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

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Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

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Preface

This preface explains the objectives, intended audience, and organization of this guide commonly referred to as the "system description" in this document, and presents the conventions that convey additional information.

Objectives

This system description describes the Cisco CRS Series Carrier Routing System from a high level. It provides background information and basic theory of operation for anyone wanting to understand the routing system. It describes the major assemblies that comprise the routing system. It can be read as a supplement to the site planning guide, installation documents, and software documents. This system description focuses on the hardware elements of the routing system.

Audience

This guide is intended for general audiences who want an overview of the Cisco CRS routing system and its major components.

Document Organization

This system description contains the following chapters and appendixes:

- Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Router Overview , on page 1, provides an overview of the routing system.
- Cisco CRS 16-Slot Chassis Power Systems , on page 19, provides a detailed physical description of the line card chassis DC and AC power systems.
- Cooling System, on page 57, provides an overview of the line card chassis cooling system.

Documentation Conventions

This publication uses these conventions:

- **Ctrl** represents the key labeled Control. For example, the key combination *Ctrl- 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. For example:

  RP/0/RSP0/CPU0:router#

Convention	Description
bold font	Commands and keywords and user-entered text appear in **bold** font.
Italic font	Document titles, new or emphasized terms, and arguments for which you supply values are in *italic* font.
[ ]	Elements in square brackets are optional.
{x | y | z}	Required alternative keywords are grouped in braces and separated by vertical bars.
[x | y | z]	Optional alternative keywords are grouped in brackets and separated by vertical bars.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.
`courier` font	Terminal sessions and information the system displays appear in `courier` font.
	Indicates a variable for which you supply values, in context where italics cannot be used.

Convention	Description
< >	Nonprinting characters such as passwords are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Note *Means reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Tip *Means the following information will help you solve a problem*. The tips information might not be troubleshooting or even an action, but could be useful information, similar to a Timesaver.

Caution *Means reader be careful*. In this situation, you might perform an action that could result in equipment damage or loss of data.

Warning IMPORTANT SAFETY INSTRUCTIONS

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

SAVE THESE INSTRUCTIONS

Warning Statements using this symbol are provided for additional information and to comply with regulatory and customer requirements.

Related Cisco CRS-1 Series Documentation

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

Hardware Documents

- Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Site Planning Guide
- Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Installation Guide
- Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Unpacking, Moving, and Securing Guide
- Cisco CRS Carrier Routing System SIP and SPA Hardware Installation Guide

- Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Hardware Operations and Troubleshooting Guide
- Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note
- Cisco CRS Carrier Routing System Packet-over-SONET/SDH Physical Layer Interface Module Installation Note
- Cisco CRS-1 Carrier Routing System to Cisco CRS-3 Carrier Routing System Migration Guide
- Cisco CRS Carrier Routing System Regulatory Compliance and Safety Information

Software Documents

For a complete listing of software documentation for the Cisco CRS Carrier Routing System, see http://www.cisco.com/c/en/us/support/routers/carrier-routing-system/tsd-products-support-series-home.html

Changes to This Document

This table lists the technical changes made to this document since it was first created.

Table 1: Document Change History

Date	Change Summary
March 2015	Added recommendation to use modular power supplies with CRS-X line cards.
December 2014	Added support for the CRS-MSC-X-L and CRS-FP-X-L line cards.
July 2014	Added updates to support the Cisco CRS-X 400G back-to-back and multishelf systems, which include new CRS-16-FC400/M switch fabric card.
January 2014	Added updates to support the Cisco CRS-X, which includes new line cards, switch fabric cards, and PLIMs.
January 2012	Corrected weight of the Performance Route Processor (PRP) in the Route Processor chapter.
July 2011	Added information about new CRS-LSP Label Switch Processor (LSP) card.
April 2011	Added information about new CRS-16-PRP-6G and CRS-16-PRP-12G Performance Route Processor (PRP) cards. Technical updates and minor editorial changes were also made.
3/4/2011	Added modular power configuration information and graphics. Added CRS-1 and CRS-3 information. Also added technical updates and made minor editorial changes.
October 2010	Added information about the new MSC140 and FP140 line cards; CRS-16-FC140/S switch fabric card; 20-port, 14-port, 8-port, and 4-port 10-GE PLIMs; and the 1-port 100-GE PLIM. Minor editorial and technical changes were also made.
June 2010	Added information about the new modular AC and DC power solutions.
February 2010	Updated weight and floor loading values in Appendix A.
February 2007	Updated the document with technical corrections.
May 2007	Updated the document with information on DC power systems and other technical corrections.

Date	Change Summary
April 2006	Updated document with technical corrections.
July 2005	Added information about the S13 switch fabric card, the distributed route processor (DRP), and the DRP physical layer interface module (DRP PLIM). Also added information to describe the single-chassis (standalone) version of the chassis and the multishelf system version.
December 2004	Updated document with technical corrections.
July 2004	Initial release of this document.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, using the Cisco Bug Search Tool (BST), submitting a service request, and gathering additional information, see *What's New in Cisco Product Documentation*, at: http://www.cisco.com/c/en/us/td/docs/general/whatsnew/whatsnew.html.

Subscribe to *What's New in Cisco Product Documentation*, which lists all new and revised Cisco technical documentation as an RSS feed and delivers content 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

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

This chapter includes the following sections:

About the CRS 16-Slot Line Card Chassis

The 16 slots in the Cisco CRS 16-slot Line Card Chassis (LCC) can contain the following:

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

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

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

Each slot has the capacity of up to 200 gigabits per second (Gbps) ingress and 200 Gbps egress, for a total routing capacity per chassis of 6400 Gbps or 6.4 terabits per second (Tbps). (A terabit is 1 x 1012 bits or 1000 gigabits.)

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

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

- The Cisco CRS-X Carrier Routing System uses fabric cards designed for 200G operation (CRS-16-FC400/S or CRS-16-FC400/M cards in 200G mode).

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

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

The chassis has an integrated rack and does not require an external rack. The chassis is bolted to the facility floor. It contains its own power and cooling systems. Two types of power systems are available: fixed and modular. Both power configurations use either AC or DC power.

This system description is not a planning, an installation, or a configuration guide.

Chassis Components

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

The LCC contains:

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

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

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    - The MSC card is available in the following versions: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X (200G mode).
    - The FP card is available in the following versions: CRS-FP140, CRS-FP-X and CRS-FP-X-L (200G mode).
    - The LSP card is: CRS-LSP.
- Each line card can be associated with different types of PLIMs, which provide different interface speeds and technologies. Note the following:
    - The CRS-MSC-B card is compatible with both 40G CRS-1 and 140G CRS-3 fabric cards.
    - The CRS-MSC-140G card is only compatible with the 140G CRS-3 fabric card.
    - The CRS-MSC-X and CRS-MSC-L card (200G mode) is only compatible with the 400G CRS-X fabric card.
- A chassis midplane. The midplane connects a line card to its associated PLIM. The midplane design allows the line card to be removed from the chassis without having to disconnect the cables that are attached to the associated PLIM. The midplane, which also distributes power, connects the line cards to the switch fabric cards, and provides control plane interconnections, is not field replaceable by the customer.

- Two route processor (RP) cards. The RPs supply the intelligence of the system by functioning as the chassis system controller.

A Performance Route Processor (PRP) card is also available for the Cisco CRS 16-slot line card chassis. The PRPs perform the same functions as RPs, but provide enhanced performance for both route processing and system controller functionality.

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

- Two fan controller cards. The cards control the speed of high-speed fans in the fan trays to adjust the airflow for ambient conditions.
- Upper and lower fan trays. The trays push and pull air through the chassis. A removable air filter is located above the lower fan tray.
- Eight switch fabric cards. These fabric cards provide a three-stage Benes switch fabric for the system.
  - As a single-shelf (standalone) system, the line card chassis contains S123 switch fabric cards that provide all three stages of the three-stage Benes switch fabric.
  - As part of a multishelf system, the LCC contains S13 fabric cards that provide stage 1 and stage 3 of the switch fabric. S2 fabric cards in the FCCs provide stage 2 of the fabric, and fabric cables connect the fabric cards to each other.

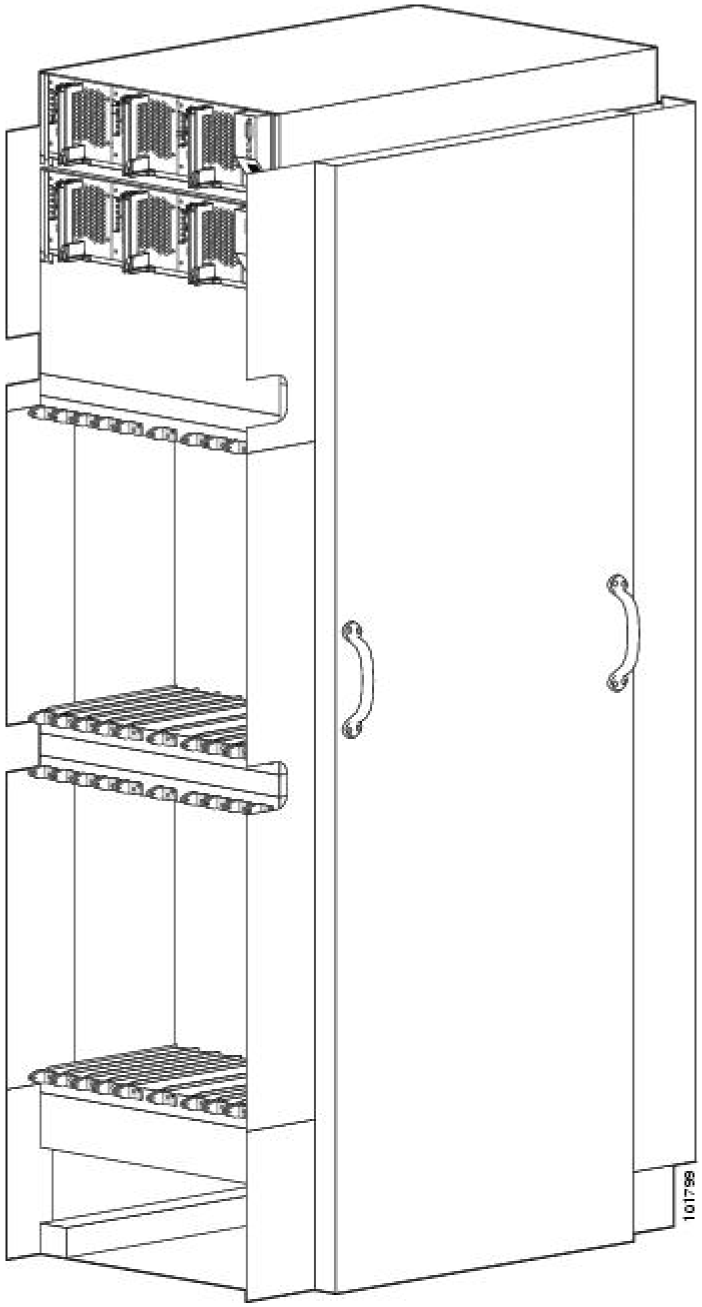
Caution The LCC, when installed as part of a multishelf system, supports either 40 G fabric cards (CRS-16-FC/M cards), 140 G fabric cards (CRS-16-FC140/M cards), or 400G fabric cards (CRS-16-FC400/M cards in 200G mode). A LCC with a mix of 40G, 140G, and 400G fabric cards is not a supported mode of operation. Such a mode is allowed temporarily only during the upgrade process.

Caution The LCC, when installed as a single-shelf (standalone) system, supports either 40G fabric cards (CRS-16-FC/S cards), 140G fabric cards (CRS-16-FC140/S cards), or 400G fabric cards (CRS-16-FC400/S cards). A LCC with a mix of 40G, 140G, and 400G fabric cards is not a supported mode of operation. Such a mode is temporarily allowed only during the upgrade process.

- Two alarm modules. The alarm modules provide external alarm system connections. The alarm modules are located in the AC or DC power shelves.
- Two types of power systems are available: fixed configuration power and modular configuration power. Both power configurations use either AC or DC power. Both Fixed and modular power support redundant power shelves and power modules.

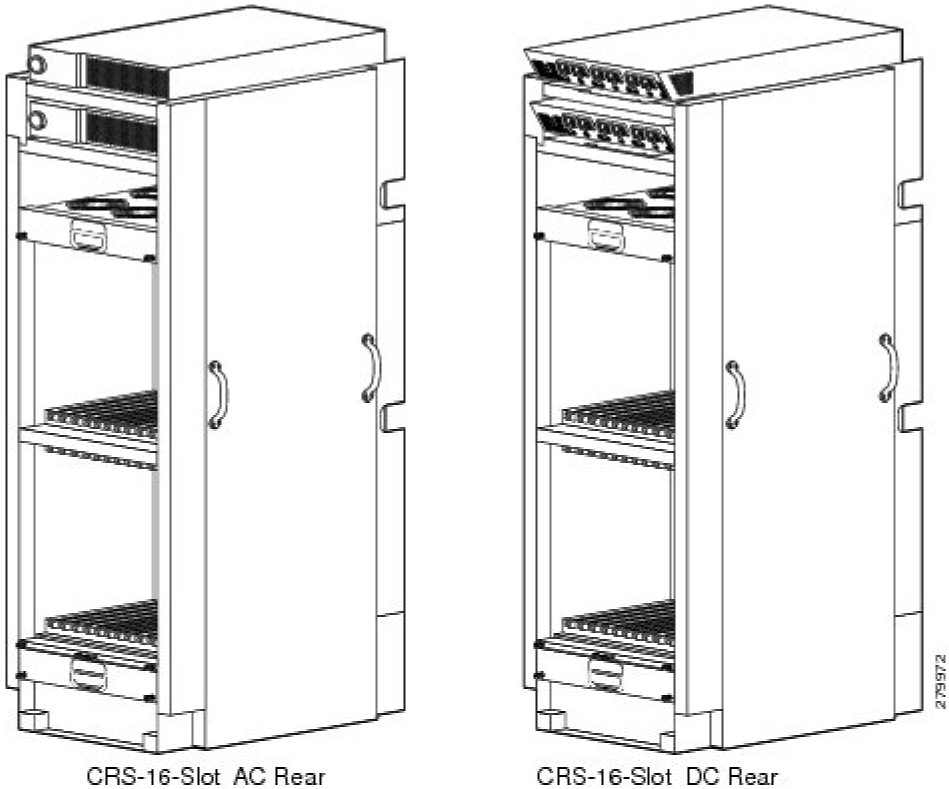
The following figure shows a front view of a Cisco CRS 16-slot line card chassis with an AC fixed configuration power supply. The front view of a Cisco CRS 16-slot line card chassis with a DC fixed configuration power supply is similar.

Figure 1: Line Card Chassis Front (PLIM) Side View - Fixed Configuration Power



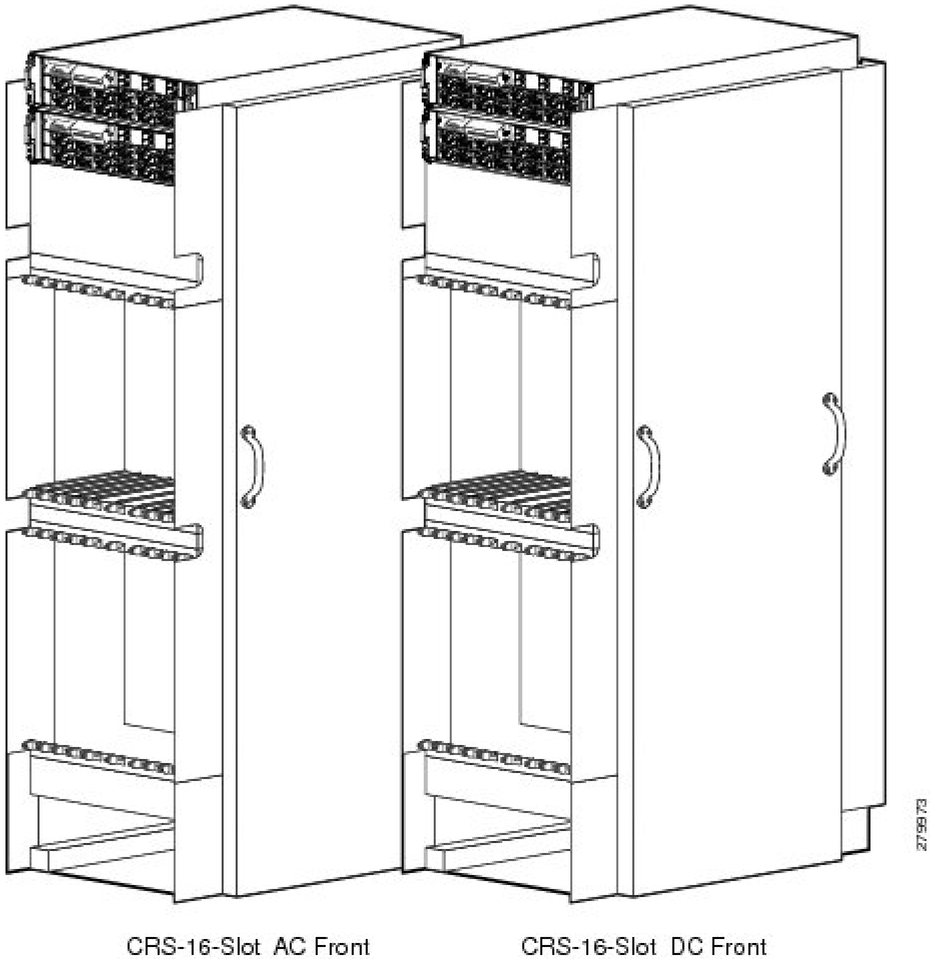
The following shows the rear view of a Cisco CRS 16-slot line card chassis with an AC and DC fixed configuration power supply.

Figure 2: Line Card Chassis Rear (MSC) Side View - Fixed Configuration Power



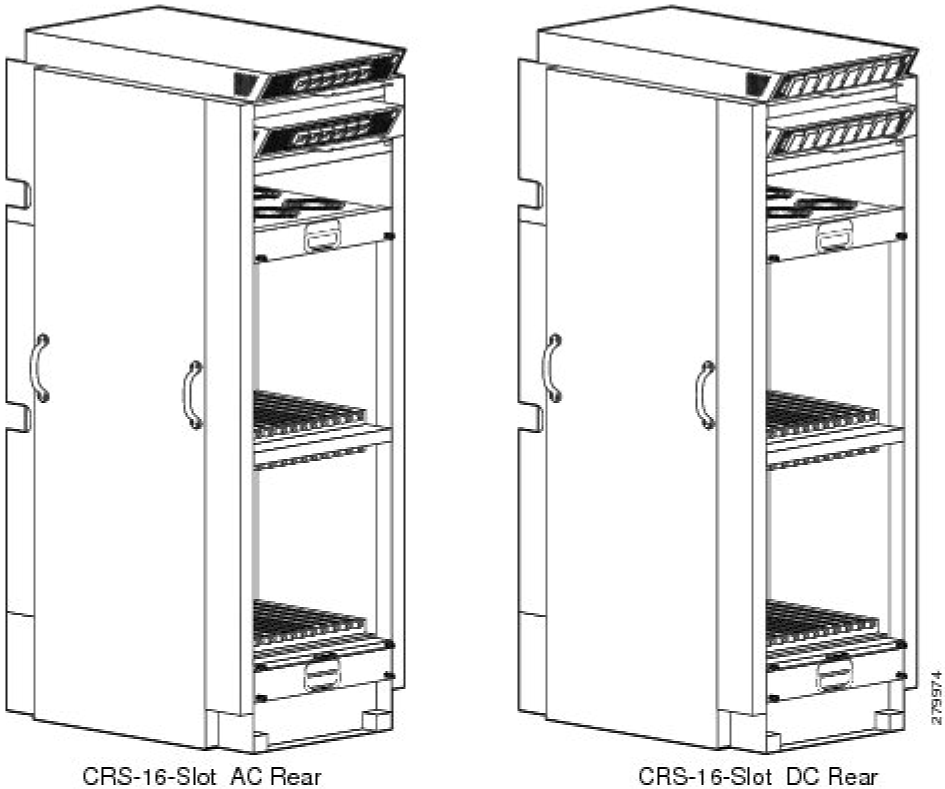
The following figure shows a front view of a Cisco CRS 16-slot line card chassis with an AC and DC modular configuration power supply.

Figure 3: Line Card Chassis Front (PLIM) Side View - Modular Configuration Power



The following figure shows the rear view of a Cisco CRS 16-slot line card chassis with an AC and DC modular configuration power supply.

Figure 4: Line Card Chassis Rear (MSC) Side View - Modular Configuration Power

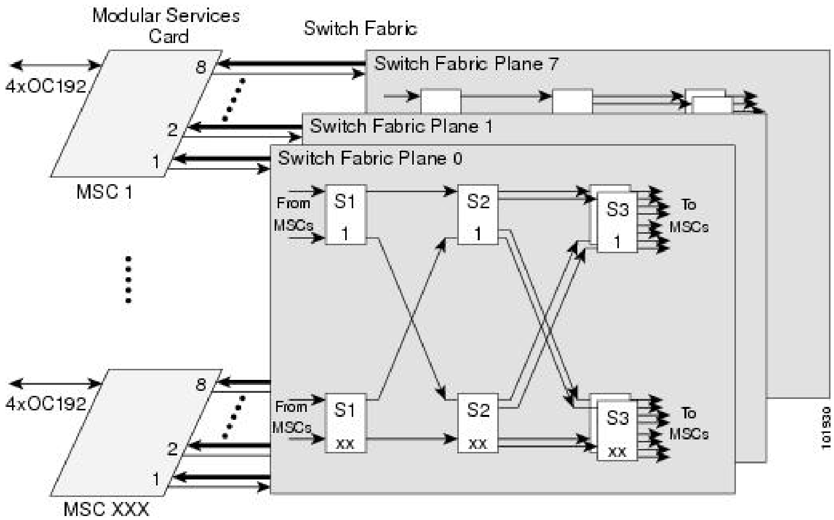


System Architecture

Every Cisco CRS 16-slot line card chassis has 16 MSC, FC, or LSP slots, each with a capacity of up to 200 gigabits per second (Gbps) ingress and 200 Gbps egress, for a total routing capacity per chassis of 6400 Gbps or 6.4 terabits per second (Tbps). (A terabit is 1 x 1012 bits or 1000 gigabits.)

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

Figure 5: Simple Cisco CRS Series Routing System Architecture



The figure illustrates the following concepts, which are common to all Cisco CRS routing systems:

- Packet data enters the line card through physical data interfaces located on the associated PLIM. In the figure, these physical interfaces are represented by four OC-192 ports.
- Data is routed through the line card, a Layer 3 forwarding engine, to the three-stage Benes switch fabric. Each line card and its associated PLIM have Layer 1 through Layer 3 functionality, and each line card can deliver line-rate performance (200 Gbps aggregate bandwidth). See Line Cards and Physical Layer Interface Modules, on page 73 for more information.
- The three-stage Benes switch fabric cross-connects the line cards in the routing system. The switch fabric is partitioned into eight planes (plane 0 to plane 7) and is implemented by several components. See Switch Fabric, on page 65 for more information.

Main Features

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

- A highly scalable router that provides a routing capacity between 1.28 and 6.4 Tbps.
- A wide range of interface speeds and types (for example, OC-48 packet-over-SONET (POS) and OC-192 POS), and a programmable MSC, FP, or LSP forwarding engine that provides full-featured forwarding at line-rate speeds.
- Redundancy and reliability features allow nonstop operation even during service upgrades of equipment, with no single points of failure in hardware or software.
- Potential for expanding from single-chassis to multichassis (or multishelf) systems.
- Partitioning into logical routers. A logical router (LR) is a set of 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 Overview

The Cisco CRS Series 16-slot line card chassis is the mechanical enclosure that contains the system components. The line card chassis is secured to the floor and has a locking front and optional rear doors. The line card chassis is a complete rack enclosed in a cabinet. A single-shelf (standalone) system consists of a single line card chassis only. A multishelf system consists of up to nine line cards and connects up to four switch fabric cards.

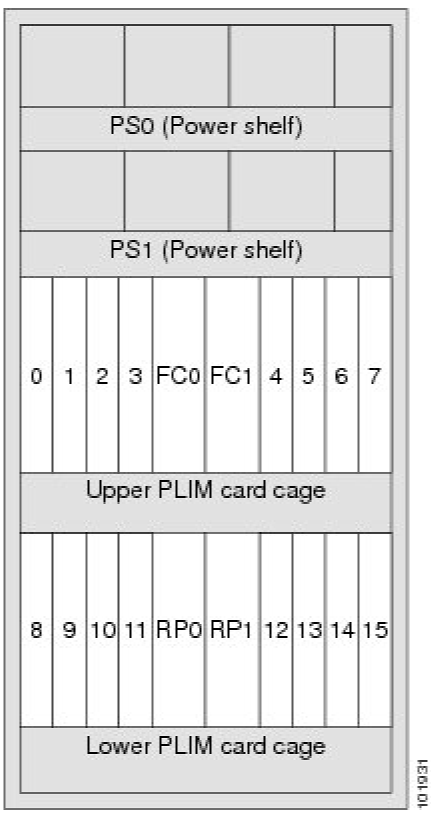
This section includes the following topics:

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.

The following figure shows the slot numbering on the front (PLIM) side of the Cisco CRS 16-slot line card chassis.

Figure 6: Line Card Chassis Slot Numbering—(PLIM Side)



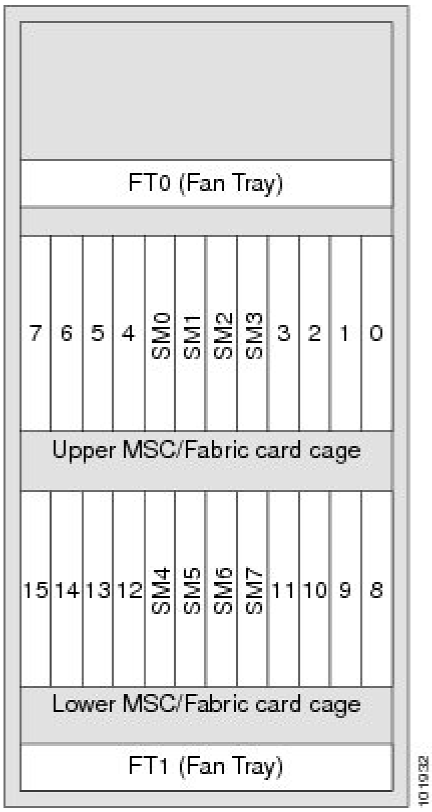
As shown in the above figure, the Cisco CRS 16-slot line card chassis numbers on the PLIM side of the chassis include the card cage with:

- Top power shelf (PS0)
- Lower power shelf (PS1)

- Upper PLIM card cage, left to right, eight PLIM slots (0, 1, 2, 3 and 4, 5, 6, 7) around two double-width fan controller card slots (FC0, FC1)
- Lower PLIM card cage, left to right, eight PLIM slots (8, 9, 10, 11 and 12, 13, 14, 15) around two double-width route processor card slots (RP0, RP1)

The figure below shows the slot numbers on the rear (MSC) side of the Cisco CRS 16-slot line card chassis.

Figure 7: Line Card Slot Numbers—Rear (MSC Side)



As shown in the above figure, the components on the rear (MSC) side of the 16-slot chassis include:

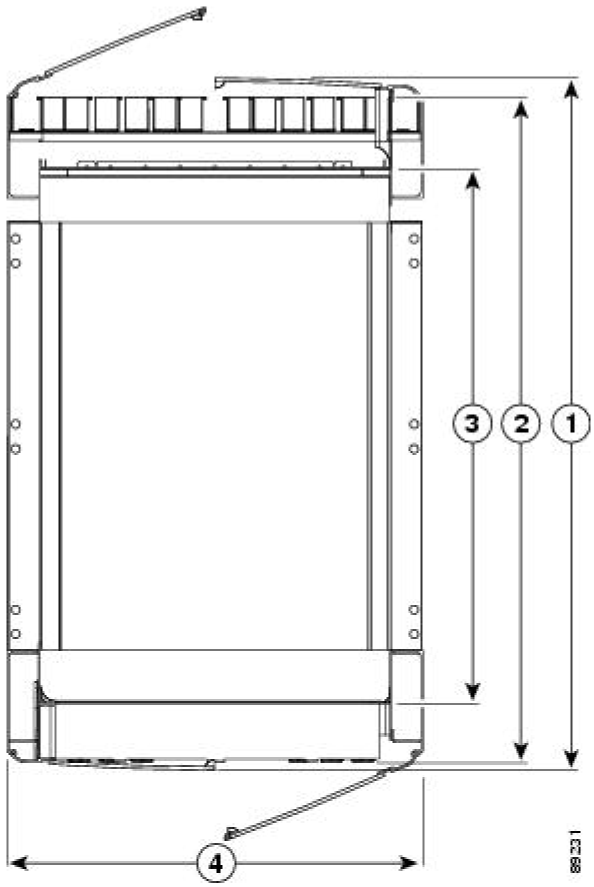
- Top fan tray (FT0)
- Upper MSC-switch fabric card cage, eight line card slots (7, 6, 5, 4, and 3, 2, 1, 0) around four switch fabric card slots (SM0, SM1, SM2, and SM3)
- Lower MSC-switch fabric card cage, eight line card slots (15, 14, 13, 12 and 11, 10, 9, 8) around four switch fabric card slots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

The MSC slot numbers are reversed from the PLIM slot numbers on the other side of the chassis. Because an MSC is associated and actually mates through the midplane with a PLIM, 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 it 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 (2 through 15).

Chassis Footprint

The following figure is a top view of the line card chassis footprint (with optional front and rear cosmetics installed).

Figure 8: Top View of CRS 16-Slot Line Card Chassis



1	40.2 in. (102.2 cm)	2	38.3 in. (97.2 cm)
3	32.8 in. (83.2 cm)	4	23.5 in. (59.8 cm)

The dimensions listed in the figure show the:

- Depth of the line card chassis with the doors attached and closed, which is 40.2 in. (102.2 cm).
- Depth of the front cable management to the rear cable management, excluding the doors, which is 38.3 in. (97.2 cm).
- Distance from the front surface to the rear surface of the chassis, excluding cable management and the doors, which is 32.8 in. (83.2 cm).
- Width of the chassis, which is 23.5 in. (59.8 cm).

Note Because there is no external switch-fabric interconnection cabling on the single line card chassis system, the rear door is optional.

Cable Management

The Cisco CRS 16-slot line card chassis has cable management features for both the front (PLIM) and rear (MSC) sides of the chassis. The PLIM side has horizontal cable management features above both card cages. The horizontal cable management trays have a special telescoping feature that allows them to be extended when the chassis is upgraded with higher-density cards. This extension feature also helps when installing the cables in the chassis.

Note The front doors need to be removed from the chassis when the telescoping feature is in use.

