Cisco CRS Carrier Routing System 8-Slot Line Card Chassis System Description

First Published: 2013-08-25

Last Modified: 2017-02-10

CONTENTS

Preface

This preface explains the objectives, intended audience, and organization of this *Cisco CRS Carrier Routing System 4-Slot Line Card Chassis System Description*, commonly referred to as the system description in this document, and presents the conventions that convey additional information. This preface includes the following sections:

Objective

This guide describes the Cisco CRS 8-Slot Line Card Chassis from a system point of view. This guide focuses on the hardware elements, including descriptions of most of the major assemblies, such as the power and cooling systems, the switch fabric, route processor, and modular services cards. It also provides background information and the basic theory of operation for this routing system.

This guide can be read as a supplement to the Site Planning Guide, Installation Guide, and the related software documents.

Audience

This guide is intended for service provider customers and Cisco installation partners who have substantial background in configuring router-based internetworks and experience with routers and Cisco IOS XR software. The system description provides a high-level introduction to the components and vocabulary used within the Cisco CRS 8-Slot Line Card Chassis product.

Document Organization

This system description contains the following chapters and appendixes:

- The "Overview" chapter provides an overview of the chassis architecture and hardware.
- The "Installing Power Systems" chapter provides a description of the two power systems available for the chassis.
- The "Cooling System" chapter provides an overview of the chassis and fan tray cooling systems.
- The "Switch Fabric" chapter provides an overview of the switch fabric configuration and the switch modules used in the single chassis.
- "Line Cards and Physical Layer Interface Modules Overview," provides an overview of the Physical Layer Interface Module (PLIM) and MSC (Modular Services Card), which are cards used in the chassis.
- The "Route Processor" chapter provides an overview of chassis route processor.
- Appendix A, "Technical Specifications," provides the specifications for the chassis.
- Appendix B, "Product IDs" provides tables of product IDs for components of the chassis.

Document Conventions

This guide uses the convention where the symbol ^ represents the key labeled Control or Ctrl. For example, the key combination ^ z means hold down the Control key while you press the z key.

Command descriptions use these conventions:

- Examples that contain system prompts denote interactive sessions, indicating the commands that you should enter at the prompt. The system prompt indicates the current level of the EXEC command interpreter. For example, the prompt router> indicates that you should be at the user level, and the prompt router# indicates that you should be at the privileged level. Access to the privileged level usually requires a password. Refer to the related software configuration and reference documentation listed in Related Documentation for additional information.

- Commands and keywords are in **bold**.

- Arguments for which you supply values are in italics.

- Elements in square brackets ([ ]) are optional.

- Alternative but required keywords are grouped in braces ({}) and separated by vertical bars (|).

Examples use these conventions:

- Terminal sessions and sample console screen displays are in screen font.

- Information you enter is in boldface screen font.

- Nonprinting characters, such as passwords, are in angle brackets (< >).

- Default responses to system prompts are in square brackets ([]).

- Exclamation points (!) at the beginning of a line indicate a comment line.

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

IMPORTANT SAFETY INSTRUCTIONS

Note   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 routing system conforms.

Related Documentation

For a complete listing of Cisco CRS planning, installation, and configuration documents, see the following publications:

- Cisco CRS Carrier Routing System 8-Slot Line Card Chassis Unpacking, Moving, and Securing Guide
- Cisco CRS-1 Carrier Routing System 8-Slot Line Card Chassis Site Planning Guide
- Cisco CRS Carrier Routing System 8-Slot Line Card Chassis Installation Guide
- 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

Changes to This Document

The following table lists the technical changes made to this document since it was first printed.

Table 1: Changes to This Document

Date	Change Summary
April 2015	Added information about the new back-to-back fabric card CRS-8-FC400/M.
March 2015	Added recommendation to use modular power supplies with CRS-X line cards and fabric cards.
December 2014	Added support for the CRS-MSC-X-L and CRS-FP-X-L line cards.
July 2014	Added support for new 2x100GE-FLEX-40 PLIM.

Date	Change Summary
January 2014	Added updates to support the Cisco CRS-X, which includes new line cards, switch fabric cards, and PLIMs.
April 2012	Added Alarm Port section with pin outs to Chapter 6 to fix caveat.
November 2011	Updated text regarding exterior cosmetic components.
August 2011	Updated text and graphics based on documentation comments.
July 2011	Added information about new CRS-LSP Label Switch Processor (LSP) card.
June 2011	Updated text and graphics. Added Appendix B listing product IDs.
April 2011	Added information about new CRS-8-PRP-6G and CRS-8-PRP-12G Performance Route Processor (PRP) cards. Corrected graphics and made technical updates. Updated front matter.
March 2011	Added modular power configuration information and graphics. Added CRS-1 and CRS-3 information. Also added technical updates and made minor editorial changes. Power architecture diagrams were updated.
October 2010	Added information about the new MSC140 and FP140 line cards, CRS-8-FC/s and CRS-8-FC140/S switch fabric cards, 14-port and 20-port 10-GE PLIMs, and the 1-port 100-GE PLIM. Minor editorial and technical changes were also made.
September 2010	Added information in Installing Power Systems about the modular power system now available in addition to the standard, fixed power system. Updated Appendix A "Technical Specifications."
June 2010	Added information in Chapter 2 about the modular power system now available in addition to the standard, fixed power system. Updated Appendix A, "Technical Specifications".
May 2008	Corrected the specifications in the "Regulatory, Compliance, and Safety Specification" section.
February 2008	The document was updated with technical corrections.
April 2006	• Technical updates have been entered throughout the text. • The glossary was removed. • The title was changed to *Cisco CRS 8-Slot Line Card Chassis System Description*.

Date	Change Summary
April 2005	• In the "Software Documentation" section, a URL was added for the Getting Started guides. • The switch fabric card name was corrected from S123 to HS123. (part ID: CRS-8-FC/S.) • Chapter 1: The alphanumeric displays on the MSC, switch fabric card, and RP cards are explained in a new section. • Added Chapter 2: "Fixed Configuration DC Power" section. • The term load zone was modified to power zone for accuracy. • Modified Warning numbers to match the warnings presented in Regulatory Compliance and Safety Information for the Cisco CRS Carrier Routing System. The warnings changed as follows: • Warning Statement 75 became Statement 1071. Text changed slightly. • Warning Statement 26 became Statement 113. Text did not change. • Warning Statement 70 became Statement 125. Text did not change.
December 2004	Initial release of this document.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, obtaining support, providing documentation feedback, security guidelines, and also recommended aliases and general Cisco documents, 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.

CHAPTER 1

Overview

This chapter provides an overview of the Cisco CRS 8-Slot Line Card Chassis and the basic system configuration. It contains the following topics:

- Chassis Overview, on page 1
- Chassis Components, on page 2
- System Architecture, on page 6
- Chassis Main Features, on page 7
- Chassis Slot Numbers, on page 8
- Exterior Cosmetic Components, on page 10
- Control Plane and Data Plane Overview, on page 10
- CRS Hardware Compatibility, on page 14

Chassis Overview

The Cisco CRS 8-slot Line Card Chassis router supports 40 G, 140 G, and 200 G fabric cards and line cards. The Cisco CRS 8-Slot Line Card Chassis Enhanced router consists of one of the following:

- A single, 8-slot, 40-Gbps-per-slot line-card shelf for a total switching capacity of 640 Gbps
- A single, 8-slot, 140-Gbps-per-slot line-card shelf for a total switching capacity of 2.24 Tbps
- A single, 8-slot, 200-Gbps-per-slot line-card shelf for a total switching capacity of 6.4 Tbps

The 8-slot chassis is a half-height, rack-mounted 8-slot version of the Cisco CRS 16-Slot Line Card Chassis router.

The routing systems are built around a scalable, distributed three-stage switch fabric and a variety of line card (packet) interfaces. These packet interfaces are located on modular services cards (MSCs), forwarding processors (FP), or label switch processor (LSP) cards and their associated physical layer interface modules (PLIMs) which can be referred to as line cards and are effectively cross-connected to each other through the switch fabric. MSC, FP, and LSP cards are also referred to as line cards.

The routing system consists of a single, rack-mounted chassis that contains the system components:

- Up to eight MSC, FP, or LSP line cards.
- Up to eight physical layer interface modules or PLIMs (one for each line card).
- Route processor (RP) cards (up to two) or performance route processor (PRP) cards (up to two)
- Switch fabric cards (four required)
- SPA Interface Processors (SIPs) and Shared Port Adapters (SPAs) which can be installed instead of PLIMs.

> • SIP is a carrier card that is similar to a PLIM and inserts into a line card chassis slot and interconnects to a line card like a PLIM does. Unlike PLIMs, SIPs provide no network connectivity on their own.
> • SPA is a modular type of port adapter that inserts into a subslot of a compatible SIP carrier card to provide network connectivity and increased interface port density. A SIP can hold one or more SPAs, depending on the SIP type and the SPA size. POS/SDH and Gigabit Ethernet SPAs are available.

> • A chassis midplane that connects MSCs, FPs, and LSPs to their PLIMs and to switch fabric cards

The Cisco CRS 8-slot Line Card Chassis router supports 40G, 140G, and 200G fabric cards, as follows:

- The Cisco CRS-1 Carrier Routing System uses fabric cards designed for 40 G operation (CRS-8-FC/S or CRS-8-FC/M cards).
- The Cisco CRS-3 Carrier Routing System uses fabric cards designed for 140G operation (CRS-8-FC140/S or CRS-8-FC140/M cards).
- The Cisco CRS-X Carrier Routing System uses fabric cards designed for 200G operation (CRS-8-FC400/S fabric card or CRS-8-FC400/M back-to-back fabric card). For information about the CRS back-to-back system, see Introduction to the CRS-3 Back-to-Back System.

A mixture of 40G, 140G, and 200G 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.

Chassis Components

This section lists the chassis main components. 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.

Power Components

The chassis contains a power system that provides redundant power to the chassis. Two types of power systems are available:

- Fixed configuration power
- Modular configuration power

Both power configurations use either AC or DC power.

The fixed configuration power solution contains two power distribution units (PDUs), with either one AC rectifier or one DC power entry modules (PEM) per PDU. The modular configuration power solution contains two power shelves with either up to three AC PMs per power shelf or up to four DC power modules (PMs).

This figure shows a front view of the chassis with a fixed configuration AC power system installed. The front view of the chassis with a DC fixed configuration power system installed is similar.

Figure 1: Front (PLIM) View of Line Card Chassis—Fixed Configuration AC Power

1	Cable management bracket	4	Air filter
2	Chassis vertical mounting brackets	5	Disconnect switch
3	PLIM and RP slots (RPs in middle 2 slots)	6	PEM (AC power entry module)

This figure shows the rear view of the chassis with an AC and a DC fixed configuration power supply installed.

Figure 2: Rear (MSC) View of the Line Card Chassis—Fixed Configuration AC and DC Power

CRS 8-Slot AC Rear

CRS 8-Slot DC Rear
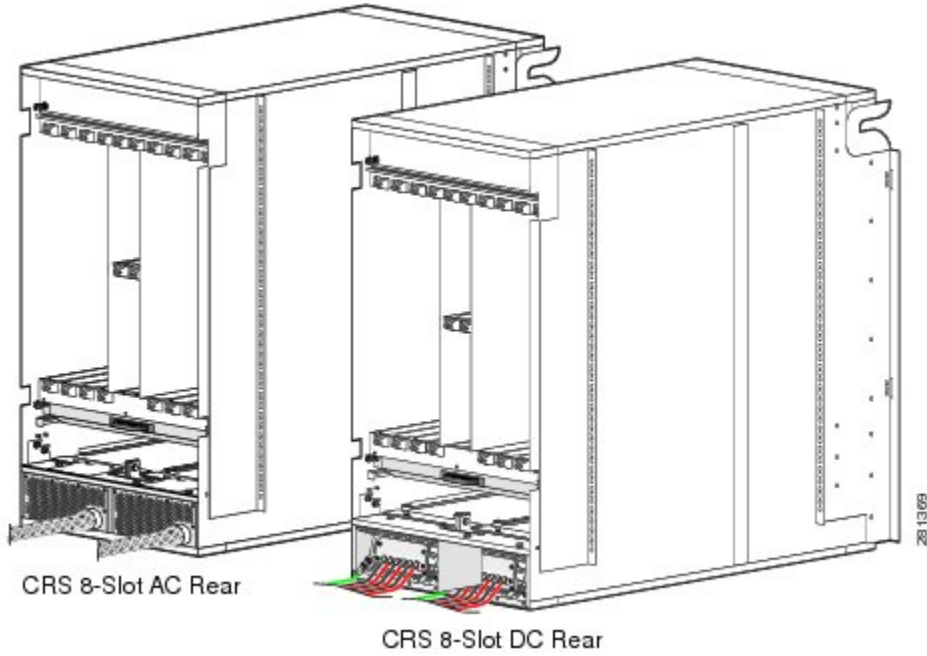
This figure shows the front view of the chassis with an AC and a DC modular configuration power supply installed.

Figure 3: Front (PLIM) View of Line Card Chassis—Modular Configuration AC and DC Power
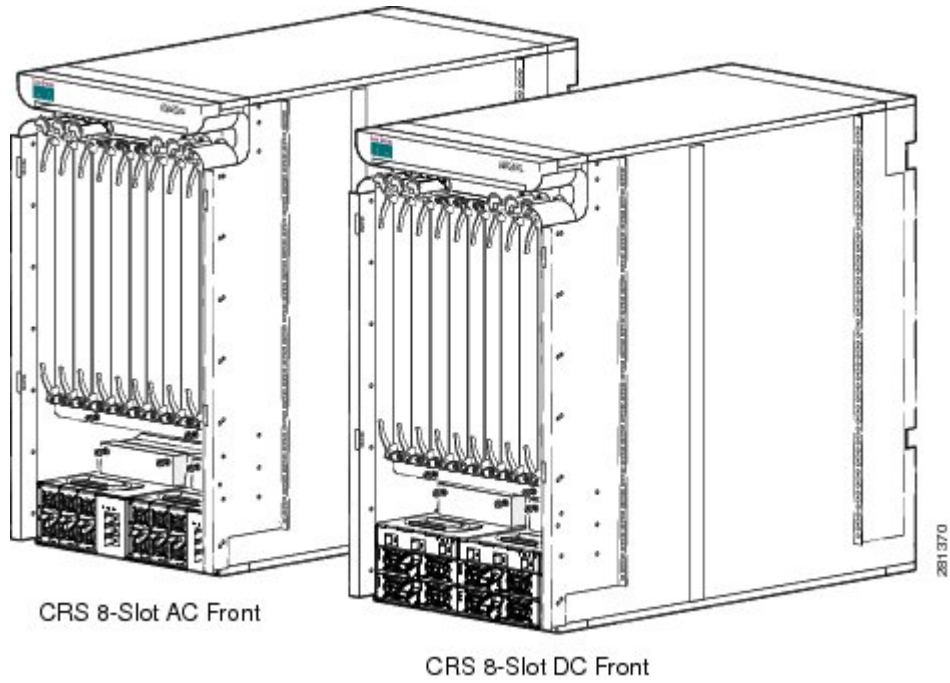
CRS 8-Slot AC Front

CRS 8-Slot DC Front

This figure shows the rear view of the chassis with an AC and a DC modular configuration power supply installed.

Figure 4: Rear (MSC) View of the Line Card Chassis—Modular Configuration AC and DC Power
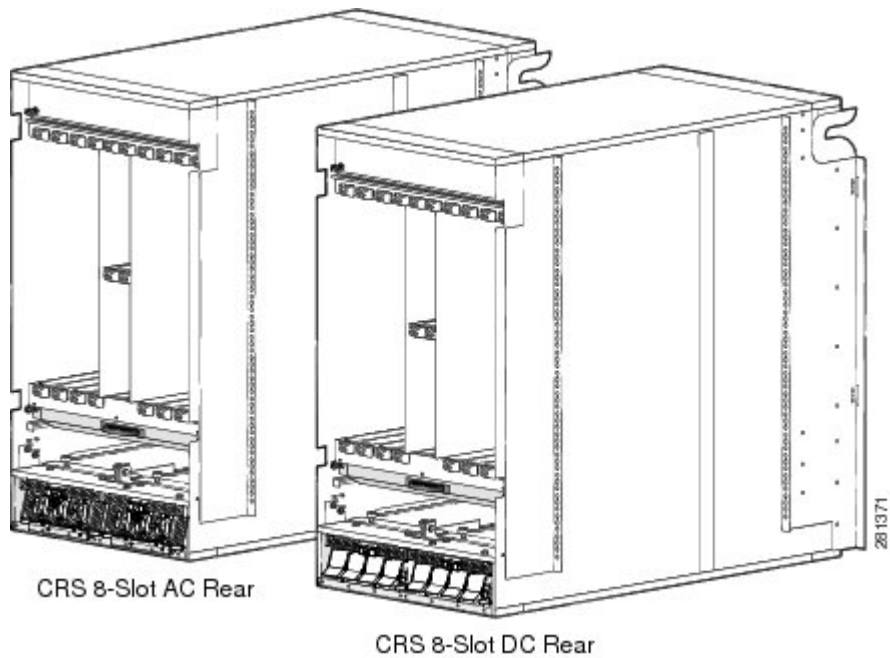
CRS 8-Slot AC Rear

CRS 8-Slot DC Rear

This figure shows the rear view of the chassis with a fixed configuration AC power system installed.

Figure 5: Rear (MSC) View of the Line Card Chassis—Fixed Configuration AC Power
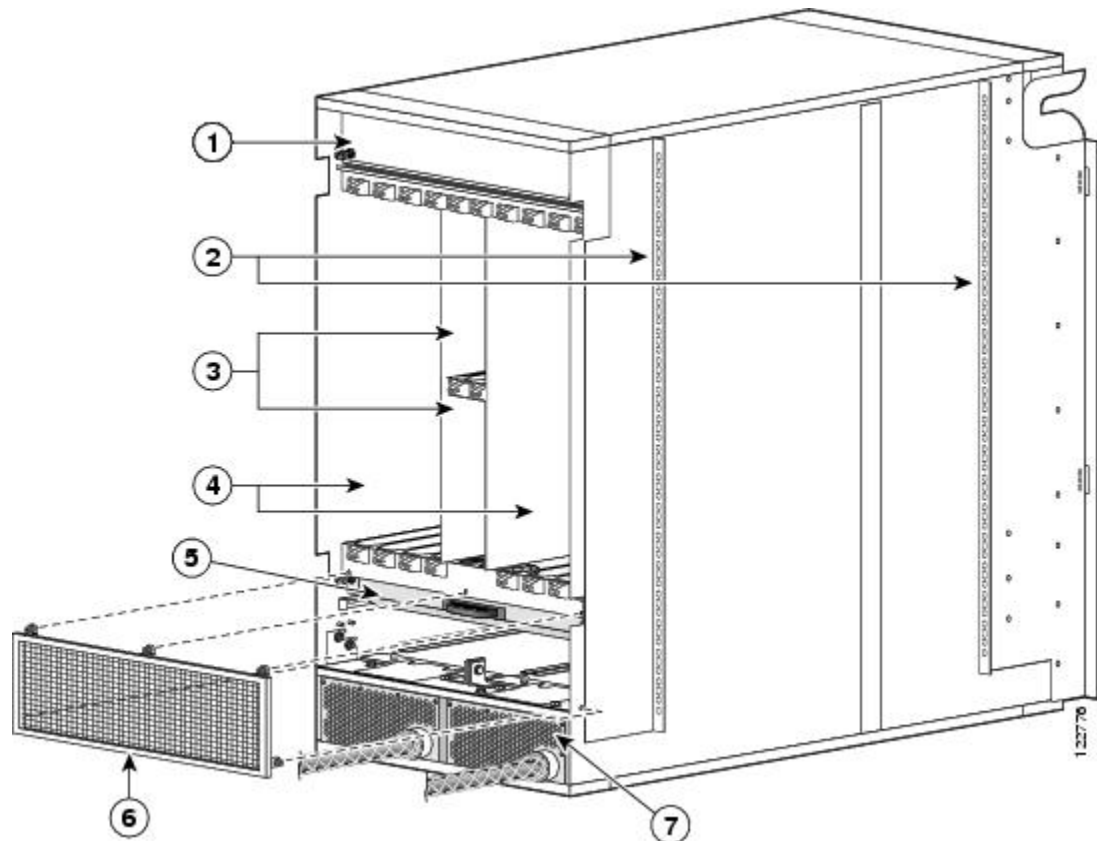
1	Upper fan tray (beneath cover)	5	Lower fan tray
2	Chassis vertical mounting brackets	6	Rear exhaust screen
3	Switch fabric card (half-height) slots	7	PEM (AC power entry module)
4	MSC slots		

Routing and Switch Fabric Components

The chassis contains these components:

- As many as eight MSC, FP, and LSP cards (all types are also called line cards), and eight PLIMs. The line card and PLIM are an associated pair of cards that mate through the chassis midplane. The line card provides the forwarding engine for Layer 3 routing of user data, and the PLIM provides the physical interface and connectors for the user data. The line card can be associated with several different PLIMs, which provide different interface speeds and technologies.

✎

Note   For a complete list of line cards, route processors, SPAs and SIPs, and interface modules supported in the Cisco CRS 8-slot line card chassis, see the Cisco Carrier Routing System Data Sheets .

- A chassis midplane that connects line cards to their associated PLIMs. The midplane design allows a line card to be removed from the chassis without having to disconnect the cables that are attached to the associated PLIM. The midplane distributes power, connects the line card to the switch fabric cards, and provides control plane interconnections. The midplane is not field replaceable by the customer.
- One or two route processor cards (RPs). The RPs provide the intelligence of the system by functioning as the Cisco CRS 8-slot line card chassis system controller (serving as part of the control plane in multi-chassis systems) and providing route processing. Only one RP is required for system operation. For redundant operation, you can order a second RP as an option (CRS-8-RP/R). When two RPs are used, only one RP is active at a time. The second RP acts as a "standby" RP, serving as a backup if the active RP fails.

The RP also monitors system alarms and controls the system fans. LEDS on the front panel indicate active alarm conditions.

A Performance Route Processor (PRP) is also available for the Cisco CRS 8-slot line card chassis. Two PRPs perform the same functions as two RPs, but provide enhanced performance for both route processing and system controller functionality.

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

- Upper and lower fan trays. The fans pull cool air through the chassis.
- Four half-height switch fabric cards. These cards provide the three-stage Benes switch fabric for the routing system. The switch fabric performs the cross-connect function of the routing system, connecting every line card (and its associated PLIM) with every other line card (and its associated PLIM) in the system.

The switch fabric receives user data from one line card and PLIM pair and performs the switching necessary to route the data to the appropriate egress line card and PLIM pair. The switch fabric is divided into eight planes that are used to evenly distribute the traffic across the switch fabric. Each switch fabric card implements two planes of the switch fabric.

- A power system that provides redundant power to the chassis. Two types of power systems are available: fixed configuration power and modular configuration power. Both power configurations use either AC or DC power. The fixed configuration power solution contains two power distribution units (PDUs), with either one AC rectifier or one DC power entry modules (PEM) per PDU. The modular configuration power solution contains two power shelves with either up to four DC power modules (PMs) or up to three AC PMs per power shelf.

The PLIM side of the chassis is considered the front of the chassis, where user data cables attach to the PLIMs and cool air enters the chassis. The MSC side, which is where warm air is exhausted, is considered the rear of the chassis.

System Architecture

Every Cisco CRS 8-Slot Line Card Chassis has 8 MSC slots, each with a capacity of 140 gigabits per second (Gbps) for a total routing capacity for each chassis of 2.24 terabits per second. (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 MSC, FP, or LSP through the chassis midplane. The switch fabric cross-connects MSCs, FPs, and LSPs to each other. This figure is a simple diagram of the basic chassis architecture.

Figure 6: Simple Schematic of Cisco CRS 8-Slot Line Card Chassis Architecture
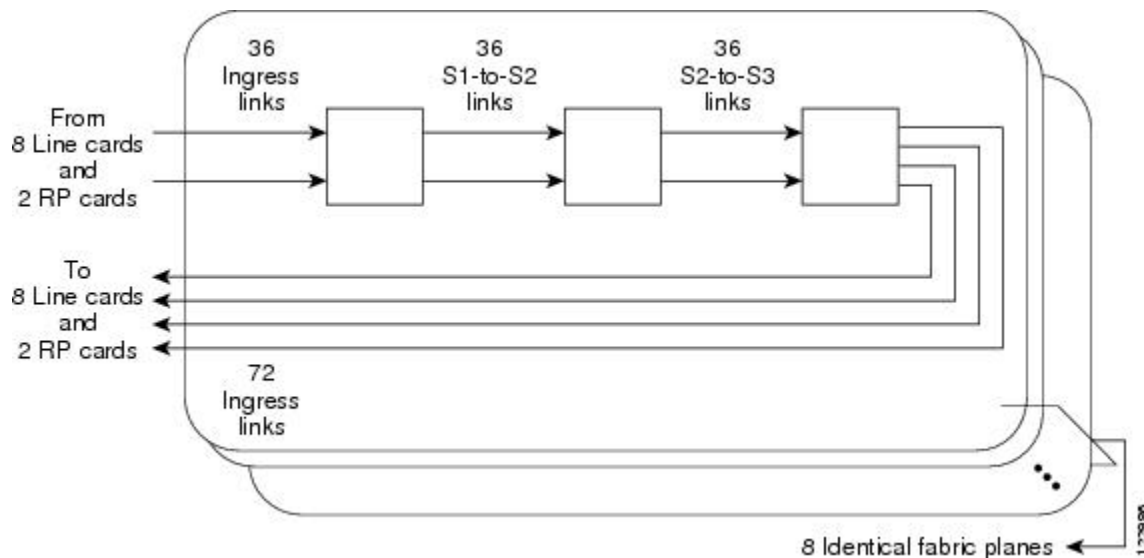
The figure illustrates the following concepts, which are common to all Cisco CRS-1s:

- Packet data enters the line card through physical data interfaces located on the associated PLIM.
- Data is routed through the line card, a Layer 3 forwarding engine, to the three-stage Benes switch fabric. Each line card and associated PLIM have Layer 1 through Layer 3 functionality, and each line card delivers line-rate performance (200-Gbps aggregate bandwidth).
- The three-stage Benes switch fabric cross-connects the line cards in the routing system. The switch fabric is partitioned into eight planes (cards 0 to 3 each have two planes).

Chassis Main Features

The main features of all Cisco CRS-1 8-slot routing systems include:

- A highly scalable service provider router with a capacity of up to 6.4 terabits per second (Tbps) of bandwidth.
- A wide range of interface speeds and types (for example, OC-48 packet-over-SONET (POS) and OC-192 POS), and a programmable line card 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.
- Partitioning into logical routers. A logical router (LR) is a set of line cards 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 Slot Numbers

This section identifies the location and slot numbers for major cards and modules (primarily the field-replaceable units) that plug into the chassis.

This figure shows the slot numbering on the front (PLIM) side of the Cisco CRS 8-slot line card chassis.

Figure 7: Line Card Chassis Slot Numbering—Front (PLIM) Side
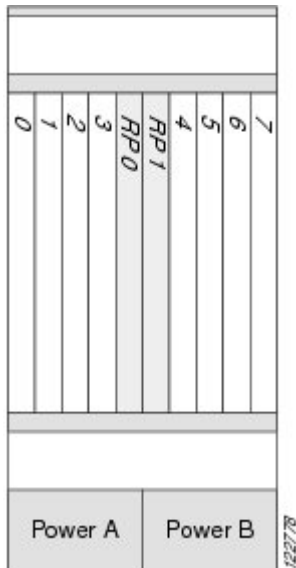
As shown, the Cisco CRS 8-slot line card chassis numbers on the PLIM side of the chassis include the card cage with:

- Eight PLIM slots: left to right, 0, 1, 2, 3, 4, 5, 6, 7
- Two route processor card slots, RP0 and RP1
- Power shelf A and power shelf B

This figure shows the slot numbers on the rear (MSC) side of the Cisco CRS 8-slot line card chassis.

