



E Series™ Broadband Services Routers

E120 and E320 Hardware Guide

Release

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Audience

This guide is intended for experienced system and network specialists working with Juniper Networks E Series Broadband Services Routers in an Internet access environment.

E Series and JunosE Text and Syntax Conventions

Table 1 on page xiv defines notice icons used in this documentation.

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 xiv defines text and syntax conventions that we use throughout the E Series and JunosE documentation.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents commands and keywords in text.	<ul style="list-style-type: none"> Issue the clock source command. Specify the keyword exp-msg.
Bold text like this	Represents text that the user must type.	host1(config)#traffic class low-loss1
Fixed-width text like this	Represents information as displayed on your terminal's screen.	host1#show ip ospf 2 Routing Process OSPF 2 with Router ID 5.5.0.250 Router is an Area Border Router (ABR)
<i>Italic text like this</i>	<ul style="list-style-type: none"> Emphasizes words. Identifies variables. Identifies chapter, appendix, and book names. 	<ul style="list-style-type: none"> There are two levels of access: <i>user</i> and <i>privileged</i>. <i>clusterId</i>, <i>ipAddress</i>. <i>Appendix A, System Specifications</i>
Plus sign (+) linking key names	Indicates that you must press two or more keys simultaneously.	Press Ctrl + b.
Syntax Conventions in the Command Reference Guide		
Plain text like this	Represents keywords.	terminal length
<i>Italic text like this</i>	Represents variables.	<i>mask</i> , <i>accessListName</i>

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

Convention	Description	Examples
(pipe symbol)	Represents a choice to select one keyword or variable to the left or to the right of this symbol. (The keyword or variable can be either optional or required.)	diagnostic line
[] (brackets)	Represent optional keywords or variables.	[internal external]
[]* (brackets and asterisk)	Represent optional keywords or variables that can be entered more than once.	[level1 level2 l1]*
{ } (braces)	Represent required keywords or variables.	{ permit deny } { in out } { clusterId ipAddress }

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- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

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

Opening a Case with JTAC

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PART 1

Product Overview

- E120 and E320 Overview on page 3

CHAPTER 1

E120 and E320 Overview

This chapter provides introductory information about the Juniper Networks E120 and E320 Broadband Services Routers. It contains the following sections:

- System Description on page 3
- Chassis Overview on page 3
- E120 and E320 Modules on page 7
- Network Management Tools on page 13
- Redundancy Features on page 13

System Description

E Series routers are modular, carrier-class networking devices that deliver performance, reliability, and service differentiation to both enterprise and residential Internet users. The E120 router and E320 router are next-generation, high-capacity additions to the E Series product family offering high-port density and high bandwidth in a fully redundant system, supporting evolving IP-based broadband services. The E120 router supports the same services as the E320 router, but with smaller capacity and scaling capabilities for smaller configurations.

The routers utilize the same JunosE™ Software architecture and provide a single IP entry point into the service provider network with the same IP-based protocols and services that are available on existing E Series products. They address a wide range of edge applications, including subscriber management (including 802.11 hotspots), video on demand, Voice over IP (VoIP), Metro Ethernet, customer circuit aggregation, virtual private networks (VPNs), and wholesale services.

E Series routers offer the complete edge solution for IP-optimized carriers.

Chassis Overview

Two models are available:

- E120 router
- E320 router

Both models use the same software and share a system architecture and common components:

- Switch route processors (SRPs)—Perform system management, routing table calculations maintenance, forwarding table computations, and other control plane functions
- Switch fabric modules (SFMs)—Create a distributed shared memory switching fabric
- Line modules (LMs)—Are frame processing and forwarding engines for IOAs
- Input/output adapter (IOA)—Provide the physical connection to the network via 10-Gigabit Ethernet, Ethernet, ATM, and Packet over SONET (PoS) interfaces
- Power modules—Distribute redundant power feeds through the system to all components

E320 Model

A fully configured E320 router consists of 2 switch route processors (SRPs), 3 switch fabric modules (SFMs), 12 line modules, and up to 2 I/O adapters (IOAs) per line module. See Figure 1 on page 5 and Figure 2 on page 5.

An IOA shelf (bracket) can be installed on a slot-by-slot basis to create an upper IOA bay and lower IOA bay, enabling you to use up to two IOAs in the same slot. This architecture enables you to combine different IOA types in the same slot and to support oversubscribed configurations.



NOTE: The routers illustrated in this book might look different than your router due to configuration variations.

Figure 1: E320 Router, Front View

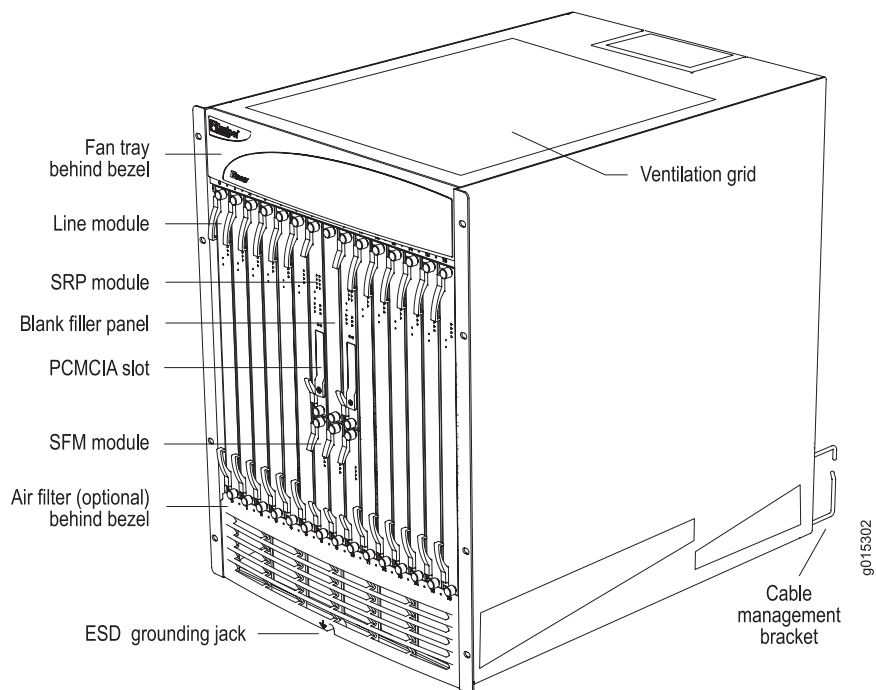
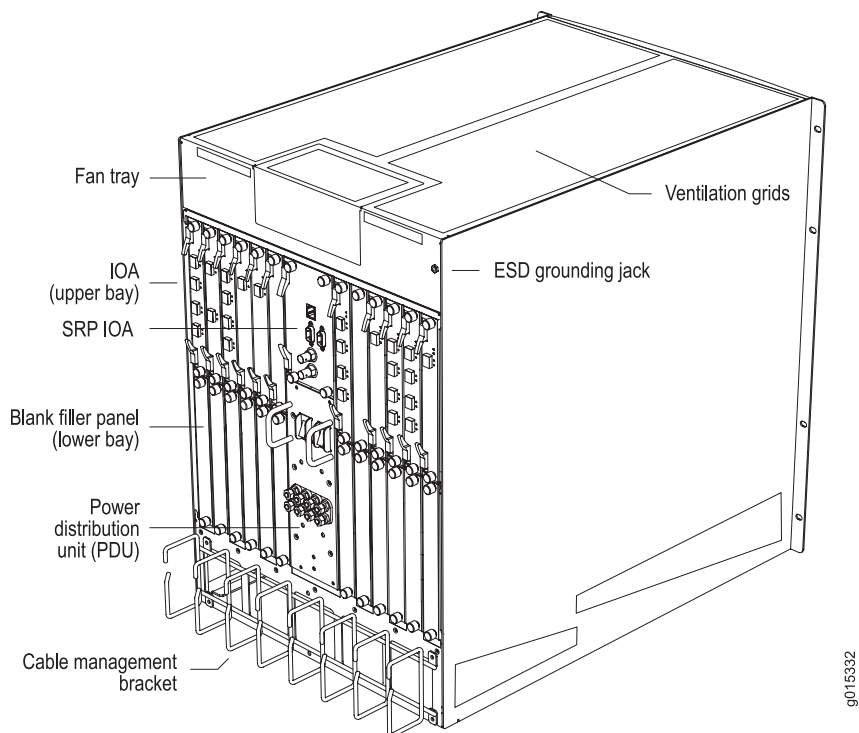


Figure 2: E320 Router, Rear View



E120 Model

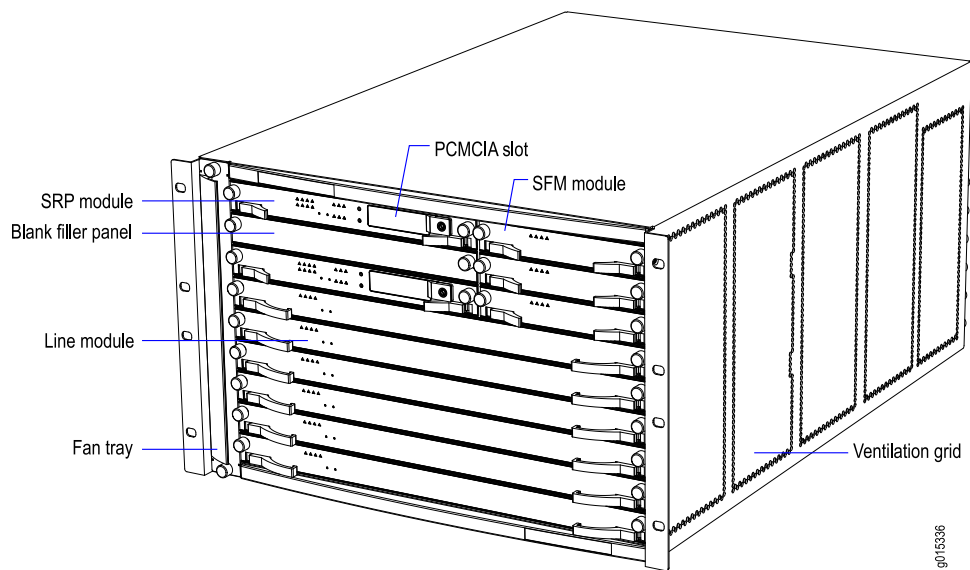
A fully configured E120 router consists of 2 switch route processors (SRPs), 3 switch fabric modules (SFM), 6 line modules, and up to 2 I/O adapters (IOAs) per line module. See Figure 3 on page 6 and Figure 4 on page 7.

An IOA shelf (bracket) can be installed on a slot-by-slot basis to create a left and right IOA bay, enabling you to use up to two IOAs in the same slot. This architecture enables you to combine different IOA types in the same slot and to support oversubscribed configurations. Air is pulled in from the right of the router by the fan tray and is exhausted out the left side.



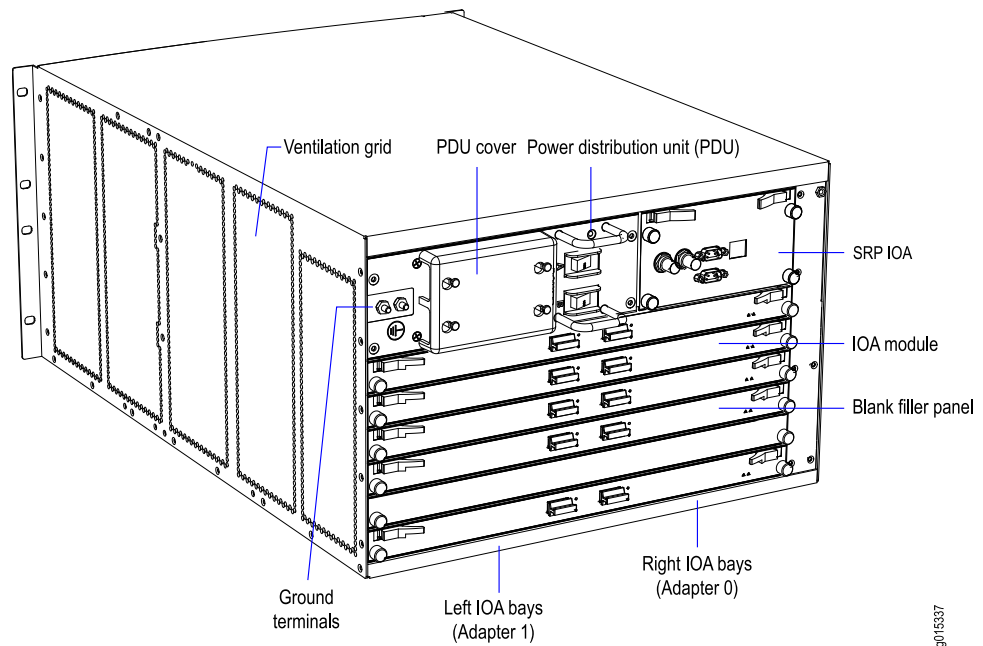
NOTE: The routers illustrated in this book might look different than your router due to configuration variations.

Figure 3: E120 Router, Front View



9015336

Figure 4: E120 Router, Rear View



E120 and E320 Modules

The routers support SRP modules, SFM modules, line modules, and IOAs. You can use a line module for *access* or *uplink*. Access line modules receive traffic from low-speed circuits, and the system routes the traffic onto higher-speed uplink line modules and then to the core of the network. Line modules act as frame forwarding engines for the physical interfaces (the IOAs) via a passive midplane.

Most line modules, IOAs, SFMs, and SRP modules can be installed in either router. There are a few exceptions, however:

- Similar-capacity modules must be used in the same router. For example, you cannot install an SRP-100 in a router that contains an SFM-320. You can only use a SRP-100 module with a SFM-100 module.
- Higher-capacity SRP modules can be used in lower-capacity routers, but lower-capacity SRP modules cannot be used in high-capacity routers. For example, an SRP-320 can be used in an E120 router, but an SRP-120 cannot be used in an E320 router.
- The SRP-100 module and the SFM-100 module are not supported in the E120 router.

See the *E120 and E320 Module Guide* for module and chassis compatibility.

The front panel of each module contains a collection of status LEDs (light-emitting diodes). For information about how to interpret the LEDs, see “Troubleshooting” on page 79. For complete module specifications, see the *E120 and E320 Module Guide*.

SRP Module

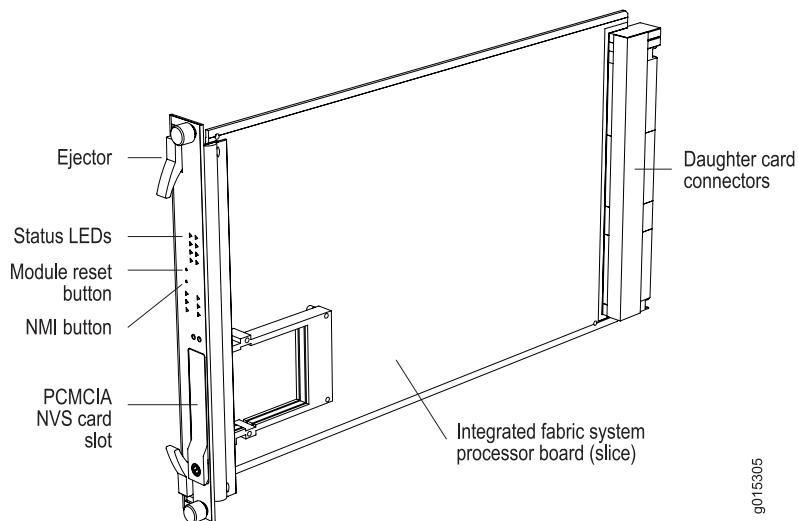
Switch route processor (SRP) modules perform system management, routing table calculations and maintenance, forwarding table computations, statistics processing, configuration storage, and other control plane functions. The SRP module identifies which line modules are physically present in the chassis and monitors and controls vital functions on the line modules.

Each SRP module (Figure 5 on page 8) is a PowerPC-based system with its own memory, nonvolatile storage (NVS), and power converter. The SRP module works with the SFM modules and contains a switch fabric *slice* common to both modules. See “Fabric Slices” on page 10 for more information.



NOTE: Because of different physical dimensions and switch fabric capabilities, SRP modules are not interchangeable between all routers. For example, the SRP-100 used in the E320 router cannot be used in other E Series routers, and vice versa. See the *E120 and E320 Module Guide* for SRP module compatibility.

Figure 5: Representative SRP Module



Module Details

An SRP module must be present for the router to boot. The routers support up to two redundant SRP modules operating in an active/standby configuration. The redundant SRP module takes control when a failover occurs. See “Redundancy Features” on page 13 and the *E120 and E320 Module Guide* for more SRP module information.



CAUTION: Do not remove the SRP module while the system is running, unless you have properly issued the `halt` command. See *JunosE System Basics*

Configuration Guide, Chapter 6, Managing Modules for information about the halt commands.



NOTE: You cannot use SRP modules of different capacities in the same configuration. For example, you cannot install a SRP-100 module and a SRP-320 module in the same router.

For details about installing SRP modules, see “Installing Modules” on page 27.

Nonvolatile Storage

Depending on the model, each SRP module has either two Type II PCMCIA nonvolatile storage (NVS) cards or two ATA flash cards (0, 1). (See Figure 5 on page 8.) One card is loaded with the system's software and configuration files while the other card holds core dumps. The NVS cards in the active SRP module are designated disk0 and disk1. The NVS cards in the redundant SRP module are designated standby-disk0 and standby-disk1. The PCMCIA card is factory installed.



CAUTION: Before you insert or remove flash cards from a running router, we strongly recommend that you halt the SRP module or shut down the router. Failure to do this can result in file corruption in one or both cards. See “Replacing an NVS Card” on page 72 for more information.

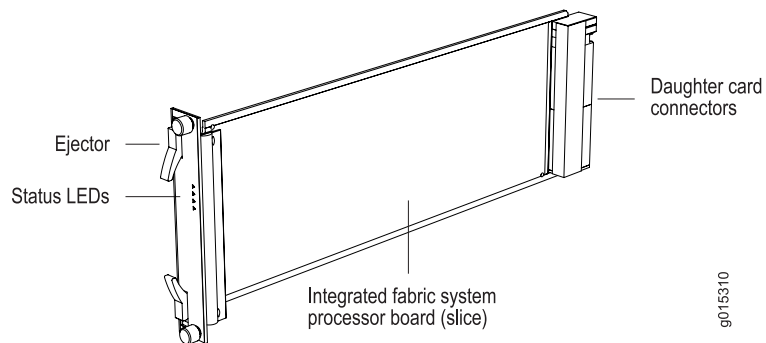
SFM Module

The switch fabric modules (SFMs) work with the SRP module to create a shared memory fabric for the router. Each SFM module (Figure 6 on page 10) has its own memory and power converter. Like the SRP module, the SFM module contains a fabric system processor board (slice). See “Fabric Slices” on page 10.



NOTE: You must use a SRP module that corresponds with the fabric type (SFM module) that is installed. For example, you can only use a SRP-100 module with a SFM-100 module. You cannot use a SRP-100 module with a SFM-320 module.

Figure 6: SFM Module



Fabric Slices

The router's switch fabric is distributed across two SRP modules and three SFM modules. Each module has a fabric *slice* on it. For the router to operate, at least four of the five slices must be operational.

When all five modules are installed, the fabric slice of the standby SRP acts as a redundant module. For example, the router can operate with:

- Two SRP modules (the second of which is redundant) and three SFM modules
- One SRP module (non-redundant) and three SFM modules
- Two SRP modules and two SFM modules



NOTE: You cannot use SFM modules of different capacities in the same configuration. For example, you cannot install a SFM-100 module and a SFM-320 module in the same router.

SRP IOA

The SRP I/O adapter (IOA) is a single input/output adapter that interfaces with the SRP modules through the system's midplane. See Figure 2 on page 5 and Figure 4 on page 7 for its location.

Module Details

The SRP IOA provides standard management interfaces, including:

- 10/100Base-T—The port enables access to the router for Ethernet management functions through Telnet, Secure Shell Server (SSH), command-line interface (CLI), or Simple Network Management Protocol (SNMP), for example.
- RS-232—One port (console) provides a serial connection for monitoring the system's hardware configuration through a PC (running terminal emulation software) or ASCII terminal and enables direct CLI access. The second port (auxiliary) provides access to debug ports on specific processors (SRP module, line module). Juniper Networks customer support engineers use the auxiliary port. We recommend that users do not use the auxiliary port.

- External timing inputs—The BNC connectors provide a method of ensuring that the clock timing used by the router remains synchronized with the network's system clock.

You can hot-swap SRP IOAs. Hot-swapping enables you to add or remove SRP IOAs without powering down the system. When you complete hot-swapping an SRP IOA, its MAC address in the subnet is automatically refreshed without rebooting the SRP or the chassis. Also, you can re-insert an SRP IOA that you had taken out previously to the same network without refreshing the MAC address of the SRP IOA.



NOTE: Hot-swapping an SRP IOA is unsupported during a unified in-service software upgrade (ISSU).

If you have configured RADIUS server on an SRP IOA that you want to replace, you can perform either of the following actions to prevent loss of accounting or logout information:

- Disable accounting and, when there is no subscriber login or logout activity, hot-swap SRP IOA.
- Increase the timeout value of the RADIUS server configured depending on the time used for IOA replacement. The maximum timeout value is 1000 seconds.

After you complete hot-swapping the SRP IOA, you can use the **show version all** command to display the state of the SRP IOA.

The SRP IOA hot-swapping is supported on the following routers:

- E320 router with SRP-100 or SRP-320
- E120 router



NOTE: You must complete the hot-swapping of the SRP IOA within 1800 seconds.

