CHAPTER 1

Product Overview

This chapter provides an overview of the Cisco XR 12416 and Cisco XR 12816 Router. It contains physical descriptions of the router hardware and major components, as well as functional descriptions of the hardware-related features.

Physical and Functional Description of Router

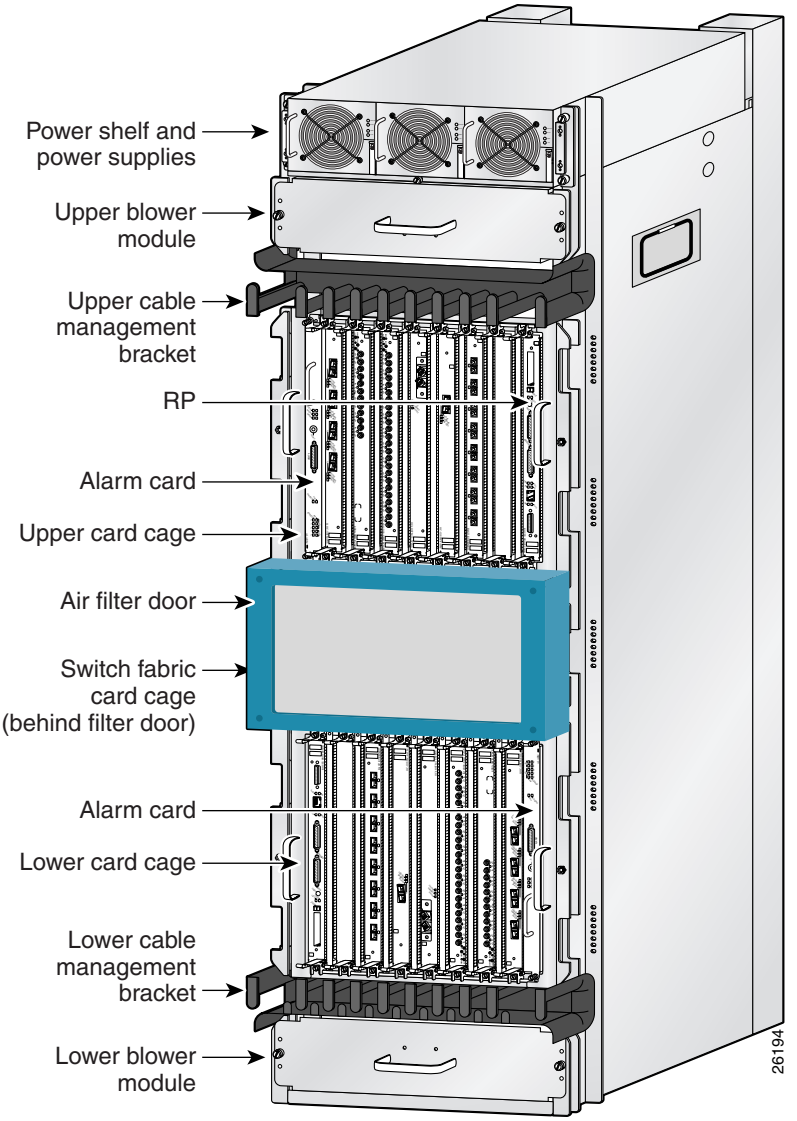
The Cisco XR 12416 and Cisco XR 12816 Router chassis is a sheet-metal enclosure that houses router components. The major components consist of three power supplies, upper and lower line card cages, a switch fabric card cage, and upper and lower blower modules. Power is distributed to these components over the chassis backplane.

All router models contain the following major components (Figure 1-1):

- Power shelf and power supplies—Three AC or DC power entry modules (PEMs) provide power to the router. See the "AC and DC Power Subsystems" section on page 1-4 for additional information.
- Upper blower module—Supplies cooling air to the upper half of the router so it does not overheat. See the "Blower Module" section on page 1-36 for additional information.
- Upper and lower cable management brackets—Used to neatly route line card cables. See the "Upper and Lower Cable Management Brackets" section on page 1-36 for additional information.

- Upper Line card and Route Processor card cage—Has 8 user-configurable slots that support a combination of line cards, a route processor (RP), and an alarm card. See the "Alarm Card and Line Card Overview" section on page 1-18 for additional information.
- Switch fabric card cage—Located behind the air filter door, this card cage contains 5 slots for the switch fabric card set. The switch fabric card set is made up of 3 switch fabric cards (SFCs) and 2 clock scheduler cards (CSCs). See the "Switch Fabric Overview" section on page 1-16 for additional information.
- Lower Line card and Route Processor card cage—Has 8 user-configurable slots that support a combination of line cards, a redundant route processor (RP), and an alarm card. See the "Alarm Card and Line Card Overview" section on page 1-18 for additional information.
- Lower blower module—Supplies cooling air to the lower half of the router so it does not overheat. See the "Blower Module" section on page 1-36 for additional information.
- Chassis backplane (not shown)—Distributes power to card cages and to the blower modules.

Figure 1-1 Cisco XR 12016 Router Components—Front View



AC and DC Power Subsystems

A router ships with either an AC or DC powered system. Source power connects to the power shelf at the back of the chassis which route power to the power supplies, also referred to as power entry modules (PEMs).

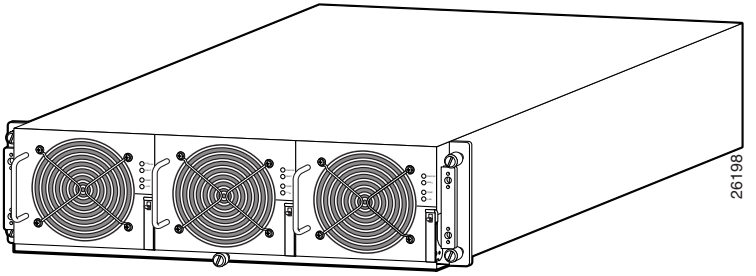
Standard AC Power Shelf

The standard AC-input power subsystem consists of a single-level AC-input power shelf that house three AC power supplies which supply full redundant power to the router.

The power supplies participate in an N+1 redundant current-sharing scheme that is divided among all three power supplies. If one power supply fails, the system can continue to operate temporarily, (depending on your system configuration) with the remaining two power supplies. Failed power supplies should be replaced as soon as possible to ensure full redundancy.

Caution To ensure that the chassis configuration complies with the required power budgets, use the on-line power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails. Contact your local sales representative for assistance.

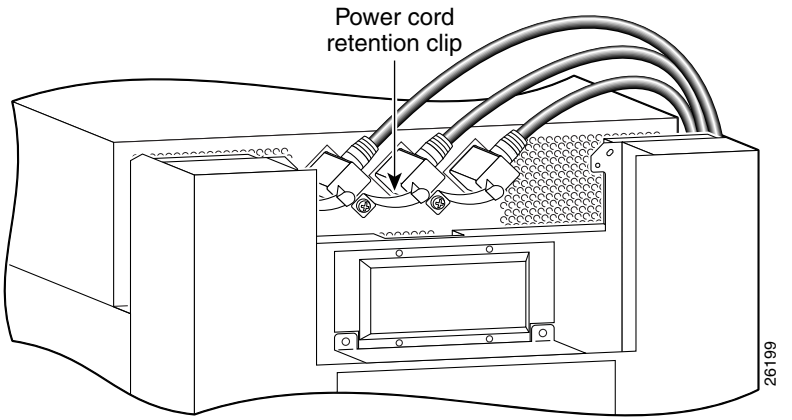
Figure 1-2 Standard AC-Input Power Subsystem



Caution A router equipped with the standard AC power subsystem must be operated with three power supplies installed in the power shelf at all times for electromagnetic compatibility (EMC).

AC power to the router is provided through power cords connected from AC power outlets to connectors on back of the power shelf as shown in Figure 1-3.