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

Chassis Exterior Components

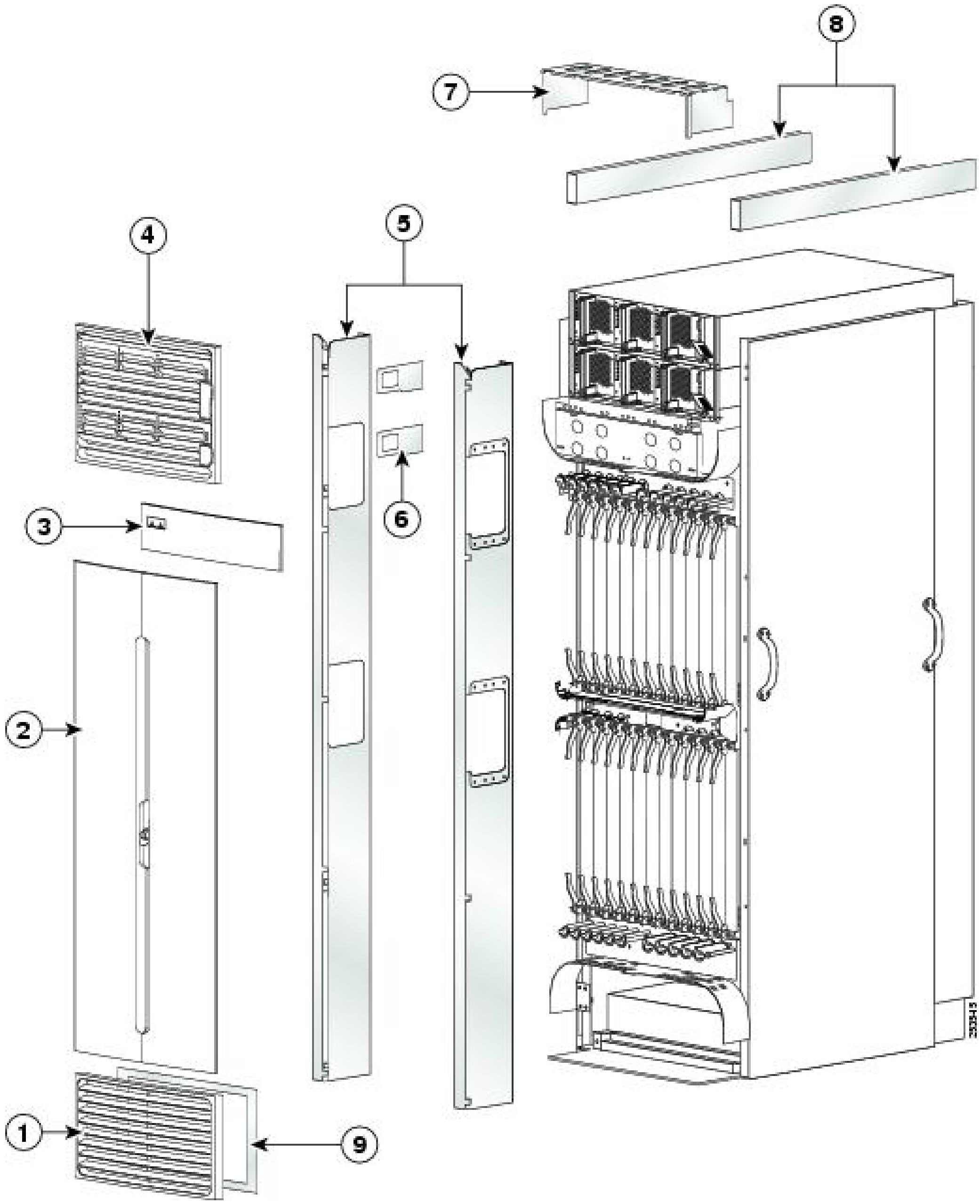
This section contains information about the exterior cosmetic components.

The Cisco CRS 16 slot line card chassis is shipped with exterior cosmetic components for the front (PLIM) side and rear (MSC) side of the chassis.

Note Some exterior cosmetic components are not required to be installed.

The following figure shows the exterior cosmetics for the front (PLIM) side of a chassis with fixed configuration power shelves installed. The front view of a Cisco CRS 16-slot line card chassis with modular configuration power shelves installed is similar.

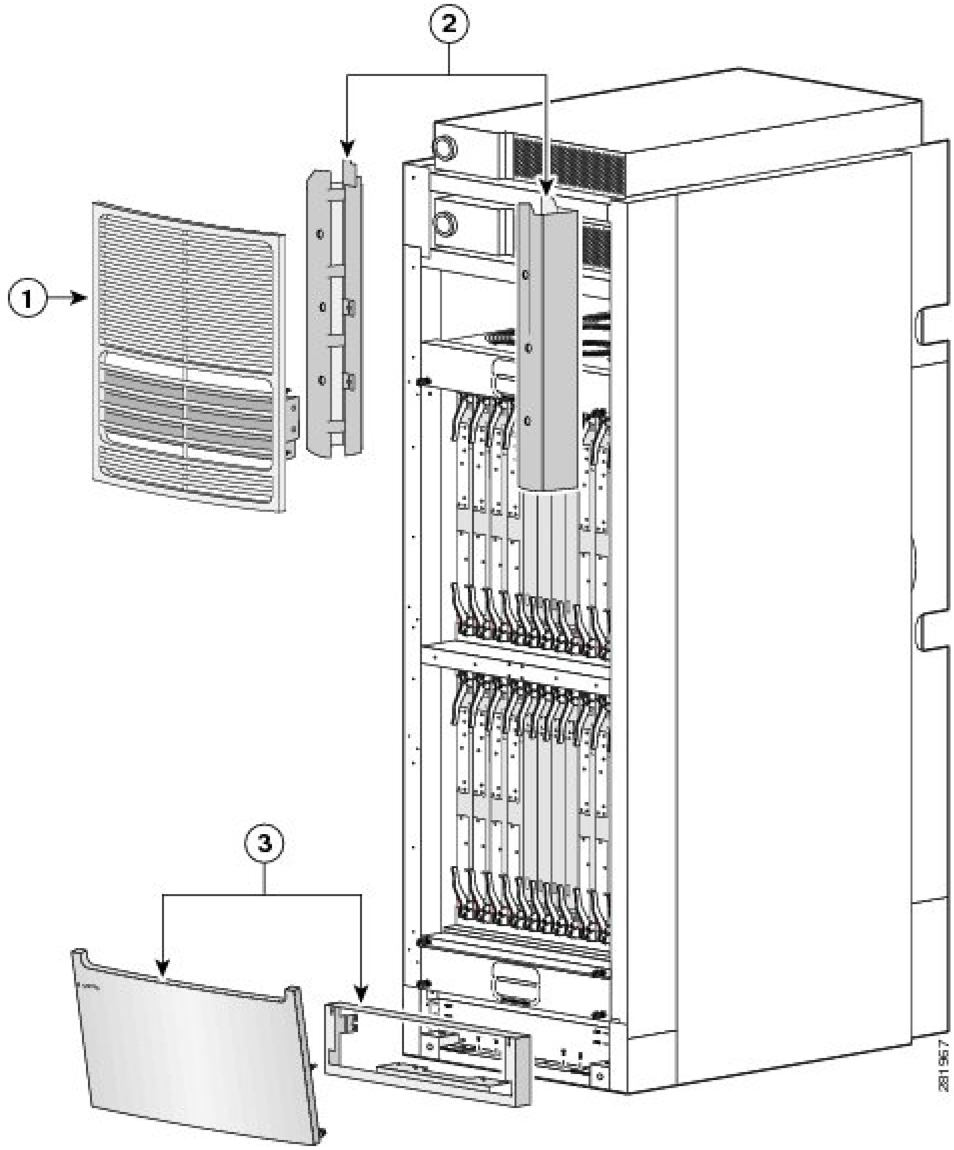
Figure 9: Front (PLIM) Side Exterior Cosmetic Components—Fixed Configuration Shown



1	Lower grille	6	Power shutoff extenders (fixed configuration power only)
2	Doors	7	Upper grille support
3	Logo bezel	8	Unistruts
4	Upper grille	9	Lower grille frame
5	Vertical cable troughs		

The following figure shows the exterior cosmetics on the rear (MSC) side of a Cisco CRS 16-slot line card chassis, with fixed configuration power shelves installed. The upper air grille and vertical brackets are shipped with the Cisco CRS 16 slot line card chassis, but are not pre-installed on the system the system. The rear view of a Cisco CRS 16-slot line card chassis with modular configuration power shelves installed is similar.

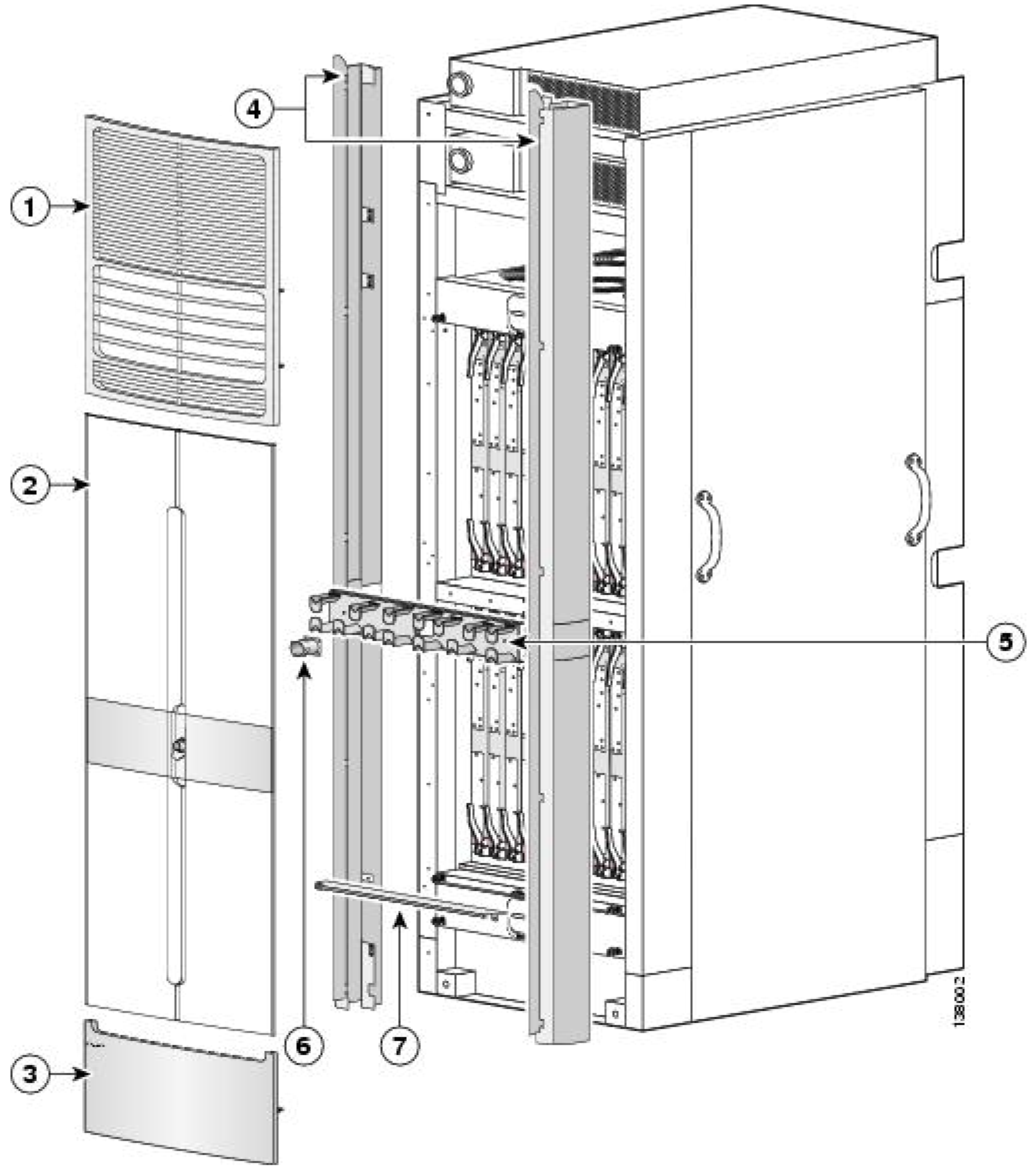
Figure 10: Rear (MSC) Side Exterior Cosmetic Components—Fixed Configuration Shown



1	Upper air grille	3	Rear kick panel kit
2	Vertical brackets		

The following figure shows the exterior cosmetics for the rear (MSC) side of an optional multi chassis system with fixed configuration power shelves installed. The rear view of an optional multi chassis system with modular configuration power shelves installed is similar.

Figure 11: Rear (MSC) Side Exterior Cosmetic Components—Optional Multi Chassis System



1	Upper air grille	5	Midchassis horizontal cable management bracket
2	Doors	6	Strike tube
3	Lower chassis cosmetic bezel	7	Door stop
4	Vertical cable troughs		

Hardware Compatibility

The following table lists the compatibility of 40G CRS, 140G CRS, and 400G CRS fabric, forwarding, and line card components for the CRS 16-slot system.

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

Table 2: CRS Compatibility Matrix

Switch Fabric	RP/DRP	MSC/FP/LSP	PLIMs
CRS-16-FC/S	RP-A (CRS-16-RP), RP-B (CRS-16-RP-B), DRP-B (CRS-DRP-B)	CRS-MSC-B	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
CRS-16-FC140/S	RP-A (CRS-16-RP), RP-B (CRS-16-RP-B), 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
CRS-16-FC140/S	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G)	CRS-MSC-140G	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-XFP14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
CRS-16-FC140/S	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G))	CRS-FP140	1OC768-DPSK/C 1OC768-ITU/C 1OC768-POS-SR 4-10GE-ITU/C 8-10GBE CRS1-SIP-800 4-10GE 42-1GE 2-10GE-WL-FLEX 4-10GBE-WL-XFP 8-10GBE-WL-XFP14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE
CRS-16-FC140/S	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G)	CRS-LSP	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-XFP14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE

Switch Fabric	RP/DRP	MSC/FP/LSP	PLIMs
CRS-16-FC400/S	PRP (CRS-16-PRP-6G, CRS-16-PRP-12G)	CRS-MSC-X and CRS-MSC-X-=L (200G)	4x100GE-LO 40x10GE-WLO2x100GE-FLEX40
		CRS-FP-X and CRS-FP-X-L (200G)	
		CRS-LSP	

CHAPTER 2

Cisco CRS 16-Slot Chassis Power Systems

This chapter includes the following sections:

Power specifications are provided in Technical Specifications, on page 117

Power Systems Overview

The chassis power system provides power to chassis components and is made up of two power shelves that contain power modules. Each power shelf is connected to a separate and independent power source. Input power enters the power shelves and is processed by the power modules before being distributed to the components in the chassis.

The line card chassis can be either DC or AC powered. There are two options for power systems:

Fixed configuration power system—consists of two power shelves, AC rectifiers or DC power entry modules (PEMs), and alarm modules. The AC version requires either 3-phase AC-Delta or 3-phase AC-Wye input power to the power shelves. In redundant configuration, the fixed configuration power system provides power sharing per power zone. The fixed configuration power system includes SNMP MIBS and XML support.

Modular configuration power system —consists of two power shelves, AC or DC power modules (PMs), and alarm modules. However, unlike the fixed configuration power system, the AC version of the modular configuration power system requires single-phase AC input power to the power shelves; there is no 3-phase AC-Wye or AC-Delta. If you have 3-phase AC Delta or AC Wye at your equipment, a *Cisco CRS 3-phase AC power distribution unit (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 3-phase AC PDU* which is required to convert 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 http://www.cisco.com/en/US/docs/routers/crs/crs1/mux_box/installation/quick_start/guide/crs_pdu_qs.html Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide .

Maximum input power requirements for line card chassis with a fixed configuration power system installed are as follows:

- DC-powered chassis requires up to a maximum of 13,895 W (13.9 kW) of DC input power when the chassis is fully loaded (95% efficiency).
- AC-powered chassis requires up to a maximum of 15,000 W (15.0 kW) of AC input power when the chassis is fully loaded (88% efficiency).

Maximum input power requirements for line card chassis with a modular configuration power system installed are as follows:

- DC-powered chassis requires up to a maximum of 14,667 watts (14.7 kW) of DC input power when the chassis is fully loaded (88% efficiency).
- AC-powered chassis requires up to a maximum of 14,348 watts (14.4 kW) of AC input power when the chassis is fully loaded (92% efficiency).

Note If you have a *Cisco CRS 3-phase AC PDU* installed, six AC PMs are required to be installed in each modular configuration AC power shelf to maintain a balanced 3-phase power load.

Note These power requirements are for a fully loaded chassis with sixteen PLIMs. A chassis with fewer PLIMs uses slightly less power. However, it is a good idea to allocate this much power for each chassis to ensure that enough power is available for future system expansion.

Power Component Information Common to the Two Types of Power Systems

This section introduces information shared by the fixed configuration power components and the modular configuration power components in the following topics:

Basic Chassis Power Details

The Cisco CRS 16-Slot line card chassis can be configured with either an AC-input power subsystem or a DC-input power subsystem. Site power requirements differ, depending on the source voltage used. Follow these precautions and recommendations when planning power connections to the router:

- Check the power at your site before installation and periodically after installation to ensure that you are receiving clean power. Install a power conditioner, if necessary.

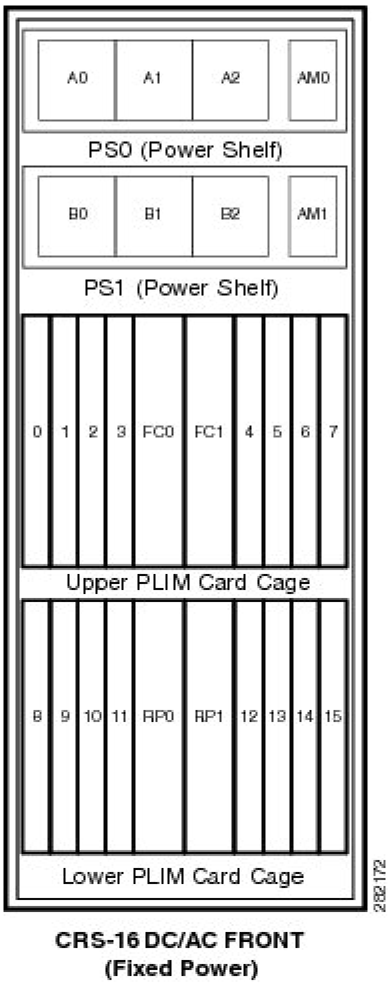
- Install proper grounding to avoid damage from lightning and power surges.

The Cisco CRS 16-slot line card chassis requires that at least one power shelf and its components be installed to operate properly; however, if you install only one power shelf and its components, your system will not be 2N redundant.

Two types of power shelves exist in fixed and modular configurations:

- Fixed configuration—AC shelf and a DC shelf. A fixed configuration AC power shelf houses the AC rectifiers, while a fixed configuration DC power shelf houses the DC PEMs. The following figure shows the fixed configuration power supply shelves and alarm modules.

Figure 12: Line Card Chassis DC/AC Fixed Configuration Power—Slot Numbering

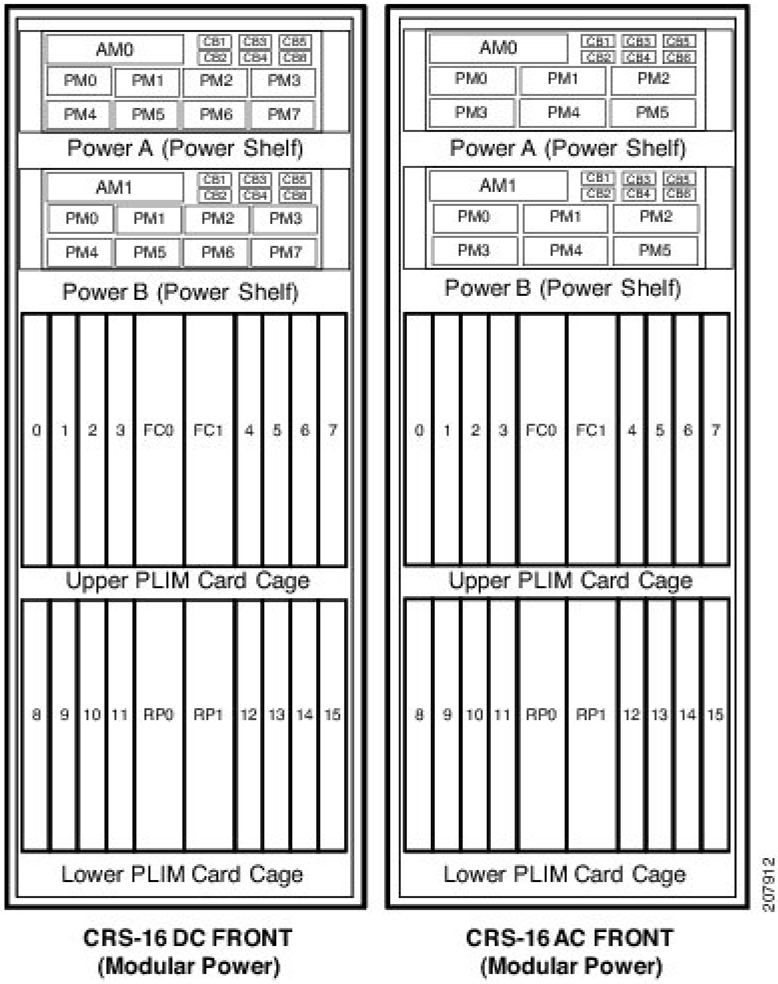


- Modular configuration—AC power shelf houses the AC PMs, while a modular configuration DC power shelf houses the DC PMs. It is required that you use only one type of power shelf in a chassis at a time.

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

The following figure shows the DC and AC power modular numbering in a modular power configuration.

Figure 13: Line Card Chassis DC and AC Modular Configuration Power—Slot Numbering



Chassis Grounding Guidelines

The16-slot chassis has a safety earth ground connection in conjunction with power cabling to the fixed configuration power shelves. The chassis allows you to connect the central office ground system or interior equipment grounding system to the bonding and grounding receptacles on the router chassis, when either a fixed or modular configuration power system is installed. Two threaded ground inserts are located on top of the chassis rear (MSC) side panel to the left of the lower power shelf.

DC Power Systems

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

- In the fixed configuration power system, each power shelf contains three DC PEMs. The power shelves and DC PEMs are field replaceable. Each DC PEM has its own circuit breaker.

- In the modular configuration power system, each shelf can accept up to eight DC PMs. The power shelves and DC PMs are field replaceable.

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

Fixed Configuration DC Power

The Cisco CRS 16-slot line card chassis fixed configuration DC power system provides 13,200 watts to power the chassis. Due to its power zones, the Cisco CRS 16-slot line card chassis using fixed configuration power requires a total of 12 dedicated 60 A DC input power connections, two for each DC PEM, to provide redundant DC power to all six power zones of Cisco CRS 16-slot line card chassis midplane. We recommend that you have two separate, redundant –48/-60 DCV power battery sources to provide power to the Cisco CRS 16-slot line card chassis. Connect the six 60 A DC inputs to the upper power shelf (PS0) to one battery, and the other six inputs to the lower power shelf (PS1) to the other battery.

At sites where the Cisco CRS 16-slot line card chassis is equipped with a DC-input power supply shelf and DC PEMs, observe the following guidelines:

- All power connection wiring should follow the rules and regulations in the National Electrical Code (NEC) and any local codes.
- Each DC-input PEM connection is rated at 60 A maximum. A dedicated, commensurately rated DC power source is required for each PEM connection.
- For DC power cables, we recommend that you use commensurately rated, high-strand-count copper wire cable. Each DC PEM requires two –48/-60 VDC inputs, which means twelve cables in total (six pairs) for each power shelf, plus the grounding wire. The length of the cables depends on the router location. These cables are not available from Cisco Systems; they are available from any commercial vendor.

Modular Configuration DC Power

The Cisco CRS 16-slot line card chassis modular configuration DC power system can provide up to 16,800 watts to power the chassis. However, by default, the power capability of a system when shipped, with 6 PMs per power shelf, is 12,600 watts.

At sites where the Cisco CRS 16-slot line card chassis is equipped with a DC-input power supply shelf and DC PMs, observe the following guidelines:

- All power connection wiring should follow the rules and regulations in the National Electrical Code (NEC) and any local codes.
- Each DC-input PM connection is rated at 60 A maximum. A dedicated, commensurately rated DC power source is required for each PM connection.
- Each PM requires one –48/-60 VDC input, which leads to twelve wires in total (six pairs) for each power shelf and one shelf grounding wire.
- For DC power cables, we recommend that you use commensurately rated, high-strand-count copper wire cable. Each DC PM requires two –48/-60 VDC inputs, which means sixteen cables in total (eight pairs) for each power shelf, plus the grounding cable. The length of the cables depends on the router location. These cables are not available from Cisco Systems; they are available from any commercial vendor.

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

Each modular configuration DC power shelf supports up to eight DC PMs. The power shelves and DC PMs are field replaceable.

Note Although each modular configuration DC power shelf can support up to eight DC PMs, the modular configuration DC power shelf is shipped with six DC PMs per shelf.

AC Power Systems

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

- Fixed configuration power system—each shelf contains three AC power rectifiers. The power shelves and AC power rectifiers are field replaceable. Each shelf and AC power rectifier has its own circuit breaker.
- Modular configuration power system—each shelf can contain up to six AC PMs. The power shelves and the AC PMs are field replaceable.

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

Fixed Configuration AC Power

The Cisco CRS 16-slot line card chassis fixed configuration AC power system provides 13,200 watts to power the chassis. Two versions of the 3-phase AC power shelf are available to provide either an AC Delta or an AC Wye input configuration. Each of the AC power shelf versions has a different Cisco part number to distinguish the Wye from the Delta configuration. The AC connections to the Cisco CRS 16-slot line card chassis are made to terminal blocks on the AC power shelves that have been hard wired for a Wye or Delta configuration. All chassis should have two power shelves of the same type, that is, two Delta or two Wye AC power shelves.

In the fixed configuration power system, each shelf supports three AC-to-DC rectifiers that are field replaceable. The AC-to-DC rectifiers convert 200-to-240 VAC power to –54 VDC used by the Cisco CRS 16-slot line card chassis.

The AC Wye power shelf has a Wye 3-phase, 5-wire connection: 200 to 240 (L-N)/346 to 415 (L-L) VAC, 3W+N+PE, 50 to 60 Hz, 25 A. For redundant operation, two 3-phase Wye branch circuits are required: 40 A (North America) or 32 A (International). One power connection is required for each power shelf.

The AC Delta power shelf has a Delta 3-phase, 4-wire connection: 200 to 240 VAC, 3-phase, 3W+PE, 50 to 60 Hz, 42 A. For redundant operation, two 3-phase Delta 60-A branch circuits are required. One power connection is required for each power shelf.

Note The power cables for the power shelves are shipped unattached and need to be installed.

Modular Configuration AC Power

The Cisco CRS 16-slot line card chassis modular configuration AC power system can provide up to 18,000 watts to power the chassis. However, by default, the power capability of a system when shipped, with 5 AC PMs per power shelf, is 15,000 watts.

Each modular configuration power shelf supports up to six PMs. The power shelves and PMs are field replaceable.

Note Although the system is capable of delivering this level of power, depending on the hardware deployed at your site, your system may not consume, or be capable of consuming, this much power.

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

Each modular configuration AC PM has the following input power requirements:

- Single-phase, 200 to 240 VAC nominal, 50 to 60 Hz, 16 A.

Each power shelf contains six IEC-320-C22 receptacles which can accept up to six IEC-320-C21 connector cords, depending on how many AC PMs are installed in the shelf.

Note In order to maintain a balanced 3-phase power load, six AC PMs are required to be installed in a Cisco CRS 16-slot line card chassis AC modular configuration power shelf.

Note If single-phase AC power is available at your site, we recommend that you use appropriate short-circuit protection in compliance with national and local electrical codes.

Fixed Configuration Power Supply

This section contains the following topics:

- AC Fixed Configuration Power Systems, on page 34
- Alarm Module for Fixed Configurations, on page 39

The fixed configuration power includes the following major components:

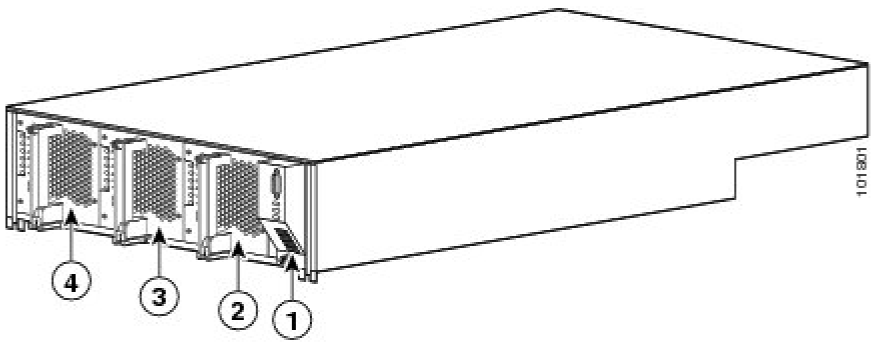
- Two (redundant) AC or DC power shelves
- Three AC rectifiers or three DC power entry modules (PEMs) per power shelf

- Alarm modules, one per power shelf

In the fixed configuration power system, different power shelves are used for DC, AC Wye, and AC Delta input power. Each power shelf contains three AC rectifiers or three DC PEMs and an alarm module. The following figure shows a front view of a fixed configuration AVC Wye power shelf with AC rectifiers and alarm module installed. The front view of a fixed configuration AC Delta power shelf with AC rectifiers and alarm module installed and a fixed configuration DC power shelf with DC PEMs and alarm module installed are similar.

Note Although differences exist among the different power shelf types (AC Wye, AC Delta, and DC), they are installed in the same manner.

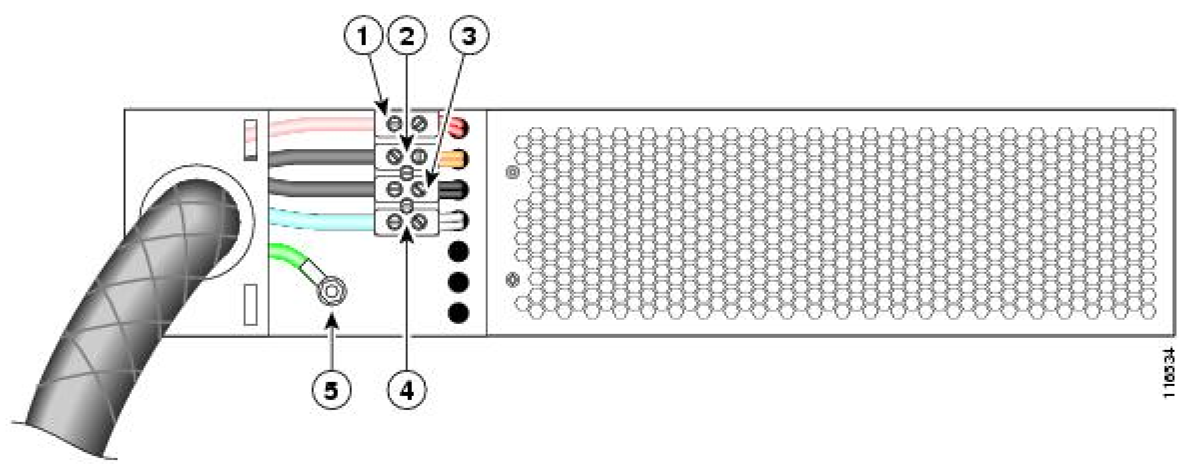
Figure 14: AC Wye Power Shelf with AC Rectifiers Installed - Front View



1	**Alarm module**	3	**AC rectifier 1**
2	AC rectifier 2	4	AC rectifier 0

The following figure shows the AC Wye power shelf with a 5-wire Wye cord and an IEC 60309 plug rated 415 V/32 A, IP44, 3W+N+PE; it is 4 meters long. The power shelf has five corresponding leads: three active (hot), one neutral, and one ground.

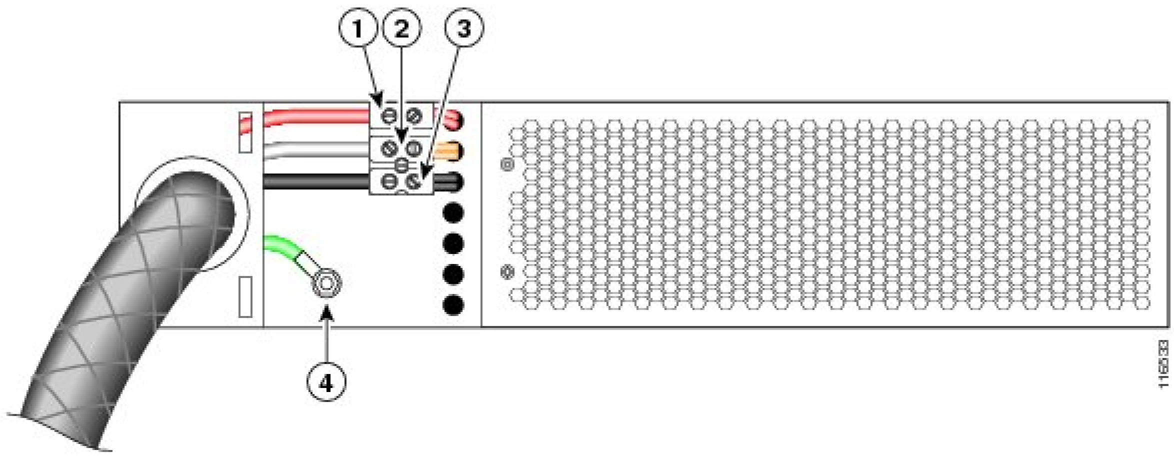
Figure 15: Fixed AC Wye Power Shelf - Rear View



1	Lead 1 (L1)	4	Lead 4 (L4, neutral)
2	Lead 2 (L2)	5	Ground
3	Lead 3 (L3)		

The following figure shows the Delta power shelf. The power cord has a 4-pin 460P9W plug (3W+PE) that plugs into a 460R9W power receptacle.