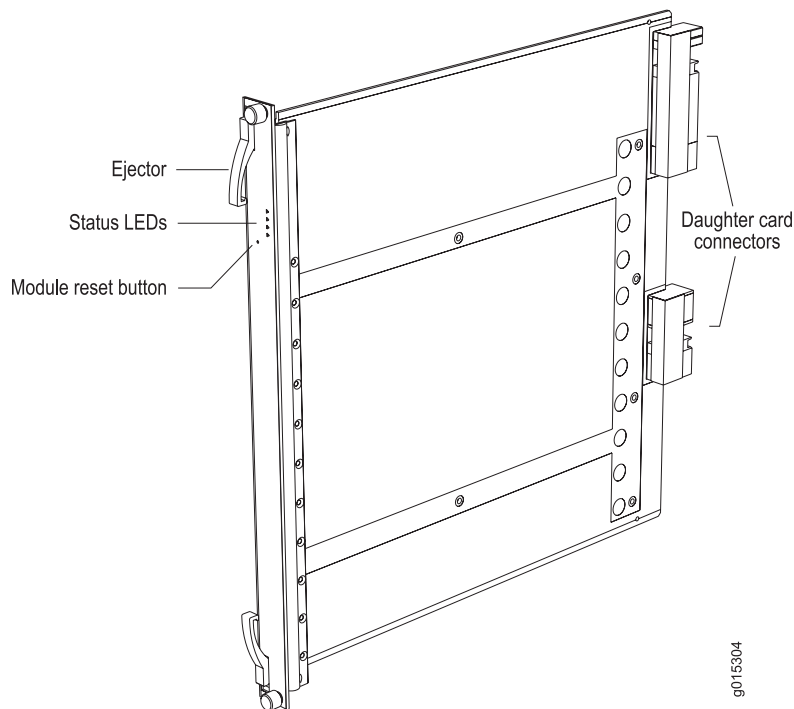
For details about installing the SRP IOA, see “Installing Modules” on page 27.

Line Modules

Line modules (LMs) act as frame forwarding engines for the physical interfaces (the IOAs) and process data from different types of network connections. For information about available line modules, and which SRP modules support specific line modules, see the *E120 and E320 Module Guide*.

Figure 7 on page 12 shows a representative line module. For details about installing line modules, see “Installing Modules” on page 27.

Figure 7: Representative Line Module



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Packet Classification

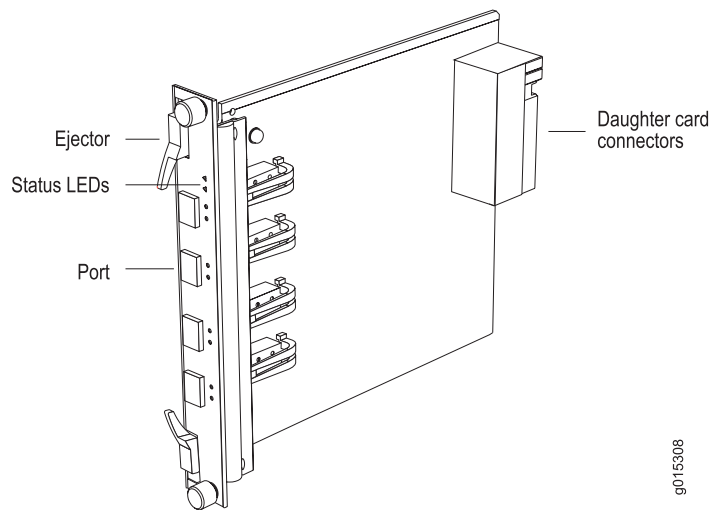
The line module supports packet classification on ingress. A classification engine on the line module matches specific fields (such as source and destination IP address, source and destination port, and protocol), the ingress IP interface, layer 2 fields, or some combination of these against user-configured filters at wire speed.

I/O Adapters

Most input/output adapters (IOA) provide the physical interconnection to the network via small form-factor pluggable transceivers (SFPs). You insert each IOA into the passive midplane in the rear of the chassis, directly behind a line module. See Figure 2 on page 5 for IOA location in the router and Figure 8 on page 13 for a representative IOA model. See “Installing and Removing SFPs” on page 43 and the *E120 and E320 Module Guide* for information on SFPs.

For a list of hot-swappable IOAs, see Table 4 on page 32.

Figure 8: Representative IOA



An IOA bracket can be installed to create upper and lower IOA bays (E320 router) or left and right IOA bays (E120 router), enabling you to use two IOAs in the same slot. This architecture enables you to combine different IOA types in the same slot and to support oversubscribed configurations.

Restrictions exist concerning which IOAs can be combined in the same slot and which bay (upper or lower, left or right) they may be installed in. See “IOA Slot Combinations” on page 32 and the *E120 and E320 Module Guide* for information. For details about installing IOAs, see “Installing Modules” on page 27.

Network Management Tools

You can use different management tools to configure the system to meet the specific networking requirements.

CLI Management

The command-line interface (CLI) provides fully developed and automated configuration and status functionality through a local RS-232 port, Telnet, or SSH over any reachable network. For a full discussion of the CLI, see *JunosE System Basics Configuration Guide, Chapter 2, Command-Line Interface*.

SNMP MIB Management

The system offers a complete SNMP interface for configuration, status, and alarm reporting. The system supports both Standard and Enterprise MIBs (Management Information Bases). The Juniper Networks E Series Enterprise MIB is ASN.1 notated for easy importing into third-party SNMP management applications. For more information, see *JunosE System Basics Configuration Guide, Chapter 4, Configuring SNMP*.

Redundancy Features

This section describes system redundancy features.

SRP Modules

The router uses a 1:1 redundancy scheme for the SRP module. When two SRP modules are installed in the router, one acts as the primary (active) and the second as a redundant (standby) module. Both SRP modules share a single SRP IOA located in the rear of the chassis. After you install two SRP modules, the modules negotiate for the primary role. A number of factors determine which module becomes the primary; however, preference is given to the module in the lower-numbered slot. The SRP modules record their latest roles and retain them the next time you power up the system.

If the standby SRP module detects that the primary SRP module is not active (and high-availability mode is not enabled), it reboots the system and takes control. If high-availability mode has been enabled, automatic switchover occurs with near hitless failover. For information about configuring and managing SRP module redundancy, see *JunosE System Basics Configuration Guide, Chapter 6, Managing Modules*.

NVS Cards

Each SRP module has two NVS cards (0, 1). The NVS cards in the active SRP module are designated disk0 and disk1. The NVS cards in the redundant SRP module are designated standby-disk0 and standby-disk1. After you install new NVS cards or SRP modules, you must issue the **synchronize** command to match the file system of the NVS card on the redundant SRP module with the file system of the NVS card on the active SRP module. See “Replacing an NVS Card” on page 72 for more information.

Power

The routers provide a power architecture that distributes redundant –48 VDC feeds through the router to each line module, IOA, SRP module, SFM module, and fan module where DC-to-DC converters provide local conversion to the required secondary voltages.

Fans

The E320 router employs a bottom-to-top cooling system to keep the temperature of the modules and components within normal operating limits. Eight cooling fans are located in a tray at the top of the router. (See Figure 1 on page 5 and Figure 2 on page 5.) Air is pulled in from the front of the router at the bottom and is exhausted out the top.

The E120 router employs a right-to-left cooling system. Nine cooling fans are located in a tray at the left of the router. (See Figure 3 on page 6.) Air is pulled in from the right of the router and is exhausted out the left.

The system monitors the temperature of each module. If the temperature of a module exceeds the maximum limit, the system immediately goes into thermal protection mode and the LMs and SFM modules are powered off. The system controllers remain active and respond on all management interfaces. All other modules remain in a power-off condition. The failure of any two components (fan or converter), or the absence of the fan tray, causes the chassis to enter thermal protection mode to prevent hardware damage. For information about troubleshooting high operating temperatures, see “Troubleshooting” on page 79.

The E320 fan tray has two primary converters that power four fans each. If a primary converter fails, a third redundant converter takes over. The E120 fan tray has dual converters that load share for redundancy. If one converter fails, the other redundant converter takes over. The system software reports an alarm if any of the fans or converters fail.

PART 2

Initial Installation

- Unpacking and Inspecting the Router on page 19
- Installing the Router on page 23
- Installing Modules on page 27
- Cabling the Router on page 47
- Powering Up the Router on page 57
- Accessing E Series Routers on page 61

CHAPTER 2

Unpacking and Inspecting the Router

This chapter reviews shipping contents and unpacking procedures for the router. It contains the following sections:

- Before You Begin on page 19
- Unpacking the Router on page 19
- Inspecting Router Components and Accessories on page 20
- If You Detect or Suspect Damage on page 20
- Contacting Juniper Networks on page 21
- The Next Step on page 21

Before You Begin

Before you begin unpacking the router, be sure you have the following tools:

- A No. 2 Phillips screwdriver
- A utility knife
- A mechanical lift, or at least two people to assist in lifting

Unpacking the Router

The router is delivered boxed, bolted, and strapped to a skid. For your convenience, we recommend that you unpack the router in the location where you want to install it.

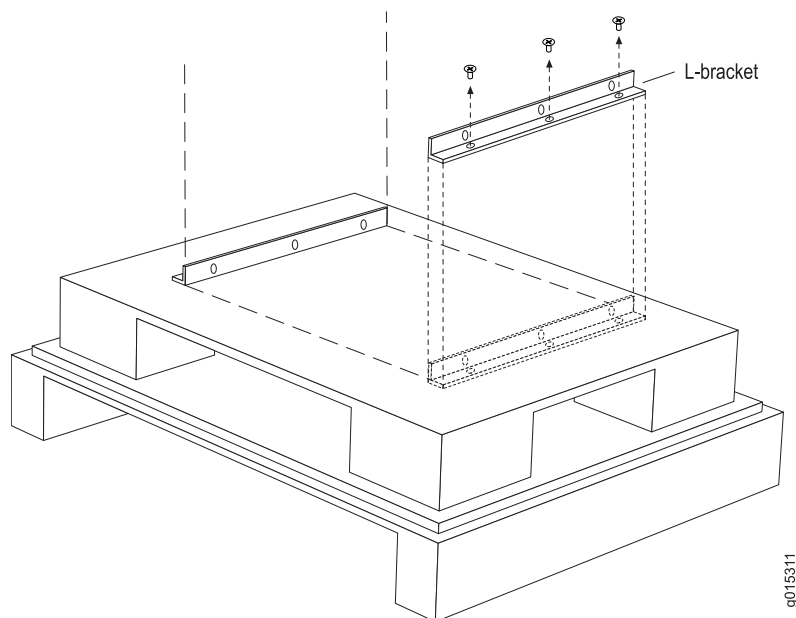


WARNING: Three people are required to install the router in a rack: two to lift the system into position and one to screw it to the rack.

To unpack the router:

1. Cut the two straps that secure the carton to the skid, open the carton from the top, and remove the box of accessories that sits on top of the router.
2. Unlock the four plastic clips that hold the box to the skid by squeezing them in their center and pulling out, and then lift the carton off the router.
3. Remove the three screws that attach each of the two L-brackets to the router.
4. To avoid scratching the router when removing it from the skid, detach one of the L-brackets from the skid by removing the three screws. See Figure 9 on page 20.

Figure 9: Removing an L-bracket



Inspecting Router Components and Accessories

After you remove the equipment from the shipping containers:

- Confirm the contents of each container.
- Inspect all external surfaces and external connectors for visible signs of damage.
- Inspect all accessories shipped with each unit.
- Document any damage noted during your inspection.
- Confirm that the router has the correct number and type of modules for your ordered configuration.

If You Detect or Suspect Damage

If you detect or suspect damage to any equipment:

- Contact the shipper responsible for delivery, and formally report the damage.
- Contact your Juniper Networks sales representative or reseller.

Contacting Juniper Networks

Please contact Juniper Networks at 1-888-314-JTAC (from the United States, Canada, or Mexico) or 1-408-745-9500 (from elsewhere), or contact your sales representative if you have any questions or concerns. See “Contacting Customer Support and Returning Hardware” on page 113 for complete contact information.

The Next Step

- To familiarize yourself with the electrical, environmental, and other guidelines and requirements for installing the router, see “Installation Guidelines and Requirements” on page 97.
- If you are familiar with these guidelines and requirements, see “Installing the Router” on page 23.

CHAPTER 3

Installing the Router

This chapter describes how to install the router. It contains the following sections:

- Before You Begin on page 23
- Freestanding Installation on page 23
- Rack-Mounted Installation on page 25
- The Next Step on page 26

Before You Begin

Before installing the router, be sure you:

- Have a plan for installing the router that takes into consideration future expansion of your system.
- Have the tools and accessories needed to complete the installation.
- Read and understand the clearance requirements for the front and back of the chassis for cable routing and other unit access. See “Environmental Requirements” on page 97 for more information.
- Read and understand the clearance requirements for the top and bottom of the chassis to ensure adequate ventilation.
- Prepare the equipment racks by measuring and marking space for each router and plenum you plan to install.

Freestanding Installation

When installing the system on a table top or in any other freestanding mode, be sure to leave enough space around the system for adequate ventilation. Position the router with easy access to the connections that it needs for power, local communications, and remote communications.

See “Installation Guidelines and Requirements” on page 97, and “System Specifications” on page 91, for more information.



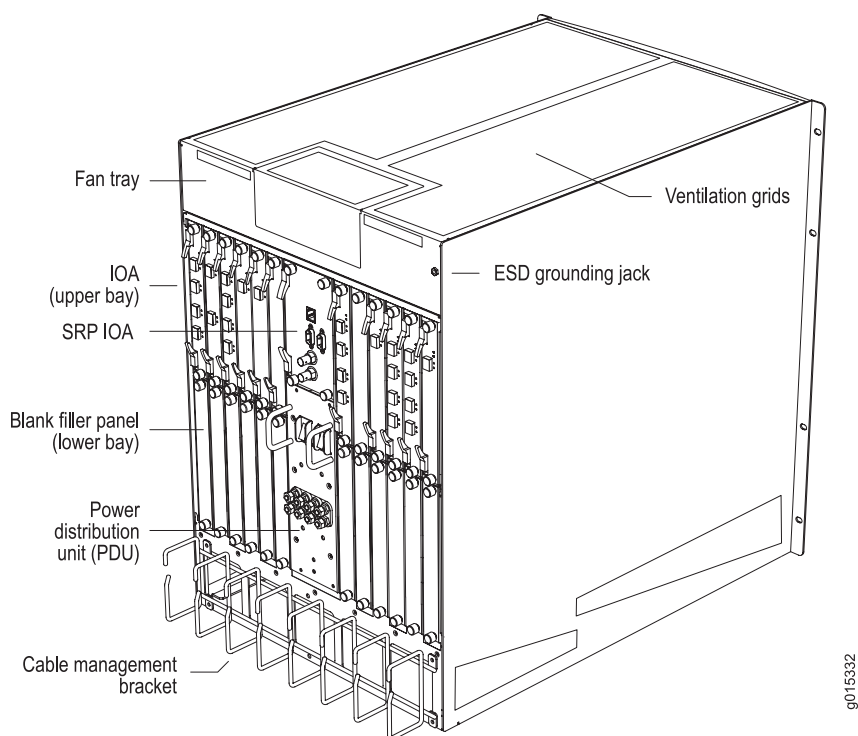
WARNING: Two people are required to lift the router.



CAUTION: To prevent electrostatic damage to the system and its components, make sure persons handling the router wear an antistatic device.

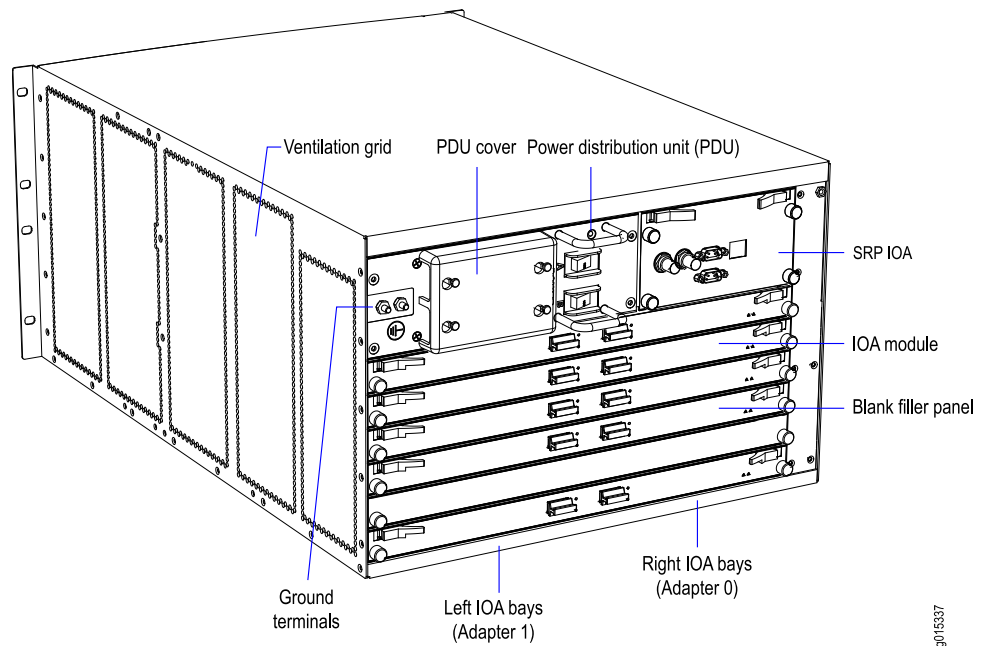
Connectors are located on the IOAs, SRP IOA, and the power distribution unit (PDU). These modules are installed from the rear of the router (Figure 10 on page 24 and Figure 11 on page 25). See “Cabling the Router” on page 47 for cabling installation procedures.

Figure 10: E320 Router, Rear View



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Figure 11: E120 Router, Rear View



Rack-Mounted Installation

We recommend that you use a standard EIA distribution rack. See “Equipment Rack Requirements” on page 99 for rack information.

Installation Guidelines

Before installing the systems in a rack, consider the following guidelines:

- You can install up to three E320 Broadband Services Routers or six E120 Broadband Services Routers in a single 7-ft. (2.1-m) rack. Installing multiple systems in a single rack enables you to maximize your available space.



CAUTION: To maintain airflow requirements, a plenum must be installed above the E320 router before any piece of equipment (other than an E320 router) is installed above the router. This plenum is available from Juniper Networks. Plenums are not required when E320 routers are installed above one another because the router has a built-in plenum at the bottom. See “Installation Guidelines and Requirements” on page 97 and Figure 34 on page 101.

- Install heavier systems, such as an E320 router, on the bottom of the rack. Mount lighter systems higher in the rack.



NOTE: An optional mounting kit is available for mid-chassis mounting. Contact your Juniper Networks sales representative for more information.

Preparing the Equipment Racks

Following your installation plan, use a tape measure and marking pen to measure and mark space on each equipment rack for each router component. For horizontal spacing follow Network Equipment Building System (NEBS) requirements. To maintain airflow requirements, a plenum must be installed above the E320 router before any piece of equipment (other than an E320 router) is installed above the router. If you choose not to install a plenum, be sure to include 2 U of space between the E320 router and the other component for proper exhaust. A plenum, however, is highly recommended.

Installing the Router

To complete the installation of the router in a rack, you need:

- A No. 2 Phillips screwdriver
- Eight 10-32 x 3/8 Phillips screws (provided with the router) for each router to be installed



WARNING: Do not use the cable management bracket as a handle to lift the E320 router.

To install the router in the rack:

1. With one person standing on the left side of the router and another standing on the right side, lift the router into the rack.
2. Position the router in its designated location in the equipment rack. Make sure the holes of the mounting brackets align evenly with the holes of the equipment rack on both sides.
3. Starting at the bottom of the router, have the third person secure the router in the equipment rack by using the 10-32 x 3/8 Phillips screws.
4. Connect the necessary cables. (See “Cabling the Router” on page 47 for instructions on installing the cables.)

The Next Step

After you finish installing the router:

- If you need to install any modules, see “Installing Modules” on page 27.
- If the router was delivered with the modules already installed, see “Cabling the Router” on page 47, for instructions on connecting cables.

CHAPTER 4

Installing Modules

This chapter describes how to install and remove modules. For information about managing installed modules, see *JunosE System Basics Configuration Guide, Chapter 6, Managing Modules*.

This chapter contains the following sections:

- Overview on page 27
- Safety Guidelines on page 37
- Installing an SRP Module or SFM Module on page 38
- Installing an IOA Shelf on page 40
- Installing a Line Module or an IOA on page 41
- Removing Modules and IOAs on page 42
- Installing and Removing SFPs on page 43
- The Next Step on page 46

Overview

Slots for line modules, switch route processor (SRP) modules, and switch fabric module (SFM) modules are located in the front of the router, while slots for input/output adapters (IOAs) and SRP IOAs are located in the rear.

- In the E320 Broadband Services Router, modules mount vertically in a 15-slot chassis, numbered left to right (0–16). See Figure 12 on page 28 and Figure 13 on page 29 for front and rear views of the router.

