



Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router System Description

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Preface

This preface explains the objectives, intended audience, and organization of this *Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router System Description*, commonly referred to as the “system description” in this document, and presents the conventions that convey additional information.

Objective

This system description describes the Cisco CRS 16-Slot Line Card Chassis (LCC) Enhanced router from a high level. It provides background information and basic theory of operation for anyone wanting to understand the routing system. It describes the major assemblies that comprise the routing system. It can be read as a supplement to the site planning guide, installation documents, and software documents. This system description focuses on the hardware elements of the routing system.

Audience

This guide is intended for general audiences who want an overview of the Cisco CRS Series Carrier Routing System and its major components.

Document Organization

This system description contains the following chapters and appendixes:

- [Chapter 1, “Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Overview,”](#) provides an overview of the routing system.
- [Chapter 2, “Power Systems,”](#) provides a detailed physical description of the chassis DC and AC power systems.
- [Chapter 3, “Cooling System,”](#) provides an overview of the chassis cooling system.
- [Chapter 4, “Switch Fabric,”](#) provides an overview of the switch fabric. It also describes the switch fabric cards used in the single-chassis system and the multishelf system.
- [Chapter 5, “Line Cards and Physical Layer Interface Modules,”](#) provides an overview of the MSC (line card) and its associated PLIMs.

- [Chapter 6, “Route Processor,”](#) provides an overview of the route processor (RP), performance route processor (PRP), distributed route processor (DRP), and DRP physical layer interface module (PLIM).
- [Chapter 7, “Single-Chassis System Summary,”](#) provides a summary of the single-chassis system and includes brief introduction of the routing system cabling requirements. This chapter also describes the Building Integrated Timing System (BITS).
- [Chapter 8, “Control Plane,”](#) provides an overview of the routing system control plane, logical routers, and system diagnostics.
- [Appendix A, “Cisco CRS Carrier Routing System 16-Slot Enhanced Line Card Chassis Specifications,”](#) provides tables of specifications for the LCC and its components.
- [Appendix B, “Product IDs,”](#) provides information about the product structure and product IDs for components of the Cisco CRS Carrier Routing System 16-Slot Enhanced Chassis Line Card Chassis.

Document Conventions

This guide uses the following conventions:



Note

Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.



Caution

Means *reader be careful*. You are capable of doing something that might result in equipment damage or loss of data.

Warning Definition



Warning

IMPORTANT SAFETY INSTRUCTIONS

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

See [Cisco CRS Carrier Routing System Regulatory Compliance and Safety Information](#) for translations of warnings and information about the compliance and safety standards with which the Cisco CRS conforms.

Related Cisco CRS Series Documentation

For complete planning, installation, and configuration information, refer to the following documents:

Hardware Documents

- [Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Site Planning Guide](#)
- [Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Installation Guide](#)
- [Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Unpacking, Moving, and Securing Guide](#)
- [Cisco CRS Carrier Routing System SIP and SPA Hardware Installation Guide](#)
- [Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Hardware Operations and Troubleshooting Guide](#)
- [Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note](#)
- [Cisco CRS Carrier Routing System Packet-over-SONET/SDH Physical Layer Interface Module Installation Note](#)
- [Cisco CRS-1 Carrier Routing System to Cisco CRS-3 Carrier Routing System Migration Guide](#)
- [Cisco CRS Carrier Routing System Regulatory Compliance and Safety Information](#)

Software Documents

For a complete list of software documentation available for the Cisco CRS Carrier Routing System, see *About Cisco IOS-XR Software Documentation*, available online at <http://www.cisco.com>.

See the “[Obtaining Documentation and Submitting a Service Request](#)” section on page viii for more information.

Changes to This Document

[Table 1](#) lists the technical changes made to this document since it was first published.

Table 1 Document Change History

Revision	Date	Change Summary
OL-25578-04	July 2014	Added updates to support the Cisco CRS-X 400G back-to-back and multishelf systems, which include new CRS-16-FC400/M switch fabric card.
OL-25578-03	January 2014	Added updates to support the Cisco CRS-X, which includes new line cards, switch fabric cards, and PLIMs.

Table 1 Document Change History (continued)

Revision	Date	Change Summary
OL-25578-02	May 2012	Minor updates to Route Processor dimensions and product specifications.
OL-25578-01	October 2011	<p>Initial release of this document.</p> <p>This document introduces the Cisco CRS 16-Slot Line Card Chassis Enhanced router. The Cisco CRS 16-Slot Line Card Chassis Enhanced router includes the following new features:</p> <ul style="list-style-type: none"> • The midplane on the Cisco CRS 16-Slot Line Card Chassis Enhanced router is redesigned to support 400G per slot. • A new reduced height Power Shelf has been introduced for the Cisco CRS 16-Slot Line Card Chassis Enhanced router, which results in larger space for air intake (at the bottom of the chassis). This increases the overall cooling efficiency of the chassis. • A new Alarm Card has been introduced for the Cisco CRS 16-Slot Line Card Chassis Enhanced router that is designed to fit in the new reduced height Power Shelf. • The Cisco CRS 16-Slot Line Card Chassis Enhanced router Fan Controller monitors and controls nine cooling fans per fan tray using Pulse Width Modulation (PWM). This new Pulse Width Modulation (PWM) controlled Fan Tray gets power directly from the midplane. The Cisco CRS 16-Slot Line Card Chassis router used Voltage Controlled Fan Trays. • The Cisco CRS 16-Slot Line Card Chassis Enhanced router removes the zone circuit breaker and power-zoning requirement.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

<http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html>

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS version 2.0.



Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Overview

This chapter provides an overview of the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router, referred to as LCC in this document. It contains the following sections:

- [Overview, page 1-1](#)
- [Line Card Chassis Components, page 1-3](#)
- [Main Features of the Cisco CRS Series Carrier Routing System, page 1-5](#)
- [Chassis Overview, page 1-5](#)
- [Safety Guidelines, page 1-12](#)
- [Preventing Electrostatic Discharge, page 1-12](#)

Overview

The 16 slots in the LCC can contain the following:

- Modular services cards (MSCs)
- Forwarding processor (FPs) cards
- Label switch processor (LSP) cards



Note MSCs, FPs, and LSPs are referred to as line cards.

- Associated physical layer interface modules (PLIMs)
- SPA Interface Processors (SIPs)

Each slot has the capacity of up to 400 gigabits per second (Gbps) ingress and 400 Gbps egress, for a total routing capacity per chassis of 12800 Gbps or 12.8 terabits per second (Tbps). (A terabit is 1×10^{12} bits or 1000 gigabits.)

The LCC supports 40G, 140G, and 400G fabric cards, as follows:

- The Cisco CRS-1 Carrier Routing System uses fabric cards designed for 40 G operation (CRS-16-FC/S or CRS-16-FC/M cards).
- The Cisco CRS-3 Carrier Routing System uses fabric cards designed for 140G operation (CRS-16-FC140/S or CRS-16-FC140/M cards).

- The Cisco CRS-X Carrier Routing System uses fabric cards designed for 400G operation (CRS-16-FC400/S or CRS-16-FC400/M cards).

A mixture of 40G, 140G, and 400G fabric cards is not supported except during migration.



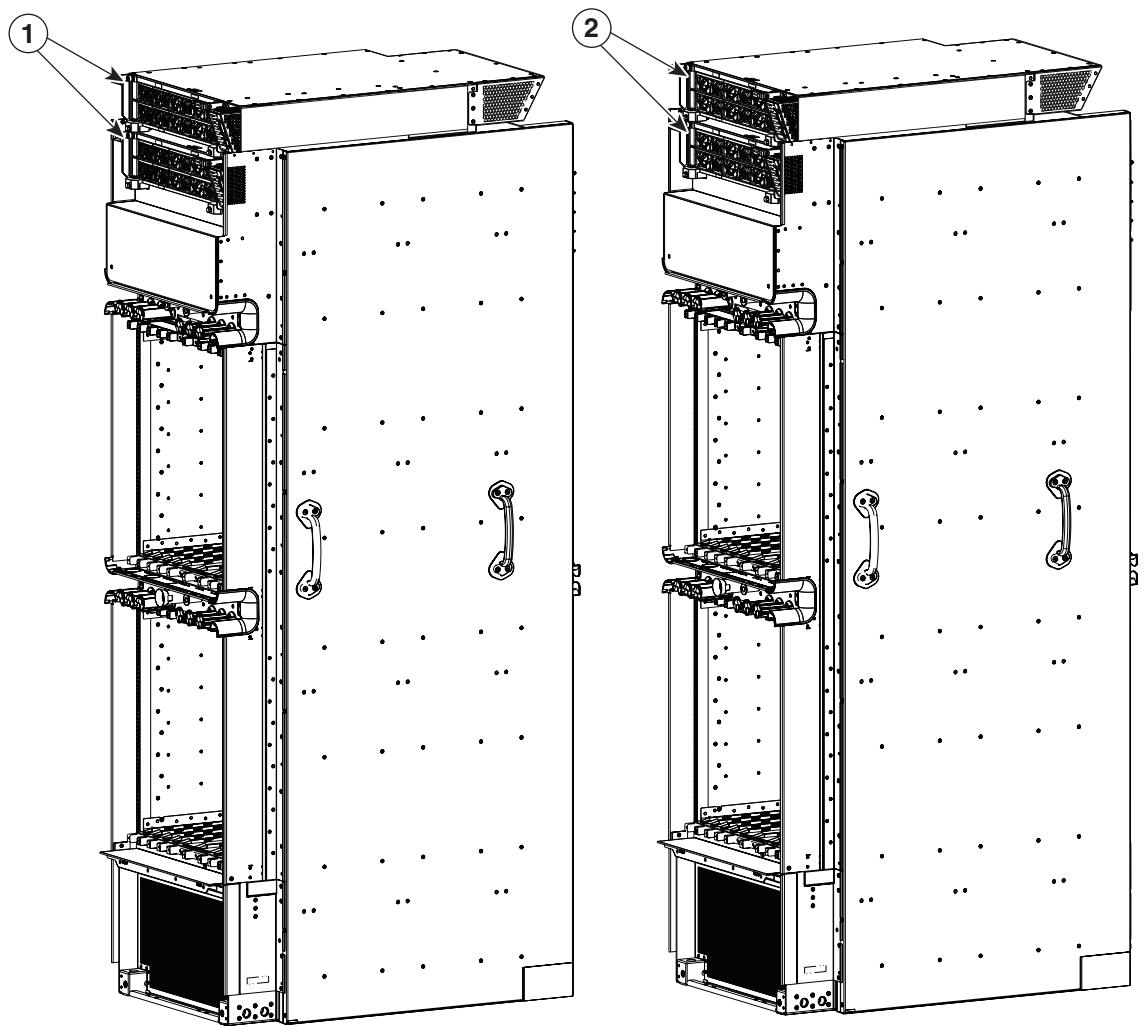
Note

Throughout this document, the generic term Cisco CRS Carrier Routing system refers to the Cisco CRS-1, Cisco CRS-3, and Cisco CRS-X Carrier Routing Systems, unless otherwise specified.

The chassis has an integrated rack and does not require an external rack. It is bolted to the facility floor. It contains its own power and cooling systems. Power systems are available using AC or DC power.

Figure 1-1 shows the front view of the LCC with AC and DC power shelves installed.

Figure 1-1 LCC Front (PLIM) Side View

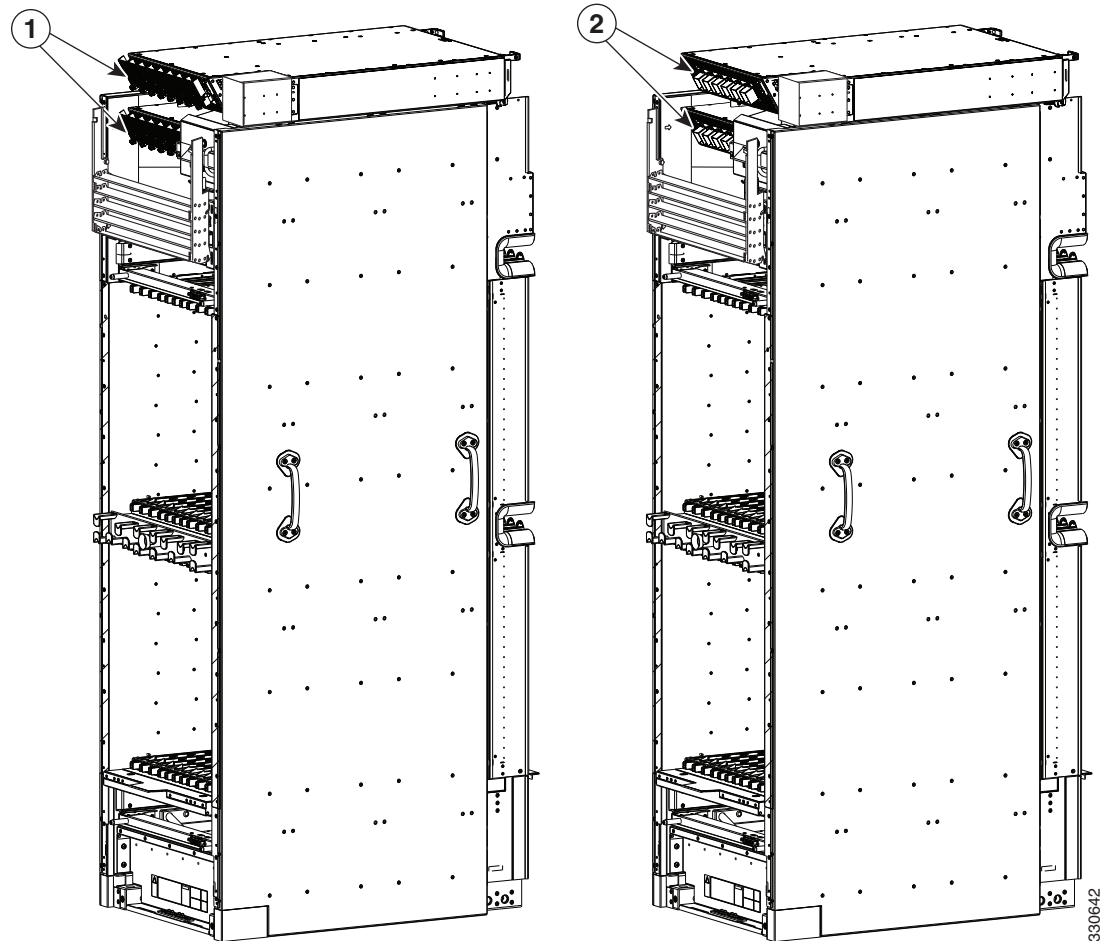


1 DC power shelves (two installed)

2 AC power shelves (two installed)

Figure 1-2 shows the rear view of the LCC.

Figure 1-2 Line Card Chassis Rear (MSC) Side View



1	DC power shelves (two installed)	2	AC power shelves (two installed)
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Line Card Chassis Components

This section lists the main components of the LCC. It primarily identifies the components that are considered field-replaceable units (FRUs), but where additional detail is useful, identifies subassemblies that are not field replaceable.

The line card chassis contains:

- Up to 16 line cards, associated PLIMs, and SIPs/SPAs. A line card and a PLIM or SIP/SPA are an associated pair of cards that connect through the chassis midplane. The line card provides the forwarding engine for Layer 3 routing of user data that is switched through the system, and the PLIM or SIP/SPA provides the physical interface and connectors for the user data.



Note For a complete list of available PLIMs, consult your Cisco sales representative or visit: <http://www.cisco.com>

- The MSC card is available in the following versions: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X (400G mode).
- The FP card is available in the following versions: CRS-FP140, CRS-FP-X (400G mode).
- The LSP card is available in the following versions: CRS-LSP, CRS-LSP-X.
- Each line card can be associated with different types of PLIMs, which provide different interface speeds and technologies. Note the following:
 - The CRS-MSC-B card is compatible with both 40G CRS-1 and 140G CRS-3 fabric cards.
 - The CRS-MSC-140G card is only compatible with the 140G CRS-3 fabric card.
 - The CRS-MSC-X card is only compatible with the 400G CRS-X fabric card.
- Chassis midplane. The midplane connects a line card to its associated PLIM. The midplane design allows the line card to be removed from the chassis without having to disconnect the cables that are attached to the associated PLIM. The midplane, which also distributes power, connects the line cards to the switch fabric cards, and provides control plane interconnections, is not field replaceable by the customer.
- Two route processor cards (RPs). The RPs provide the intelligence of the system by functioning as the chassis system controller. There are two types: RP and Performance Route Processor (PRP).



Note A chassis may not be populated with a mix of RP and PRP cards. Both route processor cards should be of the same type (RP or PRP).

- Eight switch fabric cards. These fabric cards provide a three-stage Benes switch fabric for the system.
 - As a single-shelf (standalone) system, the line card chassis contains S123 switch fabric cards that provide all three stages of the three-stage Benes switch fabric.
 - As part of a multishelf system, the LCC contains S13 fabric cards that provide stage 1 and stage 3 of the switch fabric. S2 fabric cards in the FCCs provide stage 2 of the fabric, and fabric cables connect the fabric cards to each other.



Note The LCC supports either 40G fabric cards (FC/S cards), 140G fabric cards (FC-140/S cards), or 400G fabric cards (FC-400/S cards). An LCC with a mix of 40G, 140G, and 400G fabric cards is not a supported mode of operation. Such a mode is temporarily allowed only during the upgrade process.

- A power system that provides redundant power to the chassis. Two types of power systems are available: either AC or DC power.
- Two alarm modules. The alarm modules provide external alarm system connections. The alarm modules are located in the AC or DC power shelves.
- Upper and lower fan trays. The trays push and pull air through the chassis. A removable air filter is located above the lower fan tray.
- Two fan controller cards. The cards control the speed of high-speed fans in the fan trays to adjust the airflow for ambient conditions.

- Front and rear cable management features. The front (PLIM) side of the chassis has horizontal cable management brackets above both card cages. The rear (MSC) side of the chassis has one cable management bracket located in the middle of the chassis above the lower card cage.

Main Features of the Cisco CRS Series Carrier Routing System

The main features of all Cisco CRS Series routing systems include:

- A highly scalable router that provides a routing capacity between 1.28 and 12.8 Tbps.
- A wide range of interface speeds and types (for example, OC-48 packet-over-SONET or POS) and OC-192 POS), and a programmable MSC or FP forwarding engine that provides full-featured forwarding at line-rate speeds.
- Redundancy and reliability features allow nonstop operation even during service upgrades of equipment, with no single points of failure in hardware or software.
- Potential for expanding from single-chassis to multichassis (or multishelf) systems.
- Partitioning into logical routers. A logical router (LR) is a set of MSCs or FPs and route processors (RPs) that form a complete router. More specifically, each LR contains its own instance of dynamic routing, IP stack, SysDB (system database), interface manager, event notification system, and so on.

Chassis Overview

This section provides an overview of the physical chassis characteristics:

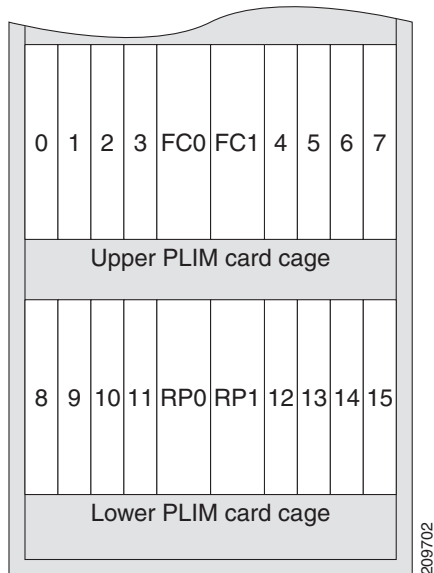
- [Slot Numbers, page 1-5](#)
- [Chassis Cable Management, page 1-8](#)
- [Chassis Exterior Components, page 1-8](#)

Slot Numbers

A single-shelf (standalone) system consists of a single LCC. A multishelf system includes up to nine LCCs and connects up to four switch fabric card chassis.

This section identifies the locations of and slot numbers for major cards that plug into the chassis.

[Figure 1-3](#) shows the chassis slot numbers on the PLIM side of the LCC.

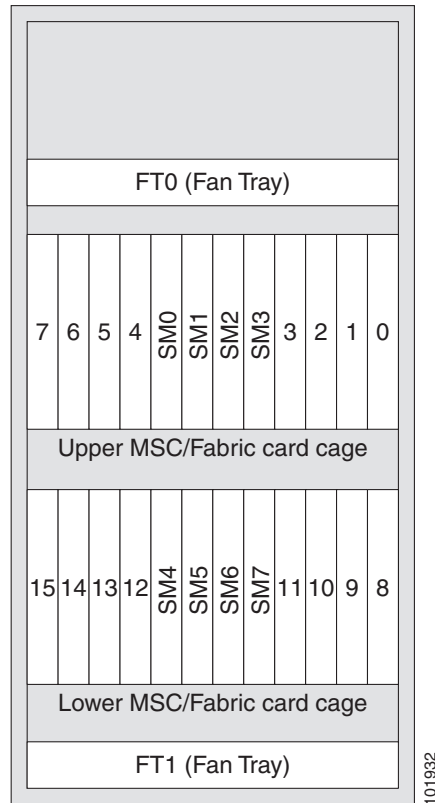
Figure 1-3 Line Card Chassis Front (PLIM) Side Slot Numbers

As shown in [Figure 1-3](#), the components on the front (PLIM) side of the chassis include:

- Upper PLIM card cage with eight PLIM slots (left to right: 0, 1, 2, 3, 4, 5, 6, 7) spaced around two double-width fan controller card slots, FC0 and FC1. (These thicker-width slots accept only the two fan controllers.)
- Lower PLIM card cage with eight PLIM slots (left to right: 8, 9, 10, 11, 12, 13, 14, 15) and two double-width route processor card slots, RP0 and RP1. (These thicker-width slots accept only the RPs.)

Figure 1-4 shows the chassis slot numbers on the rear (MSC) side of the LCC.

Figure 1-4 Rear (MSC) Side Slot Numbers



As shown in Figure 1-4, the components on the rear (MSC) side of the chassis include:

- Upper fan tray (FT0)
- Upper card cage, eight MSC slots (left to right: 7, 6, 5, 4, 3, 2, 1, 0) spaced around four switch fabric card slots (SM0, SM1, SM2, and SM3)
- Lower card cage, eight MSC slots (left to right: 15, 14, 13, 12, 11, 10, 9, 8) spaced around four switch fabric card slots (SM4, SM5, SM6, and SM7)
- Lower fan tray (FT1)

The MSC slot numbers on the rear of the chassis are reversed from the PLIM slot numbers on the front side of the chassis. A mated MSC and PLIM are slot specific and mated through the midplane. The MSC slot 0, on the far right side of the chassis looking at it from the rear (MSC) side, is mated with the PLIM slot 0, on the far left side of the chassis looking at it from the front (PLIM) side. All other MSC and PLIM slots (2 through 15) are mated via matching slot numbers through the midplane also.

Chassis Cable Management

The LCC has cable management features for both the front (PLIM) and rear (MSC) sides of the chassis. The PLIM side has horizontal cable management features above both card cages. The horizontal cable management trays have a special telescoping feature that allows them to be extended when the chassis is upgraded with higher-density cards. This extension feature also helps when installing the cables in the chassis. Ensure that the horizontal cable management trays are pushed in before closing the front door.

There are two types of vertical cable troughs as part of the chassis cable management: standard width and wider width.

The MSC side of the chassis has one cable management system above the lower card cage (in the middle of the chassis). These cable management trays are not telescoping because there is a preset amount of fiber cabling to be managed.

Chassis Exterior Components

This section contains information about the exterior cosmetic components.

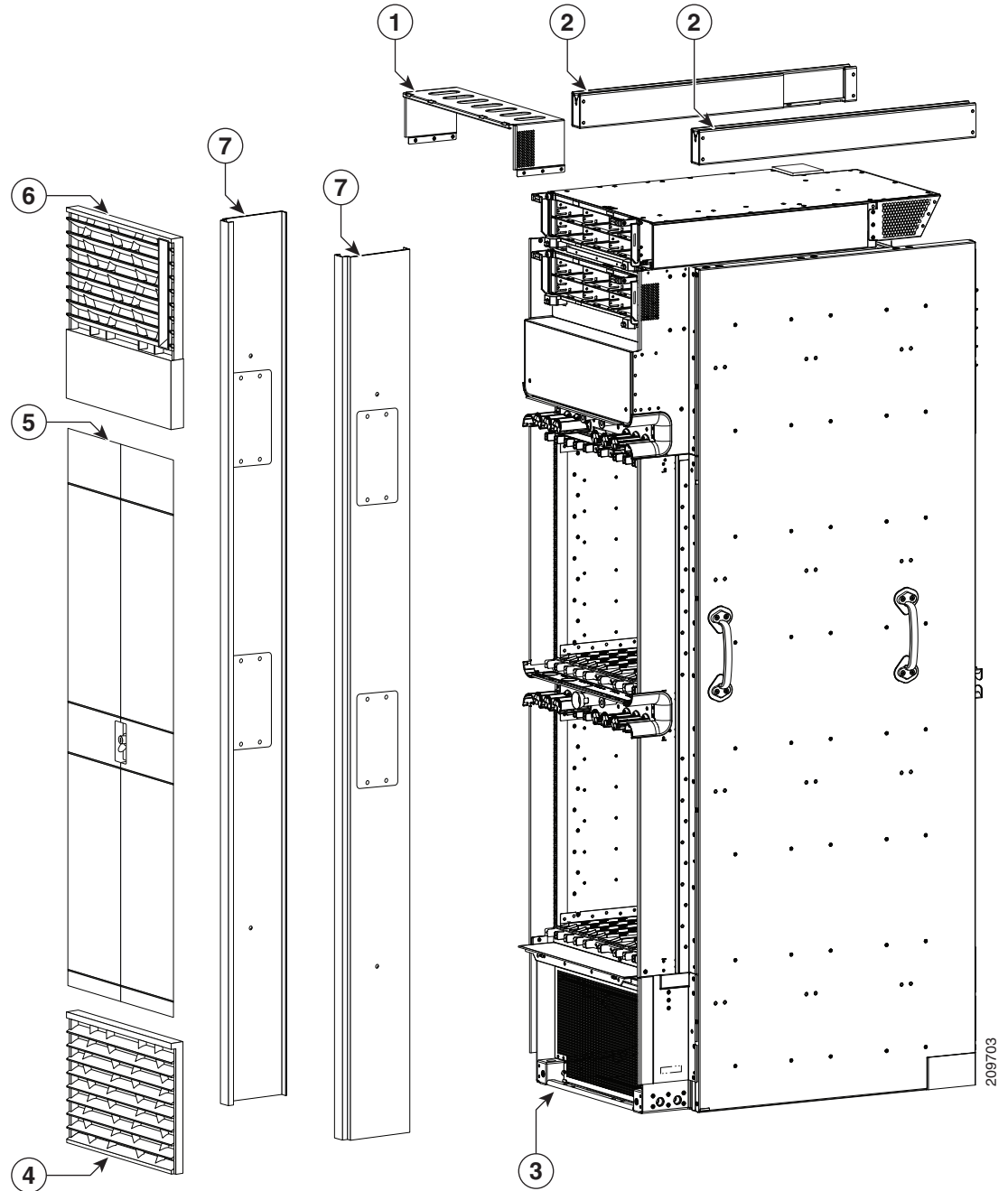
The LCC is shipped with exterior cosmetic components for the front (PLIM) side and rear (MSC) side of the chassis.

**Note**

Some exterior cosmetic components are not required to be installed.

Figure 1-5 shows the exterior cosmetics for the front (PLIM) side of a chassis.

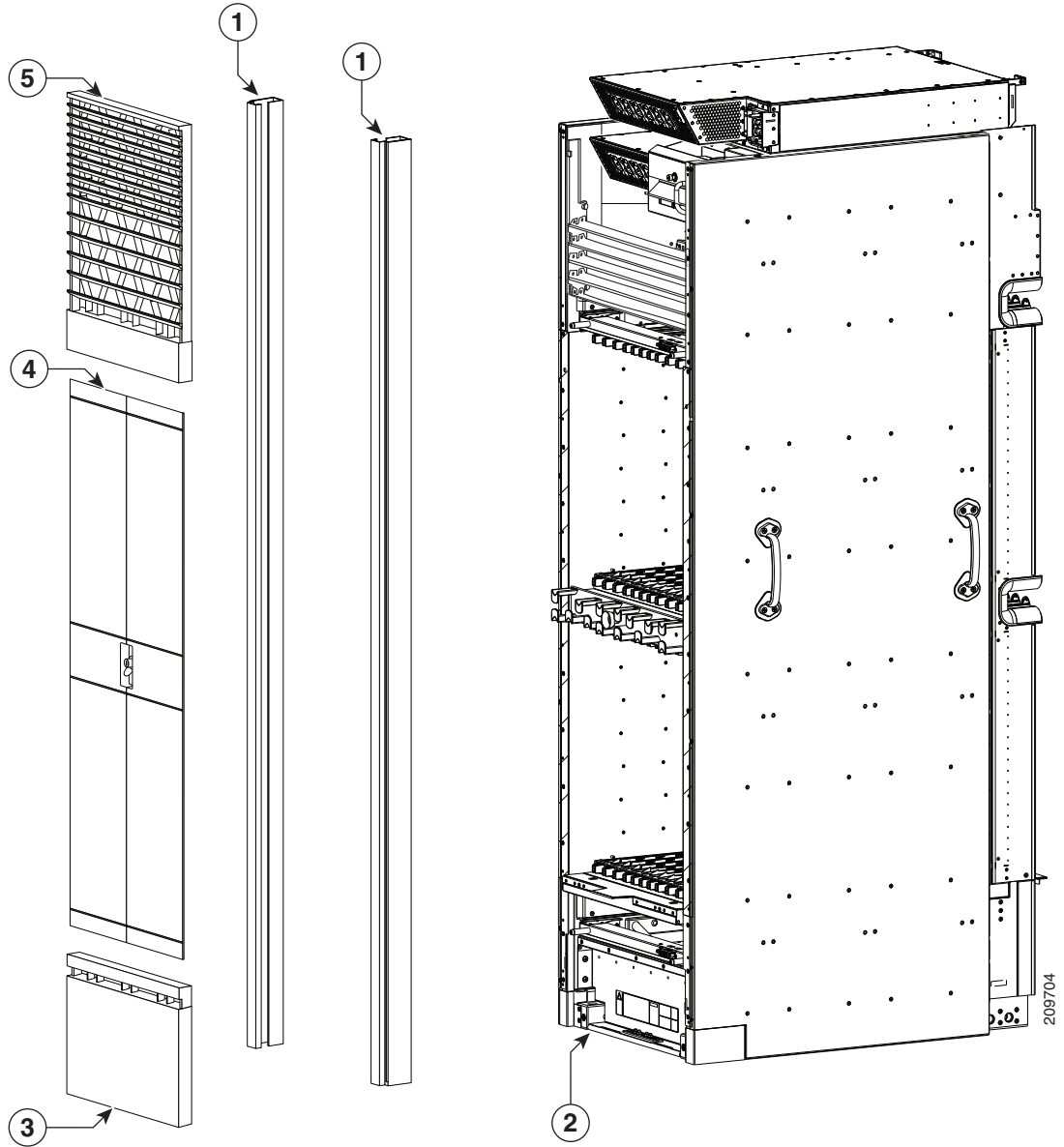
Figure 1-5 Front (PLIM) Side Exterior Cosmetic Components



1	Upper grille support	5	Doors
2	Unistruts	6	Upper grille
3	Bracket for lower grille	7	Vertical cable troughs
4	Lower grille		

Figure 1-6 shows the exterior cosmetics on the rear (MSC) side of the LCC.

