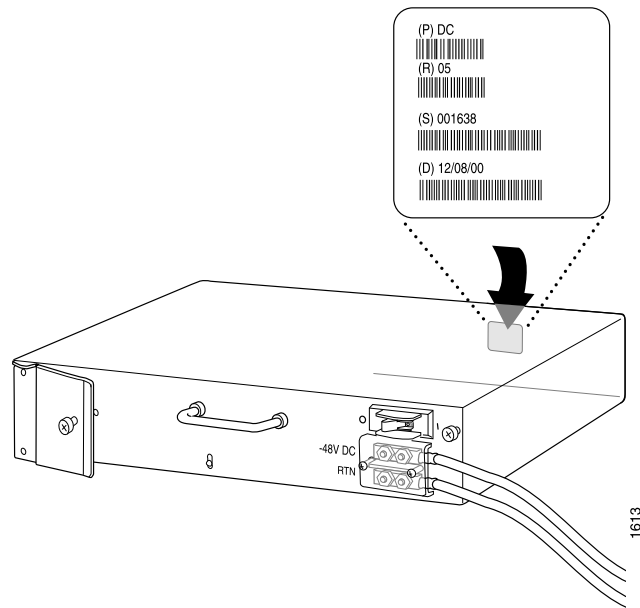
Figure 87: PIC Serial Number ID Label



Power Supply Serial Number ID Label

The serial number ID label on a power supply is located on the right side of the back, as shown in Figure 88 on page 223 (which shows a DC power supply).

Figure 88: Power Supply Serial Number ID Label



Routing Engine Serial Number ID Label

The location of the serial number ID label depends on the type of Routing Engine (see Figure 89 on page 224 and Figure 90 on page 224). Some Routing Engines might have more than one serial number. Contact your Juniper Networks support representative if you need assistance in determining which serial number to provide.

Figure 89: Routing Engine 333 Serial Number ID Label

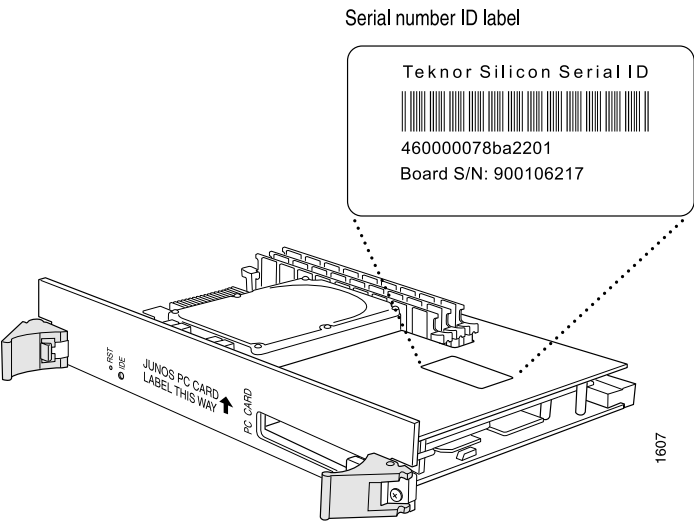
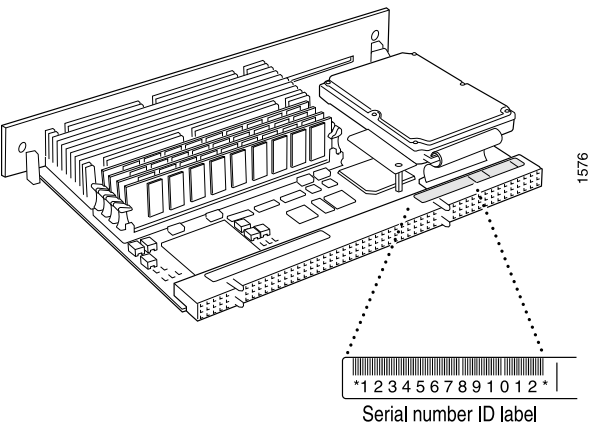