Figure 12: E320 Router, Front View

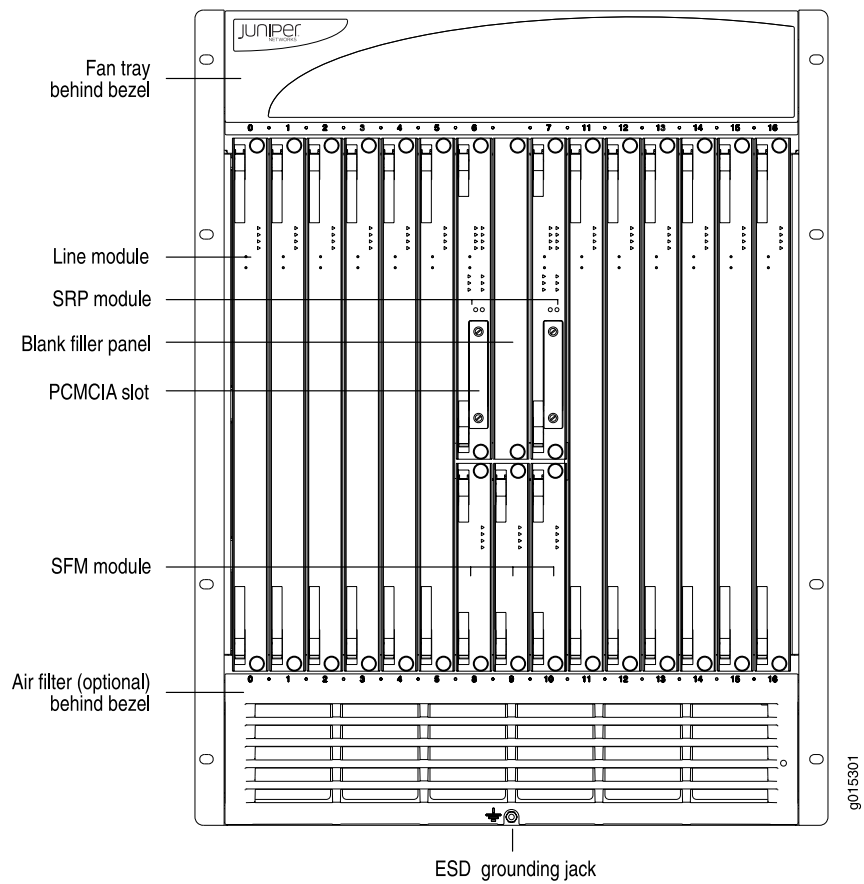
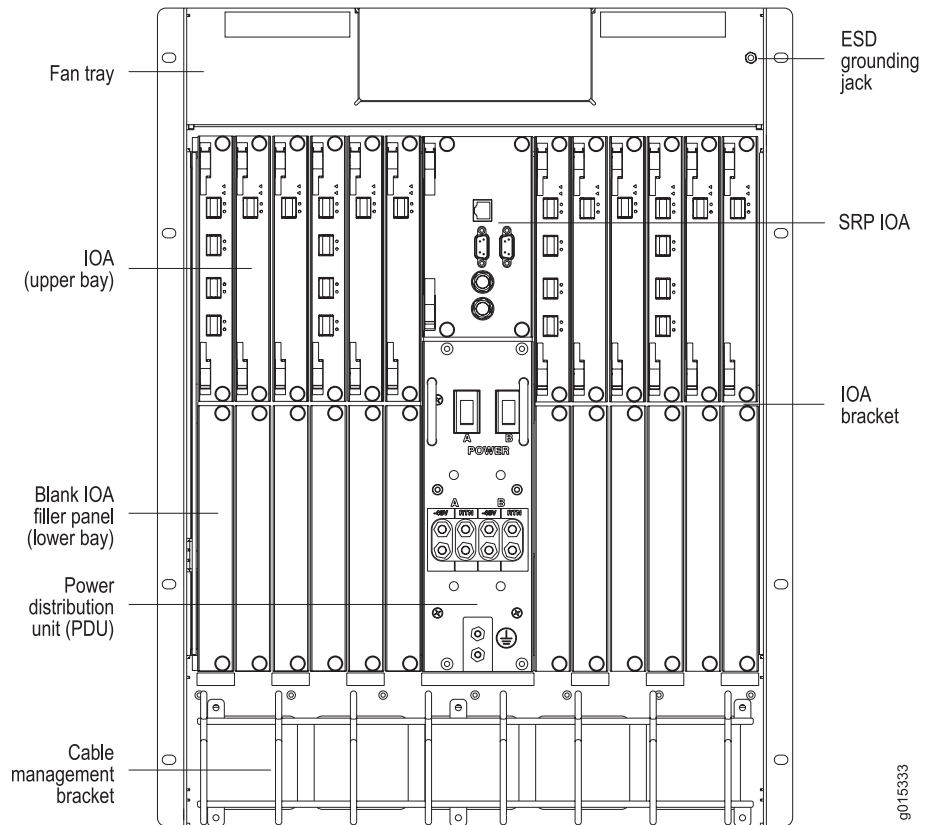


Figure 13: E320 Router, Rear View



- In the E120 Broadband Services Router, modules mount horizontally in a 9-slot chassis, numbered bottom to top (0–10). See Figure 14 on page 29 and Figure 15 on page 30 for front and rear views of the router.

Figure 14: E120 Router, Front View

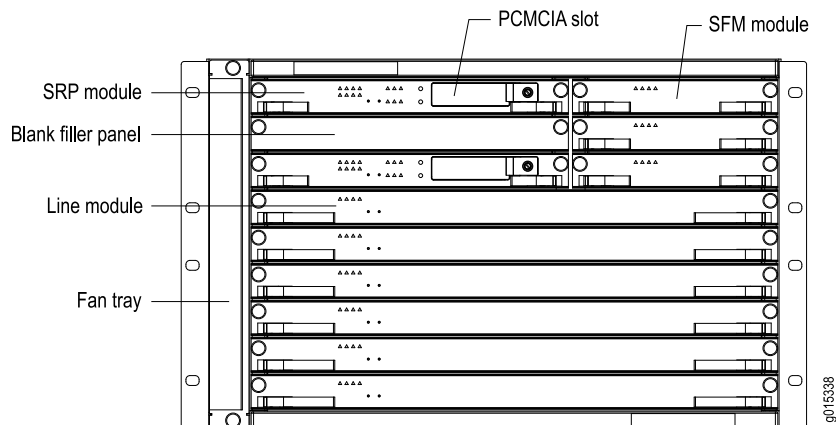
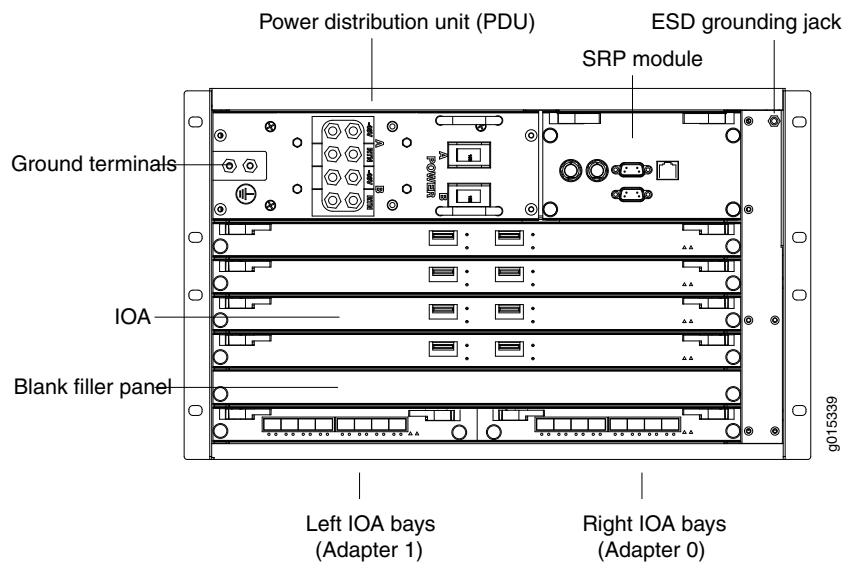


Figure 15: E120 Router, Rear View



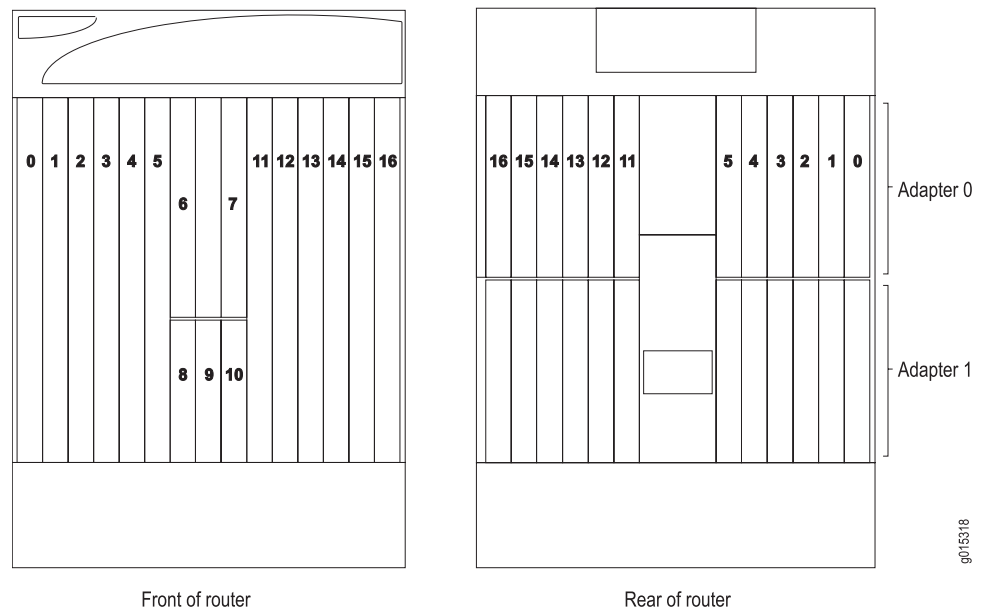
For details about available line modules, IOAs, and compatibility between line modules and SRP modules, see the *E120 and E320 Module Guide*.

Slot Numbering

Slot numbering for the routers is similar.

- In the E320 router, modules mount vertically in a 15-slot chassis, numbered left to right (0–16). See Figure 16 on page 31 and Table 3 on page 31 for slot locations. Because two half-height IOAs can be installed in a slot, the upper bay is designated *Adapter 0* and the lower bay is designated *Adapter 1*. The router does not have slot groups.

Figure 16: E320 Slot Numbering



- In the E120 router, modules mount horizontally in a 9-slot chassis, numbered bottom to top (0–10). See Figure 17 on page 31 and Table 3 on page 31 for slot locations. Because two half-height IOAs can be installed in a slot, the right bay is designated *Adapter 0* and the left bay is designated *Adapter 1*. The router does not have slot groups.

Figure 17: E120 Slot Numbering

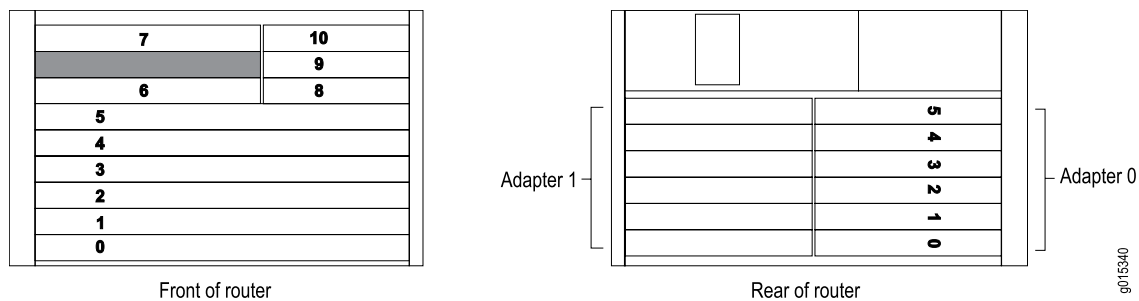


Table 3: Module Slot Locations

Component	Chassis Location	Slot
LM (line module)	Front	<ul style="list-style-type: none"> E320 router—0–5, 11–16 E120 router—0–5
SRP module	Front	6, 7
Blank filler panel	Front	Non-numbered empty slot between 6 and 7
SFM module	Front	8, 9, 10

Table 3: Module Slot Locations (*continued*)

Component	Chassis Location	Slot
IOA	Rear	<ul style="list-style-type: none"> E320 router—0–5, 11–16 <ul style="list-style-type: none"> Upper bay: Adapter 0 Lower bay: Adapter 1 E120 router—0–5 <ul style="list-style-type: none"> Right bay: Adapter 0 Left bay: Adapter 1

IOA Slot Combinations

Depending on the software release and IOA type, you must install IOAs in certain slots and bays combined with other IOAs in the same slot:

- You must insert some IOAs only in the upper bay or right bay (Adapter 0) of each IOA module slot. If you insert one of these IOAs into a lower bay or left bay (Adapter 1) slot, the line module diagnostics fail, an error message states that the bottom slot is not supported for the currently installed software release, and the slot is disabled.
- If you insert an unrecognized IOA, such as an IOA that is not supported by a particular software release, the line module diagnostics fail, an error is generated, and the slot is disabled.
- If you remove an IOA and replace it with a different IOA in the same slot, an error message states the mismatch and the slot is disabled.
- Full-height IOAs take up the entire slot (both Adapter 0 and Adapter 1).

For information about working with modules and IOAs, see *JunosE System Basics Configuration Guide, Chapter 6, Managing Modules*. See Table 4 on page 32 for currently available IOAs and the bays in which you may insert them.

Table 4: IOA Locations and Combinations

IOA	Upper/Right Bay (Adapter 0)	Lower/Left Bay (Adapter 1)	Both Bays Concurrently	Combined with Other IOAs in Same Slot	Hot-Swapping Support
ES2-S1 GE-4	Yes	Yes	No	No	Yes
ES2-S1 GE-8	Yes	Yes	Yes	Yes (GE-8 when paired with ES2 4G LM or ES2 10G LM; GE-8, OC3/STM1, and OC12/STM4 IOAs when paired with ES2 4G LM)	Yes
ES2-S3 GE-20	Yes	Not applicable	Not applicable	Not applicable	No
(Full-height IOA)					

Table 4: IOA Locations and Combinations (*continued*)

IOA	Upper/Right Bay (Adapter 0)	Lower/Left Bay (Adapter 1)	Both Bays Concurrently	Combined with Other IOAs in Same Slot	Hot-Swapping Support
ES2-S1 10GE (Full-height IOA)	Yes	Not applicable	Not applicable	Not applicable	No
ES2-S2 10GE PR (Full-height IOA)	Yes	Not applicable	Not applicable	Not applicable	No
ES2-S1 OC3-8 STM1 ATM	Yes	Yes	Yes	Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)	Yes
ES2-S1 OC12-2 STM4 ATM	Yes	Yes	Yes	Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)	Yes
ES2-S1 OC12-2 STM4 POS	Yes	Yes	Yes	Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)	Yes
ES2-S1 OC48 STM16 POS	Yes	Yes	No	No	Yes
ES2-S1 SERVICE (Full-height IOA)	Yes	Not applicable	Not applicable	Not applicable	No
ES2-S1 REDUND (Full-height IOA; slots 0 and 11 only)	Yes	Not applicable	Not applicable	Not applicable	No

Module Combinations

Line modules can only be paired with specific IOA, SFM, and SRP modules. See Table 5 on page 33 for valid combinations.

Table 5: Module Combinations

Modules	ES2 4G LM	ES210G UPLINK LM	ES2 10G LM	ES2 10G ADV LM
SRP Modules				
SRP-100	✓	✓	✓	—
This module is only supported in the E320 router.				

Table 5: Module Combinations (*continued*)

Modules	ES2 4G LM	ES2 10G UPLINK LM	ES2 10G LM	ES2 10G ADV LM
SRP-120	✓	✓	✓	✓
This module is only supported in the E120 router.				
SRP-320	✓	✓	✓	✓
SFM Modules				
SFM-100	✓	✓	✓	—
This module is only supported in the E320 router.				
SFM-120	✓	✓	✓	✓
This module is only supported in the E120 router.				
SFM-320	✓	✓	✓	✓
IOA Modules				
ES2-S1 GE-4	✓	—	—	—
ES2-S1 GE-8	✓	—	✓	✓
ES2-S3 GE-20	—	—	✓	✓
ES2-S1 10GE	✓	—	—	—
ES2-S2 10GE PR	—	✓	✓	✓
ES2-S1 OC3-8 STM1 ATM	✓	—	—	—
ES2-S1 OC12-2 STM4 ATM	✓	—	—	—
ES2-S1 OC12-2 STM4 POS	✓	—	—	—
ES2-S1 OC48 STM16 POS	✓	—	—	—
ES2-S1 REDUND	✓	✓	✓	✓
ES2-S1 SERVICE	✓	—	—	✓

IOAs Requiring SFPs

Small form-factor pluggable transceivers (SFPs) are used on most IOAs. A range of SFPs that support different optical modes (multimode and single mode) and cabling distances are available. You can replace SFPs without disabling the interface or removing the

module from the system. See “Installing and Removing SFPs” on page 43 for more information and the *E120 and E320 Module Guide* for IOAs that use SFPs.



NOTE: Because SFPs are the same shape and size, you are able to insert an SFP that is not compatible with the IOA. Be sure the SFP you are installing is appropriate for the interface you are plugging it into. If you insert the wrong SFP, software diagnostics detect the error.

Proper Handling of ES2 4G LMs

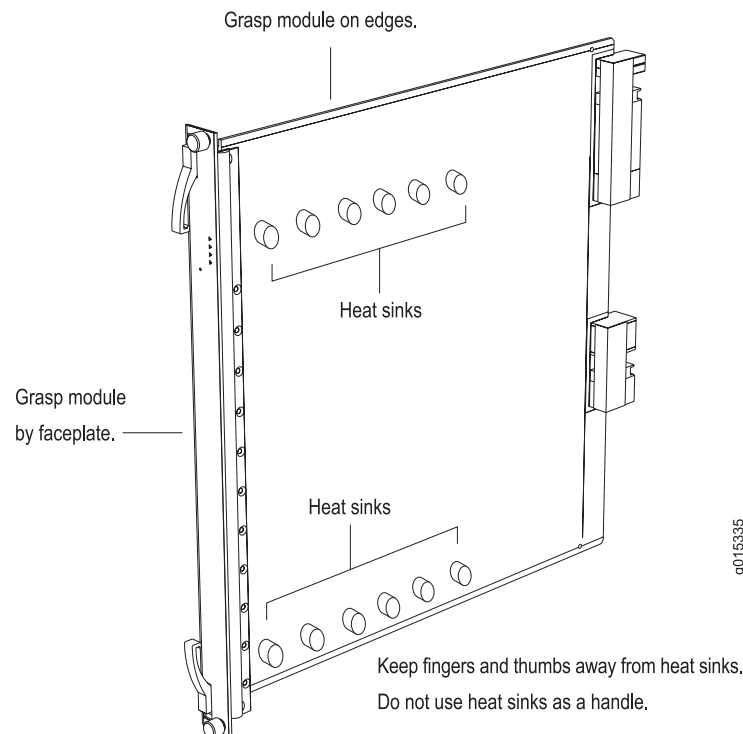
Use extra caution when handling an ES2 4G LM so that you do not damage module components or dislodge the heat sinks.



NOTE: When lifting, carrying, or holding the module, do not grasp it near the six heat sinks along the top and bottom edge of the module. Instead, hold the module along the faceplate and the edges, keeping your fingers and thumbs away from all components.

Do not use either row of heat sinks as a handle when carrying the module. You might dislodge or damage them.

Figure 18: LM4 Heat Sink Locations



ES2 10G Uplink Line Modules

In a 100 Gbps fabric configuration, you must install the ES2 10G Uplink line module in slot 2 or slot 4 only.

- If you install the line module in a slot other than slot 2 or slot 4, it will be disabled.
- If you install the module next to a configured line module that is already installed in slot 3 or slot 5, the ES2 10G Uplink line module will be disabled.

Conversely, if you install a line module in slot 3 or slot 5 next to a previously installed ES2 10G Uplink module, the non-ES2 10G Uplink module will be disabled. For example, if you install an ES2 10G Uplink line module in both slot 2 and slot 4 in an E320 router, you can install the ES2 4G line module in the following locations: 0-1 and 6-11.

Managing Modules Using the Software

For information about software procedures associated with replacing and managing modules and IOAs, see *JunosE System Basics Configuration Guide, Chapter 6, Managing Modules*.

Order of Installation

Before you attempt to install or replace a line module (inserted in the front of the chassis), make sure a compatible IOA (inserted in the rear of the chassis) is already in place. The slot diagnostics run when a line module is installed in a chassis slot. If a compatible IOA module is not present, the diagnostics fail, and you need to remove and reinsert the line module.

Hot-Swapping Modules

The router supports hot-swapping of line modules and IOAs. Hot-swapping enables you to add or remove a line module without powering down the system. IOAs that support hot-swapping enable you to add or remove an IOA without rebooting the line module. See Table 4 on page 32 for a list of hot-swappable IOAs.

Protecting Modules and Slots

The E320 router has two ESD (electrostatic discharge) grounding jacks. The front jack is located below the air filter bezel in the center of the router. The rear jack is located in the upper-right corner of the chassis. The E120 router has one ESD grounding jack located in the upper-right corner of the chassis in the rear. To prevent damage from electrostatic discharge, wear an antistatic wrist strap and connect it to one of the jacks when handling components.

To protect the modules, IOAs, and slots when installing components, observe the following guidelines:



CAUTION: When handling components, use an antistatic wrist strap connected to one of the router's ESD grounding jacks. This action helps to protect the module from damage by electrostatic discharge.



CAUTION: Always handle a module by its edges. Do not touch the components, pins, leads, or solder connections.



CAUTION: If you meet strong resistance when attempting to seat a module using the ejectors, remove it from the chassis and confirm that the slot is designed to hold the module. Also, be sure that you have aligned the top and bottom edges in the correct matching card guides.



CAUTION: Be sure to cover every empty slot with a blank filler panel to protect the system from dust or other foreign substances and to ensure proper system cooling.



CAUTION: Do not discard the antistatic bag. When a module is not in use, store it in an antistatic bag.

Required Tools and Safety Items

You need the following tools to install a line module:

- A No. 2 Phillips screwdriver
- A flathead screwdriver
- An ESD wrist strap or other grounding device

Safety Guidelines

Before and during the installation process, observe the following precautions:



WARNING: Do not work on the system or connect or disconnect cables during lightning activity.



WARNING: Be sure circuit breakers for the power source are in the OFF position before attaching power cables.



WARNING: Remove jewelry (including rings, necklaces, and watches) before working on equipment that is connected to power lines. Metal objects heat up when connected to power and ground and can cause serious burns or become welded to the terminals.



WARNING: Do not insert any metal object, such as a screwdriver, into an open slot or the midplane. Doing so can cause electric shock and serious burns.



WARNING: Never attempt to repair parts of modules yourself. Only trained customer service personnel are authorized to service parts. Call Juniper Networks Customer Service to make arrangements to return defective modules for repair.

Installing an SRP Module or SFM Module

You must install SRP modules in slot 6 or slot 7, and SFM modules in slots 8, 9, or 10. Four of the five fabric slots (SRP and SFM modules) must have a module installed for the router to function. A minimum system configuration requires all three SFMs and at least one SRP module to be installed. See “Fabric Slices” on page 10 for more information.