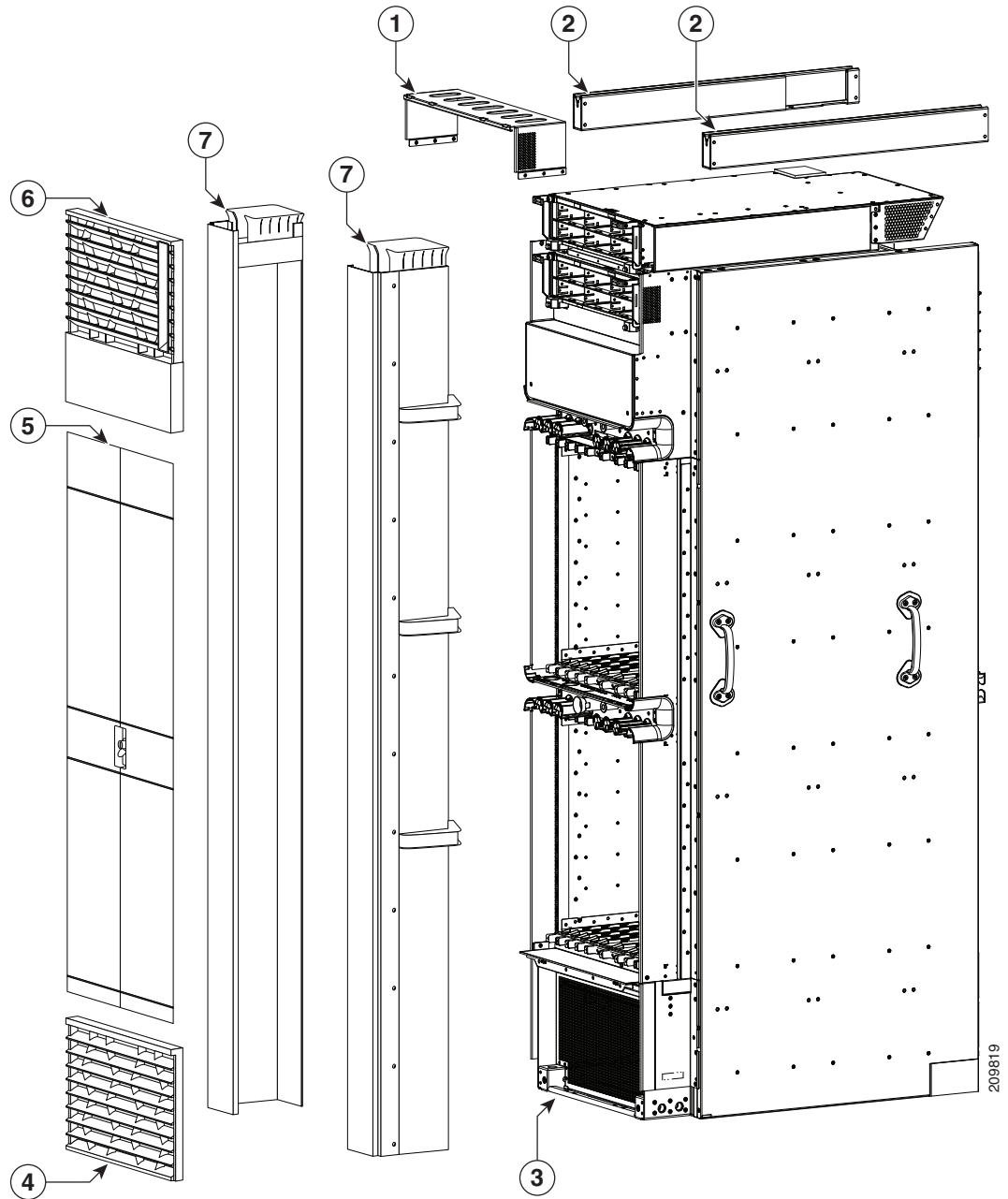
Figure 1-6 Rear (MSC) Side Exterior Cosmetic Components



1	Vertical cable troughs	4	Doors
2	Bracket for rear kick panel	5	Upper air grille
3	Rear kick panel		

Figure 1-7 shows the exterior cosmetics for the front (PLIM) side of an optional wide duct system.

Figure 1-7 Front (PLIM) Side Exterior Cosmetic Components—Optional Wide Duct System



1	Upper grille support	5	Doors
2	Unistruts	6	Upper grille
3	Bracket for lower grille	7	Wide vertical cable troughs
4	Lower grille		

Safety Guidelines

Before you perform any LCC installation procedures, review the safety guidelines in this section to avoid injuring yourself or damaging the equipment.


Note

Although power shelves may be installed or removed without powering down the system, for safety purposes we recommend that you power down the system before you install or remove a power shelf.

The following guidelines are for your safety and to protect equipment. The guidelines do not include all hazards. Be alert.


Note

Review the safety warnings listed in *Regulatory Compliance and Safety Information for the Cisco CRS Carrier Routing System* before installing, configuring, or troubleshooting any installed card.

- Never attempt to lift an object that might be too heavy for you to lift by yourself.
- Keep the work area clear and dust free during and after installation. Do not allow dirt or debris to enter into any laser-based components.
- Keep tools and router components away from walk areas.
- Do not wear loose clothing, jewelry, and other items that could get caught in the router while working with OIMs, SFCs, and their associated components.
- Use Cisco equipment in accordance with its specifications and product-usage instructions.
- Do not work alone if potentially hazardous conditions exist.
- Make sure your installation follows national and local electrical codes: in the United States, National Fire Protection Association (NFPA) 70, United States National Electrical Code; in Canada, Canadian Electrical Code, part I, CSA C22.1; in other countries, International Electrotechnical Commission (IEC) 60364, part 1 through part 7.
- Connect only a DC power source that follows the safety extra-low voltage (SELV) requirements in UL/CSA/IEC/EN 60950-1 and AS/NZS 60590 to the DC-input power system.
- Make sure that you have a readily accessible two-poled disconnect device incorporated in the fixed configuration wiring of a CRS configured with the DC-input power system.
- Make sure that you provide short-circuit (overcurrent) protection as part of the building installation.

Preventing Electrostatic Discharge

Electrostatic discharge (ESD) damage, which can occur when electronic cards or components are improperly handled, results in complete or intermittent failures. We recommend use of an ESD-preventive strap whenever you handle network equipment or one of its components.

Following are guidelines for preventing ESD damage:

- Always use an ESD-preventive wrist or ankle strap, and ensure that it makes good skin contact. Connect the equipment end of the connection cord to an ESD connection socket on the router or to a bare metal surface on the chassis.
- Handle a card by its ejector levers, when applicable, or its metal carrier only; avoid touching the board or connector pins.

- Place a removed card board side up on an antistatic surface or in a static-shielding bag. If you plan to return the component to the factory, immediately place it in a static-shielding bag.
- Avoid contact between the card and clothing. The wrist strap protects the board from only ESD voltage on the body; ESD voltage on clothing can still cause damage.



Power Systems

This chapter describes the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router (LCC) power systems. It contains the following sections:

- [Power Systems Overview, page 2-1](#)
- [Power Architecture, page 2-5](#)
- [DC Power System, page 2-5](#)
- [AC Power System, page 2-11](#)
- [Alarm Module, page 2-16](#)
- [Cisco CRS 3-Phase Power Distribution Unit, page 2-18](#)



Note

For the complete set of power specifications, see [Appendix A, “Cisco CRS Carrier Routing System 16-Slot Enhanced Line Card Chassis Specifications.”](#)

Power Systems Overview

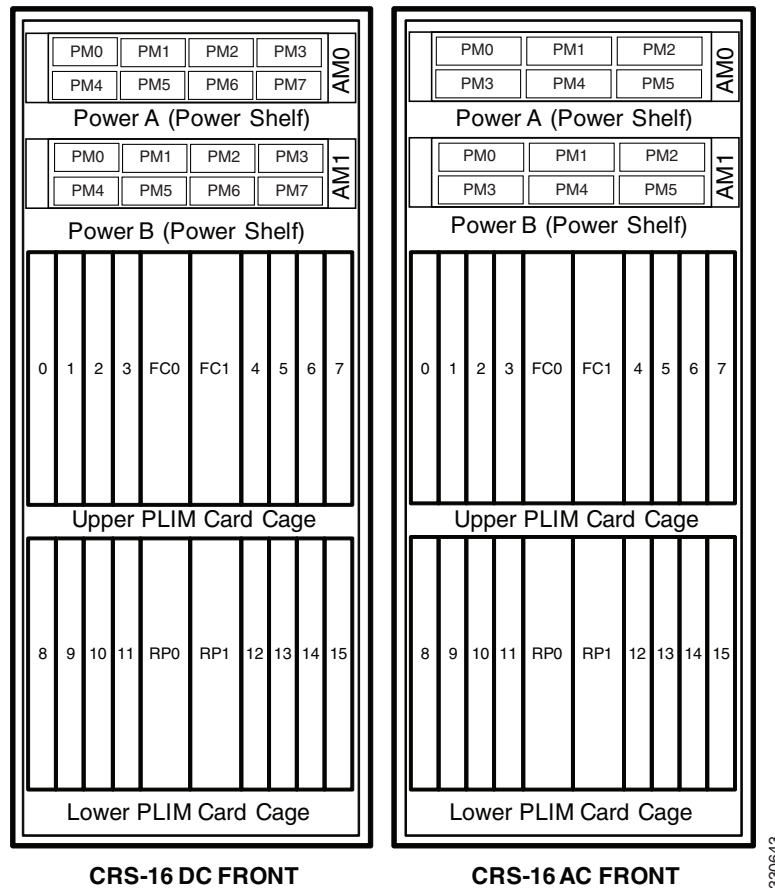
The Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router can be either DC or AC powered. The AC power system requires single-phase AC input power. If only 3-phase AC Delta or AC Wye is available at the equipment, a Cisco CRS 3-phase AC power distribution unit (PDU) will be required. This converts 3-phase AC input power to single-phase. See the [“Cisco CRS 3-Phase Power Distribution Unit” section on page 2-18](#).

Both AC and DC power systems are fully redundant and contain the following components:

- Two AC or DC power shelves
- Six AC PMs or eight DC PMs per shelf
- Alarm modules, one per shelf
- Dual bus bars, providing redundant power to the chassis component
- Special components such as DC/DC converts, OR-ing diodes and EMI filtering
- SNMP MIBS and XML support

Figure 2-1 shows the DC and AC power shelf and PM numbering.

Figure 2-1 Line Card Chassis DC and AC Power Shelf and PM Numbering



Chassis Grounding Guidelines

The router chassis has two safety earth ground connections. The chassis allows you to connect the central office ground system or interior equipment grounding system to the bonding and grounding receptacles on the router chassis. Threaded ground inserts are located on top of the chassis rear (MSC) side panel to the right of the lower power shelf. There are also two sets of grounding studs located at the bottom of the rear (MSC) side of the chassis.



Note

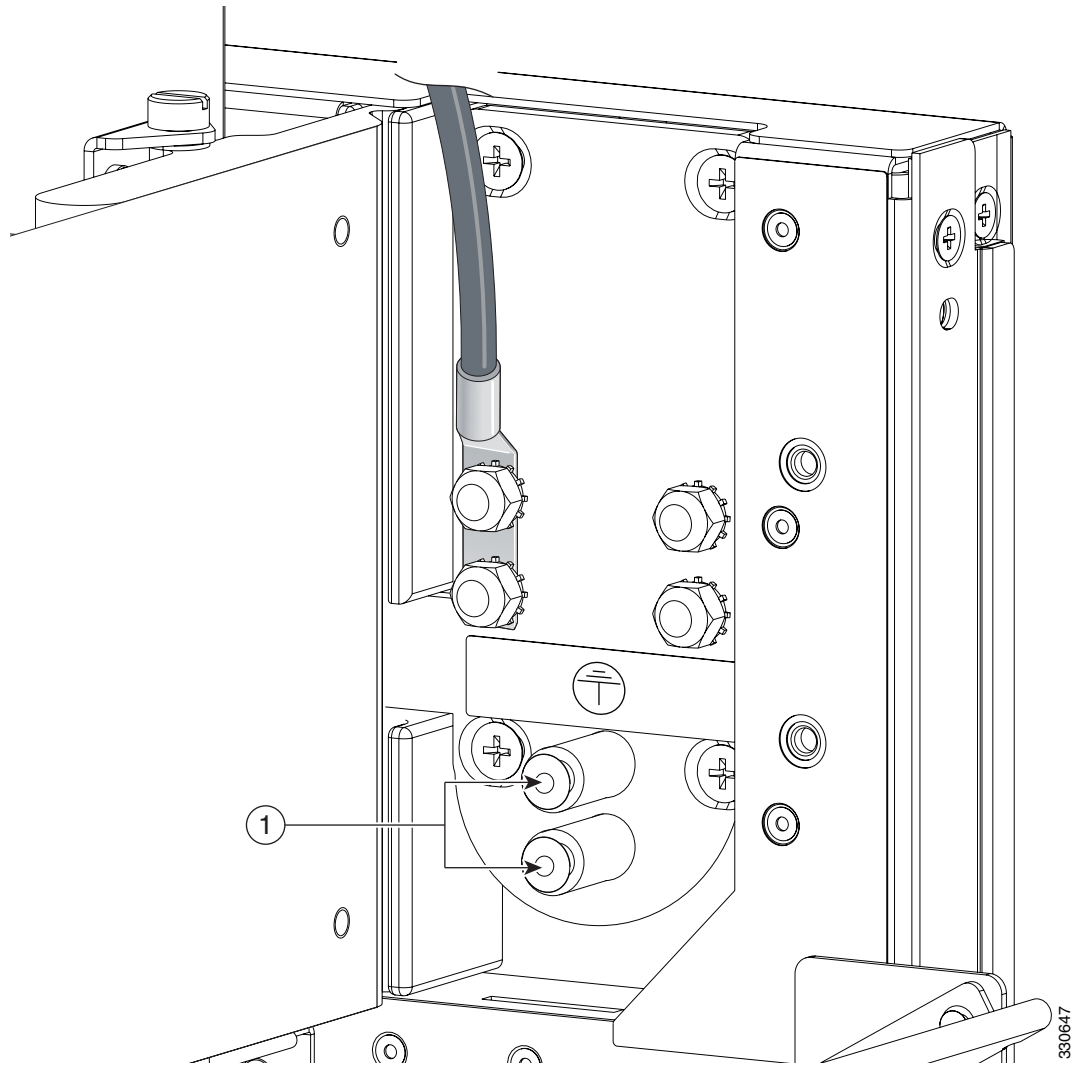
Figure 2-3 shows the grounding points at the top on the rear (MSC) side of the chassis. This grounding point is also referred to as the network equipment building system (NEBS) bonding and grounding point. These bonding and grounding receptacles are provided to satisfy the Telcordia NEBS requirements for bonding and grounding connections.



Caution

Do not remove the chassis ground cable unless the chassis is being replaced.

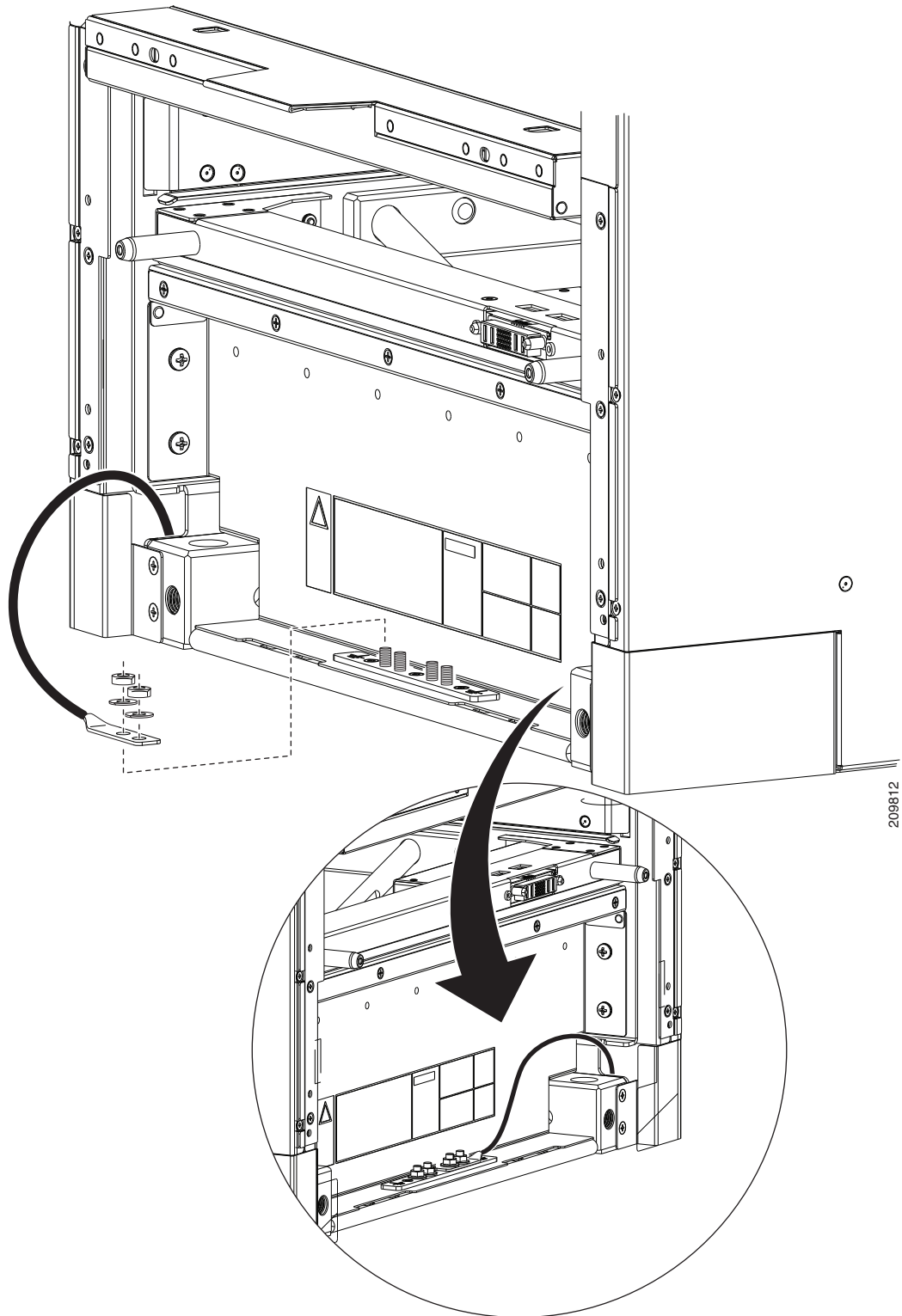
Figure 2-2 NEBS Bonding and Grounding Points—DC Power Shelf Shown

**Note**

The two bolts below the NEBS bonding and grounding points at the top of the chassis are required for proper bonding and grounding of the chassis and should not be removed.

Figure 2-3 shows the NEBS and grounding points at the bottom on the rear (MSC) side of the chassis.

Figure 2-3 NEBS Bonding and Grounding Points—Bottom Rear (MSC) Side of Chassis



Power Architecture

The Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router power architecture provides the following features:

- AC or DC power shelf redundancy
- N+N power module redundancy
- Elimination of power zone distribution, while maintaining zone protection
- Module power supplies only
- Capacity for future growth

The AC and DC power systems use A and B power shelves to provide reliable, 2N redundant power to all chassis components. In addition, the power supplies work in parallel with each other, and they can monitor power consumption, performance, analysis, and power management concurrently.

The AC or DC power shelf distributes power and passes it to the system. A separate alarm module provides all PM status monitoring and handles alarm functions. Each PM has its own integrated fuse to protect the system, and each PM is plugged into its own power outlet. Each PM provides 54 VDC.

The Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router can continue to operate normally if:

- One AC or DC PM fails
- One entire power shelf fails
- One internal bus bar fails
- PMs are added to or removed from the power shelf

Individual chassis components have power-related devices, such as OR-ing diodes, inrush control circuits, and EMI filters. Because each PM can power all chassis components, these devices can be inserted or removed while the chassis is online (hot swapping). It takes two failures for the system to be degraded. The Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router can lose any single PM or an entire power shelf and still have the power to operate. The detailed power routing distribution is shown in [Figure 2-7](#) (DC) and [Figure 2-11](#) (AC).

[Figure 2-1](#) shows the power shelves from the front (PLIM) side of the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router.

- Power shelf A supports everything in it. PM 0-7 supports everything in the entire chassis that needs power which are cards, fans, alarm modules.
- Power shelf B supports everything in it. PM 0-7 supports everything in the entire chassis that needs power which are cards, fans, alarm modules.

DC Power System

This section provides details on the DC power system:

- [DC Power Requirements, page 2-6](#)
- [DC Power System Configuration, page 2-6](#)
- [DC Power Routing Distribution, page 2-10](#)

DC Power Requirements

The following power requirements apply to the DC-powered chassis:

- Based on capacity, each DC-powered chassis requires up to a maximum of 19,090 watts (19.10 kW) of DC input power when the chassis is fully loaded. A chassis with fewer PLIMs uses less power; however, it is a good idea to allocate this much power for each chassis to ensure that enough power is available for future system expansion.
- Two separate and independent power sources are required for N+N redundancy, each providing nominal -48/-60 VDC service (eight inputs per shelf). The system will operate with power to only one shelf but will not have N+N redundancy.
- The power shelves are grounded externally but internally to the chassis sidewall enclosure.
- All power connection wiring should conform to the rules and regulations in the National Electrical Code (NEC) and any local codes. In addition, make sure that the wiring conforms to any internal requirements at the installation site.
- Each DC power source must comply with the safety extra-low voltage (SELV) requirements in UL 60950-1, CSA-C22.2 No. 60950-1, EN60950-1, AS/NZS 60950, and IEC60950-1.
- A DC-powered system should be installed in a restricted access area in accordance with the National Electric Code, ANSI/NFPA 70.
- All components in the area where DC input power is accessible must be properly insulated.
- If it is not possible to rely on the identification of the earthed conductor in the DC mains supply, whereby the equipment is not provided with a two-pole disconnect device, then a two-pole disconnect device is to be provided external to the equipment.

For detailed DC power specifications including input current rating, see [Appendix A, “Cisco CRS Carrier Routing System 16-Slot Enhanced Line Card Chassis Specifications.”](#)

DC Power System Configuration

The modular DC power shelf is the enclosure that houses the DC PMs, the alarm module, and power distribution connections and wiring. The power shelf installs in the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router from the front and plugs into the chassis power interface connector panel.

Each DC-powered chassis contains two DC power shelves for 2N redundancy. The shelves contain the input power connectors.



Note

Each DC power shelf is shipped with six DC PMs but can be expanded up to eight DC PMs per shelf. The power shelves and DC PMs are field replaceable.

Each PM has its own power connector to connect input DC power -48/-60 VDC (nominal). Each connector consists of two terminals (- and +). The terminals have a safety cover.

Each DC power shelf accepts one battery feed per PM. Input DC power enters the power shelf and is processed by the PMs before being distributed to the chassis midplane. The PMs perform inrush current limiting, EMI filtering, surge protection, and circuit isolation on the input DC power, and then distribute the power via the internal bus bar in the chassis midplane.

The power shelf also has an alarm module that monitors the condition of each DC PM and provides status signals that indicate the health of the power supplies (see the “[DC Power Module Indicators](#)” section on page 2-8).

Figure 2-4 shows the front view of the DC power shelf.

Figure 2-4 DC Power Shelf - Front View

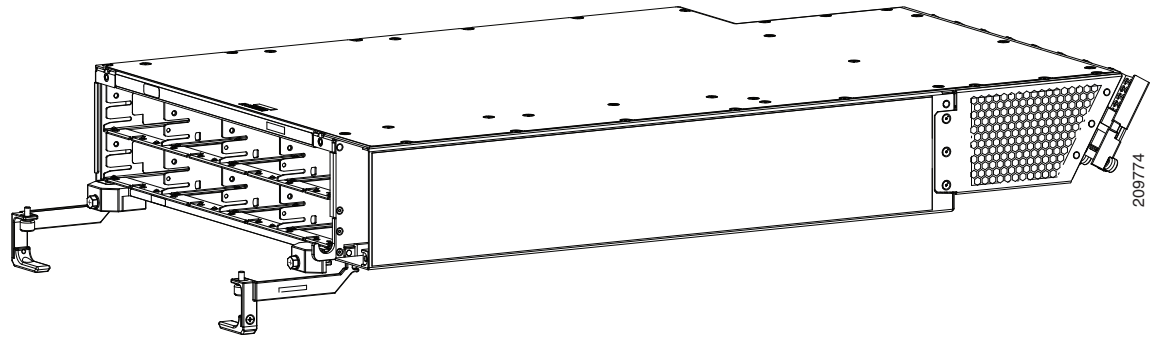
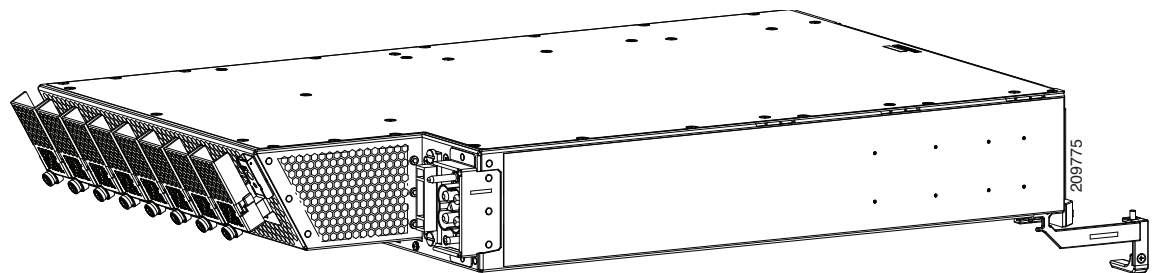


Figure 2-5 shows the rear view of the DC power shelf.

Figure 2-5 DC Power Shelf - Rear View



DC Power Module

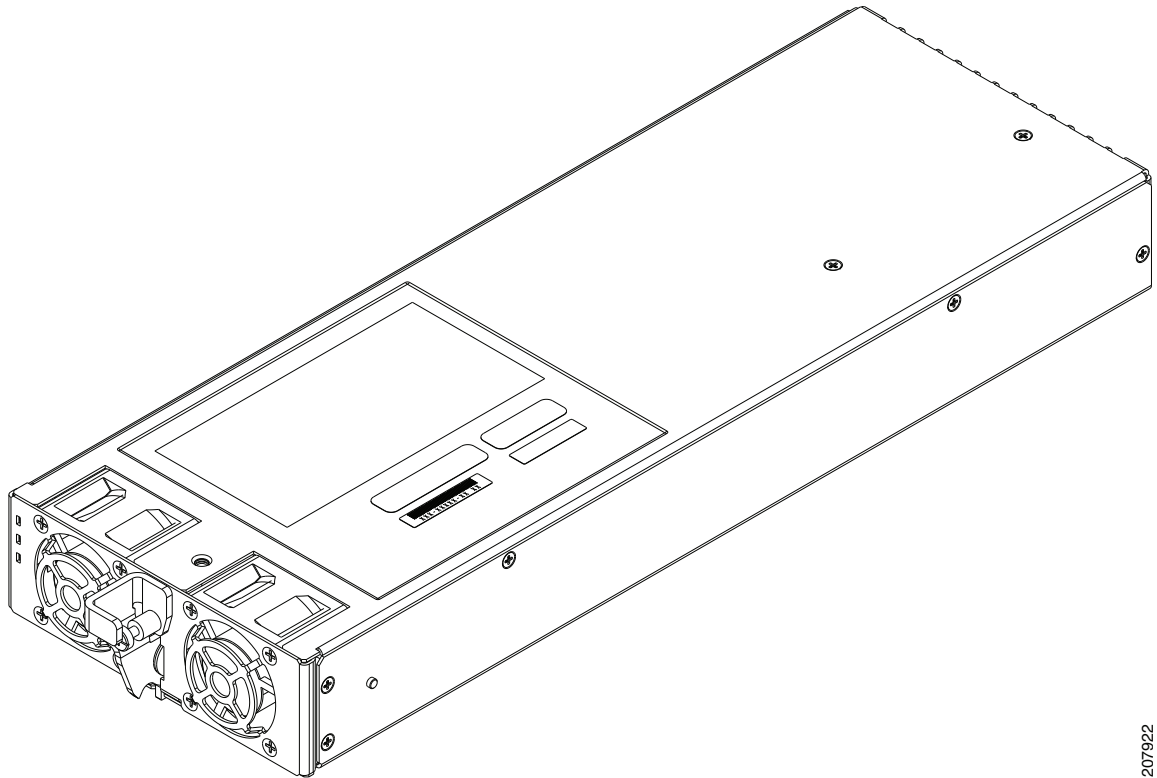
Each DC PM provides 2100 W of power. The DC PM, shown in [Figure 2-6](#), passes the power via the internal bus bar to the system. PMs are field-replaceable and can be hot swapped.

One $-48/-60$ VDC input enters the PM at the rear of the power shelf, exits the PM, and is distributed to the chassis midplane. Each PM contains an ID EEPROM that stores information used by control software (for example, part number, serial number, assembly deviation, special configurations, test history, and field traceability data). The system software reads the EEPROM of each FRU in the system to determine if it is the correct FRU.