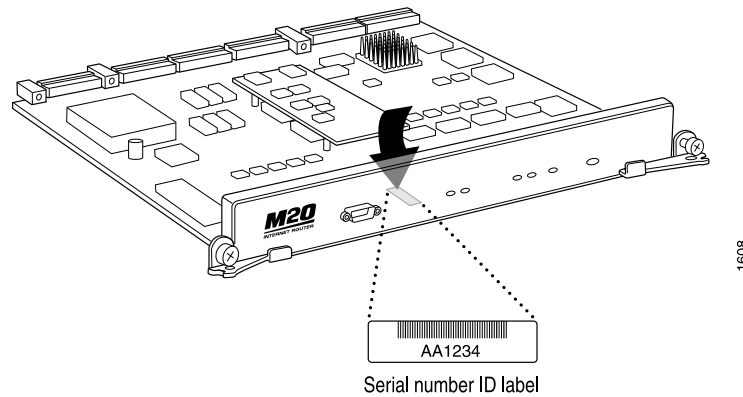
Figure 90: Routing Engine 600 Serial Number ID Label



SSB Serial Number ID Label

The serial number ID label on an SSB is located on the board just behind the faceplate, as shown in Figure 91 on page 225.

Figure 91: SSB Serial Number ID Label



Contacting Customer Support

You can contact Juniper Networks Technical Assistance Center (JTAC) 24 hours a day, seven days a week in one of the following ways:

- On the Web, using the Case Manager link at:

<http://www.juniper.net/support/>

- By telephone:

From the US and Canada: 1-888-314-JTAC

From all other locations: 1-408-745-9500

If contacting JTAC by phone, enter your 11-digit case number followed by the # key if this is an existing case, or press the * key to be routed to the next available support engineer.

Information You Might Need to Supply to JTAC

When requesting support from JTAC by telephone, be prepared to provide the following information:

- Your existing case number, if you have one
- Details of the failure or problem
- Type of activity being performed on the router when the problem occurred
- Configuration data using one or more of the show commands

Return Procedure

If the problem cannot be resolved by the JTAC technician, an RMA is issued. This number is used to track the returned material at the factory and to return repaired or new components to the customer as needed.



NOTE: Do not return any component to Juniper Networks, Inc. unless you have first obtained an RMA number. Juniper Networks, Inc. reserves the right to refuse shipments that do not have an RMA. Refused shipments will be returned to the customer via collect freight.

For more information about return and repair policies, see the customer support Web page at <http://www.juniper.net/support/guidelines.html>.

For product problems or technical support issues, contact the Juniper Networks Technical Assistance Center (JTAC) using the Case Manager link at <http://www.juniper.net/support/>, or at 1-888-314-JTAC (within the United States) or 1-408-745-9500 (from outside the United States).

When you need to return a component:

1. Determine the part number and serial number of the component. For instructions, see “Locating Component Serial Numbers” on page 219.
2. Obtain a Return Materials Authorization (RMA) number from the Juniper Networks Technical Assistance Center (JTAC). You can send e-mail or telephone as described above.
3. Provide the following information in your e-mail message or during the telephone call:
 - Part number and serial number of component
 - Your name, organization name, telephone number, and fax number
 - Description of the failure
4. The support representative validates your request and issues an RMA number for return of the component.
5. Pack the router or component for shipment, as described “Packing the Router for Shipment” on page 227 or “Packing Components for Shipment” on page 228.

Tools and Parts Required

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

- 2.5-mm Phillips (+) screwdriver, for detaching alarm relay contact wires
- Mechanical lift, if available
- Phillips (+) screwdrivers, numbers 1 and 2

- 7/16-in. hexagonal-head external drive socket wrench, or nut driver, with a torque range between 23 lb-in. (2.6 Nm) and 25 lb-in. (2.8 Nm), for loosening nuts to terminal studs on the circuit breaker box on a DC-powered router



CAUTION: Do not substitute a metric nut driver or wrench. A tool that does not fit the nuts exactly can damage them.

- Electrostatic bags or antistatic mats, one for each electronic component removed
- Electrostatic damage (ESD) grounding wrist strap

Packing the Router for Shipment

To pack the router for shipment:

1. Retrieve the shipping crate and packing materials in which the router was originally shipped. If you do not have these materials, contact your Juniper Networks representative about approved packaging materials.
2. Attach an electrostatic discharge (ESD) grounding strap to your bare wrist and connect the strap to one of the ESD points on the chassis. Verify that the router is attached to a proper earth ground. For more information about ESD, see “Preventing Electrostatic Discharge Damage” on page 172.
3. On the console or other management device connected to the master Routing Engine, enter CLI operational mode and issue the following command to shut down the router software. (If two Routing Engines are installed, also issue the command on the backup Routing Engine.)

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



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

For more information about the command, see the *JUNOS System Basics and Services Command Reference*.