Figure 16: Fixed Delta Power Shelf - Rear View



1	Lead 1 (L1)	3	Lead 3 (L3)
2	Lead 2 (L2)	4	Ground

Fixed Configuration Power Architecture

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

For details showing the CRS 16-slot line card chassis power routing distribution for a fixed DC configuration, see Figure 19: CRS 16-Slot Line Card Chassis Power Distribution - Fixed DC Configuration and for an AC fixed configuration, see Figure 22: Cisco CRS 16-Slot Line Card Chassis Power Distribution - Fixed AC Configuration .

Input power enters the chassis through the two power shelves and is distributed to the A or B power bus. Both bus bars distribute power through the midplane to the MSC, PLIM, switch fabric, RP, and fan controller card slots.

- The A power shelf supplies –54 VDC to the A bus bar.
- The B power shelf supplies –54 VDC to the B bus bar.

Because chassis components are powered by both A and B power inputs, the Cisco CRS 16-slot line card chassis can continue to operate normally if:

- One AC PEM or DC PEM fails
- One entire power shelf fails
- One bus bar 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 to 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 component, also called hot-swapping.

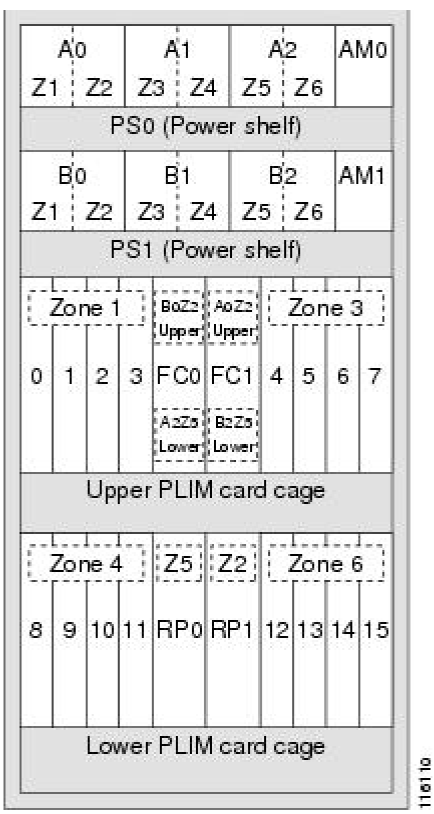
Fixed Configuration Chassis Power Zones

Chassis power zones distribute power throughout the chassis and provide redundant power to chassis slots. In the fixed configuration power system, each power zone is powered by a set of power modules (one module from each power shelf). In each set of power modules (A0 and B0, A1 and B1, and A2 and B2) each power module is considered a backup for the other. Each set of power modules provides power to the same set of chassis power zones. If either power module fails, the other continues to provide power to those slots.

The AC or DC fixed configuration power system distributes power in the chassis through six power zones, which provide power redundancy and reliability. Each power zone receives power from both bus bars (A and B), which ensures that each card and module in the chassis is powered by both power shelves.

A Cisco CRS 16-slot line card chassis can lose a single power module or an entire power shelf and still have the power to operate for a fixed configuration. For a power zone to lose complete power, a power module in each power shelf would have to fail. The following figure shows the power zones on the PLIM side of the chassis with a fixed configuration power system installed.

Figure 17: Line Card Chassis Power Zones—(PLIM Side) Fixed Configuration Power



As shown in the figure, each power module (DC PEM or AC rectifier) powers two power zones:

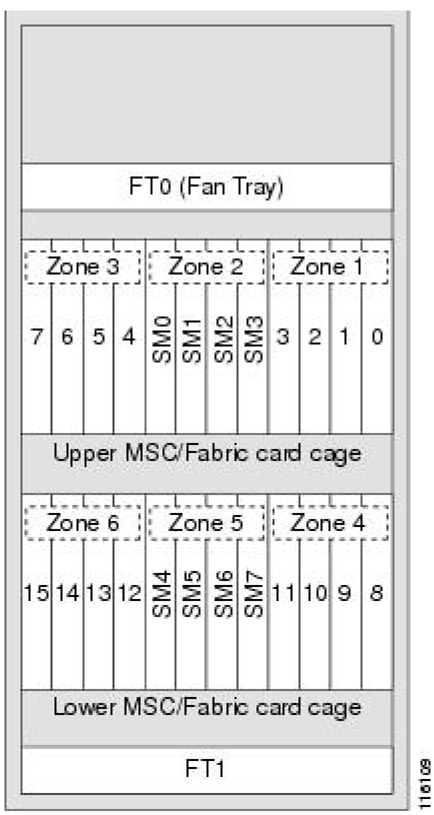
- Power module A0 powers power zones 1 and 2 (Z1 and Z2)
- Power module A1 powers power zones 3 and 4 (Z3 and Z4)
- Power module A2 powers power zones 5 and 6 (Z5 and Z6)
- Power module B0 powers power zones 1 and 2 (Z1 and Z2)
- Power module B1 powers power zones 3 and 4 (Z3 and Z4)
- Power module B2 powers power zones 5 and 6 (Z5 and Z6)
- The upper fan tray is powered by power zone 2 (A0Z2 and B0Z2) and the lower fan tray is powered by power zone 5 (A2Z5 and B2Z5) through the fan controller cards.
- Alarm module AM0 is assigned to the upper power shelf PEM A0, A1, A2
- Alarm module AM1 is assigned to power shelf B, for B0, B1, B2

The figure also shows which power zones power which chassis slots:

- Power zone 1 (Z1) powers chassis slots 0, 1, 2, and 3
- Power zone 2 (Z2) powers chassis slots FC0 (upper), FC1 (upper) and RP1
- Power zone 3 (Z3) powers chassis slots 4, 5, 6, and 7
- Power zone 4 (Z4) powers chassis slots 8, 9, 10, and 11
- Power zone 5 (Z5) powers chassis slots FC0 (lower), FC1 (lower) and RP0
- Power zone 6 (Z6) powers chassis slots 12, 13, 14, and 15

The following figure shows the six power zones on the MSC side of the Cisco CRS 16-slot line card chassis.

Figure 18: Line Card Chassis Power Zones—(MSC Side) Fixed Configuration Power



The above figure shows which power zones power which chassis slots on the MSC side of the chassis:

- Power zone 1 (Z1) powers chassis slots 0, 1, 2, and 3
- Power zone 2 (Z2) powers chassis slots SM0, SM1, SM2, and SM3
- Power zone 3 (Z3) powers chassis slots 4, 5, 6, and 7
- Power zone 4 (Z4) powers chassis slots 8, 9, 10, and 11
- Power zone 5 (Z5) powers chassis slots SM4, SM5, SM6, and SM7
- Power zone 6 (Z6) powers chassis slots 12, 13, 14, and 15

The fan trays (FT0 and FT1) receive their operating power from the fan controller cards (FC0 and FC1).

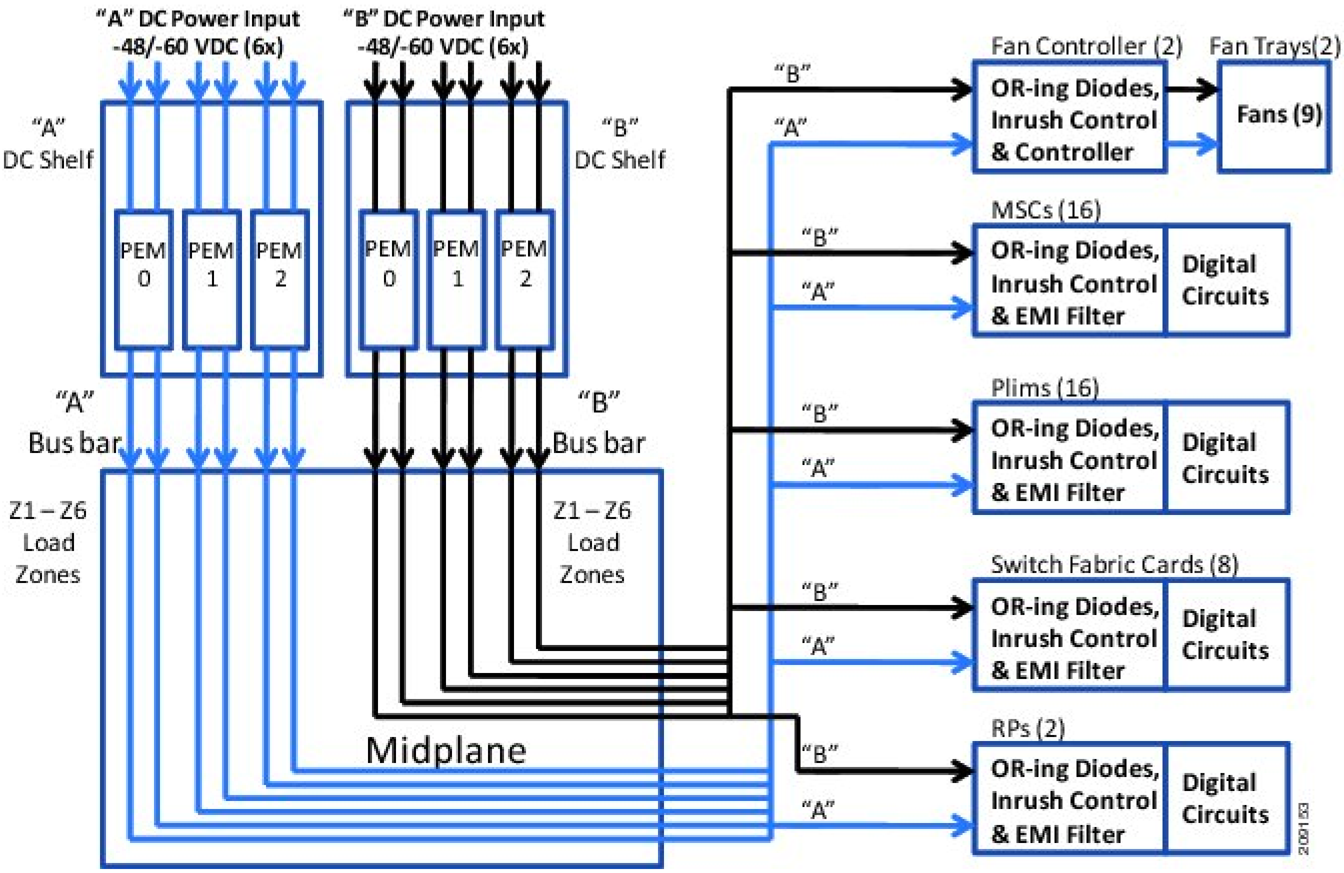
DC Fixed Configuration Power Systems

The Cisco CRS 16-slot line card chassis DC fixed configuration power system provides 13,200 Watts to power the Cisco CRS 16-slot line card chassis. The DC power system, which provides 2N power redundancy for the routing system, contains the following components:

- Two DC power shelves—Contain the input DC power connectors and house the DC power entry modules (PEMs).
- Three DC PEMs (per power shelf)—Take input DC power from the power shelf, provide filtering and surge protection, and pass the power to either the A or B bus bar. Each PEM is field replaceable.
- Each power shelf has its own circuit breaker, and each PEM has its own circuit breaker.
- Each AC or DC power shelf contains an alarm module that monitors the health of the entire system including the power system and provides an external interface for system alarms.

The following figure shows the 16-slot line card chassis power routing distribution for a fixed DC configuration.

Figure 19: CRS 16-Slot Line Card Chassis Power Distribution - Fixed DC Configuration



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

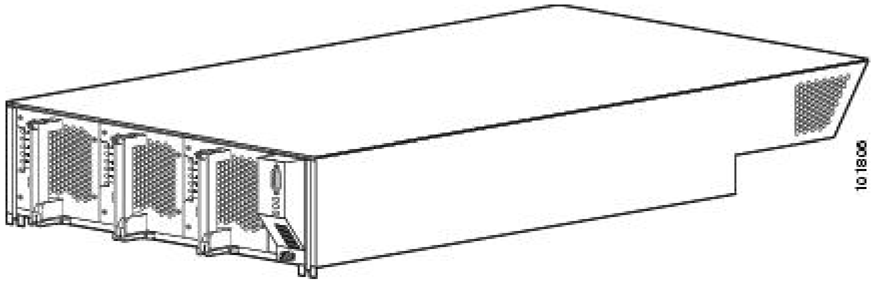
Input power enters the chassis through the two power shelves and is distributed to the A or B power bus. Both bus bars distribute power through the midplane to the MSC, PLIM, switch fabric, RP, and fan controller card slots.

- The A power shelf supplies –54 VDC to the A bus bar.
- The B power shelf supplies –54 VDC to the B bus bar.

Fixed Configuration DC Power Shelf

The fixed configuration DC power shelf is the enclosure that houses three DC PEMs, the alarm module, and power distribution connections and wiring. The power shelf installs in the Cisco CRS 16-slot line card chassis from the front and plugs into the chassis power interface connector panel.

Figure 20: DC Fixed Configuration Power Shelf)



Each power shelf has six pair of input power terminals and each –48/–60 VDC (nominal), 60 A service return. Each connector consists of two terminals (– and +). Each terminal consists of two M6 threaded studs, 0.6 inches long, and centered 0.6 inches apart. The terminals have a safety cover and there is strain relief on the power shelf to secure the input power cables.

The power shelf also has a service processor that monitors the condition of each PEM and provides status signals that indicate the health of the power supplies.

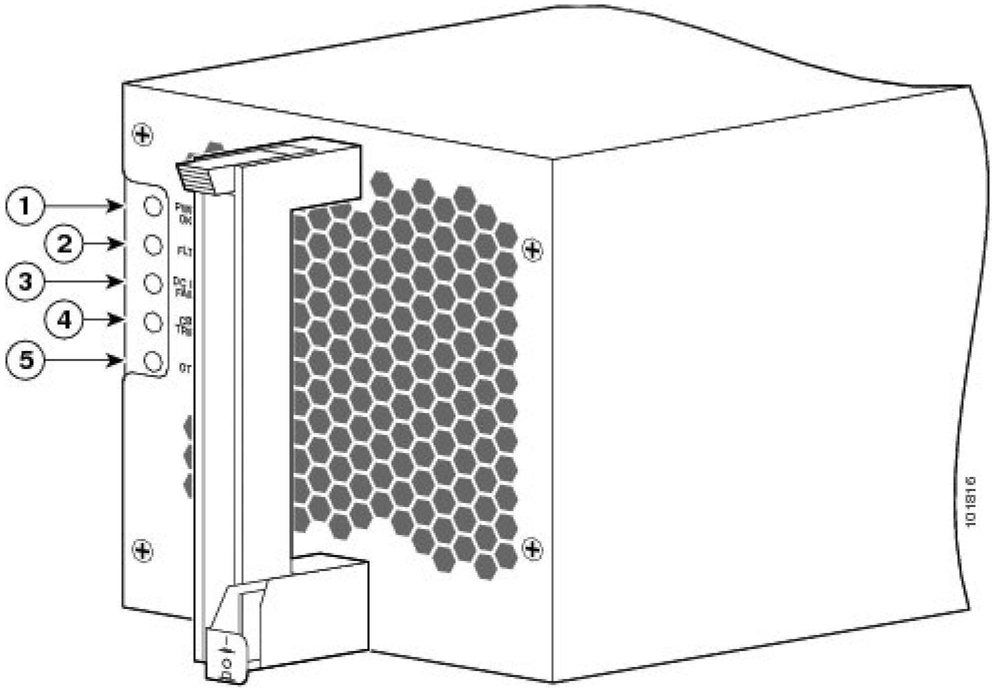
Each DC power shelf supports three PEMs, and accepts two 60A battery feeds. Input DC power enters the power shelf and is processed by the PEMs before being distributed to the chassis midplane. The PEMs perform inrush current limiting, EMI filtering, surge protection, and circuit isolation on the input DC power, and then distribute the power to either the A or B bus bar in the chassis midplane.

To provide 2N redundancy, one DC power shelf powers the A bus and the other shelf powers the B bus. Power zones in the chassis midplane provide power from both the A and B bus to each card and module in the chassis. For detailed information about how power is distributed through the chassis, see Figure 19: CRS 16-Slot Line Card Chassis Power Distribution - Fixed DC Configuration .

Fixed Configuration DC Power Entry Module

The fixed configuration DC PEM, shown in the following figure, processes input power from the power shelf and passes the power to the A or B bus bar. DC PEMs are field-replaceable.

Figure 21: Fixed Configuration DC Power Entry Module



1	PWR OK	4	BREAKER TRIP
2	FAULT	5	OT
3	DC INPUT FAIL		

Two –48/–60 VDC inputs enter the PEM at the rear of the power shelf through a connector on the power shelf midplane. The PEM performs inrush current limiting, EMI filtering, surge protection, and circuit isolation to process the power before it exits the PEM and is distributed to the chassis midplane.

A service processor module (in the power shelf) monitors each PEM and reports the status to the system controller function on the route processor. The service processor detects whether the PEM is present, and monitors PEM output voltages and current, and fault and alarm conditions (see the next section).

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

Fixed Configuration PEM Indicators

Each fixed configuration DC PEM has power and status indicators. DC PEM indicators are powered by both DC power shelves; therefore, the indicators are operational even when the DC PEM is not being powered from its input voltage. The following table lists the DC PEM status indicators and their functions.

Table 3: DC PEM Status Indicators

Name	Color	Function
PWR OK	Green	PEM is operating normally with power.

Name	Color	Function
FAULT	Yellow	A PEM fault was detected (for example, failed bias supply, over-temperature or over-current, or DC output out of range).
DC INPUT FAIL	Yellow	No DC input to the PEM, or DC input is out of range.
OT	Yellow	PEM is overheated and has been shut down.
BREAKER TRIP	Yellow	Circuit breaker has tripped and is in the off position.

The following table lists the conditions of the LEDs under certain failure conditions.

Table 4: 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 power	Off	Off	On	Off	Off
Overheated temperature	Off	On	Off	On	Off
Tripped breaker	Off	Off	Off	Off	On

AC Fixed Configuration Power Systems

The fixed configuration AC power system provides 13,200 watts to power the Cisco CRS 16-slot line card chassis. The AC power system, which provides 2N power redundancy for the routing system, contains the following components:

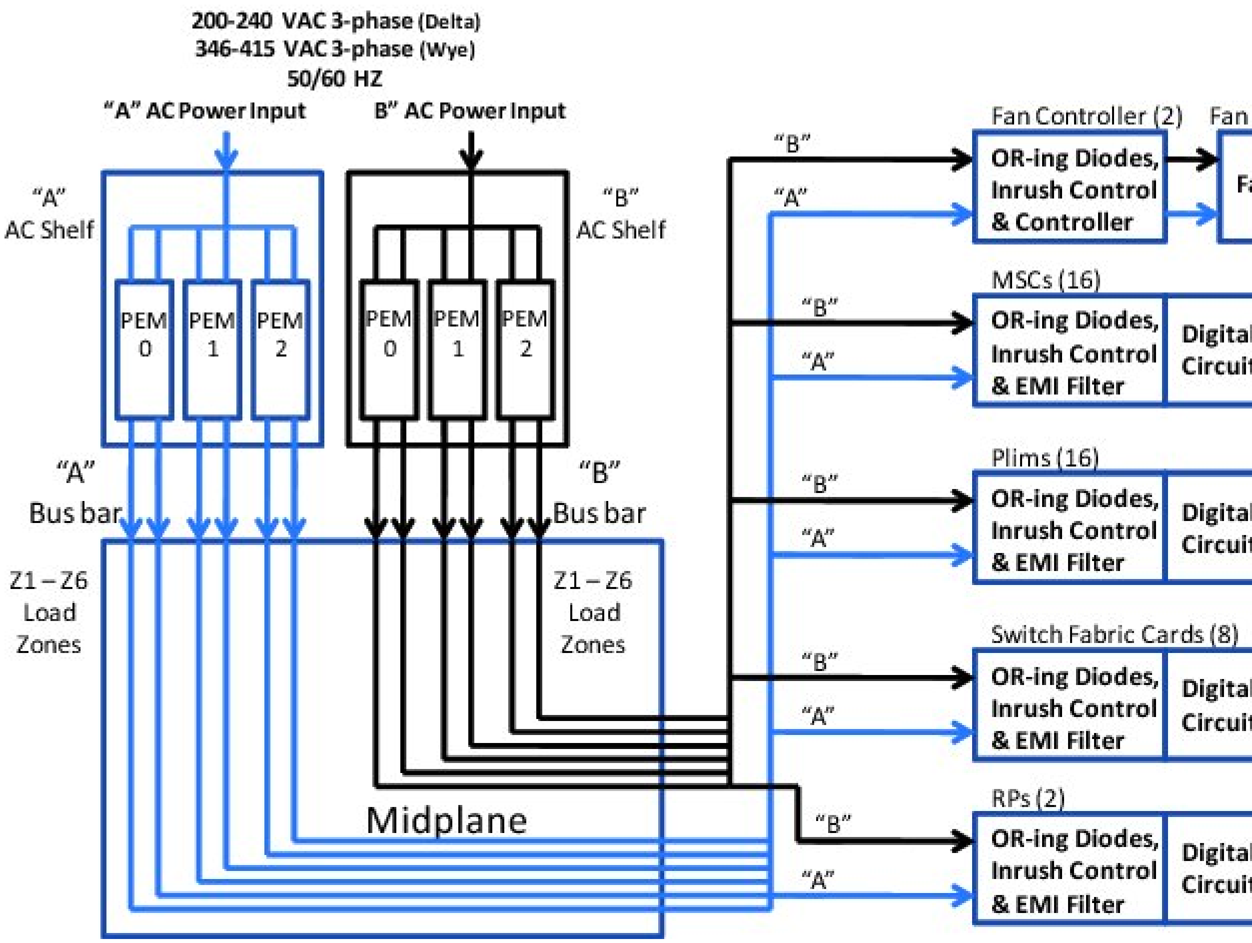
- Two AC power shelves (per chassis)—Contain the input AC power connectors and hold the AC rectifier modules. The power shelves are available in either AC Delta or AC Wye configurations. The chassis requires two power shelves of the same type (Delta or Wye).
- Three AC rectifier modules (per power shelf)—Convert 200- to 240-VAC input power to 54 VDC used by the Cisco CRS 16-slot line card chassis. Each AC rectifier is field replaceable.
- Each power shelf has its own circuit breaker and each AC rectifier has its own circuit breaker.

Two versions of the 3-phase AC power shelf are available to support AC Delta or AC Wye input configurations. Each version of the AC power shelf has a different part number. The input AC power for each type of power shelf is as follows:

- The AC Wye power shelf has a Wye 3-phase, 5-wire connection: 200 to 240(L-N)/346 to 415(L-L) VAC, 3W+N+PE, 50-60 Hz, 25 A. For redundant operation, two 3-phase Wye branch circuits are required: 40 A (North America) or 32 A (International). One power connection to each power shelf.
- The AC Delta power shelf has a Delta 3-phase, 4-wire connection: 200 to 240 VAC, 3-phase, 3W+PE, 42 A, 50 to 60 Hz. For redundant operation, two 3-phase Delta 60-A branch circuits are required. One power connection goes to each power shelf.

The following figure shows the Cisco CRS 16-slot line card chassis power routing distribution for a fixed AC configuration.

Figure 22: Cisco CRS 16-Slot Line Card Chassis Power Distribution - Fixed AC Configuration



Input AC power enters the power shelf and is distributed to the three AC rectifiers in the shelf. The AC rectifiers convert AC power into DC power, provide filtering, and then pass the DC power to either the A or B bus bar in the chassis midplane. For redundancy, one AC power shelf powers the A bus and the other shelf powers the B bus. Power zones in the chassis midplane provide power from both the A and B bus to each card and module in the chassis.

The power shelf also has a service processor module that monitors the condition of each AC rectifier and provides status signals that indicate the health of the power supplies (Fixed Configuration AC Rectifier Indicators, on page 39).

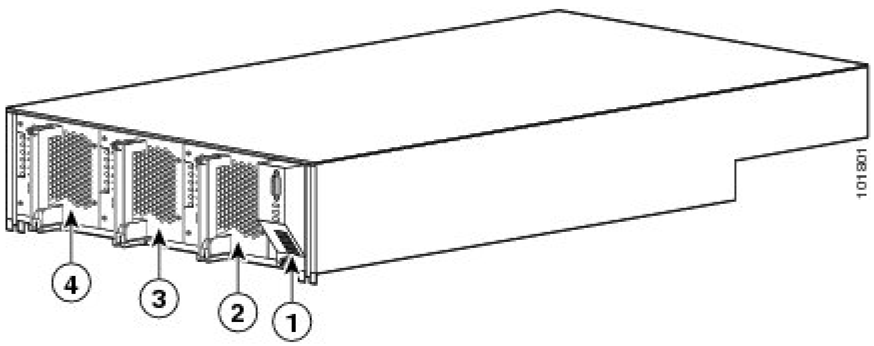
Note The same AC rectifier is used in both the AC Delta and AC Wye power shelves. See Fixed Configuration AC Rectifier, on page 37.

Note The power cables for the fixed configuration AC power shelves are not shipped pre-attached.

Fixed Configuration AC Delta Power Shelf

The AC Delta power shelf is the enclosure that houses three AC rectifier modules, an alarm module, and power distribution connections and wiring. The AC Delta power shelf, shown in the following figure, is installed in the Cisco CRS 16-slot line card chassis from the front and plugs into the chassis power interface connector panel.

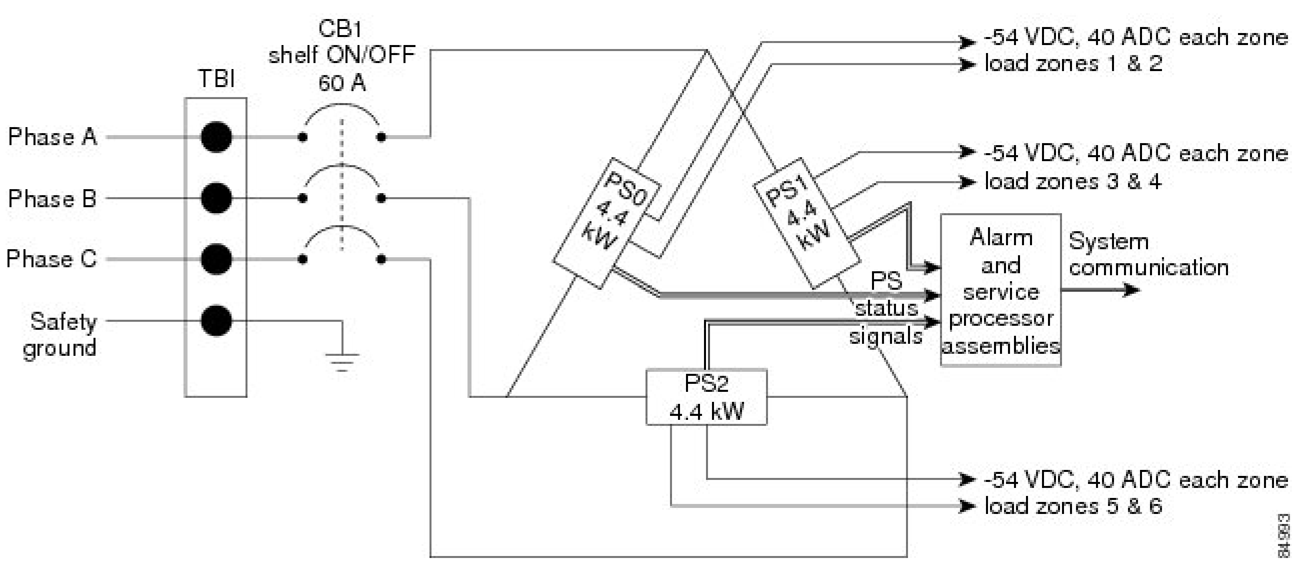
Figure 23: AC Wye Power Shelf with AC Rectifiers Installed - Front View



1	Alarm module	3	AC rectifier 1
2	AC rectifier 2	4	AC rectifier 0

The following figure shows the wiring of an AC Delta power shelf. As shown, four-wire AC Delta 3-phase power is wired into the AC Delta power shelf at a terminal block (TB1). The 3-phase power is then routed through the shelf circuit breaker to the three AC rectifiers (PS0, PS1, and PS2) in the power shelf. The AC rectifiers convert the AC power into 54 VDC power for the chassis. Each AC rectifier powers two of the chassis power zones.

Figure 24: AC Delta Power Wiring



Fixed Configuration AC Wye Power Shelf

The AC Wye power shelf is the enclosure that houses three AC rectifier modules, an alarm module, and power distribution connections and wiring. The power shelf (see the above figure) is installed in the Cisco CRS 16-slot line card chassis from the front and plugs into the chassis power interface connector panel.

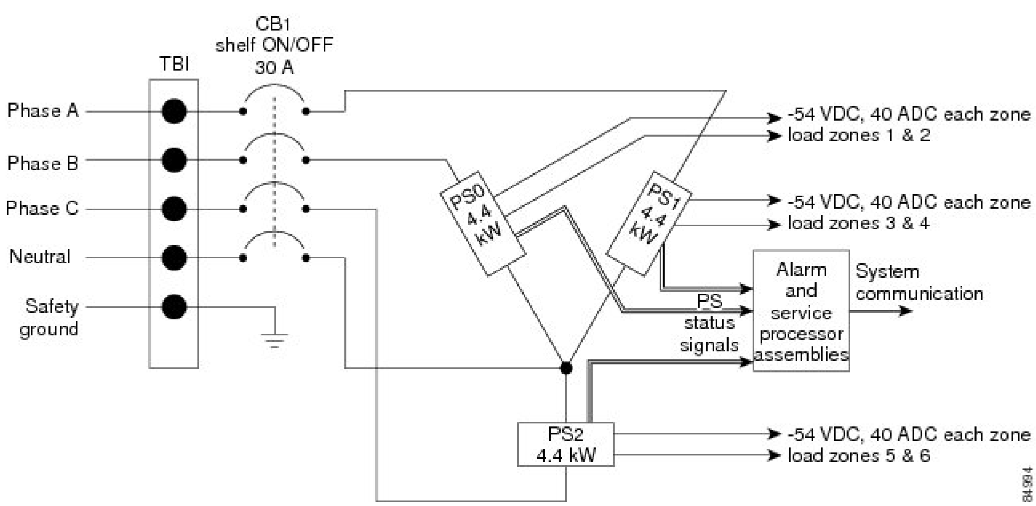
Input AC power enters the power shelf and is distributed to the three AC rectifiers in the power shelf. The AC rectifiers convert AC power into DC power, provide filtering, and then pass the DC power to either A or B bus bar in the chassis midplane. For redundancy, one AC power shelf powers the A bus and the other shelf powers the B bus. Power zones in the chassis midplane provide power from both the A and B bus to each card and module in the chassis. For details on power routing distribution for the CRS 16-slot line card chassis for a fixed AC configuration, see Figure 22: Cisco CRS 16-Slot Line Card Chassis Power Distribution - Fixed AC Configuration .

The power shelf also has a service processor module that monitors the condition of each AC rectifier and provides status signals that indicate the health of the power supplies.

Note The same AC rectifier is used in AC Delta and AC Wye power shelves. See the next section for more information.

The following figure shows the wiring of an AC Wye power shelf. As shown in the previous figure, 5-wire AC Wye 3-phase power is wired into the AC Wye power shelf at a terminal block (TB1). The 3-phase power is then routed through the shelf circuit breaker to the 3 AC rectifiers in the power shelf. The AC rectifiers (PS0, PS1, and PS2) convert the AC power into the DC (54 VDC) power. Each AC rectifier powers two of the chassis power zones. The DC power is distributed to the FRUs in the various power zones through the bus bar and the chassis midplane.