Note

The DC and AC power modules are slightly different in width.
 The DC power module dimensions are: 1.60 H x 4.0 W x 13.56 D
 The AC power module dimensions are: 1.60 H x 4.75 W x 13.56 D

Figure 2-6 DC Power Module

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DC Power Module Indicators

The following LED status indicators are located on the front of each DC PM:

- Input OK - Green
- Output OK - Green
- Internal Fault - Red

The PM LED status indicators are not visible when the front grille is installed.

[Table 2-1](#) lists the PM status indicators and their functions.

Table 2-1 DC PM Status Indicators

Name	Color	Function
Input OK	Green	<p>Input OK LED turns on continuously when input voltage is present and within the regulation range.</p> <p>Input OK LED flashes when input voltage is present but not within the regulation range.</p> <p>Input OK LED is off when input voltage is not present.</p> <p>Input OK LED flashes when hot-unplugging the power supply from the power shelf to indicate that there is energy in the power supply until the input bulk capacitor is completely discharged or the housekeeping circuit is shut down.</p>
Output OK	Green	<p>Output OK LED turns on continuously when power supply output voltage is on.</p> <p>Output OK LED flashes when power supply output voltage is in a power limit or an overcurrent situation.</p>
Internal Fault	Red	Internal Fault LED turns on continuously when there is an internal fault in the PM.

The Internal Fault LED on the DC PM is turned on continuously to indicate that one or more of the following internal faults is detected inside the power supply:

- 5V out of range
- Output Stage OT
- Fan Fault
- OR-ing fault (Output voltage less than bus voltage)
- OC shutdown
- OT shutdown
- OV shutdown
- Input stage OT
- Fault induced shutdown occurred
- Thermal sensor fault
- Vout out of range
- Boost Vbulk fault

Once all of the faults have been removed and the power supply is operating normally, the Internal Fault LED is turned off.

DC Power Routing Distribution

Figure 2-7 shows the power routing distribution for the DC configuration. Table 2-2 shows the maximum input current draw and associated input voltage per feed.

Figure 2-7 DC Power Routing Distribution

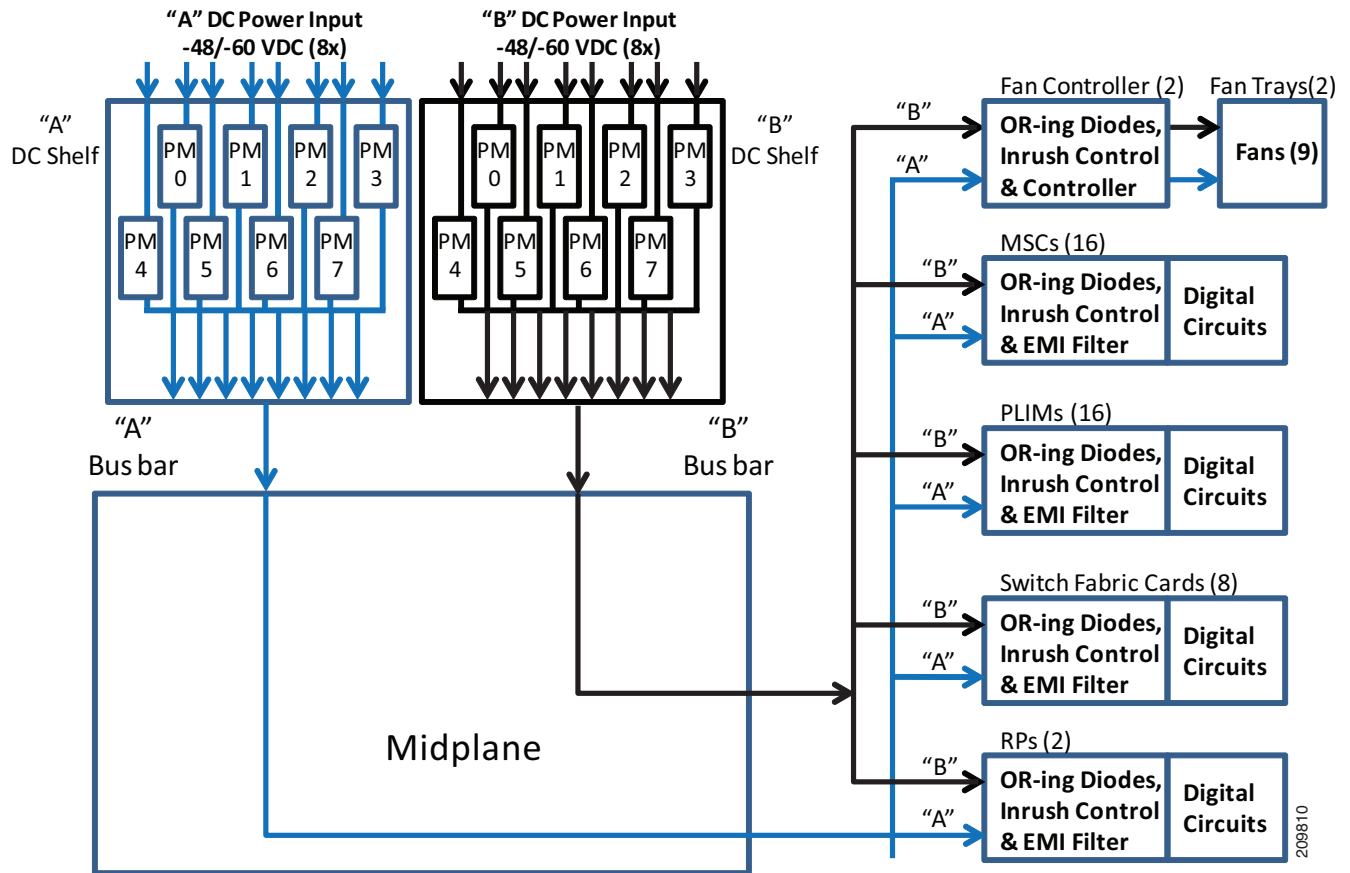


Table 2-2 Maximum Input Current Draw Versus Input Voltage per Feed

Maximum Input Current Draw	Input Voltage per Feed
60A	-40 VDC
50 A	-48 VDC (North America)
40 A	-60 VDC (EU)

AC Power System

This section provides details on the AC power system:

- [AC Power Requirements, page 2-11](#)
- [AC Power System Configuration, page 2-12](#)
- [AC Power Routing Distribution, page 2-15](#)

AC Power Requirements

The following power requirements apply to the AC-powered chassis:

- An AC-powered chassis requires up to a maximum of 19,565 watts (19.56 kW) of AC input power when the chassis is fully loaded.
- Two separate and independent AC power sources are required for N+N redundancy, one for each power shelf. Each power shelf should be connected to a different power source to provide 2N power redundancy in case a power source fails. The system will operate with power to only one shelf but will not have N+N redundancy.
- Each AC power source must provide single-phase AC power, and have its own circuit breaker.
- The AC power receptacles used to plug in the chassis must be the grounding type. The grounding conductors that connect to the receptacles should connect to protective earth ground at the service equipment.
- AC single-phase input:
 - Single-phase, 200 to 240 VAC nominal, 50 to 60 Hz, 16 A International and 20 A North America.
 - Each AC power shelf contains six IEC-320-C22 receptacles which can accept up to six IEC-320-C21 connector female cords.
- If it is not possible to rely on the identification of the earthed conductor in the AC mains supply, whereby the equipment is not provided with a two-pole disconnect device, then a two-pole disconnect device is to be provided external to the equipment.
- If you have 3-phase AC Delta or AC Wye power, a Cisco CRS 3-phase AC PDU will be required to convert 3-phase AC input power to single-phase AC input power for the power shelf. For further information, refer to *Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide*. If you have a Cisco CRS 3-phase AC PDU installed, six AC PMs are required to be installed in each modular configuration AC power shelf to maintain a balanced 3-phase power load.

For detailed AC power specifications, see [Appendix A, “Cisco CRS Carrier Routing System 16-Slot Enhanced Line Card Chassis Specifications.”](#)

AC Power System Configuration

The modular AC power shelf is the enclosure that houses the AC PMs, the alarm module, and power distribution connections and wiring. The AC power shelf installed in the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router from the front and plugs into the chassis power interface connector panel.

Each AC-powered chassis contains two AC power shelves for 2N redundancy. Each AC power shelf supports up to six AC PMs. The AC PMs convert AC power into DC power, provide filtering, and then distribute the DC power to the chassis midplane.



Note

Each AC power shelf is shipped with five AC PMs but can be expanded up to six AC PMs per shelf. Six PMs per shelf are required for power input balance. The power shelves and AC PMs are field replaceable.

The power shelf also has an alarm module that monitors the condition of each AC PM and provides status signals that indicate the health of the power supplies (see the “[AC Power Module Indicators](#)” section on page 2-14).

Figure 2-8 shows the front view of the AC power shelf.

Figure 2-8 AC Power Shelf - Front View

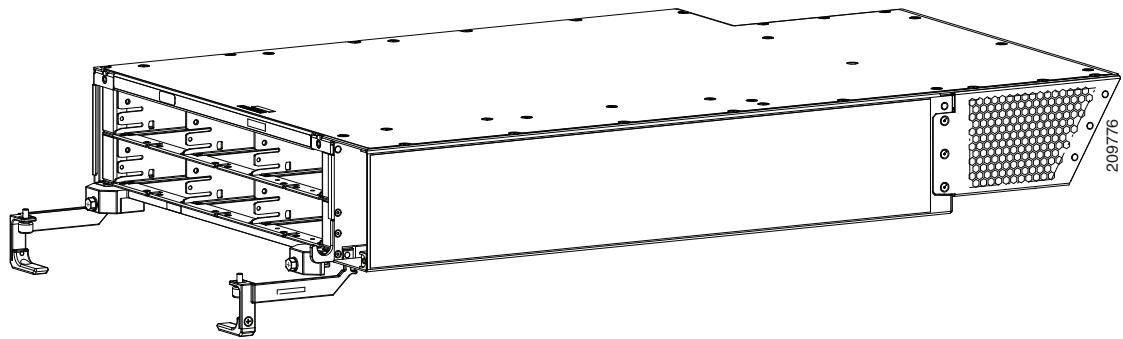
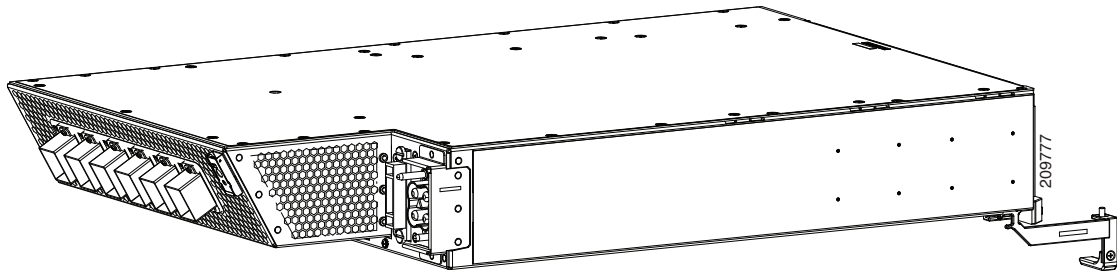


Figure 2-9 shows the rear view of the AC power shelf.

Figure 2-9 AC Power Shelf - Rear View



AC Power Module

The AC PM is an AC power supply that converts single phase input AC power into the DC power necessary to power chassis components. The AC PM takes input AC power from the power shelf, converts the AC into DC, provides filtering and control circuitry, provides status signaling, and passes the DC power to the chassis midplane.

The AC power shelf has the following input power requirements:

Each AC PM has a single-phase, 3-wire connection:

Input: 200 to 240 VAC nominal, 50 to 60 Hz, 16A

Tolerance: +/-10%(180 to 264) VAC, 50 to 60 Hz, 16A

Each power shelf contains six IEC-320-C22 receptacles that can accept up to six IEC-320-C21 connector cords.



Note

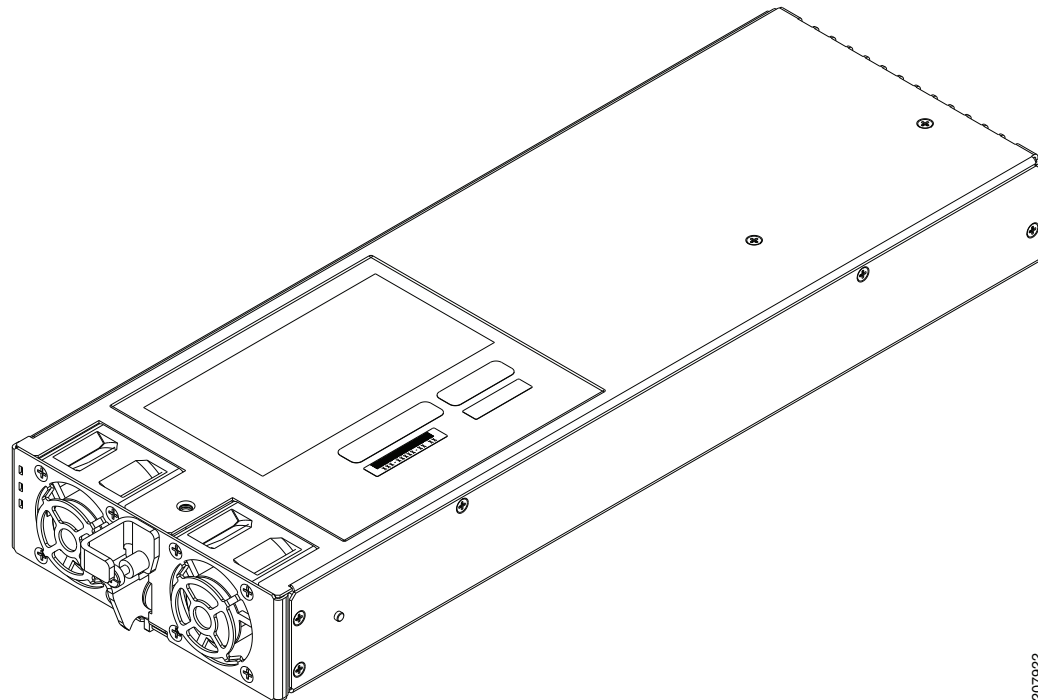
The DC and AC power modules are slightly different in width.

The DC power module dimensions are: 1.60 H x 4.0 W x 13.56 D

The AC power module dimensions are: 1.60 H x 4.75 W x 13.56 D

Figure 2-10 shows the AC modular configuration PM.

Figure 2-10 AC Power Module



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Each AC PM provides 3000 Watts of power. When power enters the AC PM, shown in Figure 2-10, internal circuits rectify the AC into DC, filter and regulate it. PMs are field-replaceable and can be hot swapped.

Each AC PM contains an ID EEPROM that stores information used by control software (including part number, serial number, assembly deviation, special configurations, test history, and field traceability data). The system software reads the EEPROM of each FRU in the system to determine if it is the correct FRU.

AC Power Module Indicators

The following LED status indicators are located on the front of each AC PM:

- Input OK - Green
- Output OK - Green
- Internal Fault - Red

Table 2-3 lists the PM status indicators and their functions.

Table 2-3 AC PM Status Indicators

Name	Color	Function
Input OK	Green	<p>Input OK LED turns on continuously when input voltage is present and within the regulation range.</p> <p>Input OK LED flashes when input voltage is present but not within the regulation range.</p> <p>Input OK LED is off when input voltage is not present.</p> <p>Input OK LED flashes when hot-unplugging the power supply from the power shelf to indicate that there is energy in the power supply until the input bulk capacitor is completely discharged or the housekeeping circuit is shut down.</p>
Output OK	Green	<p>Output OK LED turns on continuously when power supply output voltage is on.</p> <p>Output OK LED flashes when power supply output voltage is in a power limit or an overcurrent situation.</p>
Internal Fault	Red	<p>Internal Fault LED turns on continuously when there is an internal fault in the PM.</p>

The Internal Fault LED on the AC PM is turned on continuously to indicate that one or more of the following internal faults is detected inside the power supply:

- 5V out of range
- Output Stage OT
- Fan Fault
- OR-ing fault (Output voltage less than bus voltage)
- OC shutdown
- OT shutdown
- OV shutdown
- Input stage OT
- Fault induced shutdown occurred
- Thermal sensor fault

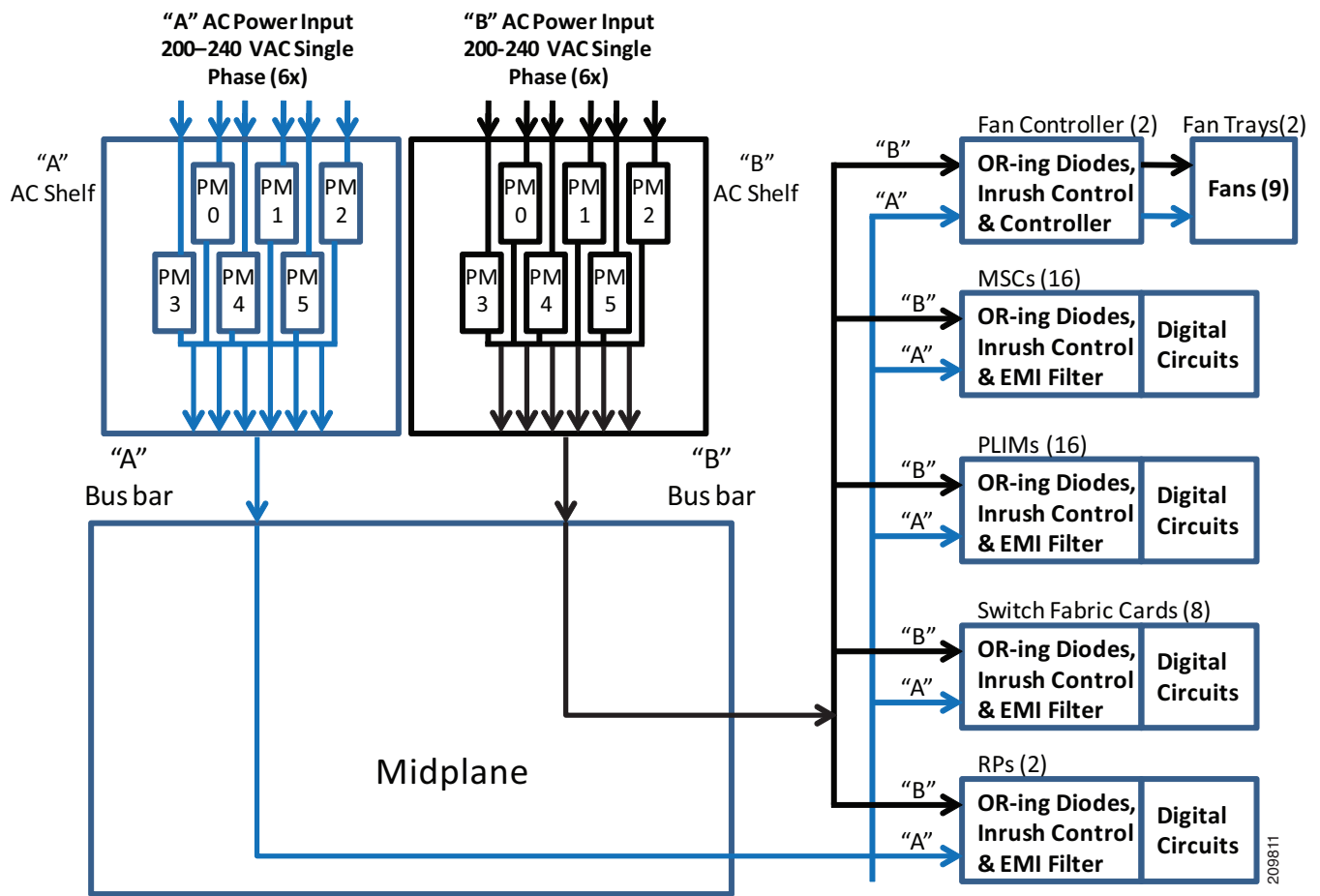
- Vout out of range
- Boost Vbulk fault

After all of the faults are removed and the power supply is operating normally, the Internal Fault LED is turned off.

AC Power Routing Distribution

Figure 2-11 shows the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router power routing distribution for the AC configuration.

Figure 2-11 AC Power Routing Distribution



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Alarm Module

Each power shelf contains an alarm module that monitors the presence and performance of the PMs. It also monitors the status of the power shelf and provides an external interface for system alarms. [Figure 2-12](#) shows an alarm module, and [Figure 2-13](#) shows the alarm module front panel.

Figure 2-12 Alarm Module

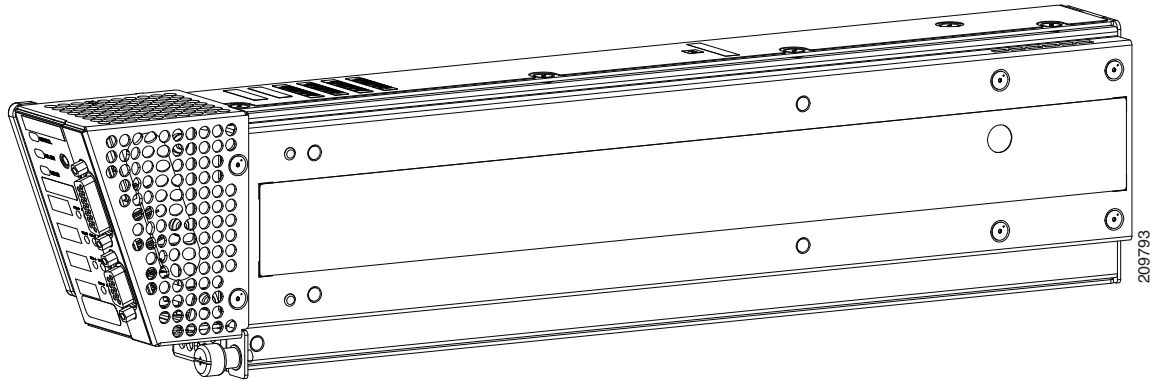
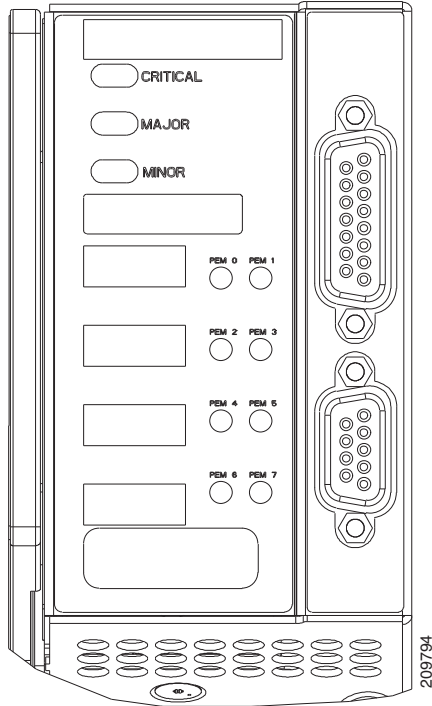


Figure 2-13 Alarm Module Front Panel



The alarm module receives power from both power shelves. As a result, it can report the status of an unpowered shelf as well as that of a powered shelf.

The alarm module performs the following functions:

- Alarm outputs, both relay and LEDs:
 - Alarm LEDs—Three large LEDs (Critical, Major, and Minor) indicate the status of the chassis. The LEDs are controlled by software on the RP system controller.
 - Relay—The alarm module output function consists of a relay and its associated driver. As directed by the system controller (on the RP or the switch controller/fan controller (SCFC), depending on the chassis type), the service processor module on the alarm module activates the relay. The alarm relay connector is a standard DA-15S connector.
- PM status monitoring—The alarm module monitors the performance and status of the PMs. The alarm module monitors Power Good, Power Fail, Internal Fault, Over Temp conditions, PM presence, and voltage and current output levels. The alarm module can report these statuses even for an unpowered shelf.
- Alarm monitoring—Four alphanumeric displays provide information about the status of the chassis.
 - If the system is operating properly, “RACKX IOS XR” appears in the alpha-numeric display, where X represents the rack number.
 - If an alarm occurs, the alpha-numeric display indicates the card or component that is experiencing a problem. For example, if a fan tray is missing, the display indicates which fan tray is missing. A display such as “0 1 SP” indicates that the MSC in rack 0, slot 1 is experiencing a problem.

A service processor module monitors the status of each PM and communicates with the system controller of the Route Processor (RP). The service processor monitors the following PM faults and alarm conditions:

- Fault—Indicates a failure in a PM, such as failed bias supply, over temperature or current limit. It includes a warning that the DC output is outside the allowable output range.
- Input Fail—Indicates that the Input voltage is out of range.
- Over temperature—Indicates that the PM has exceeded the maximum allowable operating temperature.
- PM Present—Indicates that the PM is present and seated properly in the power shelf.
- Voltage and Current Monitor signals (Vmon, Imon)—Indicate that the output voltages and currents provided by the PM are within range.

Table 2-4 lists the pin outs for the alarm relay connector.

Table 2-4 Alarm Relay Connector Pin Outs

Signal Name	Pin	Description
Alarm_Relay_NO	1	Alarm relay normally open contact
Alarm_Relay_COM	2	Alarm relay common contact
Alarm_Relay_NC	9	Alarm relay normally closed contact

Only Pins 1, 2, and 9 are available for customer use. The remaining pins are for Cisco manufacturing test, and should not be connected. Use a shielded cable for connection to this port for EMC protection.

Cisco CRS 3-Phase Power Distribution Unit

This section describes the Cisco CRS 3-Phase AC Power Distribution Unit (PDU) for the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router. The PDU converts 3-phase AC input power to single phase AC output power for delivery through the rear of the AC power shelf. For further information, refer to the *Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide*.

The PDU includes either an AC Delta or AC Wye power interface to convert 3-phase input power to single phase output. The PDU has power input and power output cords entering and exiting the box. The PDU can be installed in a 19 inch rack or attached to the sides of the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router by using custom mounting brackets.

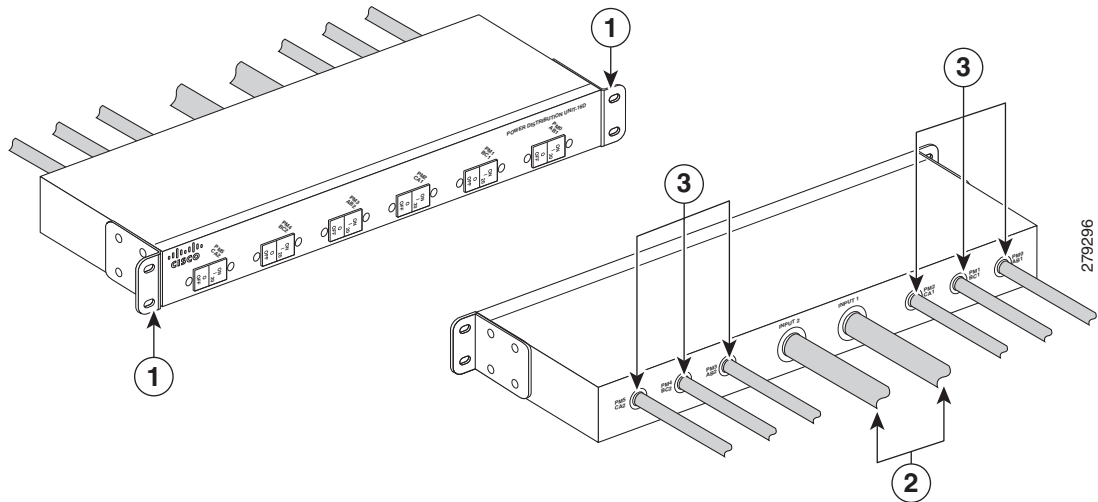
One PDU is required for each modular power shelf installed in the chassis for system redundancy. The PDU should be installed on both sides of the chassis.

There are two versions of the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router PDU:

- CRS-16-PDU-Delta—Redundant 3-phase to single-phase Delta PDU, 2 input/6 output
- CRS-16-PDU-Wye—Redundant 3-phase to single-phase Wye PDU, 1 input/6 output

Figure 2-14 shows the PDU that converts 3-phase AC Delta input power to single phase AC output power.

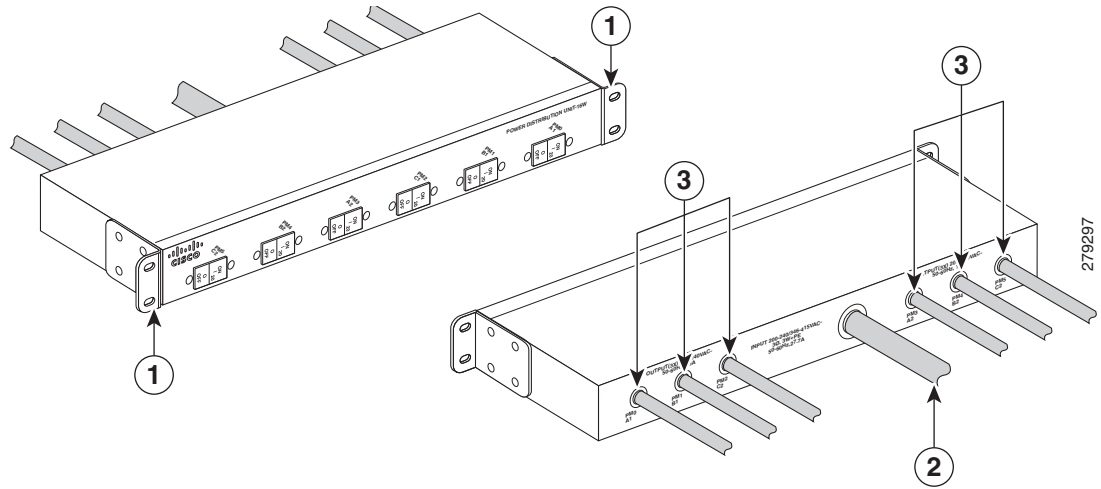
Figure 2-14 AC Delta Power Distribution Unit



1	Rack mounting ears	2	Input Cords
3	Output Cords		

Figure 2-15 shows the PDU that converts 3-phase AC Wye input power to single phase AC output power.

Figure 2-15 AC Wye Power Distribution Unit



1	Rack mounting ears	3	Output Cords
2	Input cord		

Note

The power cables for the PDU are shipped pre-attached.