Figure 1-3 Standard Power Shelf AC-Input Connections



Optional AC Power Shelf

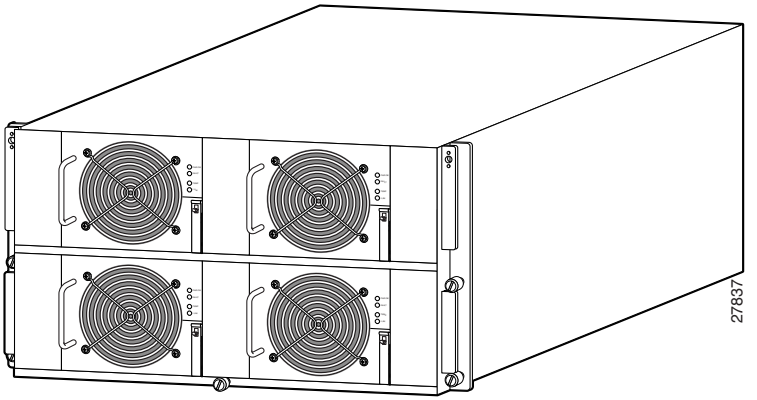
The power subsystem consists of a double-level AC-input power shelf with bays for 4 AC-input power supplies. Figure 1-4 shows the optional power shelf. It attaches to the top of the router chassis and is secured to the chassis the same way as the standard AC-input power shelf.

Note A router equipped with the optional AC-input power subsystem stands 77.5 inches (196.85 cm) tall and does not fit in a standard 7-foot (2.1 m) rack.

The 4 power supplies in the optional power shelf participate in an N+2 redundant current-sharing scheme in which current sharing is divided among all 4 power supplies. Up to two power supplies can fail and the system can continue to operate temporarily, (depending on your system configuration) using the remaining two power supplies. Failed supplies should be replaced as soon as possible to ensure full redundancy.

Caution To ensure that the chassis configuration complies with the required power budgets, use the on-line power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails. Contact your local sales representative for assistance.

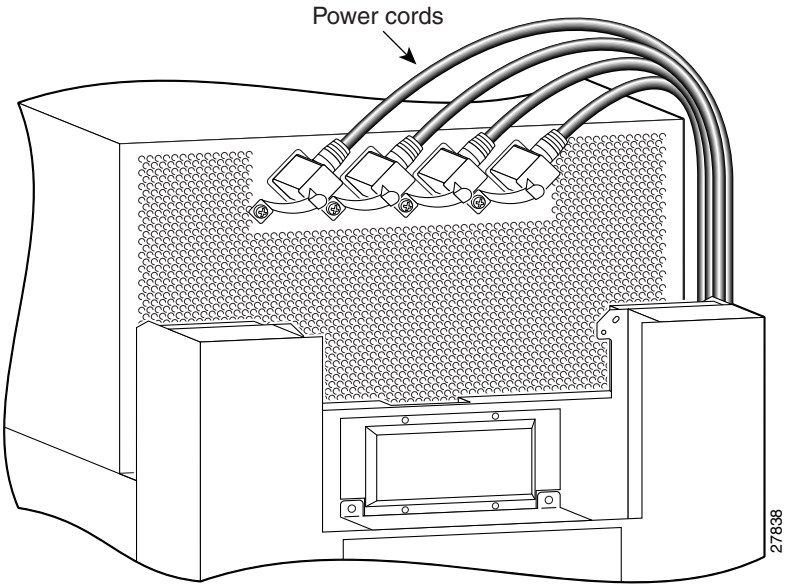
Figure 1-4 Optional AC-Input Power Subsystem



Caution A router equipped with the optional AC power subsystem must be operated with 4 power supplies installed in the power shelf at all times for electromagnetic compatibility (EMC).

AC power to the router is provided through power cords connected from AC power outlets to the connectors on the back of the power shelf as shown in Figure 1-5.

Figure 1-5 Optional Power Shelf AC-Input Connections

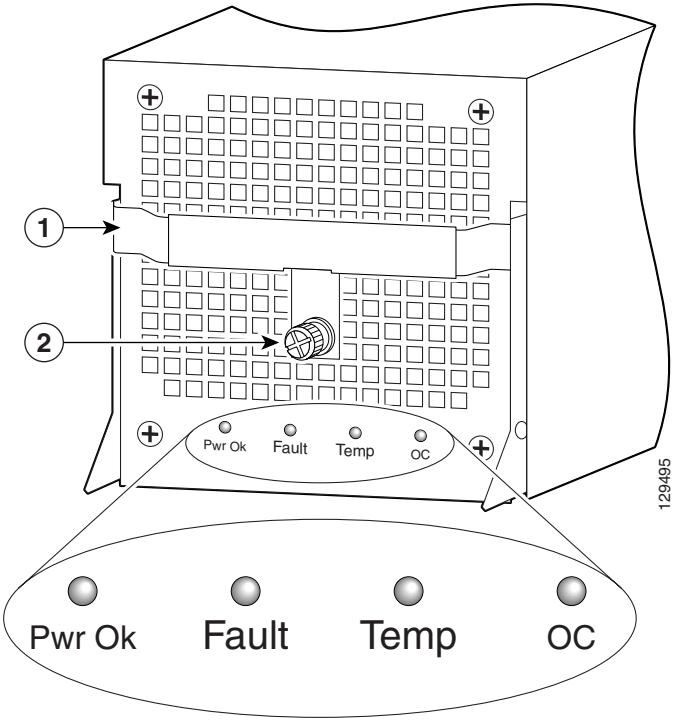


AC Power Supplies

Each AC PEM converts 200 to 240 VAC into -48 VDC, which is distributed through the chassis backplane to all cards, RPs, and the blower modules.

Figure 1-6 identifies the components of a 2500 W AC power supply.

Figure 1-6 2500 W AC Power Supply Components



1	Ejector handle	**2**	Captive screw

The status LEDs on an AC PEM provide information about the current operational status of the power supply:

- PWR OK (green)—Indicates that the power supply module is operating normally.
- FAULT (yellow)—Indicates that a fault is detected within the PEM.
- TEMP (yellow)—Indicates the PEM is in an overtemperature condition and shutdown has occurred.
- ILMI (yellow)—Indicates the PEM is operating in a current-limiting condition.

For additional information about troubleshooting AC PEMs, see the "Troubleshooting an AC Power Supply" section on page 4-5.

DC Power Shelf

A DC-input power subsystem consists of a DC-input power shelf that houses 4 DC PEMs that provide full redundant power to the router. Figure 1-7 shows a DC-input power shelf.

The chassis is electrically divided between the PEMS. These sections are referred to as power zones and are labeled accordingly:

- Two PEMs power the upper card cage (Zone 1)
- Two PEMs power the lower card cage (Zone 2)

Each zone provides power to one blower, one alarm card, line cards and route processor cards.

Zone 2 also supplies power to all switch fabric cards. The result is that there is less power available for line cards in Zone 2, limiting the number of high-powered line cards that can be configured in the lower cage.

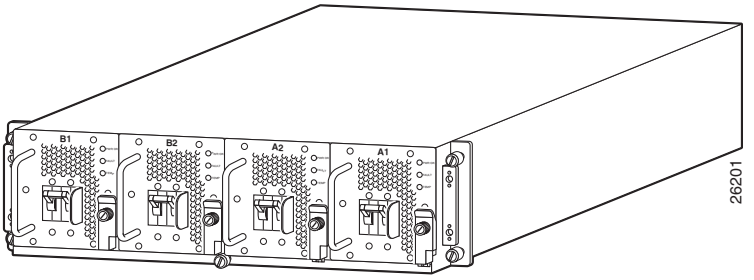
Caution To ensure that the chassis configuration complies with the required power budgets, contact your sales representative to provide you with the required power calculator. Failure to properly verify the configuration may result in an unpredictable state if one of the power units fails.

Contact your local sales representative for assistance.