Figure 25: AC Wye Power Wiring

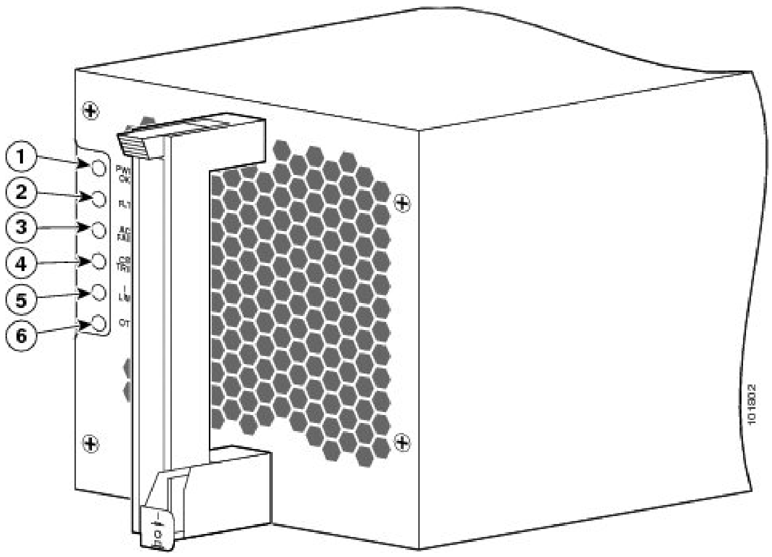


Fixed Configuration AC Rectifier

The fixed configuration AC rectifier, shown in the following figure, is an AC power supply that converts input AC power into the DC power necessary to power chassis components. The same rectifier is used for both AC Wye and AC Delta power shelves.

The rectifier takes input AC power from the power shelf, rectifies the AC into DC, provides filtering and control circuitry, provides status signaling, and passes the DC power to either the A or B bus bar in the chassis midplane. Each AC rectifier has a self-contained cooling fan that draws air through the module.

Figure 26: Fixed Configuration AC Power Rectifier



1	PWR OK	4	OT
2	FAULT	5	BREAKER TRIP
3	DC INPUT FAIL	6	ILIM

As shown in Figure 25: AC Wye Power Wiring, a single phase of the 3-phase AC input power (200 to 240 VAC or 346 to 415 VAC) is routed to each AC power rectifier in the AC power shelf. The AC power enters the AC rectifier at the rear of the power shelf through a connector located on the power shelf midplane.

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 350 VDC power. 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 the 350 VDC primary side power to 54 VDC isolated 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). 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 side 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)—Indicates that the output voltages and currents provided by the AC rectifier are within range.

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). The system software reads the EEPROM of each FRU in the system to determine if it is the correct FRU.

Fixed Configuration AC Rectifier Indicators

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

The following table lists the AC rectifier status indicators and their functions.

Table 5: Fixed Configuration AC Rectifier Status Indicators

Name	Color	Function
PWR OK	Green	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	AC rectifier is overheated and it has been shut down.
BREAKER TRIP	Yellow	Input circuit breaker is off (in the off position).
ILIM	Yellow	AC rectifier is operating in a current limiting condition.

The following table lists the LED readings during failure conditions.

Table 6: Fixed Configuration AC Rectifier LED Conditions

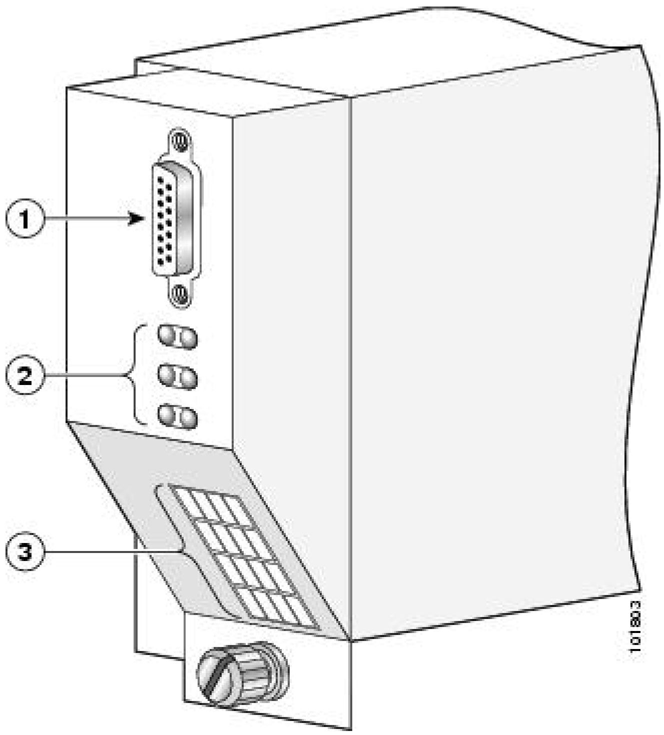
Condition	PWR OK LED	Fault LED	AC Input Fail LED	OT LED	Breaker Trip LED	ILIM LED
No fault (power is on)	On	Off	Off	Off	Off	Off
Failed AC power	Off	Off	On	Off	Off	Off
Overheated temperature	Off	On	Off	On	Off	Off
Tripped breaker	Off	Off	Off	Off	On	Off
Current limit	Off	Off	Off	Off	Off	On

Alarm Module for Fixed Configurations

This section describes an alarm module in a fixed configuration power supply in the Cisco CRS 16-slot line card chassis. An alarm module can be installed only in the far right slot of the power shelf (as you are facing the front [PLIM] side of the chassis).

Each AC or DC power shelf contains an alarm module, which monitors the status of the power shelf and provides an external interface for system alarms. A dedicated alarm module slot exists on the right side of every power shelf. The same alarm module is used in all power shelves.

Figure 27: Fixed Configuration Alarm Module



1	External alarm connector	3	LED display
2	Alarm LEDs		

The alarm module performs the following functions:

- Alarm outputs, both relay and LEDs:
    - Alarm LEDs—Three large LEDs (Critical, Major, and Minor) indicate the status of the chassis. The LEDs are controlled by software on the RP system controller. For redundancy, each alarm indicator has two LEDs (to ensure that alarm status is visible even if one of the LEDs fails).
    - Relay—The alarm module output function consists of a relay and its associated driver. As directed by the system controller (on the RP or the switch controller/fan controller (SCFC), depending on the chassis type), the microprocessor on the alarm module activates the relay. The alarm relay connector is a standard DA-15S connector.
- PEM or AC rectifier status monitoring—The alarm module monitors the performance and status of the AC rectifiers or DC PEMs. The module monitors Circuit Breaker Tripped conditions, Power Good, Power Fail, Internal Fault, Over Temp conditions, AC rectifier or PEM presence, and voltage and current output levels. Since it receives power from both power shelves, the alarm module can report the status of an unpowered shelf.
- Alarm monitoring—An LED display provides information about the status of the chassis.
    - If the system is operating properly, "IOS-XR" appears in the LED display.

- If an alarm occurs, this LED indicates the card or component that is experiencing a problem. For example, if a fan tray is missing, the display indicates which fan tray is missing. A display such as “0 1 SP” indicates that the MSC in rack 0, slot 1 is experiencing a problem.

The following table lists the pin outs for the alarm relay connector.

Table 7: Alarm Relay Connector Pin Outs

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

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

Modular Configuration Power Supply

This section includes the following topics:

The modular configuration power system includes the following major components:

- Two (redundant) AC or DC power shelves
- Up to six AC power modules (PMs) or eight DC PMs per power shelf
- Removable alarm module, one per power shelf
- Each DC PM provides 2100 Watts, with potential growth up to 16,800 Watts per power shelf
- Each AC PM provides 3000 Watts, with potential growth up to 18,000 Watts per power shelf

In the modular configuration power system, different power shelves are used for AC and DC power. The AC power solution requires single phase input power. If you have AC Delta or AC Wye at your site, a *Cisco CRS 3-Phase Power Distribution Unit* may be required to convert 3-phase input power to single phase output power for the power shelf. For more information, see Cisco CRS 3-Phase Power Distribution Unit, on page 54.

Modular configuration power system consists of two power shelves, AC or DC power modules (PMs), and alarm modules. It is available in versions for DC and AC power supplies. However, unlike the fixed configuration power system, the AC version of the modular configuration power system requires single-phase AC input power to the power shelves; there is no 3-phase AC-Wye or AC-Delta.

For details showing the CRS 16-slot line card chassis power routing distribution for a modular DC configuration, see Figure 33: CRS 16-Slot Line Card Chassis Power Distribution - Modular DC Configuration and for the AC modular configuration, see Figure 35: CRS 16-Slot Line Card Chassis Power Distribution - Modular AC Configuration .

If you have 3-phase AC Delta or AC Wye at your equipment, a Cisco CRS power distribution unit (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.

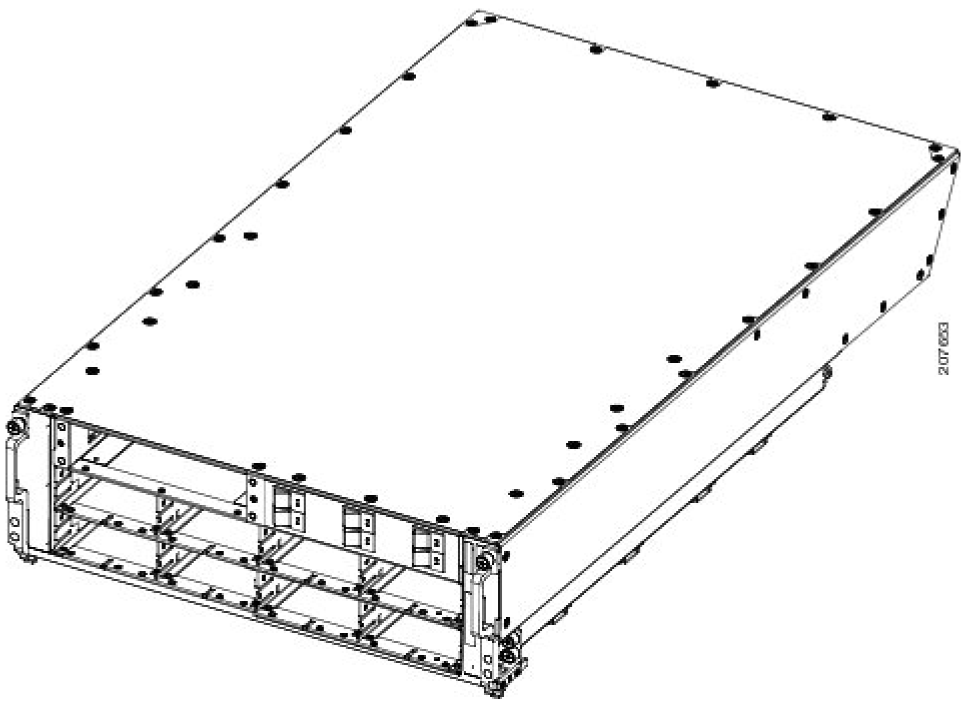
Note In a modular configuration AC power system, PDU refers to the Cisco CRS PDU which is required to convert 3-phase AC-Wye or AC-Delta input power to single-phase AC input power for the modular configuration AC power shelf. For further information, see the Cisco CRS 3-Phase AC Power Distribution Unit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

Each modular power solution can contain up to eight DC PMs or six AC PMs. For details on power routing distribution for the CRS 16-slot line card chassis with a modular AC configuration, see Figure 35: CRS 16-Slot Line Card Chassis Power Distribution - Modular AC Configuration .

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

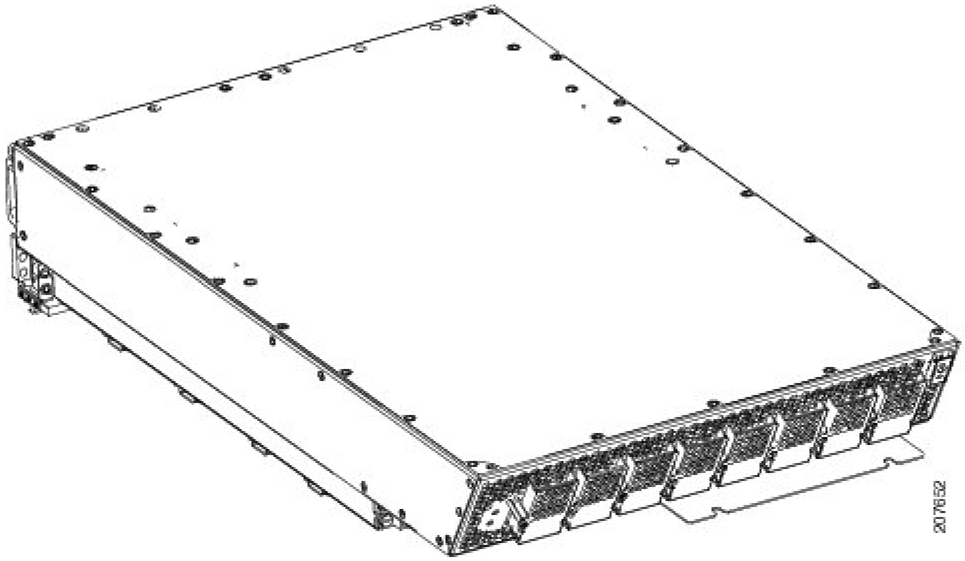
The following figure shows the front view of the modular configuration DC power shelves.

Figure 28: DC Modular Configuration Power Shelf - Front View



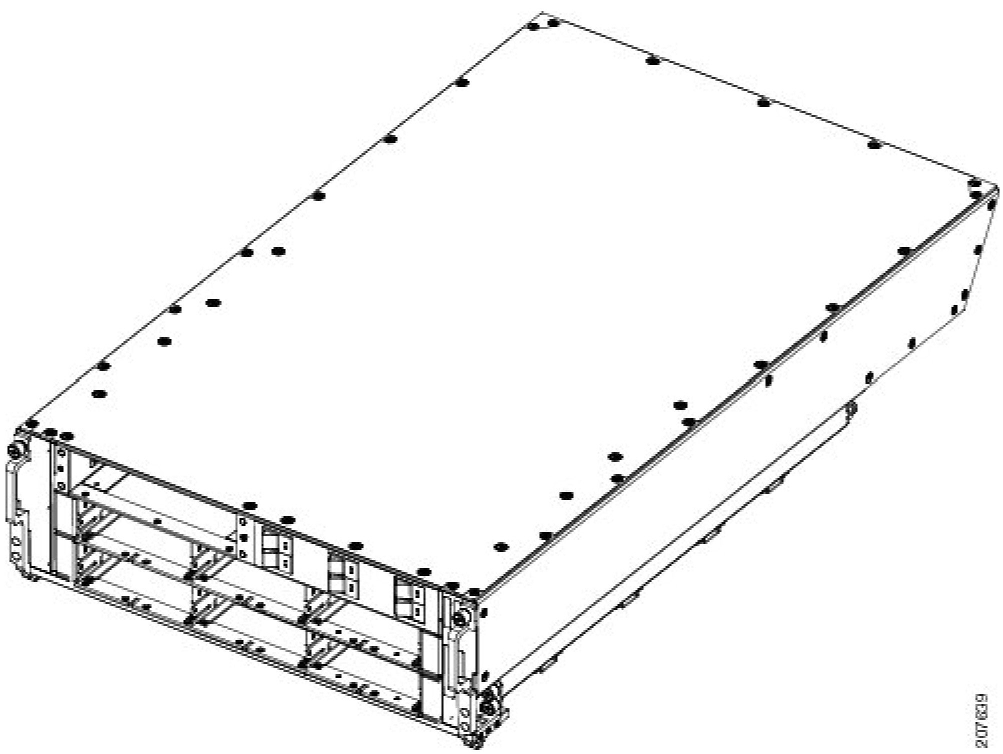
The following figure shows the rear view of the modular configuration DC power shelves.

Figure 29: DC Modular Configuration Power Shelf - Rear View



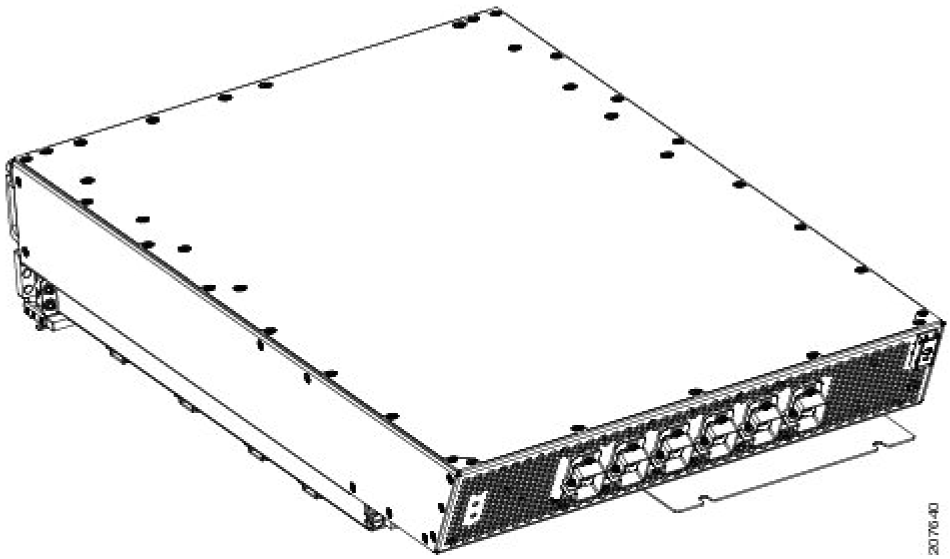
The following figure shows the front view of the modular configuration AC power shelves.

Figure 30: AC Modular Configuration Power Shelf - Front View



The following figure shows the rear view of the modular configuration AC power shelves

Figure 31: AC Modular Configuration Power Shelf - Rear View



Modular Configuration Power Architecture

The modular configuration power supply for the Cisco CRS 16-slot line card chassis provides the following features:

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

The modular AC and DC power systems use A or B power shelves to provide reliable, 2N redundant power to all chassis components. All PMs in the modular power shelf power all zones as long as the zone circuit breaker is not tripped. In addition, the modular power supplies work in parallel with each other, and they can monitor power consumption, performance, analysis, and power management concurrently.

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

For details showing the CRS 16-slot line card chassis power routing distribution for a modular DC configuration, see Figure 33: CRS 16-Slot Line Card Chassis Power Distribution - Modular DC Configuration and for the AC modular configuration, see Figure 35: CRS 16-Slot Line Card Chassis Power Distribution - Modular AC Configuration .

Each PM provides 2 voltages:

- Output voltage 1 is 54 VDC
- Output voltage 2 is +5 Vaux

The Cisco CRS 16-slot line card chassis can continue to operate normally if:

- One AC or DC PM fails
- One entire power shelf fails
- One internal bus bar fails

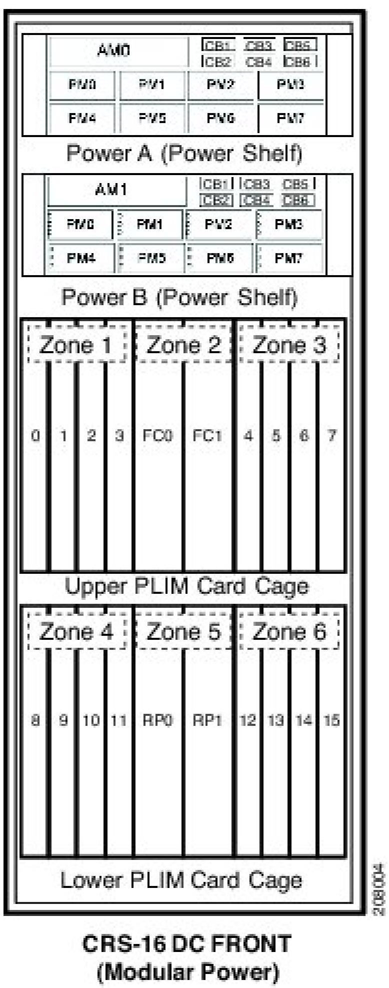
- PMs are added to or removed from the power shelf

The AC or DC power system distributes power in the chassis through six power zones, which provide power redundancy and reliability. Each power zone receives power from both bus bars (A and B), which ensures that each card and module in the chassis is powered by both power shelves as shown in Figure 33: CRS 16-Slot Line Card Chassis Power Distribution - Modular DC Configuration for modular DC configuration and Figure 35: CRS 16-Slot Line Card Chassis Power Distribution - Modular AC Configuration for modular AC configuration.

Because no exact redundancy exists across the PMs, individual PMs can be installed or 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 each PM 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.

A Cisco CRS 16-slot line card chassis can lose any single PM or an entire power shelf and still have the power to operate. The following figure shows the front (PLIM) side of the Cisco CRS 16-slot line card chassis power shelf location in a modular configuration. The Cisco CRS 16-slot line card chassis will continue to operate, even if one or more PMs across multiple power shelves fails, provided it receives enough power to meet the system requirements.

Figure 32: CRS 16-Slot Chassis Front (PLIM) Side Power Shelf Location—Modular Configuration



The figure shows chassis power zones on the MSC side of the chassis:

- Power shelf A supports everything in it. PM 0-7 supports everything in the entire chassis that needs power which are cards, fans, alarm modules. CB1 supports Z1, CB2 supports Z2 ... CB6 supports Z6
- Power shelf B supports everything in it. PM 0-7 supports everything in the entire chassis that needs power which are cards, fans, alarm modules. CB1 supports Z1, CB2 supports Z2 ... CB6 supports Z6
- Power zone 1 supports chassis slots 0, 1, 2, and 3
- Power zone 2 supports chassis slots FC0 and FC1
- Power zone 3 supports chassis slots 4, 5, 6, and 7
- Power zone 4 supports chassis slots 8, 9, 10, and 11
- Power zone 5 supports chassis slots RP0 and RP1
- Power zone 6 supports chassis slots 12, 13, 14, and 15

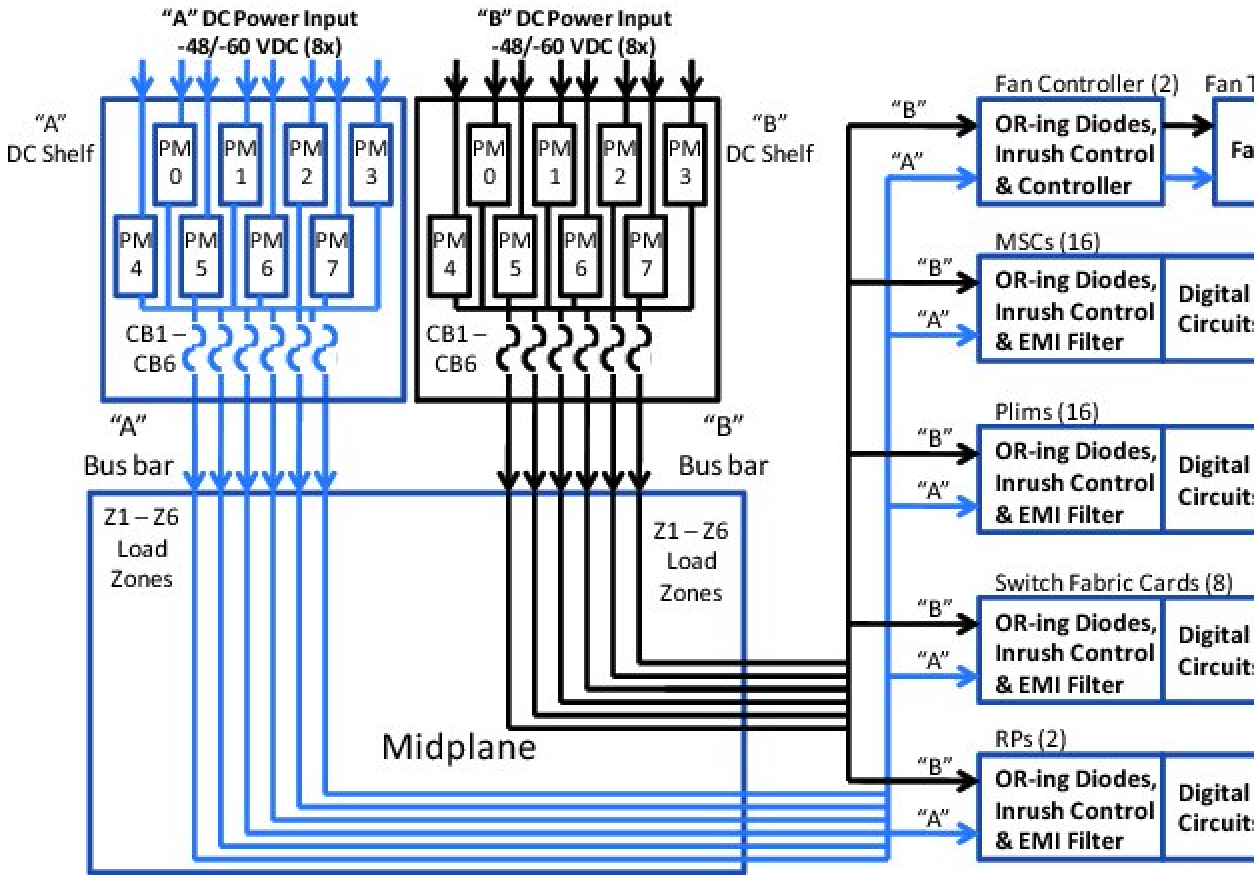
DC Modular Configuration Power Systems

The DC modular configuration power system provides up to 16,800 watts DC power to the Cisco CRS 16-slot line card chassis. The DC modular power system contains the following components:

- Two DC power shelves. Each power shelf contains the DC input power connections and houses the DC PMs and alarm Module. The chassis requires two power shelves for redundancy.
- Up to eight field-replaceable DC PMs per shelf.

The following figure shows the Cisco CRS 16-slot line card chassis power routing distribution for a modular DC configuration.

Figure 33: CRS 16-Slot Line Card Chassis Power Distribution - Modular DC Configuration



Note Although each modular configuration DC power shelf can support up to eight DC PMs, the modular configuration DC power shelf is shipped with six DC PMs per shelf.

Modular Configuration DC Power Shelf

The DC modular power shelf is the enclosure that houses the DC PMs, the alarm module, and power distribution connections and wiring. The power shelf installs in the Cisco CRS 16-slot line card chassis from the front and plugs into the chassis power interface connector panel. Figure 28: DC Modular Configuration Power Shelf - Front View shows the front view of the modular configuration DC power shelves and Figure 29: DC Modular Configuration Power Shelf - Rear View shows the rear view of the modular configuration DC power shelves.

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

See Figure 33: CRS 16-Slot Line Card Chassis Power Distribution - Modular DC Configuration for a diagram of the Cisco CRS 16-slot line card chassis power routing distribution for a modular DC configuration.

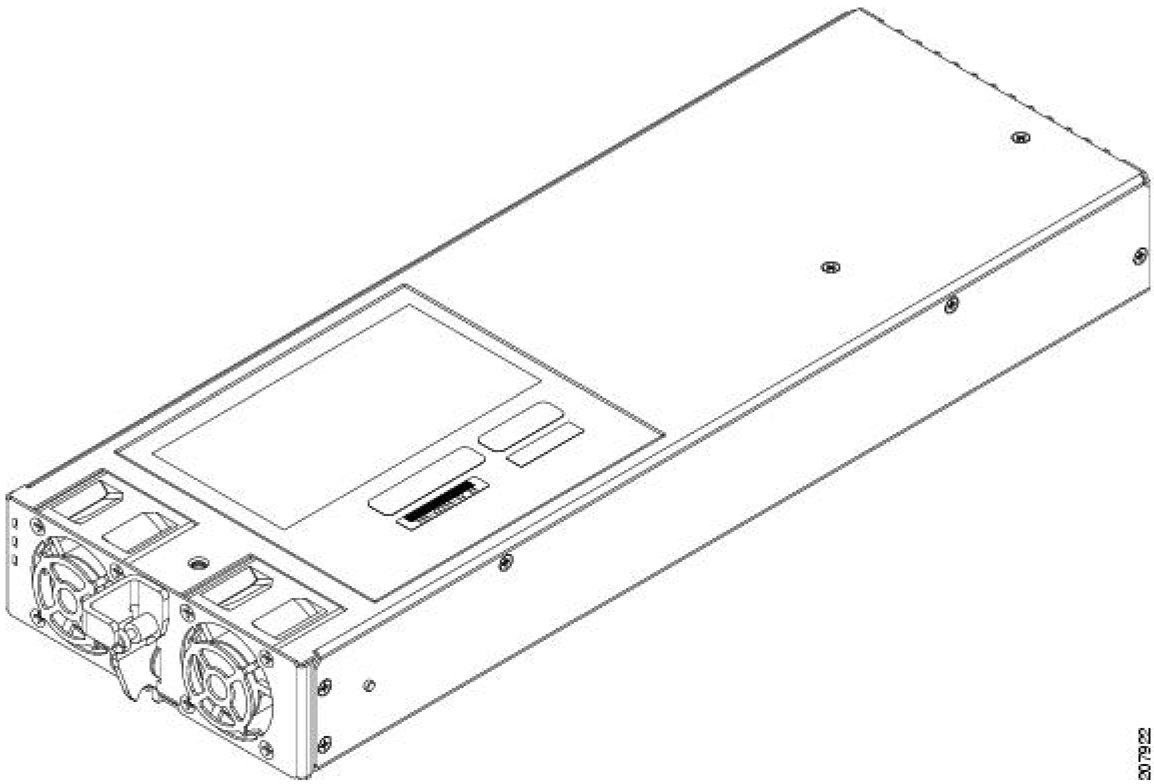
Each DC power shelf supports up to eight power modules and accepts one 60 A battery feed per PM. Input DC power enters the power shelf and is processed by the PMs before being distributed to the chassis midplane.

The PMs perform inrush current limiting, EMI filtering, surge protection, and circuit isolation on the input DC power, and then distribute the power via the internal bus bar in the chassis midplane.

Modular Configuration DC Power Module

Each DC PM provides 2100 Watts. The DC PM, shown in the following figure, passes the power via the internal bus bar to the system. PMs are field-replaceable.

Figure 34: Modular Configuration DC Power Module



Two –48/–60 VDC inputs enter the PM at the rear of the power shelf, and exits the PM and is distributed to the chassis midplane.

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

Modular Configuration DC Power Module Indicators

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

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

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

The following table lists the PM status indicators and their functions.

Table 8: DC PM 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 supply from the power shelf to indicate that there is energy in the power supply until the input bulk capacitor is completely discharged or the housekeeping circuit is shut down.
Output OK	Green	Output OK LED turns on continuously when power supply output voltage is on. Output OK LED flashes when power supply 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 PM.