The PDU is shipped with the following hardware for specific configurations:

- Two single AC Delta PDUs with 19-inch rack mounting brackets pre-attached and two custom chassis mounting brackets. Each AC Delta PDU has two AC power inputs and six AC power outputs
- Two single AC Wye PDUs with 19-inch rack mounting brackets pre-attached and two custom mounting brackets. Each AC Wye PDU has one AC power input and six AC power outputs

Different versions of the AC PDU are available for AC input power, AC Wye and AC Delta. Each PDU has a different Cisco part number to distinguish it from the other.

AC Wye

- The AC Wye PDU has a Wye 3-phase, 5-wire input power connection consisting of 3 wire + neutral + protective earthing, or ground wire (3W+N+PE).
Input: 200 to 240 (L-N)/346 to 415 (L-L) VAC, 50 to 60 Hz, 32A.
Tolerance: +/-10% (180 to 264)(L-N)/(311 to 456)(L-L) VAC, 50 to 60 Hz, 32A.
- The AC Wye PDU has six single phase output power connections.
Output: 200 to 240 VAC, 50 to 60 Hz, 16A.
Tolerance: +/-10%(180 to 264) VAC, 50 to 60 Hz, 16A.

The following power cables are shipped preattached to the power shelves:

- The Wye input power cord is rated for 415 VAC, 32 A. The power cord has a 5-pin IEC 60309 plug (3W+N+PE).
- The Wye output cord has a 3-pin IEC-320 C21 90 degree female plug.

AC Delta

- The AC Delta PDU has two Delta 3-phase, 4-wire input power connections, each consisting of 3 wire + protective earthing, or ground wire (3W+PE).
Input: 200 to 240 VAC, 50 to 60 Hz, 27.7A.
Tolerance: +/-10% (180 to 264) VAC, 50 to 60 Hz, 27.7A.
- The AC Delta PDU has six single phase output power connections.
Output: 200 to 240 VAC, 50 to 60 Hz, 16A.
Tolerance: +/-10%(180 to 264) VAC, 50 to 60 Hz, 16A.

The following power cables are shipped preattached to the power shelves:

- The Delta input power cord is rated for 250 VAC, 60 A. The power cord has a 4-pin IEC 60309 plug (3W+PE).
- The Delta output cord has a 3-pin IEC-320 C21 90 degree female plug.



Cooling System

This chapter describes the components that make up the cooling system of the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC). It contains the following sections:

- [Cooling System Overview, page 3-1](#)
- [Fan Tray, page 3-6](#)
- [Fan Controller Card, page 3-7](#)

Cooling System Overview

The LCC cooling system includes the components and control system that draw ambient air through the system to dissipate heat and keep the system operating in a desired temperature range. It is designed to support the 40G, 140G, 400G and future higher capacity fabric cards and line cards. The complete LCC cooling system includes:

- Two fan trays
- Two fan controller cards
- Temperature sensors distributed on cards and modules in the chassis
- Operating software that controls the cooling system
- Air filter
- Inlet and outlet air vents and bezels
- Impedance carriers for empty chassis slots

Chassis Airflow

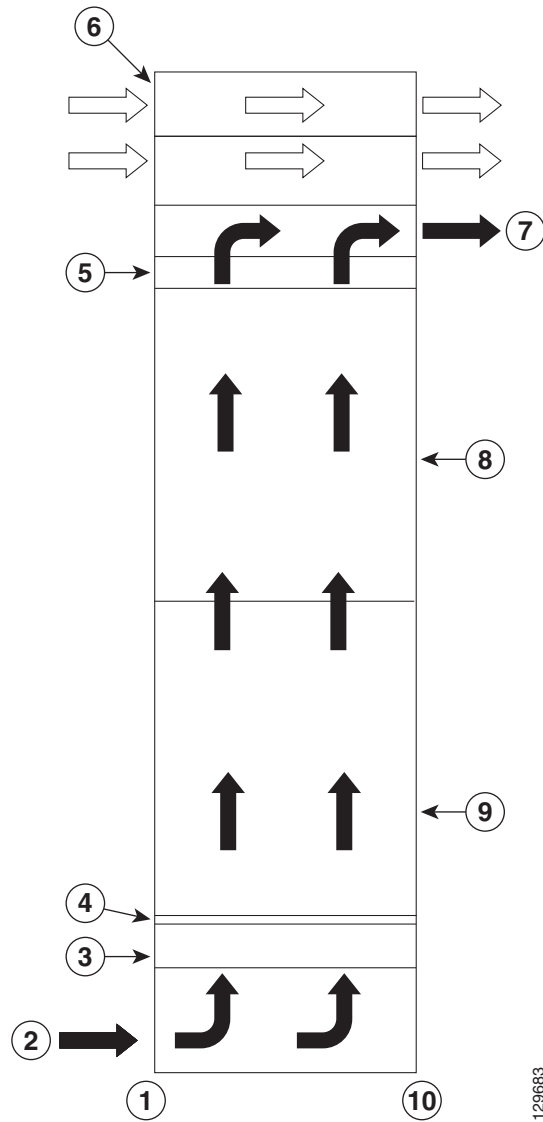
The airflow through the LCC is controlled by a push-pull configuration. As shown in [Figure 3-1](#), ambient air flows in at the bottom front of the LCC and up through the card cages until it exhausts at the top rear. The bottom fan tray pulls ambient air in from the bottom front of the chassis; the top fan tray pushes warm air out the back of the chassis. The power modules in the power shelves have their own self-contained cooling fans.

A replaceable air filter is positioned above the lower fan tray. How often the air filter should be replaced depends on the facility environment. In a dirty environment, or when you start getting frequent temperature alarms, you should always check the intake grills for debris and the air filter to see if it needs replacement.

Before removing the air filter for replacement, you should have a spare filter on hand; follow the air filter replacement procedure in the *Cisco CRS Carrier Routing System Enhanced Chassis 16-Slot Line Card Chassis Installation Guide*.

The LCC has a maximum airflow of 2700 cubic feet (76,455 liters) per minute.

Figure 3-1 Airflow Through the FCC



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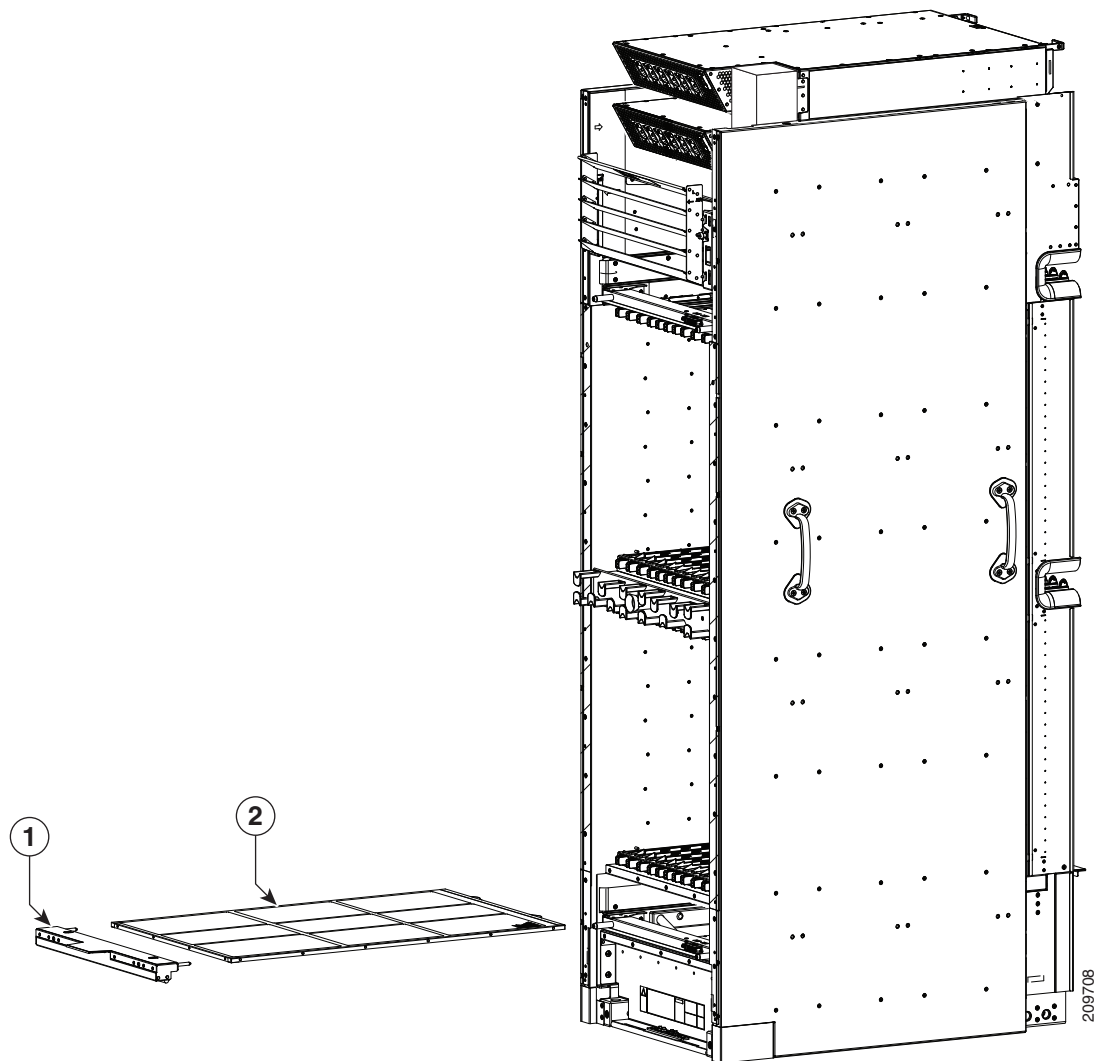
1	Front (SFC side) of chassis	6	Power shelves
2	Room air	7	Air exhaust
3	Bottom fan tray	8	Upper card cage
4	Air filter	9	Lower card cage
5	Top fan tray	10	Rear (OIM side) of chassis

Air Filter

The chassis has a replaceable air filter mounted in a slide-out tray above the lower fan tray. The filter, shown in [Figure 3-2](#), plugs into the rear (MSC) side of the chassis.

You should change the air filter as often as necessary. In a dirty environment, or when you start getting frequent temperature alarms, check the intake grills for debris and check the air filter to see if it needs to be replaced. Before removing the air filter for replacing, you should have a spare filter on hand. Insert the new air filter before removing the old one.

Figure 3-2 Air Filter



1	Air filter cover with door stop design	2	Air filter
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**Note**

A lattice of wire exists on both sides of the air filter with an arrow that denotes airflow direction and a pair of sheet metal straps on the downstream side of the filter assembly.

Cooling System Operation

The fan control software and related circuitry varies the DC input voltage to individual fans to control their speed. This increases or decreases the airflow needed to keep the line card chassis operating in a desired temperature range. The chassis cooling system uses multiple fan speeds to optimize cooling, acoustics, and power consumption. There are four normal operating fan-speeds and one high-speed setting used when a fan tray has failed.

At initial power up, control software powers on the fans to 4300 to 4500 RPM. This provides airflow during system initialization and software boot, and ensures that there is adequate cooling for the chassis in case the software hangs during boot. The fan control software initializes after the routing system software boots, which can take 3 to 5 minutes. The fan control software then adjusts the fan speeds appropriately.

During normal operation, the chassis averages the temperatures reported by inlet temperature sensors in the lower card cage (or in the upper card cage if the lower cage is empty). To determine the appropriate fan speed for the current temperature, the fan control software compares the averaged inlet temperature to a lookup table that lists the optimal fan speed for each temperature. The software then sets the fan speed to the appropriate value for the current temperature. The temperature ranges in the lookup table overlap to ensure a proper margin to avoid any type of fan speed oscillation occurring between states.

**Note**

When there are no active alarms or failures, the fan control software checks temperature sensors every 1 to 2 minutes.

Thermal Alarms

Local thermal sensors (on individual cards) monitor temperatures and generate a thermal alarm when the cooling system is not cooling properly. A temperature sensor might trip in response to elevated ambient air temperature, a clogged air filter or other airflow blockage, or a combination of these causes. A fan failure causes a fault message, but if no thermal sensors have tripped, the fan control remains unchanged.

When a thermal sensor reports a thermal alarm, the sensor passes the fault condition to its local service processor (SP), which then notifies the system controller on the route processor (RP). The system controller passes the fault condition to the SP on each fan controller board. The fan control software then takes appropriate action to resolve the fault.

When a thermal sensor trips, the fan control software tries to resolve the problem (for example, by increasing fan speed). The software performs a series of steps to prevent chassis components from getting anywhere near reliability-reducing, chip-destroying temperatures. If the fault continues, the software shuts down the card or module to save components.

Quick-Shutdown Mode

The fan controller cards and fan trays have a quick-shutdown mode that kills power when a card or fan tray is disengaged from the chassis midplane. The quick-shutdown mode minimizes inrush current during a hot swap or OIR. In normal maintenance conditions, the software gracefully shut down the power to the failed part, allowing ample time for capacitors to discharge.

Fan Controller Redundancy in the Line Card Chassis

One of the main features of the LCC cooling system is a fully redundant fan control architecture. This architecture, which systematically controls the speed of the fans for various chassis-heating conditions, is redundant from both a power standpoint and a cooling standpoint.

The chassis is designed to run with both fan trays in place.

In a fully redundant system, equipped with dual power feeds, dual timing cards, and dual fan trays, the cooling system can withstand the failure of any one of the of the following components and still continue to properly cool the chassis:

- Fan tray—If one fan tray fails or is removed, the other fan tray automatically speeds up to the maximum limit and provides cooling for the entire chassis. (If multiple fans in a single fan tray fail, the remaining fans in the two fan trays provide cooling for the entire chassis.)
- Timing Card—If one timing card fails, the other card provides all of the controls for both fan trays
- Power shelf or power module—If one power feed fails, the other power feed provides all of the power to the fan trays.

In the single-failure cases described in this section, the rotational speed of the remaining operational fans changes automatically according to the cooling needs of the chassis.

A double-fault fan failure involves two fan trays, two fan tray boards, two fan controller cards, two power shelves, two power modules, or any combination of two of these components. When a double-fault failure occurs, the system can automatically power down individual cards if the cooling power is insufficient to maintain them. The chassis remains powered on unless both fan trays have failed or thermal alarms indicate a problem serious enough to power down the entire chassis

For information on the rotational speeds of the fans in revolutions per minute (RPM), see the [“Fan Tray” section on page 3-6](#).

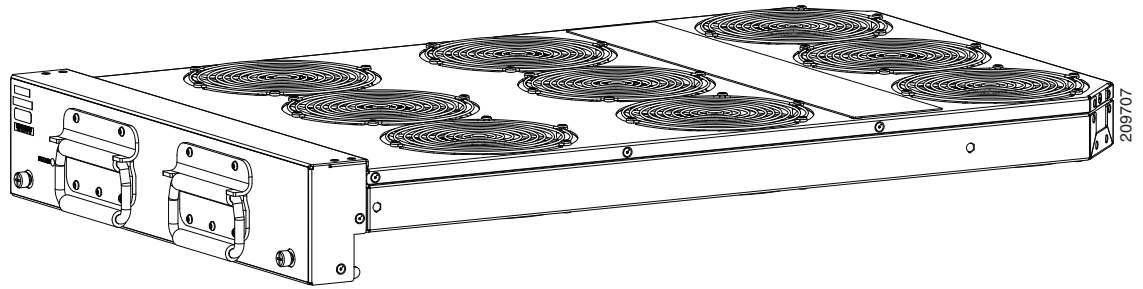
Fan Tray

The LCC has redundant fan trays (upper and lower), which are inserted from the rear side of the chassis. Each fan tray is hot swappable and is considered an FRU. Although the chassis can operate with one fan tray, both fan trays should be installed and working during normal operations.

Each fan tray is populated with nine PWM fans. The fans are controlled through a digital signal and are internally able to correct any variation in setting fan speed. Operating fan speed range is from 3300 up to 9000 RPM with a 5% tolerance.

[Figure 3-3](#) shows the fan tray. Each fan tray contains:

- Nine fans—Each fan uses a nominal +24 VDC as its input power. This voltage is adjusted to increase or decrease the speed of the fan. Two DC-to-DC converters, one on each fan controller card, provide input power to a single fan.
- A fan tray board—The board terminates signals to and from the fans, filters common-mode noise, and contains tracking and indicator parts.
- A front-panel status LED—The LED indicates the following:
 - Green—The fan tray is operating normally.
 - Yellow—The fan tray has experienced a failure and should be replaced.
 - Off—An unknown state exists or the LED is faulty.

Figure 3-3 Fan Tray

The fan tray has the following physical characteristics:

- Overall depth-32.6 in.
- Height of tray body-2.4 in.
- Height of front panel-4 in. (10.2 cm)
- Depth of front panel-2.9 in.
- Weight-44 lb (20 kg)

During normal operation, the fans operate in the range of 3300 to 5150 RPM. The system automatically adjusts the speed of the fans to meet the cooling needs of the entire chassis. If one fan controller card or one power feed fails, the fans continue to operate within the ranges specified above (up to 5150 RPM). If one fan tray fails completely, or is removed, the fans in the remaining fan tray automatically speed up to the maximum rotational limit.

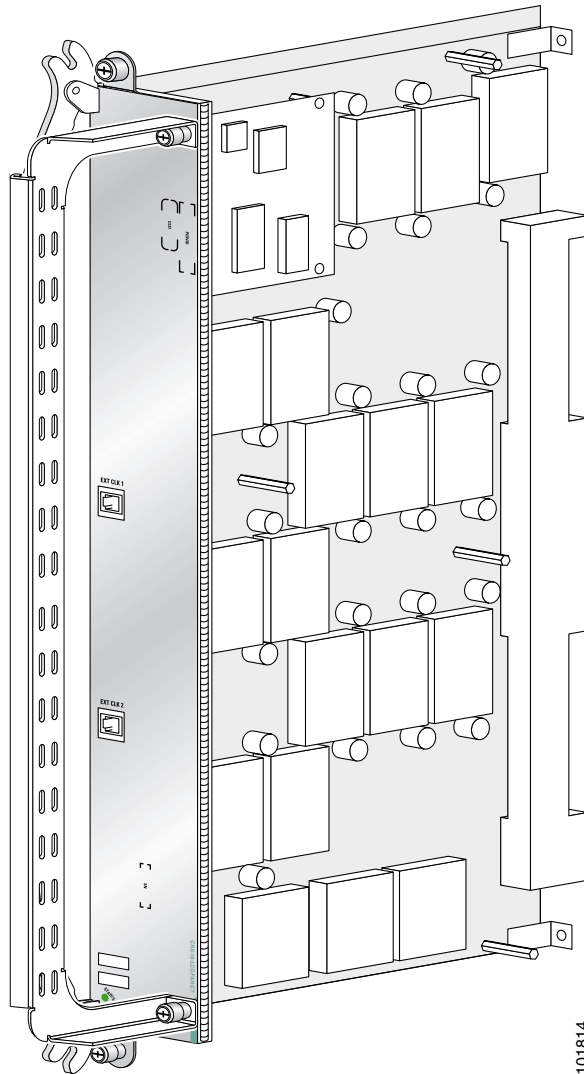
**Note**

The fan speed range limits listed in this document are nominal. These numbers have a tolerance of plus or minus 10 percent.

Fan Controller Card

The LCC contains two fan controller cards, shown in [Figure 3-4](#). Each controls one or both fan trays.

Figure 3-4 Fan Controller Card



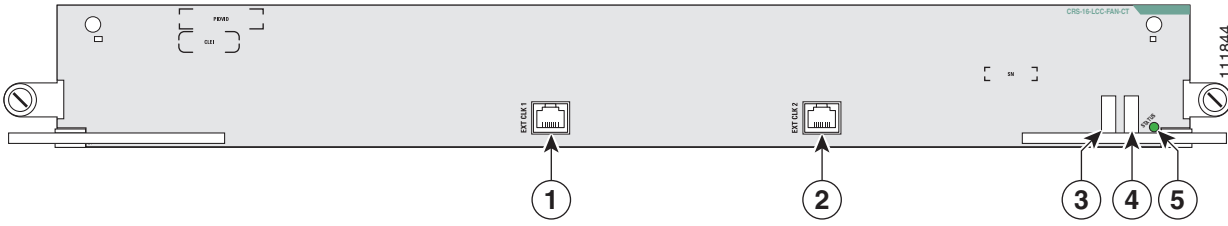
The LCC fan controller cards provide the following functions:

- Conversion of -48 VDC from the midplane to the DC voltages necessary to operate the fans.
- A service processor (SP) module that functions as part of the system control and communicates with the system controller function on the RPs.
- Inlet temperature and thermal alarms communicated to the fan controller SP module from the system controller on the RP. The chassis uses three types of temperature sensors: inlet, exhaust, and hot spot. Any of these sensors can send a thermal alarm.
- Individual fan tachometer monitoring signals from the fan tray.
- A status LED (good/bad) for each fan tray.
- Hot-swappable online insertion and removal (OIR) logic.

The LCC fan controller cards also contain the circuitry and input connector for the building integrated timing source (BITS) clock.

Figure 3-5 shows the fan controller card front panel.

Figure 3-5 Fan Controller Card Front Panel



1	EXT CLK 1 connector	4	Alphanumeric LED
2	EXT CLK 2 connector	5	Status LED
3	Alphanumeric LED		



Switch Fabric

This chapter describes the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC) switch fabric. It includes the following sections:

- [Switch Fabric Overview, page 4-1](#)
- [Switch Fabric Operation, page 4-2](#)
- [Switch Fabric Card Description, page 4-5](#)

Switch Fabric Overview

The switch fabric is the core of the Cisco CRS routing system. The Cisco CRS routing system fabric is implemented through multiple redundant switch fabric cards (SFCs) installed in the chassis. The switch fabric uses a cell-switched, buffered, three-stage Benes switch fabric architecture. The switch fabric receives user data from a modular services card (MSC) or Forwarding Processing card (FP) and performs the switching necessary to route the data to the appropriate egress MSC or FP.

The switch fabric is divided into eight planes (plane 0 to plane 7) that are used to evenly distribute traffic across the switch fabric. Each switch fabric plane is independent and not synchronized with one another. Each cell traverses the switch fabric using a single switch fabric plane (cells are not bit-sliced across the switch fabric).

When operating as a single-shelf (standalone) system, the LCC uses one of the following SFCs:

- CRS-16-FC/S (40G)
- CRS-16-FC140/S (140G)
- CRS-16-FC400/S (400G)

Each SFC implements all three stages of the switch fabric. Note the following:

- The CRS-16-FC140/S fabric is able to operate in both 40G mode and 140G mode to allow interconnection between 20G, 40G, or 140G MSCs and FPs.
- The CRS-16-FC400/S fabric is able to operate in 40G, 140G and 400G mode to allow interconnection between the 20G, 40G, 140G, or 400G MSCs and FPs.



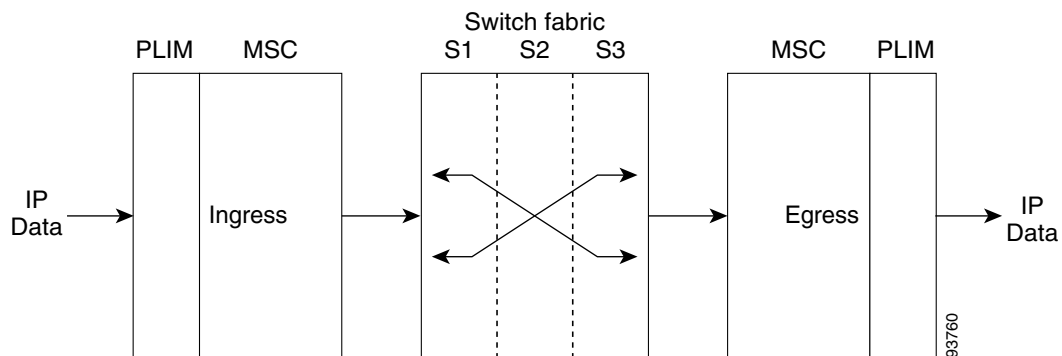
Note

The LCC supports either 40G fabric cards (FC/S cards), 140G fabric cards (FC-140/S cards), or 400G fabric cards (FC-400/S cards). A LCC with a mix of 40G, 140G, and 400G fabric cards is not a supported mode of operation. Such a mode is temporarily allowed only during the upgrade process.

When operating as part of a multishelf system for the Cisco CRS-1, Cisco CRS-3, or CRS-X, the LCC accepts either the CRS-16-FC/M (40G), CRS-16-FC140/M (140G), or CRS-16-FC400/M (400G) SFC. In a multishelf system, the SFCs installed in the LCCs perform the S1 stage and S3 stage functions, while the S2 stage of the switch fabric is provided by S2 switch fabric cards in the fabric card chassis (FCC). Like the CRS-16-FC140/S fabric, the CRS-16-FC140/M fabric operates in 40G and 140G mode. With the CRS-16-FC140/M S2 fabric in the FCC, the LCCs in a multishelf system can be a mixture of 40G fabric LCCs and 140G fabric LCCs; in this case, only those LCCs requiring 140G support would need to be upgraded. Also, like the CRS-16-FC400/S fabric, the CRS-16-FC400/M fabric operates in 40G, 140G, and 400G mode. With the CRS-16-FC400/M S2 fabric in the FCC, the LCCs in a multishelf system can be a mixture of 40G fabric LCCs, 140G fabric LCCs, and 400G LCCs; in this case, only those LCCs requiring 400G support would need to be upgraded. See the “Switch Fabric Operation” section on page 4-2 for details about the stages of the switch fabric.

Figure 4-1 shows the basic path of IP data packets through the switch fabric. Note that the figure shows a single-shelf system, in which all three stages of the switch fabric are provided by SFCs in the LCC. In a multishelf system, Stage 2 of the switch fabric is provided by S2 fabric cards in the FCC.

Figure 4-1 Basic Cisco CRS Series Carrier Routing System Switch Fabric



Ingress data packets are received at a physical interface on a PLIM and transferred to the associated MSC, where the packets are segmented into cells for efficient switching by the switch fabric hardware. Each MSC has multiple connections to each switch fabric plane, which it uses to distribute cells to each fabric plane. On egress, cells are reassembled into data packets before being transmitted by the egress MSC.



Note

The cell structure used in the Cisco CRS switch fabric is a Cisco-specific cell structure and is not related to Asynchronous Transfer Mode (ATM) cells.

Switch Fabric Operation

Several switch element components on each SFC perform the functions to implement each of the three stages (S1, S2, and S3) of the switch fabric. Each stage performs a different function:

- Stage 1 (S1)—Distributes traffic to Stage 2 of the fabric plane. Stage 1 elements receive cells from the ingress MSC and PLIM (or RP) and distribute the cells to Stage 2 (S2) of the fabric plane. Cells are distributed to S2 elements in round-robin fashion; one cell goes to the first S2 element, the next cell goes to the next S2 element, the next cell goes to the third S2 element, and so on, and then back to the first S2 in sequence.

- Stage 2 (S2)—Performs switching, provides 2 times (2x) speedup of cells, and performs the first stage of the multicast function. Stage 2 elements receive cells from Stage 1 and route them toward the appropriate:
 - Egress MSC and PLIM (single-shelf system)
 - Egress line card chassis (multishelf system)
- Stage 3 (S3)—Performs switching, provides 2 times (2x) speedup of cells, and performs a second level of the multicast function. Stage 3 elements receive cells from Stage 2 and perform the switching necessary to route each cell to the appropriate egress MSC and PLIM.

Speedup Function



Note

The speed up function only applies to the Cisco CRS-1 and Cisco CRS-3. It is not applicable for the Cisco CRS-X.

An LCC can contain up to 16 MSCs, each with up to 140 Gbps of bandwidth. To provide 140 Gbps of switching capacity for each MSC, the switch fabric must actually provide additional bandwidth to accommodate cell overhead, buffering, and congestion-avoidance mechanisms.

Congestion can occur in the switch fabric if multiple input data cells are being switched to the same destination egress MSC. Typically, little congestion exists between the S1 and S2 stages because there is little or no contention for individual links between the switch components. However, as multiple cells are switched from the S2 and S3 stages to the same egress MSC, cells might contend for the same output link.

To reduce the possibility of data cells being delayed during periods of congestion, the switch fabric uses 2 times (2x) speedup to reduce contention for S2 and S3 output links. The switch fabric achieves 2x speedup by providing two output links for every input link at the S2 and S3 stages.

S2 and S3 Buffering

Buffering is also used at the S2 and S3 stages of the switch fabric to alleviate any additional congestion that the switch fabric speedup does not accommodate. To ensure that this buffering does not cause cells to arrive out of sequence, the MSC resequences the cells before reassembling them into packets. To limit the amount of buffering required, a back-pressure mechanism is used for flow control (which slows the transmission of data cells to a congested destination). Back-pressure messages are carried in fabric cell headers.

Failure Operation

The routing system can withstand the loss of a single plane of the switch fabric with no impact on the system. The loss of multiple planes results in linear and graceful degradation of performance, but does not cause the routing system to fail.

Note the following:

- For the Cisco CRS-1 and Cisco CRS-3 routing systems, at least two planes of the switch fabric (an even plane and an odd plane) must be active at all times. Otherwise, the switch fabric fails, causing a system failure.
- For the Cisco CRS-X routing system, at least three planes of the switch fabric (an even plane, an odd plane, and one plane in either slot 6 or 7) must be active at all times for the router to operate. Otherwise, the switch fabric fails, causing a system failure.

Switch Fabric Upgrade

You can upgrade the switch fabric to a higher capacity SFC. To avoid traffic loss, you must upgrade the switch fabric one plane at a time, which allows the system to continue operating with seven fabric planes. During the upgrade, some fabric planes may run in one configuration while others run in a different configuration.

To upgrade a fabric plane, first shut down the fabric plane and then remove the fabric card that implements that plane. Then, replace the original fabric card with the new fabric card and restore service to that fabric plane before upgrading the next plane.

For information about how to perform online insertion and removal (OIR) of SFCs in a single-chassis system, see [Cisco CRS Carrier Routing System Getting Started Guide](#). For information about how to upgrade from a single-shelf system to a multishelf system, see [Cisco CRS-1 Carrier Routing System Single-Shelf to Multishelf Upgrade Guide](#).