Figure 8: Line Card Chassis Slot Numbers—Rear (MSC) Side
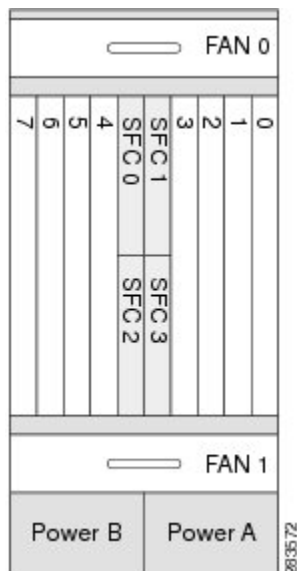
As shown, the slot numbers on the MSC side of the chassis include:

- Fan tray 0 and fan tray 1
- Card cage, including:

    - Eight MSC slots (0, 1, 2, 3, 4, 5, 6, 7)
    - Four half-height switch fabric card slots (SM0, SM1, SM2, and SM3)

- Power shelf B and Power shelf A

The MSC slot numbers are reversed from the PLIM slot numbers on the other side of the chassis. Because an MSC mates with its associated PLIM through the midplane, MSC slot 0 is on the far right side of the chassis looking at it from the rear (MSC) side.

PLIM slot 0 is on the far left side of the chassis, looking at if from the front (PLIM) side. MSC slot 0 and PLIM slot 0 mate with each other through the midplane, and so do all other MSC and PLIM slots (0 through 7).

Cable Management

The Cisco CRS 8-slot line card chassis has cable management features for the front (PLIM) side of the chassis, just above the card cage. 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 also helps when installing the cables in the chassis. If the door is installed, do not leave the fiber management brackets extended, as they will hit the door.

This figure shows the cable management bracket.

Figure 9: Cable Management Bracket
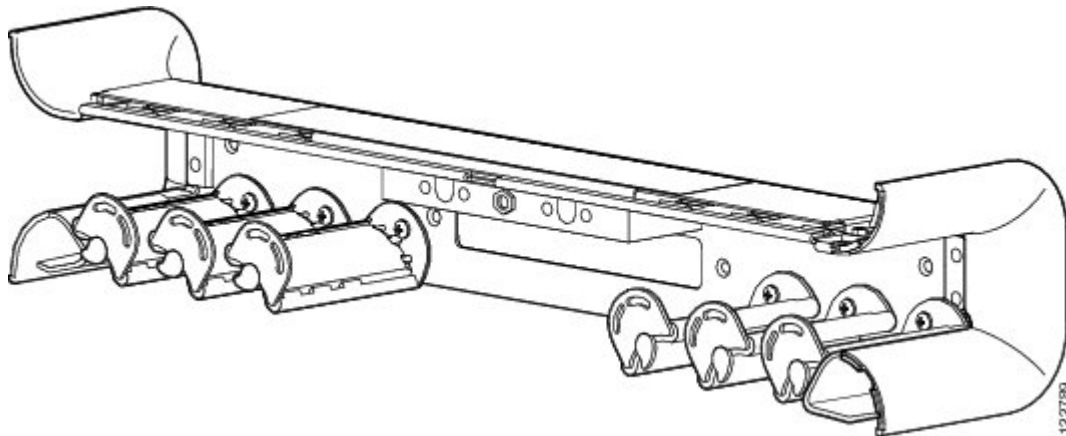
Exterior Cosmetic Components

The Cisco CRS 8-slot line card chassis includes the following exterior cosmetics:

- Cable management bracket (shipped preinstalled on the chassis)
- Inlet grille (shipped separately)
- Front cover (shipped separately)

Control Plane and Data Plane Overview

The *control plane* is a logical communication path between cards, modules, and components in the chassis, tying physical components and software functions into a unified entity. The control plane is used during system discovery, inventory, configuration, booting, management, upgrades, 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 a line card to the switch fabric to another line card 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.

System Discovery and Inventory

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 representing the CRS routing system, including individual board identification and location information. A running routing system can be upgraded or serviced at any time during operation. The control plane hardware provides online insertion and removal (OIR) detection.

High Availability

The 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, the chassis identification displays and the critical, major, and minor alarm indicators are clearly visible. Each line card, RP, 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 RP cards function as the system controller in the chassis. Note that the PLIMs are connected to the control plane through their respective line cards.

The control plane provides switched point-to-point Fast Ethernet (FE) connections between the control processors on various routing system components. This allows for control plane network messages, and some other paths for system communication. The dual RP cards and midplane FE traces provide redundant connections between all cards in the line card chassis. 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 listed in the following sections.

Online Insertion and Removal (OIR) Detection

Every line card, 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 online insertion and removal (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 primary 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 a line card is plugged into the MSC slot associated with the PLIM.

RP Active and 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 RP cards to be the primary (active) device; the other RP functions in standby mode.

The control plane verifies that the arbitration logic selected only one RP as active (due to an unusual circumstance in which both RP cards might mistakenly be made active).

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

Node Reset

Each RP has a dedicated reset line to every node in the chassis. Nodes include MSCs, RP cards, and fabric cards. The reset lines fan out from each RP and are connected to the SP on the node cards. Only the primary 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.

Service Processor (SP)

A Service Processor (SP) module is attached to the Modular Service Card (MSC), Route Processor (RP), switch fabric 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 on the RP.

System Controller (SC) Function

The System Controller (SC), which is contained on the Route Processor (RP) is the central point of control within a line card chassis. 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 primary SC is a single control-and-arbitration point in the chassis, and determines primary and standby RP status when necessary.

Modular Services Card and Forwarding Processor Card

The MSC, FP, and LSP line cards are the primary data-forwarding engines. The line card provides Layer 2 and Layer 3 packet processing and queuing. The line card 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.

Physical Layer Interface Module (PLIM)

The Physical Layer Interface Module (PLIM) contains the physical interfaces to external data circuits. The PLIM does not have its own SP module. Instead, the line card SP module controls most of the basic control plane functions for the PLIM. These functions include 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 line card itself does. When the line card SP receives a reset, it shuts off power to the line card and the PLIM power components. When there is no line card present, the associated PLIM is not powered on.

Route Processor

There are two RP slots in each line card chassis. The chassis midplane connects the arbitration logic of the two RP cards so that one RP becomes the primary (active) and one RP becomes the standby. The active RP distributes software images to the SP and line card, while the standby RP monitors the active RP in case it is required to become the active card due to a switchover event.

Note Performance Route Processor (PRP) cards are also available for the Cisco CRS 8-slot line card chassis. Two PRPs perform the same functions as two RPs, but provide enhanced performance for both route processing and system controller functionality. PRPs are required if you are using Cisco CRS-X.

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 RP cards. Routing protocols, such as BGP and OSPF, run on the RP cards and update the route databases. These databases are downloaded to the line cards, and the line card forwarding engines are programmed appropriately.

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 a service processor that provides a control plane interface. The hardware control plane interface communicates over Fast Ethernet links, which provide a channel for fabric configuration and maintenance. Fabric cards can be hot-swapped at any time, as the fabric has multiple planes and can operate with fewer planes at degraded performance levels. You can upgrade the CRS routing system switch fabric by bringing down one plane at a time. During the fabric upgrade, some fabric planes may run in one configuration while others run in a different configuration.

In addition to configuring the fabric chips, the control plane hardware monitors the fabric for faults. Some faults require software to isolate failed chips or links. The service processor software monitors link health and executes isolation actions.

Alphanumeric Displays

Alphanumeric displays on the line card, switch fabric card, and RP card reveal operational states. The display consists of two lines of four characters each, therefore some messages are wrapped or truncated.

Depending on whether it is the active RP or the standby RP in the system, the alphanumeric display on the route processor displays either:

ACTV RP

or

STBY RP

All other nodes display:

IOS- XR

Additionally, the alphanumeric displays reveal the node states listed in .

Table 2: Alphanumeric Displays

Display	Node State
PRESENT	Card is plugged in, but is not booted. This can be due to a configuration problem or other issue with the card.
IN-RESET	Card either hit critical alarms and therefore was shutdown, or it failed the boot process and hence was shut down. Manual intervention is required to recover the card.
ROMMON	State before the card boots.
MBI-BOOT	Initial minimum boot image (MBI) is loading on the card.
MBI-RUN	MBI is running and pulling the appropriate software from the active RP card to the remote nodes.
IOS-XR	Node is up and running.
BRINGDOWN	Node is down, due to user configuration or other error.
IOS-XR FAIL	There is an error on the card. The card should have shut down, but the user has overridden this by configuration.

Fan Trays

Fan trays are monitored by the RP and an SP module that measures airflow and controls fan RPM. As temperatures increase, the SP increases blower RPM to provide increased cooling capacity.

Line Card Chassis 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 store tracking-number and manufacturing information, and MAC addresses. Software stores the chassis ID value in the NVRAM.

CRS Hardware Compatibility

This table lists the compatibility of 40G CRS, 140G CRS, and 200G CRS fabric, forwarding, and line card components for the CRS 8-slot system.

Table 3: CRS Compatibility Matrix

Switch Fabric	RP/DRP	MSC/FP/LSP	PLIMS
CRS-8-FC/S(40G)	RP-A (CRS-8-RP), DRP-B (CRS-DRP-B)	CRS-MSC-B	1OC768-DPSK/C 1OC768-ITU/C 1OC768-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
	RP-A (CRS-8-RP), DRP-B (CRS-DRP-B)	CRS-FP40	4-10GE 42-1GE 20-1GE-FLEX2-10GE-WL-FLEX

Switch Fabric	RP/DRP	MSC/FP/LSP	PLIMS
CRS-8-FC140/S(140G)	RP-A (CRS-8-RP), DRP-B (CRS-DRP-B)	CRS-MSC-B	1OC768-DPSK/C 1OC768-ITU/C 1OC768-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
	RP-A (CRS-8-RP), DRP-B (CRS-DRP-B)	CRS-FP40	4-10GE 42-1GE 20-1GE-FLEX 2-10GE-WL-FLEX
	RP-B (CRS-8-RP-B) DRP-B (CRS-DRP-B)	CRS-LSP	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
	PRP (CRS-8-PRP-6G, CRS-8-PRP-12G)	CRS-MSC-140G	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
	PRP (CRS-8-PRP-6G, CRS-8-PRP-12G)	CRS-FP140	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
	PRP (CRS-8-PRP-6G, CRS-8-PRP-12G)	CRS-LSP	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
CRS-8-FC400/S(200G)	PRP (CRS-8-PRP-6G, CRS-8-PRP-12G)	CRS-MSC-X and CRS-MSC-X -L (200G)	4x100GE-LO 40x10GE-WLO2X100GE-FLEX-40
		CRS-FP-X and CRS-FP-X-L (200G)	
		CRS-LSP	
CRS-8-FC400/M(200G)	PRP (CRS-8-PRP-6G, CRS-8-PRP-12G)	CRS-MSC-X and CRS-MSC-X -L (200G)	4x100GE-LO 40x10GE-WLO2X100GE-FLEX-40
		CRS-FP-X and CRS-FP-X-L (200G)	
		CRS-LSP	

CHAPTER 2

Installing Power Systems

This chapter describes the power systems of the Cisco CRS 8-Slot Line Card Chassis. It contains the following topics:

Power Systems Overview

There are two options for power systems:

- Fixed configuration power system—consists of two power distribution units (PDUs) and either DC power entry modules (PEMs) or AC rectifiers. The AC version requires 3-phase AC-Delta or AC-Wye input power to the PDU. The PDU distributes facility power to the AC rectifier or DC PEM, which in turn provides processed power to the chassis. The fixed configuration power system includes SNMP MIBS and XML support.

Note In a fixed configuration AC or DC power system, PDU refers to the power component that connects to the AC rectifier or DC PEM.

- Modular configuration power system—consists of two power shelves and either AC or DC power modules (PMs). However, unlike the fixed configuration power system, the AC version of the modular configuration power system requires single-phase AC input power to power the shelves. If you have 3-phase AC-Delta or AC-Wye at your equipment, a Cisco CRS PDU will be required to convert 3-phase AC input power to single-phase AC input power for the power shelf. At the shelf level, the power system provides 2N redundancy; the PMs themselves provide load-share redundancy. The modular configuration power system also includes SNMP MIBs and XML support.

Note In a modular configuration AC power system, PDU refers to the Cisco CRS PDU that converts 3-phase AC-Wye or AC-Delta input power to single-phase AC input power for the modular configuration AC power shelf. For further information, see the Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide .

Power components are not interchangeable between the fixed and modular configuration power system.

Power Component Information Common to Two Types of Power System

Basic Chassis Power Details

The Cisco CRS 8-slot line card chassis can be configured with either a DC-input power system or an AC-input power system. The chassis power system provides the necessary power for chassis components. Input power availability is site dependent and may be DC, AC Delta, or AC Wye.

A fixed configuration AC PDU connects to an AC rectifier, while a fixed configuration DC PDU connects to a DC PEM. A modular configuration AC power shelf houses up to 3 AC PMs, while a modular configuration DC power shelf houses up to 4 DC PMs. It is required that you use only one type of power shelf in a chassis at a time.

Note In a modular configuration power system, both AC and DC power supplies are referred to as power modules (PMs).

Note This unit might have more than one power module connection. All connections must be removed to de-energize the unit. **Statement 1028**

Power System-Fixed Configuration

Three types of PDUs exist for fixed configuration power system:

- AC Wye PDU
- AC Delta PDU
- DC PDU

The AC PDU connects to the AC rectifier, while the DC PDU connects to the DC PEM. Although there are differences among the different PDU types (AC Wye, AC Delta, and DC), they are installed in the same manner.

Fixed configuration power system consists of two power distribution units (PDUs) and either DC power entry modules (PEMs) or AC rectifiers. The AC version requires 3-phase AC-Delta or AC-Wye input power to the PDU. The PDU distributes facility power to the AC rectifier or DC PEM, which in turn provides processed power to the chassis. The fixed configuration power system includes SNMP MIBS and XML support.

Note In a fixed configuration AC or DC power system, PDU refers to the power component that connects to the AC rectifier or DC PEM.

For detailed information about AC and DC PDUs, see the Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide .

Power System-Modular Configuration

Modular configuration power system consists of two power shelves and either AC or DC power modules (PMs). However, unlike the fixed configuration power system, the AC version of the modular configuration power system requires single-phase AC input power to power the shelves. If you have 3-phase AC-Delta or AC-Wye at your equipment, a Cisco CRS PDU will be required to convert 3-phase AC input power to single-phase AC input power for the power shelf. At the shelf level, the power system provides 2N redundancy; the PMs themselves provide load-share redundancy.

Note In a modular configuration AC power system, PDU refers to the Cisco CRS PDU that converts 3-phase AC-Wye or AC-Delta input power to single-phase AC input power for the modular configuration AC power shelf. For further information, refer to Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide.

Caution Use only one type of modular configuration power shelf—AC or DC—and its mating AC or DC PMs in a chassis at one time.

Precautions and Recommendations

Follow these precautions and recommendations when planning power connections to the router:

- For the fixed configuration power system, although PDUs 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 PDU.
- For the modular configuration power system, 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.

Grounding Guidelines

The router chassis has safety earth ground connections in conjunction with the power cabling to the fixed configuration PDUs. Modular configuration supports chassis grounding only. The chassis allows you to connect the central office ground system or interior equipment ground system to the bonding and grounding receptacles on the router chassis, when either a fixed or modular configuration power system is installed.

Each side of the chassis has one pair of threaded ground studs located on the inside of the chassis and two sets of grounding receptacles located on the outside of the chassis. These ground points are also called the network equipment building system (NEBS) bonding and grounding points.

Note These bonding and grounding receptacles satisfy the Telcordia NEBS requirements for bonding and grounding connections.

This figure shows six chassis grounding points that are provided at the rear (MSC) side of the chassis.

Figure 10: NEBS Bonding and Grounding Points (Rear of Chassis) - Fixed Configuration AC Power Shown
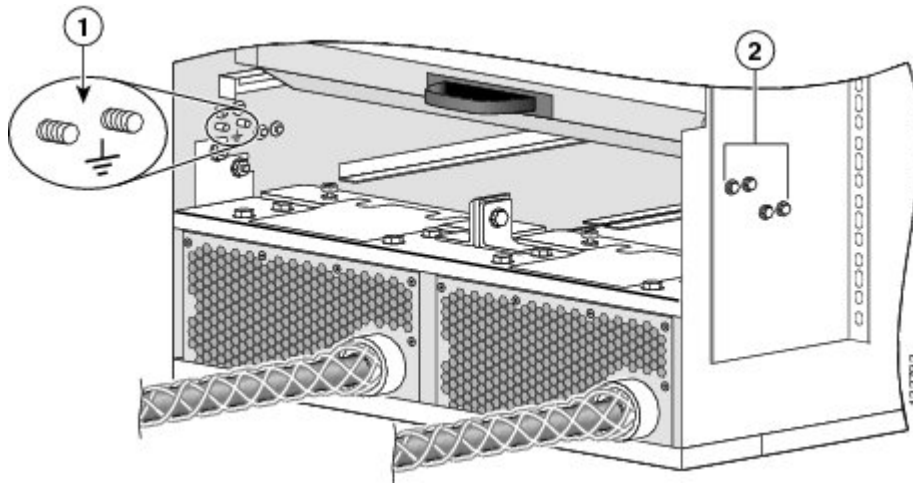
1	NEBS bonding and grounding points (inside chassis)
2	NEBS bonding and grounding points (outside chassis)

⚠️

Caution   Do not remove the chassis ground wire unless the chassis is being replaced.

See the Cisco CRS Carrier Routing System 8-Slot Line Card Chassis Installation Guide for additional grounding and bonding details and installation instructions.

DC Power Systems

Each DC powered chassis contains two fixed configuration PDUs or two modular configuration power shelves for 2N redundancy.

- In the fixed configuration power system, each PDU accepts one DC PEM for 2N redundancy. The PDUs and PEMs are field replaceable. The PDUs contain the input power connectors.
- In the modular configuration power system, each power shelf accepts up to four PMs. The power shelves and PMs are field replaceable. The power shelves contain the input power connectors.

✎

Note   Depending on the hardware deployed at your site, your system may not consume the maximum power supplied by the power system.

AC Power Systems

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

- In the fixed configuration power system, each PDU accepts one AC power rectifier. The PDUs and AC power rectifiers are field replaceable.
- In the modular configuration power system, each power shelf can contain up to three AC PMs. The power shelves and the AC PMs are field replaceable. See Modular Configuration Power System, on page 32.

Note Depending on the hardware deployed at your site, your system may not consume the maximum power supplied by the power system.

Installing a Fixed Configuration Power System

This section describes the fixed configuration power system and contains the following topics:

Fixed Power Configuration Overview

This section describes the Cisco CRS 8-slot fixed power configuration system.

Caution Use only one type of fixed configuration PDU—AC Wye, AC Delta, or DC—and its mating AC rectifier or DC PEM in a chassis at one time.

The Cisco CRS 8-slot line card chassis DC power system provides 7,500 watts to power the chassis. Each DC PDU is connected to three pairs of DC power feeds and powers a single DC PEM. Input DC power enters the PDU and is passed to the PEM, which provides power to the components in the chassis.

- Each DC PEM has its own circuit breaker.
- The fixed configuration power system distributes power in power zones.
- The DC PDUs and DC PEMs are field replaceable.

Fixed Configuration Power Architecture

Cisco CRS 8-Slot chassis AC and DC fixed configuration power systems use A and B power supplies to provide reliable power to all chassis components. In the fixed configuration power system, each PDU accepts one DC PEM for 2N redundancy. The PDUs and PEMs are field replaceable. The PDUs contain the input power connectors.

The chassis requires 8.0 kW of DC input power and 8.75 kW of AC input power from the building supply.

AC or DC input power enters the chassis through the A and B power supplies and is distributed to the A or B power bus. Both buses distribute power through the midplane to the MSC, PLIM, switch fabric, and RP card slots. See the figure titled *CRS 8-Slot Line Card Chassis Power Distribution - Fixed DC Configuration* in the *Fixed Configuration DC Power Distribution Unit* section for the 8-slot chassis power routing distribution for a fixed DC configuration and the figure titled *CRS 8-Slot Chassis AC Delta Power Distribution - Fixed Configuration* in the *Fixed Configuration AC Delta Power* section for the power routing distribution for a fixed AC configuration.

- The A power module supplies –54.5 VDC to the A bus.
- The B power module supplies –54.5 VDC to the B bus.

Because chassis components are powered by both A and B power inputs, the line card chassis can continue to operate normally if:

- One AC rectifier or DC PEM fails.
- One input power (A or B) fails.
- One bus fails.
- One PDU fails.

It takes two failures for the system to be degraded. In addition, the failures must occur in both the A and B sides of the power architecture and affect the same power zone for the degradation to occur.

Individual chassis components have power-related devices (OR-ing diodes, inrush control circuits, and EMI filters) that are part of the chassis power architecture. These power-related devices form part of the dual power source (A and B bus) architecture, and enable online insertion and removal (OIR) of the components, also called *hot swapping* .

Fixed Configuration Chassis Power Zones

The AC or DC power system distributes power in the chassis through three power zones, which provide power redundancy and reliability. Each power zone receives power from both power supplies, which ensures that each zone can operate in case of one power module failure.

This image shows the three power zones in the chassis. The table below the figure identifies the power redundancy connection for the fan trays.

Figure 11: Cisco CRS 8-Slot Line Card Chassis Power Zones

Power Supply	Fan 0	Fan 1
Power Supply A (PS A)	Power for Zone 1	Power for Zone 3
Power Supply B (PS B)	Power for Zone 3	Power for Zone 1

The zones shown in are further explained in and .

Table 4: Power Zone Assignment

Zone Number	Front (PLIM)	Rear (Line Card)
Zone 1	Slot 0, 1, 2	Slot 0, 1, 2
Zone 2	Slot 3, 4, / RP0, 1	Slot 3, 4 / FC 0, 1, 2, 3
Zone 3	Slot 5, 6, 7	Slot 5, 6, 7

Table 5: Power Connection to Power Zones and Fan

Power A			Power B		
Pin 24	Pin 22	Pin 2	Pin 24	Pin 22	Pin 2
Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Fan 0 (Zone 1)			Fan 0 (Zone 3)		
Fan 1 (Zone 3)			Fan 1 (Zone 1)		

Each fan tray—the upper fan tray (Fan 0) or the lower fan tray (Fan 1)—is powered by both PS A and PS B to have power redundancy for the fan tray. In addition, both fan trays receive power from both Power Zones 1 and 3 for redundancy. Both fan trays are monitored by RP0 and RP1 shelf controllers.

Any types of cards can be installed in a power zone.

Fixed Configuration DC Power

The Cisco CRS 8-slot line card chassis DC power system provides 7,500 watts to power the chassis. Each DC PDU is connected to three pairs of DC power feeds and powers a single DC PEM. Input DC power enters the PDU and is passed to the PEM, which provides power to the components in the chassis.

- Each DC PEM has its own circuit breaker.
- The fixed configuration power system distributes power in power zones.
- The DC PDUs and DC PEMs are field replaceable.

Unlike the Cisco CRS 16-slot line card chassis, the Cisco CRS 8-slot line card chassis does not contain an alarm module. A microprocessor in the DC PEM monitors the status of each DC PEM. The microprocessor communicates with the system controller on the route processor (RP) card. LEDs on the front panel of the RP card indicate active alarm conditions.

The DC PDU is shipped with a plastic safety cover over the input terminal block, as shown in the figure below. This safety cover has two parts, each part held on to the PDU with a Phillips screw. We recommend removing the safety cover only when wiring and unwiring the chassis. The safety cover is slotted in such a way that the wires can only come out on the bottom portion of the cover.

Figure 12: Fixed Configuration DC PDU With Plastic Safety Cover
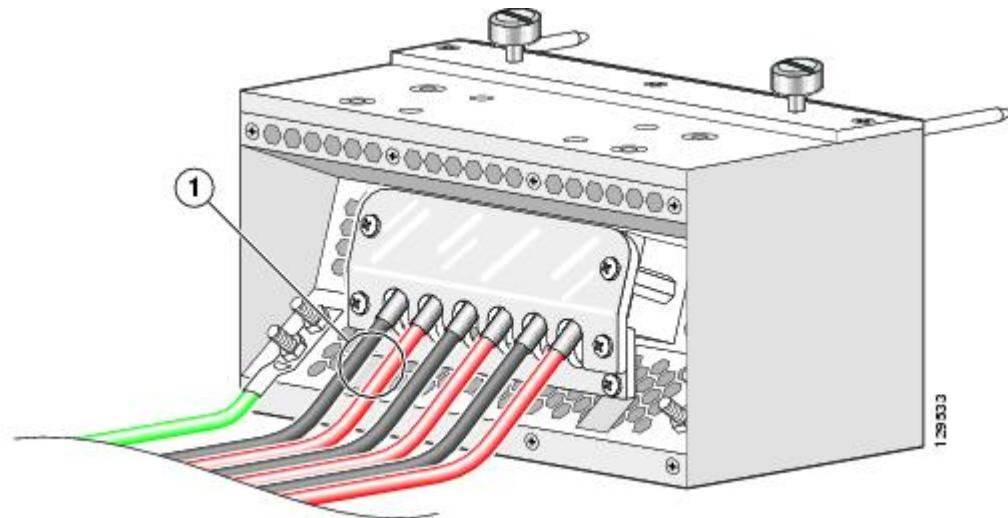
1	Each set of cables (RTN and –48/–60 VDC) is a single VDC input.

Each PDU requires three DC inputs of –48/–60 VDC (nominal), 60 A service. The PDU accepts input DC power in the range –40.5 to –75 VDC, and has three sets of double-stud terminals (-48/-60 VDC Lines and -48/-60 VDC Returns) for connecting to the VDC inputs.

Each DC PDU should be connected to a different central office DC power source:

- One PDU should be connected to three –48/–60 VDC "A" buses.
- Other PDU should be connected to three –48/–60 VDC "B" buses.

If DC power to a PDU fails, the other PDU provides enough power for the chassis. This 2N power redundancy enables the routing system to operate in spite of single power failure.

For DC power cables, we recommend that you use commensurately rated, high-strand-count copper wire cable, based on local electrical codes. These wires are not available from Cisco Systems; they are available from any commercial vendor. DC power cables must be terminated by cable lugs at the power shelf end.

This table lists the fixed configuration DC power components and PIDs for the Cisco CRS 8-Slot Line Card Chassis.

Table 6: Fixed Configuration DC Power Components

Power Component		
DC PDU	CRS-8-LCC-PDU-DC(=)	Cisco CRS DC power distribution unit(two required for each chassis)
DC PEM	CRS-8-DC-PEM(=)	Cisco CRS DC PEM[1](two required for each chassis, one for each PDU)
Power module filter	CRS-8-PWR-FILTER(=)	Filters (five per pack) for AC rectifier and DC PEM

[1] PEM = Power Entry Module

Fixed Configuration DC Power Distribution Unit

A DC power distribution unit (PDU) contains one DC input terminal block with 6 poles of two row M6 studs mating with industry standard two-hole compression lugs on 5/8-inch centers, one ground blade connector and one output connector mating with the DC PEM. One DC PDU requires three independent nominal -48/-60 VDC, 60 A input services.

One DC PDU requires six 45° angle, industry standard, 2-hole compression lugs with holes on 5/8- inch centers for three pairs (three -48/-60 VDC inputs and three returns) of DC input connections.

This figure illustrates the 8-slot chassis power routing distribution for a fixed DC configuration.