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

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

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

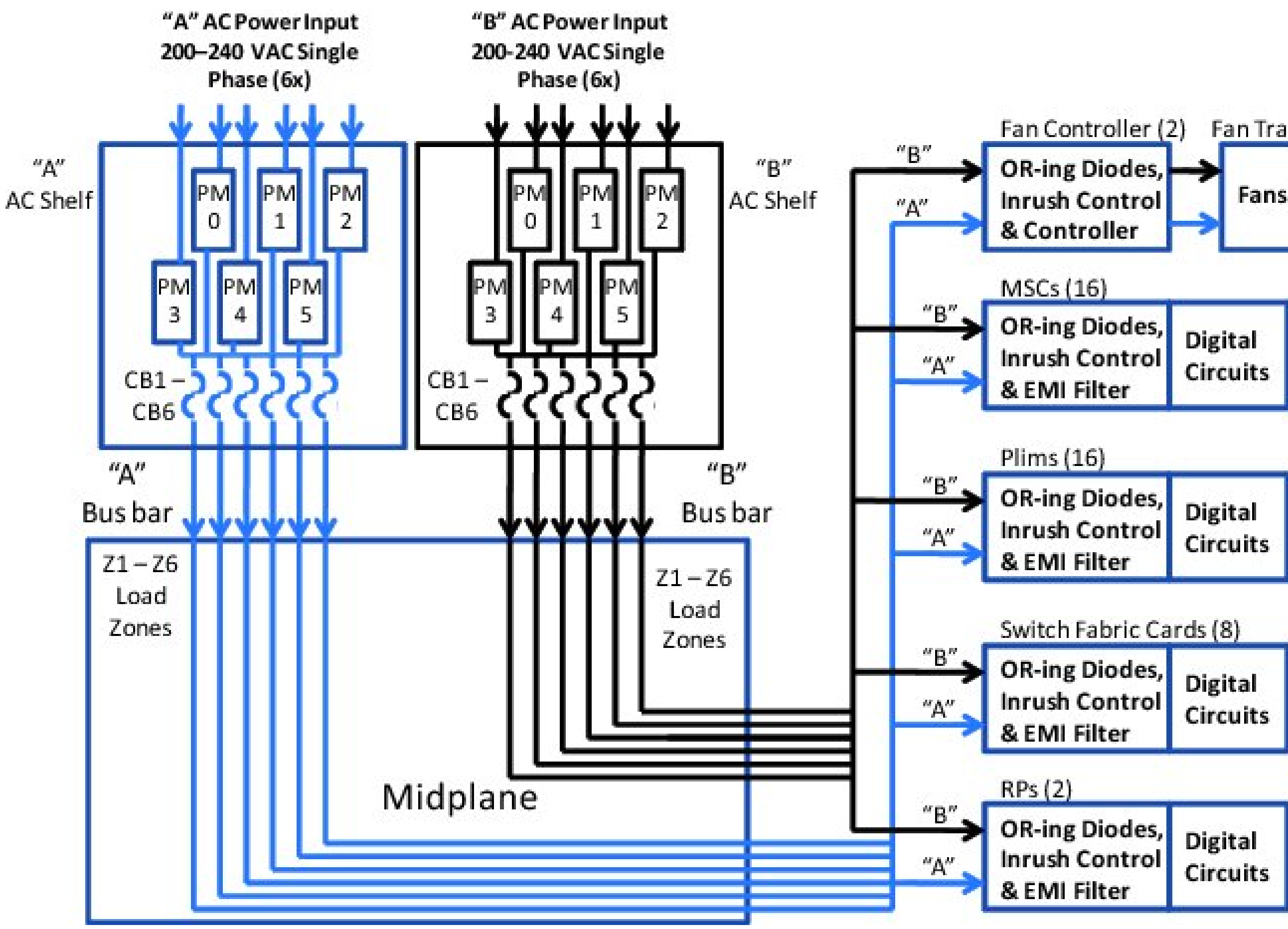
AC Modular Configuration Power Systems

The modular configuration AC power system provides up to 18,000 watts to power the Cisco CRS 16-slot line card chassis. The AC power system, which provides 2N power redundancy for the routing system, contains the following components:

- Two AC power shelves (per chassis)—Each power shelf contains the input AC power connectors and holds the AC PMs. The chassis requires two power shelves for redundancy.
- Up to six field-replaceable AC PMs per power shelf.

The following figure shows the Cisco CRS 16-slot line card chassis power routing distribution for a modular AC configuration.

Figure 35: CRS 16-Slot Line Card Chassis Power Distribution - Modular AC Configuration



Note Although each modular configuration AC power shelf can support up to six AC PMs, the modular configuration power shelf is shipped with five PMs per shelf.

Modular Configuration AC Power Shelf

The AC power shelf is the enclosure that houses the AC PMs, the alarm module, and power distribution connections and wiring. The AC power shelf, shown in Figure 30: AC Modular Configuration Power Shelf - Front View, is installed in the Cisco CRS 16-slot line card chassis from the front and plugs into the chassis power interface connector panel.

Note The power cables for the modular configuration AC power shelves are not shipped pre-attached.

Each AC power shelf supports up to six AC PMs. The AC PMs convert AC power into DC power, provide filtering, and then distribute the DC power to the chassis midplane. For details about power routing distribution for a modular AC configuration, see Figure 35: CRS 16-Slot Line Card Chassis Power Distribution - Modular AC Configuration

The power shelf also has a microprocessor that monitors the condition of each AC PM and provides status signals that indicate the health of the power supplies (see Modular Configuration AC Power Module Indicators, on page 52).

Modular Configuration AC Power Module

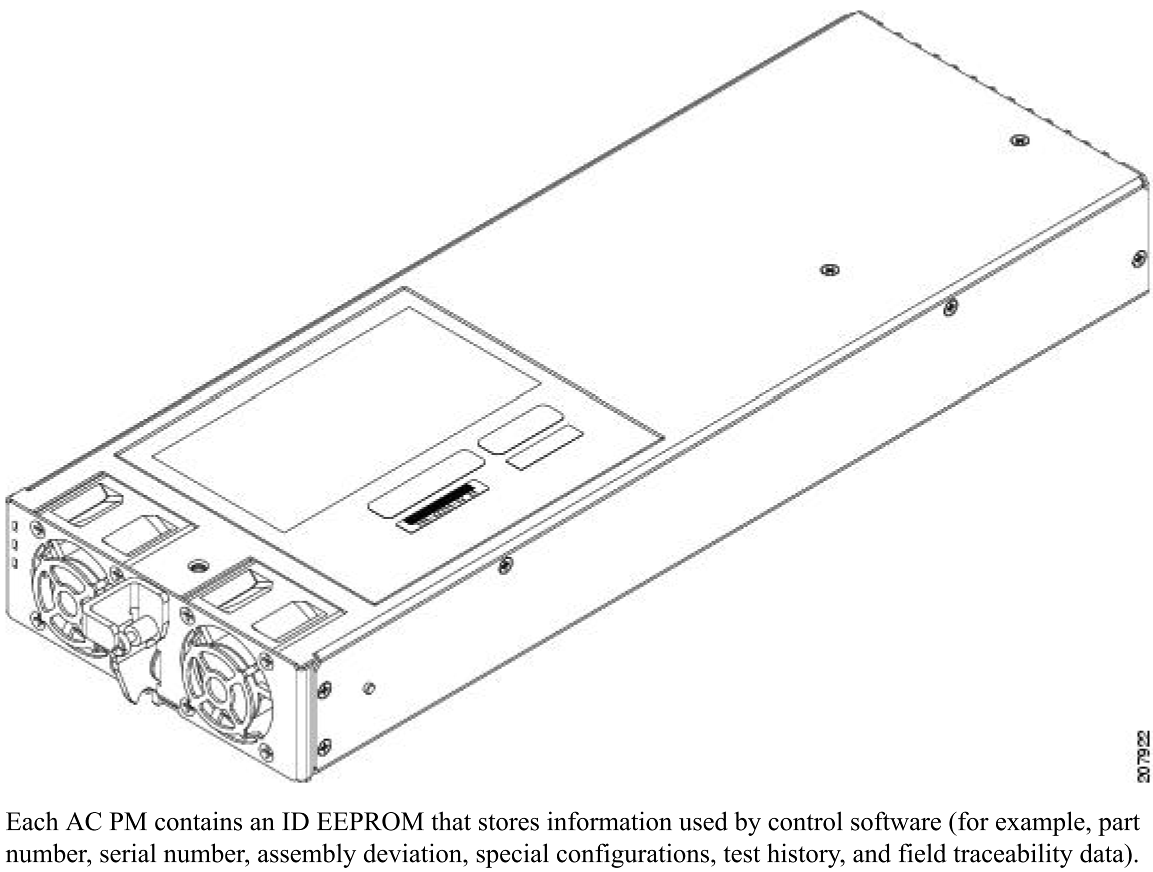
The AC PM is an AC power supply that converts single phase input AC power into the DC power necessary to power chassis components. The AC PM takes input AC power from the power shelf, converts the AC into DC, provides filtering and control circuitry, provides status signaling, and passes the DC power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

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

- Each AC PM has a single-phase, 3-wire connection:Input: 200 to 240 VAC nominal, 50 to 60 Hz, 16ATolerance: +/-10%(180 to 264) VAC, 50 to 60 Hz, 16A

Each power shelf contains six IEC-320-C22 receptacles which can accept up to six IEC-320-C21 connector cords, depending on how many AC PMs are installed in the shelf. The following figure shows the AC modular configuration PM.

Figure 36: AC Modular Configuration Power Module



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

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

- Output Voltage 1 is -54 VDC at 55.5 A

- Output Voltage 2 is +5 Vaux at 0.75 A

Modular Configuration AC Power Module Indicators

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

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

The following table lists the PM status indicators and their functions.

Table 9: AC PM 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 supply from the power shelf to indicate that there is energy in the power supply until the input bulk capacitor is completely discharged or the housekeeping circuit is shut down.
Output OK	Green	Output OK LED turns on continuously when power supply output voltage is on. Output OK LED flashes when power supply 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 PM.

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

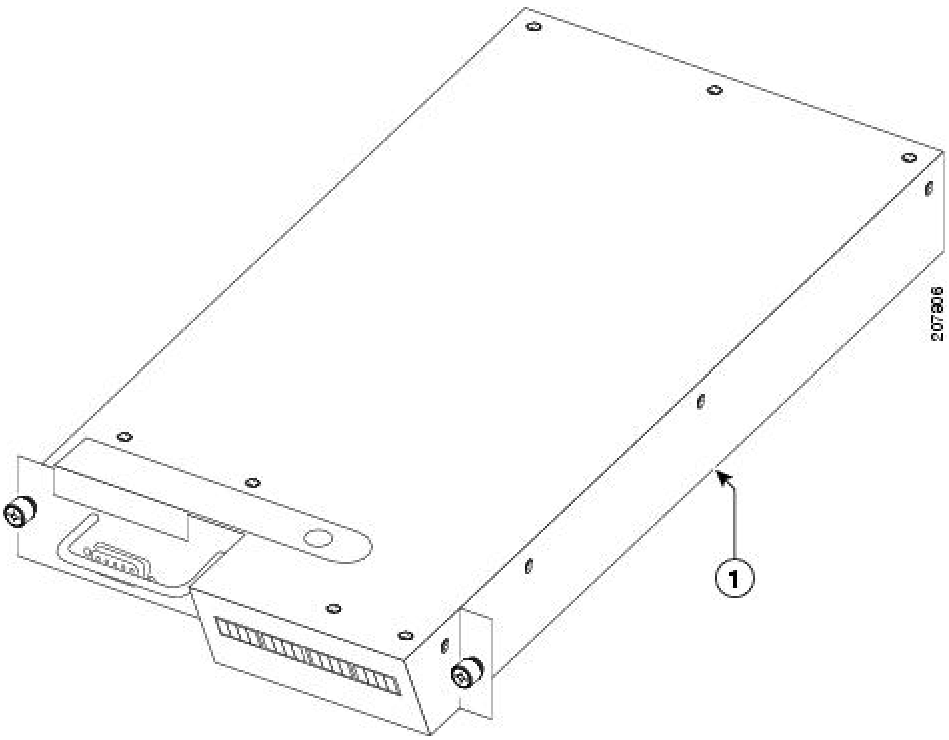
- 5V out of range
- Output Stage OT
- Fan Fault
- OR-ing fault (Output voltage less than bus voltage)
- OC shutdown
- OT shutdown
- OV shutdown
- Input stage OT
- Fault induced shutdown occurred
- Thermal sensor fault
- Vout out of range
- Boost Vbulk fault

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

Alarm Module for Modular Configurations

Each modular configuration power shelf contains an alarm module. It monitors the presence and performance of the modular PMs. It also monitors status of the power shelf and provides an external interface for system alarms. The following figure shows a modular configuration alarm module.

Figure 37: Modular Configuration Alarm Module



1	Side of alarm module to be installed on the right side of the opening

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

The alarm module performs the following functions:

- Alarm outputs, both relay and LEDs:
    - Alarm LEDs—Three large LEDs (Critical, Major, and Minor) indicate the status of the chassis. The LEDs are controlled by software on the RP system controller.
    - Relay—The alarm module output function consists of a relay and its associated driver. As directed by the system controller (on the RP or the switch controller/fan controller (SCFC), depending on the chassis type), the service processor module on the alarm module activates the relay. The alarm relay connector is a standard DA-15S connector.
- PM status monitoring—The alarm module monitors the performance and status of the PMs. The alarm module monitors Power Good, Power Fail, Internal Fault, Over Temp conditions, PM presence, and voltage and current output levels. The alarm module can report these statuses even for an unpowered shelf.
- Alarm monitoring—An alpha-numeric display provides information about the status of the chassis.

- If the system is operating properly, "RACKX IOS XR" appears in the alpha-numeric display, where X represents the rack number.
- If an alarm occurs, the alpha-numeric display indicates the card or component that is experiencing a problem. For example, if a fan tray is missing, the display indicates which fan tray is missing. A display such as "0 1 SP" indicates that the MSC in rack 0, slot 1 is experiencing a problem.

In the modular configuration power shelf, a service processor module monitors the status of each PM and communicates with the system controller of the Route Processor (RP). The service processor monitors the following PM faults and alarm conditions:

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

The following table lists the pin outs for the alarm relay connector.

Table 10: Alarm Relay Connector Pin Outs

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

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

Cisco CRS 3-Phase Power Distribution Unit

This section describes the Cisco CRS 3-Phase AC Power Distribution Unit (PDU) for the CRS 16-slot line card chassis. 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.

The PDU includes either an AC Delta or AC Wye power interface to convert 3-phase input power to single phase output. The PDU has power input and power output cords entering and exiting the box. The PDU can be installed in a 19 inch rack or attached to the sides of the CRS 16-slot line card chassis by using custom mounting brackets.

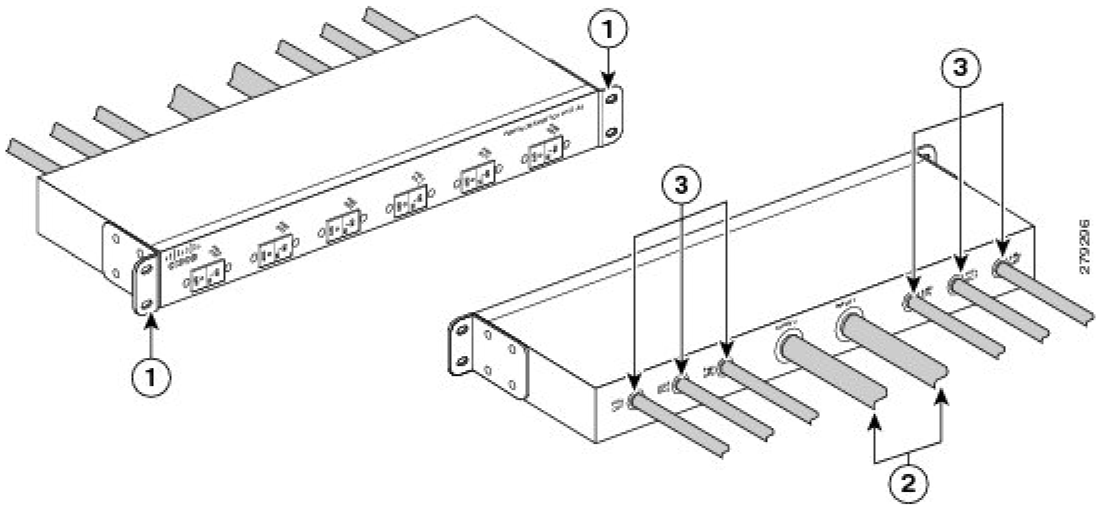
One PDU is required for each modular power shelf installed in the chassis for system redundancy. A PDU can be installed on either the left or right side of the chassis.

There are two versions of the CRS 16-slot line card chassis PDU:

- CRS-16-PDU-Delta—Redundant 3-phase to single-phase Delta PDU for Cisco CRS 16-slot line card chassis, 4 input/12 output
- CRS-16-PDU-Wye—Redundant 3-phase to single-phase Wye PDU for Cisco CRS 16-slot line card chassis, 2 input/12 output

The following figure shows the PDU that converts 3-phase AC Delta input power to single phase AC output power.

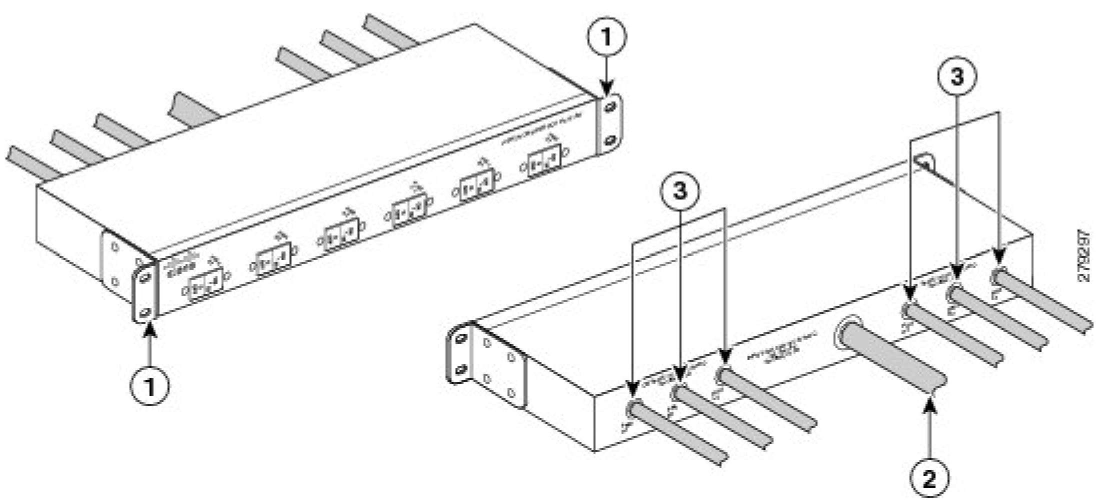
Figure 38: AC Delta Power Distribution Unit



1	Rack mounting ears	2	Input Cords
3	Output Cords		

The following figure shows the PDU that converts 3-phase AC Wye input power to single phase AC output power.

Figure 39: AC Wye Power Distribution Unit



1	Rack mounting ears	3	Output Cords
2	Input cord		

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

The PDU for the CRS 16-slot line card chassis is shipped with the following hardware for specific configurations:

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

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

AC Wye

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

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

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

AC Delta

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

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

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

CHAPTER 3

Cooling System

This chapter describes the components that make up the cooling system of the Cisco CRS Series Carrier Routing System 16-Slot Line Card Chassis. It contains the following sections:

Cooling System Overview

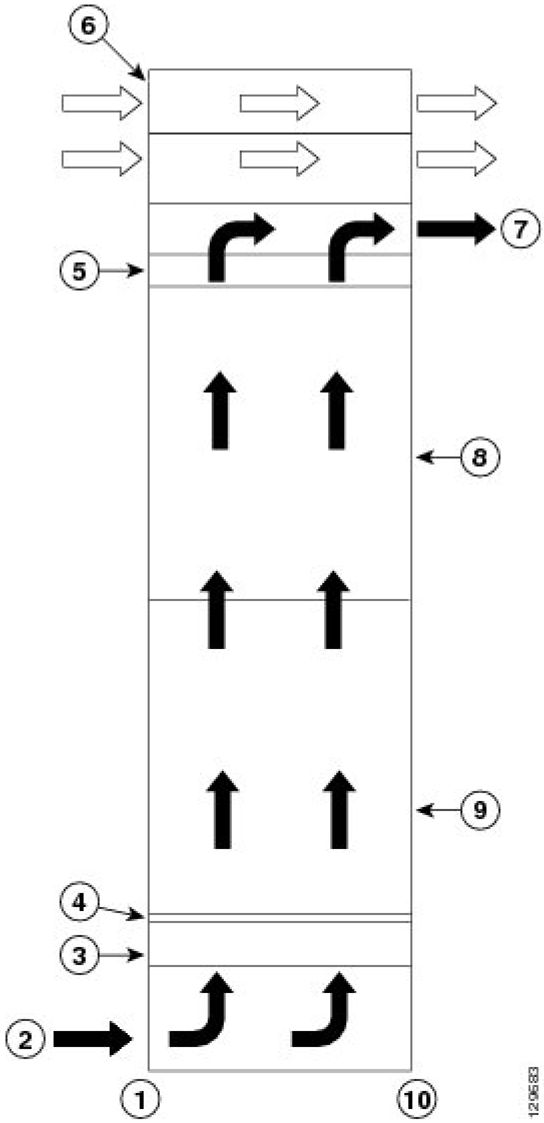
The Cisco CRS 16-slot line card chassis cooling system includes the components and control system that draw ambient air through the system to dissipate heat and keep the system operating in a desired temperature range. The complete Cisco CRS 16-slot line card chassis cooling system includes:

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

16-Slot Line Card Chassis Airflow

The airflow through the FCC is controlled by a push-pull configuration (see the following figure). 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 and exhausts warm air from the top rear of the FCC.

Figure 40: Airflow Through the FCC



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

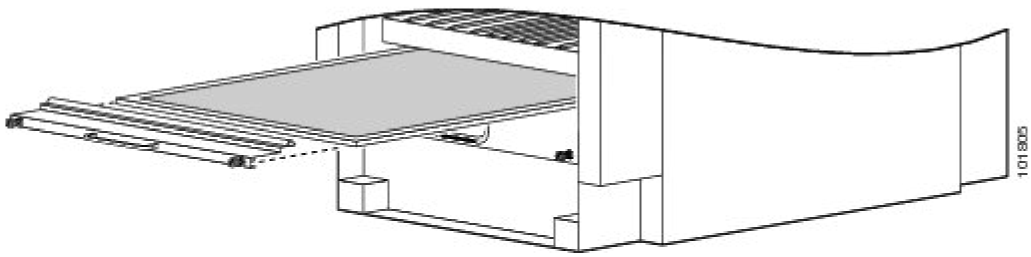
Note The Cisco CRS 16-slot line card chassis has a maximum airflow of 2050 cubic feet per minute.

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 top rear of the chassis.

The chassis has a replaceable air filter mounted in a slide-out tray above the lower fan tray. The Cisco CRS 16-slot line card chassis air filter, shown in the below figure , plugs into the rear (MSC) side of the chassis.

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

Figure 41: Air Filter



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

Cooling System Operation

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

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

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

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

Thermal Alarms

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

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

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

Quick-Shutdown Mode

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

Fan Controller Redundancy in the Line Card Chassis

The main feature of the Cisco CRS 16-slot line card chassis cooling system is fully redundant fan control architecture. This architecture, which systematically controls the speed of the fans for various chassis-heating conditions, is redundant from both a power standpoint and a cooling standpoint. The architecture supports a redundant load-sharing design. The Cisco CRS 16-slot line card chassis cooling architecture contains:

- Two fan trays, each containing nine fans
- Two fan controller cards
- Control software and logic

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

Both fan controller cards work together to provide fully redundant input power and control logic for fan trays and fans. Each fan controller card receives its input power (-48 VDC) from both the A and B power shelves. The fan controller card then provides one fan tray with input power from the A bus and provides power to the other fan tray from the B bus. This feature ensures that the upper fan tray is powered from the A bus on one fan controller card and from the B bus on the second fan controller card.

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

- Fan tray—If one fan tray fails or is removed, the other fan tray automatically speeds up to the maximum limit and provides cooling for the entire chassis. (If multiple fans in a single fan tray fail, the remaining fans in the two fan trays provide cooling for the entire chassis.)
- Fan controller card—If one fan controller card fails, the other fan controller card provides all of the power to the fan trays. In this mode, the single remaining fan controller card provides a maximum of 24 VDC.
- Power shelf or power module—If one power feed fails, the other power feed provides all of the power to the fan trays.

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

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

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

For information on the rotational speeds of the fans in revolutions per minute (RPM), see the following section.

16-Slot Line Card Chassis Fan Tray

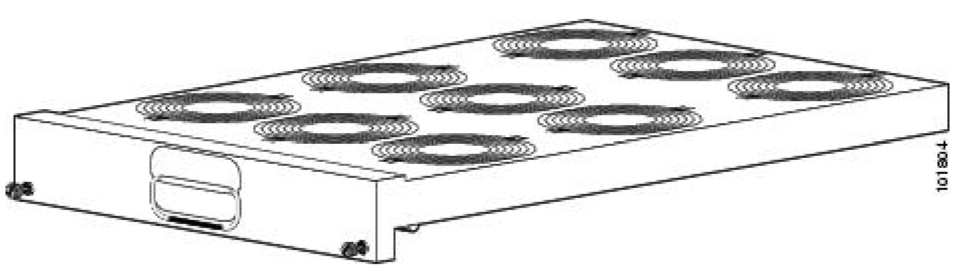
The Cisco CRS 16-slot line card chassis has two fan trays (Figure 40: Airflow Through the FCC, on page 58), one just below the lower card cage and the other just above the upper card cage. The chassis can run with only one fan tray operating. If a failure occurs in one fan tray, the other fan tray acts as the redundant fan tray to assure fault-tolerant system performance; the chassis continues to operate while the failed fan tray is replaced.

Figure 40: Airflow Through the FCC, on page 58 shows the Cisco CRS 16-slot line card chassis fan tray operates in either the upper or lower fan tray slots.

Each fan tray (see the following figure) plugs into the rear (MSC) side of the chassis and contains:

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

Figure 42: Fan Tray



The fan tray has the following physical characteristics:

- Overall depth—30.9 in. (78.5 cm)

- Height of tray body—2.5 in. (6.2 cm)
- Height of front panel—4 in. (10.2 cm)
- Depth of front panel—1 in. (2.5 cm)
- Weight—44 lb (20 kg)

During normal operation, the fans in CRS-16-LCC-FAN-TR= operate in the range of 4000 to 5150 RPM and the fans in CRS-16-LCC-FNTR-B= operate in the range of 3300 to 5150 RPM. The system automatically adjusts the speed of the fans to meet the cooling needs of the entire chassis. If one fan controller card or one power feed fails, the fans continue to operate within the ranges specified above (up to 5150 RPM). If one fan tray fails completely, or is removed, the fans in the remaining fan tray automatically speed up to the maximum rotational limit, which is 6700 RPM for CRS-16-LCC-FAN-TR= and 6600 RPM for CRS-16-LCC-FNTR-B=.

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

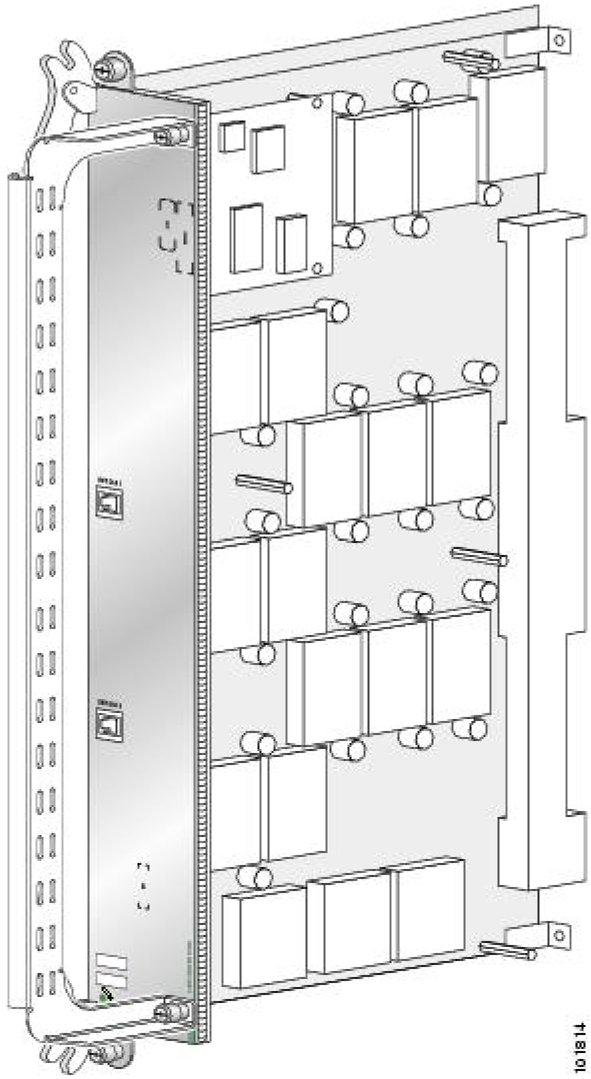
16-Slot Line Card Chassis Fan Controller Card

Note The CRS-16-LCC-FAN-CT= fan controller card is no longer orderable. Use PID CRS-16-LCC-F-CT-B= to order a spare fan controller card.

Note You can have a mix of CRS-16-LCC-FAN-CT= and CRS-16-LCC-F-CT-B= in an LCC.

A Cisco CRS 16-slot line card chassis contains two line card chassis fan controller (LCFC) cards, shown in the following figure.

Figure 43: 16-Slot Line Card Chassis Fan Controller (LCFC) Card



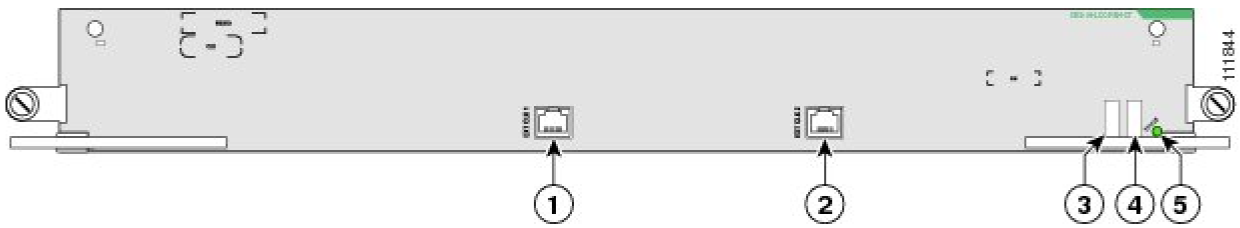
The line card chassis fan controller cards provide the following functions:

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

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

The following figure shows the fan controller card front panel.

Figure 44: Fan Controller Card Front Panel



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

CHAPTER 4

Switch Fabric

This chapter describes the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis switch fabric. It includes the following sections:

Switch Fabric Overview

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

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

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

- CRS-16-FC/S (40G)
- CRS-16-FC140/S (140G)
- CRS-16-FC400/S (200G)

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

- The CRS-16-FC140/S fabric is able to operate in both 40G mode and 140G mode to allow interconnection between 20G, 40G, or 140G MSCs and FPs.
- The CRS-16-FC400/S fabric is able to operate in 40G, 140G and 200G mode to allow interconnection between the 20G, 40G, 140G, or 200G MSCs and FPs.

Note The LCC supports either 40G fabric cards (FC/S cards), 140G fabric cards (FC-140/S cards), or 400G fabric cards (FC-400/S cards in 200G mode). An LCC with a mix of 40G, 140G, and 400G fabric cards is not a supported mode of operation. Such a mode is temporarily allowed only during the upgrade process.

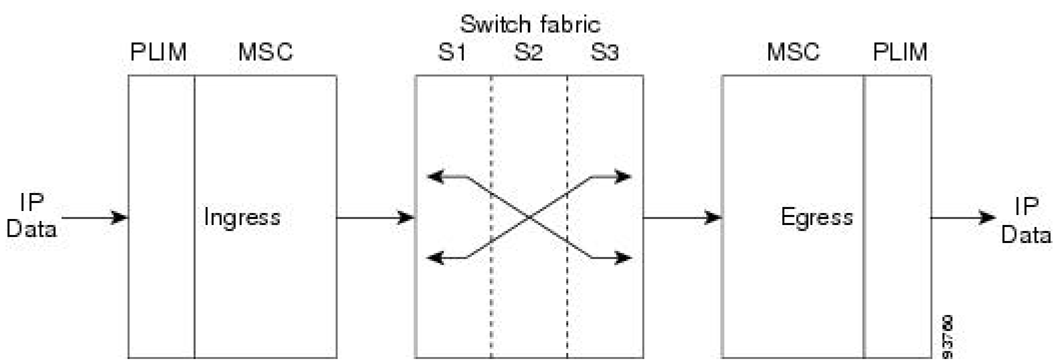
When operating as part of a multishelf system for the Cisco CRS-1,Cisco CRS-3 or CRS-X, the chassis accepts either the CRS-16-FC/M (40G), CRS-16-FC140/M (140G), or CRS-16-FC400/M (200G) SFC. In a multishelf system, the SFC cards installed in the LCCs perform the S1 stage and S3 stage functions, while the S2 stage of the switch fabric is provided by S2 switch fabric cards in the fabric card chassis (FCC). Like the CRS-16-FC140/S fabric, the CRS-16-FC140/M fabric operates in 40G and 140G mode

.With the CRS-16-FC140/M S2 fabric in the FCC, the LCCs in a multishelf system can be a mixture of 40G fabric LCCs and 140G fabric LCCs; in this case, only those LCCs requiring 140G support would need to be upgraded. Also, like the CRS-16-FC400/S fabric, the CRS-16-FC400/M fabric operates in 40G, 140G, and 200G mode.

