Cisco CRS Carrier Routing System 4-Slot Line Card Chassis System Description

First Published: 2013-08-25

Last Modified: 2017-02-10

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

CONTENTS

Preface

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

Objective

This system description describes the Cisco CRS 4-Slot Line Card Chassis 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 line card chassis. 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 line card chassis and is not a planning, installation, or configuration guide.

Audience

This guide is intended for general audiences who want an overview of the Cisco CRS 4-Slot Line Card Chassis and its major components.

Document Organization

This system description contains the following chapters and appendixes:

- Cisco CRS 4-Slot Line Card Chassis Overview, on page 1 provides an overview of the line card chassis.
- Chassis Power System, on page 11 provides a detailed physical description of the line card chassis power system.
- Chassis Cooling System, on page 25 provides an overview of the line card chassis cooling system.
- Switch Fabric, on page 31 provides an overview of the switch fabric. It also describes the switch fabric cards.
- Line Cards, Physical Layer Interface Modules, and Shared Port Adapters Overview, on page 39 provides an overview of the MSC, FP, and LSP line cards, PLIMs, and SPAs.
- Route Processor, on page 53 provides an overview of route processor (RP) cards.
- Cisco CRS 4-Slot Line Card Chassis System Specifications, on page 65 provides hardware specifications for the major line card chassis components.

Document Conventions

This guide uses the following conventions:

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

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

Warning Definition

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

See *Cisco CRS Carrier Routing System Regulatory Compliance and Safety Information* for translations of warnings and information about the compliance and safety standards with which the Cisco CRS routing system conforms.

Related Cisco CRS Documentation

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

- Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Site Planning Guide
- Cisco CRS Carrier Routing System 4-Slot Line Card Chassis System Description
- Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Installation Guide
- Cisco CRS Carrier Routing System Hardware Documentation Guide
- Cisco CRS Carrier Routing System Ethernet Physical Layer Interface Module (PLIM) Installation Note
- Cisco CRS Carrier Routing System Packet-over-SONET Physical Layer Interface Module (PLIM) Installation Note
- Cisco CRS Carrier Routing System Regulatory Compliance and Safety Information

See the Obtaining Documentation, Obtaining Support, and Security Guidelines, on page x for information on obtaining these and other publications.

Changes to This Document

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

Table 1: Changes to This Document

Date	Change Summary
April 2012	Added Alarm Port section with pin outs to Chapter 6 to fix caveat.
August 2011	Minor editorial change to Figure 1-1 to fix caveat.
July 2011	Added information about the CRS-LSP Label Switch Processor (LSP) card to the following sections: • Cisco CRS 4-Slot Line Card Chassis Overview, on page 1 • Line Cards, Physical Layer Interface Modules, and Shared Port Adapters Overview, on page 39

Date	Change Summary
April 2011	Added information about new performance route processor (PRP) cards (Cisco product IDs: CRS-8-PRP-6G, CRS-8-PRP-12G). Minor editorial changes were also made.
October 2010	Added information about the new MSC-140 and FP-140 line cards, QQ123-140G switch fabric card, 20-port and 14-port 10-GE XFP PLIMs, and the 1-port 100-GE CFP PLIM. Minor editorial and technical changes were also made.
July 2009	Module updates.
March 2008	Minor editorial changes.
June 2007	The revision includes general technical corrections.
March 2007	Added description of DC power in Chassis Power System, on page 11. Also updated Cisco CRS 4-Slot Line Card Chassis System Specifications, on page 65 with DC power specifications.
November 2006	Initial release of this document.

Obtaining Documentation, Obtaining Support, and Security Guidelines

For information on obtaining documentation, obtaining support, providing documentation feedback, security guidelines, and also recommended aliases and general Cisco documents, see the monthly *What's New in Cisco Product Documentation* , which also lists all new and revised Cisco technical documentation, at:

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

CHAPTER 1

Cisco CRS 4-Slot Line Card Chassis Overview

This chapter describes the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis and its main components.

Note Throughout the remainder of this guide, the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis is referred to as the *Cisco CRS 4-slot* line card chassis, or simply the chassis.

The Cisco CRS 4-slot line card chassis documentation set is workflow-based. There are three core documents that describe the processes required to successfully plan for and install the chassis:

- Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Site Planning Guide

Use this guide in advance of receiving the chassis to confirm that you have the needed space, tools, utilities, manpower, and so on. that are needed to perform the steps in the unpacking, moving, and securing guide and the installation guide.

- Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Unpacking, Moving, and Securing Guide

This guide is included with the chassis shipment. It includes all Cisco CRS 4-slot line card chassis unpacking, moving, and securing information.

- Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Installation Guide

This guide is used to initially install the chassis and describes how to remove and install field- replaceable units (FRUs).

Note This system description is a reference document. It details the chassis, its power and cooling system, the switch fabric, and other components. No procedural steps are presented in this document.

The following sections are included:

System Overview

The Cisco CRS router is a highly scalable routing platform designed for efficient service-provider point-of-presence (POP) evolution as the IP network grows into a multiservices network. The Cisco CRS router is currently available in 4-slot, 8-slot, 16-slot, and multishelf configurations.

The introduction of the Cisco CRS 4-slot line card chassis allows service providers to utilize the power and features of a CRS chassis, but without the space and power requirements associated with the larger versions of the chassis. The Cisco CRS 4-slot line card chassis is a mechanical enclosure that contains four slots for modular services cards (MSCs), forwarding processor (FP) cards, label switch processor (LSP) cards, and associated physical layer interface modules (PLIMs), plus four slots for the switch fabric. The MSC, FP, and LSP cards are also called line cards.

The chassis is installed in a standard external rack and contains its own power and cooling systems. The chassis also contains route processor (RP) cards that perform routing-protocol calculations. The RPs distribute forwarding tables to the line cards, provide a control path to each line card for system monitoring functions, and contain hard disks for system and error logging. RPs plug into two dedicated slots in the Cisco CRS 4-slot line card chassis.

Every Cisco CRS 4 slot line card chassis has 4 MSC slots, each with up to 140 gigabits per second (Gbps) with bi-directional forwarding capacity (4 slots x 140 Gbps x 2 directions). The router is built around a scalable, distributed three-stage Benes switch fabric and a variety of data interfaces providing a total system forwarding capacity of 1,120 Gbps (or 1.12 Tbps).

The data interfaces are contained on physical layer interface modules (PLIMs) that are mated in the Cisco CRS 4-slot line card chassis, to an associated line card. The line cards are cross-connected to each other through the switch fabric.

Main Features of the Cisco CRS-1 Series 4-Slot Line Card Chassis

The main features of the Cisco CRS-1 Series 4-slot line card chassis include:

- A highly scalable router that provides a total routing capacity of 320 Gbps of bandwidth.
- A wide range of interface speeds and types (such as OC-768, OC-192, OC-48, and 10-GE), and featuring a programmable MSC, FP, or LSP forwarding engine that provides full-featured forwarding at line-rate speeds.
- Redundancy and reliability features to allow nonstop operation, with no single points of failure in hardware or software.
- Reduced size that allows for installation in a variety of locations.

Chassis Components

This section summarizes the main components of the Cisco CRS 4-slot line card chassis. It primarily identifies the components that are considered field-replaceable units (FRUs), but where additional detail is useful, also identifies subassemblies that are not field replaceable.

The Cisco CRS 4-slot line card chassis contains the following components:

- Up to four MSC, FP, or LSP line cards and four PLIMs. A line card and a PLIM are an associated pair of cards that mate through the chassis midplane. The line card provides the forwarding engine for Layer 3 routing of user data, and the PLIM provides the physical interface and connectors for the user data.

A line card can be associated with several different PLIMs, which provide different interface speeds and technologies. The PLIM types that are available are as follows:

- ◦ Packet-over-SONET/SDH (POS) PLIMs
  ◦ Gigabit Ethernet PLIMs

For complete PLIM information, see the Cisco CRS Carrier Routing System Packet-over-SONET/SDH Physical Layer Interface Module Installation Note and the Cisco CRS Carrier Routing System Gigabit Ethernet Physical Layer Interface Module Installation Note.

- An optional interface solution (to PLIMs) is also available. SPA interface processors (SIPs) and shared port adapters (SPAs) can be installed instead of PLIMs. A SIP is a carrier card that is similar to a PLIM and inserts into a Cisco CRS 4-slot line card chassis slot and interconnects to an MSC like a PLIM. Unlike PLIMs, SIPs provide no network connectivity on their own. A SPA is a modular type of port adapter that inserts into a subslot of a compatible SIP carrier card to provide network connectivity and increased interface port density. A SIP can hold one or more SPAs, depending on the SIP type and the SPA size. POS/SDH and Gigabit Ethernet SPAs are available. For complete SIP and SPA information, see the Cisco CRS Carrier Routing System SIP and SPA Hardware Installation Guide.
- A chassis midplane. The midplane connects line cards to their associated PLIMs and allows a line card to be removed from the chassis without having to disconnect the cables that are attached to the associated PLIM. The midplane distributes power, connects the line cards to the switch fabric cards, and provides control plane interconnections. The midplane is not field replaceable by the customer.
- Two route processor cards (RPs). The RPs provide the intelligence of the system by functioning as the Cisco CRS 4-slot line card chassis system controller and performing route processing. Only one RP is active at a time. The second RP acts as a standby RP, serving as a backup if the active RP fails. The RP also monitors system alarms and controls the system fans. LEDs on the front panel indicate active alarm conditions.