Figure 13: CRS 8-Slot Line Card Chassis Power Distribution - Fixed DC Configuration
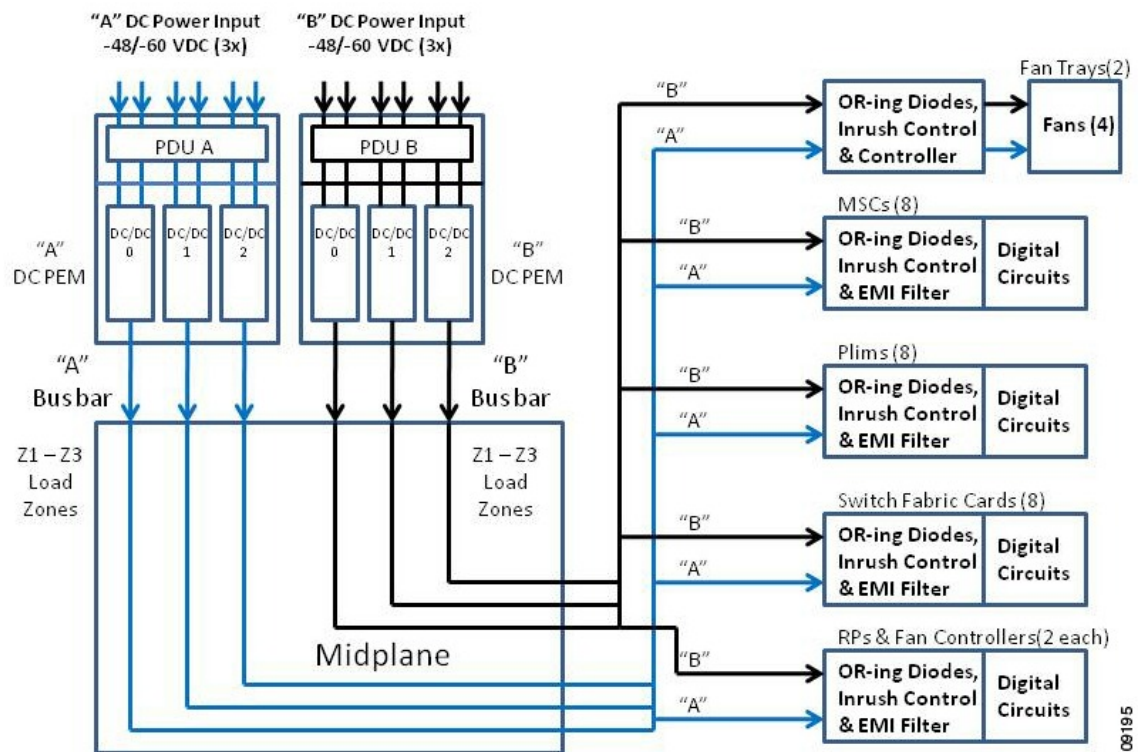
Fixed Configuration DC Power Entry Module

The DC power entry module, shown in **DC PEM—Front View** figure, processes input power from the DC PDU and passes the power to the system chassis. DC PEMs are field-replaceable.

Three -48/-60 VDC inputs enter the DC PEM at the rear of the PEM through a connector on the DC PDU. The PEM performs inrush current limiting, EMI filtering, surge protection, and over voltage protection to process the power before it exits the PEM and is distributed to the chassis midplane.

Each DC PEM has self-contained cooling fans that draw air through the module.

This figure shows the front of the DC PEM. The yellow power switch on the front top left corner can be pushed or pulled to turn the power on or off, respectively.

Figure 14: DC PEM—Front View
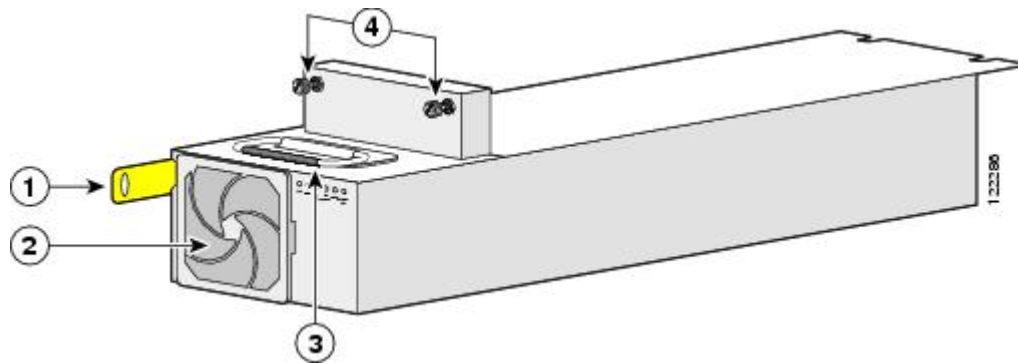
1	Power switch	3	Handle
2	Module air filter	4	Captive screws

A microprocessor in the DC PEM monitors the status of each DC PEM. The microprocessor communicates with the system controller on the route processor (RP) card. The microprocessor circuitry monitors the following DC PEM fault and alarm conditions:

- **Fault**: Indicates a failure in an DC PEM, such as failed bias supply, or over temperature. It includes a warning that the DC output voltage is outside the allowable output range.
- **DC Input Fail**: Indicates that the DC input voltage is out of range.
- **Circuit Breaker Trip**: Indicates that the DC PEM circuit breaker has tripped.
- **Over Temperature**: Indicates that the DC PEM has exceeded the maximum allowable operating temperature.
- **DC PEM Present**: Indicates that the DC PEM is present and seated properly in the system chassis.
- **Voltage and Current Monitor signals (Vmon, Imon)**: Indicates how much output voltage and current are provided by the DC PEM.

Each DC PEM contains an ID EEPROM that stores information used by the control software (for example, part number, serial number, assembly deviation, special configurations, test history, and field traceability data).

Fixed Configuration DC PEM Indicators

Each DC PEM has power and status indicators. The DC PEM indicators receive power from both DC PEMs; therefore, the indicators are operational even when the DC PEM is not powered from its input voltage.

This table lists DC PEM status indicators and their functions.

Table 7: DC PEM Status Indicators

Name	Color	Function
PWR OK	Green	The DC PEM is operating normally with power.
FAULT	Yellow	A fault has been detected in the DC PEM.
DC INPUT FAIL	Yellow	DC input is out of range or is not being provided to the DC PEM.

Name	Color	Function
OT	Yellow	The DC PEM is overheated and it has been shut down.
BREAKER TRIP	Yellow	The input circuit breaker is off (in the off position).

This table lists DC PEM LED readings during failure conditions.

Table 8: DC PEM LED Conditions

Condition	PWR OK LED	Fault LED	DC Input Fail LED	OT LED	Breaker Trip LED
No fault (power is on)	On	Off	Off	Off	Off
Failed DC input power	Off	Off	On	Off	Off
Overheated temperature	Off	On	Off	On	Off
Tripped breaker	Off	Off	Off	Off	On

Fixed Configuration AC Power

An AC-powered Cisco CRS 8-slot line card chassis contains two AC power distribution units (PDUs) and two AC rectifier modules. Each AC PDU is connected to a 3-phase (200 to 240) input VAC power source and connects to a single 7500-watt AC rectifier module that is field replaceable. Each AC rectifier module converts input AC power to the 54.5 VDC used by the chassis. Each rectifier has its own circuit breaker.

To provide 2N power redundancy for the chassis, each PDU and AC rectifier pair is connected to a different AC power source. During normal operation when both power sources are operational, both PDUs and rectifiers function together to power the chassis. However, if a power source fails, the other power source provides the other PDU and rectifier pair with enough input power to power the chassis. This 2N power redundancy enables the routing system to operate despite the power failure.

Two versions of the AC PDU are available to accommodate AC input power in either the Delta or Wye (see Figure 15: Fixed Configuration AC Wye PDU , on page 28 for fixed AC Wye PDU) configuration. Each PDU has a different Cisco part number. The PDUs are shipped with AC power cords that are 14 feet (4.3 m) long.

Unlike the Cisco CRS 16-slot line card chassis, the Cisco CRS 8-slot line card chassis does not contain an alarm module. A microprocessor in the AC rectifier monitors the status of each AC rectifier. The microprocessor communicates with the system controller on the RP card. LEDs on the front panel of the RP card indicate active alarm conditions.

The AC PDUs have the following input VAC power requirements:

- AC Wye input: 3-phase, 200 to 240 VAC nominal (phase-to-neutral), 50 to 60 Hz, 16 A (International) or 20 A (North America). The PDU is rated for 14-amp service, and accepts AC input of 16 or 20 A.

The Wye power cord has a 5-pin IEC 60309 plug that is rated for 400 VAC, 16 or 20 A, (3W + N + PE). The power cord plugs into a similarly rated IEC 60309 receptacle.

- AC Delta input: 3-phase, 200 to 240 VAC nominal (phase-to-phase), 50 to 60 Hz, 30 A. The PDU is rated for 24-amp service, and accepts AC input of 30 A.

The Delta power cord has a 4-pin NEMA L15-30P plug that is rated for 250 VAC, 30 A (3W + PE). The power cord plugs into a similarly rated NEMA L15-30R locking-type receptacle.

Figure 15: Fixed Configuration AC Wye PDU
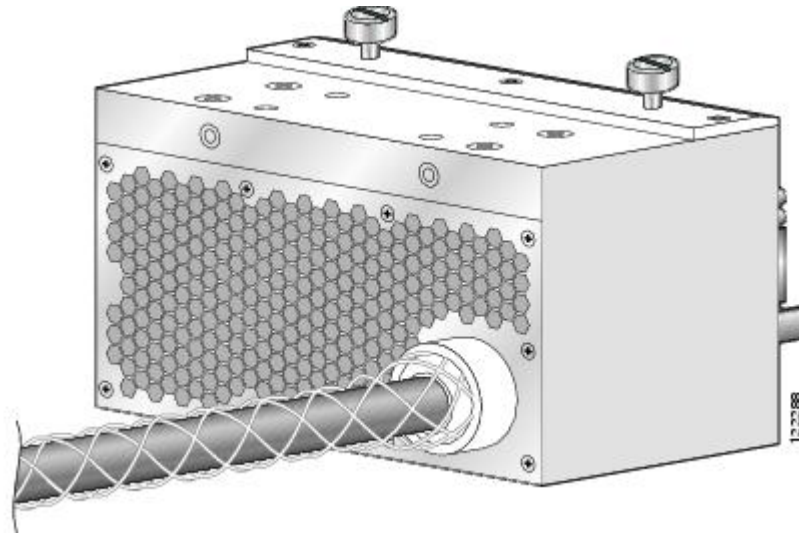
This table lists the AC power components and PIDs for the Cisco CRS 8-Slot Line Card Chassis.

Table 9: Fixed Configuration AC Power Components

AC Delta Power Component		
AC Delta PDU	CRS-8-LCC-PDU-ACD(=)	Cisco CRS AC Delta power distribution unit(two required for each chassis)
AC rectifier module	CRS-8-AC-RECT(=)	Cisco CRS AC rectifier module(two required for each chassis, one for each PDU)
AC WYE Power Component		
AC Wye PDU	CRS-8-LCC-PDU-ACW(=)	Cisco CRS AC Wye power distribution unit(two required for each chassis)
AC rectifier module	CRS-8-AC-RECT(=)	Cisco CRS AC rectifier module(two required for each chassis, one for each PDU)
Power module filter	CRS-8-PWR-FILTER(=)	Filters (five per pack) for AC rectifier and DC PEM

Note   For a complete list of CRS 8-slot chassis power specifications, see Appendix 1, "Technical Specifications."

Fixed Configuration AC Delta Power

The AC Delta PDU contains the AC cable assembly with AC plug, EMI filter, and power distribution connections and wiring.

This figure shows the 8-slot chassis power routing distribution for a fixed AC configuration.

Figure 16: CRS 8-Slot Chassis AC Delta Power Distribution - Fixed Configuration-
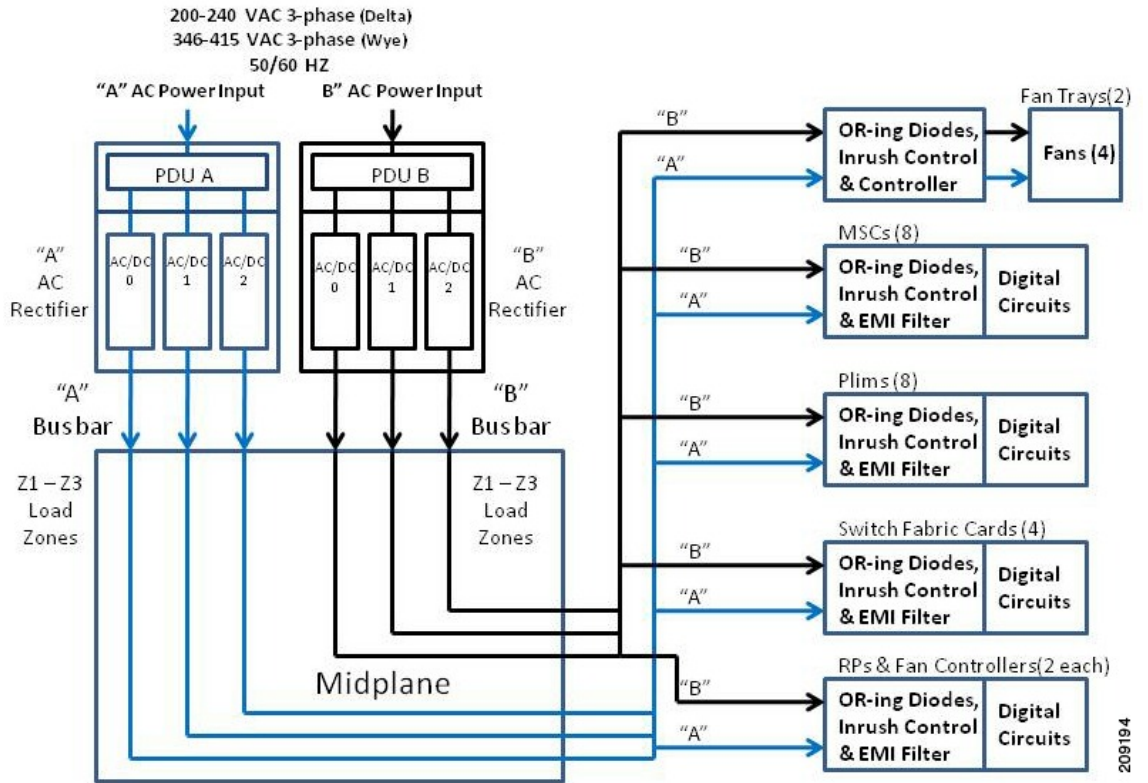
This figure shows wiring for the AC Delta PDU.

Figure 17: AC Delta Power Wiring
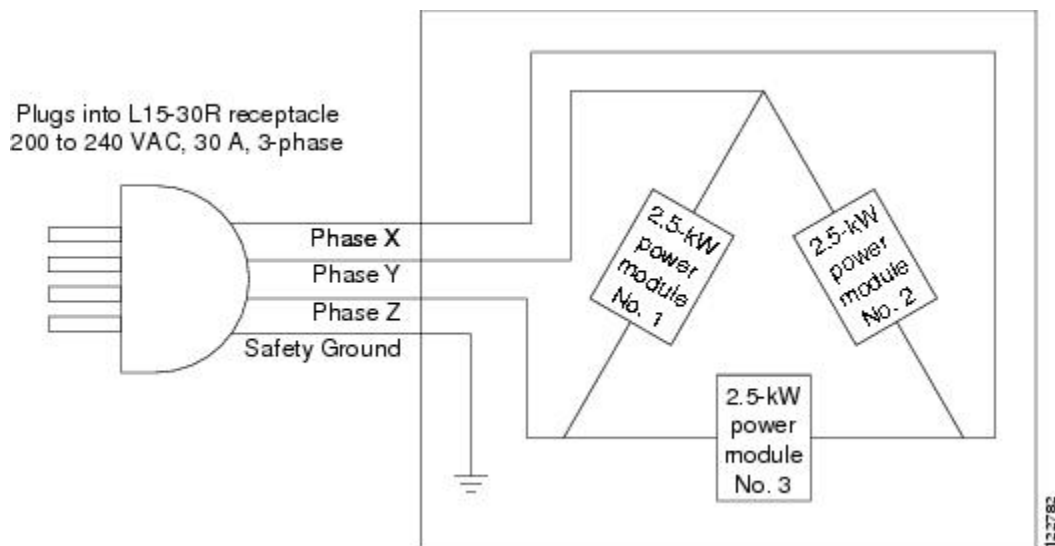
Fixed Configuration AC Wye Power

This figure shows wiring for the AC Wye PDU.

Figure 18: AC Wye Power Wiring

Plugs into IEC 60309 receptacle,
200 to 240 VAC (phase-to-neutral),
20 A (North America) 16 A (International), 3-phase

Phase X
Phase Y
Phase Z
Neutral
Safety Ground

2.5-kW power module No. 1

2.5-kW power module No. 2

2.5-kW power module No. 3
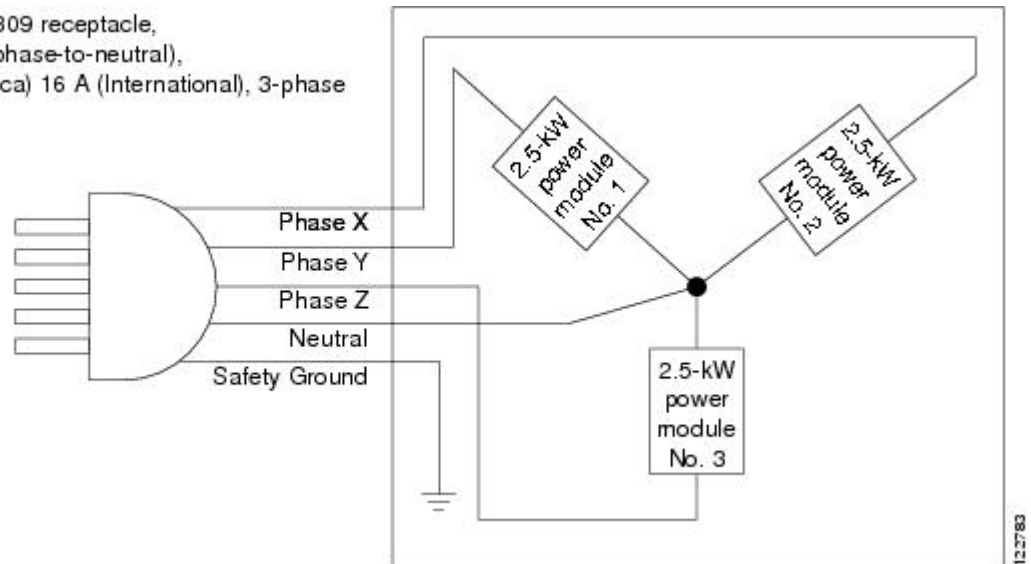
Fixed Configuration AC Rectifier

The AC rectifier is an AC power module that converts input AC power into the DC power necessary to power chassis components.

Note   The same AC rectifier is used with the AC Delta and AC Wye PDUs.

The rectifier takes AC input power from the PDU, rectifies the AC into DC, provides filtering and control circuitry, provides status signaling, and passes the regulated and isolated DC power to the chassis midplane. Each AC rectifier has self-contained cooling fans that draw air through the module.

This figure shows the front of the AC power rectifier. The yellow power switch is on the front top left corner of the rectifier. The switch can be pushed or pulled to turn the power on or off, respectively.

Figure 19: AC Power Rectifier—Front View

| 1 | Power switch | 3 | Handle |
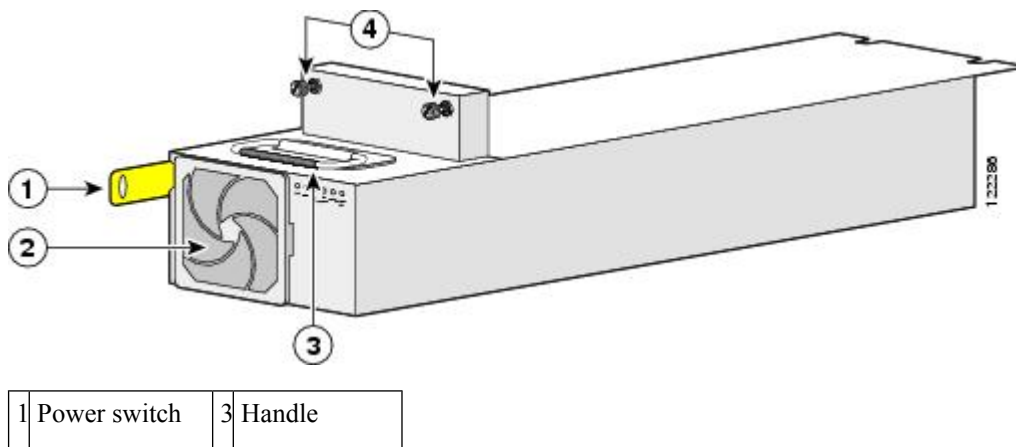
2	Module air filter	4	Captive screws

After the power enters the AC rectifier, internal circuits rectify the AC into DC, filter and regulate it. The conversion from AC to DC is done in two stages:

- The first stage is for power factor correction (PFC). The PFC process converts the AC to regulated primary DC. The PFC maintains the AC input current to be sinusoidal and in-phase with the AC input. The result is near unity power factor.
- The second stage is DC-to-DC conversion. The DC-to-DC process converts regulated primary side DC power to isolated −54.5 VDC secondary power.

A microprocessor in the AC rectifier monitors the status of each AC rectifier. The microprocessor communicates with the system controller on the route processor (RP) card. The microprocessor circuitry monitors the following AC rectifier fault and alarm conditions:

- **Fault**: Indicates a failure in an AC rectifier, such as failed bias supply, over temperature or current limit. It includes a warning that the DC output is out of the allowable output range.
- **AC Input Fail**: Indicates that the AC input voltage is out of range.
- **Circuit Breaker Trip**: Indicates that the AC rectifier circuit breaker has tripped.
- **Over Temperature**: Indicates that the AC rectifier has exceeded the maximum allowable operating temperature.
- **AC Rectifier Present**: Indicates that the rectifier is present and seated properly in the power shelf.
- **Voltage and Current Monitor signals (Vmon, Imon)**: Indicate how much output voltages and currents are provided by the AC rectifier.

Each AC rectifier 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).

Fixed Configuration AC Rectifier Status Indicators

Each AC rectifier has power and status indicators. The AC rectifier status indicators receive power from both AC power rectifiers; therefore, the status indicators are operational even when the AC rectifier is not powered from its input voltage.

Table 10: AC Rectifier Status Indicators, on page 31 lists the AC rectifier status indicators and their functions.

Table 10: AC Rectifier Status Indicators

Name	Color	Function
PWR OK	Green	The AC rectifier is operating normally with power.
FAULT	Yellow	A fault has been detected in the AC rectifier.
AC INPUT FAIL	Yellow	AC input is out of range or is not being provided to the AC rectifier.
OT	Yellow	The AC rectifier is overheated and it has been shut down.
BREAKER TRIP	Yellow	The input circuit breaker is off (in the off position).
ILIM	Yellow	The AC rectifier is operating in a current limiting condition.

Table 11: AC Rectifier LED Conditions

Condition	PWR OK LED	Fault LED	AC Input Fail LED	OT LED	Breaker Trip LED	ILIM LED
No fault (power is on)	On	Off	Off	Off	Off	Off
Failed AC input power	Off	Off	On	Off	Off	Off
Overheated temperature	Off	On	Off	On	Off	Off
Tripped breaker	Off	Off	Off	Off	On	Off
Current limit	Off	On	Off	Off	Off	On

Modular Configuration Power System

This section describes the modular configuration power system and contains the following topics:

Modular Power Configuration Overview

This section describes the CRS 8-slot chassis modular configuration power system. The modular configuration power solution is configurable. It includes the following components:

- Two (redundant) AC or DC power shelves
- Up to three AC power modules or four DC power modules per power shelf
- Each DC power module provides 2100 Watts, with potential growth up to 8.4KW DC power per power shelf
- Each AC power module provides 3000 Watts, with potential growth up to 9KW DC power per power shelf

Note   The default modular configuration power system may not ship with the maximum number of power modules configured. Additional power modules can be added at any time, depending on the system's power requirements.

The figures show an AC modular power module for the Cisco CRS 8-slot chassis.

Figure 20: Modular Configuration AC Power Shelf —Front View
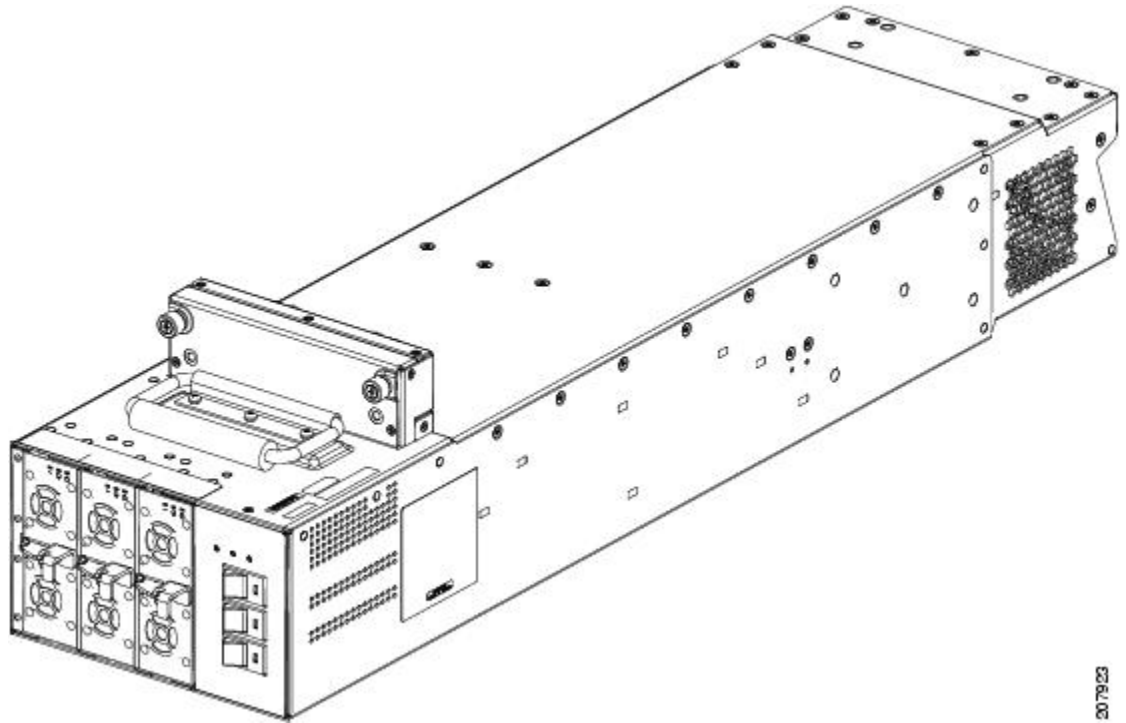
Figure 21: Modular Configuration AC Power Shelf—Rear View
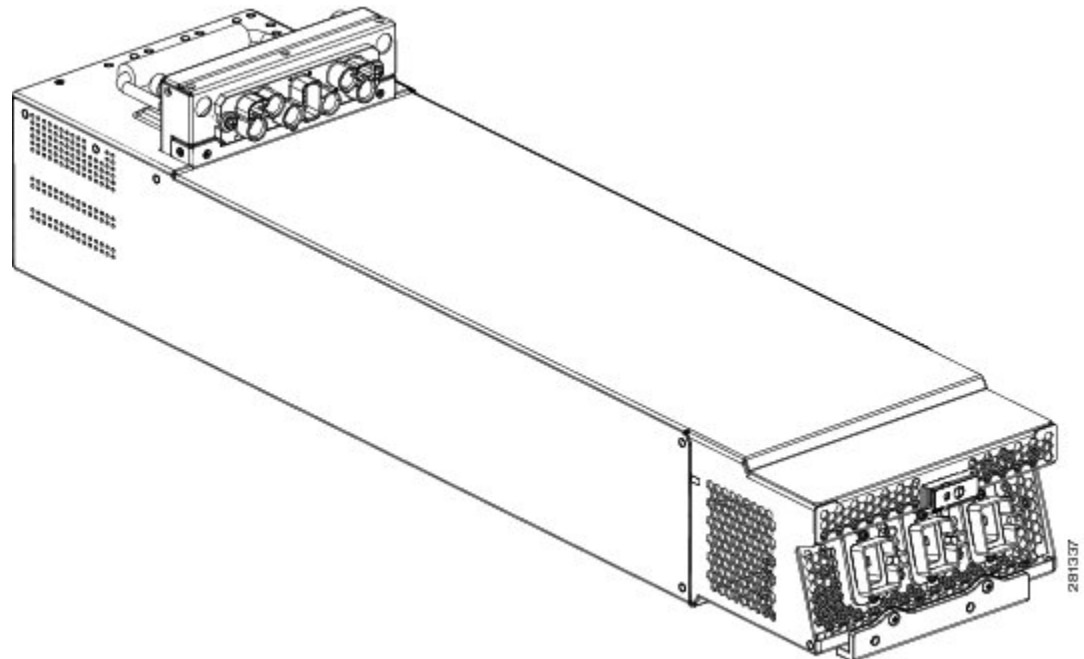
The figures show a front and rear view of a DC modular power shelf for the Cisco CRS 8-slot chassis.