With the CRS-16-FC400/M S2 fabric in the FCC, the LCCs in a multishelf system can be a mixture of 40G fabric LCCs, 140G fabric LCCs, and 200G LCCs; in this case, only those LCCs requiring 200G support would need to be upgraded. See the next section for details about the stages of the switch fabric.

The following 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 45: Basic Cisco CRS Series Carrier Routing System Switch Fabric



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

Note The cell structure used in the Cisco CRS routing system 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.

Speedup Function

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

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

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

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

S2 and S3 Buffering

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

Failure Operation

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

Note the following:

- For the Cisco CRS-1 and Cisco CRS-3 routing systems, at least two planes of the switch fabric (an even plane and an odd plane) must be active at all times. Otherwise, the switch fabric fails, causing a system failure.

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

Switch Fabric Upgrade

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

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

For information about how to perform online insertion and removal (OIR) of switch fabric cards in a single-chassis system, see the Cisco IOS XR Getting Started Guide. For information about how to upgrade from a single-shelf system to a multishelf system, see the *Cisco CRS-1 Carrier Routing System Single-Shelf to Multishelf Upgrade Guide*.

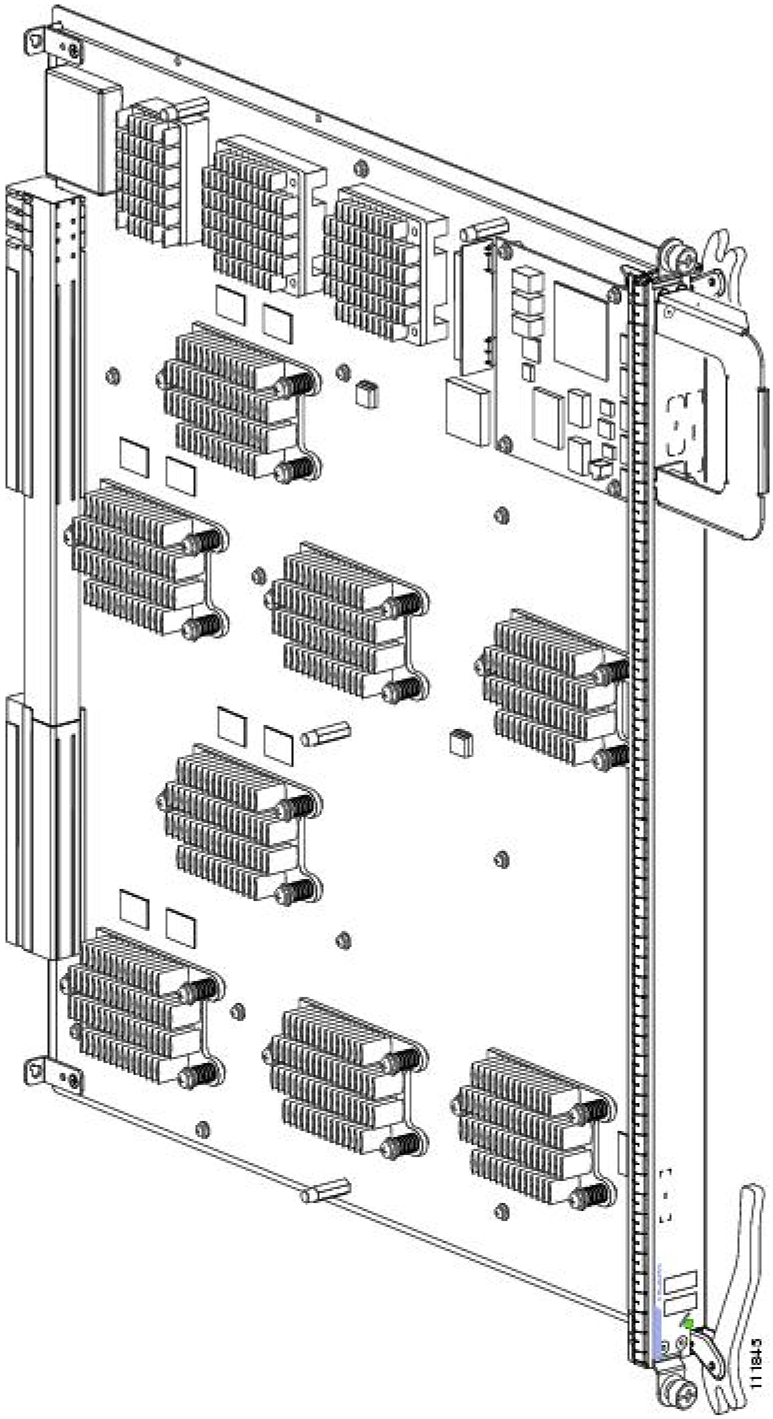
Switch Fabric Card Description

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

Switch Fabric Card (Single-Chassis System)

In a single chassis, the switch fabric card implements all three stages of the three-stage Benes switch fabric. Each card also implements one plane of the eight-plane switch fabric. The following figure shows the CRS-16-FC/S switch fabric card. The CRS-16-FC140/S is similar, but the CRS-16-FC400/S is different.

Figure 46: CRS-16-FC/S Switch Fabric Card



Switch Fabric Card Components

The switch fabric card contains the following major components:

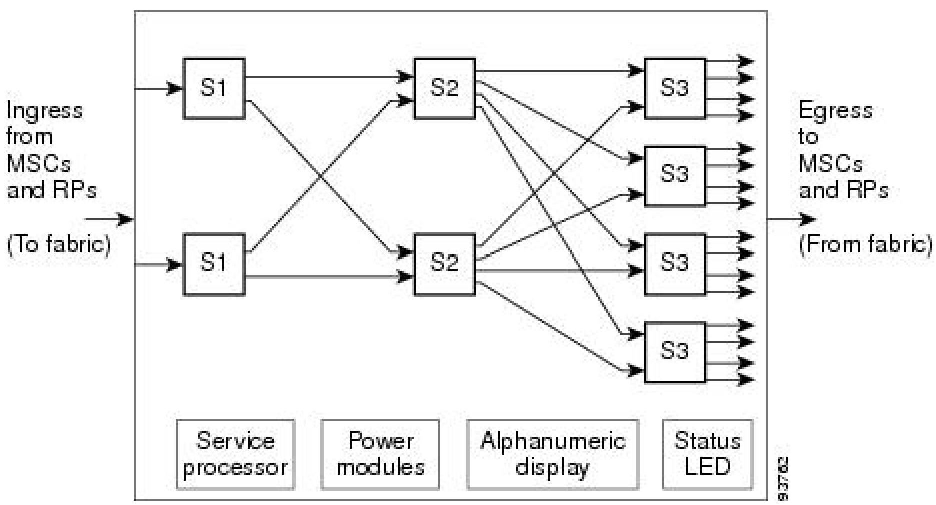
- S1 switch element—Implements Stage 1 of the switch fabric. Receives cells from the MSC or RP and distributes them to Stage 2. Each S1 switch element is connected to every S2 switch element.
- S2 switch element—Implements Stage 2 of the switch fabric. Receives cells from Stage 1, performs 2x speedup,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

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

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

The following figure shows the major components of the switch fabric card.

Figure 47: Block Diagram of the Switch Fabric Card

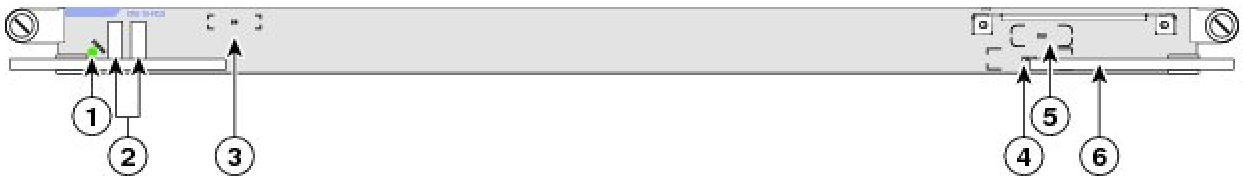


Note Each stage of the three-stage Benes switch fabric is implemented with the same switch element components. However, during system startup the components are programmed by Cisco IOS XR software to operate in S1, S2, or S3 mode, depending on their functions in the switch fabric. Each switch fabric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

Switch Fabric Card Physical Characteristics

The following figure shows the front panel of the CRS-16-FC/S switch fabric card. The front panel of the CRS-16-FC140/S CRS-16-FC400/S and is similar.

Figure 48: CRS-16-FC/S Switch Fabric Card Front Panel



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

The switch fabric card front panel contains:

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

CHAPTER 5

Line Cards and Physical Layer Interface Modules

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

This chapter includes the following sections:

Note For a complete list of cards supported in the Cisco CRS 16-slot line card chassis, see Cisco Carrier Routing System Data Sheets .

Overview of Line Cards and PLIMs

The MSC, FP, or LSP card, also called line cards, are the Layer 3 forwarding engine in the CRS 16-slot routing system. Each MSC, FP, and LSP is paired with a corresponding physical layer interface module (PLIM, also called line card) that contains the physical interfaces for the line card. An MSC, FP, or LSP can be paired with different types of PLIMs to provide a variety of packet interfaces.

- The MSC card is available in the following versions: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X/CRS-MSC-L (200G mode).
- The FP card is available in the following versions: CRS-FP140, CRS-FP-X/CRS-FP-X-L(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 Supply, on page 41.

Note See Hardware Compatibility, on page 16 for information about CRS fabric, MSC, and PLIM component compatibility.

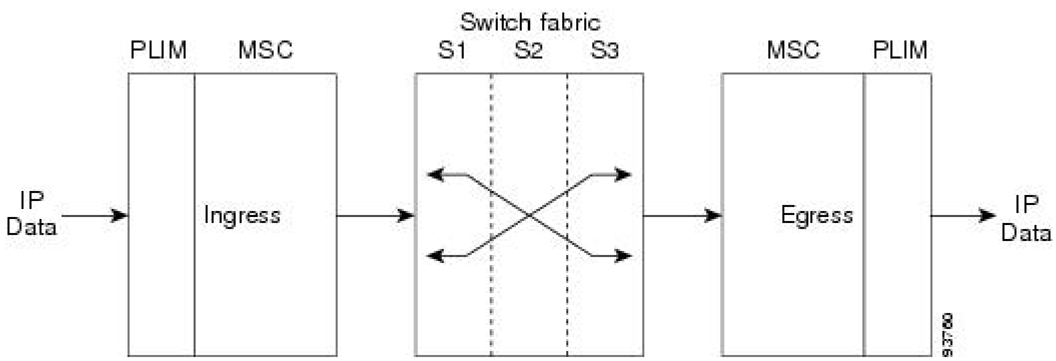
Each line card and associated PLIM implement Layer 1 through Layer 3 functionality that consists of physical layer framers and optics, MAC framing and access control, and packet lookup and forwarding capability. The line cards deliver line-rate performance (up to 200 Gbps aggregate bandwidth). Additional services, such as Class of Service (CoS) processing, Multicast, Traffic Engineering (TE), including statistics gathering, are also performed at the 200 Gbps line rate.

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

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

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

Figure 49: Data Flow through the Cisco CRS 16-Slot Line Card Chassis



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

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

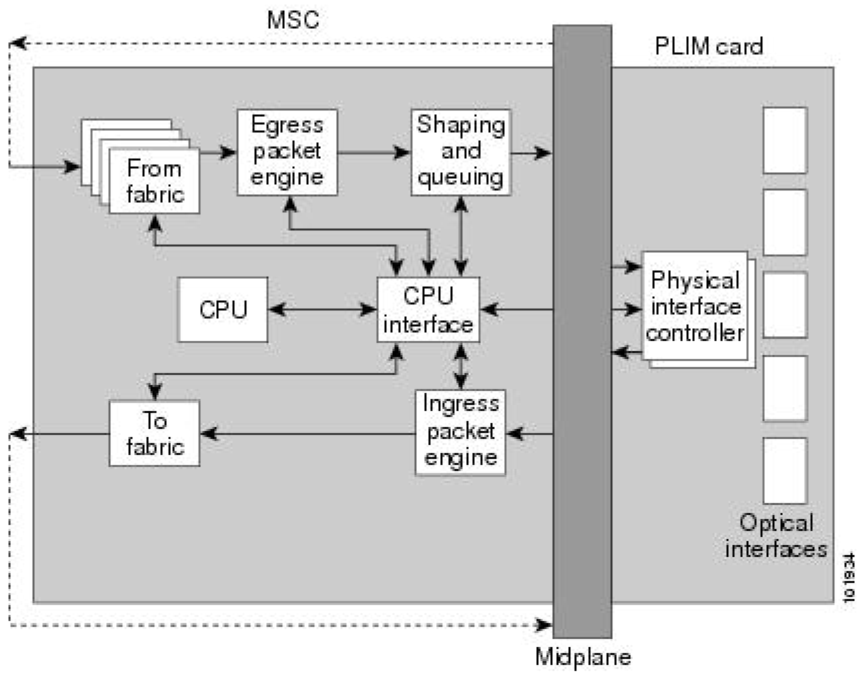
A PLIM eight-byte header is built for packets entering the fabric. The PLIM header includes the port number, the packet length, and some summarized layer-specific data. The L2 header is replaced with PLIM headers and the packet is passed to the MSC for feature applications and forwarding.

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

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

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

Figure 50: MSC and PLIM Simple Block Diagram



PLIM Physical Interface Module on Ingress

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

- Multiplexes the physical ports and transfers them to the ingress packet engine through the line card chassis midplane.
- Buffers incoming data, if necessary, to accommodate back-pressure from the packet engine.
- Provides Gigabit Ethernet specific functions, such as:
  - VLAN accounting and filtering database
  - Mapping of VLAN 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. To perform Layer 3 forwarding, the packet engine performs the following functions:

- Classifies packets by protocol type and parses the appropriate headers on which to do the forwarding lookup on
- Performs an algorithm to determine the appropriate output interface to which to route the data
- Performs access control list filtering
- Maintains per-interface and per-protocol byte-and-packet statistics

- Maintains Netflow accounting
- Implements a flexible dual-bucket policing mechanism

MSC To Fabric Section and Queuing

The “to fabric” section of the board takes packets from the ingress packet engine, segments them into fabric cells, and distributes (sprays) the cells into the eight planes of the switch fabric. Because each MSC has multiple connections per plane, the “to fabric” section distributes the cells over the links within a fabric plane. The chassis midplane provides the path between the “to fabric” section and the switch fabric (as shown by the dotted line in Figure 50: MSC and PLIM Simple Block Diagram, on page 75).

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

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

MSC From Fabric Section

The “from fabric” section of the board receives cells from the switch fabric and reassembles the cells into IP packets. The section then places the IP packets in one of its 8K egress queues, which helps the section adjust for the speed variations between the switch fabric and the egress packet engine. Egress queues are serviced using a modified deficit round-robin (MDRR) algorithm. The dotted line in Figure 50: MSC and PLIM Simple Block Diagram, on page 75 indicates the path from the midplane to the “from fabric” section.

MSC Egress Packet Engine

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

Shaping and Queuing Function

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

PLIM Physical Interface Section on Egress

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

- Support for the physical ports. Each physical interface controller can support up to four physical ports and there can be up to four physical interface controllers on a PLIM.
- Queuing for the ports

- Back-pressure signalling for the queues
- Dynamically shared buffer memory for each queue
- A loopback function where transmitted data can be looped back to the receive side

MSC CPU and CPU Interface

As shown in Figure 50: MSC and PLIM Simple Block Diagram, on page 75, the MSC contains a central processing unit (CPU) that performs the following tasks:

- MSC configuration
- Management
- Protocol control

The CPU subsystem includes:

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

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

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

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

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

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

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

Line Card Descriptions

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

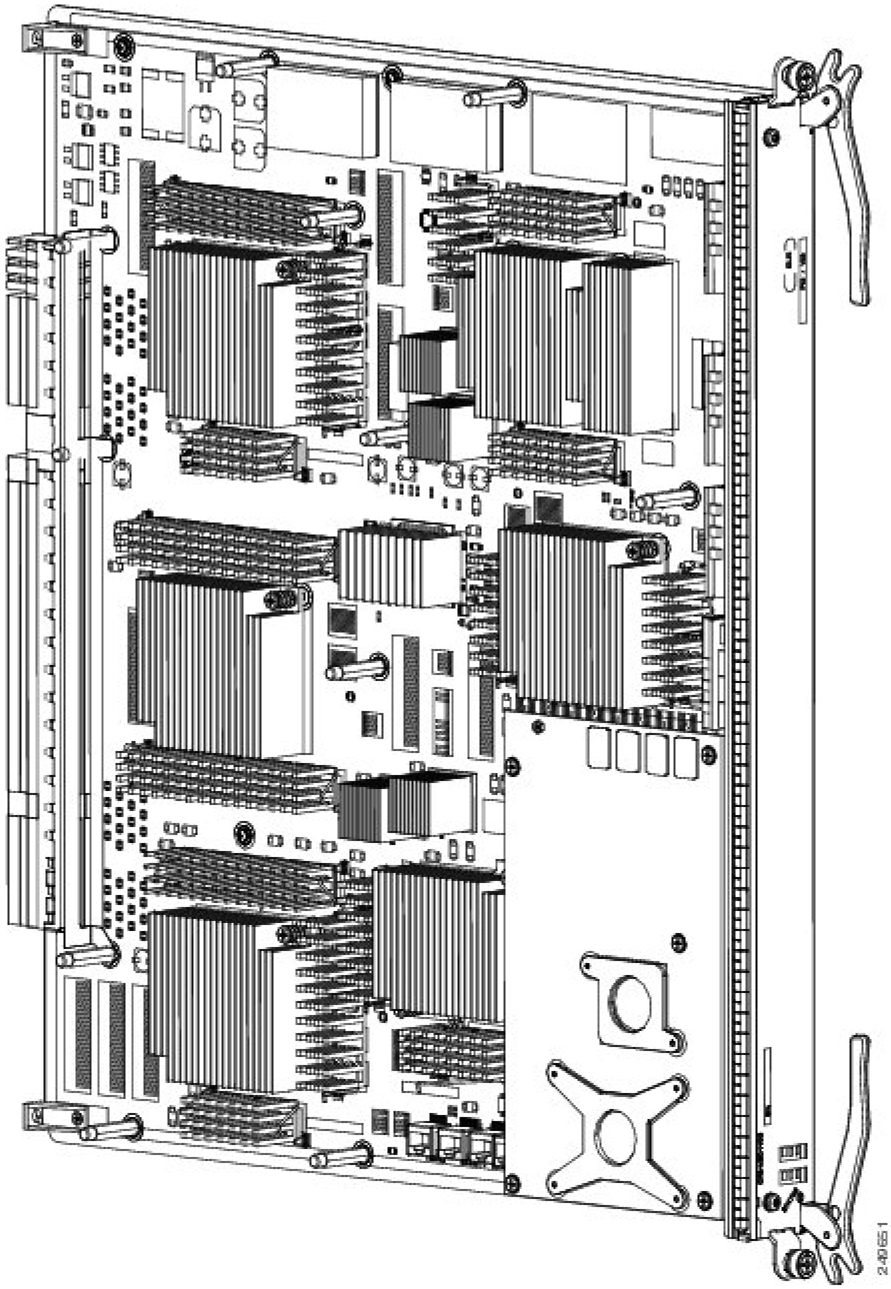
- MSCs: CRS-MSC (end-of-sale), CRS-MSC-B, CRS-MSC-140G, and CRS-MSC-X/ CRS-MSC-X-L (200G mode)
- FPs: CRS-FP40, CRS-FP140, CRS-FP-X/CRS-FP-X-L (200G mode)
- LSPs: CRS-LSP

The power consumption of the line cards are:

-
    - CRS-MSC = 350 W
    - CRS-MSC-B = 375 W
    - CRS-MSC-140G = 446 W
    - CRS-MSC-X and CRS-MSC-X-L (200G) = 450 W
    - CRS-FP-40 = 375 W
    - CRS-FP-X and CRS-FP-X-L (200G) = 450 W
    - CRS- FP140 = 446 W
    - CRS- LSP = 446 W

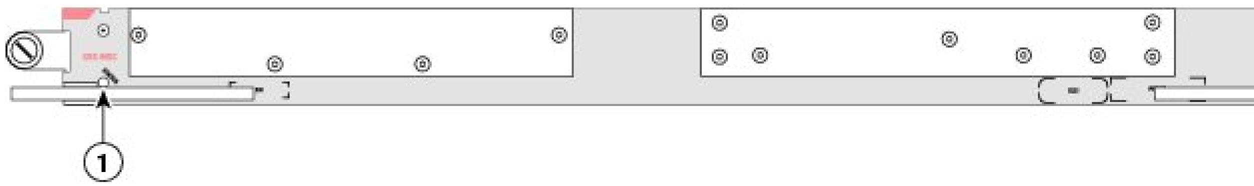
The following figure shows a Cisco CRS routing system CRS-MSC-140G.

Figure 51: Modular Services Card (CRS-MSC-140G)



The following figure shows the CRS-MSC front panel.

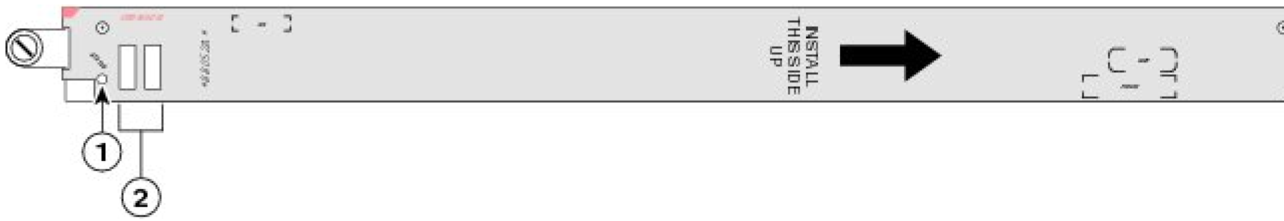
Figure 52: CRS-MSC Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the front panel of the CRS-MSC-B.

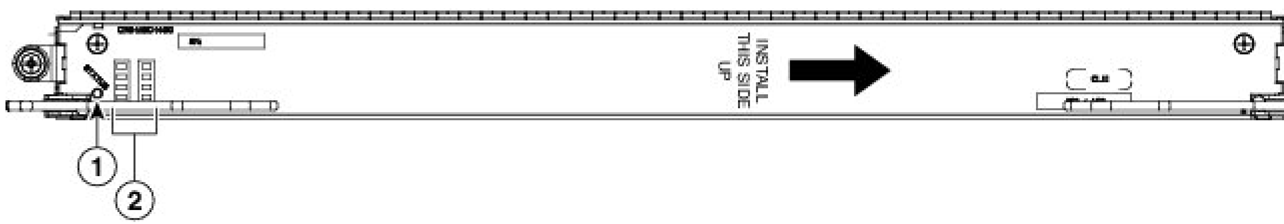
Figure 53: CRS-MSC-B Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the front panel of the CRS-MSC-140G. The CRS-MSC-X card front panel is similar.

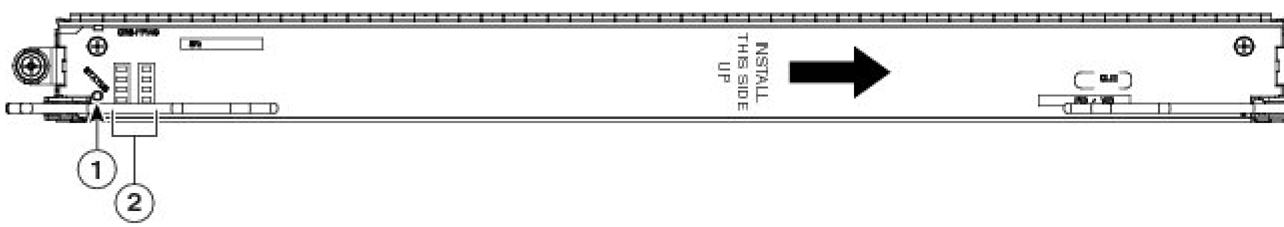
Figure 54: CRS-MSC-140G Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the front panel of the CRS-FP140. The CRS-FP40 and CRS-FP-X card front panels are similar.

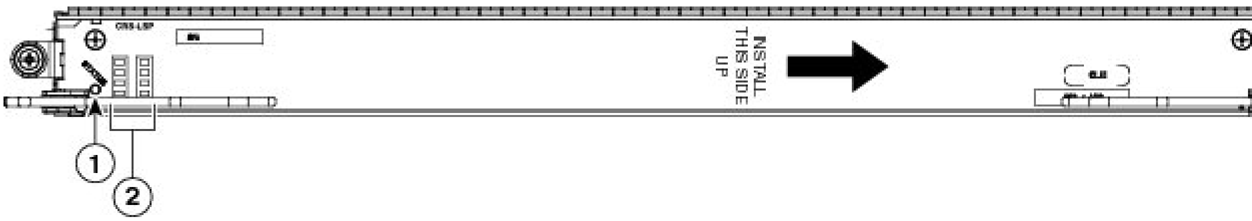
Figure 55: CRS-FP140 Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the front panel of the CRS-LSP.

Figure 56: CRS-LSP Front Panel



1	Status LED	2	Alphanumeric LED

Physical Layer Interface Modules (PLIMs)

This section includes the following topics:

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

PLIM Overview

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-1 Series components).

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

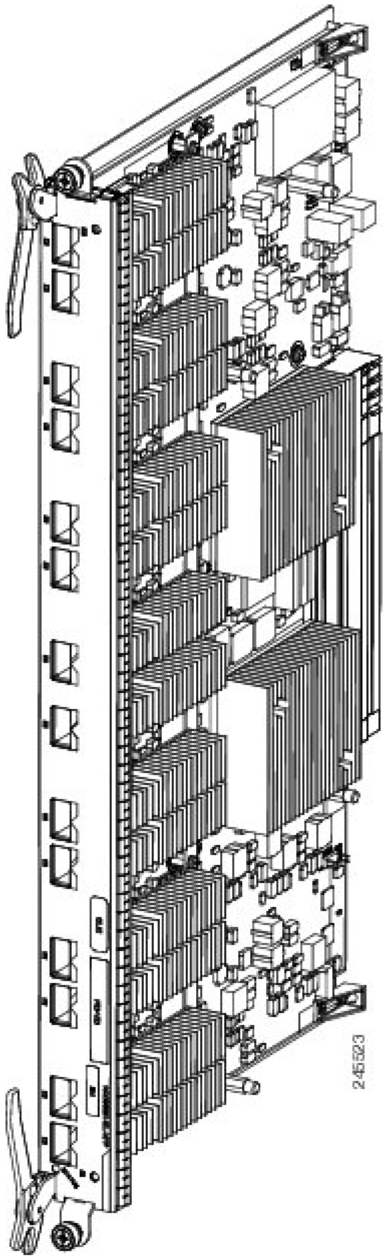
Line cards and PLIMs are installed on opposite sides of the line card chassis, and mate through the chassis midplane. Each line card and PLIM pair is installed in corresponding chassis slots in the chassis (on opposite sides of the chassis). The chassis midplane enables you to remove and replace a line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

You can mix and match PLIM types in the chassis.

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

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

Figure 57: Typical PLIM—14-Port 10-GE XFP PLIM



OC-768c/STM-256c POS PLIM

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

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

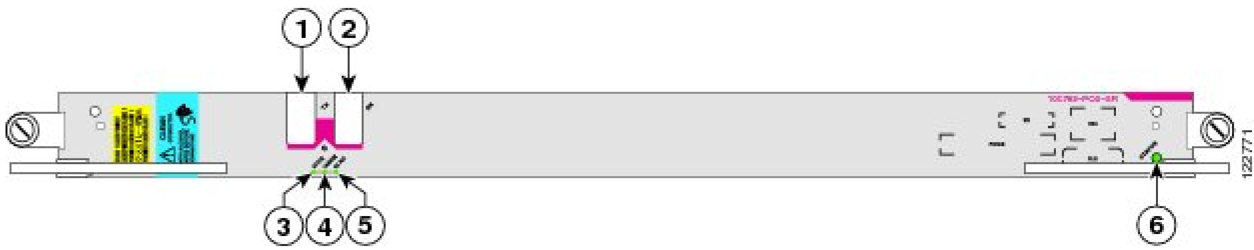
The PLIM contains:

- 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 line card.
- Additional components—Include power and clocking components, voltage and temperature sensors, and an identification EEPROM that stores initial configuration and PLIM hardware information.

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

The following figure shows the front panel of the OC-768 PLIM.

Figure 58: 1-Port OC-768 PLIM Front Panel



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

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

- A single port (0) with Tx and Rx jacks that provide SR optics with SC fiber-optic interfaces.
- 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.
- 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.
- Power consumption of the 1-port OC-768 PLIM—65 W

OC-192 POS/Dynamic Packet Transport PLIM

The 4-port OC-192 PLIM contains four ports that can be software configured to operate in packet-over-SONET (POS) or Dynamic Packet Transport (DPT) mode. This PLIM performs Layer 1 and Layer 2 processing for four OC-192 data streams by removing and adding the proper header information as data packets enter and exit the PLIM. This PLIM feeds the line card a single 40-Gbps data packet stream.

The VSR version of the PLIM is a class 1M laser product. All other versions (LR, IR, and SR) are class 1 laser products.

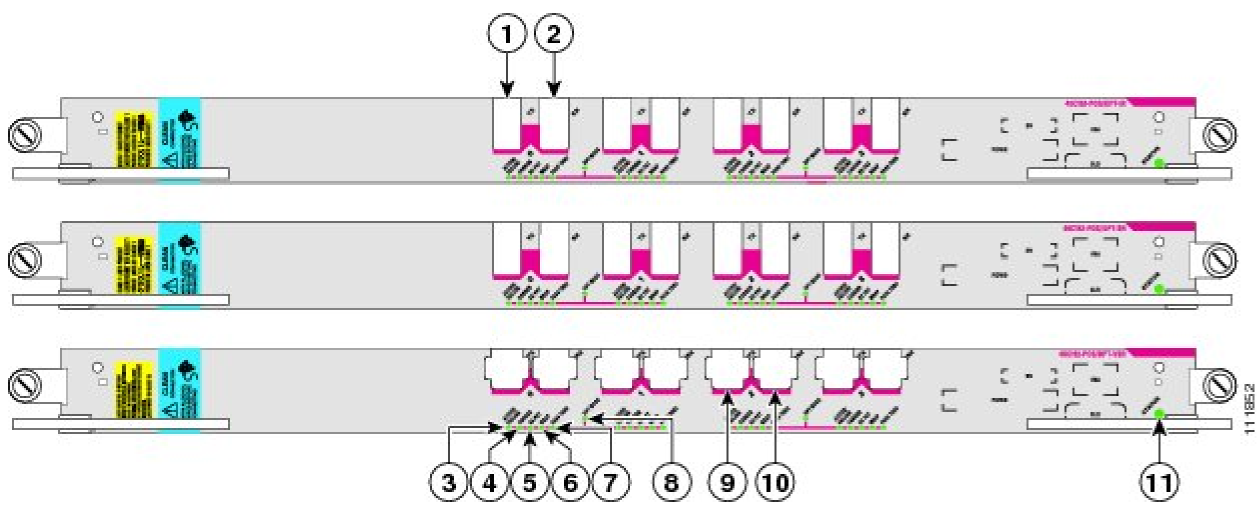
Note Dynamic Packet Transport (DPT) mode is not available at this time.

The 4-port OC-192 consists of:

- Optics modules—Provide receive (Rx) and transmit (Tx) optic interfaces that comply with GR-253-CORE. The PLIM supports the following types of optics:
    - Long-reach (LR) optics with SC fiber-optic interfaces
    - Intermediate-reach (IR) optics with SC fiber-optic interfaces
    - Short-reach (SR) optics with SC fiber-optic interfaces
    - Very-short-reach (VSR) optics with standard MTP (MPO) multi-fiber optic interfaces
- 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.
- 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.
- 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 line card.
- Additional components—Provide power, clocking, voltage and temperature sensing, and an identification EEPROM that stores initial configuration information and details about the PLIM type and hardware revision.
- Power consumption of the 4-port OC-192 PLIM—138 W

The following figure shows the front panels of the different versions of the OC-192 PLIM.