4. Shut down power to the router by pressing the power switch for all power supplies to the off (O) position. On a DC power supply, the switch is located above the terminal studs on the power supply faceplate. On an AC power supply, the switch is just below the appliance inlet on the power supply faceplate.
5. Disconnect power from the router. For instructions, see “Disconnecting and Connecting AC Power” on page 144 and “Disconnecting and Connecting DC Power” on page 153.
6. Remove the cables that connect to all external devices. For instructions, see “Replacing Connections to Routing Engine Interface Ports” on page 121 and “Removing a PIC” on page 134.
7. Remove all Field Replaceable Units (FRUs) from the router.

8. Remove the router from the rack:
 - If you are using a mechanical lift, place the lift platform under the router, unscrew and remove the mounting screws from the rack, and move the router to the shipping crate.
 - If you are not using a mechanical lift and the router weight is fully supported by a shelf or another router, unscrew and remove the mounting screws from the rack. Four people can then lift the router and move it to the shipping crate.
 - If you are not using a mechanical lift and the router weight is not fully supported by a shelf or another router, four people should grasp the router while a fifth person unscrews and removes the mounting screws from the rack. The four lifters can then move the router to the shipping crate.
9. Place the router in the shipping crate or onto the pallet. If on a pallet, bolt the router to the pallet.
10. Cover the router with an ESD bag and place the packing foam on top of and around the router.
11. Replace the accessory box on top of the packing foam.
12. Securely tape the box closed or place the crate cover over the router.
13. Write the RMA number on the exterior of the box to ensure proper tracking.

Packing Components for Shipment

To pack and ship individual components:

- When you return components, verify they are adequately protected with packing materials and packed so that the pieces are prevented from moving around inside the carton.
- Use the original shipping materials if they are available.
- Place individual boards in electrostatic bags.
- Write the RMA number on the exterior of the box to ensure proper tracking.



CAUTION: Do not stack any of the router components.

Appendix F

Cable Connector Pinouts

This chapter describes the pinouts for the following cable connectors:

- RJ-45 Connector Pinouts for the Routing Engine MGMT Port on page 229
- DB-9 Connector Pinouts for the Routing Engine AUX/MODEM and CONSOLE Ports on page 230
- RJ-48 Cable Pinouts for E1 and T1 PICs on page 230
- X.21 and V.35 Cable Pinouts for EIA-530 PIC on page 233
- RJ-21 Cable Pinouts for Fast Ethernet 12-Port PIC on page 235

RJ-45 Connector Pinouts for the Routing Engine MGMT Port

The port on the craft interface labeled **MGMT** is an autosensing 10/100-Mbps Ethernet RJ-45 receptacle that accepts an Ethernet cable for connecting the Routing Engine to a management LAN (or other device that supports out-of-band management). For more information, see “Routing Engine Interface Ports and Status Indicators” on page 29. Table 30 on page 229 describes the RJ-45 connector pinout.

Table 30: RJ-45 Connector Pinout

Pin	Signal
1	TX +
2	TX-
3	RX +
4	Termination network
5	Termination network
6	RX-
7	Termination network
8	Termination network

DB-9 Connector Pinouts for the Routing Engine AUX/MODEM and CONSOLE Ports

The ports on the craft interface labeled AUX/MODEM and CONSOLE are DB-9 receptacles that accept RS-232 (EIA-232) cable. The AUX/MODEM port connects the Routing Engine to a laptop, modem, or other auxiliary unit, and the CONSOLE port connects it to a management console. The ports are configured as data terminal equipment (DTE). For more information, see “Routing Engine Interface Ports and Status Indicators” on page 29. Table 31 on page 230 describes the DB-9 connector pinouts.

Table 31: DB-9 Connector Pinout

Pin	Signal	Direction	Description
1	DCD	< –	Carrier Detect
2	RxD	< –	Receive Data
3	TxD	– >	Transmit Data
4	DTR	– >	Data Terminal Ready
5	Ground	—	Signal Ground
6	DSR	< –	Data Set Ready
7	RTS	– >	Request To Send
8	CTS	< –	Clear To Send
9	RING	< –	Ring Indicator

RJ-48 Cable Pinouts for E1 and T1 PICs

The E1 and T1 PICs use an RJ-48 cable, which is not supplied with the PIC.



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

Table 32 on page 230, Table 33 on page 231, Table 34 on page 232, and Table 35 on page 233 describe the RJ-48 connector pinouts.