Figure 22: Modular Configuration DC Power Shelf —Front View
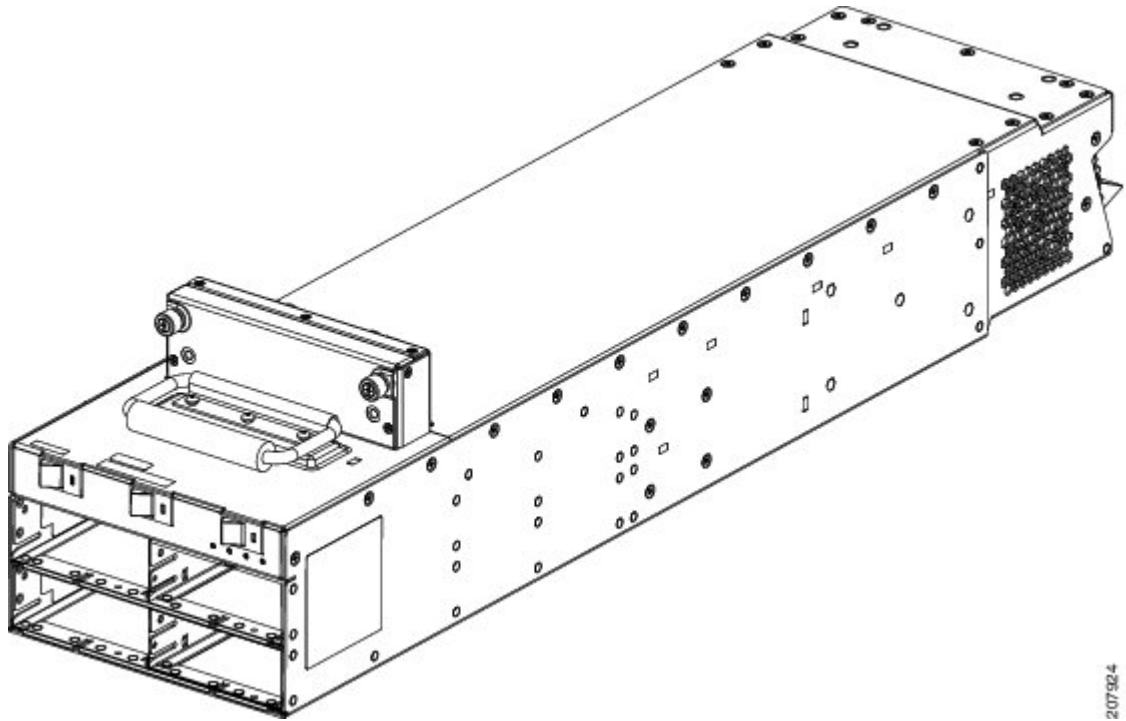
Figure 23: Modular Configuration DC Power Shelf —Rear View
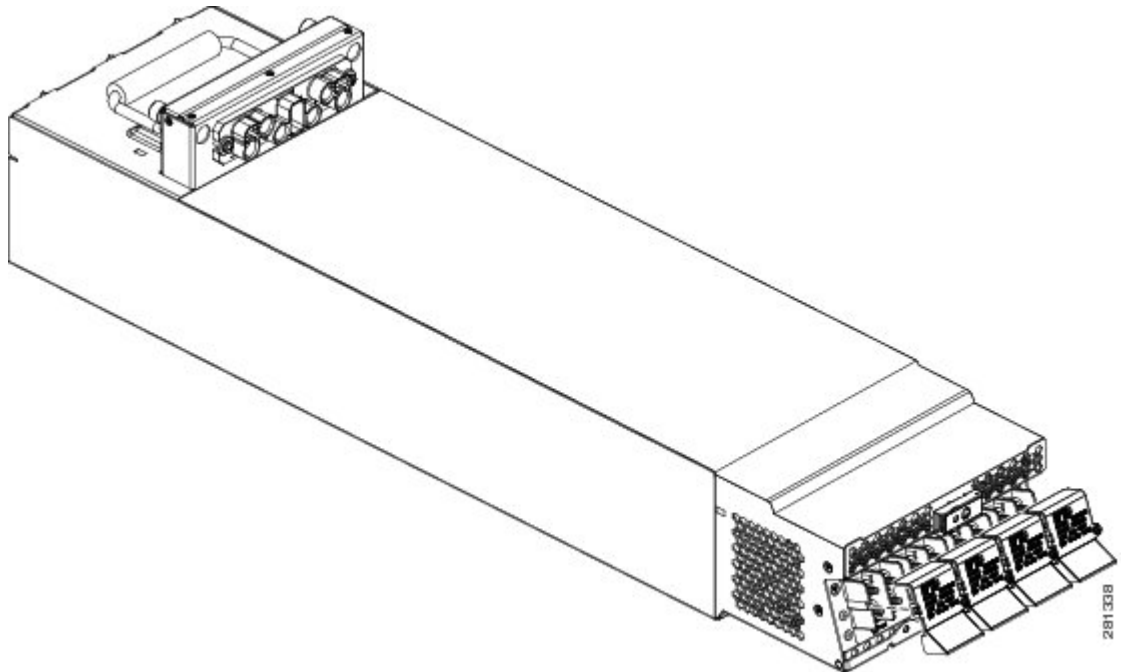
Modular Configuration Power Architecture

In the modular configuration power system, each power shelf accepts up to four PMs. The power shelves and PMs are field replaceable. The power shelves contain the input power connectors.

Note Depending on the hardware deployed at your site, your system may not consume the maximum power supplied by the power system.

The modular configuration power module provides the following features:

- AC or DC power shelf redundancy
- PM load-share redundancy
- Elimination of power zone restriction, while maintaining zone protection
- Capacity for future growth

The modular AC and DC power systems use A and B power shelves to provide reliable, 2N redundant power to all chassis components.

All power modules in the modular power shelf power all zones. In addition, the modular power supplies work in parallel with each other, and they can monitor power consumption, performance, analysis, and power management concurrently.

Unlike the Cisco CRS 16-slot line card chassis, the power shelf on the Cisco CRS 8-slot line card chassis does not contain an alarm module. Instead, alarm functionality is integrated into the Route Processor (RP). The DC power module monitors power module status and processes alarm functions. The AC or DC power module distributes power and passes power module status signals to the system. Each power module has its own integrated fuse to protect the system, and each power module is plugged into its own power outlet.

The Cisco CRS 8-Slot Line Card Chassis requires 8.0 kW of DC input power and 8.75 kW of AC input power from the building supply.

Modular Configuration DC Power

The Cisco CRS 8-slot line card chassis modular configuration DC power system can provide up to 8,400 W to power the line card chassis. The modular configuration DC power system uses A and B power shelves to provide reliable, 2N redundant power to all chassis components.

Note Depending on the hardware deployed at your site, your system may not consume the maximum power supplied by the power system.

If DC power to one modular configuration power shelf fails, the other power shelf provides enough power for the chassis. This 2N power redundancy enables the routing system to operate in spite of single power failure.

This table summarizes the DC power system specifications for the Cisco CRS 8-Slot Line Card Chassis.

Table 12: DC Power System Specifications

DC Power Component	Specifications
Power Shelf	Two DC power shelves DC Power Shelf: Supports up to four DC power modules
Power Redundancy	Two DC Power Shelves each containing up to four DC power modules—2N redundancy
DC Input	Required input current is as follows: • 50 amps at –48 VDC nominal input voltage. • 40 amps at –60 VDC nominal input voltage • 60 amps at low input voltage (–40 VDC) Required lugs: 45° angled industry standard 2-hole compression lugs with holes on 5/8- inch centers (for example, for AWG no. 2 wire: Panduit part number LCC2-14AH-Q or equivalent).
Ground Lug	Industry standard 2-hole compression lug with holes on 5/8- inch centers (Panduit part number LCD6-14A-L, or equivalent)

This figure shows the 8-slot chassis power routing distribution for a modular DC configuration.

Figure 24: CRS 8-Slot Chassis Power Distribution- Modular DC Configuration
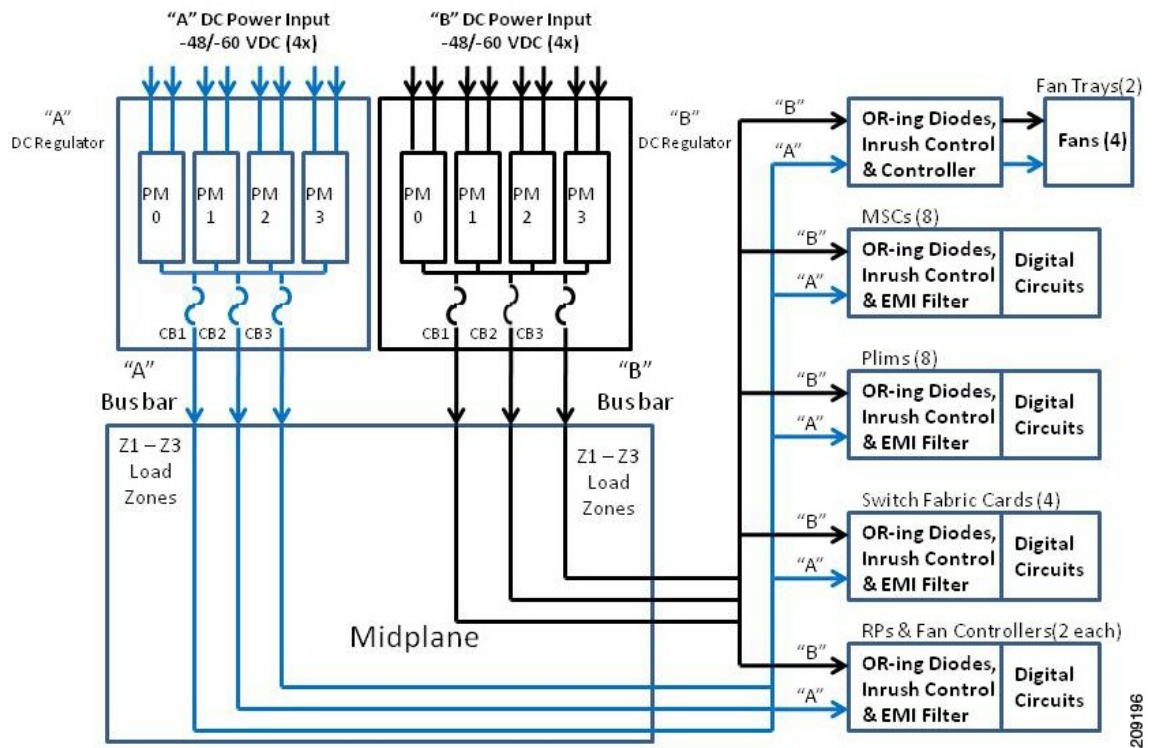
Modular Configuration DC Power Shelf

The DC modular configuration power shelf is the enclosure that houses the DC power modules and power distribution connections and wiring. The power shelf installs in the Cisco CRS 8-slot line card chassis from the front and plugs into the chassis power interface connector panel.

Each modular configuration DC power shelf requires up to four DC input feeds of either –48 VDC (nominal), 50 A or –60 VDC (nominal), 40 A. The power shelf accepts input DC power in the range –40 to –72 VDC. Each terminal consists of two M6 threaded studs, 0.6 inches long, and centered 0.625 inches apart. The terminals have a safety cover.

Each DC power shelf supports up to four power modules, and accepts one 60 A battery feed per power module. Input DC power enters the power shelf and is processed by the power modules before being distributed to the chassis midplane. The power modules 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.

Modular Configuration DC Power Module

Each DC power module provides 2100 Watts. The DC power module, shown in this figure passes the power via the internal bus bar to the system and is similar to the AC power module. Power modules are field-replaceable.

Figure 25: Modular Configuration DC Power Module .
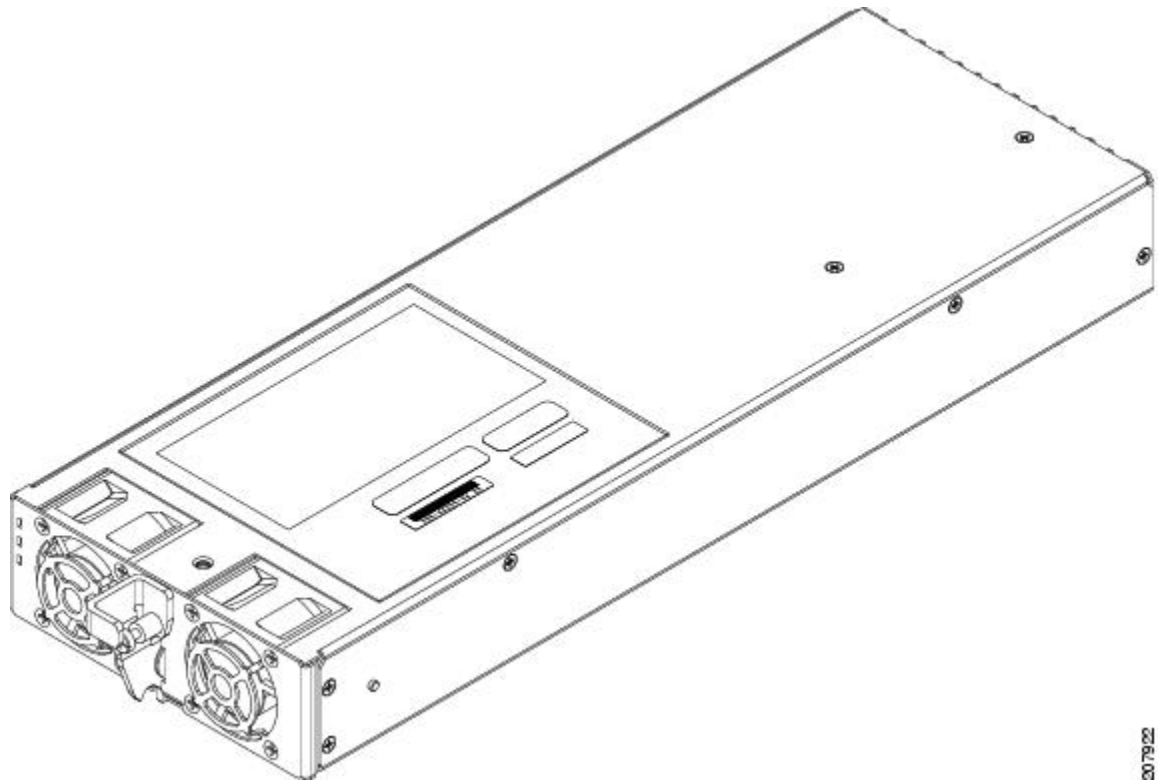
Two –48/–60 VDC inputs enter the power module at the rear of the power shelf, and exits the power module and is distributed to the chassis midplane.

Unlike the Cisco CRS 16-slot line card chassis, the power shelf on the Cisco CRS 8-slot line card chassis does not contain an alarm module. The DC power module monitors power module status and processes alarm functions. A microprocessor in the DC power module monitors the status of each DC power module. The microprocessor communicates with the system controller on the route processor (RP) card. The microprocessor circuitry monitors the following DC power module fault and alarm conditions:

- **Fault**: Indicates a failure in an DC power module, such as failed bias supply, or over temperature. It includes a warning that the DC output voltage is outside the allowable output range.
- **DC Input Fail**: Indicates that the DC input voltage is out of range.
- **Over Temperature**: Indicates that the DC power module has exceeded the maximum allowable operating temperature.
- **DC Power Module Present**: Indicates that the power module is present and seated properly in the system chassis.
- **Voltage and Current Monitor signals (Vmon, Imon)**: Indicates how much output voltage and current are provided by the DC power module.

Each DC power module contains an ID EEPROM that stores information used by the control software (for example, part number, serial number, assembly deviation, special configurations, test history, and field traceability data).

Modular Configuration DC Power Module Indicators

Each DC power module has power and status indicators. The DC power module indicators receive power from both DC power modules; therefore, the indicators are operational even when the DC power module is not powered from its input voltage. The following three LED status indicators are located on the front of each DC power module:

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

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

Table 13: Power Module Status Indicators, on page 38 lists the power module status indicators and their functions.

Table 13: Power Module Status Indicators

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

Name	Color	Function
Internal Fault	Red	Internal Fault LED turns on continuously when there is an internal fault in the power module.

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

- 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 module is operating normally, the Internal Fault LED is turned off.

Modular Configuration AC Power

The Cisco CRS 8-slot line card chassis modular configuration AC power system can provide up to 9,000 W to power the line card chassis.

Note Depending on the hardware deployed at your site, your system may not consume the maximum power supplied by the power system.

The modular configuration power system provides the following features:

- AC power shelf redundancy
- PM load-share redundancy
- Elimination of power zone distribution, while maintaining zone protection
- Capacity for future growth

The modular configuration AC power systems use A and B power shelves to provide reliable, 2N redundant power to all chassis components.

The Cisco CRS 8-slot line card chassis does not contain an alarm module. The AC PM monitors PM status and processes alarm functions. The AC PM distributes power and passes PM status signals to the system. Each PM has its own integrated fuse to protect the system, and each PM is plugged into its own power outlet. Alarms are processed through the RP. LEDs on the front panel of the RP indicate active alarm conditions.

Unlike the fixed configuration AC power system, which requires 3-phase AC Delta or AC Wye input power, the modular configuration AC power system requires single-phase AC input power. If you have 3-phase AC

Delta or AC Wye at your equipment, a *Cisco CRS PDU* will be required to convert 3-phase AC input power to single-phase AC input power for the power shelf .

This figure shows the power routing distribution of the 8-slot chassis with a modular AC configuration power system.

Figure 26: CRS 8-Slot Chassis Power Module - Modular AC Configuration
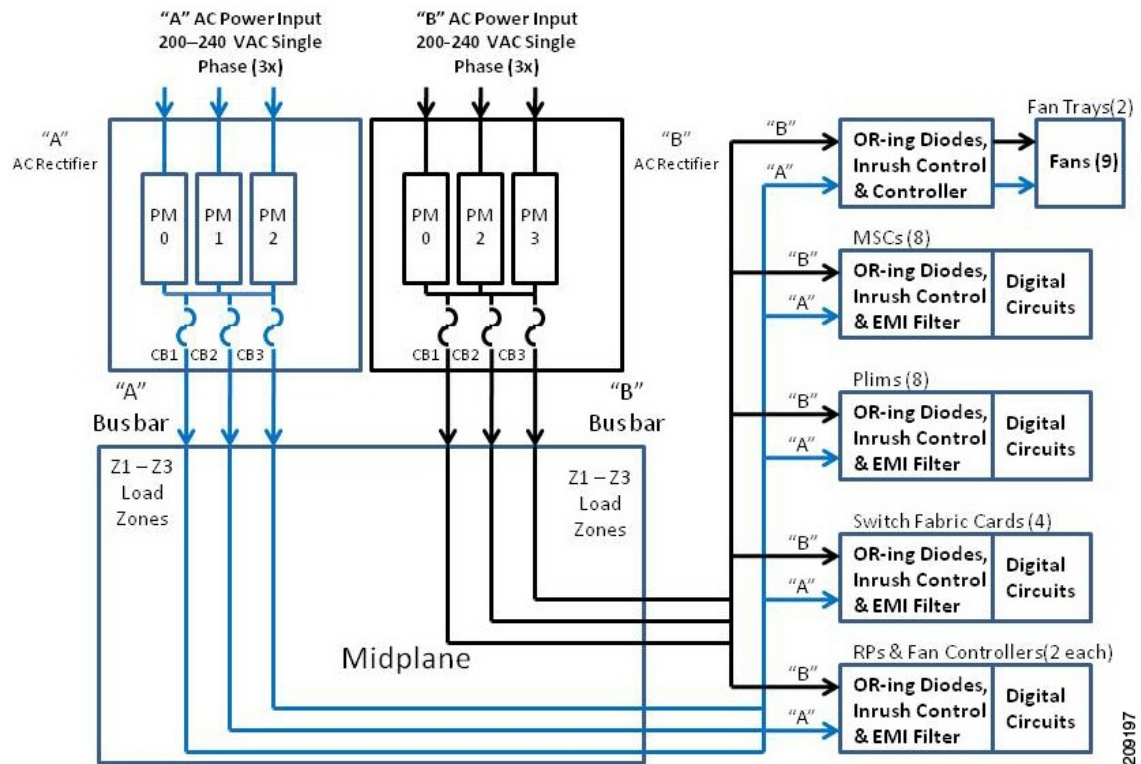
As shown in the figure, AC input power enters the chassis through the A and B power supplies and is distributed to the A or B power bus. Both buses distribute power through the midplane to the MSC, PLIM, switch fabric, and RP card slots.

Each DC power module provides 2 voltages:

   • Output voltage 1 is –54 VDC
   • Output voltage 2 is +5Vaux

Because chassis components are powered by both A and B power inputs, the line card chassis can continue to operate normally if:

   • One AC or DC power module fails
   • One input power (A or B) fails
   • One internal bus bar fails
   • One entire power shelf fails
   • Power modules are added to, or removed from the power shelf

Because no exact redundancy exists across the power modules, individual power modules can be removed without causing the chassis to lose power.

Individual chassis components have power-related devices, such as OR-ing diodes, inrush control circuits, and EMI filters. Because any power modules can power all chassis components, these devices can be inserted or removed (OIR) while the chassis is online. This component insertion and removal is also called *hot-swapping*
.

The modular configuration AC power shelf has the following input VAC power requirements:

- Single-phase, 200 to 240 VAC nominal, 50 to 60 Hz, 16 A
- Each power shelf contains three IEC-320-C22 receptacles which can accept up to three IEC-320-C21 connector female plugs, depending on how many AC PMs are installed in the shelf.

Note In order to maintain a balanced 3-phase power load, three AC PMs are required to be installed in a Cisco CRS 8-slot line card chassis AC modular configuration power shelf.

Modular Configuration AC Power Shelf

The AC power shelf is the enclosure that houses the AC power modules and power distribution connections and wiring. The AC power shelf, shown in this figure, is installed in the Cisco CRS 8-slot line card chassis from the front and plugs into the chassis power interface connector panel.

Figure 27: Modular Configuration AC Power Shelf
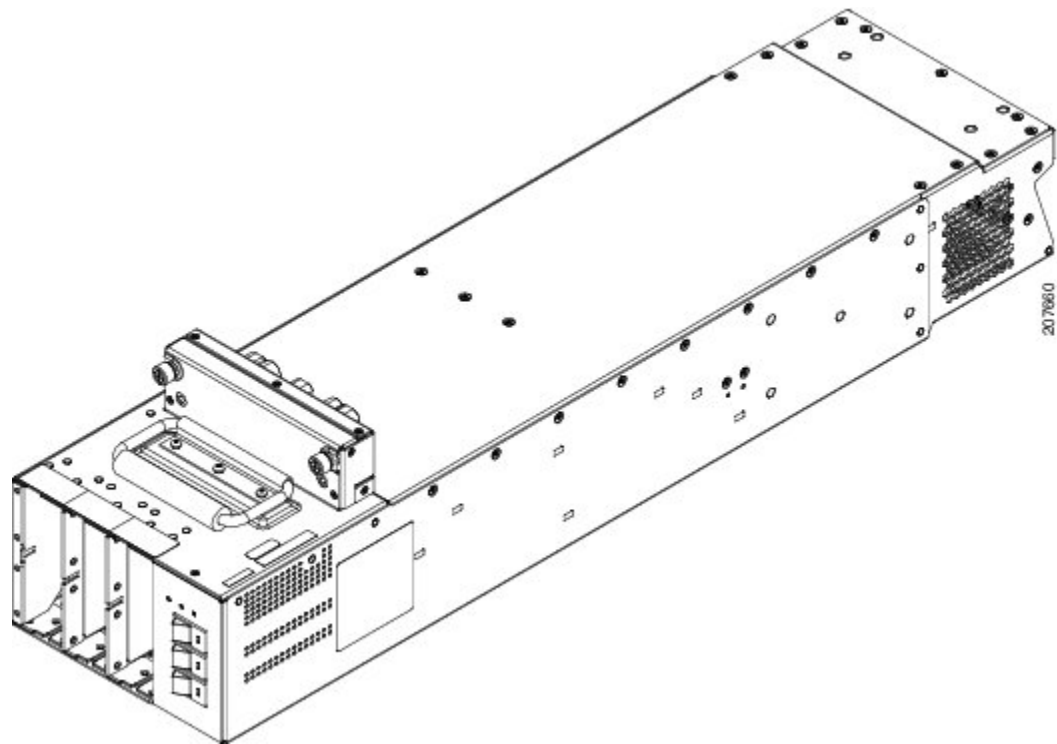
Note The power cables for the power shelves do not come pre-attached.

Modular Configuration AC Power Module

The AC power module is an AC power module that converts single phase input AC power into the DC power necessary to power chassis components.

The AC power module (see in this figure) 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.

Figure 28: Modular Configuration AC Power Module
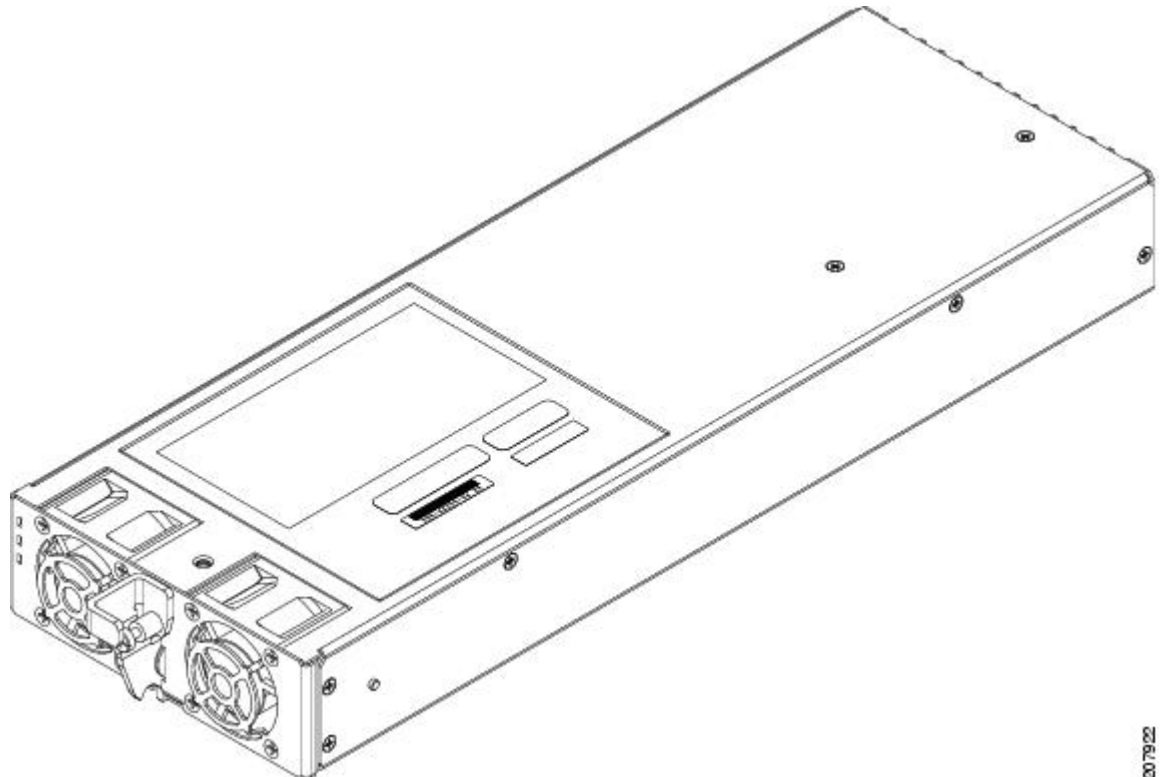
Each power module has its own power connector to connect input AC power. The input AC power for each power module is as follows:

- Each AC power module has a single-phase, 3-wire connection:Input: 200 to 240 VAC, 50 to 60 Hz, 16A. Tolerance: +/-10%(180 to 264) VAC, 50 to 60 Hz, 16A.
- A 3-pin IEC-320 C21 90 degree female plug is inserted into a 3-pin IEC-320 C22 male plug at the rear of each power module.