A Performance Route Processor (PRP) is also available for the Cisco CRS 4-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.

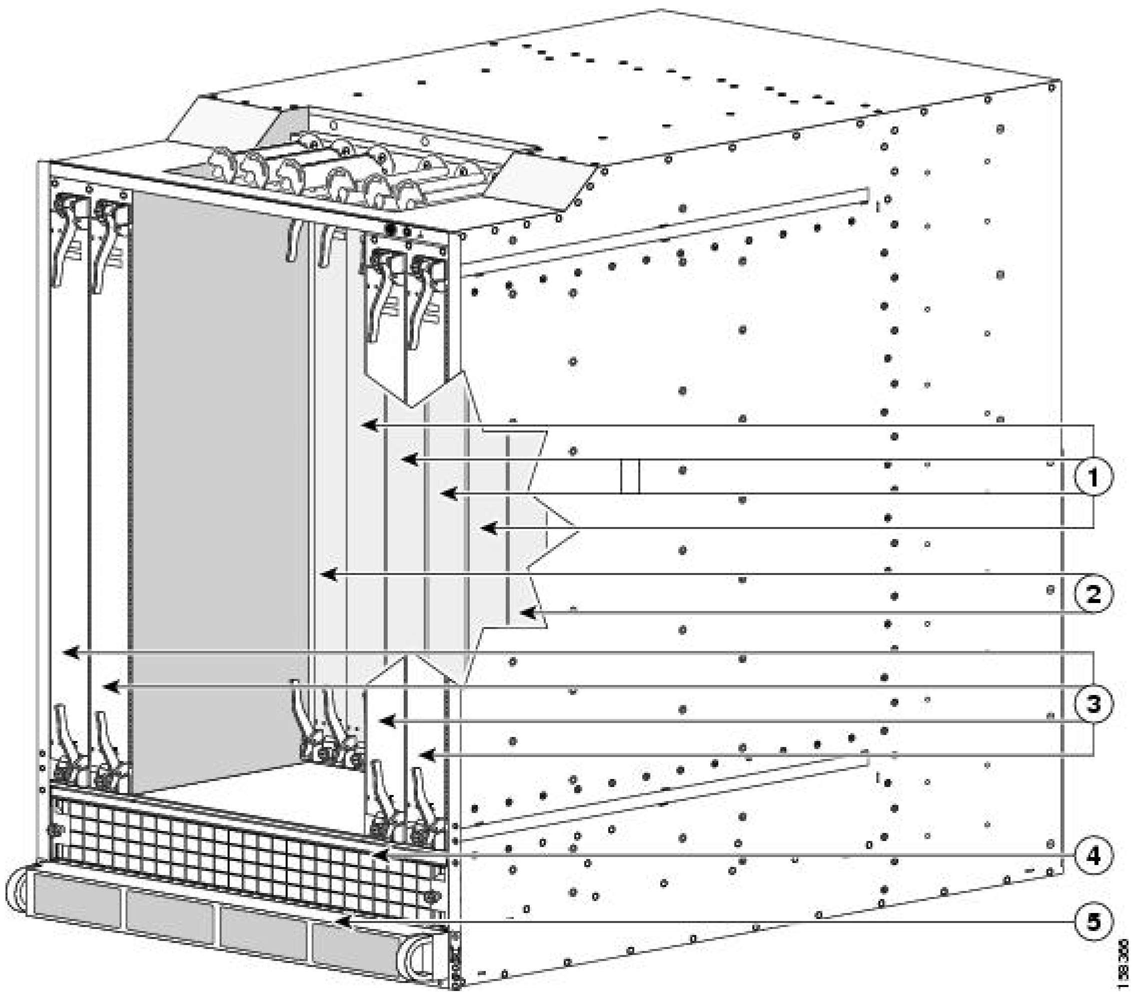
Note A chassis may not be populated with a mix of RP and PRP cards. Both route processor cards should be of the same type (RP or PRP).