In the DC-input power configuration:

- Modules A1 and B1 provide redundant power for system load zone 1 (the upper blower module and the upper card cage).
- Modules A2 and B2 provide redundant power for system load zone 2 (the switch fabric card cage, the lower card cage, and the lower blower module).

Figure 1-7 DC-Input Power Shelf

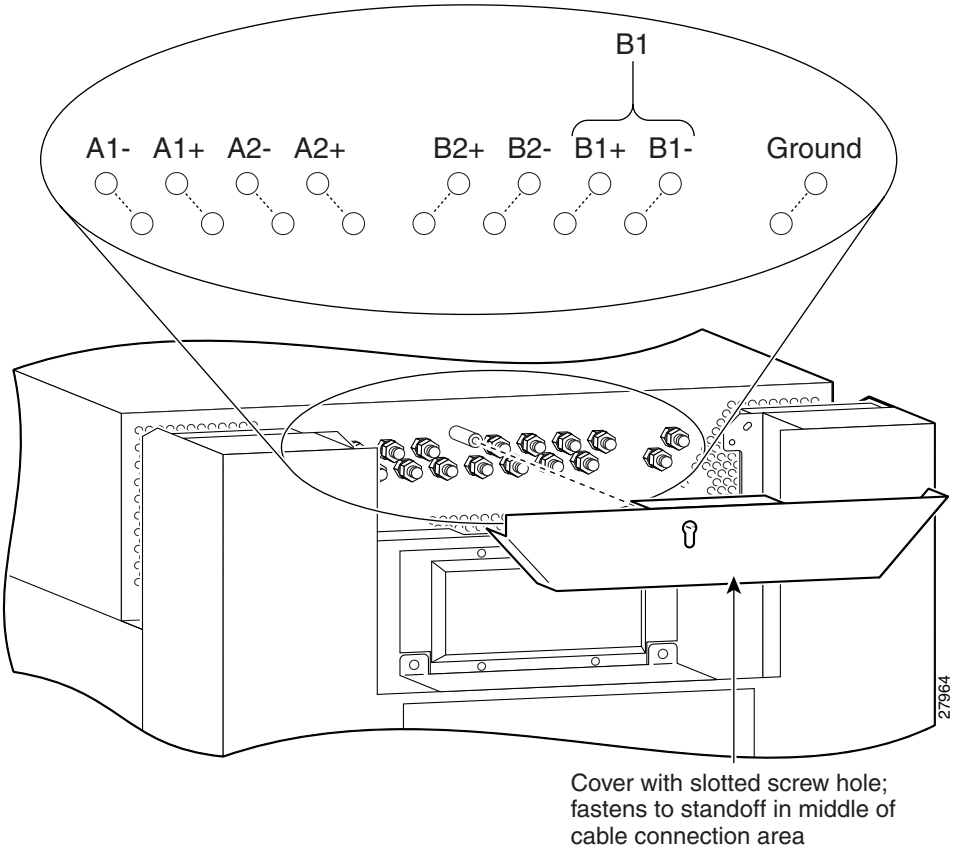


Caution A router configured for source DC operation must be operated with 4 DC-input PEMs installed at all times for electromagnetic compatibility (EMC).

Note DC PEMs support online insertion and removal (OIR) which means that you can remove and replace one PEM in each load zone (A1 or B1; A2 or B2) while the system remains powered on.

DC power to the router is provided from cables from a DC power source that are connected to threaded terminal studs on the back of the DC-input power shelf as shown in Figure 1-8.

Figure 1-8 DC-Input Power Shelf Connections

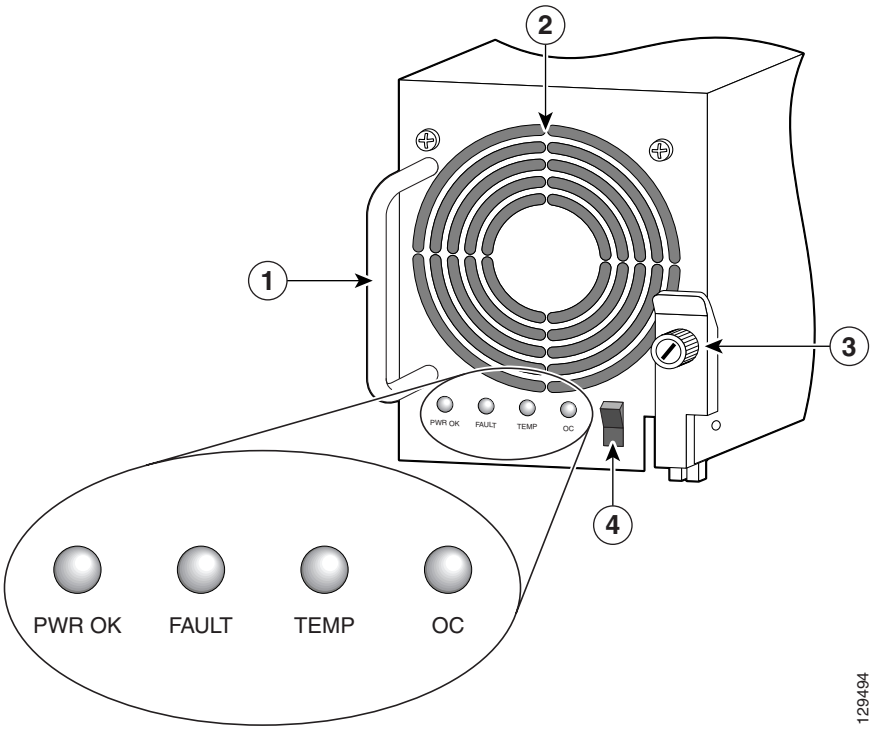


DC Power Supplies

Each DC PEM operates from a nominal source DC voltage of –48 to –60 VDC and requires a dedicated 60 amp service.

Figure 1-9 identifies the components of a 2400 W DC power supply.

Figure 1-9 2400 W DC Power Supply Components



1	Handle	**3**	Ejector lever
2	Fan	**4**	Power switch

The status LEDs on a DC PEM provide information about the current operational status of the power supply:

- PWR OK (green)—Indicates that the power supply module is operating normally.
- FAULT (yellow)—Indicates that a fault is detected within the PEM.
- TEMP (yellow)—Indicates the PEM is in an overtemperature condition and shutdown has occurred.

For additional information about troubleshooting DC PEMs, see the "Troubleshooting a DC Power Supply" section on page 4-10.

Chassis Card Cages

There are three integral card cages in the chassis: the upper card cage, the lower card cage, and the switch fabric card cage (see Figure 1-1).

Upper Card Cage

The upper card cage has eight user-configurable slots that support a combination of line cards, an alarm card, and an RP.

- Alarm—The far *left* slot is a dedicated slot for an alarm card.
- Slots 0 through 6—Can be populated with any line cards supported by the router.
- Slot 7—The far *right* slot is reserved for the RP.

Lower Card Cage

The lower card cage also has eight user-configurable slots that support additional line cards, an alarm card, and an optional, redundant RP.

Note The lower card cage is an inverted, or *head-down,* copy of the upper card cage, which means that cards are installed in an inverted or head-down orientation. The orientation of the slots is opposite that of the upper card cage.

- Slot 8—The far *left* slot is reserved for an optional redundant RP.

Note This slot may be used for a line card if you are not using an redundant RP.

- Slots 9 through 15—Can be populated with any line cards supported by the router.
- Alarm—The far *right* slot is a dedicated slot for an alarm card.

Switch Fabric Card Cage

The router ships from the factory with 2 CSCs and 3 SFCs installed in five of the eight slots in the switch fabric card cage.

- The 2 CSCs are installed in slot 0 (CSC0) or slot 1 (CSC1)
- The 3 SFCs are installed in slot 2 (SFC0), slot 3 (SFC1), and slot 4 (SFC2).
- Three non-working slots with no backplane connectors. These non-working slots are not labeled, but there is a blank filler panel installed in the far left slot to help maintain proper air flow through the chassis.