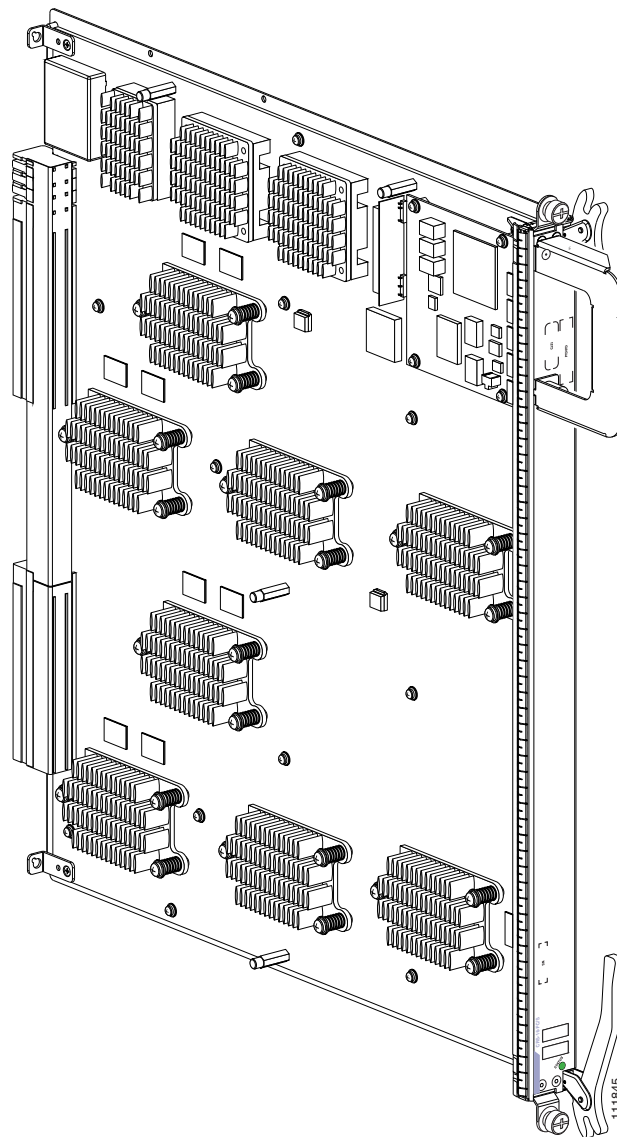
Switch Fabric Card Description

The single-chassis supports the CRS-16-FC/S, CRS-16-FC140/S, or CRS-16-FC400/S switch fabric card.

Switch Fabric Card (Single-Chassis System)

In a single chassis, the SFC implements all three stages of the three-stage Benes switch fabric. Each card also implements one plane of the eight-plane switch fabric. [Figure 4-2](#) shows the CRS-16-FC/S switch fabric card. The CRS-16-FC140/S is similar, but the CRS-16-FC400/S is different.

Figure 4-2 CRS-16-FC/S Switch Fabric Card



Switch Fabric Card Components

The SFC contains the following major components:

- S1 switch element—Implements Stage 1 of the switch fabric. Receives cells from the MSC or RP and distributes them to Stage 2. Each S1 switch element is connected to every S2 switch element.
- S2 switch element—Implements Stage 2 of the switch fabric. Receives cells from Stage 1, performs 2x speedup, and routes the cells toward the appropriate egress S3 element. Each S2 switch element is connected to every S3 switch element.

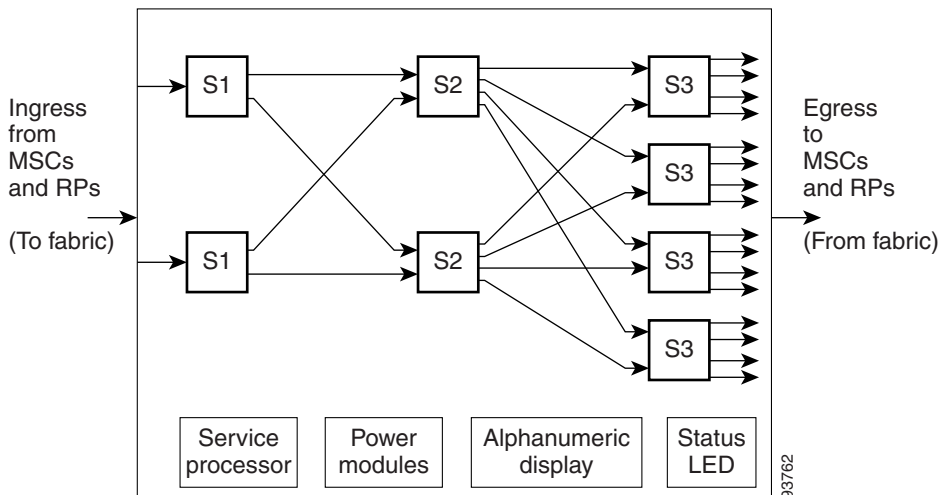


Note The speed up function only applies to the Cisco CRS-1 and Cisco CRS-3. It is not applicable for the Cisco CRS-X.

- S3 switch element—Implements Stage 3 of the switch fabric. Receives data cells from Stage 2 and performs switching and 2x speedup. The S2 and S3 switch elements are pure output-buffered switch elements with a central memory to buffer cells and queuing capabilities to distinguish between high-priority and low-priority traffic.
- Service processor—Controls the operation of the fabric card and provides the interface to the system control plane. The service processor performs card power up and power down, performs link-up and link-down processing, configures switch element components, updates the fabric group ID (FGID) for multicast traffic, and maintains cell configuration.
- Power modules—Take -48 VDC input power from the midplane and convert it to the voltages required by the components on the switch fabric card.

Figure 4-3 shows the major components of the switch fabric card.

Figure 4-3 Block Diagram of the Switch Fabric Card



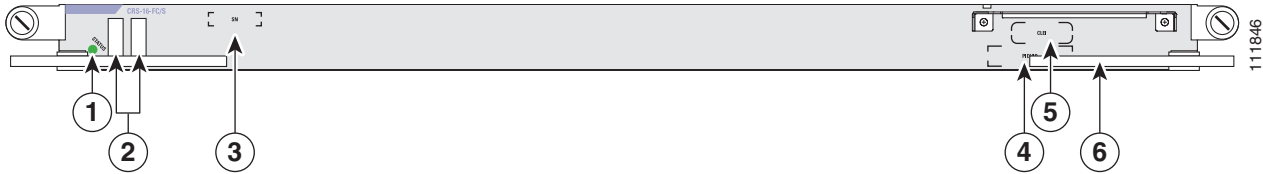
Note

Each stage of the three-stage Benes switch fabric is implemented with the same switch element components. However, during system startup the components are programmed by Cisco IOS XR software to operate in S1, S2, or S3 mode, depending on their functions in the switch fabric. Each switch fabric card contains two S1, two S2, and four S3 components.

Switch Fabric Card Physical Characteristics

Figure 4-4 shows the front panel of the CRS-16-FC/S SFC. The front panel of the CRS-16-FC140/S and CRS-16-FC400/S are similar.

Figure 4-4 CRS-16-FC/S Switch Fabric Card Front Panel



1	Status LED	4	PID/VDN
2	Two Alphanumeric LEDs	5	CLEI
3	SN	6	Ejector

The SFC front panel contains:

- Status LED—Indicates the status of the fabric card.
- Alphanumeric display—Displays switch fabric card messages.
- SN—Serial number
- PID/VDN—Product identification and vector directory number
- CLEI—Common Language Equipment Identifier code label
- Ejector levers



Line Cards and Physical Layer Interface Modules

This chapter describes the modular services card (MSC), forwarding processors (FP), the label switch processor (LSP) card, and the associated physical layer interface modules (PLIMs) of the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC).

This chapter includes the following sections:

- [Overview of Line Card Architecture, page 5-1](#)
- [Overview of Line Cards and PLIMs, page 5-2](#)
- [Line Card Descriptions, page 5-7](#)
- [Physical Layer Interface Modules \(PLIMs\), page 5-10](#)



Note

For a complete list of cards supported in the LCC, go to the Cisco Carrier Routing System Data Sheets at: http://www.cisco.com/en/US/products/ps5763/products_data_sheets_list.html

Overview of Line Card Architecture

The MSC, FP, or LSP card, also called line cards, are the Layer 3 forwarding engine in the CRS 16-Slot routing system. Every LCC has 16 MSC, FC, or LSP slots, each with a capacity of up to 400 gigabits per second (Gbps) ingress and 400 Gbps egress, for a total routing capacity per chassis of 12800 Gbps or 12.8 terabits per second (Tbps). (A terabit is 1 x 10¹² bits or 1000 gigabits.)

The routing system is built around a scalable, distributed three-stage Benes switch fabric and a variety of data interfaces. The data interfaces are contained on PLIMs that mate with an associated line card through the chassis midplane. The switch fabric cross-connects line cards to each other. [Figure 5-1](#) is a simple diagram of the basic Cisco CRS architecture.

Figure 5-1 Simple Cisco CRS Series Routing System Architecture

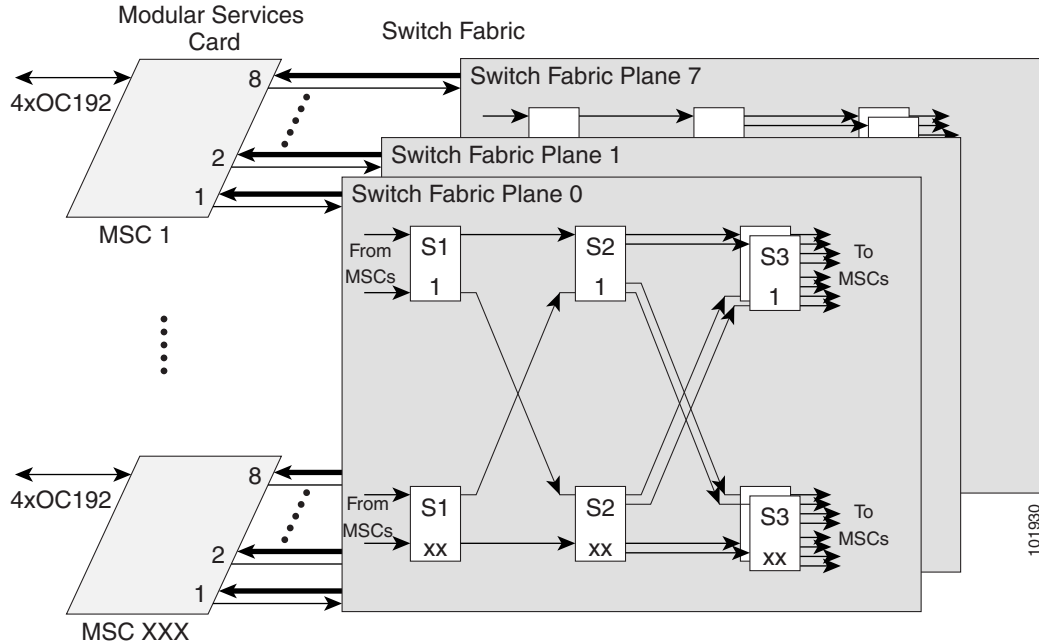


Figure 5-1 illustrates the following concepts, which are common to all Cisco CRS-1 routing systems:

- Packet data enters the line card through physical data interfaces located on the associated PLIM. In Figure 5-1, these physical interfaces are represented by four OC-192 ports.
- Data is routed through the line card, a Layer 3 forwarding engine, to the three-stage Benes switch fabric. Each line card and its associated PLIM have Layer 1 through Layer 3 functionality, and each line card can deliver line-rate performance (140 Gbps aggregate bandwidth). See “[Overview of Line Cards and PLIMs](#)” section on page 5-2 for more information.
- The three-stage Benes switch fabric cross-connects the line cards in the routing system. The switch fabric is partitioned into eight planes (plane 0 to plane 7) and is implemented by several components (see Figure 5-1). See Chapter 4, “[Switch Fabric](#),” for more information.

Overview of Line Cards and PLIMs

Each MSC, FP, and LSP is paired with a corresponding physical layer interface module (PLIM, also called line card) that contains the physical interfaces for the line card. An MSC, FP, or LSP can be paired with different types of PLIMs to provide a variety of packet interfaces.

- The MSC card is available in the following versions: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X (400G mode).
- The FP card is available in the following versions: CRS-FP140, CRS-FP-X (400G mode).
- The LSP card is available in the following versions: CRS-LSP, CRS-LSP-X.



Note

See the “[Line Card Chassis Components](#)” section on page 1-3 for information about CRS fabric, MSC, and PLIM component compatibility.

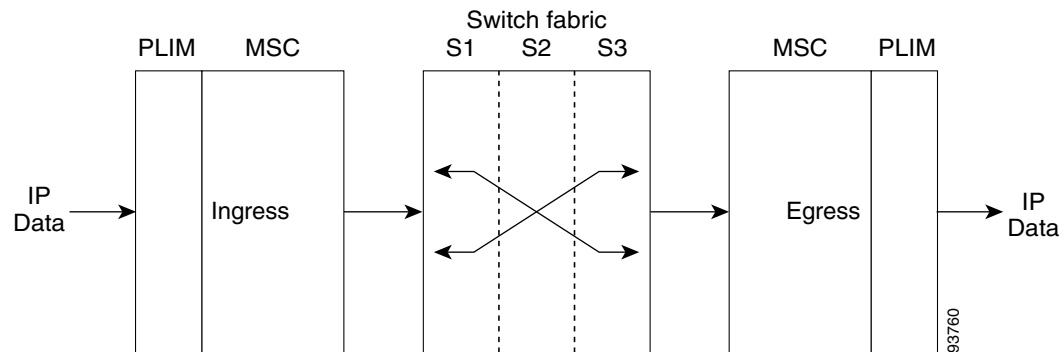
Each line card and associated PLIM implement Layer 1 through Layer 3 functionality that consists of physical layer framers and optics, MAC framing and access control, and packet lookup and forwarding capability. The line cards deliver line-rate performance (up to 400 Gbps aggregate bandwidth). Additional services, such as Class of Service (CoS) processing, Multicast, Traffic Engineering (TE), including statistics gathering, are also performed at the 400 Gbps line rate.

Line cards support several forwarding protocols, including IPV4, IPV6, and MPLS. Note that the route processor (RP) performs routing protocol functions and routing table distributions, while the MSC, FP, and LSP actually forward the data packets.

Line cards and PLIMs are installed on opposite sides of the LCC, and mate through the LCC midplane. Each MSC/PLIM pair is installed in corresponding chassis slots in the chassis (on opposite sides of the chassis).

Figure 5-2 shows how the MSC takes ingress data through its associated PLIM and forwards the data to the switch fabric where the data is switched to another MSC, FP, and LSP, which passes the egress data out its associated PLIM.

Figure 5-2 Data Flow through the Cisco CRS LCC



Data streams are received from the line side (ingress) through optic interfaces on the PLIM. The data streams terminate on the PLIMs. Frames and packets are mapped based on the Layer 2 (L2) headers.

The line card converts packets to and from cells and provides a common interface between the routing system switch fabric and the assorted PLIMs. The PLIM provides the interface to user IP data. PLIMs perform Layer 1 and Layer 2 functions, such as framing, clock recovery, serialization and deserialization, channelization, and optical interfacing. Different PLIMs provide a range of optical interfaces, such as very-short-reach (VSR), intermediate-reach (IR), or long-reach (LR).

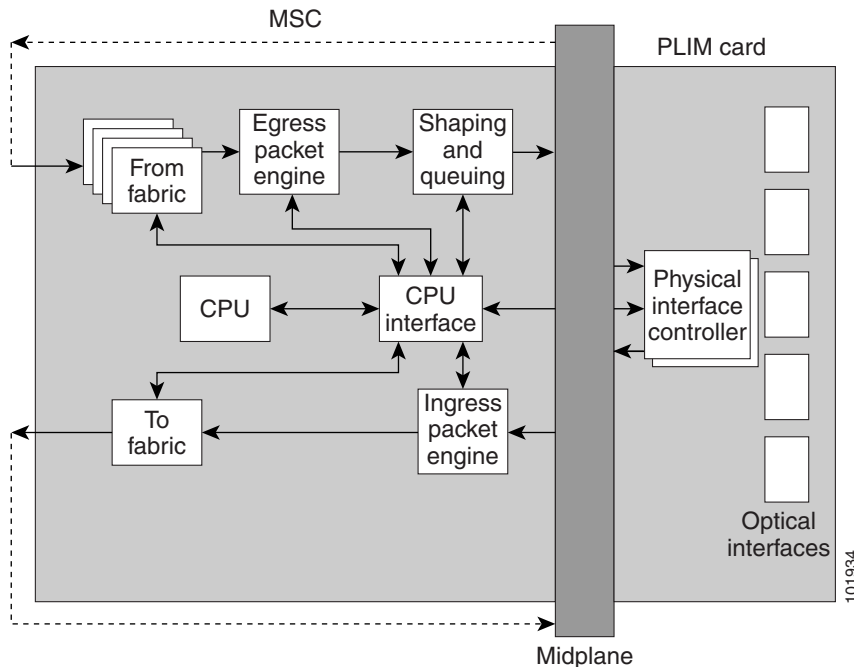
A PLIM eight-byte header is built for packets entering the fabric. The PLIM header includes the port number, the packet length, and some summarized layer-specific data. The L2 header is replaced with PLIM headers and the packet is passed to the MSC for feature applications and forwarding.

The transmit path is essentially the opposite of the receive path. Packets are received from the drop side (egress) from the line card through the chassis midplane. The Layer 2 header is based on the PLIM eight-byte header received from the line card. The packet is then forwarded to appropriate Layer 1 devices for framing and transmission on the fiber.

A control interface on the PLIM is responsible for configuration, optic control and monitoring, performance monitoring, packet count, error-packet count and low-level operations of the card, such as PLIM card recognition, power up of the card, and voltage and temperature monitoring.

Figure 5-3 is a simple block diagram of the major components of an MSC and PLIM pair. These components are described in the sections that follow. This diagram also applies to the FP and LSP line cards.

Figure 5-3 MSC and PLIM Simple Block Diagram



PLIM Physical Interface Module on Ingress

As shown in Figure 5-3, received data enters a PLIM from the physical optical interface. The data is routed to the physical interface controller, which provides the interface between the physical ports, and the Layer 3 function of the line card. For receive (ingress) data, the physical interface controller performs the following functions:

- Multiplexes the physical ports and transfers them to the ingress packet engine through the LCC midplane.
- Buffers incoming data, if necessary, to accommodate back-pressure from the packet engine.
- Provides Gigabit Ethernet specific functions, such as:
 - VLAN accounting and filtering database
 - Mapping of VLAN supports

MSC Ingress Packet Engine

The ingress packet engine performs packet processing on the received data. It makes the forwarding decision and places the data into a rate-shaping queue in the “to fabric” section. To perform Layer 3 forwarding, the packet engine performs the following functions:

- Classifies packets by protocol type and parses the appropriate headers on which to do the forwarding lookup on
- Performs an algorithm to determine the appropriate output interface to which to route the data

- Performs access control list filtering
- Maintains per-interface and per-protocol byte-and-packet statistics
- Maintains Netflow accounting
- Implements a flexible dual-bucket policing mechanism

MSC To Fabric Section and Queuing

The “to fabric” section of the board takes packets from the ingress packet engine, segments them into fabric cells, and distributes (sprays) the cells into the eight planes of the switch fabric. Because each MSC has multiple connections per plane, the “to fabric” section distributes the cells over the links within a fabric plane. The chassis midplane provides the path between the “to fabric” section and the switch fabric (as shown by the dotted line in [Figure 5-3](#)).

- The first level performs ingress shaping and queuing, with a rate-shaping set of queues that are normally used for input rate-shaping (that is, per input port or per subinterface within an input port), but can also be used for other purposes, such as to shape high-priority traffic.
- The second level consists of a set of destination queues where each destination queue maps to a destination line card, plus a multicast destination.

Note that the flexible queues are programmable through the Cisco IOS XR software.

MSC From Fabric Section

The “from fabric” section of the board receives cells from the switch fabric and reassembles the cells into IP packets. The section then places the IP packets in one of its 8K egress queues, which helps the section adjust for the speed variations between the switch fabric and the egress packet engine. Egress queues are serviced using a modified deficit round-robin (MDRR) algorithm. The dotted line in [Figure 5-3](#) indicates the path from the midplane to the “from fabric” section.

MSC Egress Packet Engine

The transmit (egress) packet engine performs a lookup on the IP address or MPLS label of the egress packet based on the information in the ingress MSC buffer header and on additional information in its internal tables. The transmit (egress) packet engine performs transmit side features such as output committed access rate (CAR), access lists, diffServ policing, MAC layer encapsulation, and so on.

Shaping and Queuing Function

The transmit packet engine sends the egress packet to the shaping and queuing function (shape and regulate queues function), which contains the output queues. Here the queues are mapped to ports and classes of service (CoS) within a port. Random early-detection algorithms perform active queue management to maintain low average queue occupancies and delays.

PLIM Physical Interface Section on Egress

On the transmit (egress) path, the physical interface controller provides the interface between the line card and the physical ports on the PLIM. For the egress path, the controller performs the following functions:

- Support for the physical ports. Each physical interface controller can support up to four physical ports and there can be up to four physical interface controllers on a PLIM.
- Queuing for the ports
- Back-pressure signalling for the queues
- Dynamically shared buffer memory for each queue
- A loopback function where transmitted data can be looped back to the receive side

MSC CPU and CPU Interface

As shown in [Figure 5-3](#), the MSC contains a central processing unit (CPU) that performs the following tasks:

- MSC configuration
- Management
- Protocol control

The CPU subsystem includes:

- CPU chip
- Layer 3 cache
- NVRM
- Flash boot PROM
- Memory controller
- Memory, a dual in-line memory module (DIMM) socket, providing the following:
 - Up to 2 GB of 133 MHz DDR SDRAM on the CRS-MSC
 - Up to 2 GB of 166 MHz DDR SDRAM on the CRS-MSC-B
 - Up to 8GB of 533 MHz DDR2 SDRAM on the CRS-MSC-140G
 - Up to 15GB of 667 MHz DDR3 DIMM on the CRS-MSC-X

The CPU interface provides the interface between the CPU subsystem and the other ASICs on the MSC and PLIM.

The MSC also contains a service processor (SP) module that provides:

- MSC and PLIM power-up sequencing
- Reset sequencing
- JTAG configuration
- Power monitoring

The SP, CPU subsystem, and CPU interface module work together to perform housekeeping, communication, and control plane functions for the MSC. The SP controls card power up, environmental monitoring, and Ethernet communication with the LCC RPs.

The CPU subsystem performs a number of control plane functions, including FIB download receive, local PLU and TLU management, statistics gathering and performance monitoring, and MSC ASIC management and fault-handling.

The CPU interface module drives high-speed communication ports to all ASICs on the MSC and PLIM. The CPU talks to the CPU interface module through a high-speed bus attached to its memory controller.

Line Card Descriptions

An MSC, FP, or LSP fits into any available MSC slot and connects directly to the midplane. There are the following types of MSC, FP, and LSP cards:

- MSCs: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X (400G mode)
- FPs : CRS-FP40, CRS-FP140, CRS-FP-X (400G mode)
- LSPs: CRS-LSP, CRS-LSP-X

Table 5-1 Power Consumption for Line Cards

Line Card	Power Consumption (in watts)
CRS-MSC	350 W
CRS-MSC-B	375 W
CRS-MSC-140G	446 W
CRS-MSC-X (400G)	650 W
CRS- FP40	375 W
CRS- FP140	446 W
CRS-FP-X (400G)	650 W
CRS- LSP	446 W
CRS-LSP-X	650 W

Figure 5-4 shows a Cisco CRS routing system CRS-MSC-140G.

Figure 5-4 Modular Services Card (CRS-MSC-140G)

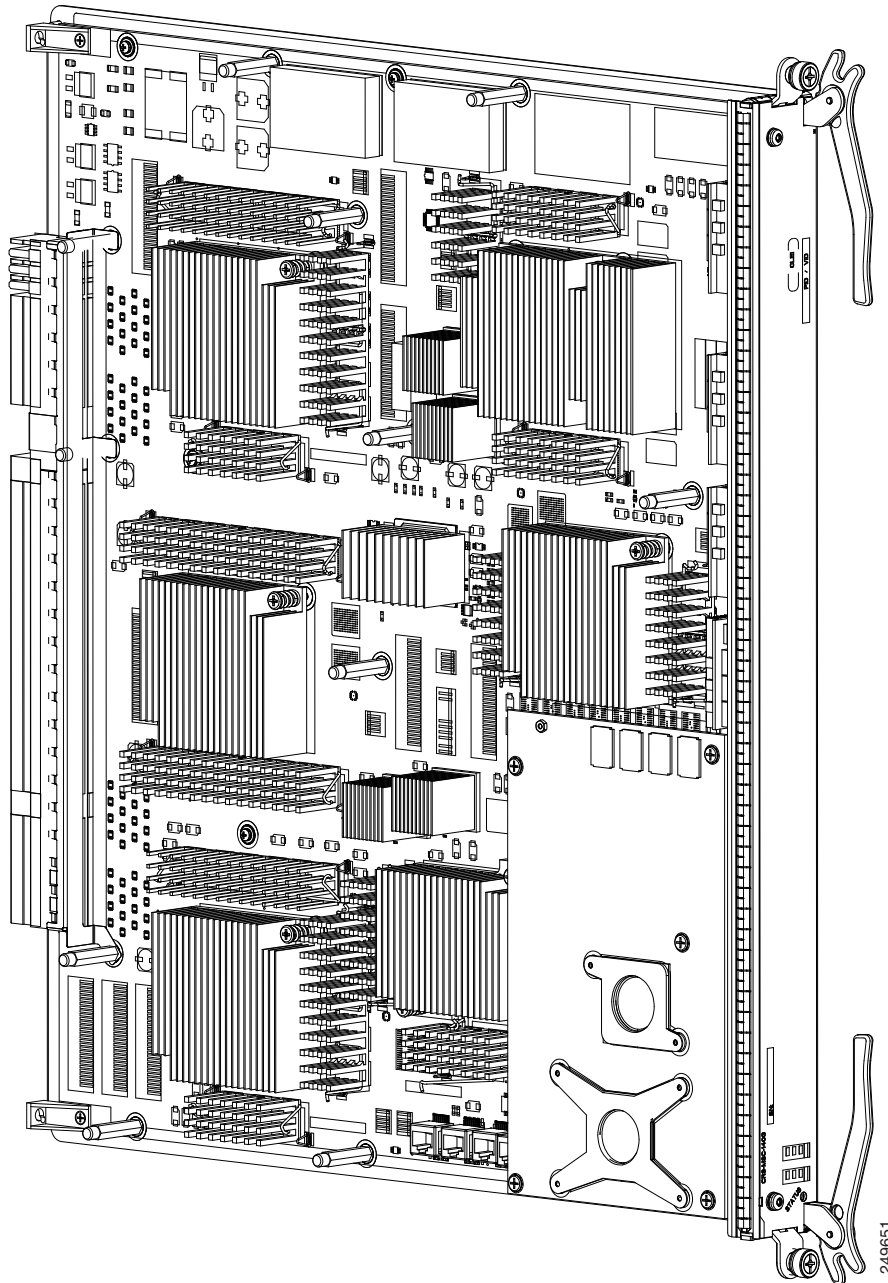
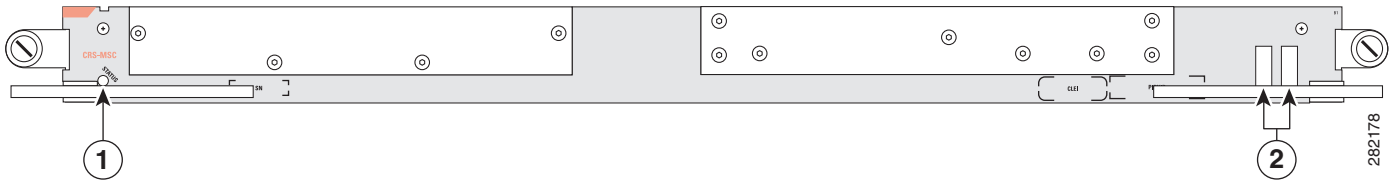


Figure 5-5 shows the CRS-MSC front panel.

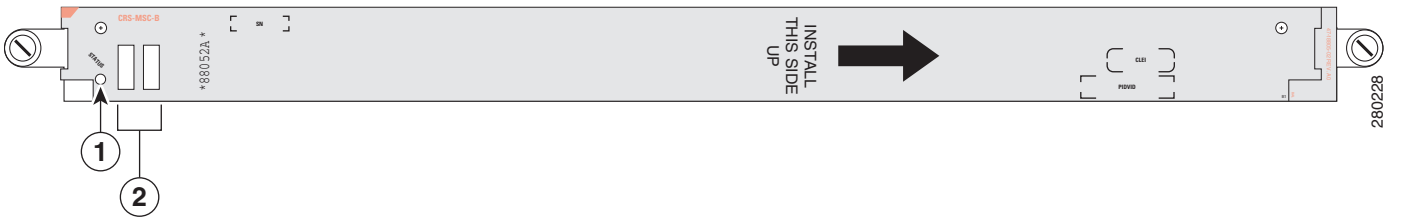
Figure 5-5 CRS-MSC Front Panel



1 Status LED	2 Alphanumeric LEDs
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Figure 5-6 shows the front panel of the CRS-MSC-B.

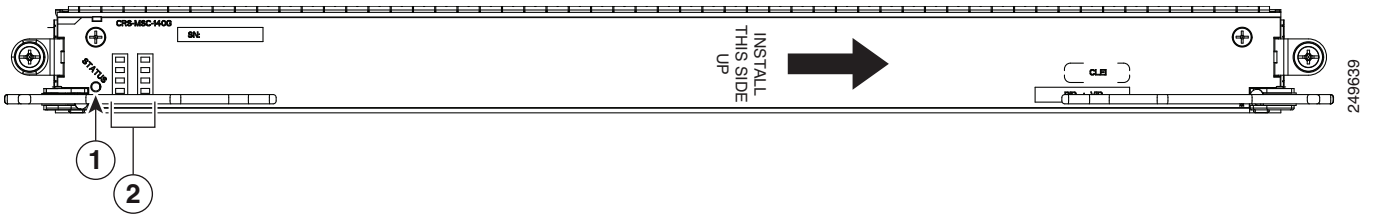
Figure 5-6 CRS-MSC-B Front Panel



1 Status LED	2 Alphanumeric LEDs
---------------------	----------------------------

Figure 5-7 shows the front panel of the CRS-MSC-140G. The CRS-MSC-X card front panel is similar.