- Four switch fabric cards (SFCs). These cards provide a three-stage Benes switch fabric for the system. The switch fabric receives user data from one line card and PLIM pair and performs the switching necessary to route the data to the appropriate egress line card and PLIM pair. The Cisco CRS 4-slot line card chassis contains switch fabric cards that provide all three stages of the three-stage Benes switch fabric and the four SFCs provide the chassis with a total switching capacity of 320 Gbps.
- A single AC power shelf with four AC rectifiers in each power shelf. The power shelf and AC rectifiers provide 4,000 watts of redundant input power for the chassis.
- A single DC power shelf with four DC power supplies. The DC power system provides 4,000 watts to power the chassis.
- Fan tray. The fan tray contains fans that push and pull air through the chassis. A removable air filter is located above the power shelf in the front of the chassis.

The front of the chassis contains the RPs, MSCs, FPs, LSPs, and PLIMs. This is where user data cables attach to the PLIMs and where cool air enters the chassis. The rear of the chassis contains the fan tray and the SFCs.

This figure shows the front view of the Cisco CRS 4-slot line card chassis.

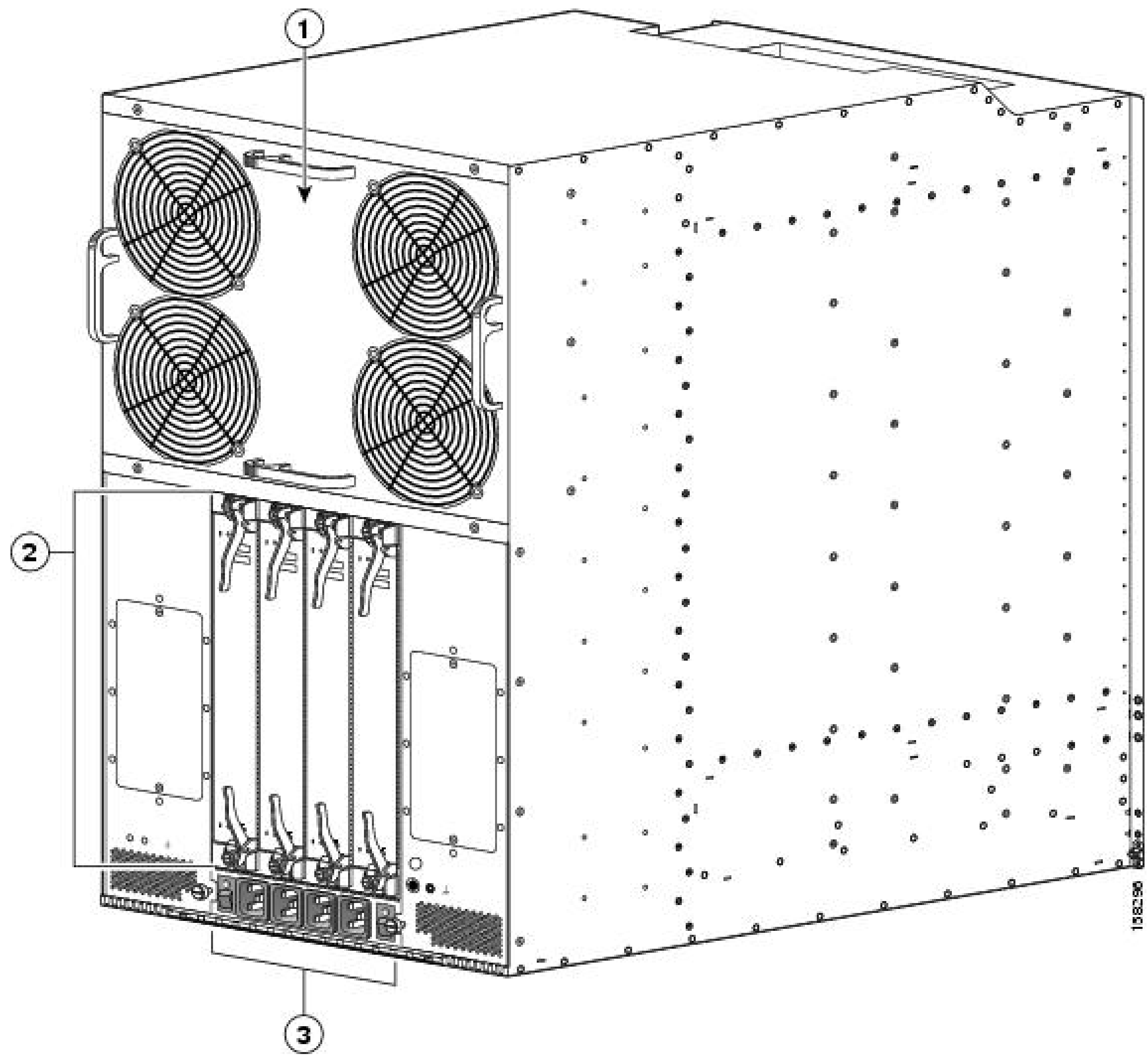
Figure 1: Cisco CRS 4-Slot Line Card Chassis (Front View)



1	PLIM slots	2	MSC slots	3	RP slots
4	Air intake	5	Power modules (behind air filter)		

This figure shows the rear view of the chassis.