The AC power enters the AC power at the rear of the power shelf. Once the power enters the AC power module, internal circuits rectify the AC into DC, filter and regulate it. Each AC power module provides two output voltages, as follows:

- Output Voltage 1 is -54VDC at 55.5A
- Output Voltage 2 is +5V at 0.75A

Each AC power module 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).

Each AC power shelf supports up to three AC power modules. The AC power modules convert AC power into DC power, provide filtering, and then distribute the DC power to the chassis midplane. The power shelf also has a service processor module that monitors the condition of each AC power module and provides status signals that indicate the health of the power supplies.

Modular Configuration AC Power Module Indicators

The following three LED status indicators are located on the front of each AC power module:

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

This table lists the power module status indicators and their functions.

Table 14: AC Power Module Status Indicators

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

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

- 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 module is operating normally, the Internal Fault LED is turned off.

3-Phase AC Power Distribution Unit

This section describes the Cisco CRS Power Distribution Unit (PDU). The PDU converts 3-phase AC input power to single-phase AC output power that connects directly to the rear of the modular configuration AC power shelf.

> **Note**   The PDU referred to in this document is different from the fixed configuration PDU.

The AC PDU includes either an AC Delta or AC Wye power interface, and has power input and power output cords entering and exiting the box. The PDU can be installed in a 19-inch rack or other locations, depending on the PDU type, by using chassis mounting brackets. In this section, single PDU refers to the individual PDU that converts 3-phase AC input power to single-phase AC output power.

A PDU kit refers to all the components that are required to be installed in a redundant CRS system. A PDU kit contains 2 single PDUs and any necessary mounting brackets or hardware. When ordering a Cisco CRS system, a PDU kit Product ID should be ordered.

Cisco Product ID numbers for PDU kits are as follows:

- CRS-8-PDU-Delta—Redundant 3-phase to single-phase Delta PDU for Cisco CRS 8-slot line card chassis, 2 input/6 output
- CRS-8-PDU-Wye—Redundant 3-phase to single-phase Wye PDU for Cisco CRS 8-slot line card chassis, 2 input/6 output

This figure shows the Power Distribution Unit 8D ((Cisco product number PDU-321-3-Delta)) that converts 3-phase AC Delta input power to single phase output power.

Figure 29: Cisco CRS-8-PDU-Delta
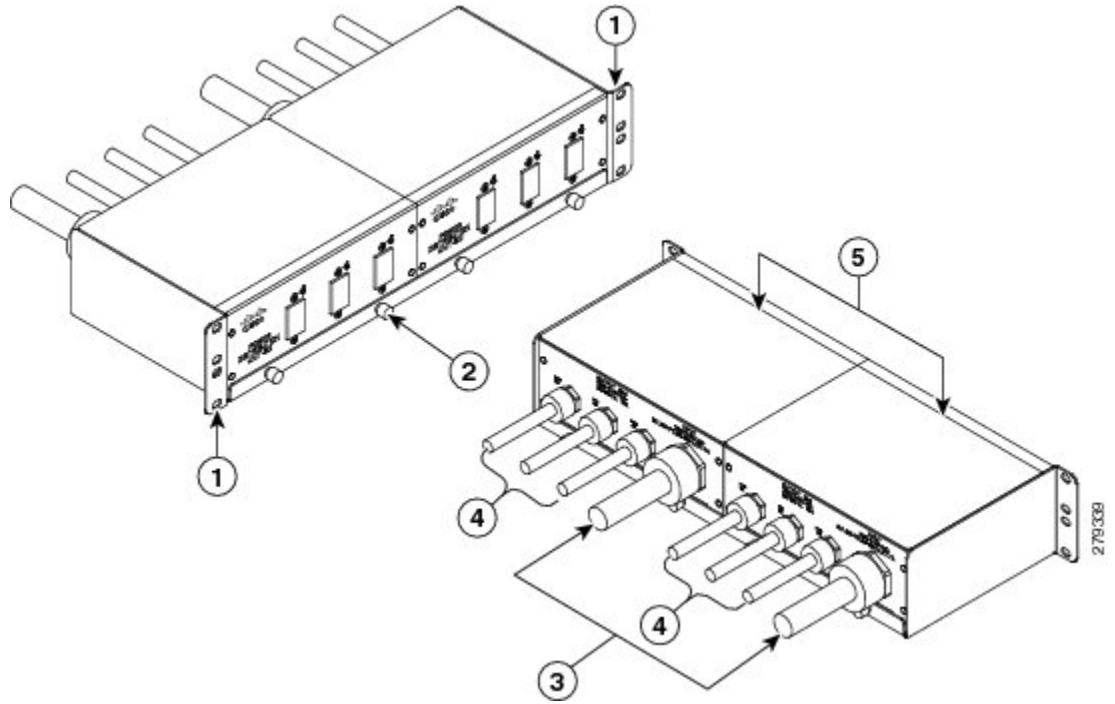
1	Rack mounting ears	2	Rack Tray
3	Input Cord	4	Output Cords

This figure shows the Power Distribution Unit 8W (Cisco product number PDU-321-3-Wye) that converts 3-phase AC Wye input power to single phase output power.

Figure 30: Cisco CRS-8-PDU-Wye
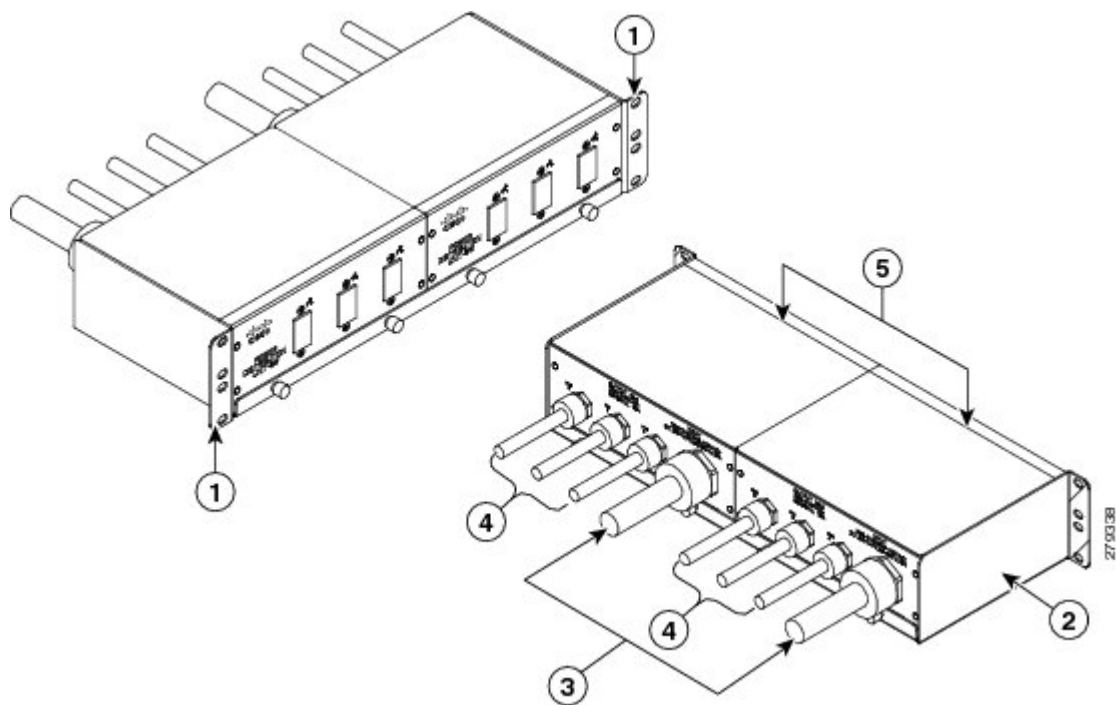
1	Rack mounting ears	2	Rack Tray
3	Input Cord	4	Output Cords

The PDU for the CRS 8-slot line card chassis is shipped with the following hardware for specific configurations:

- Two single AC Delta PDUs with 19 inch rack tray. Each AC Delta PDU has one power input and three outputs.
- Two single AC Wye PDUs with 19 inch rack tray. Each AC Wye PDU has one power input and three outputs.

For PDU specifications, see the Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide .

Cooling System

This chapter describes the components that make up the cooling system of the Cisco CRS 8-Slot Line Card Chassis. It contains the following topics:

Cooling System Overview

The line card chassis cooling system dissipates the heat generated by the routing system and controls the temperature of components in the chassis. The cooling system has a fully redundant architecture that allows the routing system to continue operating with a single-fault failure (such as a single fan or fan tray failure). See Cooling System Redundancy, on page 50 for more information. The architecture also supports a redundant load-sharing design.

The complete chassis cooling system includes:

- Two fan trays; each fan tray contains four fans.
- Temperature sensors (on cards and modules throughout the chassis).
- Control software and logic.
- An air filter, inlet and outlet air vents, and bezels.
- Blanks and impedance carriers for empty chassis slots.
- Fixed configuration rectifiers and PEMs have own fans.
- Modular configuration AC and DC PMs have their own fans.

All four fans in a fan tray operate as a group. So if it is necessary to increase or decrease airflow, all fans in the tray increase or decrease their rotation speed together. When two fan trays are operational in a chassis, the speed of fans in both trays is adjusted together.

Thermal sensors (inlet, exhaust, and hot-spot) located throughout the line card chassis are used to monitor temperature readings and identify when the system is not cooling properly.

Software running on several types of service processor (SP) modules is used to control the operation of the fans. These SP modules are connected by internal Ethernet to the system controller on the route processor (RP).

Line Card Chassis Airflow

The airflow through the line card chassis is controlled by a push-pull configuration. The bottom fan tray pulls in ambient air from the bottom front of the chassis and the top fan pulls the air up through the card cages where the warm air is exhausted out the bottom rear of the chassis.

Figure 31: Airflow Through Line Card Chassis
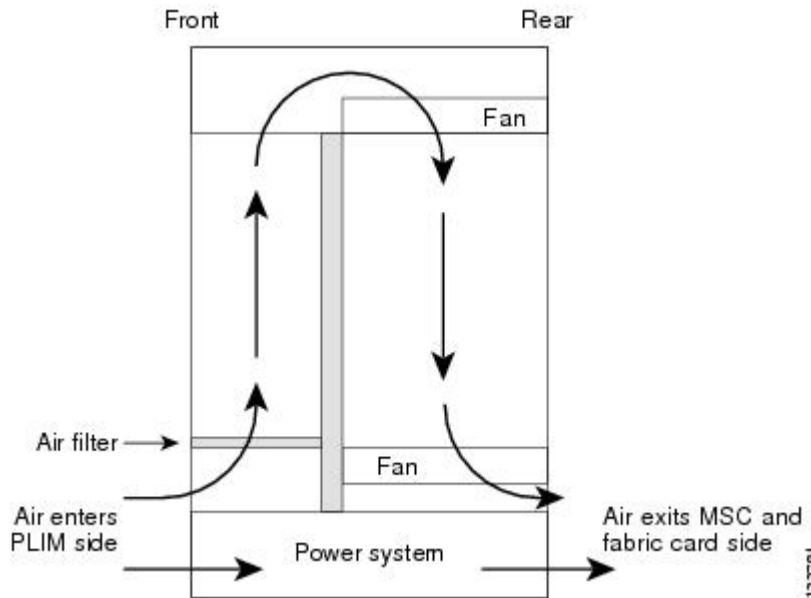
The line card chassis airflow volumes are as follows:

- Chassis airflow: Up to 900 cubic feet (25,485 liters) per minute
- Power system airflow: Up to 240 cubic feet (6,800 liters) per minute

The chassis has a replaceable air filter mounted in a slide-out tray above the lower fan tray. The line card chassis air filter, shown in the next image , plugs into the rear (MSC) side of the chassis.

Change the air filter as often as necessary. In a dirty environment, or when you start getting frequent temperature alarms, check the intake grilles 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. Then, when you remove the dirty filter, install the spare filter in the chassis.

Note We recommend that you check the air filters once a month. Replace a filter when you notice a significant amount of dust.

Figure 32: Air Filter
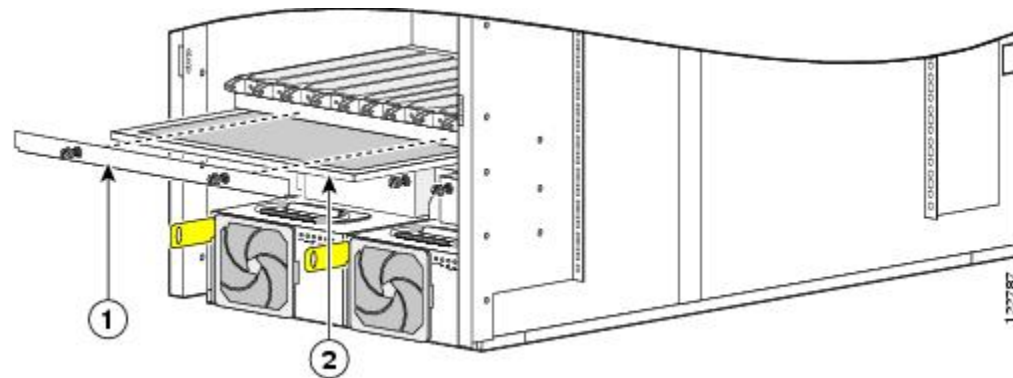
1	Air filter cover plate	2	Chassis air filter

![Note icon]

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 monitoring increases or decreases the airflow needed to keep the routing system 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, the routing system control software powers on the fans to 4,300 to 4,500 RPM. This provides airflow during system initialization and software boot, and ensures that there is adequate cooling for the system in case the software hangs during boot. The fan control software initializes after the routing system software boots, which can take three to five minutes. The fan control software then adjusts the fan speeds appropriately.

During normal operation, the system averages the temperatures reported by inlet temperature sensors in the card cage. 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 icon]

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

Thermal Alarms

Local thermal sensors (on individual cards) monitor temperatures and generate a thermal alarm when the 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. 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 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 downs the power to the failed part, allowing ample time for capacitors to discharge.

Cooling System Redundancy

The redundant architecture of the cooling system allows the cooling system to continue operating even when certain components have failed. The cooling system can withstand the failure of any one of the following components and still continue to properly cool the routing system:

- A fan tray
- DC PEM or AC rectifier
- A fan cable (internal to the chassis and not field replaceable)

A double-fault fan failure involves two fan trays, two power modules (DC PEMs or AC rectifiers), or any combination of two of these units. If a double-fault failure occurs, the system remains powered on, unless both fan trays have failed or thermal alarms indicate a problem serious enough to power down the system. The failure of multiple fans is not considered a double-fault failure because multiple fans can fail without impacting system cooling.

⚠️

Caution   When a cooling system component fails, it should be replaced as soon as possible.

Line Card Chassis Fan Tray

This image shows a fan tray for the 8-slot chassis, which plugs into the rear (MSC) side of the chassis.

Figure 33: Fan Tray for 8-Slot Chassis
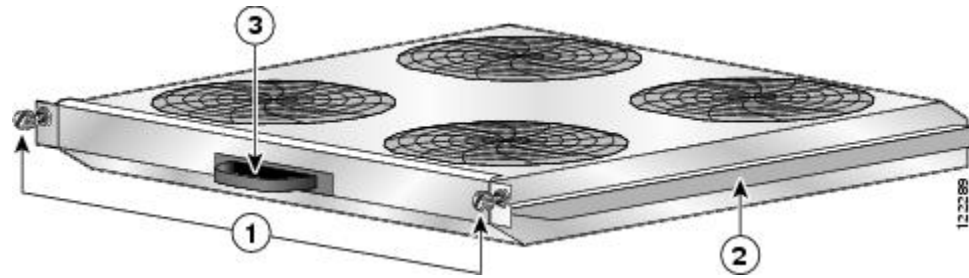
The system can operate with one or two fan trays. Each fan tray is hot-swappable and is considered a field-replaceable unit.

1	Captive screws	2	Fan tray rail
3	Fan tray handle		

Each fan tray contains:

- Four 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. The fans operate:

  - 3700 up to 6500 RPM for normal range
  - 7500 RPM for single fan tray failure

Note The fan speed range limits listed in this document are nominal, with a tolerance of plus or minus ten percent.

Two DC-to-DC converters 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 (there is no input power).

CHAPTER **4**

Switch Fabric

This chapter describes the Cisco CRS-1 Carrier Routing System switch fabric. It includes the following topics:

Switch Fabric Overview

The switch fabric is the core of the Cisco CRS routing system. The switch fabric is implemented through switch fabric cards 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) and performs the switching necessary to route the data to the appropriate egress MSC.

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.) And unlike the CRS 16-slot, the CRS 8-slot has only 4 physical switch fabric cards.

There are four types of switch fabric cards used in the line card chassis: CRS-8-FC/S, CRS-8-FC140/S, CRS-8-FC400/S (200G mode) and CRS-8-FC400/M (200G mode). Each fabric card implements all three stages of the switch fabric.

This figure shows the basic path of IP data packets through the Cisco CRS routing system switch fabric. Note that the figure shows a single-shelf system, in which all three stages of the switch fabric are provided by switch fabric cards in the line card chassis. In a multishelf system, Stage 2 of the switch fabric is provided by S2 fabric cards in the fabric card chassis.

Figure 34: Basic Cisco CRS Carrier Routing System Switch Fabric
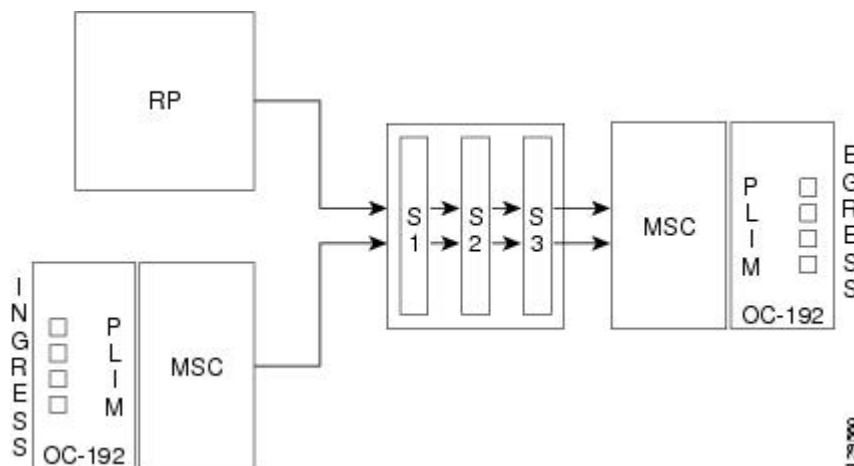
Ingress data packets are received at a physical interface on a PLIM and transferred to the associated MSC, where the packets are segmented into cells for efficient switching by the switch fabric hardware. Each MSC has multiple connections to each switch fabric plane, which it uses to distribute cells 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 switch fabric card 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.

Speed-up 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.

A line card chassis can contain up to 8 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 Card Description

Depending on the card, the fabric card can be used in a CRS single-chassis system or a CRS back-to-back system. This figure shows the single-chassis fabric card (CRS-8-FC400/S).

Figure 35: CRS-8-FC400/S Switch Fabric Card
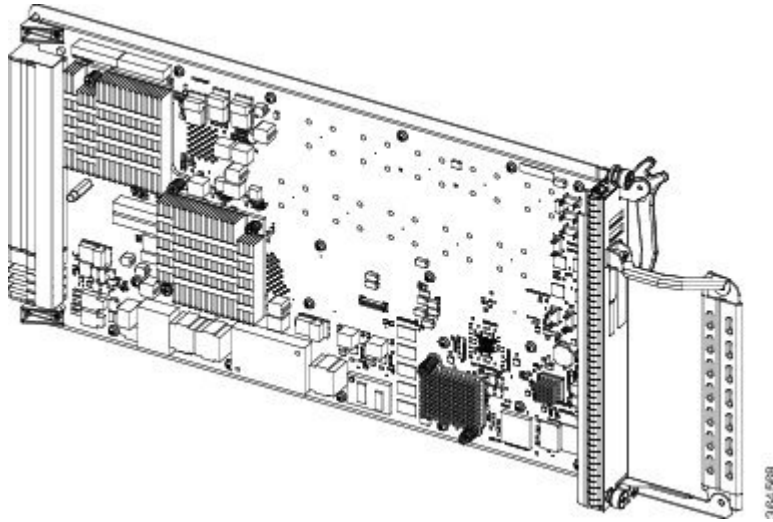
This figure shows the back-back fabric card (CRS-8-FC400/M).

Figure 36: CRS-8-FC400/M Back-to-Back Switch Fabric Card
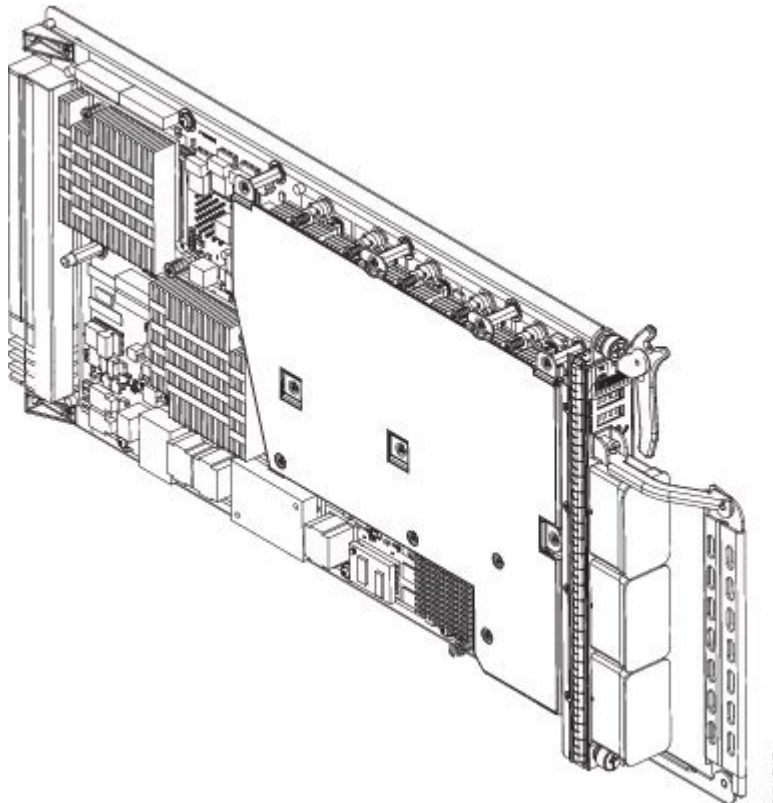
This is a block diagram of the switch fabric card.

Figure 37: Block Diagram of the Cisco CRS 8-Slot Line Card Chassis Switch Fabric Card
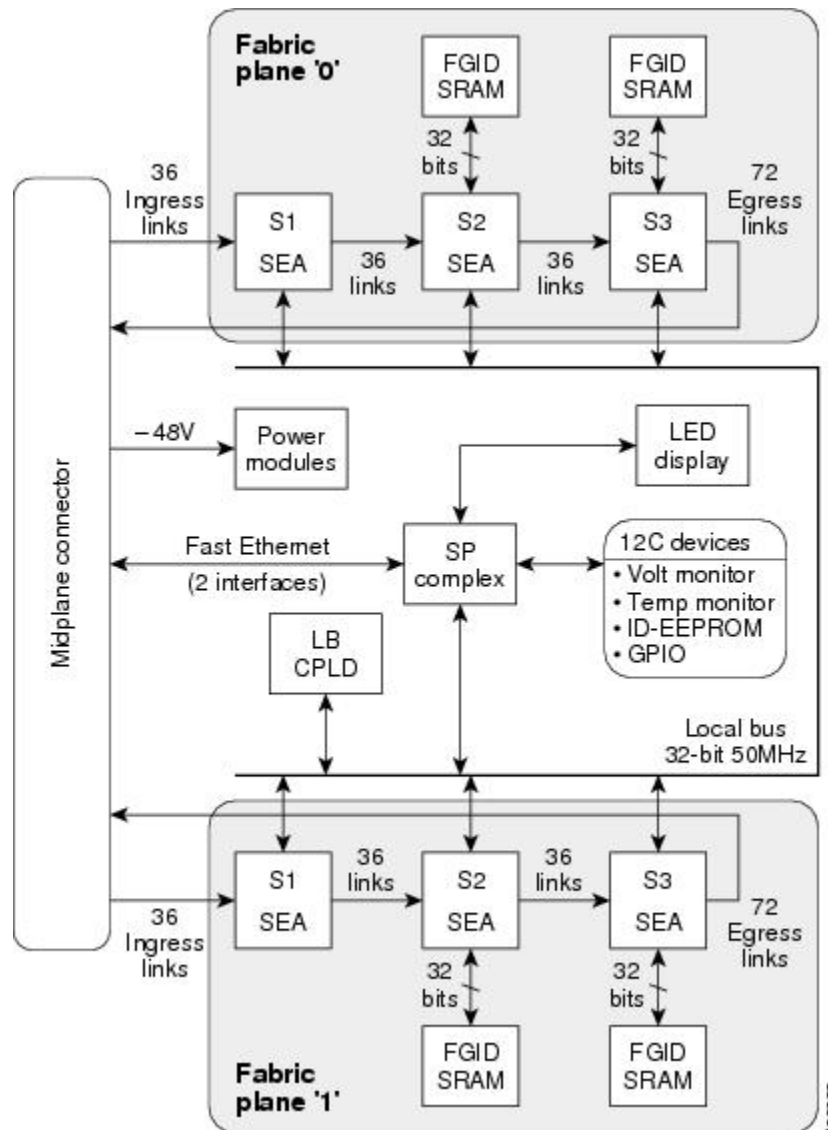
The major functional blocks of the switch fabric card are as follows:

- S1 switch element: Receives data cells from the MSC (or RP) and distributes them to the S2 stage. The S1 switch element is connected to its corresponding S2 switch element within the same fabric plane.
- S2 switch element: Receives data cells from the S1 stage. The S2 switch element is connected to its corresponding S1 and S3 switch elements within the same fabric plane. S2 has 36 inputs and 36 outputs.
- S3 switch element: Receives data cells from the S2 stage and performs switching and fabric speed-up. S3 has 36 inputs and 72 outputs.
- Service processor: Provides the interface to the Cisco CRS-1 control plane. The service processor does the following:

  - Controls power up and power down processes of the switch fabric card.
  - Configures the components in the various switch elements.
  - Updates the FGID (Fabric Group ID), for multicast traffic.

- Maintains cell configuration.
- Controls link-up and link-down processing and status.
- Collects and processes statistics for the switch fabric card.

- Power modules: Takes –48 VDC input power from the midplane and converts it to the voltages required by the components on the switch fabric card.
- Alphanumeric display: Displays switch fabric card messages. Messages are explained in the Alphanumeric Displays, page 1-15 .
- Status LED: Indicates status of the switch fabric card.