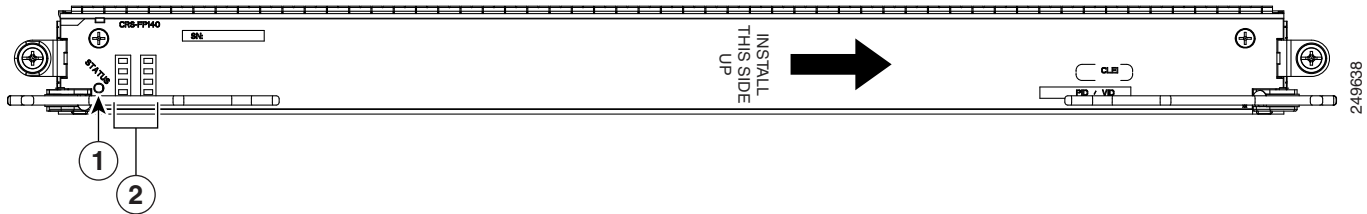
Figure 5-7 CRS-MSC-140G Front Panel



1 Status LED	2 Alphanumeric LEDs
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Figure 5-8 shows the front panel of the CRS-FP140. The CRS-FP40 and CRS-FP-X card front panels are similar.

Figure 5-8 CRS-FP140 Front Panel



1	Status LED	2	Alphanumeric LEDs
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Physical Layer Interface Modules (PLIMs)

A physical layer interface module (PLIM) provides the packet interfaces for the routing system. Optic modules on the PLIM contain ports to which fiber-optic cables are connected. User data is received and transmitted through the PLIM ports, and converted between the optical signals (used in the network) and the electrical signals (used by Cisco CRS Series components).

Each PLIM is paired with a line card through the chassis midplane. The line card provides Layer 3 services for the user data, and the PLIM provides Layer 1 and Layer 2 services. A line card can be paired with different types of PLIMs to provide a variety of packet interfaces and port densities.

Line cards and PLIMs are installed on opposite sides of the LCC, and mate through the chassis midplane. Each line card and PLIM pair is installed in corresponding chassis slots in the chassis (on opposite sides of the chassis). The chassis midplane enables you to remove and replace a line card without disconnecting the user cables on the PLIM.

You can mix and match PLIM types in the chassis.

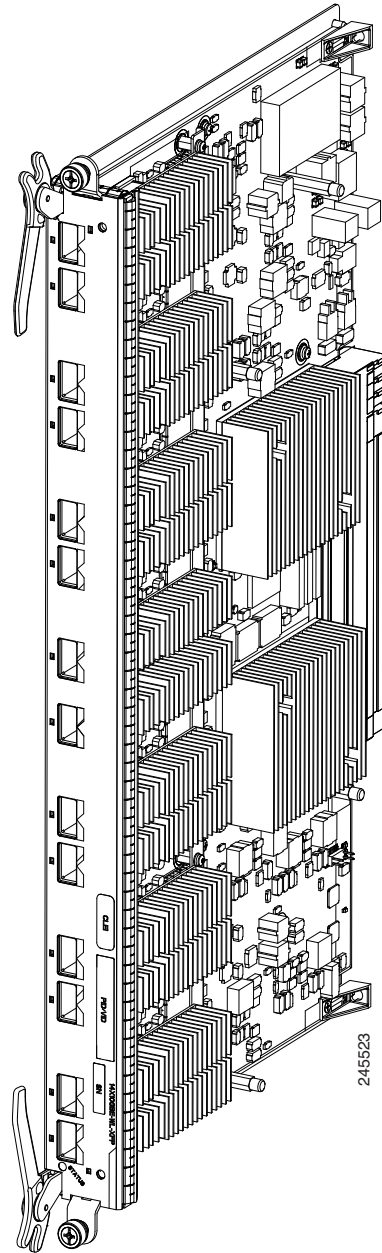


Warning

Because invisible radiation may be emitted from the aperture of the port when no fiber cable is connected, avoid exposure to radiation and do not stare into open apertures. Statement 125

Figure 5-9 shows a typical PLIM, in this case, a 14-port 10-GE XFP PLIM. Other PLIMs are relatively similar, however each PLIM has a different front panel, depending on the interface type.

Figure 5-9 Typical PLIM—14-Port 10-GE XFP PLIM



The following sections describe some of the types of PLIMs currently available for the LCC:



Note

For a full list of supported PLIMs, see the *Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note*.

- [OC-48 POS/Dynamic Packet Transport PLIM](#)

- [10-Gigabit Ethernet XENPAK PLIM](#)
- [8-Port 10-GE PLIM with XFP Optics Modules, page 5-15](#)
- [4-Port 10-GE PLIM with XFP Optics Modules, page 5-17](#)
- [1-Port 100-GE PLIM with CFP Optics Module, page 5-18](#)
- [20-Port 10-GE PLIM with XFP Optics Modules, page 5-19](#)
- [14-Port 10-GE PLIM with XFP Optics Modules, page 5-21](#)
- [PLIM Impedance Carrier, page 5-22](#)

OC-48 POS/Dynamic Packet Transport PLIM

The 16-port OC-48 PLIM contains 16 OC-48 interfaces that can be software configured to operate in packet-over-SONET (POS) or Dynamic Packet Transport (DPT) mode. The PLIM performs Layer 1 and Layer 2 processing for 16 OC-48 data streams by removing and adding the proper header information as data packets enter and exit the PLIM. The PLIM feeds the line card a single 40 Gbps data packet stream.

The PLIM is a class 1 laser product.



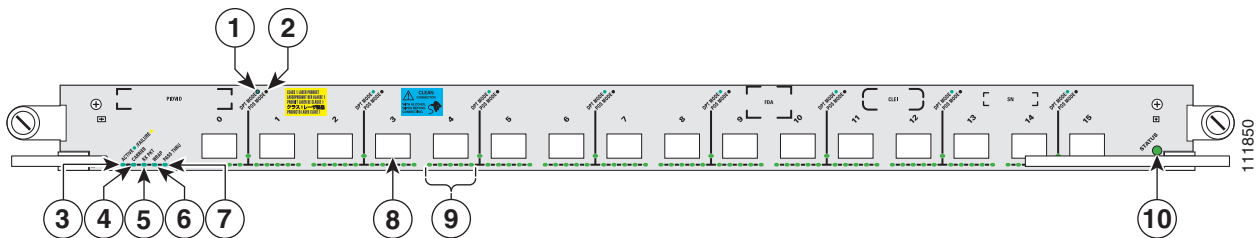
Note DPT mode is supported on the OC-192/OC-48 POS PLIM in Cisco IOS XR Release 3.4.

The 16-port OC-48 PLIM consists of the following components:

- **Optics modules**—Provide the receive (Rx) and transmit (Tx) optic interfaces for each of the 16 ports. The OC-48 PLIM uses small form-factor pluggable (SFP) optics modules that can be removed and replaced while the PLIM is powered up. The SFPs provide short-reach (SR) and long-reach (LR2) optics with LC fiber-optic interfaces.
- **Framers**—Provide processing and termination for SONET section, line, and path layers, including alarm processing and APS support and management. The framer supports both packet and cell processing for a multiservice operating mode.
- **DPT or transparent mode components**—Provide the MAC layer function for the Spatial Reuse Protocol used in the DPT mode. When the OC-48 PLIM operates in the POS mode, these components operate in the transparent mode.
- **Physical interface controller**—Provides data packet buffering and Layer 2 processing and multiplexing and demultiplexing of the 16 OC-48 data streams. This includes processing for VLANs and back-pressure signals from the line card.
- **Additional components**—Provide power, clocking, voltage and temperature sensing, and an identification EEPROM that stores initial configuration information and details about the PLIM type and hardware revision.
- **Power consumption of the OC-48 PLIM**—136 W

Figure 5-10 shows the front panel of the OC-48 PLIM.

Figure 5-10 16-Port OC-48 POS PLIM Front Panel View



1	DPT MODE LED	6	WRAP LED
2	POS MODE LED	7	PASS THRU LED
3	ACTIVE/FAILURE LEDS	8	One of sixteen slots for SFPs numbered from 0 through 15 left to right
4	CARRIER LED	9	Five LEDs per port
5	RX PKT LED	10	Status LED

As shown, the 16-port OC-48 PLIM has:

- Sixteen slots for SFP optic modules, which provide SR or LR optics with LC fiber-optic interfaces.
- STATUS LED—Green indicates that the PLIM is properly seated and operating correctly. Yellow or amber indicates a problem with the PLIM. If the LED is off (dark), check that the board is properly seated and that system power is on.
- Eight DPT MODE or POS MODE LEDs—One of these DPT MODE or POS MODE LEDs is for each pair of ports, 0 and 1, 2 and 3, 4 and 5, 6 and 7, 8 and 9, 10 and 11, 12 and 13, and 14 and 15. The DPT mode is always configured on pairs of ports. The LED is lit when a pair of ports are configured in the DPT mode. Currently, the OC-48 PLIM operates only in the POS mode.
- Five green LEDs for each port. The LEDs, which correspond to the labels on the lower left of the front panel, have the following meanings (from left to right):
 - ACTIVE/FAILURE—Indicates that the port is logically active; the laser is on.
 - CARRIER—Indicates that the receive port (Rx) is receiving a carrier signal.
 - RX PKT—Blinks every time a packet is received.
 - WRAP—Indicates that the port is in DPT wrapped mode.
 - PASS THRU—Indicates that the port is operating in the POS mode (DPT pass through).

10-Gigabit Ethernet XENPAK PLIM

The 8-port 10-Gigabit Ethernet (GE) XENPAK PLIM provides from one to eight 10-GE interfaces. The PLIM supports from one to eight pluggable XENPAK optic modules that provide the 10-GE interfaces for the card. The PLIM performs Layer 1 and Layer 2 processing for up to eight 10-GE data streams by removing and adding the proper header information as data packets enter and exit the PLIM.

Although the PLIM can terminate up to 80 Gbps of traffic, the line card forwards traffic at 40 Gbps. Therefore, the PLIM provides 40 Gbps of throughput, which it passes to the line card as two 20-Gbps data packet streams:

- Ports 0 to 3 (the upper set of ports) provide 20 Gbps of throughput.
- Ports 4 to 7 (the lower set of ports) provide another 20 Gbps of throughput.

Oversubscription of 10-GE Ports

If more than 2 optic modules are installed in either set of ports, oversubscription occurs on all ports in that set. For example, if modules are installed in ports 0 and 1, each interface has 10 Gbps of throughput. Adding another module in port 2 causes oversubscription on all of the interfaces (0, 1, and 2).



Note

If your configuration cannot support oversubscription, use the following guidelines to determine which PLIM slots to install optic modules in.

- Do not install more than four optic modules in each PLIM.
- Install the optic modules in any one of the following sets of PLIM slots:
 - Slots 0 and 1, and 4 and 5
 - Slots 0 and 1, and 6 and 7
 - Slots 2 and 3, and 4 and 5
 - Slots 2 and 3, and 6 and 7

If your configuration can support oversubscription and you want to install more than four optic modules in a PLIM, we recommend that you install additional modules in empty slots, alternating between upper and lower ports. For example, if you install a fifth optic module in an empty slot in the upper set of ports (0 to 3), be sure to install the next module in an empty slot in the lower set of ports (4 to 7), and so on.

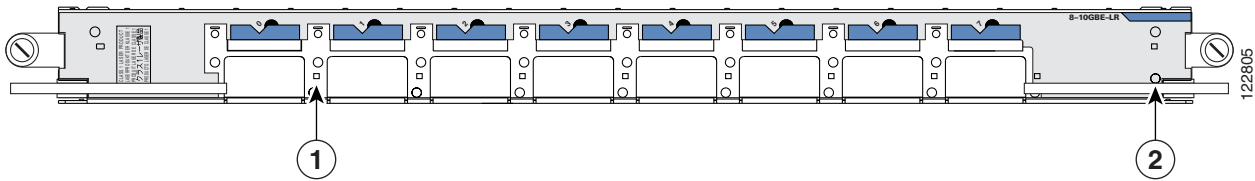
10-GE PLIM Components

The 8-port 10-GE XENPAK PLIM consists of:

- Optic modules—Provide receive (Rx) and transmit (Tx) optical interfaces that comply with IEEE 802.3ae. The PLIM supports from one to eight pluggable XENPAK optic modules, each providing full-duplex long-reach (LR) optics with SC fiber-optic interfaces. Note that the PLIM automatically shuts down any optic module that is not a valid type.
- Physical interface controller—Provides data packet buffering, Layer 2 processing, and multiplexing and demultiplexing of the 10-GE data streams, including processing for VLANs and back-pressure signals from the line card.
- Additional components—Include power and clocking components, voltage and temperature sensors, and an identification EEPROM that stores initial configuration and PLIM hardware information.

Figure 5-11 shows the front panel of the 10-GE XENPAK PLIM.

Figure 5-11 10-GE XENPAK PLIM Front Panel



1	Port LED (one per port)	2	Status LED
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The 8-port 10-GE XENPAK PLIM has the following elements:

- Eight slots that accept XENPAK optic modules, which provide LR optics with SC fiber-optic interfaces.
- A STATUS LED—Green indicates that the PLIM is properly seated and operating correctly. Yellow or amber indicates a problem with the PLIM. If the LED is off (dark), check that the board is properly seated and that system power is on.
- An LED for each port—Indicates that the port is logically active; the laser is on.
- Power consumption of the 10-GE XENPAK PLIM—110 W (with 8 optic modules)

8-Port 10-GE PLIM with XFP Optics Modules

The 8-port 10-GE XFP PLIM supports from one to eight pluggable XFP optics modules.

Figure 5-12 shows the front panel of the 8-port 10-GE XFP PLIM. The 8-port 10-GE XFP PLIM has:

- Eight ports that accept XFP optics modules
- Status LED for the PLIM
- LED for each port

The 8-port 10-GE PLIMs supports the following types of XFP optical transceiver modules:

- Single-mode low power multirate XFP module—XFP10GLR-192SR-L, V01
- Single-mode low power multirate XFP module—XFP10GER-192IR-L, V01



Note

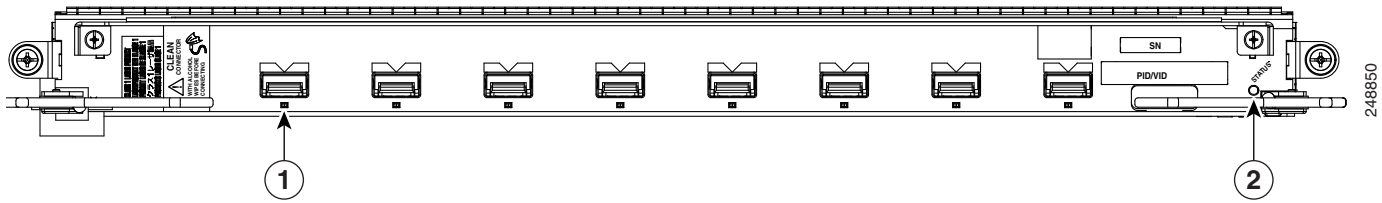
For information about the XFP optical transceiver modules supported on the 8-port 10-GE XFP PLIM, see [Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note](#).

Cisco qualifies the optics that are approved for use with its PLIMs.

For the modules listed, use a single-mode optical fiber that has a modal-field diameter of 8.7 ± 0.5 microns (nominal diameter is approximately 10/125 micron) to connect your router to a network.

Figure 5-12 shows the front panel of the 8-Port 10-GE XFP PLIM.

Figure 5-12 8-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED
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Table 5-2 describes the PLIM LEDs for the 8-Port 10-GE XFP PLIM.

Table 5-2 8-Port 10-GE XFP PLIM LED Descriptions

LED	State	Description
Status	Green	PLIM is properly seated and operating correctly.
	Yellow	PLIM has a problem.
	Off	PLIM is not properly seated or system power is off.
Port	On	Port is logically active and the laser is on.
	Off	Port is not active.

Table 5-3 provides cabling specifications for the XFP modules that can be installed on the 8-port 10-GE XFP PLIM.

Table 5-3 XFP Module Port Cabling Specifications for the 8-Port 10-GE XFP PLIM

Part Number	Description	Wavelength	Fiber Type	Typical Maximum Distance
XFP10GLR-192SR-L, V01	Low Power multirate XFP supporting 10GBASE-LR and OC-192 SR	1310 nm	SMF	6.213 miles (10 km)
XFP10GER-192IR-L, V01	Low Power multirate XFP supporting 10GBASE-ER and OC-192 IR	1550 nm	SMF	24.85 miles (40 km)

4-Port 10-GE PLIM with XFP Optics Modules

The 4-port 10-GE XFP PLIM supports from one to four pluggable XFP optics modules.

Figure 5-13 shows the front panel of the 4-port 10-GE XENPAK PLIM. The 4-port 10-GE XFP PLIM has:

- Four ports that accept XFP optics modules
- Status LED for the PLIM
- LED for each port

The 4-port 10-GE PLIMs supports the following types of XFP optical transceiver modules:

- Single-mode low power multirate XFP module—XFP10GLR-192SR-L, V01
- Single-mode low power multirate XFP module—XFP10GER-192IR-L, V01



Note

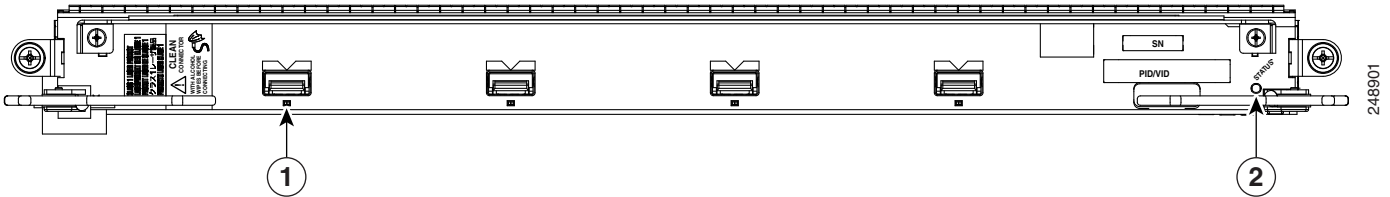
For information about the XFP optical transceiver modules supported on the 4-port 10-GE XFP PLIM, see [Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note](#).

Cisco qualifies the optics that are approved for use with its PLIMs.

For the modules listed, use a single-mode optical fiber that has a modal-field diameter of 8.7 ± 0.5 microns (nominal diameter is approximately 10/125 micron) to connect your router to a network.

Figure 5-13 shows the front panel of the 4-Port 10-GE XFP PLIMs.

Figure 5-13 4-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED
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Table 5-4 describes the PLIM LEDs for the 4-Port 10-GE XFP PLIM. The 4-Port 10-GE XFP PLIM power consumption is 74 W (with four optics modules)

Table 5-4 4-Port 10-GE XFP PLIM LED Descriptions

LED	State	Description
Status	Green	PLIM is properly seated and operating correctly.
	Yellow	PLIM has a problem.
	Off	PLIM is not properly seated or system power is off.
Port	On	Port is logically active and the laser is on.
	Off	Port is not active.

Table 5-5 provides cabling specifications for the XFP modules that can be installed on the 4-port 10-GE XFP PLIMs.

Table 5-5 XFP Module Port Cabling Specifications for the 4-Port 10-GE XFP PLIM

Part Number	Description	Wavelength	Fiber Type	Typical Maximum Distance
XFP10GLR-192SR-L, V01	Low Power multirate XFP supporting 10GBASE-LR and OC-192 SR	1310 nm	SMF	6.213 miles (10 km)
XFP10GER-192IR-L, V01	Low Power multirate XFP supporting 10GBASE-ER and OC-192 IR	1550 nm	SMF	24.85 miles (40 km)

1-Port 100-GE PLIM with CFP Optics Module

The 1-port 100-GE CFP PLIM supports one pluggable CFP optics module.

The 1-port 100-GE PLIM has:

- One port that accepts a CFP optics module
- Status LED for the PLIM
- Four LED indicators for the single port

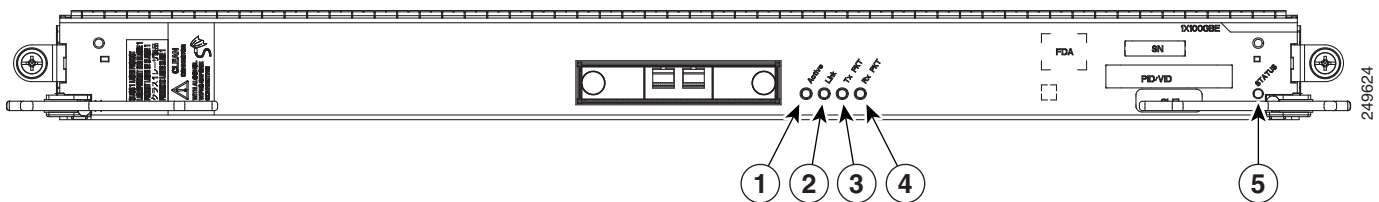
The 1-port 100-GE PLIM supports the following types of CFP optical transceiver modules:

- CFP-100GE-LR4, V01

Cisco qualifies the optics that are approved for use with its PLIMs.

Figure 5-14 shows the front panel of the 1-Port 100-GE CFP PLIM.

Figure 5-14 1-Port 100-Gigabit Ethernet CFP PLIM front panel



1	Active LED	2	Link LED	3	Tx PKT LED	4	Rx PKT LED	5	Status LED
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Table 5-6 describes the PLIM LEDs for the 1-Port 100-GE CFP PLIM.

Table 5-6 1-Port 100-GE XFP PLIM LED Descriptions

LED	State	Description
PLIM Status	Green	PLIM is properly seated and operating correctly.
	Yellow	PLIM is powered on, but initializing.
	Off	PLIM is not properly seated, system power is off, or power up did not complete successfully.
Active	Green	Port is enabled by software and there is a valid link.
	Yellow	Port is enabled by software, but there is a problem with the link.
	Off	Port is not enabled by software.
Link	Green	Active link is achieved.
	Yellow	TBD
	Off	Active link is not achieved.
Tx PKT	Green (flashing)	Packets are being transmitted on the port.
	Yellow	TBD
	Off	No packets are being transmitted on the port.
Rx PKT	Green (flashing)	Packets are being received on the port.
	Yellow	TBD
	Off	No packets are being received on the port.

20-Port 10-GE PLIM with XFP Optics Modules

The 20-port 10-GE XFP PLIM supports from one to twenty pluggable XFP optics modules.

The 20-port 10-GE PLIM has:

- Twenty ports that accept XFP optics modules
- Status LED for the PLIM
- Port status LED for each port

The 20-port 10-GE PLIM supports the following types of XFP optical transceiver modules:

- Single-mode low power multirate XFP module—XFP10GLR-192SR-L, V01
- Single-mode low power multirate XFP module—XFP10GER-192IR-L, V01



Note

For information about the XFP optical transceiver modules supported on the 20-port 10-GE XFP PLIM, see [Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note](#).



Note

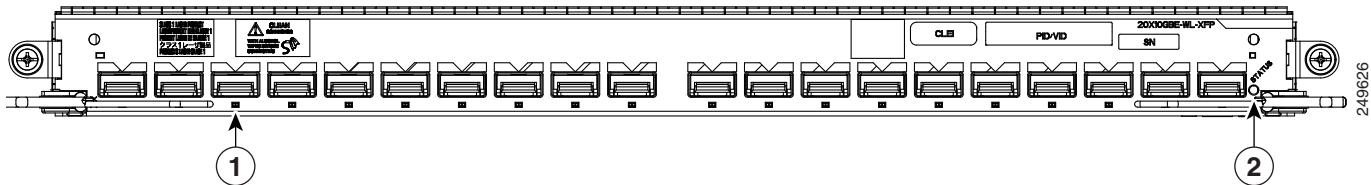
The 20-port XFP PLIM has a fixed power budget for the pluggable XFP optics. See “[XFP Optics Power Management](#)” section on page 5-22 for detailed information.

Cisco qualifies the optics that are approved for use with its PLIMs.

For the modules listed, use a single-mode optical fiber that has a modal-field diameter of 8.7 ± 0.5 microns (nominal diameter is approximately 10/125 micron) to connect your router to a network.

Figure 5-15 shows the front panel of the 20-Port 10-GE XFP PLIMs.

Figure 5-15 20-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED
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Table 5-7 describes the PLIM LEDs for the 20-Port 10-GE XFP PLIM.

Table 5-7 20-Port 10-GE XFP PLIM LED Descriptions

LED	State	Description
PLIM Status	Green	PLIM is properly seated and operating correctly.
	Yellow	PLIM is powered on, but initializing.
	Off	PLIM is not properly seated, system power is off, or power up did not complete successfully.
Port Status	On	Port is enabled by software and there is a valid link.
	Yellow	Port is enabled by software, but there is a problem with the link.
	Off	Port is not enabled by software.

The 20-port 10-GE XFP PLIM has the following physical characteristics:

- Height—20.6 in (52.2 cm)
- Depth—11.2 in (28.4 cm)
- Width—1.8 in (4.5 cm)
- Weight—8.45 lb (3.8 kg)
- Power consumption—150 W (120 W with no optics installed, 30 W optics budget)



Caution

The 20-port 10-GE XFP PLIM can have all 20 ports filled with SR (1.5W) 10km XFPs. If you use optics other than SR, you must be careful not to exceed the power budget, which may result in some ports remaining unpowered. Cisco IOS XR software enables the ports in a sequence that allows the configuration to remain within the optics power budget. For more details on how the software controls PLIM power consumption (150 W (120 W with no optics installed, 30 W optics budget)), see *Cisco IOS XR Interface and Hardware Component Command Reference for the Cisco CRS Router*.

14-Port 10-GE PLIM with XFP Optics Modules

The 14-port 10-GE XFP PLIM supports from one to fourteen pluggable XFP optics modules.

The 14-port 10-GE PLIM has:

- Fourteen ports that accept XFP optics modules
- Status LED for the PLIM
- LED for each port

The 14-port 10-GE PLIM supports the following types of XFP optical transceiver modules:

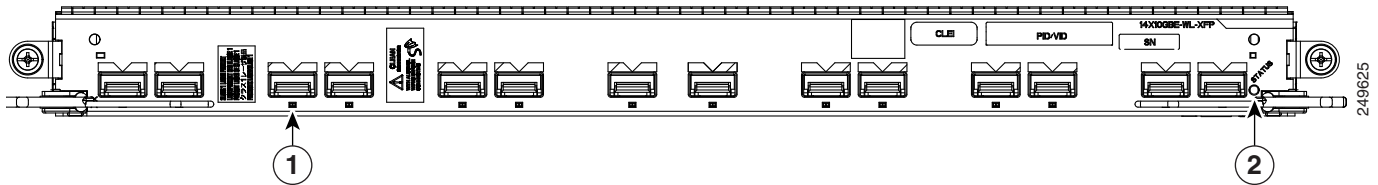
- Single-mode low power multirate XFP module—XFP10GLR-192SR-L, V01
- Single-mode low power multirate XFP module—XFP10GER-192IR-L, V01

Cisco qualifies the optics that are approved for use with its PLIMs.

For the modules listed, use a single-mode optical fiber that has a modal-field diameter of 8.7 ± 0.5 microns (nominal diameter is approximately 10/125 micron) to connect your router to a network.

Figure 5-16 shows the front panel of the 14-Port 10-GE XFP PLIMs.

Figure 5-16 14-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED
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Table 5-8 describes the PLIM LEDs for the 14-Port 10-GE XFP PLIM.

Table 5-8 14-Port 10-GE XFP PLIM LED Descriptions

LED	State	Description
PLIM Status	Green	PLIM is properly seated and operating correctly.
	Yellow	PLIM is powered on, but initializing.
	Off	PLIM is not properly seated, system power is off, or power up did not complete successfully.
Port Status	On	Port is enabled by software and there is a valid link.
	Yellow	Port is enabled by software, but there is a problem with the link.
	Off	Port is not enabled by software.

The 14-port 10-GE XFP PLIM have the following physical characteristics:

- Height—20.6 in (52.2 cm)
- Depth—11.2 in (28.4 cm)
- Width—1.8 in (4.49 cm)

- Weight—7.85 lbs (3.55 kg)
- Power consumption—150 W (115 W with no optics installed, 35 W optics budget)

**Caution**

The 14-port 10-GE XFP PLIM can have all 14 ports filled with a combination of SR (1.5W) 10km XFPs and LR (2.5W) 40km XFPs. If you use optics other than SR or LR, you must be careful not to exceed the power budget, which may result in some ports remaining unpowered. Cisco IOS XR software enables the ports in a sequence that allows the configuration to remain within the optics power budget. For more details on how the software controls PLIM power consumption (150 W (115 W with no optics installed, 35 W optics budget)), see *Cisco IOS XR Interface and Hardware Component Command Reference for the Cisco CRS Router*.

**Note**

The 20-port XFP PLIM has a fixed power budget for the pluggable XFP optics. See [“XFP Optics Power Management” section on page 5-22](#) for detailed information.

XFP Optics Power Management

The 20- and 14-port XFP PLIMs have a fixed power budget for the pluggable XFP optics. The XFP pluggable optics for the 20- and 14-port XFP PLIMs have different power consumptions based on their reach and type. The number of XFPs which will power up in a PLIM depends on their aggregate power consumption within the allocated power budget.

During XFP insertion, the power is allotted to the optics based on the insertion order of the XFPs. On boot up and reload, priority is re-assigned to the lower numbered ports.

The recommended insertion sequence is to alternate between inserting XFPs in lowest numbered ports for each interface device driver ASIC to avoid oversubscription. The insertion order for a 20 Port PLIM would be “0,10,1,11,2,12,...9,19.” For a 14 Port PLIM, insertion order would be “0,7,1,8,...6,13.”

If the PLIM power budget is exceeded, a console log message is displayed informing the user the power budget has been exceeded and to remove the XFP:

```
plim_[x]ge: %L2-PLIM-6-NO_POWER_XFP : Port <port number>, Not enough power available
to power XFP, powering off
```

Any unpowered XFPs should be removed to ensure that the same XFPs that were powered before a reload are the same XFPs that are powered after a reload. Removing the unpowered XFPs prevents the powered down XFPs being given priority after the reload.