Caution Do not remove the blank filler panel unless instructed to do so by a Cisco support representative.

Switch Fabric Overview

The switch fabric provides synchronized gigabit-speed connections between line cards and the RP. The switch fabric card cage is located behind the air filter door and consists of 2 clock and scheduler cards (CSCs) and 3 switch fabric cards (SFCs). One CSC and the 3 SFCs are the active switch fabric; the second CSC provides redundancy for the other 4 cards.

Note 10-Gbps switch fabrics do not operate in 1/4-bandwidth mode as they did in some earlier models of the Cisco 12000 series routers. You must have at least one CSC and three SFCs for the system to function. You can add an additional CSC for redundancy.

Each SFC or CSC provides 10-Gbps full-duplex connection to each line card in the system. For example, in a Cisco XR 12416 and Cisco XR 12816 Router with 16 line cards, each with 2 x 10 Gbps capacity (full duplex), the system switching bandwidth is 16x 20 Gbps = 320 Gbps.

Note The Cisco XR 12416 and Cisco XR 12816 Routers support online insertion and removal (OIR), which allows you to remove and replace a card while the router remains powered on.

Switch Fabric Card Functionality

The core of the router is a crossbar switch fabric that provides synchronized connections between the line cards and the RP. The switch fabric consists of 2 clock scheduler cards (CSCs) and 3 switch fabric cards (SFCs) installed in the switch fabric card cage. One CSC and the three SFCs are the active switch fabric; the second CSC provides redundancy for the other 4 cards.

The router also ships with a blank switch fabric card installed in the far left (non-working) slot of the switch fabric card cage. The blank filler panel balances the air flow through the switch fabric card cage which helps maintain proper air flow through the chassis.

Caution Do not remove the blank filler panel unless instructed to do so by a Cisco support representative.

Clock Scheduler Cards

Clock scheduler cards provide the following functionality:

- Scheduler—Handles all scheduling requests from the line cards for access to the switch fabric.
- System clock—Supplies the synchronizing signal to all SFCs, line cards, and the RP. The system clock synchronizes data transfers between line cards or between line cards and the RP through the switch fabric.
- Switch fabric—Carries the user traffic between line cards or between the RP and a line card. The switch fabric on the CSC is identical to the switch fabric on the SFC.

The second CSC provides redundancy for the data path, scheduler, and reference clock. Traffic between the line cards and the switch fabric is monitored constantly. If the system detects a loss of synchronization (LOS), it automatically activates the data paths on the redundant CSC so data flows across the redundant paths. The switch to the redundant CSC occurs within sub-seconds (the actual switch time depends on your configuration and its scale).

Switch Fabric Cards

The switch fabric cards augment the traffic capacity of the router. SFCs contain switch fabric circuitry that can only carry user traffic between line cards or between the RP and the line cards. SFCs receive all scheduling information and the system clock signal from the CSCs.

Alarm Card and Line Card Overview

This section provides general information about alarm cards, line cards and types of route processors installed in the router.

Note The Cisco XR 12416 and Cisco XR 12816 Router supports online insertion and removal (OIR), which allows you to remove and replace a card while the router remains powered on.

Alarm Cards

The router is equipped with 2 alarm cards:

- One alarm card occupies the dedicated far left slot of the upper card cage.
- The other alarm card occupies the dedicated far right slot of the lower card cage.

The alarm card slots differ from the rest of the card cage slots in that it is labeled as an “alarm” card slot, is physically narrower than the other slots, and has a different backplane connector.

Some of the functions that the alarm cards provide are:

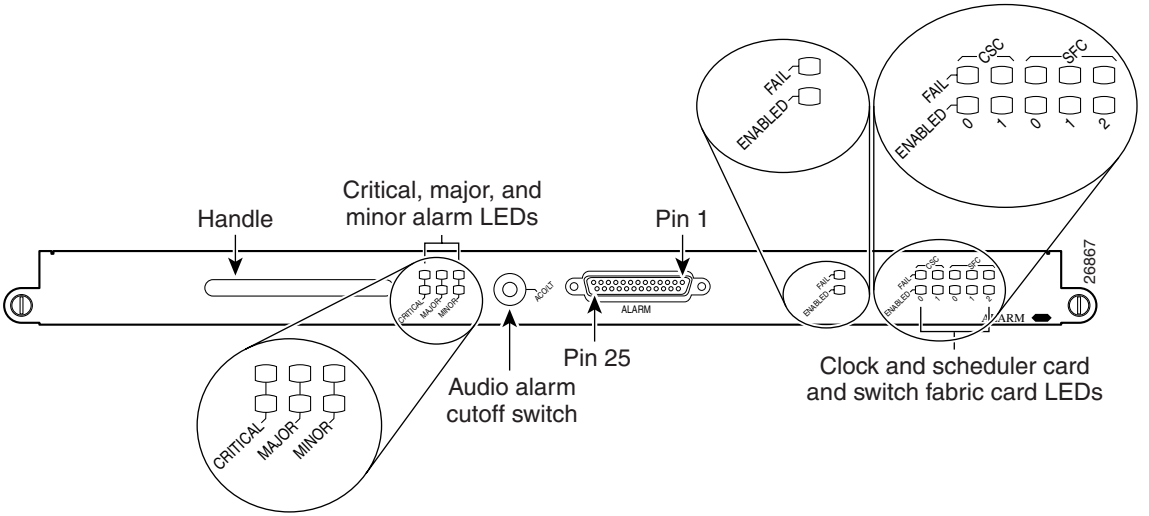
- Supplies +5 VDC to the MBus modules on router components (see AC and DC Power Subsystems, page 1-4).
- Displays alarm severity levels (critical, major, and minor) detected by the system through the MBus.
- Provides connections for an external alarm system.
- Displays the status of the alarm cards, clock scheduler cards, and switch fabric cards.

The following components and LEDs are on the front panel of the alarm card (Figure 1-10):

- Critical, Major, and Minor LEDs that identify system level alarm conditions.
- A switch to shut off an audio alarm.
- Cable connection for an external alarm (labeled Alarm)
- Alarm card LEDs:

  - ENABLED (green)—The alarm card is operational and functioning properly.
  - FAIL (yellow)—The alarm card in that slot is faulty.
- A pair of status LEDs that correspond to each of the 5 card slots in the switch fabric card cage (2 CSCs and 3 SFCs):
  - ENABLED (green)
    On—The card installed in that slot is operational and functioning properly.
    Off—Either the slot is empty or the card installed in that slot is faulty.
  - FAIL (yellow)—The card in that slot is faulty.

Figure 1-10 Alarm Card Components and LEDs



Line Cards

Up to 15 Cisco XR 12416 and Cisco XR 12816 Router line cards can be installed in the routers upper and lower card cages to support a variety of physical network media. Ports and connectors on the line card front panels provide interfaces for external connections. Line cards communicate with the RP and exchange packet data with each other through the switch fabric cards.

Caution Any unoccupied card slot in the upper and lower card cages must have a blank filler panel installed to meet electromagnetic compatibility (EMC) requirements and to ensure proper air flow through the chassis. Also, if the front panel of a line card does not completely fill the card slot opening, a narrow card filler panel must be installed to meet the EMC requirements.

A cable management bracket on the front panel of each line card helps to organize the interface cables connected to that line card.

The following line cards, SIPs, and SPAs are supported on the Cisco XR 12416 and Cisco XR 12816 Routers:

Note Refer to the current s software release notes for the most up-to-date list of supported line cards (see "Obtaining Documentation and Submitting a Service Request" section on page -xiv).

Route Processor

The route processor for the Cisco XR 12416 and Cisco XR 12816 Router is the Performance Route Processor (PRP-2). For detailed information about the PRP-2, refer to the Cisco document, *Performance Route Processor Installation and Configuration Guide*.