To install an SRP module or SFM module:

1. Ground yourself by using an antistatic wrist strap or other device and connect it to one of the ESD grounding jacks on the chassis.
2. Choose the slot in which you want to install the module.
 - SRP module – slot 6 or 7
 - SFM module – slot 8, 9, or 10

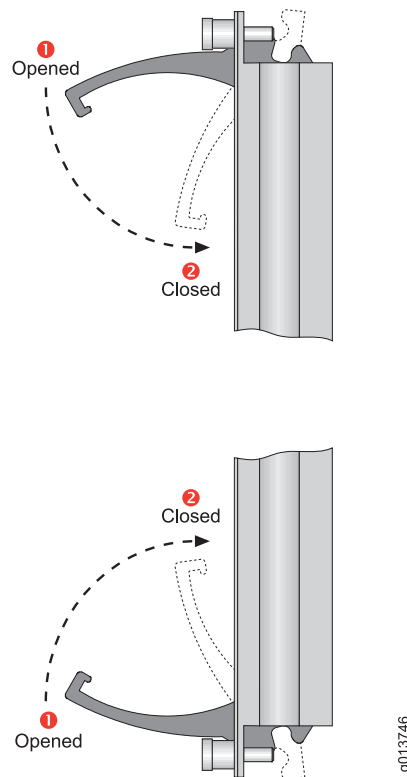
See Figure 12 on page 28 and Figure 14 on page 29 for module locations.



NOTE: Four of the five fabric slots (SRP and SFM modules) must have a module installed for the router to function. A minimum system configuration requires all three SFMs and at least one SRP module to be installed.

3. With a No. 2 Phillips screwdriver, loosen the captive screws that secure the blank filler panel covering the empty chassis slot, if present, and remove the filler panel.
4. Remove the module from its antistatic bag, being careful not to touch module components, pins, leads, or solder connections.
5. Verify that the ejectors are in the open position, as shown in Figure 19 on page 39.

Figure 19: Closing Ejectors from the Open Position



6. Slide the module into the chassis by placing it between the guides of the selected slot and pushing the module until it stops.

The module stops sliding when the ejectors make contact with the front of the chassis.



CAUTION: If you meet strong resistance when attempting to seat the module using the ejectors, remove it from the chassis and confirm that the slot is designed to hold the module. Also, be sure that you have aligned the top and bottom edges in the correct matching tracks.

7. Insert the module into the backplane by simultaneously depressing both ejectors (as shown in Figure 19 on page 39), exerting forward pressure on the module.
8. Tighten the module's captive screws using the No. 2 Phillips screwdriver.



NOTE: Tighten the captive screws completely before installing an adjacent module so that proper EMI gasket compression occurs. Failure to do this can make it difficult to install adjacent modules.

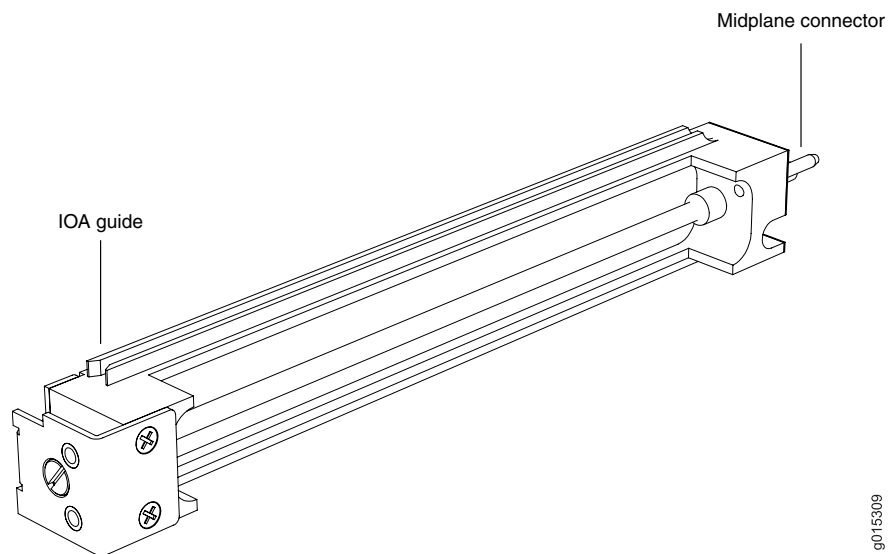


CAUTION: Do not overtighten the screws.

Installing an IOA Shelf

Use an IOA shelf (also called an IOA bracket) when installing half-height IOAs in the router. IOA shelves screw into the midplane between the upper/right bay (Adapter 0) and lower/left bay (Adapter 1). For example, in an E320 router, IOAs in the upper bay rest on the shelf, while IOAs in the lower bay use the guides on the bottom of the shelf to remain vertical. See Figure 20 on page 40.

Figure 20: IOA Shelf



CAUTION: We recommend that you power down the router before removing or installing an IOA shelf between two slots that have modules installed in them already. Otherwise, you might short-circuit the installed modules if you accidentally touch the shelf to a module. An IOA shelf installation guide is available to ensure safe installation. Contact your account representative for more information.

To install an IOA shelf:

1. Ground yourself by using an antistatic wrist strap or other device and connect it to one of the ESD grounding jacks.
2. Remove the blank IOA filler panel from the slot.
3. Align the shelf's guide pins with the corresponding holes in the midplane and insert the threaded shaft into the hole in the midplane between the upper/right bay and lower/left bay. Be sure the threaded shaft is visible from the right side. (See Figure 20 on page 40.)
4. Using a flathead screwdriver, tighten the screw snugly to secure the shelf.

Installing a Line Module or an IOA

This section describes the procedures for installing line modules and IOAs.



NOTE: Install the IOA module before you install the corresponding line module; otherwise, the diagnostics fail and the line module's status is listed as inactive when you issue the `show version` command. If this occurs, remove and reinsert the line module.

The router supports hot-swapping of line modules and IOAs. Hot-swapping enables you to add or remove a line module without powering down the system. IOAs that support hot-swapping enable you to add or remove an IOA without rebooting the line module. See Table 4 on page 32 for a list of hot-swappable IOAs.

To install a line module or IOA:

1. Ground yourself by using an antistatic wrist strap or other device and connect it to one of the ESD grounding jacks.
2. Choose the slot where you want to insert the line module or IOA.



NOTE: Line modules are in the front of the system and IOAs are in the back of the system. See Table 4 on page 32 for IOA slot locations and combinations.

3. With a No. 2 Phillips screwdriver, loosen the screws that secure the blank filler panel covering the empty chassis slot, if present, and remove the filler panel.
4. Remove the line module or IOA from its antistatic bag, being careful not to touch module components, pins, leads, or solder connections.
5. Verify that the ejectors are in the open position, as shown in Figure 19 on page 39.
6. Guide the line module or IOA into the chassis by placing it between the guides of the selected slot and pushing the module until it stops.

The module or IOA stops sliding when the ejectors make contact with the chassis.



CAUTION: If you meet strong resistance when attempting to seat the line module or IOA using the ejectors, remove it from the chassis and confirm that the slot is designed to hold the component. Also, be sure that you have aligned the top and bottom edges in the correct matching tracks.

7. Insert the line module or IOA into the midplane by simultaneously depressing both ejectors (as shown in Figure 19 on page 39) and exerting forward pressure on the module.
8. Tighten the module's captive screws using a No. 2 Phillips screwdriver.



NOTE: Tighten the captive screws completely before installing an adjacent module so that proper EMI gasket compression occurs. Failure to do this can make it difficult to install adjacent modules.



CAUTION: Do not overtighten the screws.

Removing Modules and IOAs

This section describes the procedures for removing modules and IOAs. For a list of hot-swappable IOAs, see Table 4 on page 32.



NOTE: We recommend that you issue the **slot disable** command from the CLI before removing a line module or IOA.

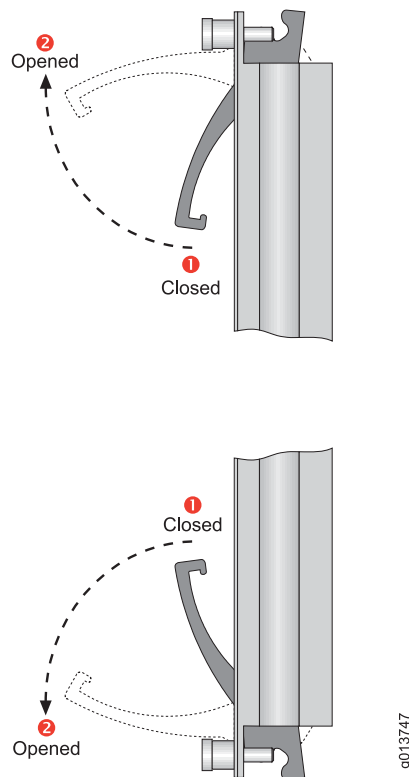


CAUTION: If you do not use the **halt** command before removing or powering down an SRP module, the system's NVS card can become corrupted.

To remove a module or an IOA:

1. For SRP modules and SRP IOAs, issue the appropriate halt command (**halt**, **halt primary-srp**, or **halt standby-srp**).
*See JunosE System Basics Configuration Guide, Chapter 6, Managing Modules for information about the **halt** commands.*
2. Ground yourself by using an antistatic wrist strap or other device and connect it to an ESD grounding jack.
3. Use a No. 2 Phillips screwdriver to loosen the captive screws located at the top and bottom of the module panel.
4. If the module has ejector handles, pull them to the open position, as shown in Figure 21 on page 43.

Figure 21: Opening Ejectors from the Closed Position



5. Carefully slide the module out of the chassis.
6. Place the module in its antistatic bag, being careful not to touch module components, pins, leads or solder connections.
7. Cover the empty chassis slot with a blank filler panel, and tighten the filler panel's captive screws using a No. 2 Phillips screwdriver. Turn both screws several times before tightening them completely.



CAUTION: Do not overtighten the screws.

If you remove an IOA and not the corresponding line module, the line module reboots. Its status becomes inactive when you issue the **show version** command.

If you remove a line module and do not delete the corresponding configuration, the status of the line module is listed as not present when you issue the **show version** command.

Installing and Removing SFPs

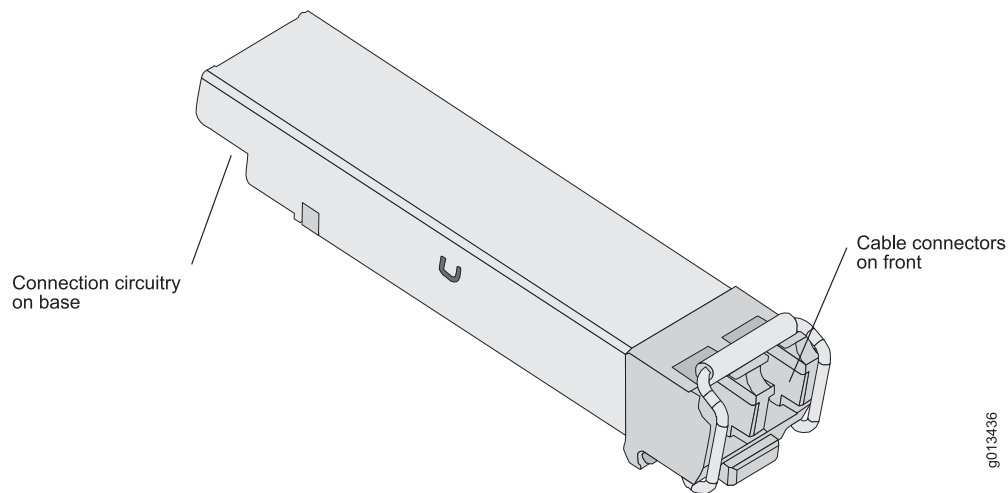
This section describes how to replace small form-factor pluggable transceivers (SFPs) on IOAs that support these devices. A range of SFPs that support different optical modes (multimode, single mode, and so forth) and cabling distances is available. You can replace the SFPs without disabling the interfaces or removing the module from the system.

Installing SFPs

To install SFPs:

1. Ground yourself by using an antistatic wrist strap or other device and connect it to an ESD grounding jack.
2. Identify the following items on the SFP (Figure 22 on page 44):
 - The connection circuitry on the base
 - The cable connectors on the front (which are protected by a dust cover)

Figure 22: Representative SFP

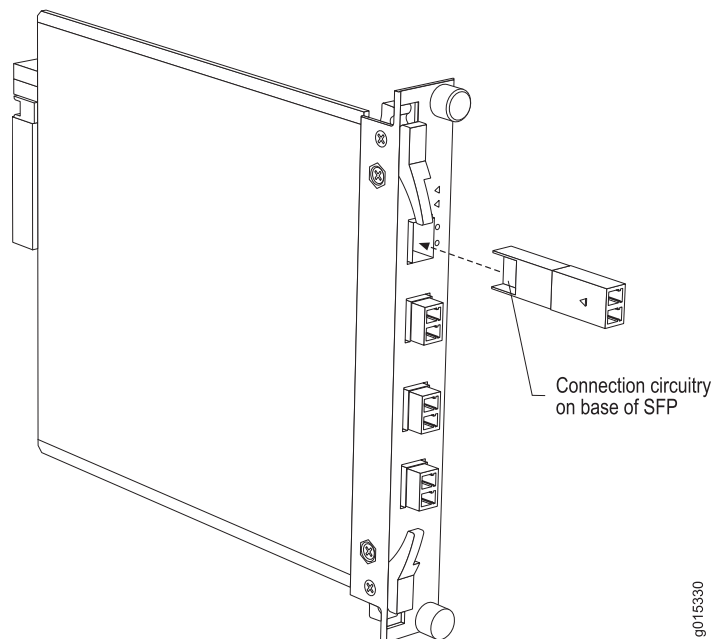


CAUTION: Be sure to position the SFP correctly before you install it.

3. Hold the SFP so that:
 - The connection circuitry is adjacent to the LK and ACT markings on the IOA's faceplate.
 - The cable connectors will be visible when you install the SFP.

For the correct orientation, see Figure 23 on page 45.

Figure 23: Installing an SFP on an IOA



4. Slide the SFP as far as you can into the IOA until the SFP clicks into place.
If the SFP does not slide smoothly into the IOA, make sure that the orientation of the SFP is correct.
5. Gently pull the SFP to confirm that it is inserted correctly.
If the SFP comes out of the slot when you pull it, repeat Step 4.
6. Remove the dust cover that protects the cable connectors.
7. Connect the new cables to the SFP.

Removing SFPs

To remove an SFP:

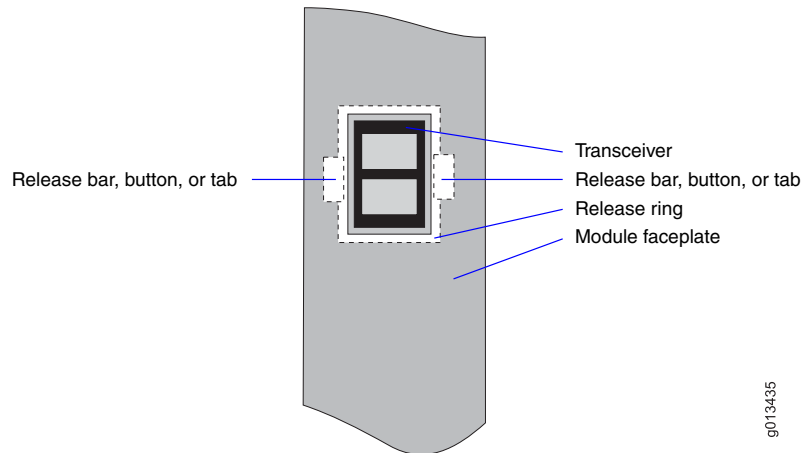
1. Obtain an antistatic container for the SFP you plan to remove. (See “Storing Modules and Components” on page 69.)
2. Ground yourself by using an antistatic wrist strap or other device and connect it to an ESD grounding jack.
3. Disconnect the cable from the SFP on the IOA.
4. Identify the release mechanism for the SFP.

Different SFPs use different release mechanisms. See Figure 24 on page 46 for possible release mechanisms, which include:

- A button that you press inward
- A ring that you press inward

- A bar that you pull sideways, then outward
- A tab that you pull sideways, then outward

Figure 24: Possible Release Mechanisms on the SFP



5. Release the SFP and pull it out of the slot.
6. Place the SFP in an antistatic bag.

When you have replaced the SFPs and connected the cables, issue the appropriate **show interface** command for each interface to verify that the interface is operational (up).

The Next Step

After you install the modules, you can connect cables to the system. See “Cabling the Router” on page 47.

CHAPTER 5

Cabling the Router

This chapter describes how to cable the router. Before you cable the router, ensure that you have completed all installation instructions identified in previous chapters.

This chapter contains the following sections:

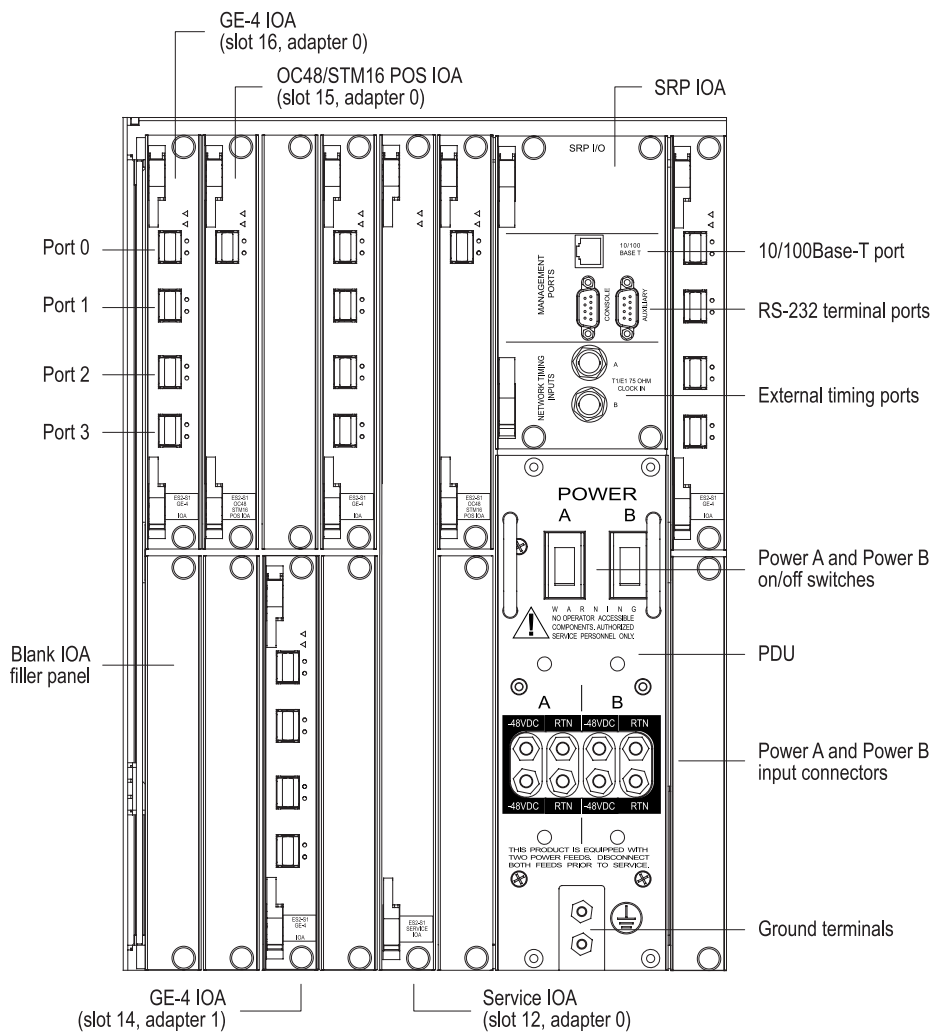
- Cabling Overview on page 47
- Required Tools, Wires, and Cables on page 48
- Cabling the SRP IOA on page 49
- Cabling IOAs on page 51
- Cabling the Router for Power on page 52
- The Next Step on page 55

Cabling Overview

Cabling the router requires the following main tasks:

1. Familiarize yourself with the module ports, and ensure that you have the cables and wires needed to complete each cabling procedure. (See Figure 25 on page 48.)
2. Read and understand all safety warnings. (See “Installation Guidelines and Requirements” on page 97.)
3. *(Optional)* Connect timing ports.
4. Connect the SRP IOA to the network and to a management console.
5. Connect grounding wires to the router chassis.
6. Connect the power cables from the power source to the power distribution unit (PDU).
7. Connect the IOAs to their appropriate network interface.

Figure 25: E320 Router Rear Ports and Connectors



9015331

Required Tools, Wires, and Cables

Cabling your system takes only a few minutes. You need the following items and those listed in Table 6 on page 49 for proper installation:

- 1/8-inch flathead screwdriver
- 3/8-inch wrench or 3/8-inch nut-driver
- No. 2 Phillips screwdriver
- Ground wires—We recommend a minimum of 6-AWG ground wire.
- Two #10 keps (supplied) to connect the ground (earth) wire to the ground terminal.
- PDU wiring—We recommend a minimum of 4-AWG wire for the router with a dual stud terminal lug with 5/8-inch spacing.

Consider the distance from the connection point and the configuration of the system when determining the size of wire used.

See “System Specifications” on page 91 for more information on router specifications.

Table 6: Required Cables

Connection	Port and Cable Used
Management connection between SRP IOA and the LAN	One 10/100Base-T Ethernet management port with an RJ-45 connector
Management connection between SRP IOA and a management console	One RS-232 port with a DB-9 connector for VT100 management access
Direct connections to IOAs	See the <i>E120 and E320 Module Guide</i> for specific IOA connector information

Cabling the SRP IOA

Before powering up the router, you must set up a management console. The console enables you to communicate with your system during the power-up process and to manage your system using the command-line interface (CLI).

When connecting a console directly to the SRP IOA, use a cable appropriate for your terminal connector. The cable must have a female DB-9 connector to attach to the RS-232 port on the SRP IOA. See Figure 26 on page 50.

The console port is considered a data terminal equipment interface (DTE). Direct connection to a terminal or PC (which also have DTE interfaces) requires a crossover cable.

The router has network timing ports and management ports located on the SRP IOA. See Figure 26 on page 50 and Table 7 on page 49 for details on each component.