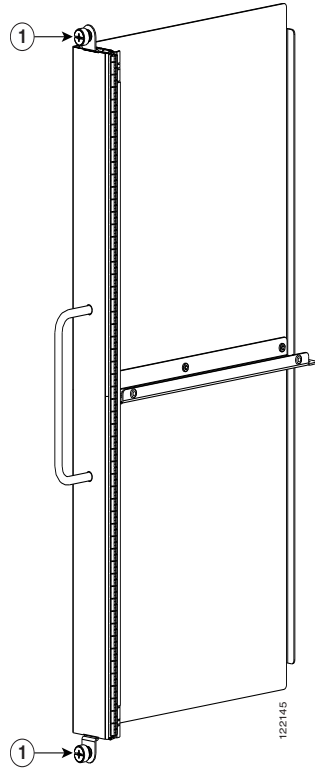
A show command is provided to indicate how much of the XFP power budget is currently used and how much power an XFP is consuming:

```
show controllers tenGigE 0/3/0/0 internal
```

PLIM Impedance Carrier

A PLIM impedance carrier must be installed in each empty PLIM slot in the Cisco CRS Series chassis (see [Figure 5-17](#)). The CRS 16-slot chassis is shipped with impedance carriers installed in the empty slots. The impedance carrier preserves the integrity of the chassis and is required for EMI compliance and proper cooling in the chassis.

Figure 5-17 PLIM Impedance Carrier



1	Impedance carrier fasteners
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Route Processor

This chapter describes the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC) route processor (RP) card or the performance route processor card (PRP) which are installed in the line card chassis. This chapter also describes the distributed route processor (DRP) card and its associated physical layer interface module (DRP PLIM), which functions as an additional route processor in the Cisco CRS routing system.

This chapter contains the following sections:

- [Route Processor Overview, page 6-1](#)
- [Route Processor Active and Standby Arbitration, page 6-4](#)
- [Route Processor Memory Options, page 6-4](#)
- [Route Processor Card, page 6-4](#)
- [Distributed Route Processor, page 6-6](#)
- [Performance Route Processor, page 6-9](#)

Route Processor Overview

The route processor (RP) card performs the route processing in the Cisco CRS-1 and CRS-3 routing systems and distributes forwarding tables to the MSCs. The RP provides a control path to each MSC, performs system-monitoring functions and contains hard disks for system and error logging.

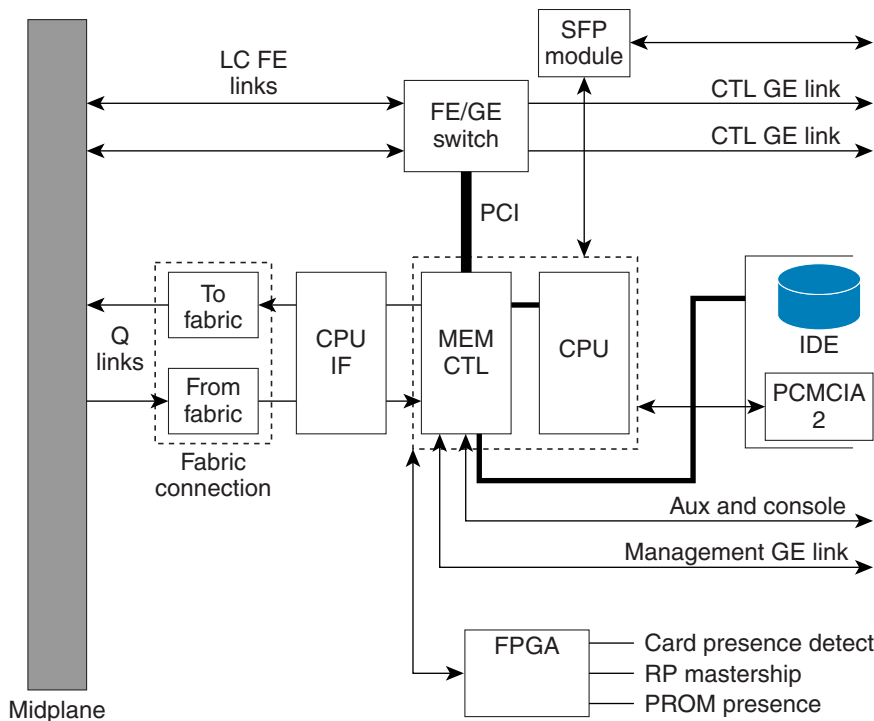
Although each line card chassis contains two RP cards, only one RP is active at a time. The other RP operates in standby mode, ready to assume control if the active RP fails. See the [“Route Processor Active and Standby Arbitration” section on page 6-4](#) for information on how the system determines which RP is active and which is standby. As of Cisco IOS XR release 3.3.0, the RP and RP-B in tandem for active and standby modes (or vice versa) are supported on the one routing system chassis.

The RP card is also the system controller for the Cisco CRS-1 and CRS-3 routing systems. (See [Chapter 8, “Control Plane,”](#) for more information about system controller functions.) System controller functionality varies between single-shelf and multishelf systems:

- In a single-shelf (standalone) system, the active RP is the system controller for the routing system.
- In a multishelf system, one of the RPs from among all of the line card chassis is selected to be the designated system controller (DSC) for the routing system. (See *Cisco CRS Carrier Routing System Multishelf System Description* for more information about the selection process.)

[Figure 6-1](#) is a simple block diagram of an RP card. The dotted lines indicate distinct RP modules, such as the CPU and memory controller (MEM CTL), and the “to fabric” and “from fabric” sections.

Figure 6-1 Route Processor Simple Block Diagram



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The main components of the RP card are listed here and described in the following sections:

- A dual-CPU symmetric multiprocessor (SMP) performs route processing. The CPU also serves as the MSC service processor (SP), and monitors the RP temperature, voltages, power supply margining (during factory test), and ID EEPROM.
- Two small form-factor pluggable (SFP) modules provide external Gigabit Ethernet (GE) connections. In a multishelf system, these modules connect to two external Cisco Catalyst 6509 Switches that interconnect all line card and fabric chassis together to form a control network. The Cat6509 systems are not used in the single-shelf system.
- A third Ethernet port for 10/100/1000 Ethernet copper provides connectivity to network management systems.
- Internal 100 Mbps Fast Ethernet (FE) midplane connections connect each MSC in the chassis to both RPs. These FE connections are traces in the midplane. There are also FE connections to the fans, blowers and power supplies. These connections all form part of the control plane.
- An IDE hard disk is used to gather debugging information, such as core dumps from the RP or MSCs. See the following section (“[IDE Hard Drive](#)”) for more information.
- PCMCIA flash slots provide support for two PCMCIA flash subsystems that each provide 2GB or 4GB of flash storage. One of the PCMCIA flash subsystems is accessible externally and removable; the other subsystem is fixed to the RP and is not removable. (See the “[PCMCIA Flash Slots](#)” section on [page 6-3](#).)

As shown in [Figure 6-1](#), the RP mates with the LCC midplane. The RP connects to the switch fabric through two fabric interface modules (from fabric and to fabric) that are similar to the fabric interface of the MSC (see the “[MSC To Fabric Section and Queuing](#)” section on [page 5-5](#)).

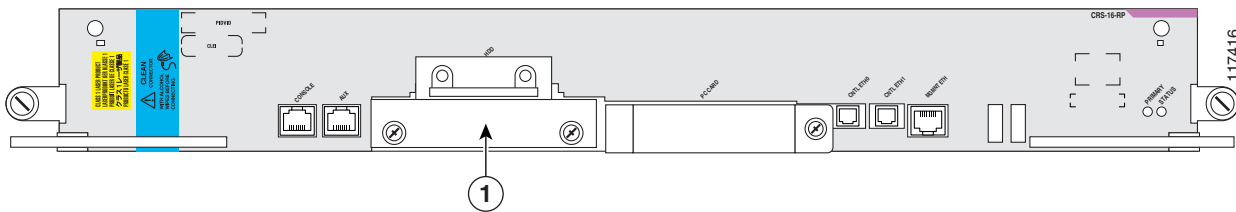
- The from fabric section (which is part of the RP receive path) queues the data from the switch fabric and reorders and reassembles the cells into packets before queuing them for slow-path processing.

- The to fabric module (which is part of the RP transmit path) queues the packets and segments them into cells before transmitting them to the switch fabric.

IDE Hard Drive

The RP hard drive (Figure 6-2) is an IDE hard disk used to gather debugging information, such as core dumps from the RP or MSCs. The hard drive is typically powered down and activated only when there is a need to store data. A hard disk is always provided as part of the RP, but may be removed from the board if necessary (under the direction of Cisco technical support).

Figure 6-2 RP Hard Drive



1 Hard drive door



Note

Physically, the hard drive is a hot-pluggable PC board and sled-mounted drive with a connector interface that seats into an RP card. In general, removal and replacement of this drive is not required.

PCMCIA Flash Slots

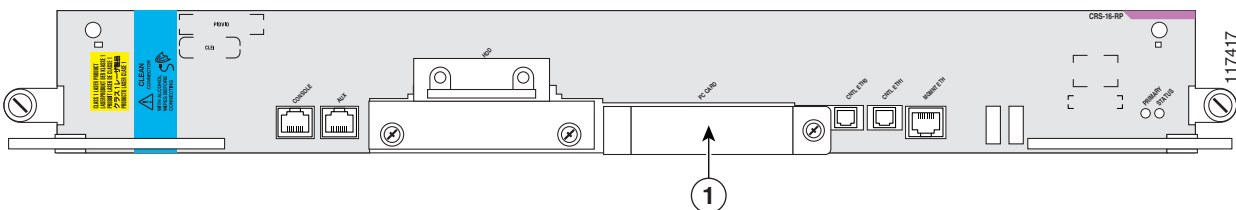
The RP card supports two PCMCIA flash cards that each provide up to 2GB or 4GB of flash storage. One of the PCMCIA flash subsystems is accessible externally and removable, and allows you to transfer images and configurations by plugging in a PCMCIA flash card. The other flash subsystem is fixed to the RP and is not removable, and is for permanent storage of configurations and images. Figure 6-3 shows the location of the externally accessible PCMCIA slot on the RP card front panel.



Note

Only the original route processor (RP) card uses a PCMCIA card. The performance route processor (PRP) card has a USB connector for using a flash drive.

Figure 6-3 RP PCMCIA Slots



1 PCMCIA flip-up door

CONSOLE and AUX Ports

The CONSOLE and AUX ports are RJ-45 serial connectors that have the following pinouts:

- Pin 1—Request to send (RTS)
- Pin 2—Data terminal ready (DTR)
- Pin 3—Transmit data (TxD)
- Pin 4—Ground (Gnd)
- Pin 5—Ground (Gnd)
- Pin 6—Receive data (RxD)
- Pin 7—Carrier detect (CD)
- Pin 8—Clear to send (CTS)

Route Processor Active and Standby Arbitration

The two RPs in an LCC operate in an active-standby relationship. Only one RP is active at a time. The other RP operates in standby mode, ready to assume control if the active RP fails.

The routing system performs the following steps to determine which RP is active and which is standby:

1. At chassis power up, each RP boots its board components and runs self-tests.
2. The RPs exchange messages with each other and with the service processors (SPs) on all other boards. Each RP examines its outgoing “Reset” lines to verify that they are inactive.
3. Based on the results of these tests, each RP decides whether it is ready to become shelf (that is, chassis) master, that is the active RP. If it is, it asserts the Ready signal to its on-board arbitration unit. The arbitration unit propagates the Ready signal to the other RP.
4. The arbitration hardware chooses the active RP from the RPs that have asserted Ready. The hardware asserts an Active signal to the chosen RP, along with an interrupt and propagates the Active signal to the other RP, which also receives an interrupt.
5. Software on each RP reads its Active signal, and branches accordingly to Primary or Standby code.
6. If the active RP is removed, powered down, or voluntarily disables its Ready signal, the standby RP becomes active after receiving an asserted Active signal, along with an interrupt.

Route Processor Memory Options

The route processor card can be configured with 2GB or 4GB of memory.

Route Processor Card

[Figure 6-4](#) shows the Cisco CRS routing system RP card. The RP card plugs into the chassis in the center of the lower PLIM card cage, on the front side of the midplane (see [Figure 1-5](#)).

Figure 6-4 Route Processor (RP) Card

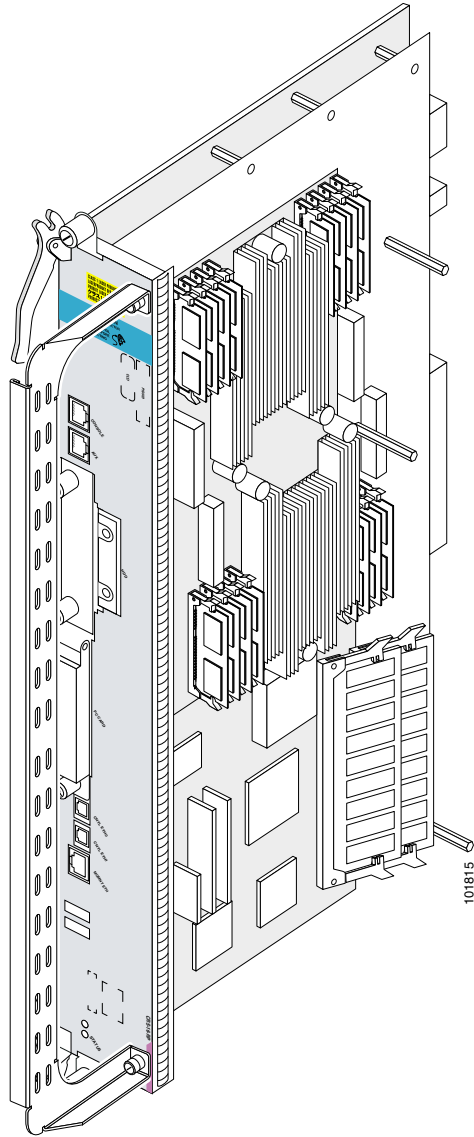
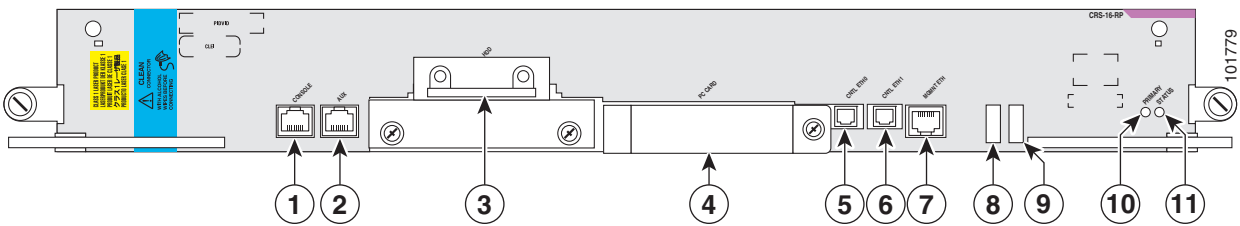


Figure 6-5 shows the RP card front panel.

Figure 6-5 RP Card Front Panel



1	CONSOLE connector	7	Management Ethernet port
2	AUX connector	8	Alphanumeric LED
3	HDD door	9	Alphanumeric LED
4	PC CARD	10	PRIMARY LED
5	Control Ethernet port 0	11	STATUS LED
6	Control Ethernet port 1		

The RP front panel includes:

- IDE hard disk
- PCMCIA flash disk slot
- Two Gigabit Ethernet connections
- GE copper port
- CONSOLE and AUX (RJ-45 serial ports)
- Alphanumeric LED
- Primary LED—Turns on to indicate that the RP is operating in primary mode. When the LED is off, the RP is operating in standby mode.
- Status LED—Green indicates that the RP is properly installed and operating correctly. Yellow indicates there is a problem with the card. If the LED is off, check to make sure that system power is on.

Distributed Route Processor

The distributed route processor (DRP) card and its associated physical layer interface module (PLIM) provide additional routing capabilities for the Cisco CRS routing system. The DRP and DRP PLIM function as an additional route processor (RP) in the system.

A DRP runs any of the routing processes that run on the RP (for example, BGP, OSPF, IS-IS, MPLS, LDP, IP multicast, and so on). You issue software commands to specify which processes are to run on the DRP instead of the RP. This action of assigning processes to a DRP is called *process placement*. By offloading processor-intensive routing tasks (such as BGP speakers and IS-IS) from the RP to the DRP, you can improve system performance.



Note

The distributed route processor (DRP) card and DRP PLIM have no dedicated slots. The DRP card is installed in an open MSC slot and the DRP PLIM is installed in a corresponding PLIM slot.

The DRP does not perform any of the control and management functions performed by the RP; therefore, it can never be the designated shelf controller (DSC) in a multishelf system. However, the DRP can be configured as the designated logical router shelf controller (dLRSC) in a logical router. A *logical router* is a part of the Cisco CRS Series routing system that functions as a complete router, running its own routing protocols and forwarding IP packets between its interfaces.



Note

Currently, the Cisco CRS routing system can function as a single logical router only.

See the “[Limitations and Restrictions](#)” section on page 6-9 for information about the limitations of the DRP that apply to this release.

The following sections describe the DRP card and the DRP PLIM. Throughout these sections, unless otherwise noted, DRP refers to both the DRP and its associated PLIM.

DRP Card

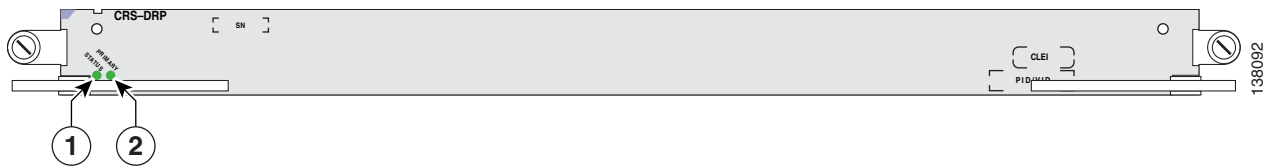
The DRP card (CRS-DRP) is an optional component that enhances Cisco CRS Series routing capabilities by serving as an additional route processor in the system. The DRP can be installed in any MSC (line card) slot in the line card chassis. The corresponding DRP PLIM is installed in the corresponding PLIM slot. The cards are connected to each other through the chassis midplane.

The main components of the DRP are:

- Two symmetric processors (SMP0 and SMP1)—Perform route processing tasks. The SMPs are independent of each other and operate simultaneously. You can assign routing processes, which normally run on the RP, to run on the DRP instead.
- Service processor module—Communicates with the RP (which is the system controller), controls DRP processes, and monitors voltages and temperatures on the DRP and DRP PLIM.
- Two CPUCTRL ASICs—Provide an interface between the SMPs and the switch fabric ASICs. Each ASIC has a set of eight ingress and egress queues for buffering data.
- Several switch fabric ASICs—Provide the interface to and from the switch fabric:
 - Two FabricQ ASICs—Receive cells from the switch fabric, reorder the cells and reassemble them into packets, and queue the packets for transmission to the CPUCTRL ASICs. The FabricQ ASICs are part of the Rx path on the DRP. Each FabricQ ASIC is connected to a different CPUCTRL ASIC.
 - IngressQ ASIC—Receives data packets from the SMP, segments the packets into cells, and distributes the cells to the switch fabric. The ASIC is part of the Tx path on the DRP. The module has connections to both SMPs, but only one SMP controls the IngressQ ASIC at any time. By default, SMP0 controls the ASIC at startup.

The IngressQ ASIC has a memory buffer for storing packets. This buffer storage provides input rate-shaping queues for shaping switch-bound traffic. Input rate shaping is used to provide bandwidth and QoS guarantees for physical and logical port traffic and to smooth traffic bursts into the switch fabric.
 - Two Qlink modules—Provide the interface to the switch fabric. The modules convert data between the format used by the FabricQ and IngressQ ASICs and the format used by the switch fabric. Each Qlink module provides an interface to four planes of the switch fabric.
- Several interfaces—Provide communications paths among the components on the DRP.
- Additional components—Include power and clocking components, voltage and temperature sensors, and an identification EEPROM that stores initial configuration and hardware information.

Figure 6-6 shows the DRP card front panel.

Figure 6-6 **DRP Card Front Panel**

1	STATUS LED	2	PRIMARY LED
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The DRP front panel contains:

- **Primary LED**—When two DRP cards are configured as a redundant pair, the LED turns green to indicate that this DRP is currently active. The other DRP is in standby mode; it takes over DRP processing if the active DRP card fails.
- **Status LED**—Green indicates that the card is operating correctly. Yellow indicates that there is a problem with the card.

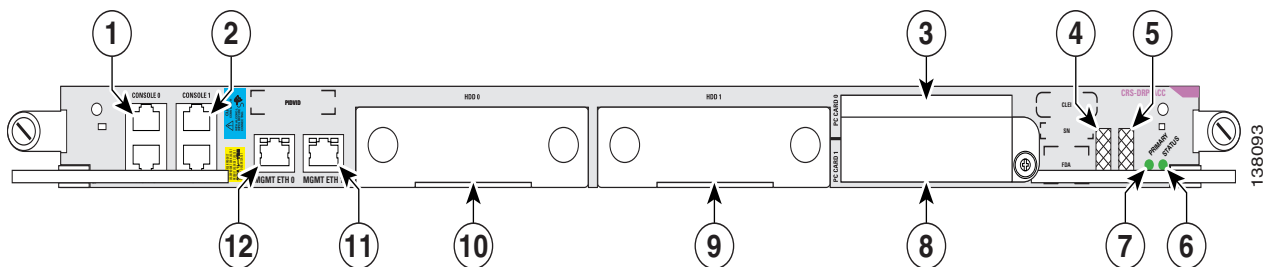
The Console, Aux, and Ethernet management ports for the DRP card are located on the DRP PLIM. (See [Figure 6-7](#).)

DRP PLIM

The DRP PLIM, or DRP front-access panel (CRS-DRP-ACC), provides access to the DRP card for configuration and system management. The DRP PLIM contains the CONSOLE, AUX, and Ethernet management ports (MGMT ETH) for the DRP and an alphanumeric LED that shows operational status.

The DRP PLIM is installed in the PLIM slot that corresponds to the MSC slot in which the associated DRP card is installed.

[Figure 6-7](#) shows the front panel of the DRP PLIM.

Figure 6-7 **DRP PLIM Front Panel**

1	CONSOLE port 0	7	PRIMARY LED
2	CONSOLE port 1	8	PC card 1
3	PC Card 0	9	Hard drive 1
4	Alphanumeric LED	10	Hard drive 0

5	Alphanumeric LED	11	MGMT ETH port 1
6	STATUS LED	12	MGMT ETH port 0

The DRP PLIM front panel contains the following components:

- Two CONSOLE ports (one set of ports for each SMP)—Provide RJ-45 serial interfaces for local and remote (modem) console terminal connections.
- Management Ethernet ports (one port for each SMP)—Provide a 10/100/1000 Ethernet interface for configuration and management (RJ-45 connector).
- Two 40-gigabyte removable hard disk drives (one for each SMP)—Store troubleshooting and debugging information.
- Two PCMCIA flash disk slots (one for each SMP)—Accept a 1-gigabyte PCMCIA flash card for storing software images.
- Alphanumeric LED (eight-digit display)—Indicates the status of the DRP and DRP PLIM cards.

Limitations and Restrictions

The current Cisco CRS Series multishelf system supports DRP functionality, with the following limitations:

- Each line card chassis supports multiple DRPs and multiple DRP PLIMs.
- Redundant DRP operation (or *DRP pairing*) is currently not supported. In the future, you will be able to install a pair of DRPs in the chassis and configure them for high availability. When paired, the DRPs operate in active and standby mode. Only one DRP is active at a time, while the other DRP functions in standby mode, ready to take over processing if the active DRP fails.
- For processes to run on the DRP, you must override the default process placement policy and configure the processes to run on a single (unpaired) DRP. This reconfiguration is necessary because the default placement policy assigns processes to paired DRPs only.

Performance Route Processor



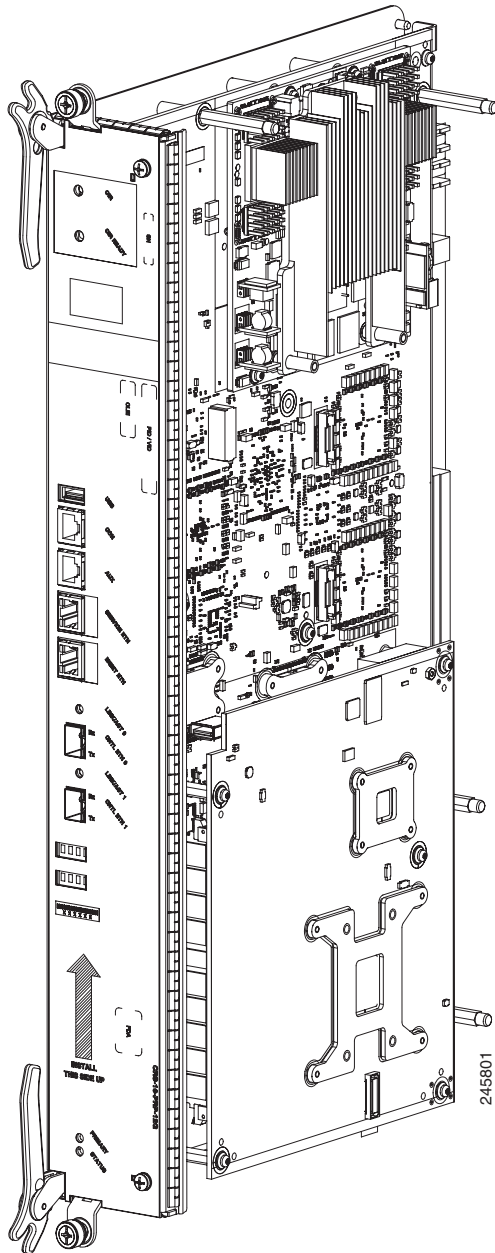
Note

For the Cisco CRS-X, the PRP is required instead of the RP.

The Performance Route Processor (PRP) is also available for the LCC. The PRP provides enhanced performance for both route processing and system controller functionality.

Two PRP cards are required per chassis for a redundant system. The PRP can be inserted in either of the two dedicated RP slots in the LCC. When two PRPs are installed, one PRP is the “Active” RP and the other is the “Standby” RP.

Figure [Figure 6-8](#) shows the PRP card.

Figure 6-8 Performance Route Processor

The PRP has the following physical characteristics:

- Height—20.6 in. (52.3 cm)
- Depth—11.2 in. (28.5 cm)
- Width—2.8 in. (7.1 cm)
- Weight—12.9 lb (5.85 kg)
- Power consumption—275 W (with two SFP or SFP+ optics modules)

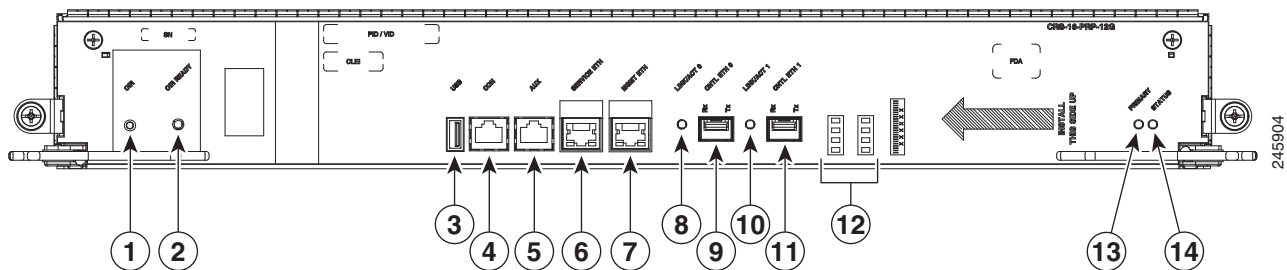
Performance Route Processor Front Panel

The PRP front panel includes:

- Two 1GE (SFP) or 10G (SFP+) ports for 1-GE or 10-GE uplinks
- Service Ethernet RJ45 port
- Console port
- Auxiliary port
- Push button switch to Initiate OIR process
- LED to indicate OIR status and readiness for extraction
- Alphanumeric Display
- LEDs for card status and RP Active or Standby status
- USB socket

Figure 6-9 shows the front panel of the PRP card.

Figure 6-9 Performance Route Processor Front Panel



1	OIR push button—initiates OIR process	8	Link/Active 0 LED
2	OIR Ready LED	9	Control Ethernet 0 port (SFP or SFP+)
3	USB socket	10	Link/Active 1 LED
4	Console port	11	Control Ethernet 1 port (SFP or SFP+)
5	Auxiliary port	12	Alphanumeric LED Display
6	Service Ethernet RJ45 port	13	PRP Active or Standby status LED
7	Management Ethernet RJ45 port	14	Card Status LED

Performance Route Processor Overview

The CRS PRP for the LCC is a next generation Intel-based RP that increases the CPU compute power, memory and storage capacity. The PRP provides both route processing and system controller functionality for enhanced performance.