This figure shows the CRS-8-FC/S switch fabric card front panel. The front panel of the CRS-8-FC140/S, CRS-8-FC400/S, and CRS-8-FC400/M are similar.

Figure 38: CRS-8-FC/S Switch Fabric Card Front Panel
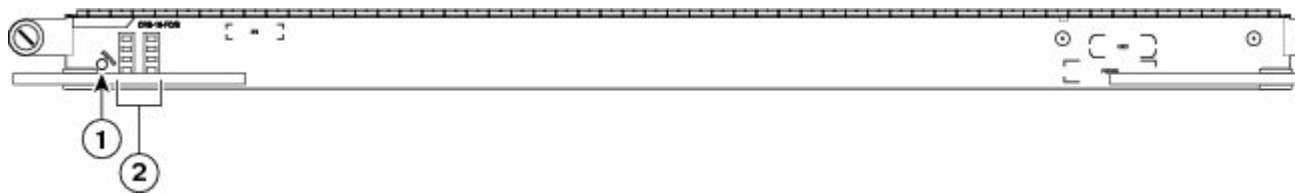
1	Status LED	2	Alphanumeric LEDs

The switch fabric card front panel contains the following elements:

- Status LED
- An alphanumeric display

See Technical Specifications, page A-1 for additional switch fabric card specifications.

CHAPTER 5

Line Cards and Physical Layer Interface Modules Overview

This chapter describes the modular services cards (MSCs), forwarding processor (FP) cards, label switch processor (LSP) cards, and associated physical layer interface modules (PLIMs) of the Cisco CRS Carrier Routing System. It includes the following topics:

> **Note**   For a complete list of line cards, route processors, SPAs and SIPs, and interface modules supported in the Cisco CRS 8-slot line card chassis, see Cisco CRS Data Sheets.

Overview of Line Cards and Physical Layer Interface Modules

The MSC, FP, and LSP card, also called line cards, are the Layer 3 forwarding engine in the CRS 8-slot routing system. Each line card is paired with a corresponding physical layer interface module (PLIM) that contains the packet interfaces for the line card. A line card can be paired with different types of PLIMs to provide a variety of packet interfaces, such as OC-192 POS and OC-48 POS.

- The MSC card is available in the following versions: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X/ CRS-MSC-X-L in 200G mode.
- The FP card is available in the following versions: CRS-FP140, CRS-FP-X/CRS-FP-X-L cards in 200G mode).
- The LSP card is: CRS-LSP.

> **Note**   For CRS-X next generation line cards and fabric cards, we recommend that you use a modular configuration power system in the chassis. See Modular Configuration Power System, page 2-19 .

Note See CRS Hardware Compatibility, page 1-17 for information about CRS fabric, MSC, and PLIM component compatibility.

Note The following MSC functional description is also generally applicable to the FP and LSP cards, unless noted otherwise.

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 at 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 line card actually forwards the data packets.

Line cards (MSCs, FPs, LSPs) and PLIMs are installed on opposite sides of the line card chassis, and mate through the line card chassis midplane. Each line card and PLIM pair is installed in corresponding chassis slots in the chassis (on opposite sides of the chassis).

The following figure shows how data enters the optical interfaces on the ingress PLIM and is passed to the ingress MSC. From there, data packets are converted to cells, and forwarded to the switch fabric, where the data cells are switched to the egress MSC and are reassembled into data packets and forwarded out the egress PLIM.

Figure 39: MSCs, PLIMs, and Switch Fabric Diagram
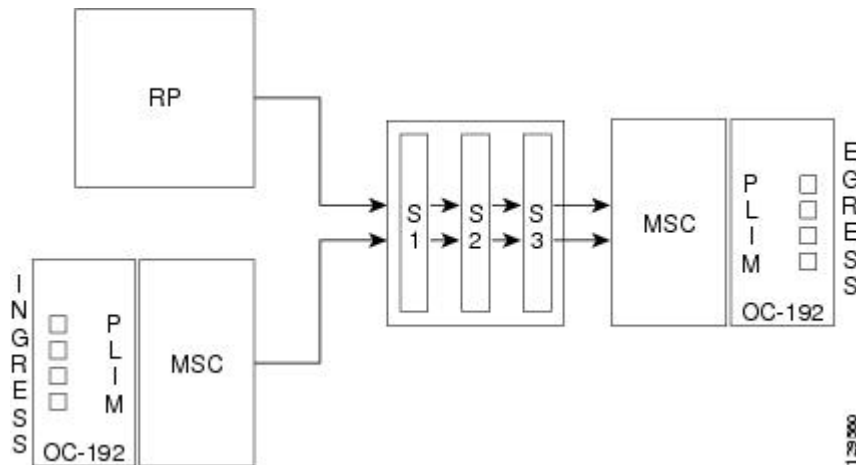
The PLIM provides the interface to user IP data. PLIMs perform Layer 1 and Layer 2 functions, such as framing, clock recovery, serialization and deserialization, channelization, and optical interfacing. Different PLIMs provide a range of optical interfaces, such as very-short-reach (VSR), intermediate-reach (IR), or long-reach (LR).

The line card receives the data from the PLIM and then, based upon the IP packet header, it will perform QoS functionality or other actions, such as the mapping of VLANs. And for ingress data, it will disassemble the packet into 36-byte fabric cells.

This is a simple block diagram of the major components of an MSC/PLIM pair. These components are described in the following sections:

This diagram also applies to the FP and LSP line cards.

Figure 40: MSC and PLIM Simple Block Diagram
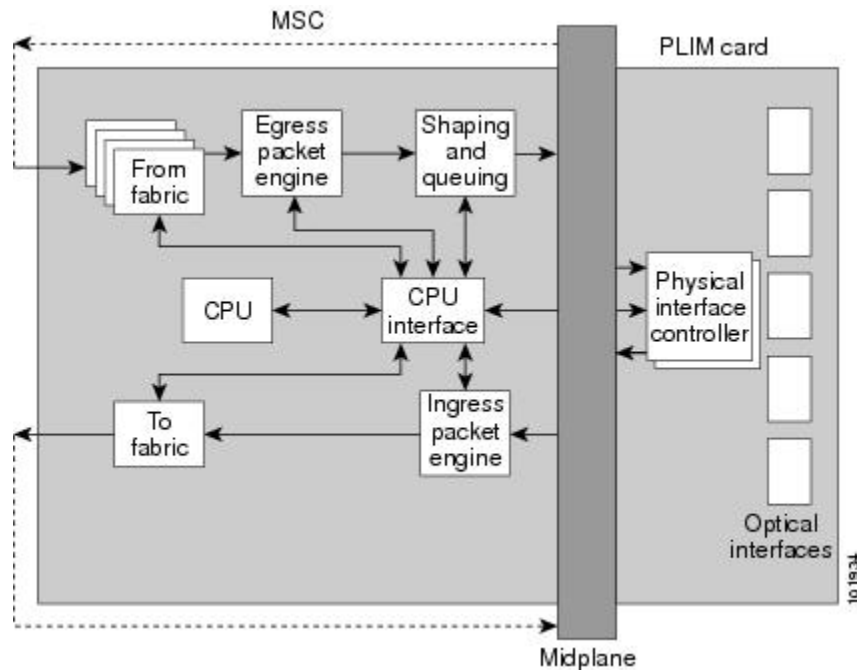
PLIM Physical Interface Module On Ingress

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 MSC. 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 line card chassis midplane.
- Buffers incoming data, if necessary, to accommodate back-pressure from the packet engine.
- A GE PLIM provides Gigabit Ethernet specific functions, such as:
    - VLAN accounting and filtering database
    - Mapping of VLAN subports

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 of the board. 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
- Determines 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 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 section.

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.

MSC Egress Packet Engine

The transmit (egress) packet engine performs a lookup on the IP address or MPLS label of the egress packet. The 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 MSC and the physical ports on the PLIM. For the egress path, the controller performs the following functions:

- Support for the physical ports.
- 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 , the MSC contains a central processing unit (CPU) that performs the following functions:

- MSC configuration

- Management
- Protocol control

The CPU subsystem includes:

- A CPU chip
- A Layer 3 cache
- NVRAM
- A flash boot PROM
- A 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 533 MHz DDR3 DIMM on the CRS-MSC-X (200G)

The CPU interface module, 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 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 line card chassis RP cards. The CPU subsystem performs a number of control plane functions, including receipt of FIB downloads, local PLU and TLU management, statistics gathering and performance monitoring, and MSC ASIC management and fault-handling. The CPU interface drives high-speed communication ports to all ASICs on the MSC and PLIM. The CPU talks to the CPU interface through a high-speed bus attached to its memory controller.

Line Card Physical Descriptions

Figure 41: Modular Services Card, Original Version (CRS-MSC), on page 65 shows a Cisco CRS Carrier Routing System Modular Services Card (MSC). An MSC fits into any available MSC slot and connects directly to the midplane. Forwarding processor (FP) cards and label switch processor (LSP) cards are similar.

Note For CRS-X next generation line cards, we recommend that you use a modular configuration power system in the chassis. See Modular Configuration Power System, page 2-3

Note You must have CRS-8-FC140/S fabric cards installed in your system to use the CRS-MSC-140G, CRS-FP140, CRS-LSP, and 14-port and 20-port 10-GE XFP PLIMs.

Note The CRS-FP40 only supports the Cisco CRS 4-port 10-GE PLIM, Cisco CRS 42-port 1-GE PLIM, Cisco CRS 20-port 1-GE Flexible Interface Module, and 2x10GE WAN/LAN Flexible Interface Module.

The power consumption of the line cards is:

- CRS-MSC (end-of-sale)= 375 W
- CRS-MSC-B = 300 W
- CRS_MSC-140G = 446 W
- CRS-MSC-X/ CRS-MSC-X-L (200G) = 450 W
- CRS-FP40 = 270 W
- CRS- FP140 = 446 W
- CRS-FP-X/CRS-FP-X-L (200G) = 450 W
- CSR-LSP = 446 W

Figure 41: Modular Services Card, Original Version (CRS-MSC)
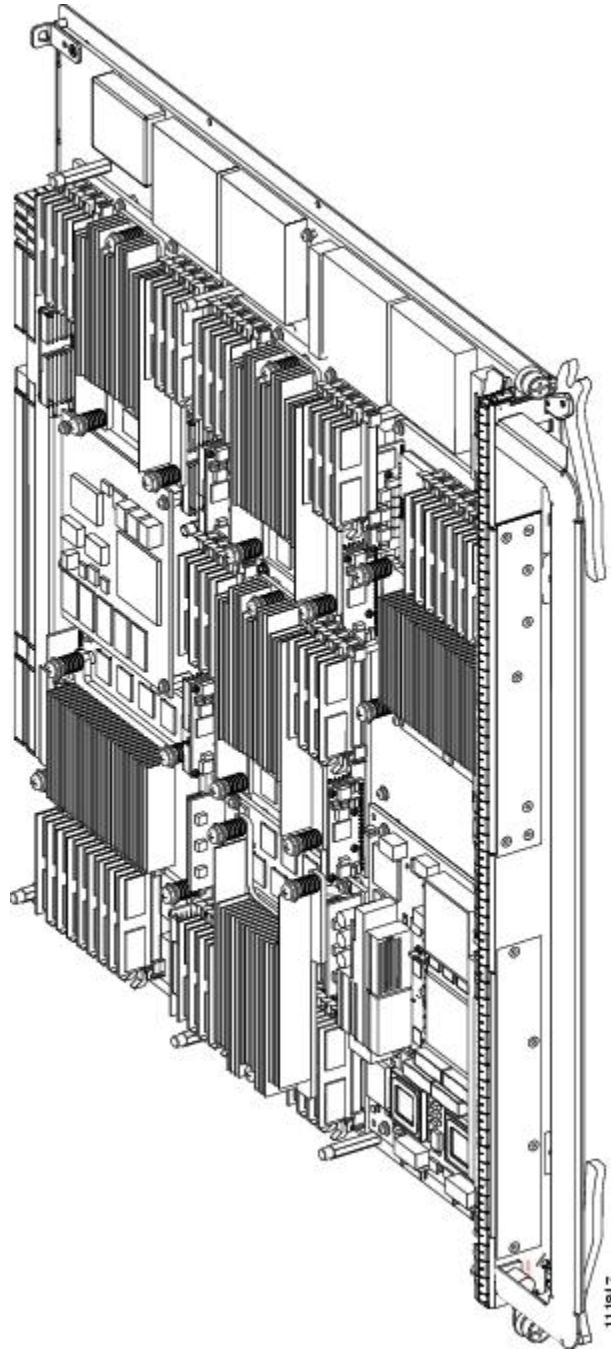
Figure 42: CRS-MSC Front Panel, on page 66 shows the front panel of the CRS-MSC (end-of-sale).

Figure 42: CRS-MSC Front Panel
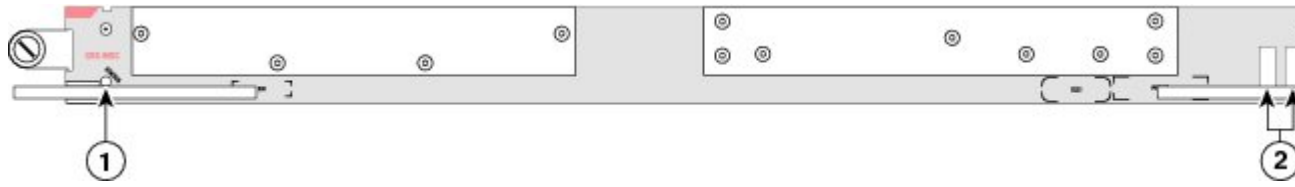
1	Status LED	2	Alphanumeric LED

Figure 43: CRS-MSC-B Front Panel, on page 66 shows the front panel of the CRS-MSC-B.

Figure 43: CRS-MSC-B Front Panel
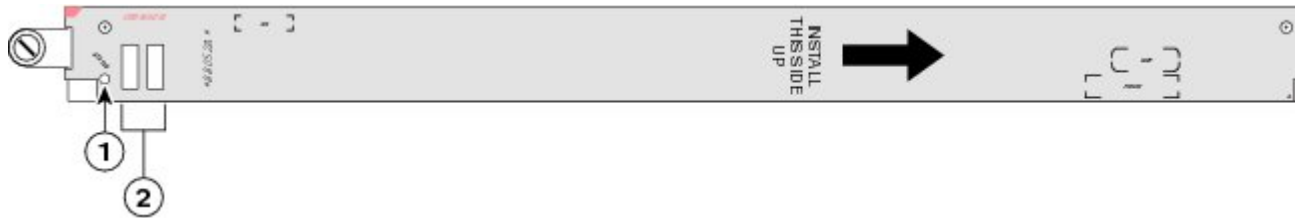
1	Status LED	**2**	Alphanumeric LEDs

Figure 44: CRS-FP40 Front Panel, on page 66 shows the front panel of the CRS-FP40.

Figure 44: CRS-FP40 Front Panel
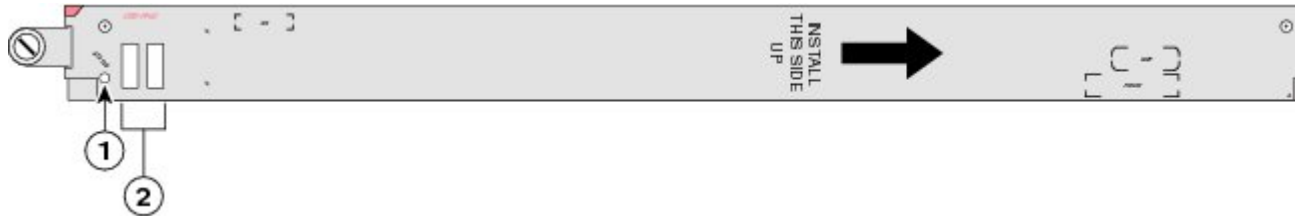
1	Status LED	**2**	Alphanumeric LEDs

Figure 45: CRS-MSC-140G Front Panel, on page 66 shows the front panel of the CRS-MSC-140G. The CRS-MSC-X card front panel is similar.

Figure 45: CRS-MSC-140G Front Panel

1	Status LED	**2**	Alphanumeric LEDs

shows the front panel of the CRS-FP140. The CRS-FP-X card front panel is similar.
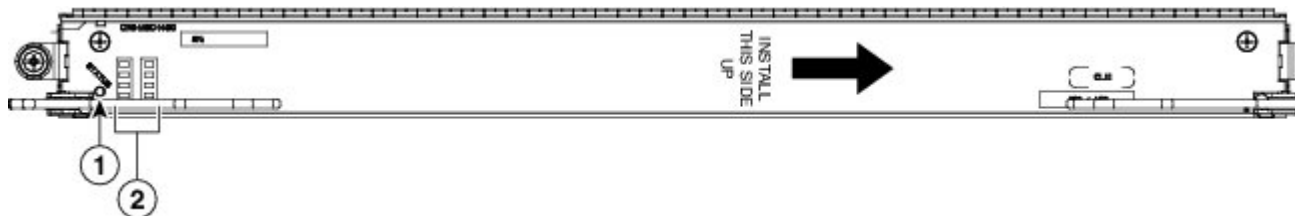
Figure 46: CRS-FP140 Front Panel
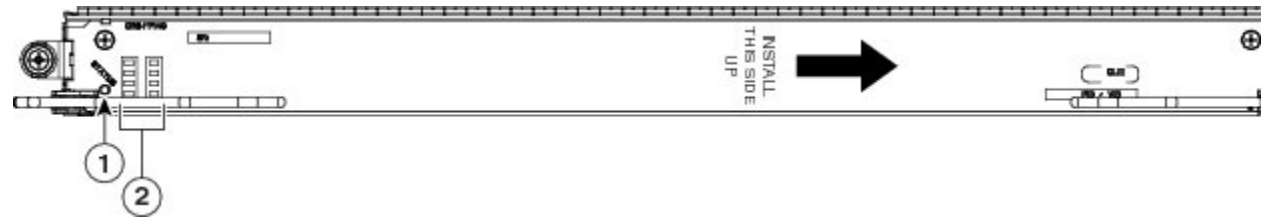
1	Status LED	**2**	Two alphanumeric LEDs

shows the CRS-LSP front panel.

Figure 47: CRS-LSP Front Panel
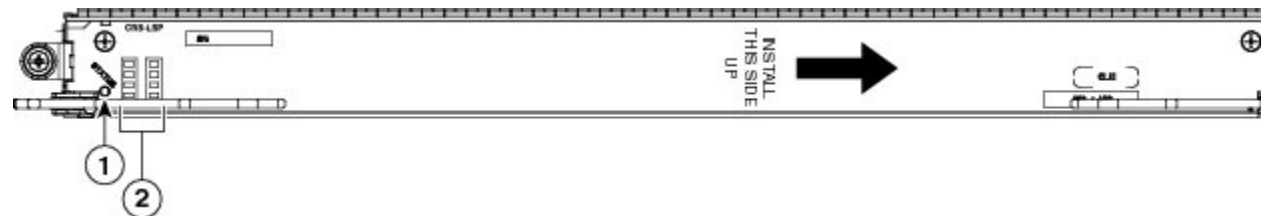
1	Status LED	2	Alphanumeric LED

Physical Layer Interface Modules

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 components).

Each PLIM is paired with an MSC, FP, or LSP 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 (for example, OC-192, 10-Gigabit Ethernet, and 100-Gigabit Ethernet).

Line cards are installed on opposite sides of the line card chassis, and mate through the chassis midplane. Each line card 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. Physical layer interface modules (PLIMs) contain the packet interfaces for the routing system.

The use of separate PLIMs also provides the ability to choose a number of different packet interfaces and port densities.

The following sections describe some of the PLIMs currently available for the Cisco CRS-1:

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

Danger Class 1 Laser Product Statement 113

Danger 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

OC-768 Packet-Over-SONET (POS) PLIMs

The 1-port OC-768 PLIM provides an interface of 40 gigabits per second (Gbps), which is the OC-768 line rate. The PLIM performs Layer 1 and Layer 2 processing for an OC-768 data stream by removing and adding the proper header information as data packets enter and exit the PLIM.

The OC-768 PLIM is a class 1 laser product that operates in POS mode only; DPT mode is not supported. The PLIM contains:

- Optics module: Provides receive (RX) and transmit (TX) optic interfaces that comply with ITU Recommendation G.693. The module provides short-reach (SR) optics with SC fiber-optic interfaces.
- Framer: Provides processing and termination for SONET/SDH section, line, and path layers, including alarm processing and automatic protection switching (APS) support.
- Physical interface controller: Provides data packet buffering and Layer 2 processing, including processing for VLANs and back-pressure signals from the MSC.
- Additional components: Include power and clocking components, voltage and temperature sensors, and an identification EEPROM that stores initial configuration and PLIM hardware information.

The Cisco IOS XR software also provides diagnostic functions for the PLIM.

Figure 48: 1-Port OC-768 PLIM Front Panel , on page 68 shows the front panel of the OC-768 PLIM.

Figure 48: 1-Port OC-768 PLIM Front Panel

1	TX Alphanumeric LED	4	CARRIER
2	RX Alphanumeric LED	5	RX PKT
3	ACTIVE	6	Status LED

The 1-port OC-768 PLIM has the following components:

- Single port (0) with SC fiber-optic interfaces for TX and RX.
- Three port LEDs that provide information about the status of the port:

    - ACTIVE: Indicates that the port is logically active; the laser is on.
    - CARRIER: Indicates that the receive port (RX) is receiving a carrier signal. The LED goes out (turns dark) if a loss-of-signal (LOS) or loss-of-frame (LOF) condition is detected.
    - RX PKT: Blinks every time a packet is received.

- 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.
- Power consumption: 65 W

OC-192 Packet-Over-SONET/Dynamic Packet Transport PLIMs

The OC-192 PLIM contains four ports that can be software configured to operate in packet-over-SONET (POS) or Dynamic Packet Transport (DPT) modes. The OC-192 PLIM provides Layer 1 and Layer 2 interface capabilities for four OC-192 data steams by removing and adding the proper Layer 1 and Layer 2 header information as data packets enter and exit the PLIM. The OC-192 PLIM feeds the MSC with one 40-Gbps data packet stream. The OC-192 PLIM has features described in .

Note   DPT mode is not available at this time.

Table 15: Features of the OC-192 PLIM

Feature	Description
Optics modules	Provide the receive (RX) and transmit (TX) optic interfaces in accordance with GR-1377 for long-reach (LR), intermediate-reach (IR), short-reach (SR), and very-short-reach (VSR).
Framers	Provide processing and termination for SONET Section, Line, and Path layers. This includes alarm processing and automatic protection switching (APS) support. The framer supports both packet and cell processing for a multiservice operating mode.
Physical interface controller	Provides data packet buffering and Layer 2 processing and multiplexing and demultiplexing the four OC-192 data streams. This includes processing for VLANs and back-pressure signals from the MSC.
DPT or transparent mode components	Provide the MAC layer function for the Spatial Reuse Protocol used in the DPT mode. When the PLIM is in POS mode, these components operate in the transparent mode.
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.

The Cisco IOS XR software also provides loopback and diagnostic functions for the OC-192 PLIM.

The four different types of optics modules define the four major variants of the OC-192 PLIM:

- Long-reach (LR), Product ID: OC192-POS/DPT-LR=
- Intermediate-reach (IR), Product ID: OC192-POS/DPT-IR=
- Short-reach (SR), Product ID: OC192-POS/DPT-SR=
- Very-short-reach (VSR), Product ID: OC192-POS/DPT-VS=

Figure 49: 4-Port OC-192 POS/DPT VSR, SR, and IR Front Panels, on page 70 shows the front panel of the three versions of the OC-192 PLIM.

Figure 49: 4-Port OC-192 POS/DPT VSR, SR, and IR Front Panels
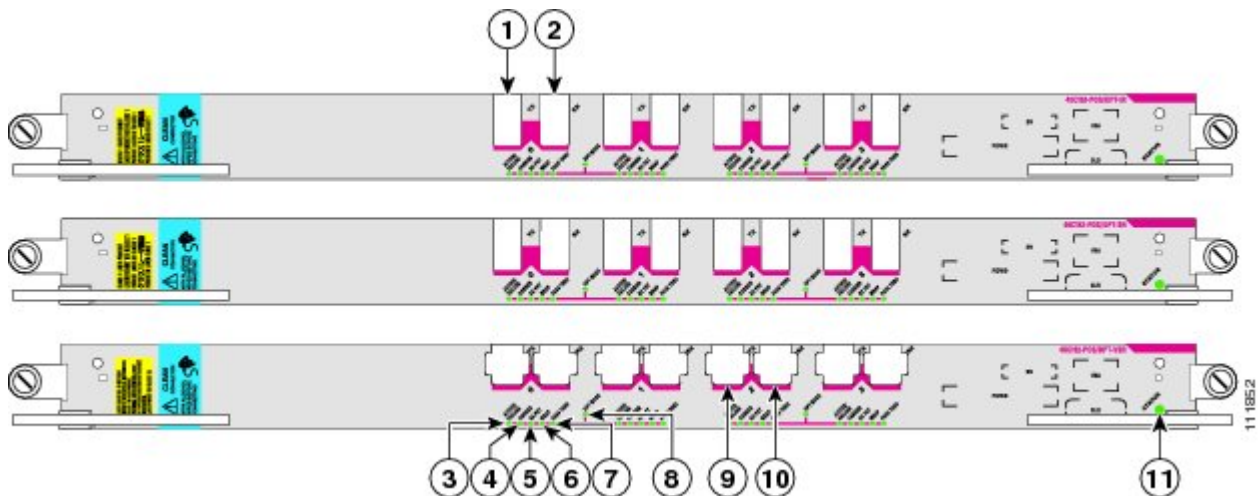
1	Port 0 with TX jacks	7	PASS THRU
2	Port 0 with RX jack	8	DPT MODE
3	ACTIVE/FAILURE LED	9	Port 2 with TX jacks
4	CARRIER	10	Port 2 with RX jack
5	RX PKT	11	STATUS LED
6	WRAP		

Each 4-port OC-192 PLIM has the following components:

- Four ports (0, 1, 2, and 3) with TX and RX jacks for each port.
- STATUS LED: Indicates that the board is properly seated and operating OK.
- Five green LEDs for each port:
  - 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).

- Two DPT MODE LEDs: One of these DPT MODE LEDs is for ports 0 and 1, and the other DPT MODE LED is for ports 2 and 3. The DPT mode is always configured on pairs of ports.
- Each 4-port OC-192 PLIM power consumption—138 W

OC-48 Packet Over SONET/Dynamic Packet Transport PLIMs

The OC-48 PLIM comes in three different variants which can be software configured to operate in packet-over-SONET (POS) or Dynamic Packet Transport (DPT) mode. The 16xOC-48 PLIM contains 16 OC-192 interfaces and provides Layer 1 and Layer 2 interface capabilities, for 16 separate OC-48 data streams, by removing and adding the proper Layer 1 and Layer 2 header information as data packets enter and exit the PLIM. The 16xOC-48 PLIM feeds the MSC with one 40 Gbps data packet stream.

Table 16: Features of the 16xOC-48 PLIM , on page 71 describes the features of the 16xOC-48 PLIM.

Table 16: Features of the 16xOC-48 PLIM

| Feature	Description
Optics modules	Provide the receive (RX) and transmit (TX) optic interfaces for each of the 16 ports. The 16xOC-48 PLIM uses small form-factor pluggable (SFP) optics modules that can be removed and replaced in the field while the PLIM is powered up. The SFPs provide the 16xOC-48 PLIM with the ability to support short-reach (SR), intermediate-reach (IR), and long-reach (LR) optics on any port.
Framers	Provide processing and termination for SONET Section, Line, and Path layers. This includes 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 16xOC-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 MSC.
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.

The Cisco IOS XR software also provides loopback and diagnostic functions for the 16xOC-48 PLIM.

Figure 50: 16xOC-48 POS PLIM , on page 72 shows a 16xOC-48 PLIM.