Table 7: SRP IOA Ports

Port	Description
Network timing ports	<ul style="list-style-type: none"> Two dual-purpose BNC connectors for BITS timing clock sources (E1 or T1) User-configurable through the CLI Primary (A) and secondary (B) 75-ohm E1 2.048-Mbps/T1 1.544-Mbps inputs terminating with a 120/75 ohm or 100/75 ohm balun
Management ports	<ul style="list-style-type: none"> One 10/100Base-T Ethernet management port with an RJ-45 connector Two RS-232 ports with a DB-9 connector for direct CLI (Console) and debug (Auxiliary) access. <p>The Auxiliary port is used to debug ports on a specific processor (SRP module, LM).</p>

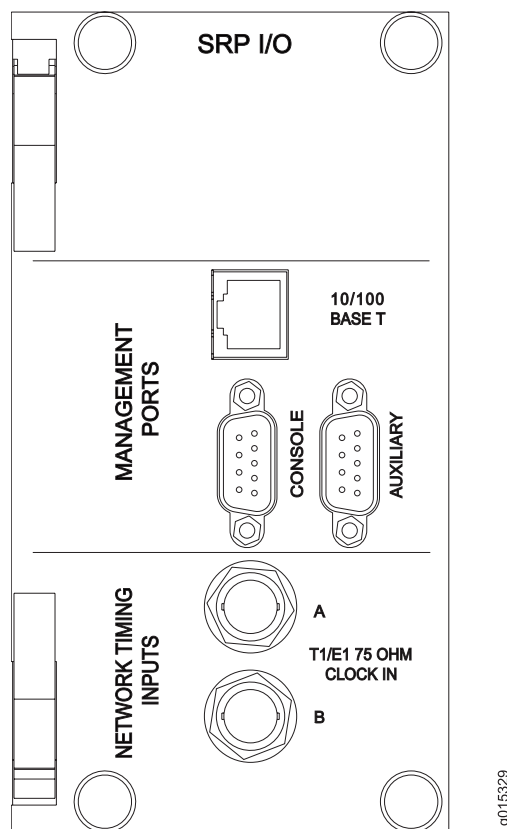
Network Timing Ports

The SRP IOA has two input ports for external network clock sources (75-ohm E1 2.048-Mbps/T1 1.544-Mbps inputs with BNC connectors). These ports provide a way to ensure that the router system clock remains synchronized with the network's system clock. The primary clock is labeled A; the secondary, redundant clock, is labeled B. See Figure 26 on page 50.



NOTE: We recommend you use shielded cables to connect the external clock sources to the clock source input ports. Shielded cables are not required for the operation of the system and do not need to be grounded at both ends.

Figure 26: SRP IOA



To connect the clock source input ports:

1. Attach the BNC connector to Clock A's network timing port.
2. Attach the opposite end of the network timing cable to your network's clock source A.
3. Repeat steps 1 and 2 for the Clock B connections.

Management Ports

The Management section of the SRP IOA has three ports (Figure 26 on page 50) for management access:

- One 10/100Base-T Ethernet port—Accepts an RJ-45 (male) connector, providing an out-of-band connection for LAN access through a Telnet session or SNMP.
- Two RS-232 management ports—Accept a DB-9 (female) connector. One port provides direct CLI access from a console terminal; the other Auxiliary port provides debug access from a console terminal.

The management port is considered a data terminal equipment interface (DTE). Direct connection to a terminal or PC (which also have DTE interfaces) requires a crossover cable.

See “Accessing E Series Routers” on page 61 for more information about management access.

Connecting to the Network

To connect the router to the network:

1. Insert an Ethernet cable (RJ-45) connector into the 10/100Base-T (RJ-45) port on the SRP IOA until it clicks into place.
2. Connect the other end of the cable to the appropriate Ethernet network for an out-of-band connection.

Connecting to a Console Terminal

When you connect a console directly to the SRP IOA, use a cable appropriate for your terminal connector. The cable must have a female DB-9 connector to attach to the RS-232 port on the SRP IOA.

To connect the console to the SRP IOA:

1. Insert the female DB-9 connector into the RS-232 port, and tighten the screws.



CAUTION: Do not overtighten the screws.

2. Connect the other end of the cable to your terminal's serial port (VT100/ANSI).

Cabling IOAs

This section describes the common connector types used with IOAs.

LC Duplex Connectors

In accordance with EN60825-1, Safety of Laser Products - Part 1: Equipment Class, Requirements, and User's Guide (2001), multimode IOAs with LC connectors are defined as follows:

CLASS 1 LED PRODUCT.

In accordance with EN60825-1, Safety of Laser Products - Part 1: Equipment Class, Requirements, and User's Guide (2001), single-mode IOAs with LC connectors are defined as follows:

CLASS 1 LASER PRODUCT.

WARNING: Do not look directly into LC-style fiber connectors. The fiber-optic laser used in single-mode fiber (SMF) meets the regulatory requirements for casual exposure to the eye; however, looking directly into a laser can cause eye damage.



WARNING: EN60825-1, Class 1 laser fiber connectors are for connection only to Class 1 laser devices.

SFPs

See "IOAs Requiring SFPs" on page 34 and the *E120 and E320 Module Guide* for information on small form-factor pluggable transceivers (SFPs) used on IOAs.

Cabling the Router for Power

After you have correctly cabled the SRP IOA, you must attach grounding and electrical wires before you attempt system power-up. See Figure 27 on page 53.

Three main tasks are involved:

1. Switch all router power switches to OFF.



CAUTION: Switches may have inadvertently flipped to ON during shipping and installation.

2. Connect the grounding wires to the chassis.



WARNING: Always connect the grounding wires first (before connecting the power cables) and disconnect them last when installing or servicing the router.

3. Connect the power cables to the PDUs.

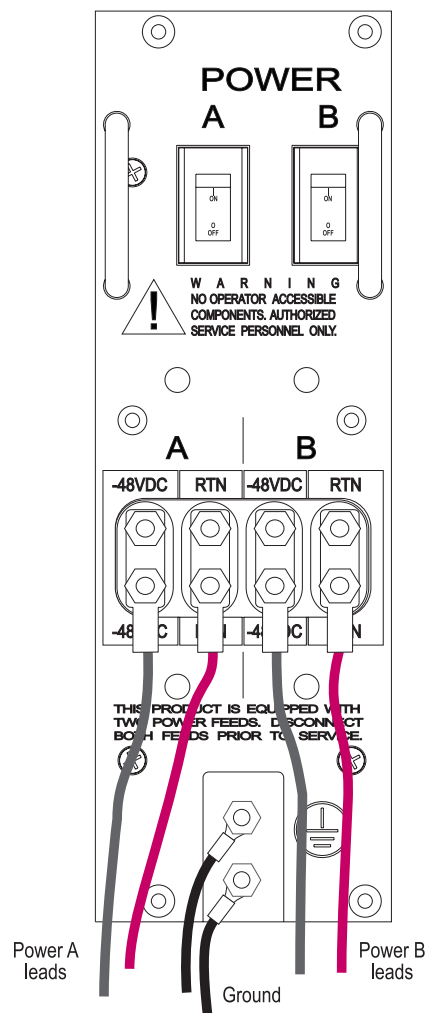
See "System Specifications" on page 91 for the power requirements for the router. Table 8 on page 53 identifies the cabling requirements.

Table 8: E320 Router PDU Cables and Wires Needed

Cable/Wire	From	To
One 6-AWG ground wire	PDU ground terminal	Termination ground
Two 4-AWG wire leads	PDU Power A –48 VDC and RTN leads	Appropriate leads on power source No.1
Two 4-AWG wire leads	PDU Power B –48 VDC and RTN leads	Appropriate leads on power source No.2

Figure 27 on page 53 shows the main components of a PDU.

Figure 27: PDU



Task 1: Turn Off All Router Power

Before starting to cable the router, push all router power switches to OFF to turn off the router.

Task 2: Connect the Grounding Cables

The router has two grounding studs located in the rear of the chassis, near the power inputs. Each stud provides grounding for a single power unit.

To ground each power unit:

1. Locate the grounding studs on the router (Figure 27 on page 53).
2. Remove the nuts and locking washers from the grounding studs.



NOTE: We recommend a minimum of 6-AWG ground wire with a ring-style terminal.

3. Place the grounding cable lead on one of the grounding studs and tighten the nuts to secure the connection.
4. Connect the other end of the ground cable to the appropriate ground termination lead.
5. Repeat Steps 3–4 for the remaining grounding stud.



NOTE: When grounding the router, leave a service loop in the grounding cable to ensure that the grounding cable is the last cable to disconnect from the shelf if strain is placed on the electrical cables.

Task 3: Connect the Power Cables

To connect power cables to the router, follow these steps. See Figure 27 on page 53 as needed.



NOTE: Juniper Networks has qualified an AC power supply unit for use with the router. Contact your account representative for more information.



WARNING: Before you begin this procedure, be sure the power source is turned off, the router is turned off, and proper grounding wires are attached.

1. Be sure you have completed “Task 1: Turn Off All Router Power” on page 53 and “Task 2: Connect the Grounding Cables” on page 54.
2. If applicable, loosen the screws from the clear power input module cover and remove it.



WARNING: The wiring color code of the power cables depends on the color coding of the DC power source installed at your site. Color code

standards for DC wiring do not exist. To ensure that the correct polarity is connected to the router power units, confirm the connection of the power cables to the + (positive) and – (negative) leads at the power source.



NOTE: Loosen the top and bottom thumbscrews (using a No. 2 Phillips screwdriver, if necessary)

3. Remove the nuts and locking washers from the posts for the power input (A or B) using a small insulated adjustable wrench.
4. Place one negative (neutral) cable lead on the post labeled –48 VDC.
5. Replace the locking washers and nuts, and tighten the nuts to secure the connection.
6. Place the other cable lead on the post labeled RTN.
7. Replace the locking washer and nut, and firmly tighten the nut to secure the connection.
8. Attach the opposite end of Power A's wire leads to the appropriate leads on your power source.



NOTE: To provide redundancy, do not use the same power source for Power A and Power B leads.

9. Place the clear plastic guard over the terminal posts, and secure it in place by tightening the four screws.
10. Repeat Steps 1–9 for each power input module in your configuration.

The Next Step

See “Powering Up the Router” on page 57.

CHAPTER 6

Powering Up the Router

This chapter describes how to power up the router and determine whether it has booted properly. It contains the following sections:

- Before You Power Up the System on page 57
- Powering Up on page 57
- Status LEDs on page 58
- Powering Down on page 59
- The Next Step on page 59

Before You Power Up the System

Before powering up the system, make sure you complete the following tasks. See the appropriate chapters in this guide for information about these tasks.



WARNING: Be sure the power source is turned off and the system is turned off before you perform the installation tasks.

- Installing an SRP Module or SFM Module on page 38
- Installing a Line Module or an IOA on page 41
- Cabling the SRP IOA on page 49
- Cabling IOAs on page 51
- Cabling the Router for Power on page 52

Powering Up



NOTE: In this procedure we assume that the system is already connected to a power source. See “Cabling the Router” on page 47.



NOTE: Juniper Networks has qualified an AC power supply unit for use with the router. Contact your account representative for more information.

For specifications on the electrical requirements for the system, see “System Specifications” on page 91. For details on the power consumed by the different modules, see the *E120 and E320 Module Guide*.



CAUTION: Evaluate the overall loading of the branch circuit before you install any equipment into a rack.

To power up the system:

1. Verify that the power source is operational and turned on.
2. Inspect all grounding and power connections to the router chassis.
3. Confirm that all connections are secure.
4. Switch the power switches to ON.
5. Monitor the LEDs on the SRP modules and SFM modules to verify that the system is booting properly. See Table 11 on page 84 for LED status explanations.

When the prompt appears on the system console, the system is in User Exec mode and is ready to be configured:

```
host1>
```

6. Enter the **enable** command to access Privileged Exec mode:

```
host1>enable
```

```
host1#
```

In Privileged Exec mode you can begin to configure the system. See *JunosE System Basics Configuration Guide, Chapter 2, Command-Line Interface* for more information.

Initialization Sequence

Each line module is initialized independently. As a result, the CLI on the SRP module can become available before the line modules have completed initialization. Commands relating to a line module might fail if the module has not completed initialization. You can use the **show version** command to display line module status, but do not enter commands for a line module until its state is online.

Status LEDs

Upon initial power-up, the components of the router run boot code, go through a series of self diagnostic tests, and synchronize with each other.

When the tests are complete, use the LEDs on each module to determine the status of the router. Observe the module LEDs on the front and rear components.

See “Troubleshooting” on page 79 for information on the system's LEDs.



NOTE: In the fan tray for the E320 Broadband Services Router, four of the eight fans turn on immediately upon initial power-up and the other four fans turn on after a delay of 10 seconds.

Powering Down

If you need to power down or remove the SRP module, first enter the **halt** command to temporarily suspend the system's operation. See *JunosE System Basics Configuration Guide, Chapter 5, Managing the System* for more information.



CAUTION: If you do not use the **halt** command before removing or powering down an SRP module, the system's NVS card might become corrupted.

If you shut down the system improperly, it runs an investigation of the file allocation table (FAT) the next time it reboots.

The Next Step

If you have problems powering up the system, see “Troubleshooting” on page 79 for help.

If the system boots properly, see “Accessing E Series Routers” on page 61.

CHAPTER 7

Accessing E Series Routers

This chapter discusses how to access the system to manage it. Managing your router includes both configuring and monitoring it. For basic information on the management of the system, see *JunosE System Basics Configuration Guide, Chapter 5, Managing the System*.

This chapter contains the following sections:

- Setting Up Management Access on page 61
- Console Port Setup on page 62
- Telnet Setup on page 64
- SNMP on page 65
- The Next Step on page 65

Setting Up Management Access

Before you power up the system, you must set up a management console. (See “Connecting to a Console Terminal” on page 51.) You use the console to communicate with the system during the power-up process, set an IP address, and manage the system using the command-line interface (CLI).

You can monitor and manage the router through either of these methods:

- Console terminal—Connect a console (PC, Macintosh, or UNIX workstation) directly to the system's RS-232 serial port.
- Remote console—Connect 10/100Base-T port on the SRP IOA to an Ethernet network, and run Telnet from a remote console.

For initial access to the system, you need to physically connect your console directly to the system's RS-232 port. Through this connection you use the CLI to set an IP address on the system. After you configure the IP address, you can access the system remotely (for example, via Telnet).

Console Port Setup

You can connect a console terminal (PC, Macintosh, or UNIX workstation) directly to the SRP IOA via the RS-232 terminal port. When you connect a console directly to the system, you can configure the system without an IP address.

To communicate with the system, you must have a terminal emulation program running on your PC or Macintosh. You can use any terminal emulation program, such as HyperTerminal. A UNIX workstation can use the emulator TIP.

Using HyperTerminal

If your console uses a version of Microsoft Windows (such as Windows XP or Windows NT 4.0) that supports the HyperTerminal application, you can access the system via HyperTerminal.

1. Click the Start button and select Programs, Accessories, Communications, and HyperTerminal.
2. In the HyperTerminal window, select HyperTerminal.
3. In the Connection Description dialog box, enter a name for your router (for example, e320) in the Name field.
4. Select any icon to represent your terminal emulation, and click OK.
5. In the Connect To dialog box, in the Connect using field, select the appropriate COM port to use (for example, COM1), and click OK.
6. In the COM1 Properties dialog box, select the following settings:
 - Bits per second: 9600
 - Data bits: 8
 - Parity: None
 - Stop bits: 1
 - Flow control: Xon/Xoff
7. Click OK.

Connecting Directly to the Router

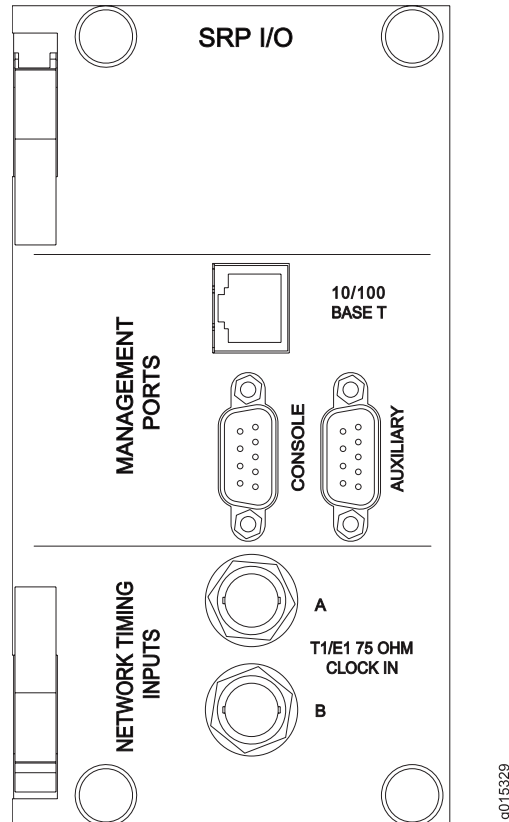
When you connect a console directly to the system, use a cable appropriate for your terminal connector. The cable must have a female DB-9 connector to attach to the RS-232 port on the system.

The console port is considered a data terminal equipment interface (DTE). Direct connection to a terminal or PC (which also have DTE interfaces) requires a crossover cable.

To connect a console directly to the system:

1. Connect the female DB-9 connector to the RS-232 port on the router's SRP IOA. See Figure 28 on page 63.

Figure 28: Router Management Ports



2. Connect the crossover adapter connector to your PC's serial port.
3. Power up the system.

When you power up the system, the CLI appears on your console's screen. The system is now in User Exec mode, and you can begin configuration. For more information on using the CLI and configuring the system, see the *JunosE System Basics Configuration Guide*.



NOTE: Direct access through the RS-232 serial port enables you to monitor the system while it boots.

Assigning an IP Address

When your console is ready to communicate with the system, power up the system. (See "Powering Up the Router" on page 57.) Then set an IP address for the system. The system powers up in User Exec mode. To assign an IP address:

1. Enter the **enable** command at the User Exec prompt.

```
host1>enable
host1#
```

The system is now in Privileged Exec mode.

2. Set an IP address on the Ethernet interface:

- Specify the identifier of the FastEthernet interface in the format: *slot/adaptor/port*.
- Use an IP address valid for the system.

```
host1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#interface FastEthernet 6/0/0
host1(config-if)#ip address 10.10.7.3 255.255.255.0
```

3. Continue to configure the system's parameters as needed.

After you have assigned an IP address to the system, you can communicate remotely by running Telnet over an Ethernet network. See "Telnet Setup" on page 64.

Telnet Setup

When you have configured an IP address for the system, you can run Telnet from a host to access the system through its Ethernet port. To connect the Ethernet port to the network:

1. Connect an Ethernet cable (RJ-45) to the system's 10/100Base-T (RJ-45) port on the SRP IOA. See Figure 28 on page 63.
2. Connect the other end of the cable to the appropriate Ethernet network for an out-of-band connection.

Before you can access the system with Telnet, you must either configure a password for Telnet access or disable the password requirement from the management console. In the following example, you disable the password.

1. Enter the **enable** command.

```
host1>enable
host1#
```

The system is now in Privileged Exec mode.

2. Enter the **configure** command.

```
host1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#
```

The system is now in Global Configuration mode.

3. Enter the **line** command.

```
host1(config)#line vty 0 4
host1(config-line)#
```

The system is now in Line Configuration mode.

4. Disable the password.


```
host1(config-line)#no login
```



NOTE: In this example, you disabled the password requirement, but you can choose to set a password instead. See *JunosE System Basics Configuration Guide, Chapter 8, Passwords and Security* for information on setting a password.

5. Run Telnet from a host on the same Ethernet network as the system.

6. Enter the IP address of the system to open the Telnet session.

The User Exec prompt appears when the Telnet session to the system is established.

```
host1>
```

7. Enter the **enable** command.

```
host1>enable
host1#
```

The system is now in Privileged Exec mode.

8. Enter the **configure** command.

```
host1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
host1(config)#
```

The system is now in Global Configuration mode, from which you can configure the system. See *JunosE System Basics Configuration Guide, Chapter 2, Command-Line Interface*.



CAUTION: Do not change the IP address for the Ethernet interface that you are using to communicate with the system. If you change the address, you will lose the Telnet session.

SNMP

The system supports Simple Network Management Protocol (SNMP), a standard management protocol for IP networks. You can configure the system as an SNMP agent.

As an SNMP agent, the system provides access to management information that it maintains. See *JunosE System Basics Configuration Guide, Chapter 4, Configuring SNMP* for information on SNMP. See *JunosE Command Reference Guide A to M* and *JunosE Command Reference Guide N to Z* for the commands that are available for configuring the system as an SNMP agent.

The Next Step

See “Maintaining the Router” on page 69.

PART 3

Hardware Maintenance, Replacement, and Troubleshooting Procedures

- Maintaining the Router on page 69
- Troubleshooting on page 79

CHAPTER 8

Maintaining the Router

This chapter lists the tools, items, and steps needed for installing and uninstalling router components. Other maintenance procedures must be performed by an authorized Juniper Networks technician.

This chapter contains the following sections:

- Required Tools and Items on page 69
- Storing Modules and Components on page 69
- Cleaning the System on page 70
- Upgrading NVS Cards on SRP Modules on page 70
- Replacing an NVS Card on page 72
- Replacing Fan Trays on page 73
- Installing an Air Filter on page 75
- Replacing a Power Distribution Unit on page 76

Required Tools and Items

You need the following tools and other items to replace router components:

- Flathead and No. 2 Phillips screwdrivers
- Insulated adjustable wrench
- Antistatic wrist strap
- Antistatic bags (or other protective packaging to hold components)
- Plastic boots or other protective covers for fiber-optic SC and LC connectors

Storing Modules and Components

Retain the packaging in which a module or component was shipped, and use this packaging to store the item. Modules are shipped in antistatic bags and protective packaging. Components, such as transceivers and nonvolatile storage (NVS) cards, are shipped in antistatic plastic containers within an antistatic padded box.



CAUTION: Failure to store electronic modules and components correctly can lead to damage of these items.