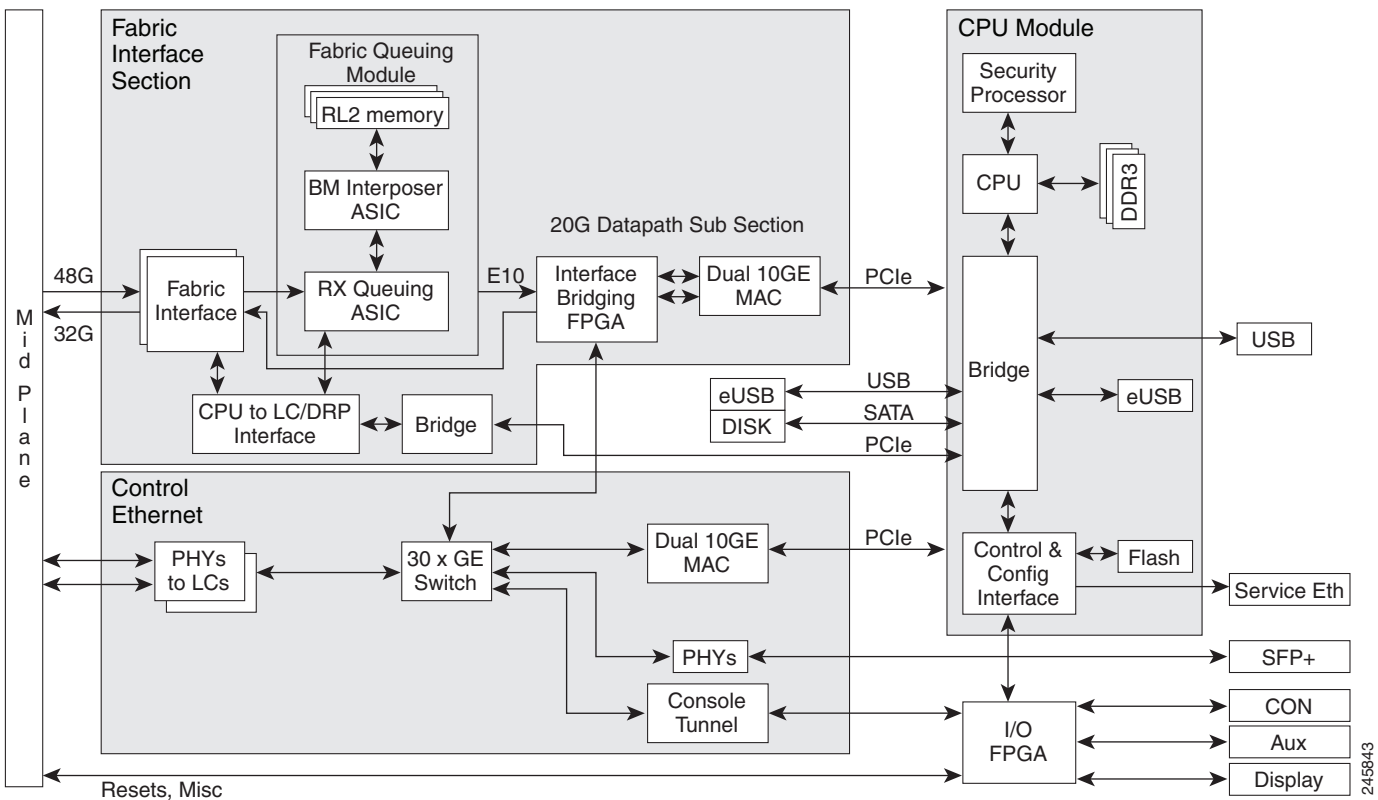
A CPU interface and system control ASIC provides resources and communication paths between the CPU and the rest of the system to provide line card management, configuration, monitoring, protocol control, and exception packet handling. The fabric queuing portion of this ASIC acts as the fabric interface to handle the traffic to the fabric. Traffic from the fabric is handled by the ingress queuing portion of an interface bridging FPGA.

**Note**

A chassis may not be populated with a mix of RP and PRP cards. Both route processor cards should be of the same type (RP or PRP).

Figure 6-10 shows a block diagram of the PRP card.

Figure 6-10 Performance Route Processor Block Diagram



Performance Route Processor Memory Options

The following memory configurations are supported by the CPU memory controller:

- Three 2GB DDR3 DIMMs, for a total of 6GB
- Three 4GB DDR3 DIMMs, for a total of 12GB

**Note**

The memory on the 6GB PRP is not upgradable to 12GB.

Initiate OIR Pushbutton

The PRP front panel includes an OIR pushbutton (see item 1 in [Figure 6-9](#)). Pressing the OIR button initiates the OIR process and avoids the loss of card information caused by a surprise extraction.

If a card is extracted without initiating the OIR process (surprise extraction), the saving of logs or other important information is not possible. Although surprise extraction is supported, using the OIR process allows you to save important card information and logs.

After pressing the button, the OIR Ready LED (item 2 in [Figure 6-9](#)) blinks during the OIR process. When the OIR process is complete, the OIR Ready LED glows solidly to indicate that the board is ready for extraction.

If for some reason the OIR process cannot be completed, the OIR Ready LED will continue blinking. If this occurs, you should check the log and console messages for a failure reason.

If the card is not removed within five minutes, the PRP resets itself and the OIR Ready LED will stop glowing.

The OIR process operates as described even if the PRP is not in a redundant configuration or if the standby PRP is not ready.

Control and Management Ports

Two Control Ethernet optical ports (CNTL ETH 0, CNTL ETH 1) provide connectivity to network control systems. These ports use small form-factor pluggable (SFP or SFP+) modules to provide external Gigabit Ethernet (GE) or 10-Gigabit Ethernet (10-GE) connections.

A Management RJ45 port (MGMT ETH) provides connectivity to network management systems.

Console and Aux Ports

[Table 6-1](#) lists the pinouts for the Console (CON) and Auxiliary (AUX) RJ45 ports on the PRP (items 4 and 5 in [Figure 6-9](#)).

Table 6-1 Pinouts for Console and Aux Ports

Pin	Console Port	Aux Port
1	Request to send (RTS)	Request to send (RTS)
2	Data terminal ready (DTR)	Data terminal ready (DTR)
3	Transmit data (TxD)	Transmit data (TxD)
4	EMI Filter Ground (Gnd Console)	EMI Filter Ground (Gnd Aux)
5	EMI Filter Ground (Gnd Console)	EMI Filter Ground (Gnd Aux)
6	Receive data (RxD)	Receive data (RxD)
7	Carrier detect (CD)	Carrier detect (CD)
8	Clear to send (CTS)	Clear to send (CTS)

Service Ethernet Port

PRP functions include a Service Ethernet feature that enhances serviceability and troubleshooting of the system. The Service Ethernet RJ45 port provides a backdoor mechanism into the PRP if the main CPU subsystem is stuck and cannot be recovered.

Through the Service Ethernet connection, you can perform the follow functions:

- Reset any cards in the chassis, including the local PRP
- Perform console attachment to other CPUs to support console tunneling in the chassis
- Dump memory or device registers on the PRP

USB Port

The PRP has an external USB port on the faceplate for connecting a USB 2.0 thumb flash drive. The external devices connected to this port can be used for logging, external file transfer, and installing software packages.



Single-Chassis System Summary

This chapter provides a summary of the single-chassis system and an overview of the cabling and system interconnection for the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC). It includes the following sections:

- [Single-Chassis System Summary, page 7-1](#)
- [Building Integrated Timing Source, page 7-2](#)

For instructions on cabling a Cisco CRS Series single-shelf system, see [Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Installation Guide](#).

Single-Chassis System Summary

The single-shelf system comprises one LCC that contains a set of switch fabric cards (SFCs) that make up the complete three-stage Benes switch fabric. Because the single-shelf system is a standalone system, it is not interconnected with any other chassis, and does not require interconnection cabling.

In a single-shelf system, the following components or functions have external connectivity:

- CONSOLE or AUX RJ-45 RS-232 serial ports on the route processor cards for terminal connections
- Ethernet ports on the route processor for connecting network management equipment
- Physical layer interface modules (PLIMs) for data connections
- RJ-45 external clock (EXT CLK 1 and EXT CLK 2) connectors for the Building Integrated Timing Source (BITS) signal
- Alarm module alarm-out connector

Building Integrated Timing Source


Note

Support for BITS is not currently available on the Cisco CRS. This information is provided as future reference only.

The LCC fan controller card contains the circuitry for the building integrated timing source (BITS) clocking. BITS is centralized clocking architecture that provides a single common network clock for all SONET/SDH equipment in a point-of-presence (POP) or central office.

The main component of the BITS architecture is a Stratum 1 clock signal that comes from a dedicated transport facility or a GPS receiver. A BITS “box” in the central office or POP receives this reference clock signal and distributes it through dedicated T1 (1.544 MHz) or E1 (2.048 MHz) facilities to all of the SONET/SDH equipment that requires network timing (digital switches, DCSs, ADMs, routers, and so on). In this way, all of the equipment is synchronized to the same master clock. The BITS box also contains a Stratum 2 (or Stratum 3E) local clock to provide a holdover clock signal in case the primary network clock signal is lost. If the input Stratum 1 clock fails, the holdover clock signal is used.


Note

The BITS clock signals are analog alternate mark inversion (AMI) signals.

The fan controller card receives the BITS clock signal through an RJ-45 connector on its front panel. The BITS clock signal is routed to synchronous equipment timing source (SETS) circuitry on the fan controller card. The SETS circuitry locks onto the BITS reference timing signal and generates a 19-MHz clock signal, which it then distributes to each PLIM slot in the LCC. This ensures that all PLIMs are synchronized to the same master clock.

For redundant operation, each fan controller card receives two independent input BITS clock signals (EXT CLK 1 and EXT CLK 2). If one of the primary clock sources fails, the SETS circuitry reverts to the redundant input BITS reference timing signal. If both input timing signals fail, the SETS circuitry enters a holdover mode and uses an internal Stratum 3 (12.8-MHz) clock as the reference timing signal. This way, all of the PLIMs in the LCC receive an accurate timing signal.

Each BITS RJ-45 connector supports one input signal:

- Pins 1 and 2 support one pair of RTIP and RRING signals.
- Pins 4 and 5 are not used.

Each fan controller card has two RJ-45 BITS connectors. This means that the LCC can receive four BITS input clock references (2 per fan controller card).



Control Plane

This chapter provides an overview of the routing system control plane in the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC). It contains the following sections:

- [Control Plane Overview, page 8-1](#)
- [Control Plane Components, page 8-3](#)

Control Plane Overview

The LCC control plane provides a communication path between cards, modules, and components in the chassis. The control plane is a logical entity that ties physical chassis components and software functions into a unified entity. The control plane connects the system controller functionality on the route processor (RP) to the service processor (SP) module used to control each card and module in the chassis.

The control plane is used for:

- System discovery and inventory
- Configuration management, system boot, and upgrades
- Inventory control and asset tracking
- Fault detection and recovery, and performance monitoring

The data plane is the path that packets take through the routing system from the physical layer interface module (PLIM) to the modular services card (MSC) to the switch fabric to another MSC and out a PLIM. The control plane and data plane may share some physical components. For instance, the control plane uses the switch fabric for some types of intrasystem communication, just as the data plane uses it to switch packets.

The control plane hardware provides for system discovery and inventory. This process includes mechanisms to determine system topology of the control plane and switch fabric before the system has been configured. In addition to topology discovery, the control plane hardware must also provide mechanisms for card- or module-presence detection and tracking information, such as the card type, revision, and serial number. These mechanisms allow system management software to build a database that represents the routing system configuration, including individual board identification and location information. The control plane hardware provides online insertion and removal (OIR) detection.

The Cisco CRS routing system hardware detects, isolates, and recovers from a broad range of faults, and provides failover mechanisms to redundant hardware. The control plane is a central element in achieving high availability, as it must isolate failures and direct failover events, both in the data plane and in the control plane. To ease serviceability, chassis identification displays and critical, major, and minor alarm indicators are clearly visible. Each MSC, RP, fan controller card, and switch fabric card has an alphanumeric display and green OK LED to show current board status. Environmental conditions, including temperature and voltage levels, are monitored by several internal measurement points and reported to the routing system operator.

The RPs function as the system controller in the LCC. Note that the PLIMs are connected to the control plane through their respective MSCs. The control plane includes a switched point-to-point Fast Ethernet (FE), driven by these FE switches, for control plane network messages, and some other paths for system communication. The dual RPs and midplane FE traces provide redundant connections between all cards in the LCC. Most cards or modules contain a service processor (SP) module that provides the communication for that device within the control plane.

Some of the important functions and implementations of the control plane are:

- Online insertion and remove (OIR) detection—Every MSC, RP, switch fabric card, power module, and so on provides a presence-detection signal to the system controller function on the RP cards. This dedicated hardware signal indicates the physical presence of a card in every slot. The presence-detection signal allows the Cisco IOS XR configuration software to quickly detect OIR events, and identify cards that have been inserted but cannot communicate over the control plane.
- PLIM inventory—Every PLIM slot is probed by the master RP to get the board ID and type and other inventory information. The RP can read an identification chip on each PLIM, even if the PLIM is not powered on. The PLIM inventory chip can be accessed by the RP, whether or not an MSC is plugged into the MSC slot associated with the PLIM.
- RP active/standby arbitration—Both RP slots are directly connected by dedicated midplane signals to special hardware arbitration logic. During the boot process, this logic selects one of the RPs to be the master (active) device; the other RP functions in standby mode. See the [“Route Processor Active and Standby Arbitration”](#) section on page 6-4 for more information.

After hardware arbitration, software should verify single RP mastership via control plane FE messaging. The arbitration hardware could elect two masters due to an unusual hardware fault. The control plane FE provides a redundant path so mastership can be verified absolutely.

- Node reset—Each RP has a dedicated reset line to every node in the chassis. Nodes include MSCs, RPs, and fabric cards. The reset lines fan out from each RP and are connected to the SP on the node cards. Only the master RP can assert these reset lines; the standby RP reset lines are isolated by the RP arbitration logic. The reset lines allow the RP to force a board reset from hardware, and is used only if a board does not respond to control network messages. When this mechanism is used to reset an SP, power to all other chips on that node are turned off until the reset SP has rebooted and enabled power to the local board. To prevent glitches on the reset lines from causing inadvertent resets, as might occur during an RP OIR event, a reset from this signal can be triggered only from an encoded string of high to low transitions.

Control Plane Components

This section describes the control plane functions of various components in the routing system.

- A service processor (SP)—A service processor module is attached to the MSC, RP, alarm module, switch modules, and the power control and blower control systems. When a card or module is inserted into a powered-up chassis, the SP module on that card is always powered up, it cannot be powered down separately from the chassis power. Each service processor module has a Fast Ethernet (FE) connection to each SC or RP.
- A system controller (SC) function—The SC, which is contained on the RP, is the central point of control within the LCC. At least one SC must be operational at all times for a chassis to function as part of a routing system. Redundant SCs are provided for each chassis, so that loss or removal of any single SC does not bring down a chassis. The SC instructs individual SPs to power up nodes, provides code images for each card or module to download, and resets any node that it determines is unresponsive. The master SC is a single control-and-arbitration point in the chassis, and determines master and standby RP status when necessary.
- A modular services card (MSC)—The MSC is the primary data-forwarding engine. The MSC provides Layer 2 and Layer 3 packet processing and queuing. The MSC CPU performs a number of control plane functions, including forwarding information base (FIB) download receive, local PLU/TLU management, statistics gathering and performance monitoring, and ASIC management and fault handling.
- A PLIM—The PLIM contains the physical interfaces to external data circuits. The PLIM does not have its own SP module. Instead, the MSC SP module controls most of the basic control plane functions for the PLIM. This includes reading and writing the PLIM NVRAM, which contains the board type, revision, serial number, and other information from manufacturing.

The PLIM does not have a dedicated reset signal coming directly from the RP, as the MSC itself does. When the MSC SP receives a reset, it shuts off power to the MSC and the PLIM power components. When there is no MSC present, the associated PLIM is not powered on.

- A route processor—There are two RP slots per LCC. The chassis midplane connects the arbitration logic of the two RPs so that one RP becomes the master (primary) and one RP becomes the standby. The primary RP distributes software images to the SP and MSC, while the standby RP monitors the primary RP in case it is required to become the primary because of a failover event.

The RP is a building block of the routing system control plane processing and database solution. The RIB and FIB databases reside on one or more RPs. Routing protocols, such as BGP and OSPF, run on the RPs and update the route databases. These databases are downloaded to the MSCs, and the MSC forwarding engines are programmed appropriately.

A Performance Route Processor (PRP) card is also available for the LCC. Two PRPs perform the same functions as two RPs, but provide enhanced performance for both route processing and system controller functionality.



Note A chassis may not be populated with a mix of RP and PRP cards. Both route processor cards should be of the same type (RP or PRP).

- Switch fabric cards—All switch fabric cards contain switch element chips, and in some cases parallel optical devices, and an SP that provides a control plane interface. The hardware control plane interface communicates over FE links, which provide a channel for fabric configuration and maintenance. The control plane hardware configures the fabric chips and monitors the switch fabric for faults. Some faults require software to isolate failed chips or links. The SP software monitors link health and executes isolation actions.

The switch fabric can operate with fewer than eight planes at reduced performance levels. This means that you can perform online insertion and removal (OIR) of switch fabric cards while the router is running (for example, to upgrade the switch fabric). For information about how to perform OIR on switch fabric cards, see *Cisco CRS-1 Carrier Routing System Getting Started Guide*.

- An alarm module and power supplies—The routing system alarm module displays faults and messages to the operator. The alarm module is clearly visible, and includes an alphanumeric display and three LEDs that signify critical, major, and minor faults. When a fault occurs, the alphanumeric display indicates the cause of the fault. The alarm module contains only the alphanumeric and LED display devices and an SP to drive the display and provide control network connectivity.
- Fan trays—Fan trays are monitored by an SP module that measures airflow and controls fan RPM. As temperatures increase, the SP increases blower RPM to provide increased cooling capacity.
- The LCC midplane—The chassis midplane provides intrachassis connectivity for cards and modules in the routing system. The midplane is mostly passive, though it does contain active NVRAM components that are used to store tracking-number and manufacturing information, and MAC addresses. Software stores the chassis ID value in the NVRAM.



Cisco CRS Carrier Routing System 16-Slot Enhanced Line Card Chassis Specifications

This appendix contains tables that list the specifications for the main components of the Cisco CRS 16-slot enhanced line card chassis.



Note

For a complete list of cards supported in the LCC, go to the Cisco Carrier Routing System Data Sheets at: http://www.cisco.com/en/US/products/ps5763/products_data_sheets_list.html

The appendix includes the following topics:

- [Line Card Chassis Specifications, page A-1](#)
- [Power Specifications, page A-3](#)
- [Line Card Chassis Environmental Specifications, page A-4](#)
- [Regulatory, Compliance, and Safety Specifications, page A-5](#)

Line Card Chassis Specifications

[Table A-1](#) lists the specifications for the LCC.

Table A-1 *Cisco CRS 16-Slot EC Line Card Chassis Specifications*

Supported Cards and Modules	16 modular services cards (MSCs), forwarding processor (FP) cards, or label switch processor (LSP) cards (line cards) 16 physical layer interface modules (PLIMs), one for each MSC, FP, or LSP 8 switch fabric cards (SFCs) 2 route processor (RP) cards or 2 performance route processor (PRP) cards 2 fan trays 1 air filter
Chassis Dimensions	
Height	80 in. (203.2 cm) as shipped 84 in. (213.4 cm) as installed (with two power shelves)

Table A-1 Cisco CRS 16-Slot EC Line Card Chassis Specifications (continued)

Width	23.6 in. (59.9 cm) (without cosmetics) 36.0 in. (91.5 cm) with PDU and brackets 31.8 in. (80.8 cm) with optional wide cable management troughs
Depth	36 in. (91 cm) without doors and other cosmetics 39.7 in. (101 cm) with front and rear doors 40.3 in. (102.2 cm) with optional wide cable management troughs
Floor space requirement	Chassis: 7.5 sq ft (.7 sq m) Aisle spacing to install chassis (front): 48 in. (122 cm) Aisle spacing to service FRUs (front): 36 in. (91 cm) Aisle spacing to service FRUs (rear): 36 in. (91 cm)
Chassis	
Chassis shipping weight	993 lb (450.42 kg)
Chassis in shipping crate with pallet	1300 lb (589.67 kg)
Chassis with power shelves only, no power modules	1101 lb (499.4 kg)
Chassis with power shelves, power modules, alarm module	1180 lb (535.2 kg)
Chassis, fully loaded with cards, without cosmetics	1535 lb (696.3 kg)
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on)	1650 lb (748.43 kg)
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on), AC Wye PDU, and brackets	1720.7 lb (780.5 kg)
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on), AC Delta PDU, and brackets	1720.7lb (780.5 kg)
Floor Loading	
Chassis footprint	7.2 sq ft (6689 sq cm)
Floor contact area	5.88 sq ft (5462 sq ft)
Maximum floor loading	max floor loading without cosmetics and doors 263.6 lb/sq ft max floor loading with cosmetics and doors 292.6 lb/sq ft
Chassis Cooling	
Chassis airflow	2 fan trays, push-pull configuration 2700 cubic ft/ minute (76,455 liters)
Power shelf airflow	200 cubic ft/ minute (5660 liters)

Power Specifications

Table A-2 lists the power specifications for the LCC.

Table A-2 Line Card Chassis Power Specifications

Description	Value
Power shelves	2 AC or 2 DC power shelves (Cannot mix AC and DC power shelves.)
DC power shelf	Supports up to 8 DC power modules (PMs) 6 PMs are shipped per shelf
AC power shelf	Supports up to 6 AC power modules (PMs) 5 PMs are shipped per shelf
Maximum Input Power	
DC, chassis fully loaded	19,091 Watts
AC, chassis fully loaded	19,565 Watts
Maximum Output Power	
DC, chassis fully loaded	16.80 kW
AC, chassis fully loaded	18.00 kW
Power Redundancy	
DC	2N: Up to 8 "A" battery plant feeds and up to 8 "B" battery plant feeds
AC	2N: Up to 6 "A" AC single-phase power sources and up to 6 "B" single-phase AC power sources required.
DC Input	
Nominal input voltage	–48 VDC North America –60 VDC International Range: 40 to –72 VDC
Input current	50 A max at –48 VDC 40 A max at –60 VDC 60 A at –40 VDC (maximum)
AC Input	Single-phase
Nominal input voltage	200 to 240 VAC (range 180 to 264 VAC)
Nominal line frequency	50/60 Hz (range 47 to 63 Hz)
Recommended AC service	20 A (North America) dedicated branch circuit 16 A (International) dedicated branch circuit
AC power cord length	167 in. (4.25 m)

Line Card Chassis Environmental Specifications

Table A-3 lists the environmental specifications for the line card chassis.

Table A-3 Line Card Chassis Environmental Specifications

Description	Value
Temperature	Operating, nominal: 41° to 104°F (5° to 40°C) Operating, short-term: 23° to 122°F (–5° to 50°C) ¹ Nonoperating: –40° to 158°F (–40° to 70°C)
Humidity	Operating: 5 to 90% noncondensing Nonoperating: 5 to 93% noncondensing, short-term operation
Altitude	–197 to 5906 ft (–60 to 1800 m) at 122°F (50°C), short-term Up to 13,123 ft (4000 m) at 104°F (40°C) or below
Heat dissipation	49,134 BTU per hour (maximum) DC ² 56,641 BTU per hour—(maximum) AC ³
Air exhaust temperature	140°F (60°C)—at room temperatures of 95 to 102°F (35 to 39°C) 158°F (70°C)—maximum exhaust temperature on a fully loaded system during worst-case operating conditions (50°C and 6000 ft altitude) Note Air temperature rise is 68°F (20°C) on a fully loaded system with fans running at maximum speed (5150 RPM).
Air velocity (at exhaust)	1000 ft/min (5.1m/s) at 3500 rpm 2250 ft/min(11.4m/s) at 7500 rpm Note Software controls the speed of the fans based on measurements from the chassis thermal sensors.
Sound power level (AC and DC power)	Fan speed 3500 RPM, temperature 80°F (27°C): 77.2 dB—modular configuration power Fan speed 5150 RPM, temperature 104°F (40°C): 88.8 dB—modular configuration power
Shock and vibration	Designed and tested to meet the NEBS shock and vibration standards defined in GR-63 Issue 3 March 2006.

1. Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year. This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period.
2. Heat dissipation from the modular configuration DC power system based on maximum output power capacity at 90% efficiency.
3. Heat dissipation from the modular configuration AC power system based on maximum output power capacity at 92% efficiency.

Depending on the hardware deployed at your site, your system may not consume or be capable of consuming the maximum power supplied by the power system.

Regulatory, Compliance, and Safety Specifications

For information about the regulatory, compliance, and safety standards to which the Cisco CRS Series system conforms, see *Regulatory Compliance and Safety Information for the Cisco CRS Carrier Routing System*.



Product IDs

This appendix provides information about the product structure, product IDs, and hardware compatibility. It contains:

- [Chassis Product IDs, page B-1](#)
- [CRS Hardware Compatibility, page B-2](#)

The table lists system components, their product IDs (the part numbers to use to order the component), and descriptions.



Note

In the following tables, an equals sign (=) at the end of the product ID indicates that the component can be ordered as a spare. For those components, be sure to include the equals sign as part of the product ID.



Note

Although this appendix provides product IDs for routing system components, the Cisco online ordering and pricing tool has the most up-to-date information on the routing system and product IDs: <http://www.cisco.com>. CCO login is required. Enter a search term such as “CRS” to view a list of components.

Chassis Product IDs

[Table B-1](#) lists the PIDs for the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced router and its components.

CRS Hardware Compatibility

Table B-1 Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Product IDs

Component	Product ID	Description
Line card chassis (complete)	CRS-16-LCC-B(=)	CRS 16 slot line card chassis for CRS-16/S-B
	CRS-16-LCC/M-B(=)	CRS 16 slot Carrier Routing System/single-enhanced
	CRS-16/S-B	CRS 16 slot line card chassis/M-B
Switch fabric cards		
Switch fabric card (single-shelf system)	CRS-16-FC/S(=)	S123 switch fabric cards for CRS-1 40G system
	CRS-16-FC140/S(=)	S123 switch fabric cards for CRS-3 140G system
	CRS-16-FC400/S(=)	S123 switch fabric cards for CRS-X 400G system (8 required for each line card chassis)
Switch fabric card (multi-shelf system)	CRS-16-FC/M(=)	S13 switch fabric cards for CRS-1 40G system
	CRS-16-FC140/M(=)	S13 switch fabric cards for CRS-3 140G system
	CRS-16-FC400/M(=)	S13 switch fabric cards for CRS-X 400G system (8 required for each line card chassis)
Route processors		
Route processor	CRS-16-RP(=)	Route processor (2 required for each line card chassis)
Performance route processor (PRP)	CRS-16-PRP-6G=	Performance route processor (6GB memory)
	CRS-16-PRP-12G=	Performance route processor (12GB memory) (2 PRPs required for each line card chassis)
Distributed route processor (DRP)	CRS-DRP(=)	Additional route processor for the system (optional) (includes two cards, DRP CPU and DRP PLIM)
	To order DRP cards separately, use the following IDs (both cards are required for DRP operation):	
	<ul style="list-style-type: none"> • CRS-DRP-B-CPU(=) • CRS-DRP-B-PLIM(=) 	DRP card only (requires DRP PLIM) DRP PLIM only (requires DRP CPU)
Power		
AC power system	CRS-16-ACKIT-M-B(=)	CRS modular power AC kit for CRS-16/S-BAC power shelf for CRS-16/S-B
	CRS-16-PWRSH-AC(=)	CRS 16 slot AC power shelf for CRS-16/S-B
DC power system	CRS-16-DCKIT-M-B(=)	CRS modular power DC kit for CRS-16/S-BDC power shelf for CRS-16/S-B
	CRS-16-PWRSH-DC(=)	CRS 16 slot DC power shelf for CRS-16/S-B
AC power module	CRS-PM-AC(=)	AC power module (Up to 6 required for each power shelf)
DC power module	CRS-PM-DC(=)	DC power module (Up to 8 required for each power shelf)
Alarm module	CRS-16-ALARM-B(=)	CRS 16 slot alarm board for CRS-16/S-B

Table B-1 Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router Product IDs (continued)

Component	Product ID	Description
AC power cord	CRS-AC-CAB-NA	AC power cord—North America
	CRS-AC-CAB-AU	AC power cord—Australia
	CRS-AC-CAB-UK	AC power cord—United Kingdom
	CRS-AC-CAB-EU	AC power cord—Europe
	CRS-AC-CAB-IT	AC power cord—Italy
		Note Length of each power cord is 4.25 m.
Power Distribution Unit (PDU)	CRS-16-PDU-DELTA	3-phase to single-phase AC Delta PDU for line card chassis
	CRS-16-PDU-WYE	3-phase to single-phase AC Wye PDU for line card chassis
Cooling		
Fan tray	CRS-16-FANTRAY(=)	CRS 16 slot fan tray for CRS-16/S-B
Fan controller	CRS-16-FAN-CT(=)	CRS fan controller for CRS-16/S-B
Air filter	CRS-16-filter(=)	CRS air filter for CRS-16/S-B
Cable management and cosmetics		
Front cable management	CRS-16-FRONT-CM(=)	CRS 16 slot front cable management for CRS-16/S-B
Rear cable management	CRS-16-REAR-CM	CRS 16 slot chassis rear cable management for CRS-B
Front door	CRS-16-DOORS-F	CRS 16 slot chassis front doors for CRS-16/S-B
Rear door	CRS-16-DOORS-R	CRS 16 slot chassis rear doors for CRS-16/S-B
Power grille	CRS-16-PW-GRILL-B(=)	CRS modular power grille for CRS-16/S-B
Chassis installation accessories (included with chassis)		
Drill hole template	CRS-16-DRILLTEMP	CRS 16 slot drill template for CRS-16/S-B
Chassis access template	CRS-16-FLOORTEMP	CRS 16 slot floor template for CRS-16/S-B

For detailed specifications for Cisco CRS-1 routing system PLIMs, RPs and other components refer to the data sheet on: http://www.cisco.com/en/US/partner/products/ps5763/products_data_sheets_list.html.

CCO login is required.

For additional information on Cisco CRS routing system SPA interface processor (SIP) and shared port adapters (SPAs), see *Cisco CRS SIP and SPA Hardware Installation Guide*.

Table B-2 lists the compatibility of 40G CRS, 140G CRS, and 400G CRS fabric, forwarding, and line card components for the LCC system.

**Note**

A router with a mix of 40G, 140G, and 400G fabric cards is not a supported mode of operation. Such a mode is temporarily allowed only during the upgrade process.

Table B-2 CRS Compatibility Matrix

Switch Fabric	RP/DRP	MSC/FP/LSP	PLIMs
CRS-16-FC/S	RP-A (CRS-16-RP), RP-B (CRS-16-RP-B), DRP-B (CRS-DRP-B)	CRS-MSC-B	10C768-DPSK/C 10C768-ITU/C 10C768-POS-SR 4-10GE-ITU/C 8-10GBE CRS1-SIP-800 4-10GE 42-1GE 20-1GE-FLEX 2-10GE-WL-FLEX 4-10GBE-WL-XFP 8-10GBE-WL-XFP
CRS-16-FC140/S	RP-A (CRS-16-RP), RP-B (CRS-16-RP-B), DRP-B (CRS-DRP-B)	CRS-MSC-B	10C768-DPSK/C 10C768-ITU/C 10C768-POS-SR 4-10GE-ITU/C 8-10GBE CRS1-SIP-800 4-10GE 42-1GE 20-1GE-FLEX 2-10GE-WL-FLEX 4-10GBE-WL-XFP 8-10GBE-WL-XFP
	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G)	CRS-MSC-140G	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G))	CRS-FP140	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G)	CRS-LSP	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
CRS-16-FC400/S (400G)	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G)	CRS-MSC-X (400G)	4x100GE-LO 40x10GE-WLO 2x100GE-FLEX40
		CRS-FP-X (400G)	
		CRS-LSP-X (400G)	