Figure 50: 16xOC-48 POS PLIM
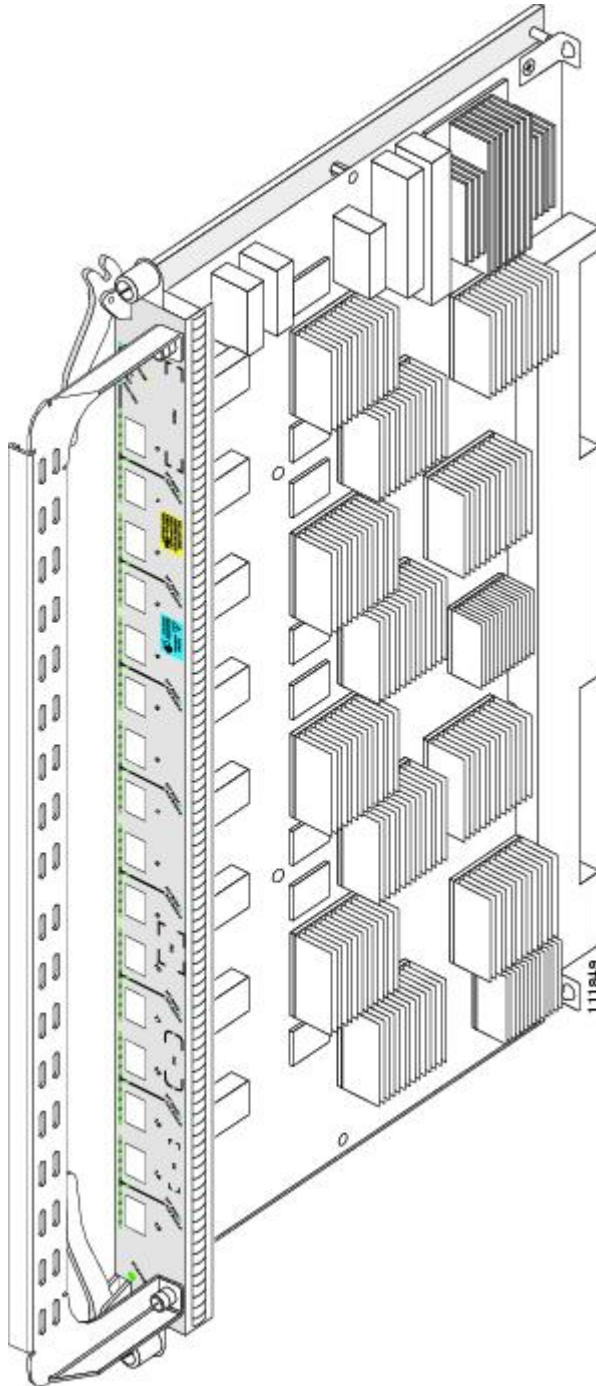
Figure 51: OC-48 POS PLIM Front Panel View, on page 73 shows the front panel of the OC-48 PLIM.

Figure 51: OC-48 POS PLIM Front Panel View
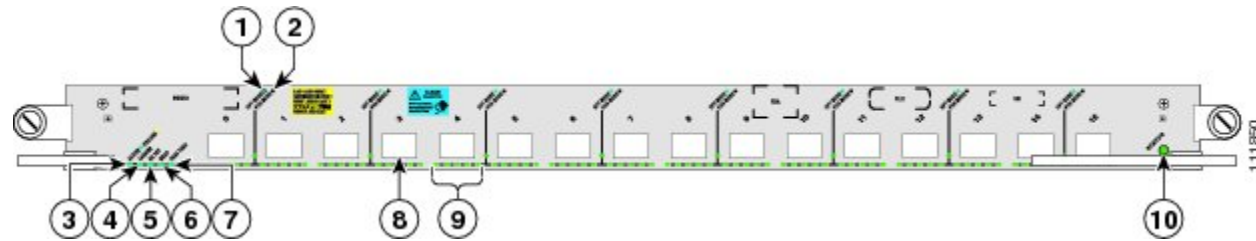
1	DPT MODE LED	6	WRAP LED
2	POS MODE LED	7	PASS THRU LED
3	ACTIVE/FAILURE LEDS	8	One of sixteen slots for SFPs numbered from 0 through 15 left to right
4	CARRIER LED	9	Five LEDs per port
5	RX PKT LED	10	Status LED

Each OC-48 PLIM has the following components:

- A STATUS LED: Indicates that the card is properly seated and operating OK.
- 16 ports with SFP optic modules for each port.
- 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. At this time, the 16xOC-48 PLIM operates only in the POS mode.
- Five green LEDs for each port:

  - 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).

- Each 16xOC-48 PLIM power consumption—136 W

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 MSC forwards traffic at 40 Gbps. Therefore, the PLIM provides 40 Gbps of throughput, which it passes to the MSC 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 two 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, do not install more than 4 optic modules in each PLIM, and do not install more than 2 optic modules in each set of ports: upper (0 to 3) or lower (4 to 7).

10-GE XENPAK PLIM Components

The 8-port 10-GE 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 MSC.
- Additional components: Include power and clocking components, voltage and temperature sensors, and an identification EEPROM that stores initial configuration and PLIM hardware information.

shows the front panel of the 10-GE PLIM.

Figure 52: 10-GE XENPAK PLIM Front Panel

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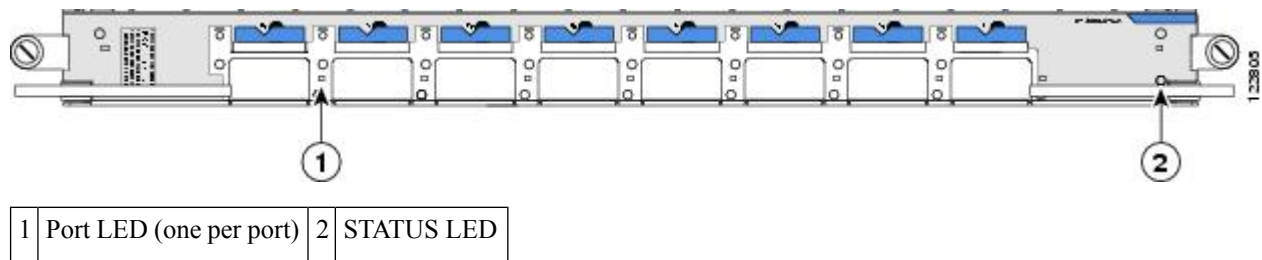
The 8-port 10-GE XENPAK PLIM has the following components:

- 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.

The 8-port 10-GE XENPAK PLIM power consumption—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. The 8-port 10-GE XFP PLIM has:

- Eight ports that accept XFP optics modules

- Status LED for the PLIM
- LED for each port

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

The 8-port 10-GE XFP 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 53: 8-Port 10-Gigabit Ethernet XFP PLIM front panel, on page 75 shows the front panel of the 8-Port 10-GE XFP PLIM.

Figure 53: 8-Port 10-Gigabit Ethernet XFP PLIM front panel
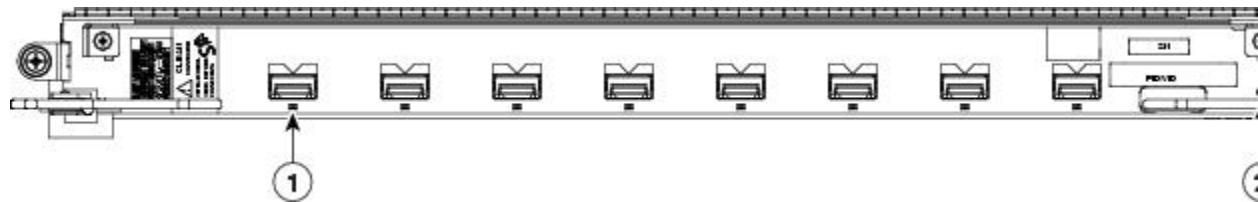
| 1 | Port LED (one per port) | 2 | Status LED |

Table 17: 8-Port 10-GE XFP PLIM LED Descriptions , on page 75 describes the PLIM LEDs for the 8-Port 10-GE XFP PLIM.

Table 17: 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.

The 8-port 10-GE XFP PLIM power consumption—88 W (with eight optics modules)

Table 18: XFP Module Port Cabling Specifications for the 8-Port 10-GE XFP PLIM, on page 76 provides cabling specifications for the XFP modules that can be installed on the 8-port 10-GE XFP PLIM.

Table 18: 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. The 4-port 10-GE XFP PLIM has:

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

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

The 4-port 10-GE XFP 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 54: 4-Port 10-Gigabit Ethernet XFP PLIM front panel, on page 76 shows the front panel of the 4-Port 10-GE XFP PLIM.

Figure 54: 4-Port 10-Gigabit Ethernet XFP PLIM front panel
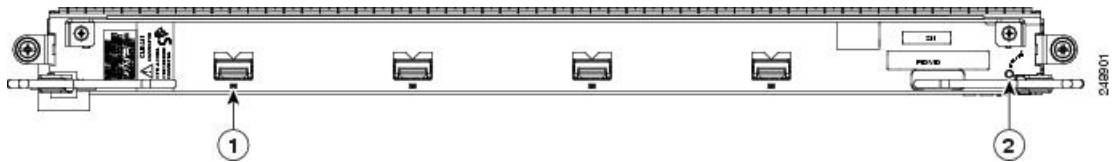
1	Port LED (one per port)	2	Status LED

Table 19: 4-Port 10-GE XFP PLIM LED Descriptions , on page 77 describes the PLIM LEDs for the 4-Port 10-GE XFP PLIM.

Table 19: 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.

The 4-port 10-GE XFP PLIM power consumption—74 W (with four optics modules).

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

Table 20: 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 CFP PLIM power consumption—150 W

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

- 100-GE pluggable optical transceiver module—CFP-100GE-LR4, V01

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

Figure 55: 1-Port 100-Gigabit Ethernet CFP PLIM front panel, on page 78 shows the front panel of the 1-Port 100-GE CFP PLIM.

Figure 55: 1-Port 100-Gigabit Ethernet CFP PLIM front panel
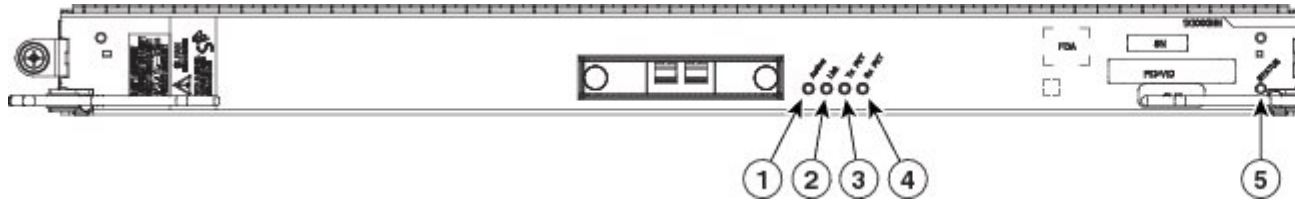
| 1 | Active LED | 2 | Link LED | 3 | Tx PKT LED | 4 | Rx PKT LED | 5 | Status LED |

Table 21: 1-Port 100-GE XFP PLIM LED Descriptions, on page 78 describes the PLIM LEDs for the 1-Port 100-GE CFP PLIM.

Table 21: 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.

The CFP uses duplex single mode SC fiber cabling. Table 22: CFP Module Port Cabling Specifications, on page 79 provides cabling specifications for the CFP modules that can be installed on the 1-Port 100-GE CFP PLIM.

⚠

Caution   A CFP optics module must be installed in the CFP transceiver module slot of each 100GE PLIM installed in the Cisco CRS chassis. The CFP transceiver module preserves the integrity of the card and is required for EMI and Safety compliance and proper cooling in the chassis.

Table 22: CFP Module Port Cabling Specifications

Part Number	Description	Wavelength	Fiber Type	Typical Maximum Distance
CFP-100GE-LR4, V01	100-GE pluggable optical transceiver modules	1295.56 nm1300.055 nm1304.585 nm1309.14 nm	SMF	6.213 miles (10 km)

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

✎

Note   For information about the XFP optical transceiver modules supported on the 20-port 10-GE XFP PLIM, see the 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, on page 82 for detailed information.

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

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 56: 20-Port 10-Gigabit Ethernet XFP PLIM front panel, on page 80 shows the front panel of the 20-Port 10-GE XFP PLIMs.

Figure 56: 20-Port 10-Gigabit Ethernet XFP PLIM front panel

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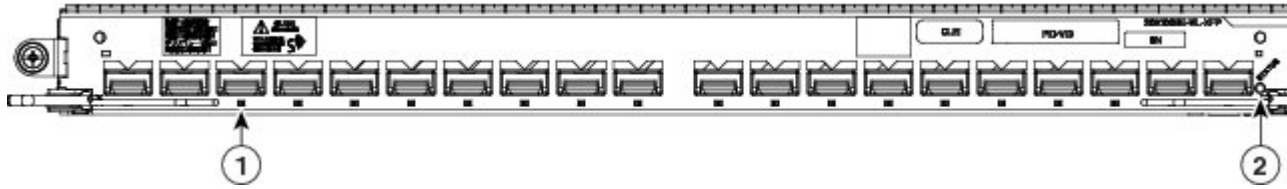
describes the PLIM LEDs for the 20-Port 10-GE XFP PLIM.

Table 23: 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 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, 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

Note

For information about the XFP optical transceiver modules supported on the 14-port 10-GE XFP PLIM, see Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note.

Note

The 14-port XFP PLIM has a fixed power budget for the pluggable XFP optics. See XFP Optics Power Management, on page 82 for detailed information.

The14-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 57: 14-Port 10-Gigabit Ethernet XFP PLIM front panel, on page 81 shows the front panel of the 14-Port 10-GE XFP PLIMs.

Figure 57: 14-Port 10-Gigabit Ethernet XFP PLIM front panel
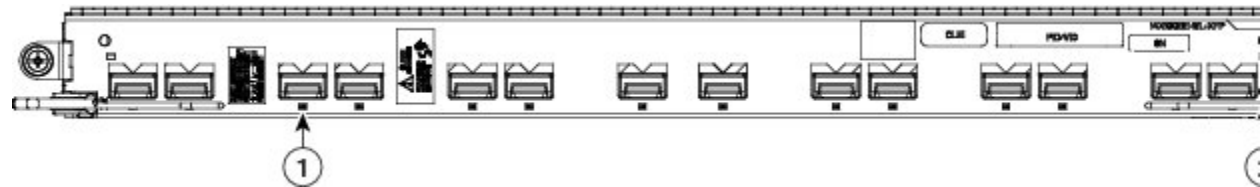
| 1 | Port LED | 2 | Status LED |

Table 24: 14-Port 10-GE XFP PLIM LED Descriptions , on page 81 describes the PLIM LEDs for the 14-Port 10-GE XFP PLIM.

Table 24: 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 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, see Cisco IOS XR Interface and Hardware Component Command Reference for the Cisco CRS Router .

✎

Note The 14-port XFP PLIM has a fixed power budget for the pluggable XFP optics. See XFP Optics Power Management, on page 82 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-1 chassis (Figure 58: PLIM Impedance Carrier, on page 83). The CRS 8-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 58: PLIM Impedance Carrier

| 1 | Impedance carrier fasteners |
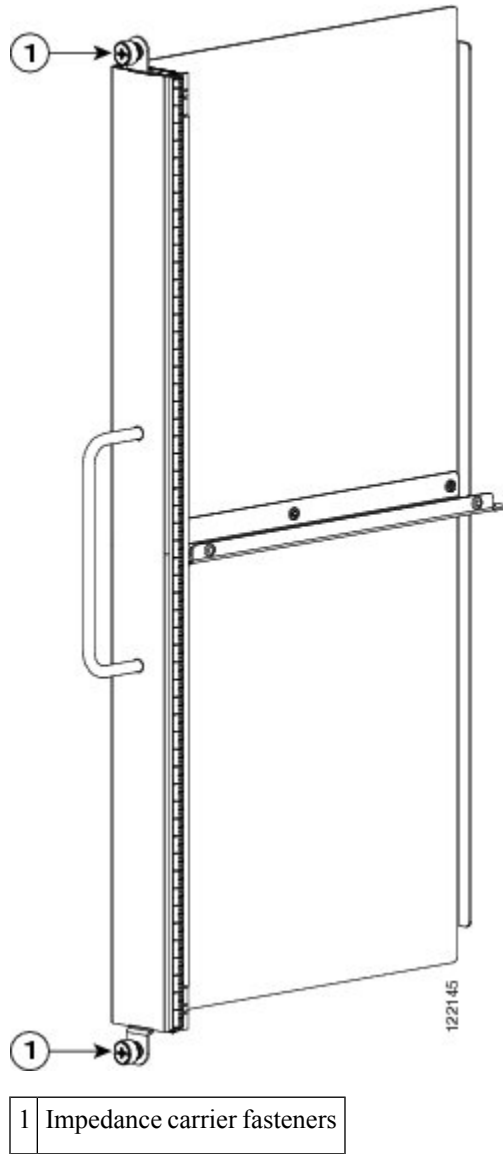
Route Processor

This chapter describes the route processor (RP) card and the performance route processor card (PRP) in the Cisco CRS Carrier Routing System. It contains the following topics:

Route Processor Overview

The route processor (RP) card is the system controller for the Cisco CRS Carrier Routing System. It performs route processing 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 the routing system 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 Active and Standby Arbitration, on page 88 for information on how the system determines which RP is active and which is standby.

The RP card provides route processing, alarm, fan and power supply controller function in the Cisco CRS Carrier Routing System. The RP card controls fans, alarms, and power supplies through the use of an *i2c* communication link from the RP card to each fan tray/power supply.

Two RP cards are required per chassis for redundancy—one is *active* , and the other is *standby* . An RP card can be inserted in either of the two dedicated slots in the chassis.

Figure 59: Route Processor Card, on page 86 illustrates the route processor card.

Figure 59: Route Processor Card
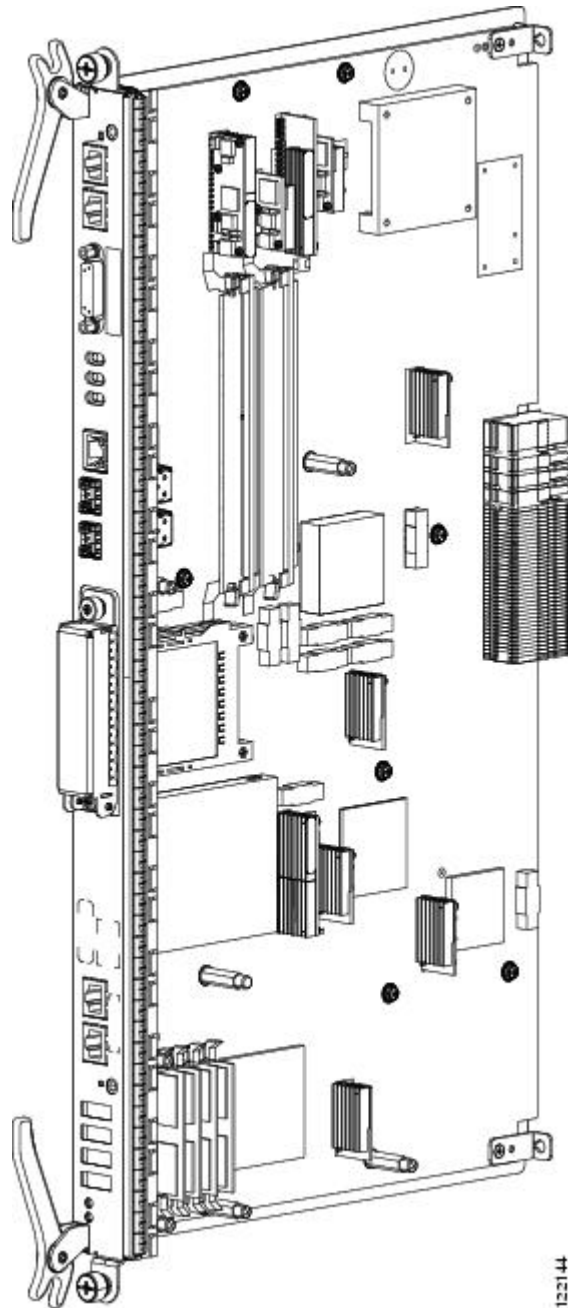
Details on the faceplate of the RP card are shown in Figure 60: Details on the Front Panel of the Route Processor Card, on page 87 and are described in Table 25: Description of RP Card Components , on page 87.

The Cisco IOS XR Getting Started Guide, available online at http://www.cisco.com/en/US/products/ps5763/prod_technical_documentation.html

Figure 60: Details on the Front Panel of the Route Processor Card

Table 25: Description of RP Card Components

RP Card Component	Description
Hard drive	An IDE hard drive is used to gather debugging information, such as core dumps from the RP or MSCs. It is typically powered down and activated only when there is a need to store data.

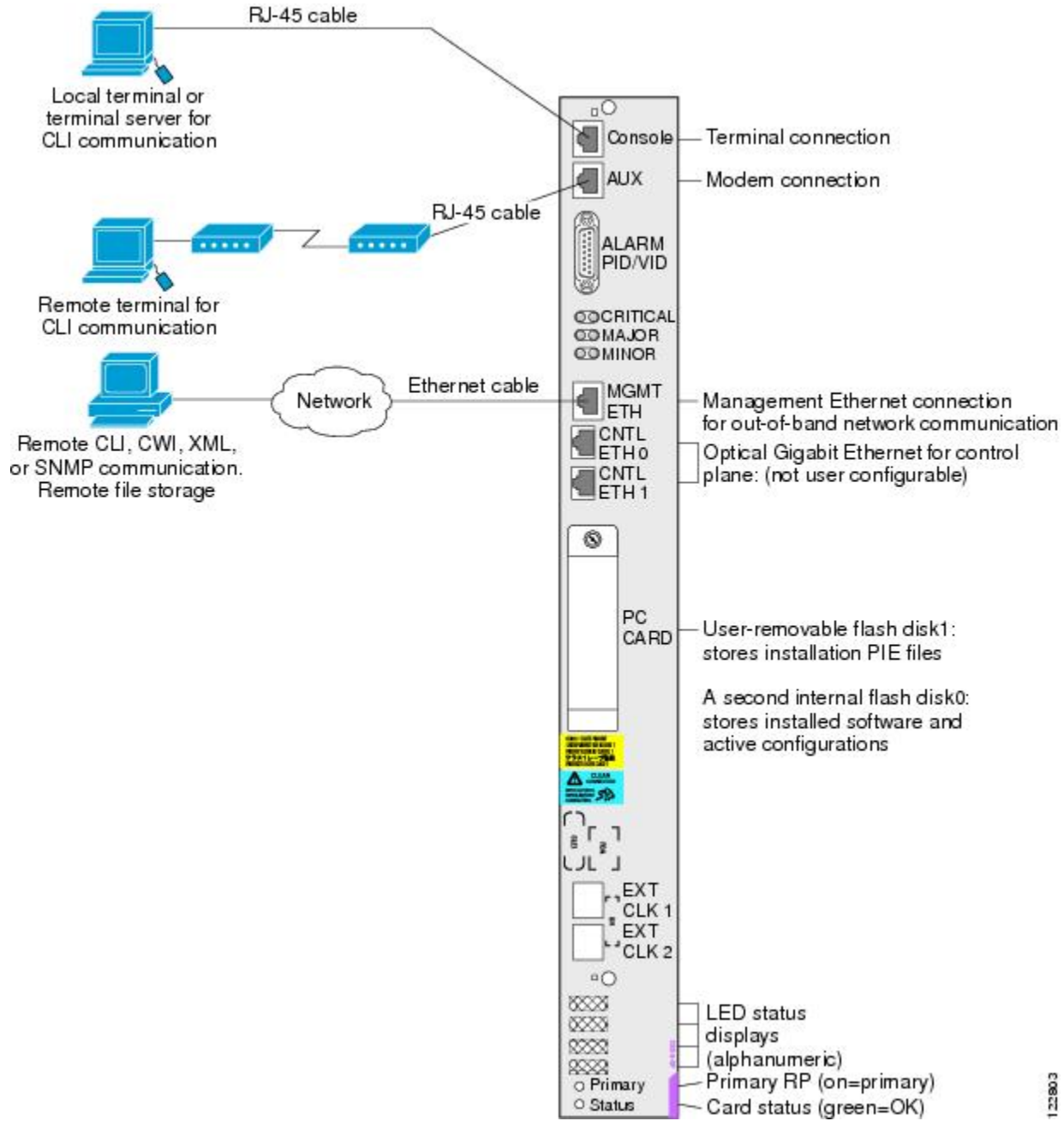| RP Card Component	Description
Memory	Memory resides in a SIMM module on the RP card. The RP can be configured with 2 or 4 GB of memory.
PCMCIA Subsystems	Two PCMCIA flash slots provide support for 2Gb and 4Gb of flash subsystem storage, each. One of the PCMCIA flash subsystems is accessible externally and removable, and allows you to transfer images and configurations by plugging in a PCMCIA flash card. The other PCMCIA flash subsystem is fixed to the RP, for permanent storage of configurations and images.
Dual-processing CPU	A dual-processing 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.
SFP modules	Two small form-factor pluggable (SFP) modules support external Gigabit Ethernet connections for multi-chassis systems.
RJ45 Ethernet port	An RJ45 10/100/1000 copper Ethernet port is available for providing connectivity to network management systems.
Fast Ethernet Midplane Connector	Internal 100 Mbps Fast Ethernet (FE) midplane connections connect each MSC in the chassis to both RP cards. These FE connections are traces in the midplane. There are also FE connections to the fans power supplies. These connections all form part of the control plane.

Active and Standby Arbitration

The two RP cards in a line card chassis operate in an active-standby relationship. 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 RP cards 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 its self-test, each RP decides whether it is ready to become primary (active). If so, the RP asserts the "Ready" signal to its on-board arbitration unit, which propagates the "Ready" signal to the other RP.
4. The arbitration hardware chooses the active RP and asserts an "Active" signal to the chosen RP, along with an interrupt. The hardware also propagates the "Active" signal to the other RP, along with 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 de-asserts its "Ready" signal, the standby RP immediately receives an asserted "Active" signal, along with an interrupt.

RP Card to Fabric Module Queuing

The RP card mates with the line card chassis midplane (Figure 61: Route Processor Architecture Diagram, on page 89). 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 MSC To Fabric Section Queuing, page 5-4).

- The "From fabric" module (on 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 (on the RP transmit path) queues the packets and segments them into cells before transmitting them to the switch fabric.

Figure 61: Route Processor Architecture Diagram
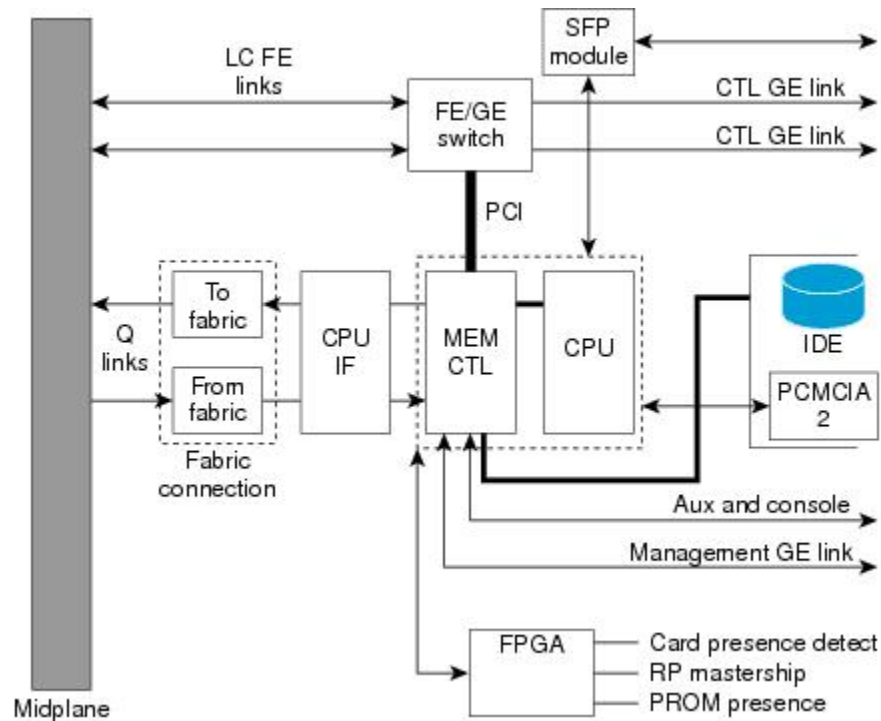
Distributed Route Processor

The distributed route processor (DRP) card and its associated physical layer interface module (PLIM) provide additional routing capabilities for the Cisco CRS. 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 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 can function as a single logical router only.