Follow these guidelines for storing modules and components:

- Store each module in a separate antistatic bag.
- Store components in an antistatic plastic container. Some of these containers can accommodate several components in separate compartments.
- Do not store multiple modules or components in an antistatic bag or container where they can touch other items.
- (Optional) Store the item in its antistatic bag or container within the protective packaging or padded box that the item was shipped in.

Cleaning the System

Dust is attracted to the where the air intake vents are located. Clean the area with a dry cloth every few weeks to prevent excessive accumulation of dust. This cleaning helps to maintain the efficiency of the cooling system and to prevent damage to electronic components.



WARNING: Do not insert any metal object, such as a screwdriver, or place your hand into an open slot or the backplane when the router is on. Remove jewelry (including rings, necklaces, and watches) before working on equipment that is connected to power lines. These actions prevent electric shock and serious burns.



CAUTION: When cleaning the system, wear an antistatic wrist strap connected to an ESD grounding jack. This action helps to protect modules from damage by electrostatic discharge.

Upgrading NVS Cards on SRP Modules

This section describes how to install higher-capacity NVS cards on switch route processor (SRP) modules. The procedure you use depends on the number of SRP modules in the system. A new NVS card already contains the software release you ordered.



NOTE: The new NVS card must contain the same software release that you are running on the system.

Upgrading a System That Contains One SRP Module

If the system contains only one SRP module, you must power down the system before you upgrade the NVS card.



CAUTION: If you do not use the `halt` command before removing or powering down an SRP module, the system's NVS card can become corrupted.

To upgrade the NVS card on a system that contains one SRP module:

1. Enter the **halt** command.

See *JunosE System Basics Configuration Guide, Chapter 6, Managing Modules* for information about the **halt** command.



WARNING: Do not insert any metal object, such as a screwdriver, or place your hand into an open slot or the backplane when the router is on. Remove jewelry (including rings, necklaces, and watches) before working on equipment that is connected to power lines. These actions prevent electric shock and serious burns.



CAUTION: When handling modules, use an antistatic wrist strap connected to an ESD grounding jack. This action helps to protect the module from damage by electrostatic discharge.

2. Connect the antistatic wrist strap to an ESD grounding jack on the router.
3. Power down the system.
4. Remove the SRP module.
5. Replace the NVS card on the SRP module. (See “Replacing an NVS Card” on page 72.)
6. Reinsert the SRP module into the chassis.
7. Power up the system. (See “Powering Up the Router” on page 57.)

Upgrading a System That Contains Two SRP Modules

In a system that contains two SRP modules, you can upgrade the NVS cards on the SRP modules without powering down the system.



WARNING: Do not insert any metal object, such as a screwdriver, or place your hand into an open slot or the backplane when the router is on. Remove jewelry (including rings, necklaces, and watches) before working on equipment that is connected to power lines. These actions prevent electric shock and serious burns.



CAUTION: When handling modules, use an antistatic wrist strap connected to an ESD grounding jack. This action helps to protect the module from damage by electrostatic discharge.

To upgrade the NVS cards on the SRP modules in a system that contains two SRP modules:

1. Wear an antistatic wrist strap and connect it to one an ESD grounding jack on the router.

2. Halt the redundant SRP module.

host1#halt standby-srp

3. Remove the redundant SRP module from the chassis.
4. Replace the NVS card on this SRP module. (See "Replacing an NVS Card" on page 72.)
5. Reinsert the SRP module into the chassis.
6. When this SRP module is available, synchronize the SRP modules.

host1#synchronize

7. When the SRP modules are synchronized, reboot the SRP module that you upgraded.

host1#reload standby-srp

8. When this SRP module is available, synchronize the SRP modules.

host1#synchronize

9. When the SRP modules are synchronized, force the redundant SRP module to take over from the primary SRP module.

host1#srp switch

10. Halt the redundant (former primary) SRP module.

host1#halt standby-srp

11. Immediately remove the former primary SRP module.
12. Repeat Steps 4–8 for the former primary SRP module.

Replacing an NVS Card

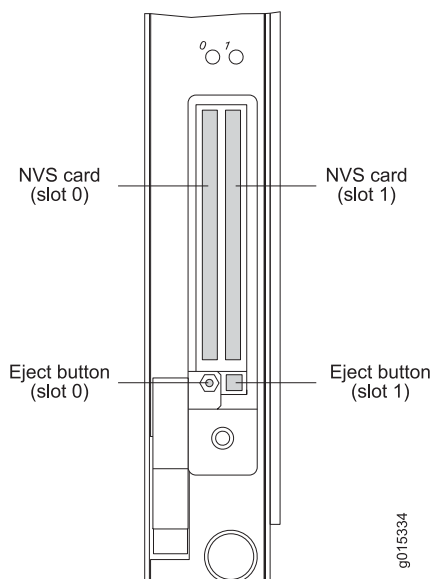
To replace an NVS card in slot 0 or slot 1 of an SRP module:



CAUTION: Before you insert or remove an NVS card from a running SRP module, we strongly recommend that you halt the SRP module or shut down the router. Failure to do this can result in file corruption in one or both cards. See *JunosE System Basics Configuration Guide, Chapter 6, Managing Modules* for information about the halt command.

1. Obtain an antistatic container for the NVS card you plan to remove. (See “Storing Modules and Components” on page 69.)
2. Be sure you have halted the SRP module using the **halt** command. See “Upgrading a System That Contains One SRP Module” on page 71.
3. With a small flathead screwdriver, remove the faceplate from the NVS card slot on the SRP module.
4. Eject the NVS card. (See Figure 29 on page 73.)
 - Slot 0—Insert a paperclip or similar device in the hole beneath slot 0 to eject the NVS card.
 - Slot 1—Use a screwdriver or similar device to depress the button beneath slot 1 and eject the card.

Figure 29: NVS Card Slots and Eject Buttons



5. Remove the NVS card and place it in the antistatic container.
6. Insert the new NVS card into the slot and push it until it clicks into place.
7. Replace the faceplate on the NVS card slot.

Replacing Fan Trays

A tray of cooling fans provides forced air cooling for components in the router. The fan tray is hot-swappable; you can replace it without powering down the system. However, if you do not replace the fan tray within 60 seconds, the system enters thermal protection mode. For information about thermal protection mode, see “Monitoring Temperatures of Modules” on page 85. You can monitor fan status by observing the LEDs on the SRP module or on the fan tray behind the faceplate. For complete LED information, see “Understanding Status LEDs to Troubleshoot” on page 80.



NOTE: On the SRP module or fan tray, if the red FAN FAIL LED is illuminated, either a critical or non-critical failure exists. Fan tray LEDs are located behind the fan tray bezel.



CAUTION: If the FAN FAIL LED on the SRP module is illuminated and none of the fans are spinning when you remove the fan tray, quickly power down the system until a new fan tray is available. Operating a router with inadequate air circulation can damage the modules.

Removing an E320 Fan Tray

To remove the fan tray:

1. Place a flathead screwdriver in the groove where the top bezel meets the chassis on the top of the system, and lever the top bezel off the front of the system.
2. With an appropriate screwdriver, loosen the captive screws located at the corners of the fan tray.



WARNING: Do not place your fingers near the fans when removing the fan tray. The blades might still be moving.



NOTE: Loosen the top and bottom thumbscrews (using a No. 2 Phillips screwdriver, if necessary)

3. Pull the fan tray halfway out of the shelf until it stops on the safety catch.
4. Pull both red safety handles upward while gripping the sides of the fan tray and pull the tray out slightly until the safety catch is released.
5. Place one hand under the fan tray and the other on the front handle and continue to pull the fan tray out of the chassis.

Use two hands to hold the fan tray after it comes out of the chassis.

Installing an E320 Fan Tray

To install the fan tray:



CAUTION: Do not use the fan tray handle to carry the fan tray assembly. Use the handle only to push the tray into the chassis.

1. With two hands hold the tray horizontally or so that the captive screws point toward you and you can read text on the labels.
2. Place the bottom corners of the tray housing in the fan tray compartment and push toward the back of the chassis until the tray stops.

An electrical connector on the back of the fan tray pairs with an electrical connector at the back of the shelf.

3. With an appropriate screwdriver, tighten the captive screws.

Alternate between screws when tightening them to ensure that the electrical connectors at the back of the tray fit tightly.



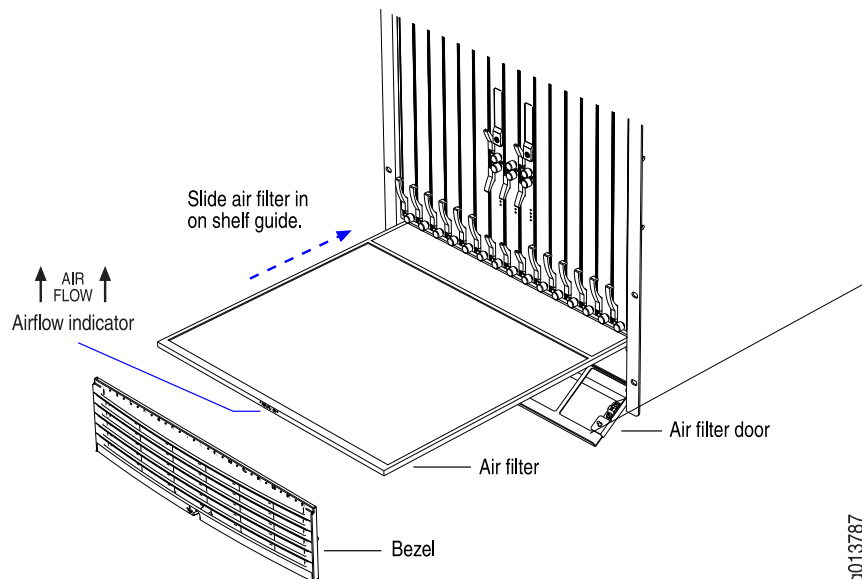
CAUTION: Do not overtighten the screws.

4. Fold down the fan tray handle and push the top bezel back on the front of the system.

Installing an Air Filter

Air filters are hot-swappable; you do not have to power down the system to replace the filter. The filter is located behind the fan tray bezel located at the bottom of the front of the system. Remove the bezel to access the air filter. See Figure 30 on page 75.

Figure 30: Installing an Air Filter into an E320 Router



To install an air filter:

1. Ground yourself by using an antistatic wrist strap or other device and connect it to one of the ESD grounding jacks.
2. Remove the front bezel by grabbing the edges and pulling straight out toward you.

3. Unscrew the two captive screws on the air filter door and swing the door down to open it.
4. Remove the old air filter (if present).
5. Insert the new filter by sliding it in on the shelf guides. Be sure the mesh side is facing up.
6. Close the door, tighten the captive screws, and snap the bezel on.



CAUTION: Do not overtighten the screws.

Replacing a Power Distribution Unit

To replace a power distribution unit (PDU):

1. Power down the router. See “Powering Down” on page 59.
2. Remove the clear plastic guard covering the PDU.



WARNING: Be sure the power source is turned off and all power switches are in the OFF position.

3. Disconnect the power cables and grounding cables. See Figure 31 on page 77.
4. With an appropriate screwdriver, loosen the screws located at the corners of the PDU.



NOTE: Loosen the top and bottom thumbscrews (using a No. 2 Phillips screwdriver, if necessary)

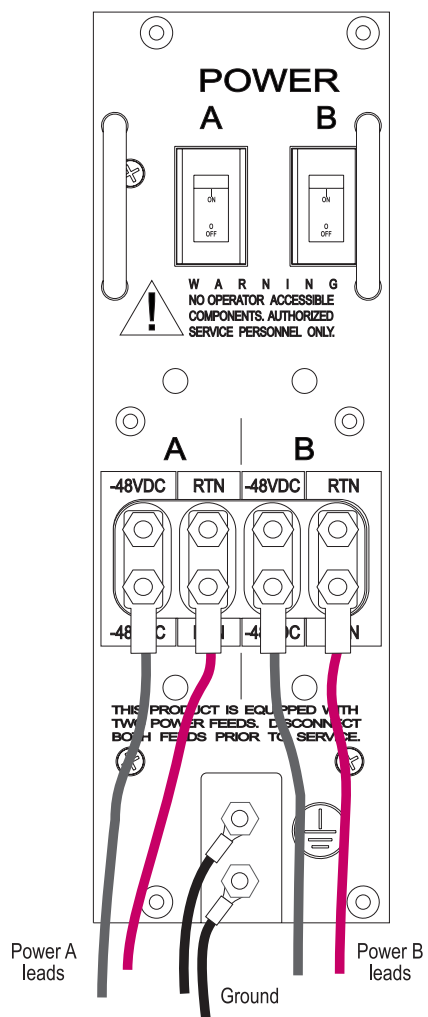
5. Using two hands, pull the PDU out of the chassis.
6. Install the new PDU and tighten the screws.



CAUTION: Do not overtighten the screws.

7. Reconnect the power cables and grounding cables. See “Cabling the Router for Power” on page 52
8. Replace the clear plastic guard.
9. Power up the router. See “Powering Up the Router” on page 57.

Figure 31: PDU



CHAPTER 9

Troubleshooting

This chapter explains how you can troubleshoot a specific problem, such as abnormal LED activity or no system power, when you power up the router. It contains the following sections:

- Diagnosing Problems on page 79
- Troubleshooting Power Failures on page 80
- Understanding Status LEDs to Troubleshoot on page 80
- Monitoring Temperatures of Modules on page 85
- Resetting Line Modules and SRP Modules on page 86
- Double-Bit Errors on SRP Modules on page 86

Diagnosing Problems

When you first encounter a system problem:

1. Make sure power connections are secure attached.
2. Observe the system's LEDs carefully.
3. Make sure cable connections on the system modules are securely attached.

If a problem is beyond the scope of this chapter, see “Contacting Customer Support and Returning Hardware” on page 113 for further instructions.



NOTE: Running the **show version**, **show hardware**, and **show environment** commands is often a good first step when trying to troubleshoot a problem.

Initialization Sequence

Each line module is initialized independently. As a result, the command-line interface (CLI) on the switch route processor (SRP) module might become available before the line modules have completed initialization. Commands relating to a line module might fail if the module has not completed initialization. Use the **show version** command to display line module status. Do not enter commands for a line module until its state is online.

Troubleshooting Power Failures

The system's distributed power system is designed to consume low levels of power and dissipate low levels of heat. See “System Specifications” on page 91 for specifications of power consumption and heat dissipation. If you suspect a power problem, see Table 9 on page 80.

Table 9: Causes of Power Failures

Symptom	Possible Problems	Actions
System does not power up.	<ul style="list-style-type: none"> System is not receiving power. Module's power supply has malfunctioned. Power source cannot handle system load. 	<p>The following actions apply to all of the possible problems:</p> <ol style="list-style-type: none"> 1. Verify that all power connections are correct. 2. Verify that the power supply is delivering the correct voltage, current, and wattage to the system. See “System Specifications” on page 91. 3. If the system still does not operate, contact the Juniper Networks Technical Assistance Center (JTAC).
System shuts down.	<ul style="list-style-type: none"> Temperature is too high. Power is lost. 	<p>The following actions apply to all of the possible problems:</p> <ol style="list-style-type: none"> 1. Verify that power connections are properly attached. 2. Verify that system is receiving power. 3. Look to see whether or not the LEDs are lit. 4. Run diagnostics on SRP and line modules. 5. If system does not reset, contact JTAC.

Understanding Status LEDs to Troubleshoot

Module LEDs can show you the immediate status of a module and alert you to a problem with the module or one of its ports. We recommend you familiarize yourself with LED activity so that you can easily detect and correct a module-related problem with minimal or no system downtime.

LED Identification

Most modules have two sets of status LEDs. The top set indicates basic functional status of the router or module. The bottom set indicates system status for that module, such as port status (line modules and IOAs) or fan status (SRP modules). See Figure 32 on page 81 and Figure 33 on page 81 for LED locations and labeling. See Table 10 on page 82 for descriptions of LED activity for all modules and IOAs.

Figure 32: Typical IOA LEDs

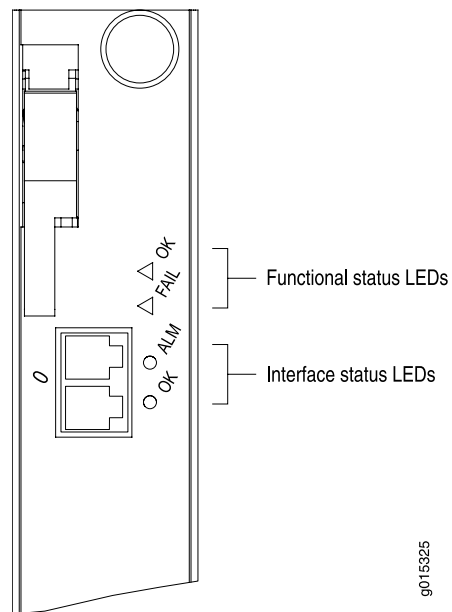
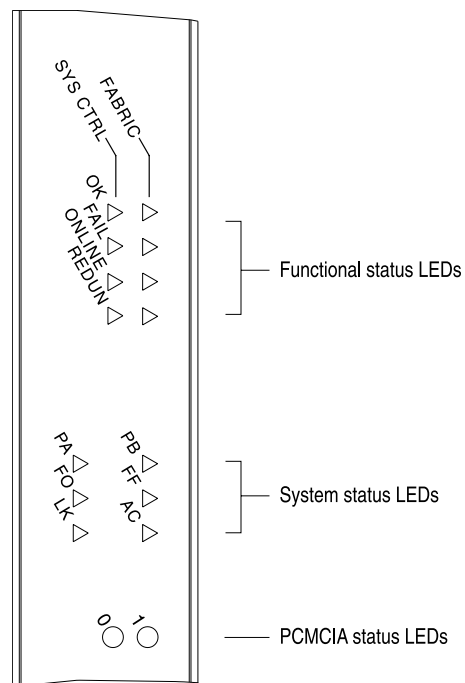


Figure 33: SRP IOA Module LEDs





NOTE: The primary SRP module illuminates the REDUNDANT LED when the SRP module is part of a redundancy group and it is up and running (or ready to take over). The standby SRP module monitors an activity signal from the primary SRP module to determine its state; it does not shadow the operations of the primary SRP module. If the standby SRP module detects that the primary SRP module is not active (and high-availability mode is not enabled), it reboots the system and takes control. If high-availability mode has been enabled, automatic switchover occurs with near hitless failover.

Table 10: LED Identification and Activity Descriptions

LED Location	LED Label	LED Indicator	LED Color	OFF to ON	ON to OFF
All modules					
	OK	Module status	Green	Self-test passed	Failure detected
	FAIL	Module status	Red	Failure detected	Diagnostic test running
	ONLINE	Module status	Green	Module online	Module offline
Line module					
	REDUN	Redundancy	Green	Module is active, and a standby module is available	Module is active, and no standby module is available
SFM module					
	REDUN	Redundancy	Green	N+1 redundancy is enabled; 2 SRPs and 3 SFMs must be installed and working. When LED is lit, you can remove the module without interrupting service.	One of the five fabric slices is down or not installed. N+1 redundancy is not enabled.
SRP module					
	REDUN	Redundancy	Green	Module is the spare system controller, is up, and is ready to take the role of the online system controller.	Module is no longer acting as the spare system controller.

Table 10: LED Identification and Activity Descriptions (*continued*)

LED Location	LED Label	LED Indicator	LED Color	OFF to ON	ON to OFF
	PA	Power A	Green	Power is online on source A.	Power is off.
	PB	Power B	Green	Power is online on source B.	Power is off.
	FO	Fan online	Green	Fan is online.	Critical fan failure.
	FF	Fan failure	Red	Critical fan failure.	Fan is online.
	NOTE: You can run the show environment command to see whether a noncritical fan failure exists.				
	LK	Ethernet link	Green	Ethernet link is up.	Ethernet link is down.
	NOTE: In case of SRP hot-swap, when SRP IOA is removed, LK is turned off. When an SRP IOA is inserted, LK is green and stable.				
	AC	Ethernet activity	Green	Blinks when Ethernet traffic is on link.	No Ethernet traffic is on link.
	NOTE: In case of SRP hot-swap, when SRP IOA is removed, AC is turned off. When an SRP IOA is inserted, AC is green and blinking.				
IOAs		NOTE: Not all IOAs have the following LEDs.			
	ALM	Port status	Yellow	The remote end of the link is experiencing loss of signal (FERF).	No FERF present, port is working correctly.
		Port status	Red	Port is experiencing loss of signal.	Port is working correctly; in sync.
	OK	Port status		Physical link is connected properly and is functioning properly.	Physical link is not connected properly and is not functioning properly.

LED Activity

When the system boots, it runs a series of tests for each module installed in the system, and the LEDs display various configurations. See Table 11 on page 84 and Table 12 on page 84 to understand normal and abnormal LED activity.



NOTE: When you reboot the system after installing a new version of the software, the line modules appear to boot twice.

Table 11: Normal Activity of Functional Status LEDs During Booting

OK	FAIL	ONLINE	Status Process
off	off	off	1. Module is in the power-up restart state; the FAIL LED stays on briefly.
off	on	off	2. Module is initializing, and diagnostic tests are running; the FAIL LED stays on briefly.
on	off	off	3. Module passed the diagnostics; the system boots.
on	off	on	4. Module is now up and running.

If the system detects an error during booting, the FAIL LED lights. Some failure conditions can cause the module not to boot. In this case, the LEDs might all be off. The system then resets the module.

If the operational software detects an error, the FAIL LED lights. Some errors can cause a module reset. Crash information is displayed at the console on the next reboot.

Table 12: Troubleshooting Abnormal LED Activity on Modules

Diagnostic Signs	Possible Problems	Actions
<ul style="list-style-type: none"> POWER A (PA) LED is not lit POWER B (PB) LED is not lit 	<ul style="list-style-type: none"> System is not receiving power from Power A. System is not receiving power from Power B. 	<ol style="list-style-type: none"> Make sure Power A and Power B terminal connections are securely attached. Verify that power switches are on. Make sure connections to power sources are securely attached. If system still does not operate, contact the Juniper Networks Technical Assistance Center.
FAIL LED lights	<ul style="list-style-type: none"> The line module and IOA are incompatible. A hardware failure, such as a failed module. 	<ol style="list-style-type: none"> Make sure that the line modules and IOAs are compatible; replace if necessary. If you replaced the IOA only, issue the reload slot slot_number command. If you replaced the line module or if there was a hardware failure, the system is supposed to automatically reset the module. If the condition persists, contact the Juniper Networks Technical Assistance Center.