The PRP-2 performs the following primary functions:

- Executes routing protocol stacks
- Performs all protocol communications with other routers
- Builds and distributes forwarding information to all line cards

- Uploads the operating system software images to all installed line cards during power-up
- Provides out-of-band system console and auxiliary ports and an Ethernet port for router configuration and maintenance
- Monitors and manages the power and temperature of system components such as line cards, power supplies, and fans

The Cisco PRP-2 and PRP-3 delivers all these functions with enhanced performance and capabilities. It also delivers the following feature enhancements (depending on the software version running):

- 2 Ethernet management ports
- Hard-drive support (optional part)
- BITS input ports
- 1 GB compact image Flash memory support (optional part)
- Memory scalability up to 4 GB with PRP-2 and up to 8 GB with PRP-3.

The PRP-2 and PRP-3 communicates with the line cards either through the switch fabric or through the MBus. The switch fabric connection is the main data path for routing table distribution as well as for packets that are sent between the line cards and the PRP. The MBus connection allows the PRP-2 and PRP-3 to download a system bootstrap image, collect or load diagnostic information, and perform general, internal system maintenance operations.

The PRP-2 can be designated as either the Designated System Controller (DSC) or the Secure Domain router (SDR).

The Designated System Controller (DSC) performs the following functions:

- Implements control plane operations for the chassis
- Monitors temperature and voltage
- Monitors line cards
- On boot up, the first card to become active is designated as the DSC.

The Secure Domain Router (SDR) controls domain security features independent of any other SDRs on the network.

In addition to the functionality listed for the PRP-2, PRP-3 provides the following specific functions:

- Reduced boot time.

- Increased overall scalability.
- Improved memory access rates and scale.
- Improved CPU performance through dual 1.3-GHz PPC processor cores.
- Improved packet processing using hardware-based acceleration.
- 10-G bandwidth backplane connectivity.
- Support for all 124*xx* and 128*xx* chassis, except low–speed fabric (2.5 G).
- New ROMMON that supports IPv4 network configuration directly.

Performance Route Processor Overview

The performance route processor (PRP-2) uses a Motorola PowerPC 7457 CPU that runs at an external bus clock speed of 133 MHz and has an internal clock speed of 1.3 GHz.

Figure 1-11 identifies the slots, ports, and LEDs on the PRP front panel.

Figure 1-11 Performance Route Processor-2 (PRP-2) Front Panel

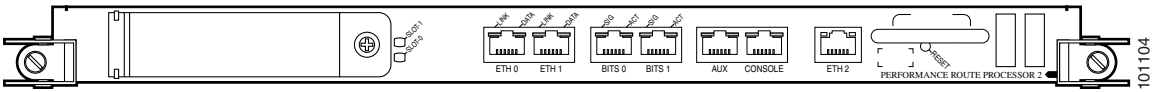


Table 1-1 Performance Route Processor-2 (PRP-2) Front Panel Hardware Components

1	PCMCIA flash disk slots (shown with cover in place) and slot LEDs	**4**	Console serial port
2	RJ-45 Ethernet ports and data status LEDs	**5**	Reset button
3	Auxiliary serial port	**6**	Alphanumeric messages

Figure 1-12 Performance Route Processor 3 (PRP-3) Front Panel

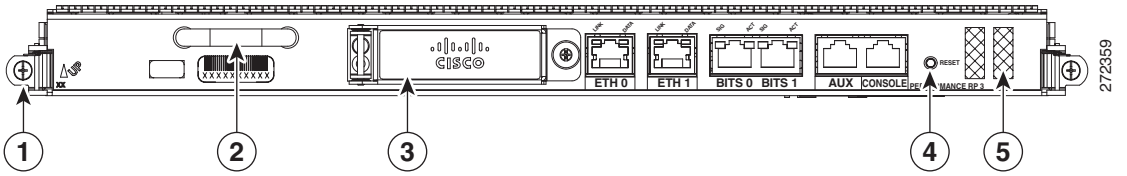


Table 1-2 PRP-3 Front Panel Hardware Components Detail

Numeric Callout	Hardware Components
1	Ejecter Lever
2	Handle
3	External Compact Flash
4	Reset button
5	Alphanumeric LEDs

PRP-3 is the route processor for the Cisco XR 12404 and 12804 Router chassis running Cisco IOS XR Software Release 3.8.0 or a later release. The PRP-3 is available as product number PRP-3 or PRP-3= for a primary route processor and is available as PRP-3/R for a redundant route processor. PRP-3 has significant improvements over PRP-2. These improvements include increased speed, improved scalability, higher system memory, faster packet processing. Because PRP-3 does not support Cisco IOS, the bootflash memory no longer exists in PRP-3. PRP-3 ROMMON has software intelligence to download a Cisco IOS XR image without the support of bootflash memory.

Note PRP-3 supports Cisco XR 12416 (10 G per slot fabric) and Cisco XR 12816 (40 G per slot fabric) Router chassis only. PRP-3 does not support Cisco XR 12004, 12006, 12010, and 12016 Router chassis (2.5 G low-speed fabric).

PRP PCMCIA Card Slots and Status LEDs

Two PCMCIA card slots (slot 0 and slot 1) provide the PRP with additional flash memory capacity. All combinations of different flash devices are supported by the PRP. You can use ATA flash disks, Type 1 or Type 2 linear flash memory cards, or a combination of the two.

Note The PRP only supports +5.2 VDC flash memory devices. It does *not* support +3.3 VDC PCMCIA devices.

Status LEDs (Slot-0 / Slot-1) indicate when the flash memory card in that slot is accessed (see Figure 1-11). Each slot has an eject button (located behind the cover) to remove a flash card from the slot.

Note PRP-3 does not have PCMCIA slots (slot 0 and slot 1). PRP-3 has an external CompactFlash (disk0:) that replaces the PCMCIA slots.

PRP Ethernet Ports and Status LEDs

The PRP has two 8-pin media-dependent interface (MDI) RJ-45 ports for either IEEE 802.3 10BASE-T (10 Mbps) or IEEE 802.3u 100BASE-TX (100 Mbps) Ethernet connections. These ports are labeled ETH 0 and ETH 1.

The transmission speed of the Ethernet port is not user-configurable. You set the speed through an autosensing scheme on the PRP which is determined by the network that the Ethernet port is connected to. However, even at an autosensed data transmission rate of 100 Mbps, the Ethernet port can only provide a usable bandwidth of substantially less than 100 Mbps. You can expect a maximum usable bandwidth of approximately 20 Mbps when using an Ethernet connection.

The following LEDs on the front panel indicate traffic status and port selection (Figure 1-13):

- LINK, EN, TX, RX—Indicate link activity (LINK), port enabled (EN), data transmission (TX), and data reception (RX).
- PRIMARY—Indicates which Ethernet port is selected (ETH 0 or ETH 1).

Note Because both ports are supported on the PRP, ETH 0 is always on. ETH 1 lights when it is selected.

Figure 1-13 PRP-2 Port Activity LEDs—Partial Front Panel

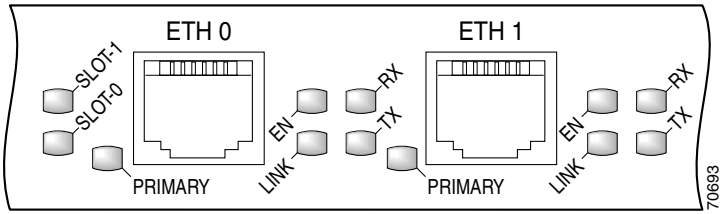
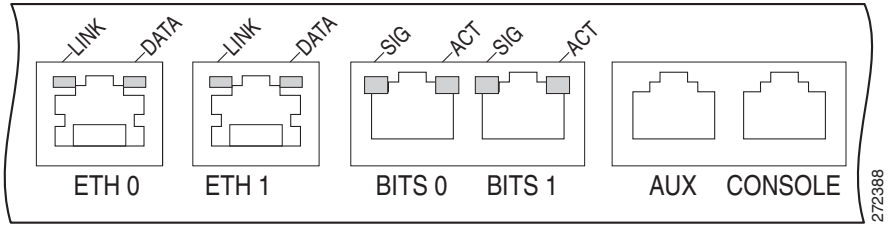


Figure 1-14 PRP-3 Port Activity—Partial Front Panel



PRP Auxiliary and Console Ports

The auxiliary and console ports on the PRP are EIA/TIA-232 (also known as RS-232) asynchronous serial ports. These ports connect external devices to monitor and manage the system.