Figure 2: Cisco CRS 4-Slot Line Card Chassis (Rear View)

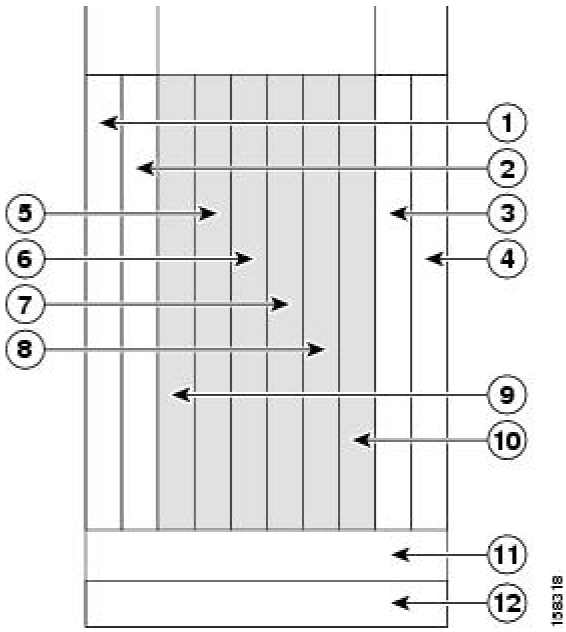


1	Fan tray	2	Switch fabric card (half-height) slots

Chassis Slot Numbers

This section describes the location and slot numbers for cards and modules that plug into the chassis. The following shows the slot numbers on the front side of the Cisco CRS 4-slot line card chassis.

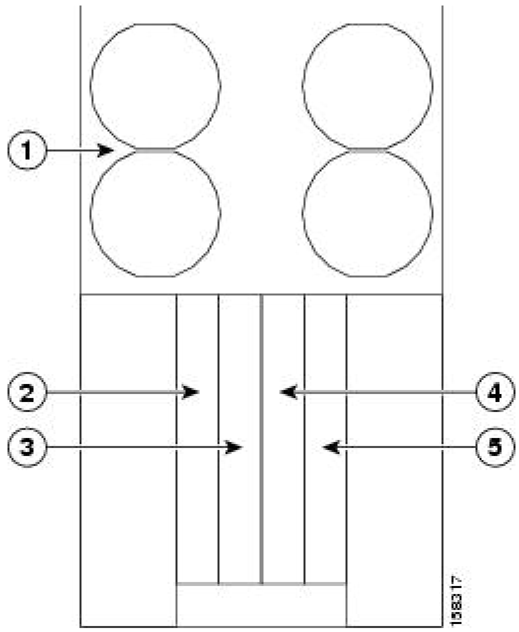
Figure 3: Cisco CRS 4-Slot Line Card Chassis Slot Numbers (Front View)



1	MSC slot 0	7	PLIM slot 2
2	MSC slot 1	8	PLIM slot 3
3	MSC slot 2	9	RP slot (RP0)
4	MSC slot 3	10	RP slot (RP1)
5	PLIM slot 0	11	Air intake
6	PLIM slot 1	12	Power shelf (PS)

The following figure shows the slot numbers on the rear side of the Cisco CRS 4-slot line card chassis.

Figure 4: 4-Slot Line Card Chassis Rear View Slot Numbers (Switch Fabric Side)