Table 32: RJ-48 Connector to RJ-48 Connector (Straight) Pinout

RJ-48 Pin		
RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	(Data numbering form)	Signal
1	1	RX, Ring, –

Table 32: RJ-48 Connector to RJ-48 Connector (Straight) Pinout *(continued)*

RJ-48 Pin (Data numbering form)	RJ-48 Pin	
	(Data numbering form)	Signal
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 33: RJ-48 Connector to RJ-48 Connector (Crossover) Pinout

RJ-48 Pin (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

Table 33: RJ-48 Connector to RJ-48 Connector (Crossover) Pinout *(continued)*

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	RJ-48 Pin (Data numbering form)	Signal
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 34: 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

Table 34: RJ-48 Connector to DB-15 Connector (Straight) Pinout *(continued)*

RJ-48 Pin (on T1/E1 PIC) (Data numbering form)	DB-15 Pin (Data numbering form)	Signal
14	No connect	No connect
15	No connect	No connect

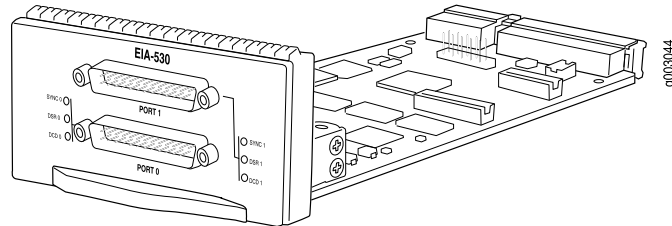
Table 35: RJ-48 Connector to DB-15 Connector (Crossover) Pinout

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

X.21 and V.35 Cable Pinouts for EIA-530 PIC

The EIA-530 PIC accepts X.21 and V.35 cable connectors.

- A V.35 connection requires an DB-25 to V.35 cable and connects to a V.35 data terminal equipment (DTE) 34-pin Winchester type male cable (one per port). Table 36 on page 234 describes the V.35 cable pinouts.
- An X.21 connection requires an DB-25 to X.21 cable and connects to a X.21 DTE DB-15 male cable. Table 37 on page 235 describes the X.21 cable pinouts.

Figure 92: EIA-530 PIC**Table 36: DB-25 Connector to V.35 Connector Pinout**

DB-25 Pin	Signal	V.35 Pin	Description
2	TD	P	Transmit Data
14	TD	S	Transmit Data
3	RD	R	Receive Data
16	RD	T	Receive Data
4	RTS	C	Ready To Send
5	CTS	D	Clear To Send
6	DSR	E	Data Set Ready
20	DTR	H	Data Terminal Ready
24	XTC	U	DTE Transmit Clock
11	XTC	W	DTE Transmit Clock
15	TC	Y	Transmit Clock
12	TC	AA	Transmit Clock
17	RC	V	Receive Clock
9	RC	X	Receive Clock
1	FGND	A	Protective Ground
7	GND	B	Signal Ground
8	DCD	F	Data Carrier Detect

Table 37: DB-25 Connector to DB-15 (X.21) Connector Pinout

DB-25 Pin	Signal	DB-15 (X.21) Pin	Description
1	FGND	1	Protective Ground
7	GND	8	Signal Ground
2	T	2	Transmit Data
14	T	9	Transmit Data
3	R	4	Receive Data
16	R	11	Receive Data
4	C	3	Request To Send
19	C	10	Request To Send
8	I	5	Data Carrier Detect
10	I	12	Data Carrier Detect
17	S	6	Receive Clock
9	S	13	Receive Clock

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

The Fast Ethernet 12-port PIC has a VHDCI connector port on its faceplate (see Figure 93 on page 235), which accepts the RJ-21 cable supplied with the PIC (see Figure 94 on page 235).

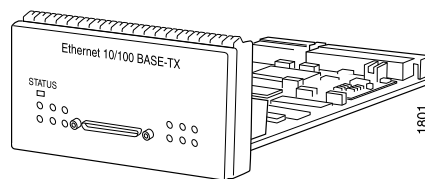
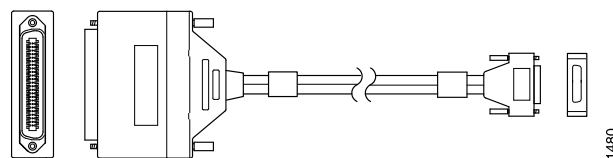
Figure 93: Fast Ethernet 12-port PIC**Figure 94: VHDCI to RJ-21 Cable**

Table 38 on page 236 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 38: RJ-21 Pin Assignments

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