- The auxiliary port—A (male) plug that provides a data terminal equipment (DTE) interface. The auxiliary port supports flow control and is often used to connect a modem, a channel service unit (CSU), or other optional equipment for Telnet management.
- The console port—A (female) receptacle that provides a data circuit-terminating equipment (DCE) interface for connecting a console terminal.

PRP-3 LEDs

The PRP-3 has the following LED indicators:

- Two Ethernet port LEDs used in conjunction with each of the three RJ-45 Ethernet connectors:
  - LINK—Indicates link activity
  - DATA—Indicates data transmission or reception
- Two BITS port LEDs used in conjunction with each of the two BITS ports:
  - SIG—Indicates carrier signal available
  - ACT—Indicates that the interface is active

Note BITS feature is not supported in Release 3.8.0.

- One auxiliary port (AUX) and one console port (CONSOLE) LED:
  - AUX—Used as a backup for the command outputs on the Console.
  - CONSOLE—Used for configuring the router by connecting an RJ-45 cable to the console terminal. The router can be configured through the console terminal.

PRP Reset Switch

Access to the (soft) reset switch is through a small opening in the PRP front panel (see Figure 1-11). To press the switch, insert a paper clip or similar small pointed object into the opening.

Caution The reset switch is *not* a mechanism for resetting the PRP and reloading the Cisco IOS image. It is intended for software development use only. To prevent system problems or loss of data, use the reset switch only on the advice of Cisco service personnel.

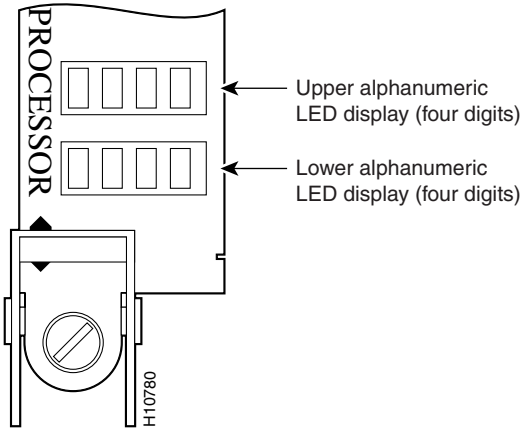
Pressing the reset switch causes a nonmaskable interrupt (NMI) and places the PRP in ROM monitor mode. When the PRP enters ROM monitor mode, its behavior depends on the setting of the PRP software configuration register. For example, if the boot field of the software configuration register is set to:

- 0x0—The PRP remains at the ROM monitor prompt (rommon>) and waits for a user command to boot the system manually.
- 0x1—The system automatically boots the first Cisco IOS image found in flash memory on the PRP.

PRP Alphanumeric Message Displays

The alphanumeric message displays are organized in two rows of four LED characters each (Figure 1-15).

Figure 1-15 Alphanumeric Message Displays—Partial Front Panel



The alphanumeric message displays show router status messages during the boot process, and after the boot process is complete.

- During the boot process, the message displays are controlled directly by the MBus module.
- After the boot process, the message displays are controlled by Cisco IOS XR software (through the MBus).

The alphanumeric messages also provide information about different levels of system operation, including the status of the PRP, router error messages, and user-defined status and error messages

Note A list of all system and error messages appears in the *Cisco IOS System Error Messages* publication (see the "Obtaining Documentation and Submitting a Service Request" section on page -xiv).

PRP Memory Components

This section describes various types of memory used on the PRP to support router functions. Table 1-3 provides a quick reference of the different types of memory, and Figure 1-16 shows the location on the PRP board.

Table 1-3 PRP-2 Memory Components

Type	Size	Quantity	Description	Location
SDRAM[1]	2 GB (default) or 4 GB (optional)	1 or 2	2-GB or 4-GB DIMMs (based on desired SDRAM configuration) for main Cisco IOS XR software functions	U15 (bank 1)[2] U18 (bank 2)
SRAM[3]	2 MB (fixed)	—	Secondary CPU cache memory functions	—
NVRAM[4]	2 MB (fixed)	1	System configuration files, register settings, and logs	—
HDD	40 GB	1	Contains log and crash information for specific Cisco IOS XR versions.	—
Flash memory	2 GB or 4 GB (optional) Compact Flash	1	Contains Cisco IOS XR boot image (bootflash), crash information, and other user-defined files	P3
	4 MB Boot ROM	1	Stores the ROMMON minimum boot image (MBI).	—
	Flash disks[5] 2 GB (default) or 4 GB (optional)	1 or 2	Contains Cisco IOS XR software images, system configuration files, and other user-defined files on up to two flash disks	Flash disk slot 0 and slot 1
	1 GB CF[6]	1	Contains large Cisco IOS XR software images	—

1. Default SDRAM configuration is 2-GB for PRP-2. Bank 1 (U15) must be populated first. You can use one or both banks to configure SDRAM combinations of 2 GB and 4 GB for the PRP-2. 1.5-GB configurations.and DIMM devices that are not from Cisco are not supported.
2. If both banks of the PRP-2 are populated, bank 1 and bank 2 must contain the same size DIMM.
3. SRAM is not user configurable or field replaceable.
4. NVRAM is not user configurable or field replaceable.
5. ATA Flash disks are supported in the PRP-2.
6. Optional PRP-2 hardware. Compact disks that are not from Cisco are not supported.