Figure 59: 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 elements:

- Four ports (0, 1, 2, and 3) with Tx and Rx jacks for each port. The VSR version of the PLIM provides standard MTP (MPO) multi-fiber optic interfaces. All other PLIMs (LR, IR, and SR) have 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.
- 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. DPT mode is always configured on pairs of ports. The OC-192 PLIM can operate in either POS mode or DPT mode (as of Cisco IOS XR Release 3.4).
- 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).

OC-48 POS/Dynamic Packet Transport PLIM

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

The PLIM is a class 1 laser product.

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

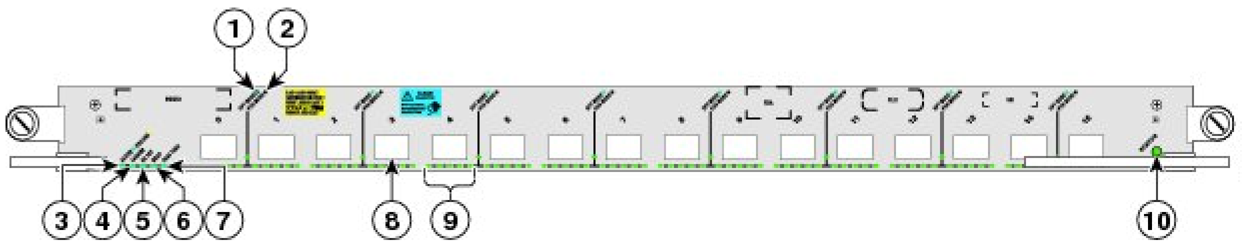
The 16-port OC-48 PLIM consists of the following components:

- Optics modules—Provide the receive (Rx) and transmit (Tx) optic interfaces for each of the 16 ports. The OC-48 PLIM uses small form-factor pluggable (SFP) optics modules that can be removed and replaced while the PLIM is powered up. The SFPs provide short-reach (SR) and long-reach (LR2) optics with LC fiber-optic interfaces.
- Framers—Provide processing and termination for SONET section, line, and path layers, including alarm processing and APS support and management. The framer supports both packet and cell processing for a multiservice operating mode.
- DPT or transparent mode components—Provide the MAC layer function for the Spatial Reuse Protocol used in the DPT mode. When the OC-48 PLIM operates in the POS mode, these components operate in the transparent mode.

- Physical interface controller—Provides data packet buffering and Layer 2 processing and multiplexing and demultiplexing of the 16 OC-48 data streams. This includes processing for VLANs and back-pressure signals from the line card.
- Additional components—Provide power, clocking, voltage and temperature sensing, and an identification EEPROM that stores initial configuration information and details about the PLIM type and hardware revision.
- Power consumption of the OC-48 PLIM—136 W

The following figure shows the front panel of the OC-48 PLIM.

Figure 60: 16-Port OC-48 POS PLIM Front Panel View



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

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

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

10-Gigabit Ethernet XENPAK PLIM

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

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

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

Oversubscription of 10-GE Ports

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

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

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

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

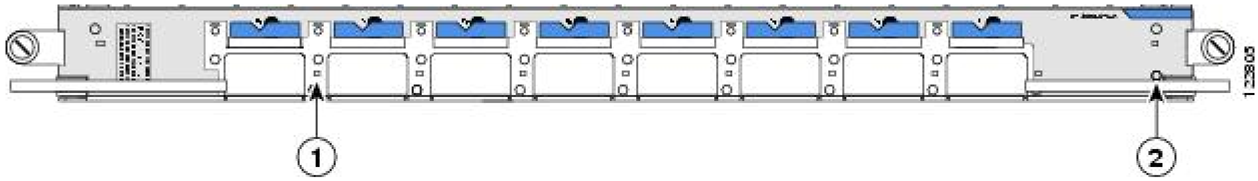
10-GE PLIM Components

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

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

The following figure shows the front panel of the 10-GE XENPAK PLIM.

Figure 61: 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 elements:

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

8-Port 10-GE PLIM with XFP Optics Modules

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

The figure below shows the front panel of the 8-port 10-GE XFP PLIM. The 8-port 10-GE XFP PLIM has:

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

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

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

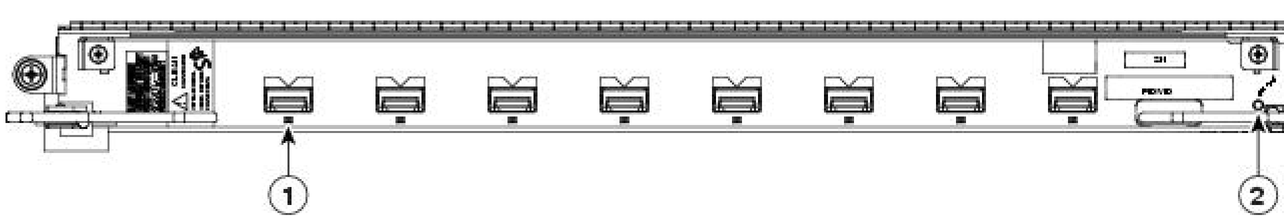
Note For information about the XFP optical transceiver modules supported on the 8-port 10-GE XFP PLIM, see the Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note.

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

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

The following figure shows the front panel of the 8-Port 10-GE XFP PLIM.

Figure 62: 8-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED

The following table describes the PLIM LEDs for the 8-Port 10-GE XFP PLIM.

Table 11: 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 following table provides cabling specifications for the XFP modules that can be installed on the 8-port 10-GE XFP PLIM.

Table 12: 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 figure below shows the front panel of the 4-port 10-GE XENPAK PLIM. The 4-port 10-GE XFP PLIM has:

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

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

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

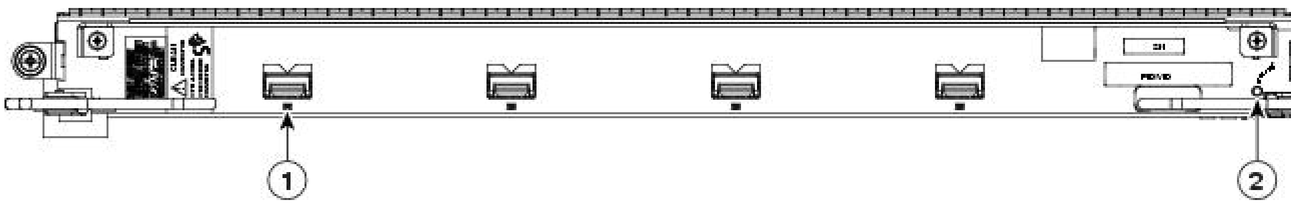
Note For information about the XFP optical transceiver modules supported on the 4-port 10-GE XFP PLIM, see the Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module Installation Note.

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

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

The following figure shows the front panel of the 4-Port 10-GE XFP PLIMs.

Figure 63: 4-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED

The following table describes the PLIM LEDs for the 4-Port 10-GE XFP PLIM. The 4-Port 10-GE XFP PLIM power consumption is 74 W (with four optics modules)

Table 13: 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 following table provides cabling specifications for the XFP modules that can be installed on the 4-port 10-GE XFP PLIMs.

Table 14: XFP Module Port Cabling Specifications for the 4-Port 10-GE XFP PLIM

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

1-Port 100-GE PLIM with CFP Optics Module

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

The 1-port 100-GE PLIM has:

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

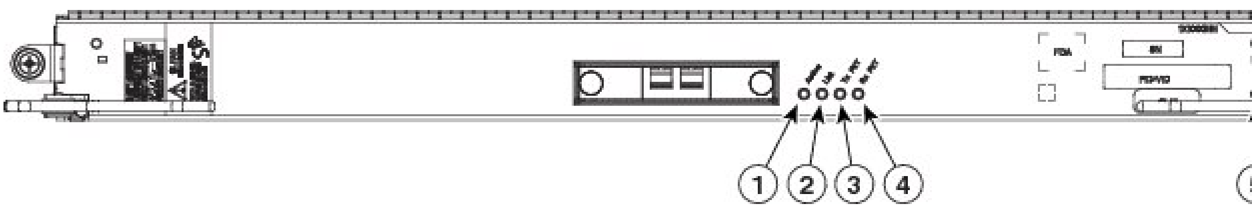
The 1-port 100-GE PLIM supports the following types of CFP optical transceiver modules:

- CFP-100GE-LR4, V01

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

The following figure shows the front panel of the 1-Port 100-GE CFP PLIM.

Figure 64: 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

The following table describes the PLIM LEDs for the 1-Port 100-GE CFP PLIM.

Table 15: 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.

LED	State	Description
Rx PKT	Green (flashing)	Packets are being received on the port.
	Yellow	TBD
	Off	No packets are being received on the port.

20-Port 10-GE PLIM with XFP Optics Modules

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

The 20-port 10-GE PLIM has:

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

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

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

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

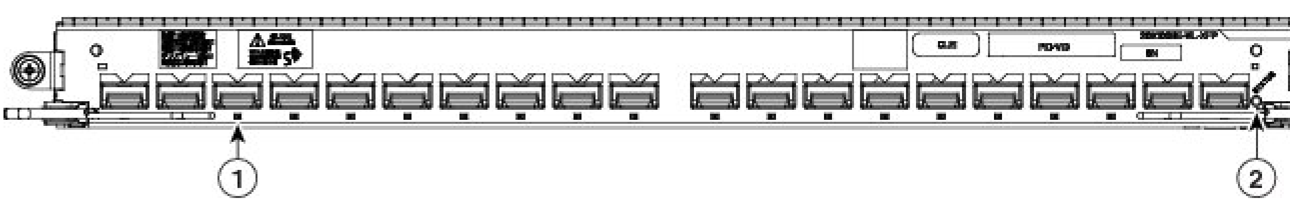
Note The 20-port XFP PLIM has a fixed power budget for the pluggable XFP optics. See XFP Optics Power Management, on page 95 for detailed information.

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

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

The following figure shows the front panel of the 20-Port 10-GE XFP PLIMs.

Figure 65: 20-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED

The following table describes the PLIM LEDs for the 20-Port 10-GE XFP PLIM.

Table 16: 20-Port 10-GE XFP PLIM LED Descriptions

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

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

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

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

14-Port 10-GE PLIM with XFP Optics Modules

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

The 14-port 10-GE PLIM has:

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

The14-port 10-GE PLIM supports the following types of XFP optical transceiver modules:

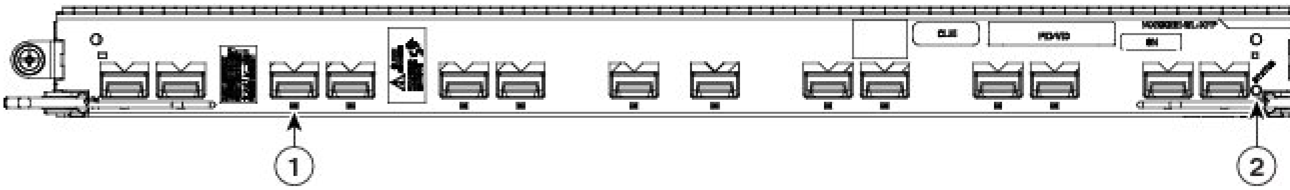
- Single-mode low power multirate XFP module—XFP10GLR-192SR-L, V01
- Single-mode low power multirate XFP module—XFP10GER-192IR-L, V01

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.

The following figure shows the front panel of the 14-Port 10-GE XFP PLIMs.

Figure 66: 14-Port 10-Gigabit Ethernet XFP PLIM front panel



1	Port LED (one per port)	2	Status LED

The following table describes the PLIM LEDs for the 14-Port 10-GE XFP PLIM.

Table 17: 14-Port 10-GE XFP PLIM LED Descriptions

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

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

- Height—20.6 in (52.2 cm)
- Depth—11.2 in (28.4 cm)
- Width—1.8 in (4.49 cm)
- Weight—7.85 lbs (3.55 kg)
- Power consumption—150 W (115 W with no optics installed, 35 W optics budget)

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

Note The 20-port XFP PLIM has a fixed power budget for the pluggable XFP optics. See the next section 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.