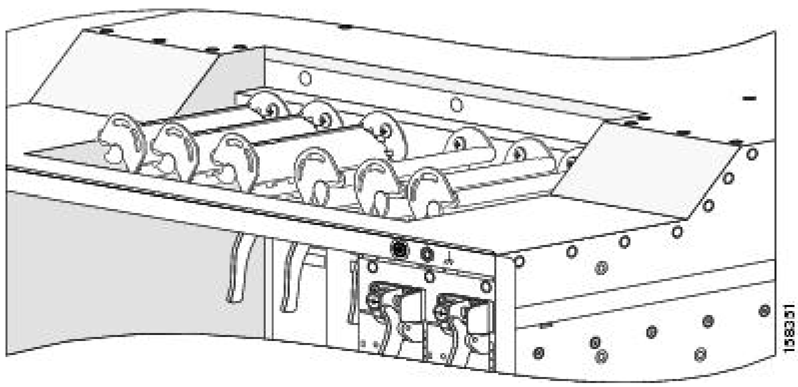
1	Fan tray (FT0)	4	Switch fabric card slot (SM1)
2	Switch fabric card slot (SM3)	5	Switch fabric card slot (SM0)
3	Switch fabric card slot (SM2)		

Chassis Cable Management

The Cisco CRS 4-slot line card chassis has cable management features for the front (PLIM) side of the chassis, just above the card cage. The horizontal cable management trays have a special telescoping feature that allows them to be extended when the chassis is upgraded with higher-density cards. This extension also helps when installing the cables in the chassis.

This figure shows the cable management bracket for the chassis.

Figure 5: Cable Management Bracket



See the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Installation Guide for detailed information about chassis cabling and cable management.

CRS Hardware Compatibility

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

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

See Cisco CRS-1 Carrier Routing System to Cisco CRS-3 Carrier Routing System Upgrade Guide for a detailed procedure for upgrading a 40 Gbps CRS to a 140 Gbps CRS.

Table 2: CRS Compatibility Matrix

Switch Fabric	RP/DRP	MSC/FP	PLIMS	Note
CRS-4-FC/S(40G)	RP-A (CRS-4-RP), DRP-B (CRS-DRP-B)	CRS-MSC-B	1OC768-DPSK/C 1OC768-ITU/C 1OC768-POS-SR 4-10GE-ITU/C 8-10GBE CRS1-SIP-800 |4-10GE 42-1GE 20-1GE-FLEX 2-10GE-WL-FLEX 4-10GBE-WL-XFP 8-10GBE-WL-XFP	
	RP-A (CRS-4-RP), DRP-B (CRS-DRP-B)	CRS-FP40	4-10GE 42-1GE 20-1GE-FLEX2-10GE-WL-FLEX	

Switch Fabric	RP/DRP	MSC/FP	PLIMS	Note
CRS-4-FC140/S(140G)	RP-A (CRS-4-RP), DRP-B (CRS-DRP-B)	CRS-MSC-B	1OC768-DPSK/C 1OC768-ITU/C 1OC768-POS-SR 4-10GE-ITU/C 8-10GBE CRS1-SIP-800 4-10GE 42-1GE 20-1GE-FLEX 2-10GE-WL-FLEX 4-10GBE-WL-XFP 8-10GBE-WL-XFP	
	RP-A (CRS-4-RP), DRP-B (CRS-DRP-B)	CRS-FP40	4-10GE 42-1GE 20-1GE-FLEX 2-10GE-WL-FLEX	
	PRP (CRS-4-PRP-6G, CRS-4-PRP-12G)	CRS-MSC-140G	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE	
	PRP (CRS-4-PRP-6G, CRS-4-PRP-12G)	CRS-FP140	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE	
	PRP (CRS-4-PRP-6G, CRS-4-PRP-12G)	CRS-LSP	14X10GBE-WL-XFP 20X10GBE-WL-XFP 1x100GBE	

CHAPTER 2

Chassis Power System

This chapter describes the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis power system. The following sections are included:

Power specifications are provided in Cisco CRS 4-Slot Line Card Chassis System Specifications, on page 65.

Power System Overview

The Cisco CRS Carrier Routing System 4-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.

The Cisco CRS 4-slot line card chassis requires that at least the power shelves and their components be installed to operate properly. Two types of power shelves exist: an AC shelf and a DC shelf. An AC power shelf houses AC rectifiers, while a DC power shelf houses the DC power input module (PIM) and DC power input shelf. We recommend that you use only one type of power shelf in a chassis at a time.

The AC power system is redundant and contains the following components:

- One AC power shelf
- Four AC rectifiers within the AC power shelf
- Dual rectifier output buses, which provide redundant power inputs to chassis components
- Special components, such as DC-to-DC converters, OR-ing diodes, and EMI filters

The DC power system consists of the following components:

- DC power input shelf (Cisco product number: CRS-4-DC-INPUT)
- Power input module (PIM) (Cisco product number: CRS-4-DC-PIM)
- DC power supplies (Cisco product number: CRS-4-DC-SUPPLY)

AC Power Architecture

The AC power system uses a single power shelf to provide reliable, 1:1 redundant power to all chassis components. AC power enters the rectifiers via the power shelf and is converted to DC. DC outputs from the supplies form 2 separate distribution buses. Both buses distribute power through the midplane.