Figure 1-16 PRP-2 Memory Locations

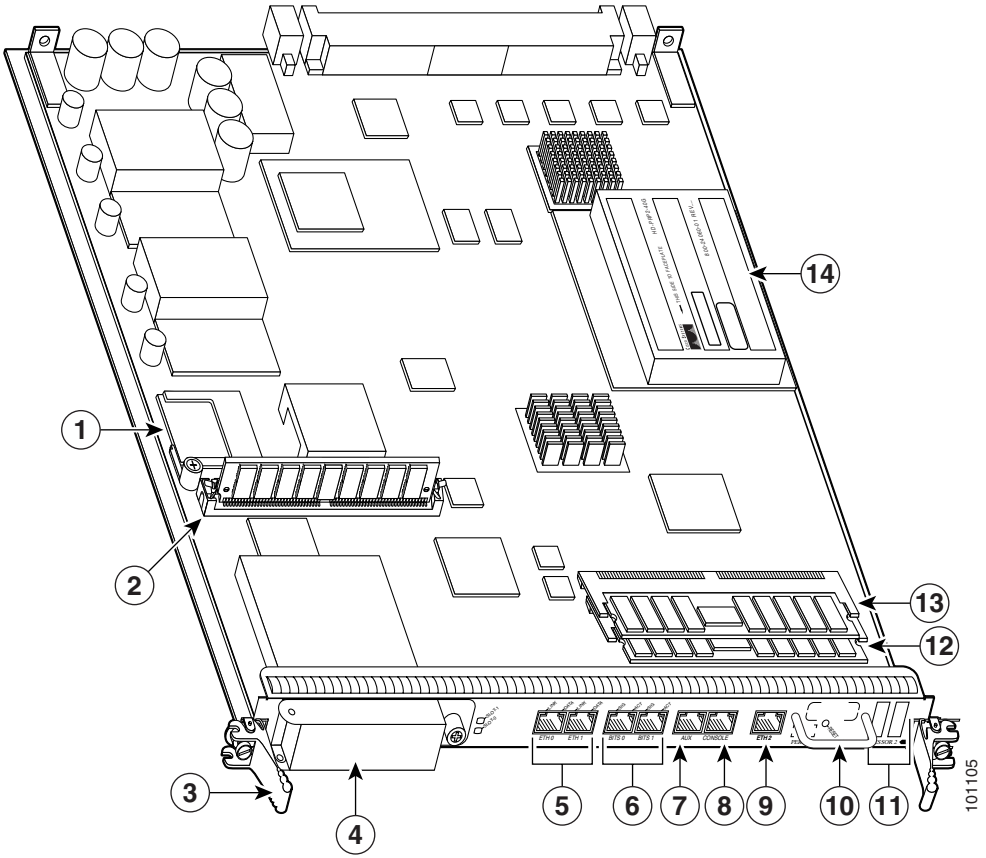
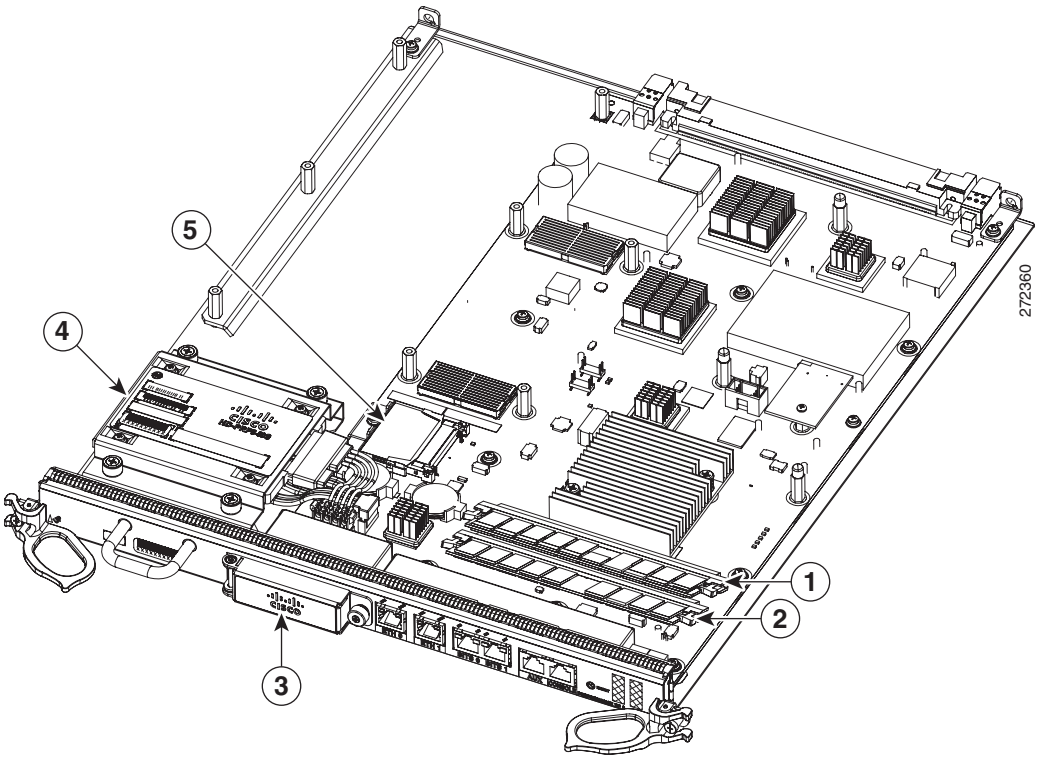


Figure 1-17 PRP-3 Memory Locations



1	SDRAM DIMM: Bank 1 - Socket number U8
2	SDRAM DIMM: Bank 2 - Socket number U10
3	External CompactFlash
4	Hard disk (80 GB)
5	Internal CompactFlash

Table 1-4 PRP-3 Memory Components

Type	Size	Quantity	Description	Location
SDRAM[1]	2 GB (Default) for each DDR2 DRAM for a total system memory of 4 GB, option for upgrade to total system memory of 8 GB (4 GB each).	2	Two 2-GB default DDR2 DRAM for main CiscoIOSXR software functions. Provision for optional upgrade to 4 GB also possible to provide total system memory of 8 GB.	U8 (bank 1)[2] U10 (bank 2)
NVRAM[3]	2 MB (fixed)	1	System configuration files, register settings, and logs	—
Flash memory	2 GB (default) or 4 GB (optional) Flash disks[4]	2 (Internal and External Compact Flash)	Contains Cisco IOS XR software images, system configuration files, and other user-defined files on two CompactFlash.	Internal and External Compact Flash[5]
Flash boot ROM	8 MB	1	Flash EPROM for the ROM monitor program boot image	—
HDD[6]	80 GB SATA	1	Contains log and crash information for specific Cisco IOS XR versions	—

1. Default SDRAM configuration is a total of 4 GB (2 x 2GB) system memory for PRP-3. Bank 1 (U15) must be populated first. You can use one or both banks to configure DDR2 DRAM combinations of 2 GB or 4 GB for the PRP-3. DIMM devices that are not from Cisco are not supported.
2. If both banks of the PRP-3 are populated, bank 1 and bank 2 must contain the same size DIMM.
3. NVRAM is not user configurable or field replaceable.
4. ATA Flash disks are supported in the PRP-3.
5. PRP-3 provides an onboard internal CompactFlash and also an external CompactFlash. The external CompactFlash in PRP-3 replaces the two PCMCIA slots (slot0 and slot1) of PRP-2.
6. Hard disk drives that are not from Cisco are not supported.

PRP SDRAM

The PRP uses Error Checking and Correction (ECC) Synchronized Dynamic Random Access Memory (SDRAM) to store routing tables, protocols, network accounting applications, and to run Cisco IOS software.

Table 1-5 lists the DRAM configurations for the PRP. If you are using:

- One DIMM—Bank 1 (U15) must be populated first.
- Two DIMMs—You cannot mix memory sizes; both banks must contain the same size DIMM.

Table 1-5 PRP-2 DRAM Configurations

Total SDRAM	SDRAM Sockets	Number of DIMMs
2 GB[1]	U15 (bank 1) U18 (bank 2)	One 2 GB DIMM or Two 2 GB DIMMs
4 GB	U15 (bank 1) U18 (bank 2)	One 4 GB DIMM or Two 4 GB DIMMs

1. Default shipping configuration.

Caution DRAM DIMMs must be 3.3-volt, 60-nanosecond devices only. Do not attempt to install other devices in the DIMM sockets. To prevent memory problems, use the Cisco approved memory products listed in Table 1-5.

PRP-3 provides more system memory than PRP-2. PRP-3 is shipped with 2 GB of system memory in each DDR2 DRAMs, for a total of 4 GB and provides an upgrade option for a total of 8 GB (4 GB x 2 DRAM).

Note The two DIMMs must be of the same sizes. Do not use two different DIMM sizes together.

Table 1-6 PRP3 DDR2 DRAM Configuration

Total SDRAM	SDRAM Sockets	Number of DIMMs
4 GB	U8 (bank 1) U10 (bank 2)	Two 2 GB DIMMs
8 GB	U8 (bank 1) U10 (bank 2)	Two 4 GB DIMMs

PRP SRAM

Static Random Access Memory (SRAM) provides 2 MB of secondary CPU cache memory. Its principal function is to act as a staging area for routing table updates, and for information sent to and received from the line cards. SRAM is *not* user-configurable and cannot be upgraded in the field.

PRP NVRAM

Non-volatile Random Access Memory (NVRAM) provides 2 MB of memory for system configuration files, software register settings, and environmental monitoring logs. Built-in lithium batteries retain the contents of NVRAM for a minimum of 5 years. NVRAM is *not* user configurable and cannot be upgraded in the field.

PRP Flash Memory

Use flash memory to store multiple Cisco IOS XR software and microcode images that you can use to operate the router. You can download new images to flash memory over the network (or from a local server) to replace an existing image, or to add it as an additional image. The router can be booted (manually or automatically) from any of the stored images in flash memory.