Table 12: Troubleshooting Abnormal LED Activity on Modules (*continued*)

Diagnostic Signs	Possible Problems	Actions
<ul style="list-style-type: none"> FAN OK LED does not light FAN FAIL LED lights 	<ul style="list-style-type: none"> Fan is not working properly or has slowed down. Fan needs replacement. 	<p>Contact the Juniper Networks Technical Assistance Center; the system must be serviced.</p> <p>NOTE: In the fan tray for the E320 Broadband Services Router, four of the eight fans turn on immediately upon initial power-up and the other four fans turn on after a delay of 10 seconds.</p>
LINK LED is not lit	<ul style="list-style-type: none"> Ethernet connection is down. 	<ol style="list-style-type: none"> Make sure that Ethernet cables are properly connected to both the Ethernet port and the appropriate network device. If the condition persists, contact the Juniper Networks Technical Assistance Center.
ALM LED is red	<ul style="list-style-type: none"> System does not recognize a port connection. Cabling is not connected properly. Cable is faulty. Clocking problem exists. 	<ol style="list-style-type: none"> Make sure that all cables are firmly plugged into the ports and the attached network device. Verify that cables are clean. Test for faulty cables. Verify clock source and configuration. Reset the system. <p>NOTE: Problem is corrected when normal LED activity occurs.</p>
ALM LED is yellow	<ul style="list-style-type: none"> Far end receive failure (FERF) exists. 	<ol style="list-style-type: none"> Correct FERF problem. Reset the system. <p>NOTE: Problem is corrected when normal LED activity occurs.</p>
PA, FO, and LK LEDs on SRP module are on, but are off on LM and SFM module	<ul style="list-style-type: none"> Thermal protection mode has been enabled. System temperature is too high. Vents are blocked. Fans are not operating. 	<ol style="list-style-type: none"> Look at your console for a message indicating the problem. If you have the system log set to a severity of WARNING or higher, a Warning message indicates the failure. Issue the show environment command to display the temperatures. If the temperature is too high, power down the system. Regulate temperature. Reset the system.

Monitoring Temperatures of Modules

You can view the temperature of each module by issuing the **show environment all** and **show environment table** commands. In addition, the system generates detailed log messages if the temperature of a module is outside normal operating limits.

For example, if the temperature of any forwarding controller exceeds 212°F (100°C), a message appears on the console and the event is added to the system log. If you receive this message, report it to your customer service representative.

If the temperature of any module exceeds the upper temperature limit, the system immediately goes into thermal protection mode. After the system has entered thermal protection mode, you must resolve the cause of the high temperature quickly.

Table 13: Troubleshooting High-Temperature Conditions

Cause of High Operating Temperature	Symptoms	Resolution
Air vents to system are blocked	Space around system does not meet specifications. (See "System Specifications" on page 91.)	Increase space around system.
Ambient temperature exceeds specifications	Ambient temperature exceeds specifications. (See "System Specifications" on page 91.)	Provide extra cooling or heating in the room where the system is located.
One or more cooling fans have failed	<ul style="list-style-type: none"> FAN OK LED (FO) on SRP module is not illuminated. FAN FAIL LED (FF) on SRP module is illuminated. 	Replace fan tray. (See "Maintaining the Router" on page 69.)
A module fails	FAIL LED on module is illuminated.	Replace module. (See "Installing Modules" on page 27.)

When you have resolved the cause of the high temperature, the system automatically resumes operation. For example, if the system entered thermal protection mode and you replaced the fan tray, a chassis reboot is not required. The system automatically restores power to the LM and SFM modules.

Resetting Line Modules and SRP Modules

Line modules and SRP modules have two recessed buttons that enable you to reset the software or module. You can use the NMI button to reset the software on the module and the module reset button to reset the module. See Figure 5 on page 8.

If a line module fails to respond for an extended time, a software problem might exist with that module. You can depress the NMI button with a paper clip to suspend the current software task. Depending on the situation, this action might also reset the software on the module.

If depressing the software reset button fails to correct the issue with the line module, depress the module reset button. This action reboots the line module.

The buttons work in the same way for the SRP module. Depressing the module reset button on an SRP module is equivalent to rebooting the router and causes all the line modules to reboot.

Double-Bit Errors on SRP Modules

SRP modules include error checking and correction (ECC) to protect their SDRAM. ECC provides error detection of single-bit and double-bit errors and correction of single-bit errors for the SDRAM as follows:

- If ECC detects a single-bit error, it automatically corrects the error, and operation continues.
- If ECC detects a double-bit error, it logs the error, stops the main processor on the controller, and takes the SRP module offline.

Detecting Double-Bit Errors

The following message appears on the console when ECC detects a double-bit error:

```
ALERT 05/10/2004 13:10:33 os: failed: ECC DOUBLE BIT ERROR OCCURRED
Address = 0xe95db10
Data (Upper 32Bits) = 0xe95db20
Data (Lower 32Bits) = 0x55d06c
ECC Data Bits = 0x2b
ECC 1Bit Error Counter = 0x0
*** YOU MUST PERFORM A HARD RESET TO CONTINUE ***
ALERT 05/10/2004 13:10:34 os: PROCESSOR EXCEPTION: 0x200n
```

When ECC detects a double-bit error in a system that contains a redundant SRP module, the redundant module becomes active and the system continues to operate. However, you must still troubleshoot the SRP module with the double-bit error. When ECC detects a double-bit error in a system that does not contain a redundant SRP module, you must troubleshoot the SRP module immediately. See “Fixing Double-Bit Errors” on page 87.

Fixing Double-Bit Errors

To fix a double-bit error:

1. Remove the second SRP module, if there is one.
2. Reboot the system with the module reset button on the primary SRP module. (See Figure 5 on page 8.)

These actions attempt to correct a transient double-bit error. However, if the console displays a memory test failure for the SRP module after you reboot, or if the FAIL LED on the SRP module stays on during rebooting, the SDRAM is permanently damaged and needs replacing. In this event, call the Juniper Networks Technical Assistance Center to arrange for repair.

PART 4

Appendixes

- System Specifications on page 91
- Installation Guidelines and Requirements on page 97
- Cable Pinouts on page 109
- Contacting Customer Support and Returning Hardware on page 113
- Declaration of Conformity on page 117

APPENDIX A

System Specifications

This chapter lists the system specifications, requirements, and certifications for the router.

- E120 Broadband Services Router Specifications on page 91
- E320 Broadband Services Router Specifications on page 93
- Router Power Requirements on page 94

E120 Broadband Services Router Specifications

Table 14: E120 Router Specifications

Category	Specification
Weight	
Chassis only	51 lb (23.1kg)
Chassis fully configured	Approximately 107 lb (48.5 kg)
Dimensions	
Chassis only	11.25 (H) x 17.45 (W) x 25.10 (D) inches; 28.57 x 44.32 x 63.75 cm
Environmental Requirements	<i>Pending</i>
Ambient operating temperature	<ul style="list-style-type: none">• Long term: 41° to 104° F (5° to 40° C)• Short term: 23° to 122° F (–5° ° to 50° C)
Ambient operating humidity	<ul style="list-style-type: none">• Long term: 5% to 85% (noncondensing)• Short term: 5% to 95% (noncondensing)
Ambient storage temperature	–40° ° to 158° F (–40° ° to 70° C), 95% relative humidity
Ambient storage humidity	5% to 95% (noncondensing)
Heat Dissipation	1920 W, 6553 BTU/hour maximum
DC Input	

Table 14: E120 Router Specifications (*continued*)

Category	Specification
Voltage	-40 to -72 VDC NOTE: If the voltage rises above -40 VDC, the system powers off. The system does not power on again until the input voltage reaches -43 +/- 0.5 VDC.
Current	40 A @ -48 VDC
Power	1920 W maximum
Redundancy (input power)	2 independent line feeds
Space Requirements	<ul style="list-style-type: none"> • 3 feet (90 cm) behind router or rack • Do not block air vents on sides of the router • Do not place equipment that exhausts hot air to left on the right of the router.
Airflow	<ul style="list-style-type: none"> • Air intake occurs from the right side of the router. • Air is exhausted out of the left side of the router.
NEBS Certification Level 3	<i>Pending</i>
Safety Agency Certification	<ul style="list-style-type: none"> • AS/NZS 60950:2000 Safety of Information Technology Equipment • CAN/CSA-C22.2, No. 60950-1-03, First Edition, Information Technology Equipment - Safety - Part 1: General Requirements • EN60825-1, Safety of Laser Products - Part 1: Equipment Class, Requirements, and User's Guide (2001) • EN 60950-1:2001, First Edition, Information Technology Equipment - Safety - Part 1: General Requirements • IEC 60950-1(2001-10) Ed. 1.0 Information Technology Equipment - Safety - Part 1: General Requirements • Low Voltage Directive (73/23/EEC) • UL 60950-1, First Edition, Information Technology Equipment - Safety - Part 1: General Requirements
Electromagnetic Emissions Agency Certification	<ul style="list-style-type: none"> • AS/NZS CISPR 22:2004 • EMC Directive (89/336/EEC) • EN 300 132-2 (Narrowband and Wideband) • EN55022 Class A (CISPR-22 Class A) • EN55024, Annex C for WAN Equipment Performance Criteria A, B, and C • EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-6 • ETSI 300-386, Telecommunication Network Equipment; ElectroMagnetic Compatibility (EMC) requirements • FCC Part 15 Class A • IECS-03 Issue 3 Class A • VCCI (Voluntary Control Council for Interference by Information Technology Equipment)

E320 Broadband Services Router Specifications

Table 15: E320 Router Specifications

Category	Specification
Weight	
Chassis only	88 lb (39.9 kg)
Chassis fully configured	Approximately 215 lb (97.5 kg)
Dimensions	
With cable management bracket and bezels	24.5 (H) x 19 (W) x 28 (D) inches; 62.23 x 48.26 x 71.12 cm
Chassis only	24.5 (H) x 19 (W) x 25 (D) inches; 62.23 x 48.26 x 63.5 cm
Environmental Requirements	
Ambient operating temperature	<ul style="list-style-type: none"> Long term: 41° to 104° F (5° to 40° C) Short term: 23° to 122° F (–5° ° to 50° C)
Ambient operating humidity	<ul style="list-style-type: none"> Long term: 5% to 85% (noncondensing) Short term: 5% to 95% (noncondensing)
Ambient storage temperature	–40° ° to 158° F (–40° ° to 70° C), 95% relative humidity
Ambient storage humidity	5% to 95% (noncondensing)
Heat Dissipation	
	3840 W, 13106 BTU/hour maximum
DC Input	
Voltage	–40 to –72 VDC NOTE: If the voltage rises above –40 VDC, the system powers off. The system does not power on again until the input voltage reaches –43 +/- 0.5 VDC.
Current	80 A @ –48 VDC
Power	3840 W maximum
Redundancy (input power)	2 independent line feeds
Space Requirements	
	<ul style="list-style-type: none"> 3 feet (90 cm) behind router or rack Do not block air vents on front, sides, top, or back of the router
Airflow	
	<ul style="list-style-type: none"> Air intake occurs in the front and left and right sides of the router. Air is exhausted out of the top of the router. Exhaust air from components installed below the router is directed by an integral plenum out the back. See Figure 34 on page 101.

Table 15: E320 Router Specifications (*continued*)

Category	Specification
NEBS Certification Level 3	<ul style="list-style-type: none"> SR-3580 (FD-15): Network Equipment Building System (NEBS) Criteria Levels, Issue 1, November 1995 GR-63–CORE: Network Equipment Building System (NEBS) Requirements: Physical Protection, Issue 2, April 2002 GR-1089 (LSSGR, FD-15): Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment, Issue 2, Revision 1, February 1999
Safety Agency Certification	<ul style="list-style-type: none"> AS/NZS 60950:2000 Safety of Information Technology Equipment CAN/CSA-C22.2, No. 60950-1-03, First Edition, Information Technology Equipment - Safety - Part 1: General Requirements EN60825-1, Safety of Laser Products - Part 1: Equipment Class, Requirements, and User's Guide (2001) EN 60950-1:2001, First Edition, Information Technology Equipment - Safety - Part 1: General Requirements IEC 60950-1(2001-10) Ed. 1.0 Information Technology Equipment - Safety - Part 1: General Requirements Low Voltage Directive (73/23/EEC) UL 60950-1, First Edition, Information Technology Equipment - Safety - Part 1: General Requirements
Electromagnetic Emissions Agency Certification	<ul style="list-style-type: none"> AS/NZS 3548:1995 (CISPR 22 Class A) EMC Directive (89/336/EEC) EN55022 Class A (CISPR-22 Class A) EN55024, Annex C for WAN Equipment Performance Criteria A, B, and C ETSI 300-386, Telecommunication Network Equipment; ElectroMagnetic Compatibility (EMC) requirements FCC Part 15 Class A IECS-03 Issue 3 Class A VCCI (Voluntary Control Council for Interference by Information Technology Equipment)

Router Power Requirements

Table 16 on page 94 lists the maximum power values for various modules and IOAs in an E120 router or E320 router and also provides the measured values when the router is operating with varying IMIX (Internet mix) values under typical conditions.

Table 16: Power Requirements for E120 Router and E320 Router

Component	Watts maximum	Watts measured @48V, nominal temperature			Model number
		100%IMIX	50%IMIX	0%IMIX	
E320 Fan Tray	495	234	234	234	ES2-FANTRAY-FRU
E120 Fan Tray	108	72	72	72	ES2-120FTRAY-FRU

Table 16: Power Requirements for E120 Router and E320 Router (*continued*)

Component	Watts maximum	Watts measured @48V, nominal temperature			Model number
		100%IMIX	50%IMIX	0%IMIX	
SRP IOA	15	5	5	5	ES2-SRP-IOA
SRP-100	75	60	58	55	ES2-100G-SRP
SFM-100	40	30	26	25	ES2-100G-SFM
SRP-120	140	73	73	72	ES2-120G-SRP
SFM-120	95	47	45	45	ES2-120G-SFM
SRP-320	140	86	85	80	ES2-320G-SRP
SFM-320	95	48	45	45	ES2-320G-SFM
ES2 4G LM	176	149	138	129	ES2-4GS1-MOD
ES2 10G UPLINK LM	150	143	127	111	ES2-10GUPS2-MOD
ES2 10G LM	198	166	148	134	ES2-10GACS3-MOD
ES2 10G ADV LM	190	159	145	131	ES2-10GACS4-MOD
ES2-S1 GE-4 IOA	21	16	16	15	ES2-GE4S1-IOA
ES2-S1 GE-8 IOA	32	29	28	25	ES2-GE8S1-IOA
ES2-S3 GE-20 IOA	92	80	79	62	ES2-GE20S3-IOA
ES2-S1 10GE IOA (ES2 10G LM)	48	42	42	38	ES2-10GES2-IOA
ES2-S1 10GE IOA (ES2 4G LM)	40	22	22	19	ES2-10GES1-IOA
ES2-S1 OC3-8 ATM IOA	50	38	36	34	ES2-8OC3AS1-IOA
ES2-S1 OC12-2 ATM IOA	40	29	28	27	ES2-2OC12AS1-IOA

Table 16: Power Requirements for E120 Router and E320 Router (*continued*)

Component	Watts maximum	Watts measured @48V, nominal temperature			Model number
		100%IMIX	50%IMIX	0%IMIX	
ES2-S1 OC12-2 POS IOA	30	18	18	18	ES2-2OC12PS1-IOA
ES2-S1-OC48 POS IOA	30	16	16	16	ES2-OC48PS1-IOA
ES2-S1 REDUND IOA	10	7	6	5	ES2-REDUNDS1-IOA
ES2-S1 SERVICE IOA	10	4	4	4	ES2-SERVS1-IOA

APPENDIX B

Installation Guidelines and Requirements

This chapter reviews preinstallation considerations such as electrical, environmental, and safety compliances for the router. For complete system specifications, see “System Specifications” on page 91.

This chapter contains the following sections:

- Your Preinstallation Responsibilities on page 97
- Environmental Requirements on page 97
- Regulatory Compliances on page 98
- Safety Guidelines on page 98
- Equipment Rack Requirements on page 99
- Cabling Recommendations on page 101
- Product Reclamation and Recycling Program on page 102
- Hardware Compliance on page 103

Your Preinstallation Responsibilities

Complete the following tasks before installing the system:

- Verify that the electrical supply meets all AC and DC power requirements. See “System Specifications” on page 91.
- Verify that the site meets all environment specifications. See “Environmental Requirements” on page 97 and “System Specifications” on page 91.
- Verify that the cables you plan to use meet the specifications, and review the cabling recommendations. See “Cabling Recommendations” on page 101.
- Verify the operation of all telephone circuits, digital services, and T1 facilities required for installation.
- Ensure that all IP requirements are met, such as IP addresses, subnet masks, and any specific routing protocol information.

Environmental Requirements

See “System Specifications” on page 91 for complete environmental specifications.

Choose a location for the router that is dry, relatively dust free, well ventilated, and air conditioned. If you install equipment in a rack, be sure that the floor is capable of supporting the combined weight of the rack and the installed equipment. Place the router in a location with sufficient access to power and network cables.



NOTE: Based on the optical fiber cables used, you may need to increase the physical space provided for the chassis. The strain relief and bend radius requirements of the optical fiber cables may exceed the specified depth of the chassis and the cable-management bracket.

Like other network devices, the router generates a significant amount of heat. You must provide a balanced environment so that the router performs properly and safely. See “System Specifications” on page 91 for acceptable ranges of temperature and humidity.

Be sure to allow enough space around the router for adequate ventilation. Inadequate ventilation can cause the system to overheat.



CAUTION: Do not block the air vents on the router. Otherwise, the router might overheat.

Regulatory Compliances

See “System Specifications” on page 91, for a complete list of regulatory compliance requirements, including safety, EMC, and telecommunications.

Safety Guidelines

For your safety, before installing the system, review all safety warnings in this section.



WARNING: The recommended maximum ambient temperature is 40 °° C (104° F). For safe operation take into consideration the internal temperature within the rack.



WARNING: Install equipment in the rack from the bottom upward. Doing this helps maintain the stability of the rack and reduces the chance of the rack tipping over.



WARNING: Do not insert any metal object, such as a screwdriver, into an open slot or the backplane. Doing so can cause electric shock and serious burns.



WARNING: Three people are required to install the router in a rack: two to lift the system into position and one to screw it to the rack.



WARNING: Connect the router or rack to ground (earth), and ensure that a reliable grounding path is maintained in the rack.



WARNING: Do not work on the system or connect or disconnect cables during lightning activity.



WARNING: Be sure circuit breakers for the power source are in the OFF position before attaching power cables.



WARNING: Before servicing the router, turn off the power.



WARNING: Remove jewelry (including rings, necklaces, and watches) before working on equipment that is connected to power lines. Metal objects heat up when connected to power and ground and can cause serious burns or become welded to the terminals.



CAUTION: Evaluate the overall loading of the branch circuit before you install any equipment into a rack.

Equipment Rack Requirements

When allocating equipment rack space, consider the following:

- Type of equipment racks recommended for the router
- Number of equipment racks required to hold your current router configuration
- Future expansion

Make sure your distribution rack meets basic mechanical and space requirements and complies with conventional standards. In the United States, use EIA-310-D Cabinets, Racks, Panels, and Associated Equipment, September 1992.

Mechanical Requirements

Follow these mechanical requirements for your rack:

- Select from the following rack options:
 - Two-post rack—a freestanding enclosed cabinet with two mounting posts in the front
 - Telco-type rack—two adjacent mounting posts that you must secure to the floor or an overhead structure
 - Four-post rack—a freestanding open rack, either open or closed
- The rack must have at least two mounting posts.
- The distance between the mounting holes in the two posts must be 18.31 inches ffl.063 inch, as specified in the EIA-310-D.
- A fully loaded rack with three E320 Broadband Services Routers must structurally support at least 645 pounds (293 kilograms).
- An optional mounting kit is available for mid-chassis mounting. Contact your Juniper Networks sales representative for more information.

Space Requirements

If you use an enclosed rack for the router, ensure that there is a minimum of 3 inches of clearance between the inner side wall and the router. This clearance space ensures adequate air flow.

Proper Rack Installation

To confirm proper equipment rack installation, verify the following:

- Racks are installed and electrically grounded according to manufacturer instructions.
- Equipment racks are anchored to the floor and, when possible, anchored to the ceiling as well.
- Equipment rack installations comply with applicable local, state, and national codes.