- AC rectifiers A0 and A1 supply –54 VDC to the A bus.
- AC rectifiers B0 and B1 supply –54 VDC to the B bus.

Because chassis components are powered by both A and B busses, the line card chassis can continue to operate normally if any two AC rectifiers fail or are not present. Only two operational rectifiers are required to operate the system if a fault prevents all four rectifiers from operating normally.

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 individual power modules.

AC Power System

The AC power system provides 4000 watts to power the line card chassis. The AC power system, which provides 1:1 power redundancy, contains the following components:

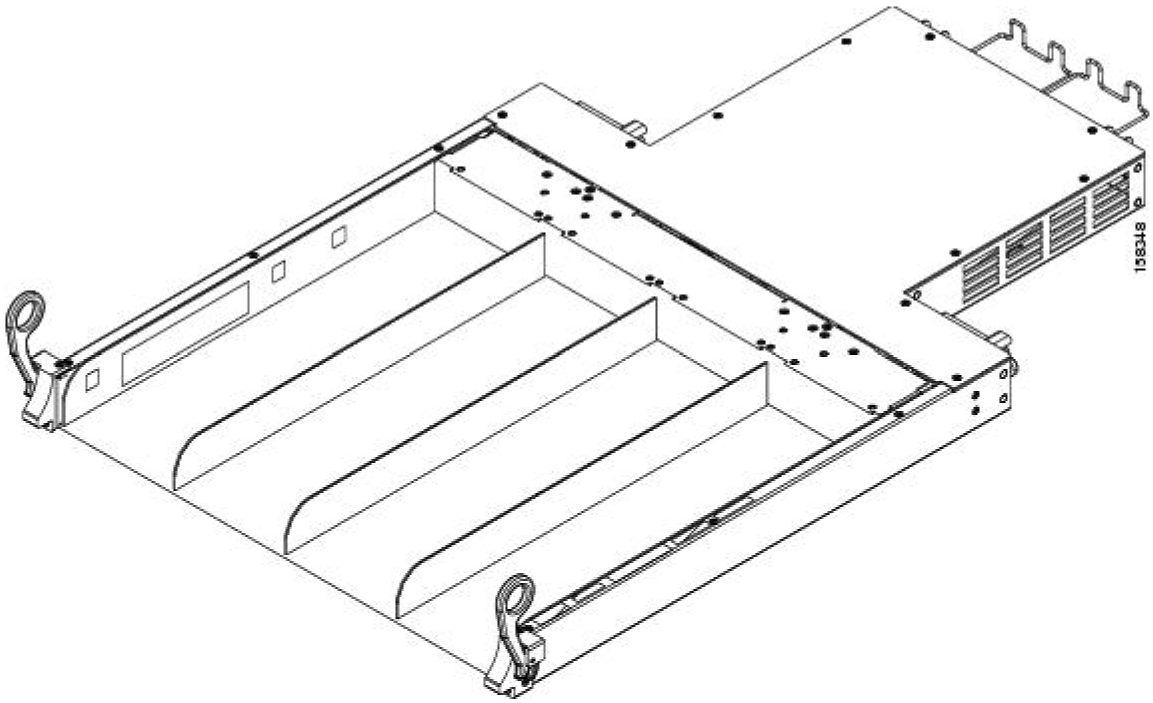
- One AC power shelf: Holds four AC rectifier modules.
- Four 2000 watt AC rectifier modules: Contains the AC input power connectors. These rectifiers convert 200- to 240-VAC input power to –54 VDC used by the line card chassis. Each AC rectifier is a field replaceable unit (FRU).

Note The power cables for the power shelves do not come pre-attached.

AC Power Shelf

The AC power shelf is the enclosure that houses four AC rectifier modules and power distribution connections and wiring. The AC power shelf, shown below, is installed in the line card chassis from the front and plugs into the chassis power interface connector panel.