Flash memory also functions as a Trivial File Transfer Protocol (TFTP) server to allow other servers to boot remotely from the stored images, or to copy them into their own flash memory.

The system uses two types of flash memory:

- Onboard flash memory (called *bootflash)*—Contains the Cisco IOS boot image
- Flash memory disks (or cards)—Contain the Cisco IOS software image

Table 1-7 lists supported flash disk sizes and Cisco part numbers.

Table 1-7 Supported Flash Disk Sizes

Flash Disk Size[1]	Part Number
2 GB[2]	MEM-FD2G=
4 GB	MEM-FD4G=

1. 4 GB is supported with 2 GB mode prior to Release 3.8.0.
2. Default shipping configuration.

PRP-3 Compact Flash

PRP-3 provides more flash memory than PRP-2. PRP-3 uses flash memory to store Cisco IOS XR software images. PRP-3 includes a default internal flash memory of 2 GB and also has an external flash memory of 2 GB. A flash memory upgrade option is also available for a total of 8 GB (2 x 4 GB).

Caution PRP-3 systems are shipped with dual compact flash disks. The internal compact flash is the recommended boot device and should not be removed even if not being used as a boot device.

PRP-2 and PRP-3 compactflashes are not compatible with each other and hence PRP-2 compactflash cannot be used in PRP-3 and vice versa. PRP-3 uses Multiword DMA to access the compactflash device, a PRP-2 compactflash does not support this access type.

Note The PRP-3 external CompactFlash disk replaces the two PCMCIA slots of PRP-2. The external CompactFlash disk can be installed or removed from the PRP-3 front panel. The internal CompactFlash disk memory is denoted as compactflash, while the external CompactFlash disk is denoted as disk0:.

Table 1-8 PRP-3 CompactFlash Disk Sizes

Flash Disk Size	Part Numbers
2 GB	FLASH-PRP3-2G(=)
4 GB	FLASH-PRP3-4G(=)

Upper and Lower Cable Management Brackets

The Cisco XR 12416 and Cisco XR 12816 Router includes upper and lower cable management brackets that work together with individual line card cable management brackets to organize interface cables entering and exiting the router (see Figure 1-1).

Network interface cables to the line cards are fed across the brackets, and then through the openings to the individual line card cable management bracket. This system keeps cables out of the way and free of sharp bends.

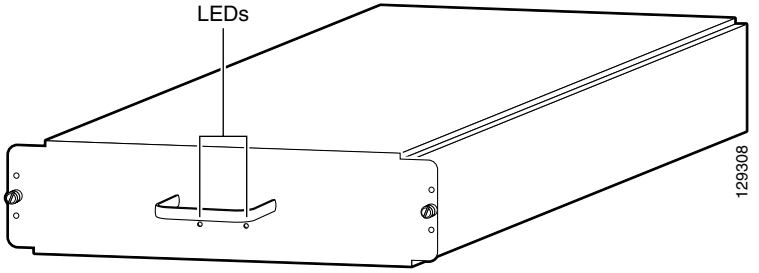
Caution Excessive bending of interface cables can damage the cables.

Blower Module

The router has two blower modules to distribute air within the chassis. One blower module is located above the upper card cage; the second blower module is located below the lower card cage (see Figure 1-1).

Each blower module contains three variable speed fans and a controller card. The two front cover LEDs provide a visual indication of blower module status (Figure 1-18):

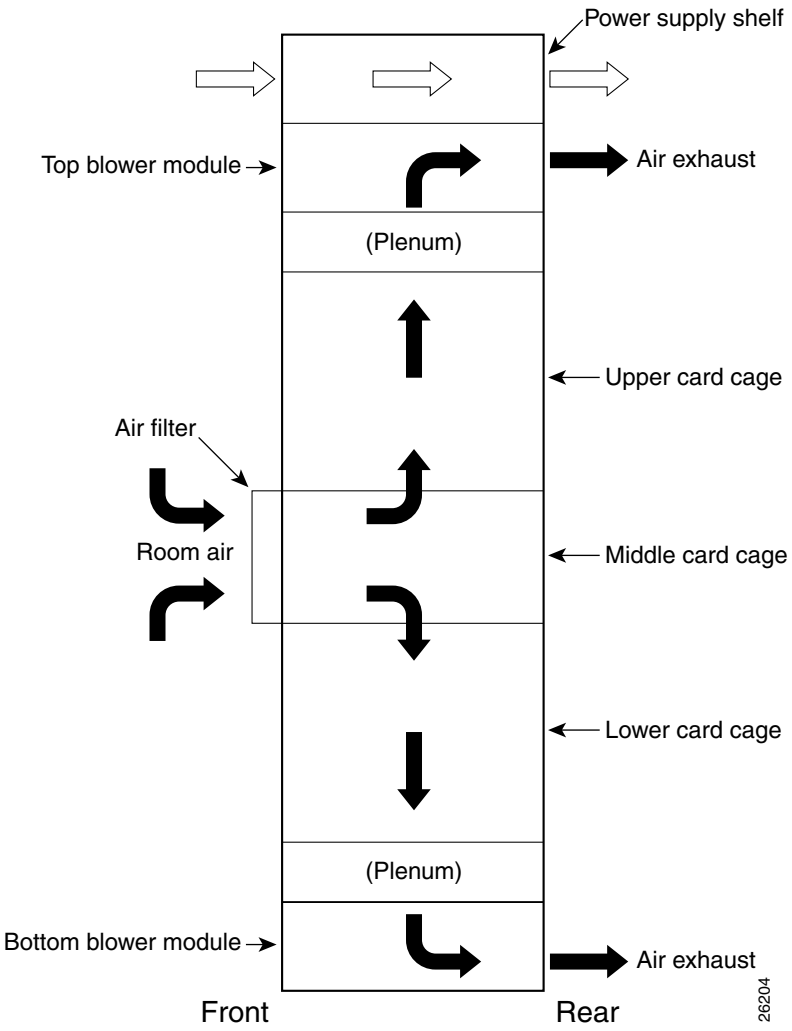
Figure 1-18 Blower Module



- OK (green)—All three fans are operating normally.
- FAIL (red)—The system has detected a fan failure or other fault in the blower module. The fault can be caused by any of the following:
  - One or more fans are not operating
  - One or more fans are running below speed
  - A controller card fault

The blower modules maintain acceptable operating temperatures for the internal components by drawing cool air through a replaceable air filter into the switch fabric card cage and then through the upper and lower card cages. Figure 1-19 illustrates the air flow path through the chassis.

Figure 1-19 Cooling Air Flow



To ensure that there is adequate air flow to prevent overheating inside the card cages keep the front and back of the router unobstructed. We recommend at least 6 inches (15.24 cm) of clearance.

Caution You should inspect and clean the air filter one time per month (more often in dusty environments). Do not operate the router without an air filter installed.

The blower module controller card monitors and controls operation of three variable-speed fans in the blower modules. The variable-speed feature allows quieter operation by running the fans at below maximum speed, while still providing adequate cooling to maintain an acceptable operating temperature inside the card cages.

Two temperature sensors on each line card monitor the internal air temperature in the card cages:

- When the ambient air temperature is within the normal operating range, the fans operate at their lowest speed, which is 55 percent of the maximum speed.
- If the air temperature rises inside the card cages the fan speed increases to provide additional cool air to the cards.
- If the air temperature continues to rise beyond the specified threshold, the system environmental monitor shuts down all internal power to prevent equipment damage due to excessive heat.
- If the system detects that one of the three fans within a blower module has failed, it displays a warning message on the console window. In addition, the two remaining fans go to full speed to compensate for the loss of the one fan. If another fan fails, the system shuts down to prevent equipment damage.

For additional troubleshooting information, see the "Blower Module Operation" section on page 4-36.