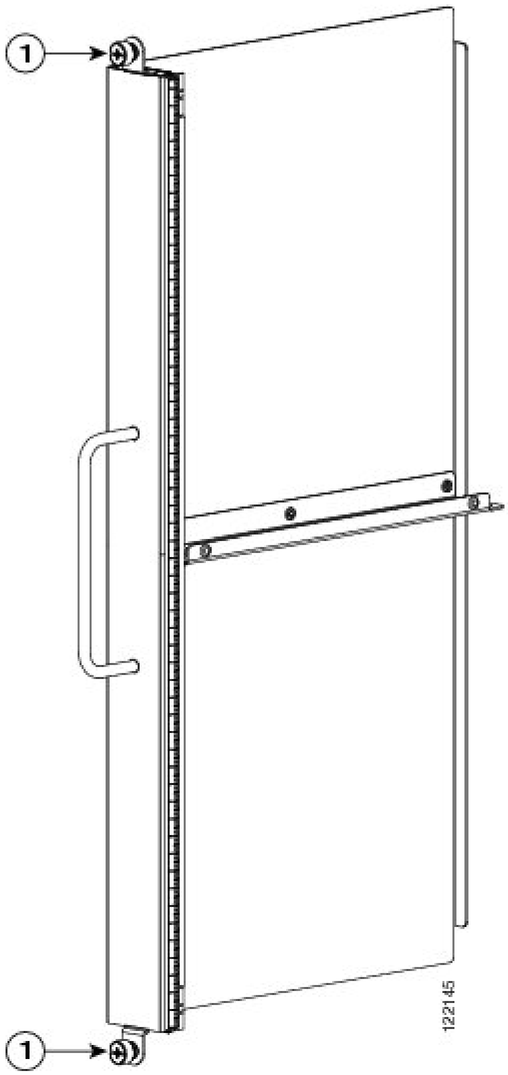
A show command is provided to indicate how much of the XFP power budget is currently used and how much power an XFP is consuming:

```
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 Series chassis (see the following figure). The CRS 16-slot chassis is shipped with impedance carriers installed in the empty slots. The impedance carrier preserves the integrity of the chassis and is required for EMI compliance and proper cooling in the chassis.

Figure 67: PLIM Impedance Carrier



1	Impedance carrier fasteners

CHAPTER 6

Route Processor

This chapter includes the following sections:

Route Processor Overview

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

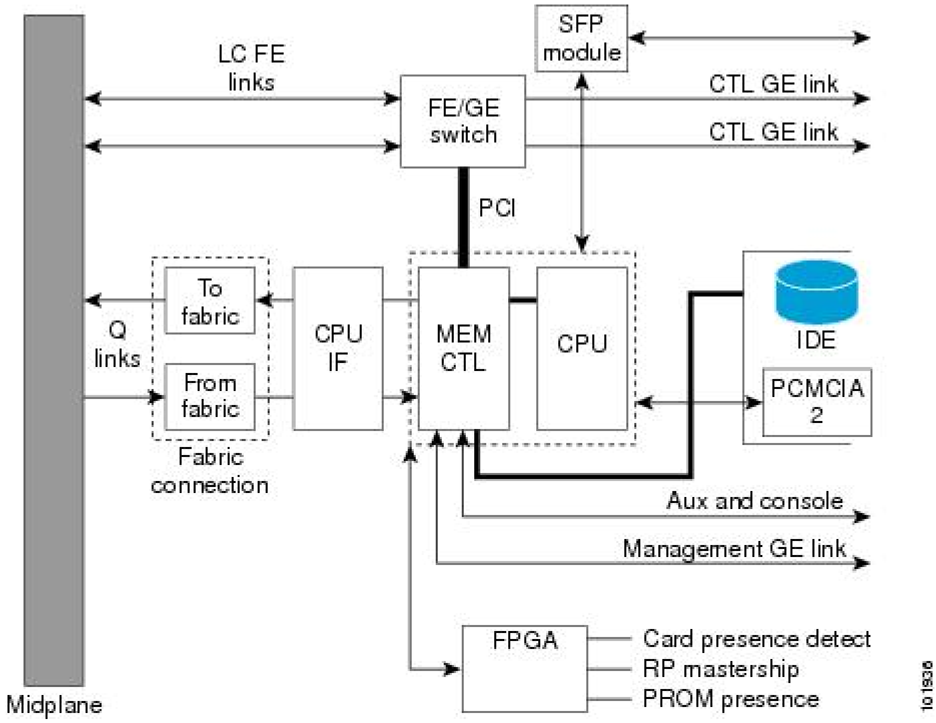
Although each line card chassis contains two RP cards, only one RP is active at a time. The other RP operates in standby mode, ready to assume control if the active RP fails. See Route Processor Active and Standby Arbitration, on page 100 for information on how the system determines which RP is active and which is standby. As of Cisco IOS XR release 3.3.0, the RP and RP-B in tandem for active and standby modes (or vice versa) are supported on the one routing system chassis.

The RP card is also the system controller for the Cisco CRS routing system. See Control Plane, on page 113 for more information about system controller functions.) System controller functionality varies between single-shelf and multishelf systems:

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

The following figure is a simple block diagram of an RP card. The dotted lines indicate distinct RP modules, such as the CPU and memory controller (MEM CTL), and the “to fabric” and “from fabric” sections.

Figure 68: Route Processor Simple Block Diagram



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

- A dual-CPU symmetric multiprocessor (SMP) performs route processing. The CPU also serves as the MSC service processor (SP), and monitors the RP temperature, voltages, power supply margining (during factory test), and ID EEPROM.
- Two small form-factor pluggable (SFP) modules provide external Gigabit Ethernet (GE) connections. In a multishelf system, these modules connect to two external Catalyst 6509 systems that interconnect all line card and fabric chassis together to form a control network. The Cat6509 systems are not used in the single-shelf system.
- A third Ethernet port for 10/100/1000 Ethernet copper provides connectivity to network management systems.
- Internal 100 Mbps Fast Ethernet (FE) midplane connections connect each MSC in the chassis to both RPs. These FE connections are traces in the midplane. There are also FE connections to the fans, blowers and power supplies. These connections all form part of the control plane.
- An IDE hard disk is used to gather debugging information, such as core dumps from the RP or MSCs. See IDE Hard Drive, on page 99 for more information.
- PCMCIA flash slots provide support for two PCMCIA flash subsystems that each provide 2GB or 4GB of flash storage. One of the PCMCIA flash subsystems is accessible externally and removable; the other subsystem is fixed to the RP and is not removable. See PCMCIA Flash Slots, on page 99.

As shown in the above figure, the RP mates with the Cisco CRS 16-slot line card chassis midplane. The RP connects to the switch fabric through two fabric interface modules (from fabric and to fabric) that are similar to the fabric interface of the MSC. See MSC To Fabric Section and Queuing , on page 76).

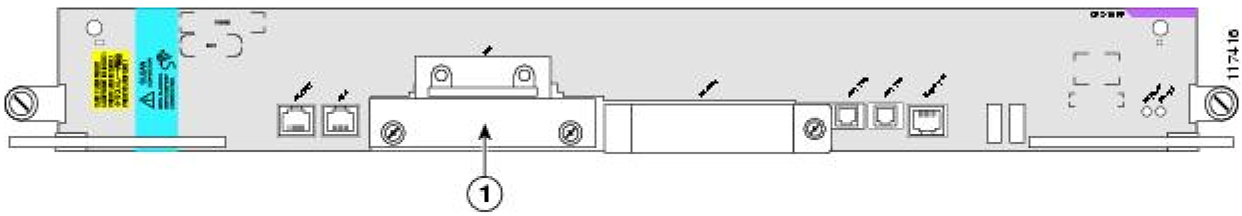
- The from fabric section (which is part of the RP receive path) queues the data from the switch fabric and reorders and reassembles the cells into packets before queuing them for slow-path processing.

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

IDE Hard Drive

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

Figure 69: RP Hard Drive



1	Hard drive door

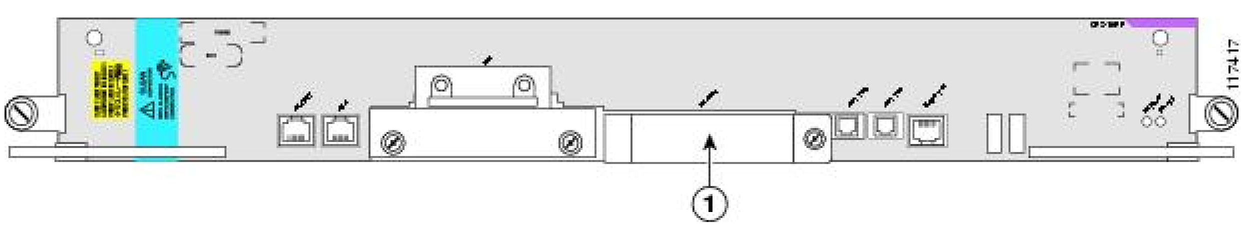
Note Physically, the hard drive is a hot-pluggable PC board and sled-mounted drive with a connector interface that seats into an RP card. In general, removal and replacement of this drive is not required.

PCMCIA Flash Slots

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

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

Figure 70: RP PCMCIA Slots



1	PCMCIA flip-up door

CONSOLE and AUX Ports

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

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

Route Processor Active and Standby Arbitration

The two RPs in a Cisco CRS 16-slot line card chassis operate in an active-standby relationship. Only one RP is active at a time. The other RP operates in standby mode, ready to assume control if the active RP fails.

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

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

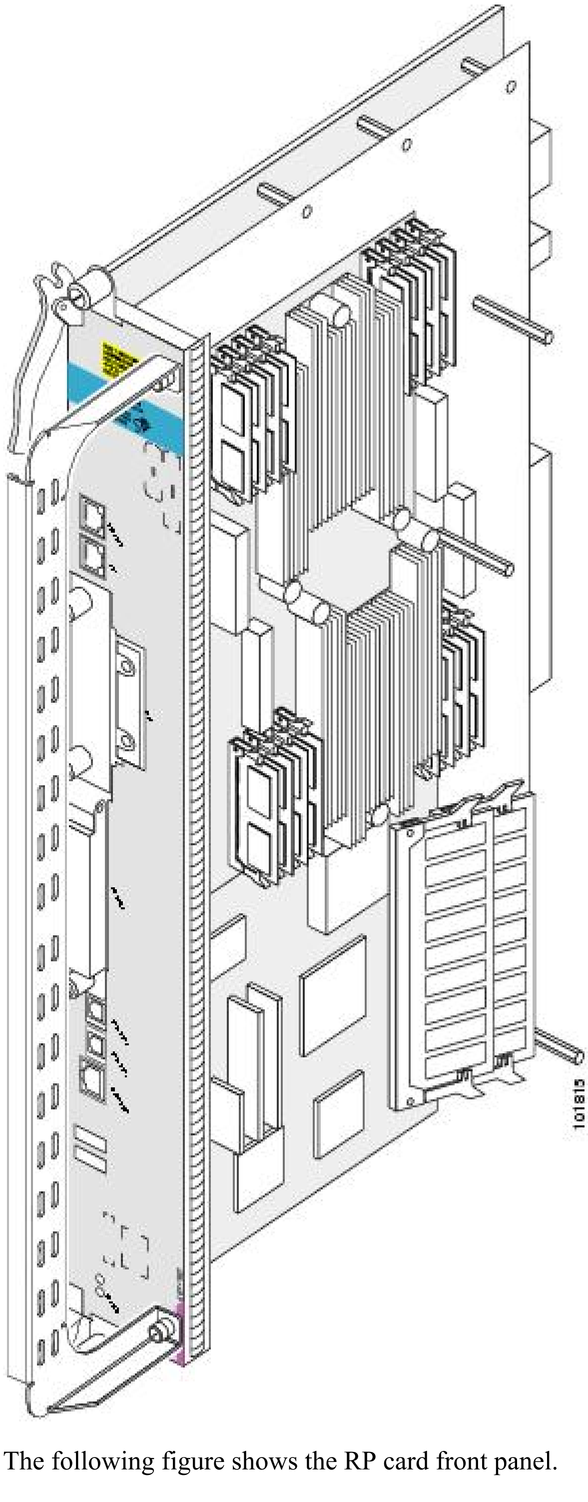
Route Processor Memory Options

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

Route Processor Card

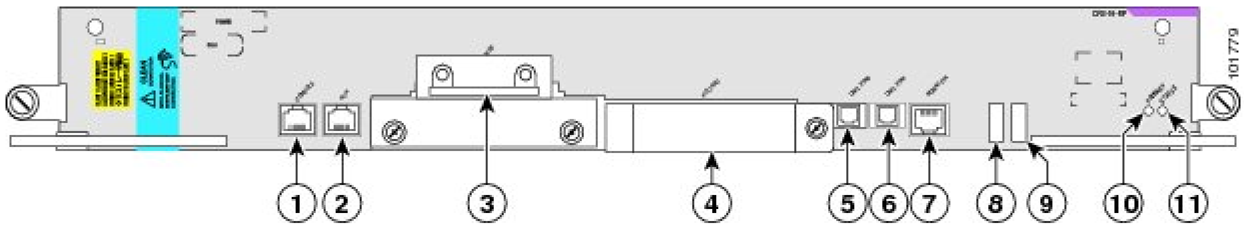
The following figure shows the Cisco CRS routing system RP card. The RP card plugs into the chassis in the center of the lower PLIM card cage, on the front side of the midplane (Figure 9: Front (PLIM) Side Exterior Cosmetic Components—Fixed Configuration Shown).

Figure 71: Route Processor (RP) Card



The following figure shows the RP card front panel.

Figure 72: RP Card Front Panel



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

The RP front panel includes:

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

Distributed Route Processor

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

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

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

The DRP does not perform any of the control and management functions performed by the RP; therefore, it can never be the designated shelf controller (DSC) in a multishelf system. However, the DRP can be configured as the designated logical router shelf controller (dLRSC) in a logical router. A *logical router* is a part of the Cisco CRS-1 Series routing system that functions as a complete router, running its own routing protocols and forwarding IP packets between its interfaces.

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

See Limitations and Restrictions, on page 105 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-1 Series routing capabilities by serving as an additional route processor in the system. The DRP can be installed in any MSC (line card) slot in the line card chassis. The corresponding DRP PLIM is installed in the corresponding PLIM slot. The cards are connected to each other through the chassis midplane.

The main components of the DRP are:

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

The IngressQ ASIC has a memory buffer for storing packets. This buffer storage provides input rate-shaping queues for shaping switch-bound traffic. Input rate shaping is used to provide bandwidth and QoS guarantees for physical and logical port traffic and to smooth traffic bursts into the switch fabric.

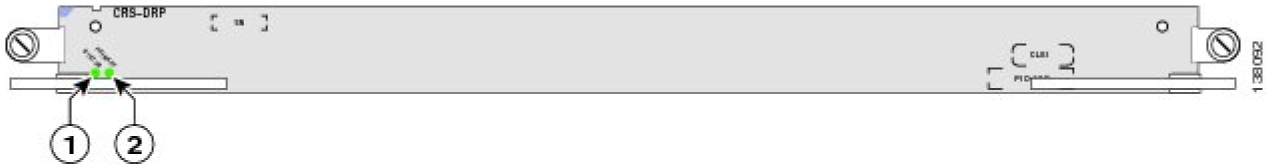
-
    - Two Qlink modules—Provide the interface to the switch fabric. The modules convert data between the format used by the FabricQ and IngressQ ASICs and the format used by the switch fabric. Each Qlink module provides an interface to four planes of the switch fabric.

- Several interfaces—Provide communications paths among the components on the DRP.

- Additional components—Include power and clocking components, voltage and temperature sensors, and an identification EEPROM that stores initial configuration and hardware information.

The following figure shows the DRP card front panel.

Figure 73: 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 (see the figure below).

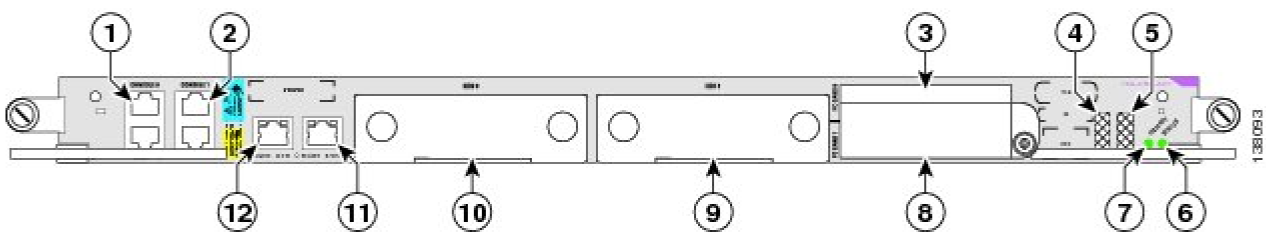
DRP PLIM

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.

The following figure shows the front panel of the DRP PLIM.

Figure 74: DRP PLIM Front Panel



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

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

The DRP PLIM front panel contains the following components:

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

Limitations and Restrictions

The current Cisco CRS-1 Series multishelf system supports DRP functionality, with the following limitations:

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

Performance Route Processor

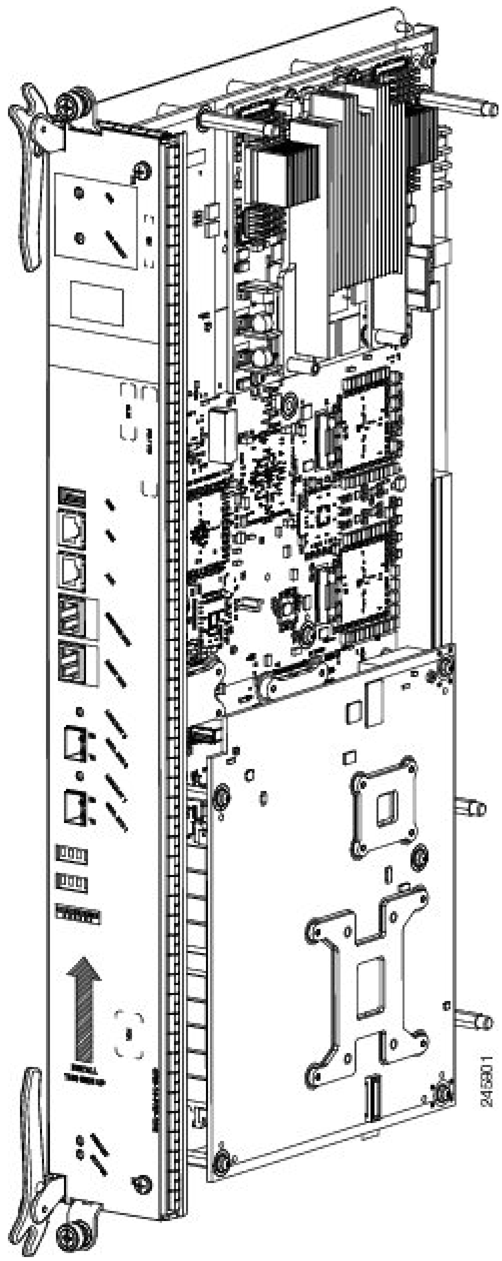
Note For the Cisco CRS-X, the PRP is required instead of the RP.

The Performance Route Processor (PRP) is also available for the Cisco CRS 16-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 16-slot line card chassis. When two PRPs are installed, one PRP is the active RP and the other is the standby RP.

The following figure shows the PRP card.

Figure 75: Performance Route Processor



The PRP has the following physical characteristics:

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

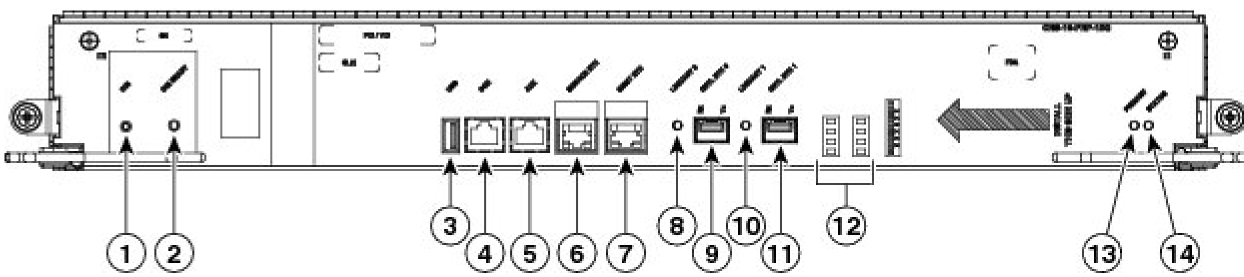
Performance Route Processor Front Panel

The PRP front panel includes:

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

The following figure shows the front panel of the PRP card.

Figure 76: Performance Route Processor Front Panel



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

Performance Route Processor Overview

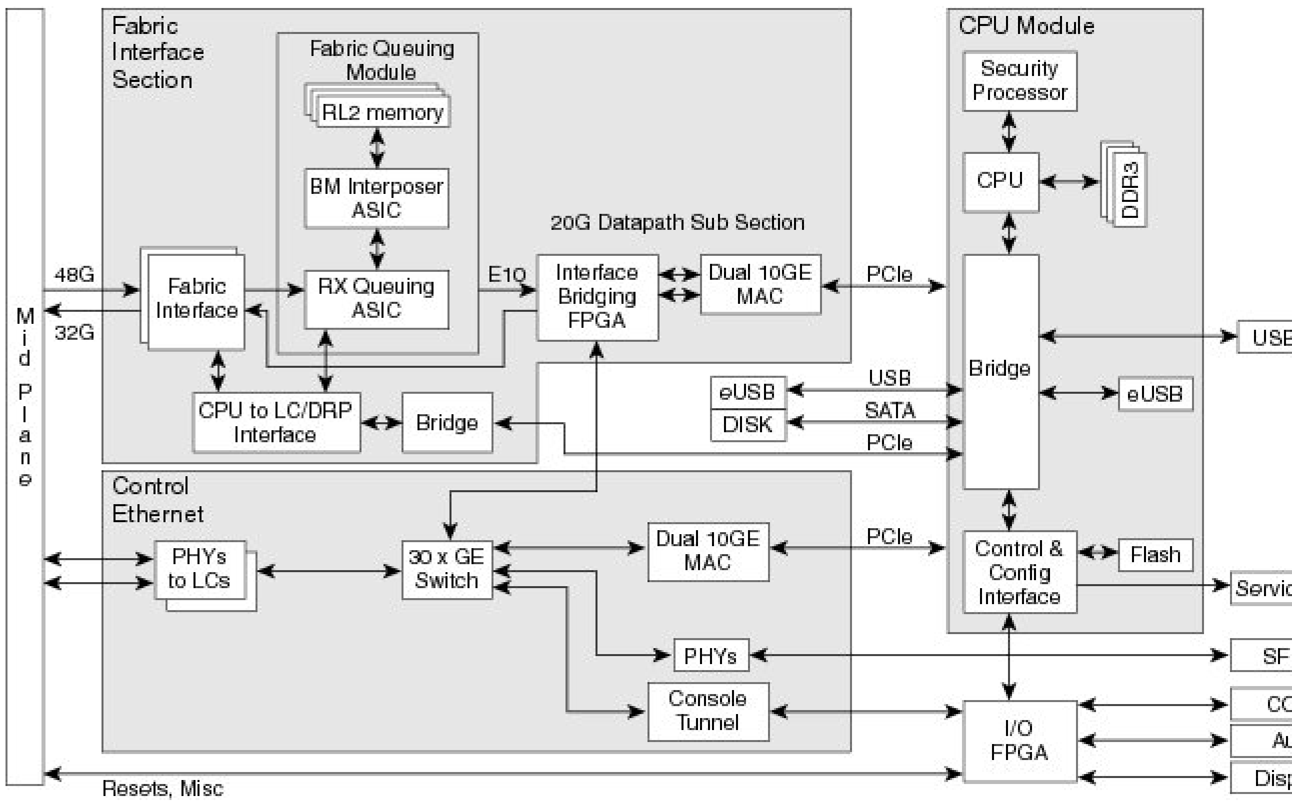
The CRS PRP for the Cisco CRS 16-slot line card chassis is a next generation Intel-based RP that increases the CPU compute power, memory and storage capacity. The PRP provides both route processing and system controller functionality for enhanced performance.

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).

The following figure shows a block diagram of the PRP card.

Figure 77: Performance Route Processor Block Diagram



Performance Route Processor Memory Options

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

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

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

Initiate OIR Pushbutton

The PRP front panel includes an OIR pushbutton (see item 1 in Figure 76: Performance Route Processor Front Panel). 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 76: Performance Route Processor Front Panel) 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

The following table lists the pinouts for the Console (CON) and Auxiliary (AUX) RJ45 ports on the PRP (items 4 and 5 in Figure 76: Performance Route Processor Front Panel).

Table 18: 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.

CHAPTER 7

Single-Chassis System Summary

This chapter includes the following sections:

For instructions on cabling a Cisco CRS-1 Series single-shelf system, see the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Installation Guide .

Single-Chassis System Summary

The single-shelf system comprises one Cisco CRS 16-slot line card chassis that contains a set of switch fabric cards that make up the complete three-stage Benes switch fabric. Because the single-shelf system is a standalone system, it is not interconnected with any other chassis, and does not require interconnection cabling.

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

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

Building Integrated Timing Source

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

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

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

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

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

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

Each BITS RJ-45 connector supports one input signal:

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

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

CHAPTER 8

Control Plane

This chapter includes the following sections:

Control Plane Overview

The Cisco CRS-1 Series Carrier Routing System 16-Slot Line Card Chassis control plane provides a communication path between cards, modules, and components in the chassis. The control plane is a logical entity that ties physical chassis components and software functions into a unified entity. The control plane connects the system controller functionality on the route processor (RP) to the service processor (SP) module used to control each card and module in the chassis.

The control plane is used for:

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

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

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

The Cisco CRS routing system hardware detects, isolates, and recovers from a broad range of faults, and provides failover mechanisms to redundant hardware. The control plane is a central element in achieving high availability, as it must isolate failures and direct failover events, both in the data plane and in the control plane. To ease serviceability, chassis identification displays and critical, major, and minor alarm indicators are clearly visible. Each MSC, RP, fan controller card, and switch fabric card has an alphanumeric display and green

OK LED to show current board status. Environmental conditions, including temperature and voltage levels, are monitored by several internal measurement points and reported to the routing system operator.

The RPs function as the system controller in a Cisco CRS 16-slot line card chassis. Note that the PLIMs are connected to the control plane through their respective MSCs. The control plane includes a switched point-to-point Fast Ethernet (FE), driven by these FE switches, for control plane network messages, and some other paths for system communication. The dual RPs and midplane FE traces provide redundant connections between all cards in the Cisco CRS 16-slot 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:

- Online insertion and remove (OIR) detection—Every MSC, RP, switch fabric card, power module, and so on provides a presence-detection signal to the system controller function on the RP cards. This dedicated hardware signal indicates the physical presence of a card in every slot. The presence-detection signal allows the Cisco IOS XR configuration software to quickly detect OIR events, and identify cards that have been inserted but cannot communicate over the control plane.
- PLIM inventory—Every PLIM slot is probed by the 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 an MSC is plugged into the MSC slot associated with the PLIM.
- RP active/standby arbitration—Both RP slots are directly connected by dedicated midplane signals to special hardware arbitration logic. During the boot process, this logic selects one of the RPs to be the primary (active) device; the other RP functions in standby mode. See Route Processor Active and Standby Arbitration, on page 100 for more information.

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

- Node reset—Each RP has a dedicated reset line to every node in the chassis. Nodes include MSCs, RPs, and fabric cards. The reset lines fan out from each RP and are connected to the SP on the node cards. Only the 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 module is attached to the MSC, RP, alarm module, switch modules, and the power control and blower control systems. When a card or module is inserted into a powered-up chassis, the SP module on that card is always powered up, it cannot be powered down separately from the chassis power. Each service processor module has a Fast Ethernet (FE) connection to each SC or RP.
- System controller (SC) function—The SC, which is contained on the RP, is the central point of control within a Cisco CRS 16-slot 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 (MSC)—The MSC is the primary data-forwarding engine. The MSC provides Layer 2 and Layer 3 packet processing and queuing. The MSC CPU performs a number of control plane functions, including forwarding information base (FIB) download receive, local PLU/TLU management, statistics gathering and performance monitoring, and ASIC management and fault handling.
- PLIM—The PLIM contains the physical interfaces to external data circuits. The PLIM does not have its own SP module. Instead, the MSC SP module controls most of the basic control plane functions for the PLIM. This includes reading and writing the PLIM NVRAM, which contains the board type, revision, serial number, and other information from manufacturing.

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

- Route processor—There are two RP slots per Cisco CRS 16-slot line card chassis. The chassis midplane connects the arbitration logic of the two RPs so that one RP becomes the primary and one RP becomes the standby. The primary RP distributes software images to the SP and MSC, while the standby RP monitors the primary RP in case it is required to become the primary because of a failover event.

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

Performance Route Processor (PRP) card is also available for the Cisco CRS 16-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 may not be populated with a mix of RP and PRP cards. Both route processor cards should be of the same type (RP or PRP).

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

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

- An alarm module and power supplies—The routing system alarm module displays faults and messages to the operator. The alarm module is clearly visible, and includes an alphanumeric display and three LEDs that signify critical, major, and minor faults. When a fault occurs, the alphanumeric display indicates the cause of the fault. The alarm module contains only the alphanumeric and LED display devices and an SP to drive the display and provide control network connectivity.

- Fan trays—Fan trays are monitored by an SP module that measures airflow and controls fan RPM. As temperatures increase, the SP increases blower RPM to provide increased cooling capacity.
- 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 are used to store tracking-number and manufacturing information, and MAC addresses. Software stores the chassis ID value in the NVRAM.

APPENDIX **A**

Technical Specifications

The appendix includes the following topics:

Note For a complete list of cards supported in the LCC, see the Cisco Carrier Routing System Data Sheets.

Line Card Chassis Specifications

The following table lists the specifications for the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis.

Table 19: Cisco CRS 16-Slot Line Card Chassis Specifications

Chassis Dimensions	
Height	80 in. (203.2 cm) as shipped84 in. (213.4 cm) as installed
Width	23.6 in. (60.0 cm) 26.1 in. (66.3 cm) with PDU and brackets
Depth	36 in. (91 cm) without doors and other cosmetics39.7 in. (101 cm) with front and rear doors
Floor space requirement	Chassis: 6 sq ft (0.56 sq m) Aisle spacing to install chassis (front): 48 in. (122 cm) Aisle spacing to service FRUs (front): 36 in. (91 cm) Aisle spacing to service FRUs (rear): 36 in. (91 cm)
Chassis	

Chassis Dimensions	
Chassis shipping weight	1175 lb (532 kg) LCC with shipping crate and pallet
Chassis with power shelves only, no power modules	849 lb (385 kg)
Chassis with power shelves, power modules, alarm module	970 lb (440 kg)
Chassis, fully loaded with cards, without cosmetics	1585 lb (719 kg)
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on)	1629 lb (739 kg)
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on), AC Wye PDU, and brackets	1689 lb (766 kg)
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on), AC Delta PDU, and brackets	1715 lb (778 kg)
Floor Loading	
Chassis footprint	4.72 sq ft (4385 sq cm)
Floor contact area	680 sq in. (4385 sq cm)
Maximum floor loading	Without cosmetics and doors: 1585 lb/4.72 sq. ft = 335 lb/sq. ft719 kg/4385 sq. cm = 0.164 kg/sq. cm With cosmetics and doors: 1695 lb/4.72 sq. ft = 359 lb/sq. ft769 kg/4385 sq. cm = 0.175 kg/sq. cm

Chassis Dimensions	
Cards/Ports/Slots	1-port OC-768c/STM-256c packet over Synchronous Optical Network (POS) 4-port OC-192c/STM-64c POS/Dynamic Packet Transport (DPT) 16-port OC-48c/STM-16 POS/DPT 8-port 10 Gigabit Ethernet 4-port 10 Gigabit Ethernet CRS1-SIP-800 Carrier Card 4-Port OC-3/STM-1 POS SPA 8-Port 1 Gigabit Ethernet SPA 1-port OC-768c/STM-256c Tunable WDMPOS 4-port 10GE Tunable WDMPHY
Chassis Cooling	2 fan trays, push-pull configuration
Chassis airflow	Up to 2050 cubic ft (58,050 liters) per minute
Power shelf airflow	100 to 140 cubic ft (2832 to 3964 liters) per minute
AC power cord length	167 in. (4.25 m)

Fixed Configuration Power Specifications

The following table lists the fixed configuration power specifications for the LCC.

Table 20: Line Card Chassis Fixed Configuration Power Specifications

Description	Value
Power shelves	2 AC or 2 DC power shelves (Cannot mix AC and DC power shelves.)
DC power shelf	3 power entry modules (PEMs) per shelf
AC power shelf	3 PEMs per shelf
Maximum Input Power	
Fixed configuration DC, chassis fully loaded	13,895 W (13.9 kW) 95% efficiency
Fixed configuration AC, chassis fully loaded	15,000 W (15.0 kW) 88% efficiency
Maximum Output Power	
Chassis fully loaded (DC and AC)	12,744 W (12.7 kW)

Description	Value
Power Redundancy (2N)	
DC	2N: Requires 6 “A” battery plant feeds and 6 “B” battery plant feeds (up to 12 total)
AC, 3-phase	2N: Requires two independent 3-phase AC sources
DC Input	
Nominal input voltage	–48 VDC North America–60 VDC European Community(range –42 to –75 VDC)
Input current	50 A max at –48 VDC40 A max at –60 VDC
AC Input, Delta 3-phase	3W+PE (3 wire + protective earthing) **Note** Protective earthing conductor (ground wire).
Nominal input voltage	3-phase 200 to 240 VAC, phase-to-phase(range 180 to 264 VAC, phase-to-phase)
Nominal line frequency	50/60 Hz (range 47 to 63 Hz)
Recommended AC service	60 A
AC Input, Wye 3-phase	3W+N+PE (3 wire + neutral + protective earthing1)
Nominal input voltage	3-phase 200-240/346-415 VAC(range 180 to 264 VAC, phase-to-neutral)(range 311 to 456 VAC, phase-to-phase)
Nominal line frequency	50/60 Hz (range 47 to 63 Hz)
Recommended AC service	40 A (North America)32 A (International)

Modular Configuration Power Specifications

The following table lists the modular configuration power specifications for the Cisco CRS 16-Slot Line Card Chassis.

Table 21: Line Card Chassis Modular Configuration Power Specifications

Description	Value
Power shelves	2 AC or 2 DC power shelves (Cannot mix AC and DC power shelves.)
DC power shelf	Supports up to 8 DC power modules (PMs) 6 PMs are shipped per shelf
AC power shelf	Supports up to 6 DC power modules (PMs) 5 PMs are shipped per shelf

Description	Value
Maximum Input Power	
Modular configuration, DC, chassis fully loaded	14,667 watts (14.7 kW) 88% efficiency
Modular configuration, AC, chassis fully loaded	14,348 watts (14.4 kW) 92% efficiency
Maximum Output Power	
Chassis fully loaded (DC and AC)	13,200 W (13.2 kW)
Power Redundancy	
DC	2N: Up to 8 “A” battery plant feeds and up to 8 “B” battery plant feeds
AC	2N: Up to 6 “A” AC single-phase power sources and up to 6 “B” single-phase AC power sources required.
DC Input	
Nominal input voltage	–48 VDC North America–60 VDC InternationalRange: 40 to –72 VDC
Input current	40 A max at –48 VDC30 A max at –60 VDC50 A at –40 VDC (maximum)
AC Input	Single-phase
Nominal input voltage	200 to 240 VAC (range 180 to 264 VAC)
Nominal line frequency	50/60 Hz (range 47 to 63 Hz)
Recommended AC service	20 A (North America) dedicated branch circuit16 A (International) dedicated branch circuit

Line Card Chassis Environmental Specifications

The following table lists the environmental specifications for the line card chassis.

Table 22: 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) **Note** Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year. This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period. Nonoperating: –40° to 158°F (–40° to 70°C)
Humidity	Operating: 5 to 85% noncondensing Nonoperating: 5 to 90% noncondensing, short-term operation
Altitude	–197 to 5906 ft (–60 to 1800 m) at 122°F (50°C), short-term Up to 13,123 ft (4000 m) at 104°F (40°C) or below
Heat dissipation	47,408 BTU per hour (maximum) fixed configuration DC Heat dissipation from the fixed configuration DC power system based on maximum output power capacity at 95% efficiency. 51,180 BTU per hour—(maximum) fixed configuration AC Heat dissipation from the fixed configuration AC power system based on maximum output power capacity at 88% efficiency. 50,042 BTU per hour (maximum) modular configuration DC Heat dissipation from the modular configuration DC power system based on maximum output power capacity at 90% efficiency. 48,955 BTU per hour—(maximum) modular configuration AC Heat dissipation from the modular configuration AC power system based on maximum output power capacity at 92% efficiency. Depending on the hardware deployed at your site, your system may not consume or be capable of consuming the maximum power supplied by the power system.
Air exhaust temperature	129°F (54°C)—at room temperatures of 95 to 102°F (35 to 39°C) 149°F (65°C)—maximum exhaust temperature on a fully loaded system during worst-case operating conditions (50°C and 6000 ft altitude) Air temperature rise is 59°F (15°C) on a fully loaded system with fans running at maximum speed (5150 RPM). At room temperatures below 95°F (35°C), exhausted air is 66.2°F (19°C) higher than room temperature. At temperatures above 102°F (39°C), exhausted air is 59°F (15°C) higher than room temperature.

Description	Value
Air velocity (at exhaust)	1400 ft per minute (426.7 m per minute) at normal room temperature, low fan speed (4000 RPM) 1800 ft per minute (548.6 m per minute) at high temperature or altitude, maximum fan speed (5150 RPM) Software controls the speed of the fans based on measurements from the chassis thermal sensors.
Sound power level(fixed configuration power)	Room temp 27°C, sound power, 76.2dB with Arctic Room temp 40°C, sound power, 88 dB with Arctic Room temp 27°C, sound power, 82.2dB with TDI AC Room temp 27°C, sound power, 77.2dB with TDI DC Room temp 40°C, sound power, 89dB with TDI AC Room temp 40°C, sound power, 88dB with TDI
Sound power level(modular configuration power)	Fan speed 3300 RPM, temperature 80°F (27°C): 76.2 dB—modular configuration power Fan speed 5150 RPM, temperature 104°F (40°C): 88.0 dB—modular configuration power
Shock and vibration	Designed and tested to meet the NEBS shock and vibration standards defined in GR-63-CORE (Issue 2, April 2002).

Regulatory, Compliance, and Safety Specifications

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

Product IDs

This appendix provides information about the product structure and product IDs. It contains the following tables:

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

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

Note See the Cisco online ordering and pricing tool for the most up-to-date information on the routing system and product IDs (Cisco login required).

Chassis Product IDs

The following table lists the high-level product IDs.

Table 23: Multishelf System Product IDs

Component	Product ID	Description
Multishelf System Components		
CRS multishelf system	CRS-MC-FC24	Cisco CRS Multishelf System

The following table lists the PIDs for the fabric card chassis and its components.

Table 24: Cisco CRS Fabric Card Chassis Product IDs

Component	Product ID	Description
Fabric card chassis (complete)	CRS-FC24(=)	Cisco CRS FCC for a multishelf system (without switch fabric cards)
Fabric card chassis (chassis only)	CRS-FCC(=)	Cisco CRS-1 routing system FCC (spare chassis)
Fan tray with fans	CRS-FCC-FAN-TR(=)	Cisco CRS FCC fan tray with fans (spare)(2 required for each chassis)
Cards and modules		
Switch fabric card (fabric chassis)	CRS-FCC-SFC(=) CRS-FCC-SFC-140(=)	S2 switch fabric cards for 40G system (8 required for each fabric chassis) S2 switch fabric cards for 140G system (8 required for each fabric chassis)
Switch fabric card blank	CRS-SFC-IMPEDANCE(=)	Blank card carrier for each switch fabric slot (used for shipment; must be replaced with fabric card)
22-port shelf controller card	CRS-FCC-SC-22GE(=)	22-port shelf controller Gigabit Ethernet (22-port SCGE) card(2 recommended for each fabric chassis)
OIM, single-width	CRS-FCC-OIM-1S(=)	Optical interconnect module (OIM)(1 required for each S2 fabric card in fabric chassis)
OIM blank	CRS-OIM-IMPEDANCE(=)	Blank carrier for each empty OIM slot
SFC and OIM eight pack bundle	CRS-FC24-SFC-8P(=)	Eight pack of S2 switch fabric cards and optional interconnect modules
FM-LED	CRS-FCC-LED(=)	Fiber module LED card (2 required for each fabric chassis)
FM-LED blank	CRS-FM-IMPEDANCE(=)	Blank carrier for each empty FM-LED slot (required for EMI compliance and cooling)
Fixed Configuration Power		
AC Delta power system	CRS-FCC-ACD-KIT(=)	AC Delta power system for fabric chassis (includes 2 power shelves and 6 AC rectifiers)
AC Wye power system	CRS-FCC-ACW-KIT(=)	AC Wye power system for fabric chassis (includes 2 power shelves and 6 AC rectifiers)

Component	Product ID	Description
DC power system	CRS-FCC-DC-KIT(=)	DC power system for fabric chassis(includes 2 power shelves and 4 power modules)
AC power rectifier	CRS-16-AC-RECT(=)	AC power rectifier for line card chassis (6 required for each chassis; 3 required for each AC power shelf)
DC PEM	CRS-16-DC-PEM(=)	AC power entry module for line card chassis (6 required for each chassis; 3 required for each DC power shelf)
Alarm module	CRS-16-ALARM(=)	Chassis alarm module (1 required for each power shelf)
Modular Configuration Power		
AC power system	CRS-FCC-ACKIT-M(=)	AC power system for fabric chassis(includes 2 power shelves and 6 AC PMs)
DC power system	CRS-FCC-DCKIT-M(=)	DC power system for fabric chassis(includes 2 power shelves and 8 DC PMs)
Alarm module	CRS-16-ALARM-C(=)	Chassis alarm module(1 required for each power shelf)
AC power cord	CRS-AC-CAB-NA CRS-AC-CAB-AU CRS-AC-CAB-UK CRS-AC-CAB-EU CRS-AC-CAB-IT	AC power cord—North America AC power cord—Australia AC power cord—United Kingdom AC power cord—Europe AC power cord—Italy Length of each power cord is 4.25 m.
Cable management and cosmetics		
Front cosmetics	CRS-FCC-FRNT-CM(=)	Front cosmetics and cable management kit (front door not included)
Rear cosmetics	CRS-FCC-REAR-CM(=)	Rear cosmetics and cable management kit(rear door not included)
Front door	CRS-FCC-DRS-FR(=)	Front door for fabric chassis
Rear door	CRS-FCC-DRS-RR(=)	Rear door for fabric chassis
AC power grille	CRS-FCC-ACGRILLE(=)	Front grille for fixed configuration AC power shelves

Component	Product ID	Description
DC power grille	CRS-FCC-DCGRILLE(=)	Front grille for fixed configuration DC power shelves
Modular power grille	CRS-16-PW-GRILL(=)	Front grille for modular configuration AC and DC power shelves
Chassis installation accessories (included with chassis)		
Drill hole template	CRS-LCC-DRILLTEMP(=)	Aluminum template showing where to drill the mounting holes to secure the chassis to the floor
Chassis access template	CRS-LCC-FLOORTEMP (=)	Mylar template showing chassis door swings and maintenance access area
Inrigger kit	CRS-FCC-ALTMNT(=)	Alternate mounting kit for anchoring chassis to floor

The following table lists the PIDs for the Cisco CRS 16-slot line card chassis and its components.

Table 25: Cisco CRS 16-Slot Line Card Chassis Product IDs

Component	Product ID	Description
Line card chassis(complete)	CRS-16-LCC/M CRS-16LCC140/M CRS-16/S	Cisco CRS-1 40G LCC (with 2 route processors [RPs], S13 fabric cards, and optical array cables) Cisco CRS-3 140G LCC (with 2 route processors [RPs], S13 fabric cards, and optical array cables) Cisco CRS LCC (with 2 route processors [RPs] and S123 fabric cards)
Conversion Kit	CRS-16-MC-CONVCRS-16-MC140-CONV	Cisco CRS Multichassis conversion kit that converts a standalone Cisco CRS 16-Slot LCC into a Cisco CRS-1 Multichassis LCCCisco CRS Multichassis conversion kit that converts a standalone Cisco CRS 16-Slot LCC into a Cisco CRS-3 Multichassis LCC
Switch fabric cards		
Switch fabric card (single-shelf system)	CRS-16-FC/S(=) CRS-16-FC140/S(=) CRS-16-FC400/S(=)	S123 switch fabric cards for CRS-1 system S123 switch fabric cards for CRS-3 system S123 switch fabric cards for CRS-X system (8 required for each line card chassis)

Component	Product ID	Description
Switch fabric card (multi-shelf system)	CRS-16-FC/M(=) CRS-16-FC140/M(=) CRS-16-FC400/M(=)	S13 switch fabric cards for CRS-1 system S13 switch fabric cards for CRS-3 system S13 switch fabric cards for CRS-X system (8 required for each line card chassis)
Route processors		
Route processor	CRS-16-RP(=)	Route processor (2 required for each line card chassis)
Performance route processor (PRP)	CRS-16-PRP-6G= CRS-16-PRP-12G=	Performance route processor (6GB memory) Performance route processor (12GB memory) (2 PRPs required for each line card chassis)
Distributed route processor (DRP)	CRS-DRP(=)	Additional route processor for the system (optional) (includes two cards, DRP CPU and DRP PLIM)
	To order DRP cards separately, use the following IDs (both cards are required for DRP operation):	
	CRS-DRP-B-CPU(=)	DRP card only (requires DRP PLIM)
	CRS-DRP-B-PLIM(=)	DRP PLIM only (requires DRP CPU)
Fixed Configuration Power		
AC Delta power shelf	CRS-16-LCC-PS-ACD(=)	AC Delta power shelf for line card chassis (2 required for each chassis)
AC Wye power shelf	CRS-16-LCC-PS-ACW(=)	AC Wye power shelf for line card chassis (2 required for each chassis)
DC power shelf	CRS-16-LCC-PS(=)	DC power shelf for line card chassis (2 required for each chassis)
AC power rectifier	CRS-16-AC-RECT(=)	AC power rectifier for line card chassis(6 required for each chassis; 3 required for each AC power shelf)
DC PEM	CRS-16-DC-PEM(=)	AC power entry module for line card chassis(6 required for each chassis; 3 required for each DC power shelf)
Alarm module	CRS-16-ALARM(=)	Chassis alarm module(2 required for each chassis; 1 required for each power shelf)
Modular Configuration Power		
AC power system	CRS-16-ACKIT-M(=)	AC power system for fabric chassis(includes 2 power shelves and 10 AC PMs)
DC power system	CRS-16-DCKIT-M(=)	DC power system for fabric chassis(includes 2 power shelves and 12 DC PMs)

Component	Product ID	Description
AC power module	CRS-PM-AC	Modular AC power module (Up to 6 required for each power shelf)
DC power module	CRS-PM-DC	Modular DC power module (Up to 8 required for each power shelf)
Alarm module	CRS-16-ALARM-C(=)	Modular power alarm module(1 required for each power shelf)
AC power cord	CRS-AC-CAB-NA CRS-AC-CAB-AU CRS-AC-CAB-UK CRS-AC-CAB-EU CRS-AC-CAB-IT	AC power cord—North America AC power cord—Australia AC power cord—United Kingdom AC power cord—Europe AC power cord—Italy Length of each power cord is 4.25 m.
Cable management and cosmetics		
Front cosmetics	CRS-16-LCC-FRNT(=)	Front cosmetics and cable management kit
Rear cosmetics	CRS-16-LCC-BCK-CM(=)	Rear cosmetics and cable management kit
Front door	CRS-16-LCC-DRS-FR(=)	Front doors
Rear door	CRS-16-LCC-DRS-RR(=)	Rear doors
AC power grille	CRS-16-ACGRILLE(=)	Front grille for fixed configuration AC power shelves
DC power grille	CRS-16-DCGRILLE(=)	Front grille for fixed configuration DC power shelves
Modular power grille	CRS-16-PW-GRILL(=)	Front grille for modular configuration AC and DC power shelves
Chassis installation accessories (included with chassis)		
Drill hole template	CRS-LCC-DRILLTEMP(=)	Aluminum template showing where to drill the mounting holes to secure the chassis to the floor
Chassis access template	CRS-LCC-FLOORTEMP (=)	Mylar template showing chassis door swings and maintenance access area
Chassis floor mounting kit	CRS-16-LCC-ALTMNT(=)	Alternate mounting kit for anchoring chassis to floor
For detailed specifications for Cisco CRS-1 routing system PLIMs, RPs and other components refer to the data sheet on: http://www.cisco.com/en/US/partner/products/ps5763/products_data_sheets_list.html . CCO login is required. For additional information on Cisco CRS-1 routing system SPA interface processor (SIP) and shared port adapters (SPAs), see *Cisco CRS SIP and SPA Hardware Installation Guide* .		

Fabric Cables

The following table lists the product ID numbers for Cisco CRS fabric cables. These cables, which are available in different lengths, connect the S13 fabric cards (in the line card chassis) to the S2 fabric cards (in the fabric chassis). Be sure to order enough cables for your system. The interconnection cables listed are shipped as a set of 24 in the meter length specified.

In the table, the cable name *LCC/M-FC-FBR-XX* means the following:

- *LCC/M* is "Line Card Chassis/Multishelf System."
- *FC* is Fabric (Card) Chassis.
- *FBR* is Fiber.
- *xx* is the length of the cable in meters.

Note = symbol at the end of a product ID number indicates that the part is a *spare* , which means the part can be ordered.

Note R = symbol at the end of a product ID number indicates that the part is a riser-rated fiber cable.

Table 26: Fabric Cables for the Cisco CRS-1 Multishelf System

Fabric Cable Product ID	Description and Length
LCC/M-FC-FBR-10=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 10 meters (32.8 feet)
LCC/M-FC-FBR-15=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 15 meters (49.2 feet)
LCC/M-FC-FBR-20=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 20 meters (65.6 feet)
LCC/M-FC-FBR-25=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 25 meters (82 feet)
LCC/M-FC-FBR-30=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 30 meters (98.43)
LCC/M-FC-FBR-40=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 40 meters (131.2 feet)
LCC/M-FC-FBR-50=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 50 meters (164 feet)
LCC/M-FC-FBR-60=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 60 meters (197 feet)
LCC/M-FC-FBR-70=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 70 meters (229.7)
LCC/M-FC-FBR-80=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 80 meters (262.5 feet)
LCC/M-FC-FBR-90=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 90 meters (295.3feet)
LCC/M-FC-FBR-100=	Cisco CRS Line Card Chassis-Fabric Chassis Fiber 100 meters (328 feet)
LCC/M-FC-FBR-10R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 10 meters (32.8 feet)

Fabric Cable Product ID	Description and Length
LCC/M-FC-FBR-15R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 15 meters (49.2 feet)
LCC/M-FC-FBR-20R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 20 meters (65.6)
LCC/M-FC-FBR-25R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 25 meters (82 feet)
LCC/M-FC-FBR-30R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 30 meters (98.43 feet)
LCC/M-FC-FBR-40R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 40 meters (131.2 feet)
LCC/M-FC-FBR-50R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 50 meters (164 feet)
LCC/M-FC-FBR-60R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 60 meters (197 feet)
LCC/M-FC-FBR-70R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 70 meters (229.7)
LCC/M-FC-FBR-80R=	Cisco CRS Line Card Chassis-Fabric Chassis Rise-rated r 80 meters (262.5 feet)
LCC/M-FC-FBR-90R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 90 meters (295.3feet)
LCC/M-FC-FBR-100R=	Cisco CRS Line Card Chassis-Fabric Chassis Riser-rated 100 meters (328 feet)

Note The Cisco CRS fiber-optic cleaning kit (CRS-FIBER-CLN-KIT=) includes a cleaning tool that advances a continuous roll of lint-free cleaning cloth across the face of the optic. For more information, see the *Cisco CRS-1 Carrier Routing System Fiber-Optic Cleaning Guide* .