See 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 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.
- The SMPs are not connected to each other internally, but they can communicate with each other through the routing system switch fabric or Ethernet control plane. 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.

shows the DRP card front panel.

Figure 62: DRP Card Front Panel

| 1 | STATUS LED | 2 | PRIMARY LED |

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. ( )

- The DRP card power consumption—371 W

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.

shows the front panel of the DRP PLIM.

Figure 63: DRP PLIM Front Panel
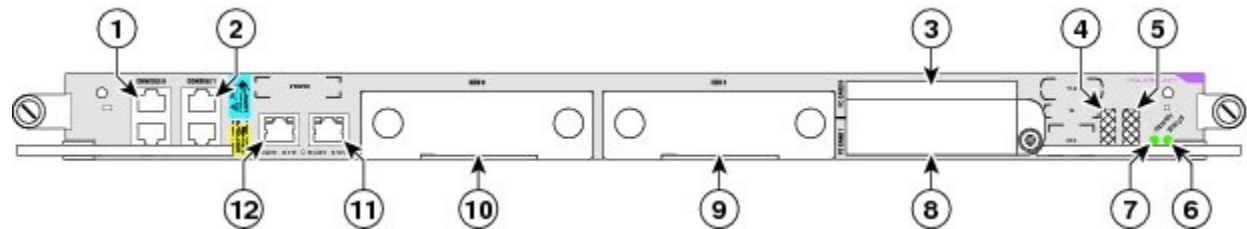
1	CONSOLE port 0	7	PRIMARY LED
2	CONSOLE port 1	**8**	PC card 1
3	PC Card 0	9	Hard drive 1
4	Alphanumeric LED	10	Hard drive 0
5	Alphanumeric LED	11	MGMT ETH port 1

6	STATUS LED	12	MGMT ETH port 0

The DRP PLIM front panel contains the following components:

- CONSOLE and AUX 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.
- DRP PLIM power consumption—20 W

Limitations and Restrictions

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

- Each line card chassis supports one DRP and one DRP PLIM. In the future, each line card chassis will support up to eight DRPs and eight 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 Cisco CRS 8-slot line card chassis. 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 Cisco CRS 8-slot line card chassis. When two PRPs are installed, one PRP is the "Active" RP and the other is the "Standby" RP.

shows the PRP card.

Figure 64: Performance Route Processor
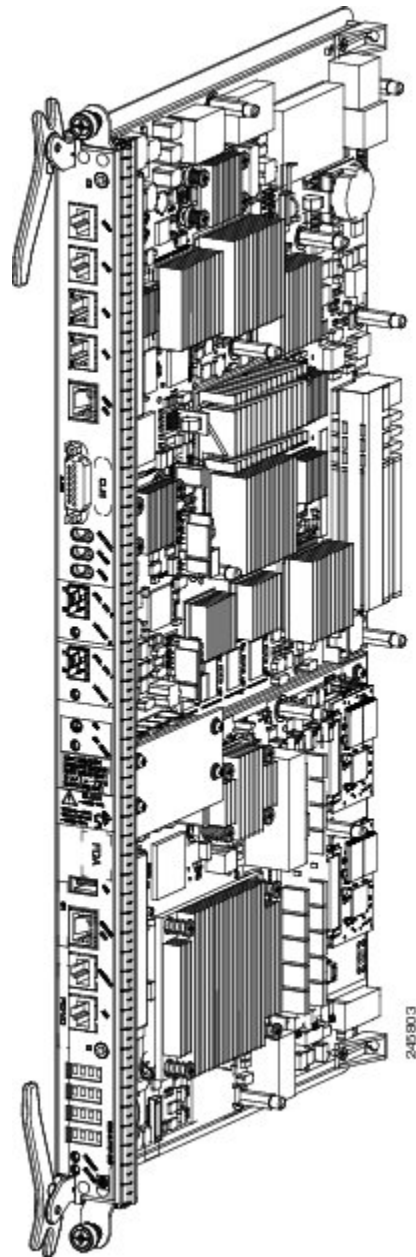
The PRP has the following physical characteristics:

- Height—20.6 in. (52.3 cm)
- Depth—11.2 in. (28.5 cm)
- Width—1.8 in. (4.6 cm)
- Weight—9.60 lb (4.35 kg)
- Power consumption—175 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 65: Performance Route Processor Front Panel, on page 95 shows the front panel of the PRP card.

Figure 65: Performance Route Processor Front Panel
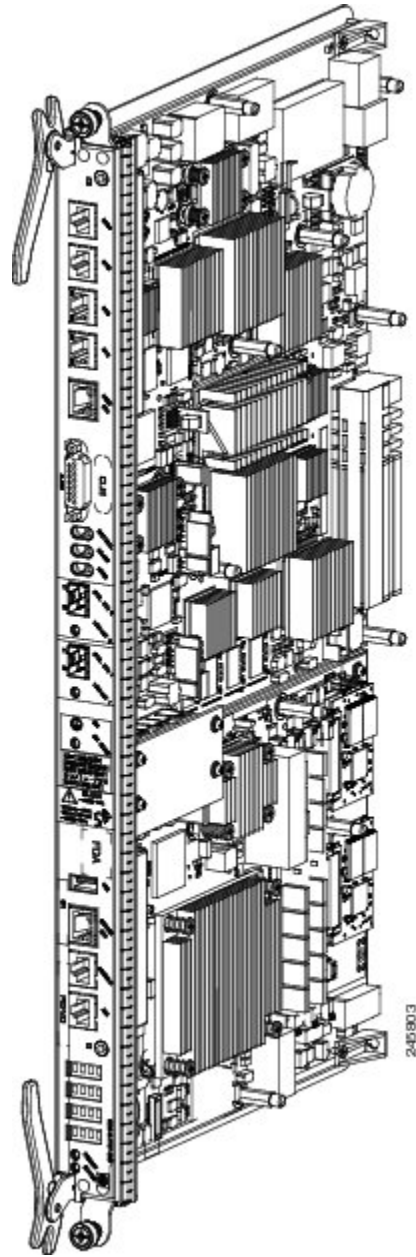
1	BITS 0	12	Control Ethernet 1 port (SFP or SFP+)
2	BITS 1	13	Link/Active 1 LED
3	DTI 0	14	OIR push button—Press to initiate OIR process
4	DTI 1	15	OIR Ready LED
5	Management Ethernet RJ45 port	16	USB socket

6	Alarm connector	17	Service Ethernet RJ45 port
7	Critical Alarm LED	18	Console port
8	Major Alarm LED	19	Auxiliary port
9	Minor Alarm LED	20	Alphanumeric LED Display
10	Control Ethernet 0 port (SFP or SFP+)	21	PRIMARY LED—PRP active or standby indicator
11	Link/Active 0 LED	22	STATUS LED—Card status indicator

Performance Route Processor Overview

The CRS PRP for the Cisco CRS 8-slot line card chassis 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 66: Performance Route Processor Block Diagram, on page 97 shows a block diagram of the PRP card.

Figure 66: Performance Route Processor Block Diagram
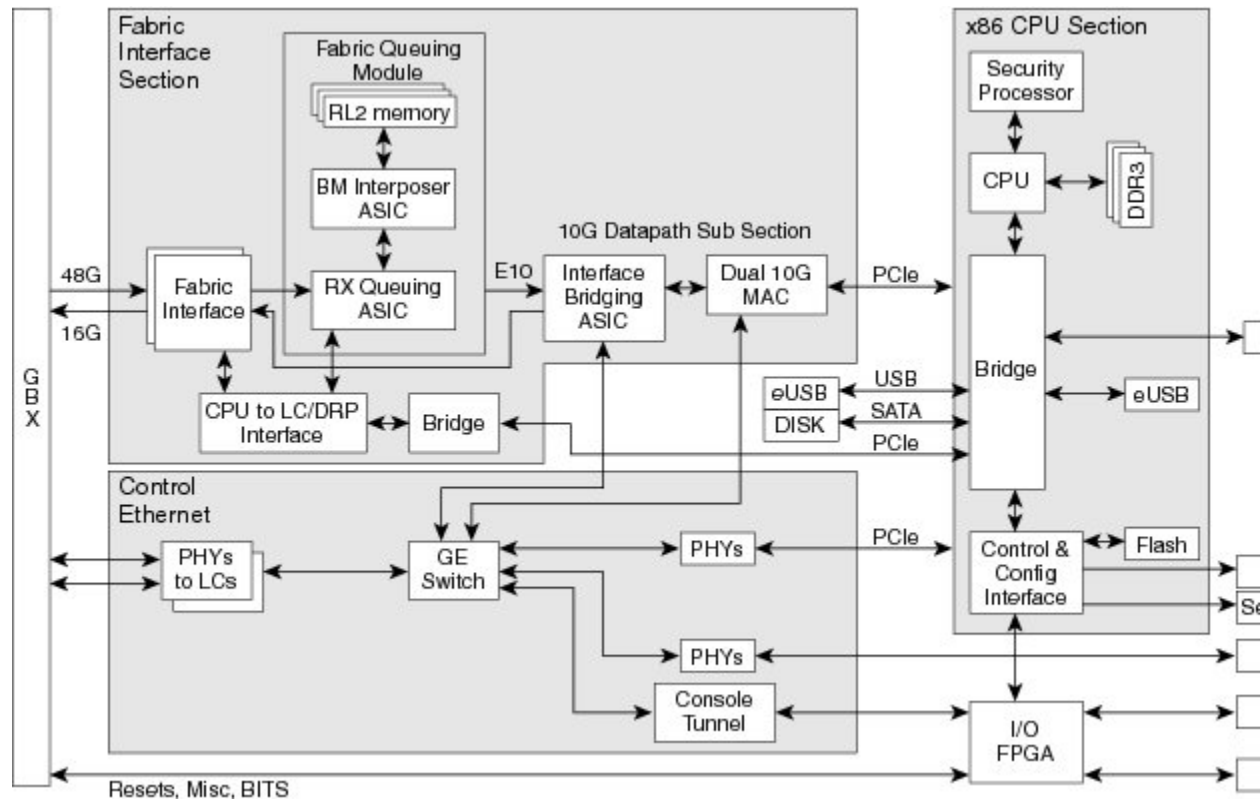
Performance Route Processor Memory Options

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

- Three 2GB DDR3 DIMMs, for a total of 6GB (Cisco product ID: CRS-8-PRP-6G)
- Three 4GB DDR3 DIMMs, for a total of 12GB (Cisco product ID: CRS-8-PRP-12G)

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 65: Performance Route Processor Front Panel, on page 95). 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 65: Performance Route Processor Front Panel, on page 95) 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 26: PRP Console Port and Aux Port Pinouts, on page 98 lists the pinouts for the Console (CON) and Auxiliary (AUX) RJ45 ports on the PRP (items 4 and 5 in Figure 65: Performance Route Processor Front Panel, on page 95).

Table 26: PRP Console Port and Aux Port Pinouts

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 back door 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.

Alarm Port

Table 27: Alarm Port Pin Outs, on page 99 lists the pin outs for the Alarm port on the PRP (item 6 in Figure 65: Performance Route Processor Front Panel, on page 95).

Table 27: Alarm Port 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.

Alarm Port

Technical Specifications

This appendix provides information about the product IDs for components of the Cisco CRS Carrier Routing System 8-Slot LCC. This appendix contains the following topics:

Note For a complete list of line cards, route processors, SPAs and SIPs, and interface modules supported in the Cisco CRS 8-slot line card chassis, see Cisco CRS Data Sheets.

Chassis Specifications

This table lists specifications for the Cisco CRS 8-slot Line Card Chassis.

Table 28: Cisco CRS 8-Slot Line Card Chassis Specifications

Chassis Dimension	
Height	38.5 in. (97.8 cm)
Width	17.5 in. (44.45 cm) 18.9 in. (48.0 cm) mounting rail flange, outside to outside
Depth	36.6 in. (93.0 cm) without exterior cosmetics 40.5 in. (102.9 cm) with full exterior cosmetics

Chassis Dimension	
Weight	330.8 lb (150.1 kg) shipping weight (chassis + inlet grill + 2 power shelves)
	430.8 lb (195.4 kg) shipping weight with packaging
	747.5 lb. (339.1 kg) fully loaded with line cards and full exterior cosmetics
	32 lb (14.5 kg) empty modular power shelf
	50 lb (22.7) fully loaded power shelf

Fixed Configuration Power Specifications

This table lists the fixed configuration power specifications for the Cisco CRS 8-slot LCC.

Table 29: 8-Slot Line Card Chassis Component and Power Specifications—Fixed Configuration Power

Description	Value
Supported Cards and Modules	8 modular services cards (MSCs), forwarding processor (FP) cards, or label switch processor (LSP) cards (line cards)
	8 physical layer interface modules (PLIMs), one for each MSC, FP, or LSP
	4 switch fabric cards (SFCs)
	2 route processor (RP) cards or 2 performance route processor (PRP) cards
	1 distributed route processor (DRP) (no dedicated slot; installs in open MSC slot)
	1 DRP PLIM (no dedicated slot; installs in PLIM slot corresponding to DRP slot)
	2 fan trays (with four fans per fan tray)
	1 air filter
Power Distribution Units	2 AC (Wye or Delta) or 2 DC power distribution units (PDUs) (cannot mix AC and DC PDUs in the chassis)
DC PDU	Supports 1 DC power entry module (PEM) per shelf
AC PDU	Supports 1 AC rectifier module per shelf
Maximum Power Consumption (total input power)	**Note** Proper grounding is also required at the site to ensure that equipment is not damaged by lightning or power surges.
Maximum DC	8.0 kW (assuming 94% efficiency)
Maximum AC	8.5 kW (Delta or Wye 3-phase) (assuming 88% efficiency)
Power Redundancy (2N)	

Description	Value
DC	Three "A" battery plant feeds required for one PDU, and three "B" battery plant feeds required for the other PDU.
AC (Delta or Wye 3-phase)	Two independent Delta or Wye 3-phase power sources required, one for each PDU.
DC Input	
Nominal input voltage	–48 VDC North America–54 VDC Telco (RBOC)–60 VDC International(range –40.5 to –75 VDC)
Input current	56 A at –48/–60 VDC (nominal voltage)66 A at –40.5 VDC (low voltage extreme)
AC Input, Delta 3-phase	3W + PE (3 wire + protective earthing conductor ground wire)
Input voltage	3-phase 200 to 240 VAC, phase-to-phase (nominal)(range 170 to 264 VAC, phase-to-phase)
Line frequency	50 to 60 Hz(range 47 to 63 Hz)
Input current(PDU rated for 24 A)	30 A
AC Input, Wye 3-phase	3W + N + PE (3 wire + neutral + protective earthing conductor ground wire)
Input voltage	3-phase 200 to 240 VAC, phase-to-neutral (nominal)(range 170 to 264 VAC, phase-to-neutral) (range 295 to 457 VAC, phase-to-phase)
Line frequency	50 to 60 Hz (nominal)(range 47 to 63 Hz)
Input current (PDU rated for 14 A)	16 A International 20 A North America

Modular Configuration Power Specifications

This table lists the system specifications for the Cisco CRS 8-slot LCC with a modular configuration power system installed.

Table 30: 8-Slot Line Card Chassis Component and Power Specifications—Modular Configuration Power

Description	Value
Supported Cards and Modules	8 modular services cards (MSCs) or forwarding processor (FP) cards (line cards)
	8 physical layer interface modules (PLIMs), one for each MSC or FP
	4 switch fabric cards (SFCs)
	2 route processor (RP) cards or 2 performance route processor (PRP) cards
	1 distributed route processor (DRP) (no dedicated slot; installs in open MSC slot)
	1 DRP PLIM (no dedicated slot; installs in PLIM slot corresponding to DRP slot)
	2 fan trays (with four fans per fan tray)
	1 air filter
Power Shelves	2 AC or 2 DC power shelves (cannot mix AC and DC power shelves in the chassis)
DC power shelf	Accepts up to 4 DC PMs
AC power shelf	Accepts up to 3 AC PMs
Maximum Power Consumption (total input power)	**Note** Proper grounding is also required at the site to ensure that equipment is not damaged by lightning or power surges.
Maximum DC	9.5 kW (assuming 88% efficiency)
Maximum AC	9.8 kW (assuming 92% efficiency)
Power Redundancy (2N)	
DC	Up to four "A" battery plant feeds required for one power shelf, and up to four "B" battery plant feeds required for the other power shelf.
AC (Delta or Wye 3-phase)	Up to three "A" AC single-phase power sources and up to three "B" AC single-phase 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 VDC40 A max at –60 VDC60 A at –40 VDC (low voltage extreme)
AC Input, single-phase	
Input voltage	Single-phase 200 to 240 VAC (nominal)(range 180 to 264 VAC)
Line frequency	50 to 60 Hz (nominal)(range 47 to 63 Hz)

Description	Value
Input current	16 A International20 A North America

Environmental Specifications

This table lists the environmental specifications for the Cisco CRS 8-slot LCC.

Table 31: 8-Slot 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)Nonoperating: –40° to 158°F (–40° to 70°C)
Humidity	Operating: 5 to 85% noncondensingNonoperating: 5 to 90% noncondensing, short-term operation
Altitude	1 to 5906 ft (0.305 m to 1800 m) at 122°F (50°C), short-termUp to 13,123 ft (4000 m) at 104°F (40°C) or below
Heat dissipation	27,297 BTU per hour (fixed configuration DC)[2] 29,003 BTU per hour (fixed configuration AC)[3] 32,415 BTU per hour (modular configuration DC)[4] 33,438 BTU per hour (modular configuration AC)[5]
External cooling requirements	2.3 tons
Chassis airflow	Up to 900 cubic feet (25,485 liters) per minute
Power system airflow	Up to 240 cubic feet (6800 liters) per minute
Sound power level (fixed configuration power)	81 dB—80°F (27°C) or lower (fan speed 4000 RPM, nominal)92 dB—104°F (40°C) or higher (fan speed 6500 RPM)
Sound power level (modular configuration power)	77 dB—80°F (27°C) or lower (fan speed 3700 RPM)89 dB—104°F (40°C) or higher (fan speed 6500 RPM)
Shock and vibration	Designed and tested to meet the NEBS shock and vibration standards defined in GR-63-CORE (Issue 2, April 2002).

[2] Heat dissipation from the DC power system based on maximum output power capacity at 94% efficiency.
[3] Heat dissipation from the AC power system based on maximum output power capacity at 88% efficiency.
[4] Heat dissipation from the DC power system based on maximum output power capacity at 88% efficiency.
[5] Heat dissipation from the AC power system based on maximum output power capacity at 92% efficiency.

Regulatory, Compliance, and Safety Specification

For information about the compliance and safety standards with which the Cisco CRS-1 conforms, see Regulatory Compliance and Safety Information for the Cisco CRS Carrier Routing System .

APPENDIX B

Product IDs

This appendix provides information about the product IDs for components of the Cisco CRS Carrier Routing System 8-Slot LCC. It contains the following tables:

These tables list the components that make up the routing system, their product IDs (the part numbers to use to order the components), and descriptions.

Note For a complete list of line cards, route processors, SPAs and SIPs, and interface modules supported in the Cisco CRS 8-slot line card chassis, see Cisco CRS Data Sheets.

Chassis Component Product IDs

This table lists the product IDs for components in the Cisco CRS 8-slot LCC.

Table 32: 8-Slot Routing System Component Product IDs

Component	Product ID	Description
CRS 8-slot routing system	CRS-8/S	Cisco CRS 8-slot routing system
CRS 8-slot line card chassis	CRS-8-LCC(=)	Cisco CRS 8-slot line card chassis (spare chassis)
Fan tray	CRS-8-LCC-FAN-TR(=)	Cisco CRS 8-slot fan tray and fans (spare)(2 required for each chassis)
Air filter	CRS-8-LCC-FILTER(=)	Line card chassis filter pack (spare)
Inlet grille	CRS-8-FRNT-GRILL(=)CRS-8-PW-GRILL(=)	Line card chassis inlet air grille—fixed configuration powerLine card chassis inlet air grille—modular configuration power

Component	Product ID	Description
Installation kit	CRS-8-INSTALL-KT(=)	Line card chassis installation kit(includes a set of horizontal shelf brackets, mounting screws, and other items)
Fixed Configuration Power Components		
Power module filter	CRS-8-PWR-FILTER(=)	Filters (five per pack) for AC rectifier and DC PEM
AC Delta power components		
AC Delta PDU	CRS-8-LCC-PDU-ACD(=)	Cisco CRS AC Delta power distribution unit(two required for each chassis)
AC rectifier module	CRS-8-AC-RECT(=)	Cisco CRS AC rectifier module(two required for each chassis, one for each PDU)
AC Wye power components		
AC Wye PDU	CRS-8-LCC-PDU-ACW(=)	Cisco CRS AC Wye power distribution unit(two required for each chassis)
AC rectifier module	CRS-8-AC-RECT(=)	Cisco CRS AC rectifier module(two required for each chassis, one for each PDU)
DC power components		
DC PDU	CRS-8-LCC-PDU-DC(=)	Cisco CRS DC power distribution unit(two required for each chassis)
DC PEM	CRS-8-DC-PEM(=)	Cisco CRS DC PEM[6](two required for each chassis, one for each PDU)
Modular Configuration Power Components		
AC power components, single-phase		
AC power shelf	CRS-8-PSH-AC(=)	Cisco CRS single-phase AC power shelf(two required for each chassis)
AC PM	CRS-PM-AC(=)	Cisco CRS AC PM[7](up to three required for each power shelf)
DC power components		
DC power shelf	CRS-8-PSH-DC(=)	Cisco CRS DC power shelf (two required for each chassis)
DC PM	CRS-PM-DC(=)	Cisco CRS DC PM(up to four required for each power shelf)

Component	Product ID	Description
Switch fabric cards		
Switch fabric cards	CRS-8-FC/S(=)CRS-8-FC140/S(=)CRS-8-FC400/S(=) (200G mode)CRS-8-FC400/M (=) (200G mode)	Cisco CRS switch fabric card (half-height)(four required for each chassis)
Switch fabric blank	CRS-8-FC-BLANK(=)	Blank card carrier for each switch fabric slot (used during shipment, must be replaced by a switch fabric card)
Switch fabric handle	CRS-8-FC-HANDLE(=)	Handle for carrying card (spare)
Route processor card		
Route processor (RP)[8]	CRS-8-RP(=)	Cisco CRS RP card(one required for each chassis; for redundant operation, you also need CRS-8-RP/R=)
Route processor, redundant	CRS-8-RP/R(=)	Optional route processor for redundant RP operation(one required for each chassis, along with CRS-8-RP=)
Route processor memory	CRS-MEM-2G(=)CRS-MEM-4G(=)	RP memory module, 2 gigabytesRP memory module, 4 gigabytes
Route processor blank	CRS-8-RP-BLANK(=)	Blank card carrier for each route processor slot(used during shipment, must be replaced by a route processor card)
Performance route processor (PRP)[9]	CRS-8-PRP-6G(=) CRS-8-PRP-12G(=)	Cisco CRS performance route processor card
Route processor handle	CRS-8-RP-HANDLE(=)	Handle for carrying card (spare)

[6] PEM = power entry module
[7] PM = power module
[8] RP = route processor
[9] PRP = performance route processor

Optional MSC, FP, PLIM, SIP, and SPA Product IDs

Tables below list the product IDs for the modular services cards (MSCs) and physical layer interface modules (PLIMs) available for the Cisco CRS-1 8-slot LCC.

Table 33: MSC Component Product IDs

Component	Product ID	Description
MSC[10]	CRS-MSC-B(=),CRS-MSC-140G(=)CRS-MSC-X (200G)CRS-MSC-X-L (200G	Cisco CRS Layer 3 modular service card (every MSC must have an associated PLIM)
FP card	CRS-FP40CRS-FP140CRS-FP-X (200G)CRS-FP-X-L (200G)	Cisco CRS Layer 3 forwarding processor(every FP must have an associated PLIM)
LSP	CRS-LSP	Cisco CRS Series Label Switch Processor 140Gbps
MSC impedance carrier	CRS-MSC-IMPEDANCE(=)	Blank card carrier for each empty MSC slot (required for EMI compliance and cooling)

[10] Refer to the product data sheet for ordering details.

Table 34: PLIM Component Product IDs

Component	Product ID	Description
1xOC-768 PLIM	1OC768-POS-SR(=)	1-port OC-768c/STM-256c PLIM, with short-reach optics (POS)
4xOC-192 PLIM	4OC192-POS/DPT-LR(=)	4-port OC-192c/STM-64c PLIM, with long-reach optics (POS or DPT)
	4OC192-POS/DPT-IR(=)	4-port OC-192c/STM-64c PLIM, with intermediate-reach optics (POS or DPT)
	4OC192-POS/DPT-SR(=)	4-port OC-192c/STM-64c PLIM, withshort-reach optics (POS or DPT)
	4OC192-POS/DPT-VS(=)	4-port OC-192c/STM-64c PLIM, with very-short-reach optics (POS or DPT)
16xOC-48 PLIM	16OC48-POS/DPT(=) POM-OC48-LR2-LC-C(=)POM-OC48-SR-LC-C(=)	OC-48c/STM-16c PLIM, uses small form-factor pluggable (SFP) modules (POS or DPT) The PLIM uses 1 to 16 single-mode, long- and short-reach optic modules (mixing allowed): • Long-reach optics (POM-OC48-LR2-LC-C=) • Short-reach optics (POM-OC48-SR-LC-C=)

Component	Product ID	Description
8x10-GE XENPAK PLIM	8-10GBE(=) CRS-XENPAK10GB-LR(=)	10-GE PLIM, uses XENPAK optic modules. The PLIM uses 1 to 8 single-mode, long-reachoptic modules: Long-reach optics (CRS-XENPAK10GB-LR=)
8x10-GE and 4x10-GE XFP PLIMs	8-10GBE-WL-XFP(=)4-10GBE-WL-XFP(=)	10-GE PLIM, uses XFP optic modules. These PLIMs use 1 to 8 (or 1 to 4) single-mode, XFP optic modules.
20x10-GE and 14x10-GE XFP PLIMs	20X10GBE-WL-XFP14X10GBE-WL-XFP	10-GE PLIM, uses XFP optic modules. These PLIMs use 1 to 20 (or 1 to 14) single-mode, XFP optic modules.
1x100-GE CFP PLIM	1X100GBE(=)	100-GE PLIM, uses one CFP optic module.
PLIM impedance carrier	CRS-INT-IMPEDANCE(=)	Blank card carrier for each empty PLIM slot (required for EMI compliance and cooling)

Table 35: SIP and SPA Component Product IDs

Component	Product ID	Description
Cisco CRS SPA Interface Processor-800	CRS1-SIP-800	Occupies one PLIM slot on the Cisco CRS 16- and 8-Slot LCC. Supports six normal-height SPAs or three double-height SPAs or any combination in between.
1-Port OC-192c/ STM- 64 POS/RPR XFP SPA	SPA-OC192POS-XFP	—
4-Port OC-3c/STM-1 POS SPA	SPA-4XOC3-POS	—
8-Port OC-12c/STM-4 Multirate POS SPA	SPA-8XOC12-POS	—
8-Port Gigabit Ethernet SPA	SPA-8X1GE	—