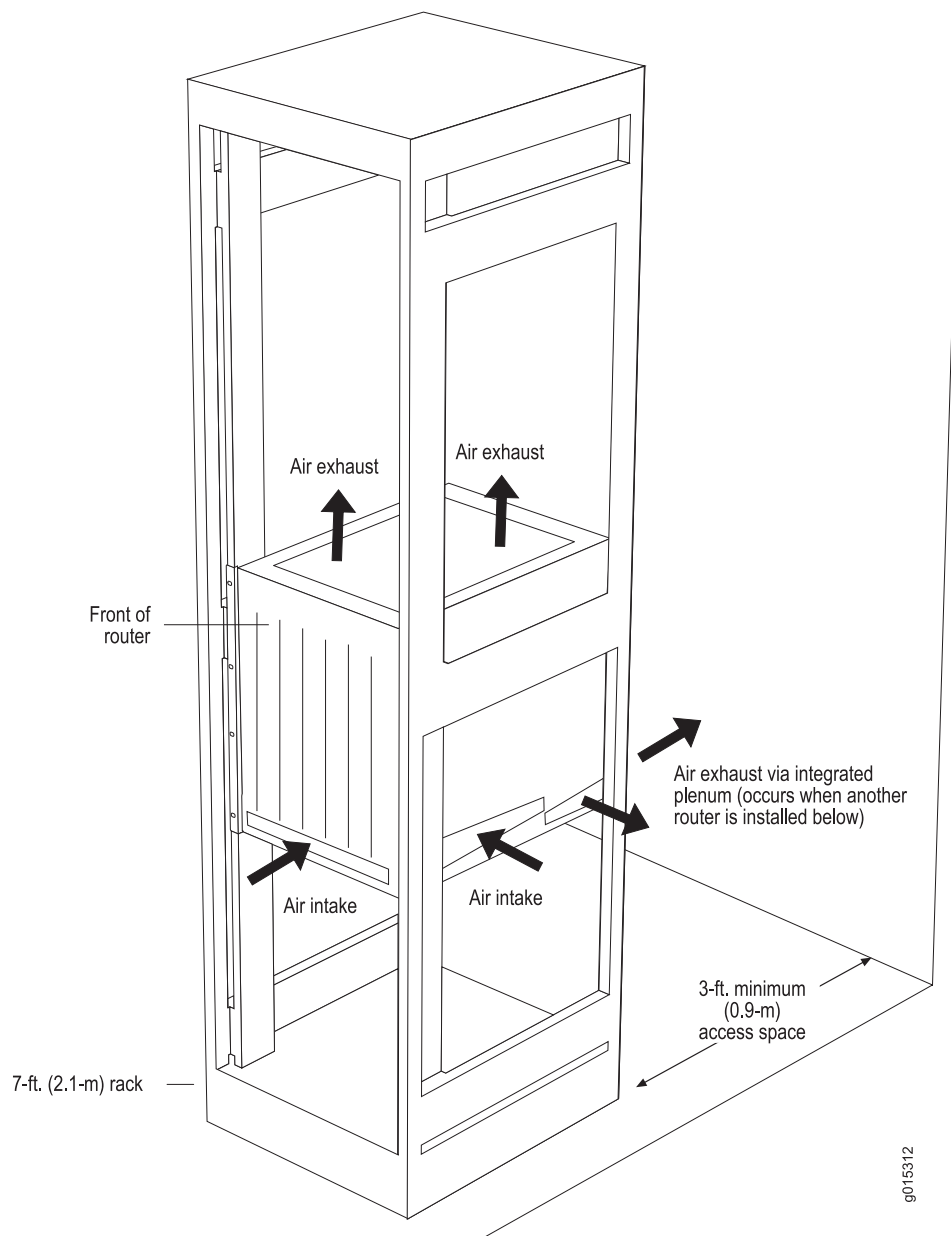


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CAUTION: To maintain airflow requirements for an E320 router, a plenum must be installed above the E320 router before any other piece of equipment is installed above it.

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Figure 34: Airflow for the E320 Router



Cabling Recommendations

Comply with the following recommendations:

- Ensure that cable distance and rate limits meet IEEE-recommended maximum speeds and distances for signaling purposes. For information about attenuation and power loss in optical fiber cables see:
 - ANSI T1.646a-1997 Telecommunications – Broadband ISDN - Physical Layer Specification for User-Network Interfaces Including DS1/ATM (1997)

- ANSI T1.646-1995 Telecommunications – Broadband ISDN - Physical Layer Specification for User-Network Interfaces Including DS1/ATM (1995)
- Ensure that power cables deliver sufficient power to the system.
- Attach laser fiber connectors only to Class 1 laser devices in accordance with IEC 60825-1, Safety of Laser Products - Part 1.
- Route cables so that they do not restrict ventilation or airflow.
- Route cables so that modules and field-replaceable units are easily accessible.
- Route cables in a logical direction to prevent loss of connectivity to other equipment in the rack, associated equipment in adjacent racks, or to the backbone network.
- Consider using cable-management brackets to keep network cables untangled and orderly and to prevent cables from hindering access to other slots.
- Verify that the cable fits within the allocated space. Some optical fiber cables incorporate strain relief features and minimum bend radius requirements and may exceed the specified depth of the chassis and the cable management bracket. To avoid cable damage, choose cables that fit in the space provided for the chassis.
- For specifications on cables for line modules, see the *E120 and E320 Module Guide*.

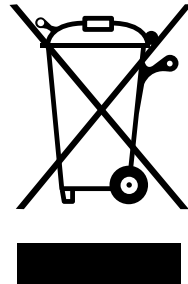
For additional cable recommendations, consult the document GR-63–CORE: Network Equipment Building System (NEBS) Requirements: Physical Protection, Issue 2, April 2002.

Product Reclamation and Recycling Program

Juniper Networks is committed to environmentally responsible behavior. As part of this commitment, we continually work to comply with environmental standards such as the European Union's *Waste Electrical and Electronic Equipment (WEEE) Directive* and *Restriction of Hazardous Substances (RoHS) Directive*.

These directives and other similar regulations from countries outside the European Union regulate electronic waste management and the reduction or elimination of specific hazardous materials in electronic products. The WEEE Directive requires electrical and electronics manufacturers to provide mechanisms for the recycling and reuse of their products. The RoHS Directive restricts the use of certain substances that are commonly found in electronic products today. Restricted substances include heavy metals, including lead, and polybrominated materials. The RoHS Directive, with some exemptions, applies to all electrical and electronic equipment.

In accordance with Article 11(2) of Directive 2002/96/EC (WEEE), products put on the market after 13 August 2005 are marked with the following symbol or include it in their documentation: a crossed-out wheeled waste bin with a bar beneath.



Juniper Networks provides recycling support for our equipment worldwide to comply with the WEEE Directive. For recycling information, go to <http://www.juniper.net/environmental>, and indicate the type of Juniper Networks equipment that you wish to dispose of and the country where it is currently located, or contact your Juniper Networks account representative.

Products returned through our reclamation process are recycled, recovered, or disposed of in a responsible manner. Our packaging is designed to be recycled and should be handled in accordance with your local recycling policies.

Hardware Compliance

The router meets the hardware compliance requirements in this section.

Federal Communications Commission (FCC) Statement

This equipment 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.

This equipment is designed for use with properly shielded and terminated cables. Refer to the installation sections of this manual before operation.

Reference: CFR 47, Part 15J, Sect 15.105 April 18, 1989

Caution: Changes or Modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Requirements for Consumer Products

This equipment complies with FCC rules, Part 68. On the back side of this equipment is a label that contains, among other information, the FCC Registration Number and Ringer

Equivalence Number (REN) for this equipment. If requested, provide this information to your telephone company.

If this equipment causes harm to the telephone network, the Telephone Company may discontinue your service temporarily. If possible, they will notify you in advance. But if advance notice isn't practical, you will be notified as soon as possible. You will be advised of your right to file a complaint with the FCC.

Your telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the proper operation of your equipment. If they do, you will be given advance notice so as to give you an opportunity to maintain uninterrupted service.

If you experience trouble with this equipment, please contact the manufacturer for warranty/repair information. The telephone company may ask that you disconnect this equipment from the network until the problem has been corrected or until you are sure that the equipment is not malfunctioning.

Food and Drug Administration, Center for Devices and Radiological Health

This equipment complies with 21 CFR 1040.10 and 1040.11 for the safe use of lasers.

Canadian Department of Communications Radio Interference Regulations

This Class B (or Class A, if so indicated on the registration label) digital apparatus meets the requirements of the Canadian Interference-Causing Equipment Regulations.

Règlement sur le brouillage radioélectrique du ministère des communications

Cet appareil numérique de la Classe B (ou Classe A, si ainsi indiqué sur l'étiquette d'enregistrement) respecte toutes les exigences du Règlement sur le Matériel Brouilleur du Canada.

Industry Canada Notice CS-03

The Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operation and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements document(s). The Department does not guarantee the equipment will operate to the user's satisfaction. Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be coordinated by a representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

Notice: The Ringer Equivalence Number (REN) assigned to each terminal device provides an indication of the maximum number of terminals allowed to be connected to a telephone interface. The termination on an interface may consist of any combination of devices subject only to the requirement that the sum of the Ringer Equivalence Numbers of all the devices does not exceed 5.

Avis CS-03 d'Industrie Canada

L'étiquette du ministère des Communications du Canada indique que l'appareillage est certifié, c'est-à-dire qu'il respecte certaines exigences de sécurité et de fonctionnement visant les réseaux de télécommunications. Le ministère ne garantit pas que l'appareillage fonctionnera à la satisfaction de l'utilisateur. Avant d'installer l'appareillage, s'assurer qu'il peut être branché aux installations du service de télécommunications local. L'appareillage doit aussi être raccordé selon des méthodes acceptées. Le client doit toutefois prendre note qu'une telle installation n'assure pas un service parfait en tout temps.

Les réparations de l'appareillage certifié devraient être confiées à un service d'entretien canadien désigné par le fournisseur. En cas de réparation ou de modification effectuées par l'utilisateur ou de mauvais fonctionnement de l'appareillage, le service de télécommunications peut demander le débranchement de l'appareillage.

Pour leur propre sécurité, les utilisateurs devraient s'assurer que les mises à la terre des lignes de distribution d'électricité, des lignes téléphoniques et de la tuyauterie métallique interne sont raccordées ensemble. Cette mesure de sécurité est particulièrement importante en milieu rural.

Attention: Les utilisateurs ne doivent pas procéder à ces raccordements eux-mêmes mais doivent plutôt faire appel aux pouvoirs de réglementation en cause ou à un électricien, selon le cas.

Avis: Veuillez prendre note que pour tout appareillage supportant des lignes de type "loopstart," l'indice d'équivalence de la sonnerie (IES) assigné à chaque dispositif terminal indique le nombre maximal de terminaux qui peuvent être raccordés à une interface. La terminaison d'une interface téléphonique peut consister en une combinaison de quelques dispositifs, à la seule condition que la somme d'indices d'équivalence de la sonnerie de tous les dispositifs n'excède pas 5. Le REN figure sur l'étiquette "FCC Rules Part 68" située sur le support du module ou à l'arrière de l'unité.

D.O.C. Explanatory Notes: Equipment Attachment Limitations

The Canadian Department of Communications label identifies certified equipment. This certification meets certain telecommunication network protective, operational and safety requirements. The department does not guarantee the equipment will operate to the users satisfaction.

Before installing the equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside

wiring associated with a single line individual service may be extended by means of a certified connector assembly (telephone extension cord). The customer should be aware that compliance with the above condition may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Users should not attempt to make such connections themselves, but should contact the appropriate electrical inspection authority, or electrician, as appropriate.

Notes explicatives du ministère des Communications: limites visant les accessoires

L'étiquette du ministère des Communications du Canada indique que l'appareillage est certifié, c'est-à-dire qu'il respecte certaines exigences de sécurité et de fonctionnement visant les réseaux de télécommunications. Le ministère ne garantit pas que l'appareillage fonctionnera à la satisfaction de l'utilisateur.

Avant d'installer l'appareillage, s'assurer qu'il peut être branché aux installations du service de télécommunications local. L'appareillage doit aussi être raccordé selon des méthodes acceptées. Dans certains cas, le câblage interne du service de télécommunications utilisé pour une ligne individuelle peut être allongé au moyen d'un connecteur certifié (prolongateur téléphonique). Le client doit toutefois prendre note qu'une telle installation n'assure pas un service parfait en tout temps.

Les réparations de l'appareillage certifié devraient être confiées à un service d'entretien canadien désigné par le fournisseur. En cas de réparation ou de modification effectuées par l'utilisateur ou de mauvais fonctionnement de l'appareillage, le service de télécommunications peut demander le débranchement de l'appareillage.

Pour leur propre sécurité, les utilisateurs devraient s'assurer que les mises à la terre des lignes de distribution d'électricité, des lignes téléphoniques et de la tuyauterie métallique interne sont raccordées ensemble. Cette mesure de sécurité est particulièrement importante en milieu rural.

Attention: Les utilisateurs ne doivent pas procéder à ces raccordements eux-mêmes mais doivent plutôt faire appel aux pouvoirs de réglementation en cause ou à un électricien, selon le cas.

EC Declaration of Conformity

The EC Declaration of Conformity is available in "Declaration of Conformity" on page 117.

Voluntary Control Council for Interference (VCCI) Statement for Japan

<p>この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用する と電波妨害を引き起こすことがあります。この場合には使用者が適切な対策 を講ずるよう要求されることがあります。</p> <p>VCCI-A</p>

The preceding translates as:

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures. VCCI-A

APPENDIX C

Cable Pinouts

This appendix lists the cables and connector pinout assignments for the cables used with the router.

- SRP IOA on page 109

SRP IOA

The SRP IOA module provides three management ports (console, auxiliary, 10/100Base-T Ethernet). You can connect a console directly to the RS-232 serial console port or debug auxiliary port using a shielded straight-through cable with a female DB-9 connector on one end and a male DB-25 with a crossover adapter on the DB-25 end. These ports are called serial ports, RS-232 ports, or console ports. These ports are considered a data terminal equipment interface (DTE). Direct connection to a terminal or PC (which also have DTE interfaces) requires a crossover cable.

- See Figure 35 on page 109 and Table 17 on page 109 for the pinout of the console port.
- See Figure 35 on page 109 and Table 18 on page 110 for the pinout of the auxiliary port.
- See Table 19 on page 110 for the pinout of the Ethernet port.

Figure 35: SRP IOA Console Port and Auxiliary Port Pinout

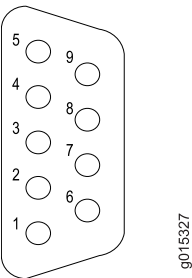


Table 17: SRP IOA – RS-232 Console Connector Pinout

Pin	Signal
1	DCD
2	RXD

Table 17: SRP IOA – RS-232 Console Connector Pinout (*continued*)

Pin	Signal
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RNG

Table 18: SRP IOA – RS-232 Auxiliary Connector Pinout

Pin	Signal
1	no connect
2	RXD
3	TXD
4	DTR
5	no connect
6	DSR
7	no connect
8	no connect
9	no connect

After you have configured an IP address on the system, you can connect using a host running Telnet over the 10/100Base-T Ethernet port on the SRP IOA. The router is shipped with a straight-through cable having a male RJ-45 Ethernet connector on each end.

See Table 19 on page 110 for the pinouts of the Ethernet cable's RJ-45 connector.

Table 19: SRP IOA – RJ-45 Connector Pinout

Pin	Signal
1	TX +

Table 19: SRP IOA – RJ-45 Connector Pinout (*continued*)

Pin	Signal
2	TX –
3	RX +
4	no connect
5	no connect
6	RX –
7	no connect
8	no connect

To facilitate connecting the system to a terminal, the system is shipped with one of each of the following cable adapters:

- DB-9 female to RJ-45 female crossover null modem adapter
- DB-9 female to RJ-45 female straight-through adapter

Table 20 on page 111 lists the pinouts for the crossover adapter.

Table 20: DB-9 – RJ-45 Crossover Adapter Pinout

DB-9 Pin	Signal	RJ-45 Pin
1	DCD	1
2	RXD	3
3	TXD	2
4	DTR	6
5	GND	5
6	DSR	4
7	RTS	8
8	CTS	7
9	RNG	no connect

Table 21 on page 112 lists the pinout for the straight-through adapter.

Table 21: DB-9 – RJ-45 Straight-Through Adapter Pinout

DB-9 Pin	RS-232 Signal Name	RJ-45 Pin	Ethernet Signal Name
1	DCD	1	TX +
2	RXD	2	TX –
3	TXD	3	RX +
4	DTR	4	no connect
5	GND (signal)	5	no connect
6	DSR	6	RX –
7	RTS	7	no connect
8	CTS	8	no connect
9	RNG	no connect	none

APPENDIX D

Contacting Customer Support and Returning Hardware

See the Juniper Networks Web site for complete customer service information:

- <http://www.juniper.net/support/guidelines.html>

This appendix contains the following sections:

- Contacting Customer Support on page 113
- Return Procedure on page 113
- Locating Component Serial Numbers on page 114
- Information You Might Need to Supply to JTAC on page 115
- Tools and Parts Required on page 115
- Returning Products for Repair or Replacement on page 116

Contacting Customer Support

For your convenience, we provide multiple options for requesting and receiving technical support from the Juniper Networks Technical Assistance Center (JTAC):

- By the Web using Juniper Networks, Inc. Case Manager:

<https://www.juniper.net/cm/index.jsp>

- By telephone:

From the US, Canada, and Mexico at 1-888-314-JTAC

From all other locations at 408-745-9500

Return Procedure

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

1. Determine the part number and serial number of the component. For instructions, see “Locating Component Serial Numbers” on page 114.

2. Obtain a Return Materials Authorization (RMA) number from the Juniper Networks Technical Assistance Center (JTAC). See “Information You Might Need to Supply to JTAC” on page 115.

Provide the following information in your e-mail message or during the telephone call:

- Part number and serial number of component
- Your name, organization name, telephone number, and fax number
- The shipping address for the replacement component, including contact name and phone number
- Description of the failure

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

3. Pack the routing node or component for shipment, performing the procedure described in “Returning Products for Repair or Replacement” on page 116.

Locating Component Serial Numbers

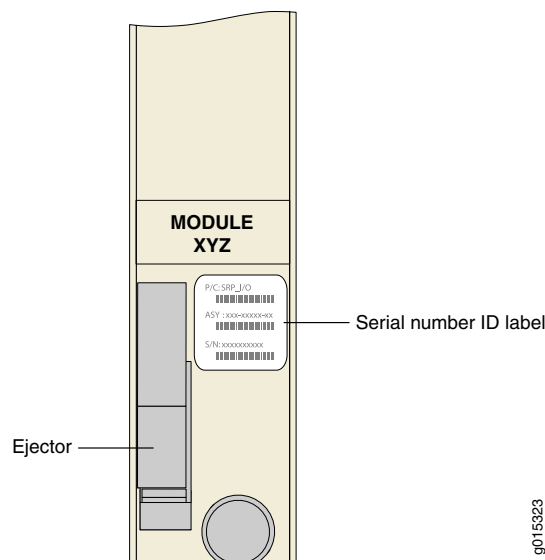
Before contacting Juniper Networks to request a Return Materials Authorization (RMA), you must find the serial number on the chassis or component. To list all the chassis modules and their serial numbers, enter the following command:

```
host1#show hardware
```

You can also find the serial numbers on the modules. ID labels are usually applied near the ejector. See Figure 36 on page 114.

Fan trays are not listed in the **show hardware** command output. You must remove the fan tray bezel to view the serial number ID label.

Figure 36: Representative Module Serial Number ID Label



Information You Might Need to Supply to JTAC

When requesting technical support from the JTAC by phone, be prepared to provide the following information:

- Priority level
- Indication of what activity was being performed on the router when the problem occurred
- Problem detail and configuration data, obtained by these commands:
 - **show version**
 - **show hardware**
 - **show environment**
 - **show configuration**

When a new request for technical support is submitted, the JTAC engineer:

1. Opens a case and assigns a number.
2. Begins troubleshooting, diagnostics, and problem replication (if appropriate).
3. Provides you with periodic updates on problem status and escalates the problem as appropriate according to escalation management guidelines.
4. Closes the case when you agree that the problem has been resolved.

Tools and Parts Required

To remove components from the chassis or the chassis from a rack prior to returning the chassis or components for repair or replacement, you need the following tools and parts:

- Mechanical lift, if available
- 3/8-inch wrench or nut driver
- Blank filler panels
- Electrostatic bag or antistatic mat
- Electrostatic discharge (ESD) grounding wrist strap
- Flat-blade (—) screwdriver
- Phillips (+) screwdrivers, numbers 1 and 2
- Plastic boots or other protective cover for fiber-optic SC and LC connectors
- Wire cutters

Returning Products for Repair or Replacement

In the event of a hardware failure, please contact Juniper Networks to obtain a Return Material Authorization (RMA) number. This number is necessary to ensure proper tracking and handling of returned material at the factory. Do not return any hardware until you have received an RMA. Juniper Networks reserves the right to refuse shipments that do not have an RMA. Refused shipments are returned to the shipper via collect freight.

See the customer support Web page for complete repair and return policies and procedures.

Packing Instructions for Returning a Chassis

If possible, use the original shipping crate, pallet, and packing materials in which the chassis was originally shipped. If these materials are unavailable, use comparable shipping material, or contact your Juniper Networks representative for information on approved packaging material.

To pack the chassis for shipment, follow these steps:

1. Ground yourself by using an antistatic wrist strap or other device.
2. Issue the proper shutdown commands to halt your system.
3. Switch all power switches to the OFF position.
4. Remove all cables from the chassis.
5. Remove all major components from the chassis, including line modules, IOAs, SRP modules, SFM modules, fan trays, and cable management systems.
6. Remove the chassis from the rack and bolt it to the shipping pallet.
7. Cover the chassis with an ESD bag and place packing foam on top of and around the chassis.
8. Place the crate cover over the chassis and fasten the cover to the pallet.

APPENDIX E

Declaration of Conformity

- Declaration of Conformity – E120 Broadband Services Router on page 117
- Declaration of Conformity – E320 Broadband Services Router on page 117

Declaration of Conformity – E120 Broadband Services Router

Declaration of Conformity

Juniper Networks, Inc.
10 Technology Park Drive
Westford, Massachusetts 01886 USA

declares that under our sole responsibility the product(s)

Broadband Router
Model E120

is 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 60950-1:2000+A11
EN 60825-1:1994+A1+A2
EN 300 386 V1.3.3:2005
EN 300 132-2 (Narrowband and Wideband)
EN 55024:1998+A1+A2
EN 55022:1998+A1 (2000)+A2 (2003) Class A,
EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-6

Place
Westford, MA

Signature
Susanne Delisle

Date
06/20/2007

Declaration of Conformity – E320 Broadband Services Router

Declaration of Conformity

Juniper Networks, Inc.
10 Technology Park Drive
Westford, Massachusetts 01886 USA

Declaration of Conformity

declares that under our sole responsibility the product(s)

**E Series Broadband Services Routers
E320, including all plug-in modules**

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 60950:2000

EN 60825-1:1994+A1+A2

EN 300 386 V1.3.1:2001

EN 55022:1998EN 61000-3-2, EN 61000-3-3, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN
61000-4-5, EN 61000-4-6, EN 61000-4-11

Place
Westford, MA

Signature
David Schilling

Date
06/24/2005

PART 5

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- Index on page 121

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