Figure 6: AC Power Shelf



The AC power shelf physical dimensions are:

- Height—1.7 in. (4.3 cm)
- Width—16.8 in. (42.6 cm)
- Depth—16.2 in. (41.2 cm)
- Weight—25 lb. (11.3 kg) with all AC rectifiers installed

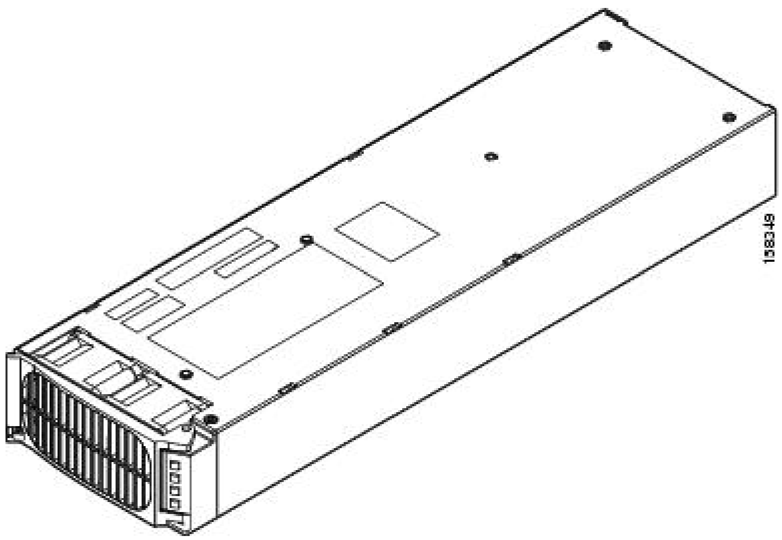
Input AC power enters into each of the four AC rectifiers in the shelf. The AC rectifiers convert AC power into DC power, provide filtering, and then pass the DC power to either the A or B bus in the chassis midplane.

To provide 1:1 redundancy, two AC rectifiers powers the A bus and the other two AC rectifiers powers the B bus. Each AC rectifier 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 (see the AC Rectifier Indicators, on page 15 section).

AC Rectifier

The AC rectifier is an AC power supply that converts input AC power into the DC power necessary to power chassis components. The rectifier takes input AC power, 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 in the chassis midplane. Each AC rectifier has two self-contained cooling fans that draws air through the module.

Figure 7: AC Rectifier



The AC rectifier module physical dimensions are:

- Height—1.6 in. (4.0 cm)
- Width—4 in. (10.1 cm)
- Depth—13.8 in. (35.1 cm)
- Weight—4.6 lb. (2.0 kg)

AC power enters the AC rectifier at the rear of the power shelf. When the power enters the AC rectifier, internal circuits rectify the AC into DC, filter, and regulate it. The DC-to-DC process converts the 350- VDC primary side power to –54-VDC isolated secondary power.

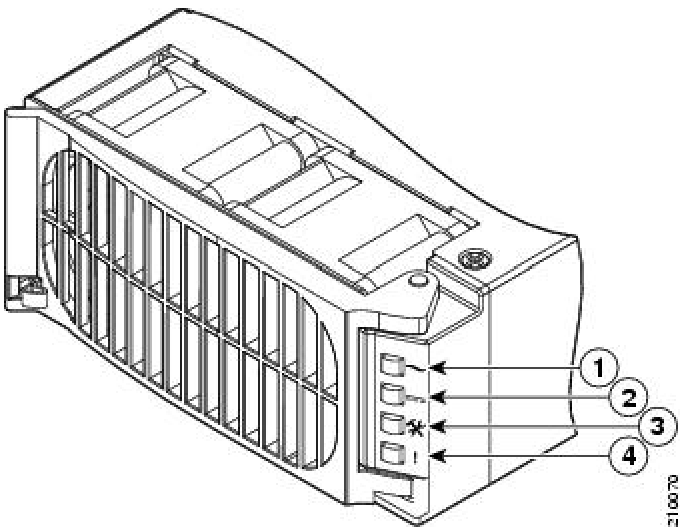
A service processor (SP) module in each AC rectifier monitors the status of each AC rectifier. The service processor communicates with the system controller on the route processor (RP). The service processor circuitry monitors the AC rectifier fault and alarm conditions.

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).

AC Rectifier Indicators

Each AC rectifier has power and status indicators. The AC rectifier shares auxiliary power with one another; therefore, the indicators are operational even when the AC rectifier is not powered from its input voltage. The indicators are shown in this figure.

Figure 8: AC Rectifier Power and Status Indicators



1	AC OK	3	Service
2	DC OK	4	Fault

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

Table 3: AC Rectifier Status Indicators

Name	Color	Function
AC OK	Green	Input voltage is within operating range.
DC OK	Green	Output voltage is within range.
Service	Amber	Indicates a thermal condition in conjunction with other LEDs.
Fault	Red	The AC rectifier is not operating normally.

The following table lists the LED readings during failure conditions.

Table 4: AC Rectifier LED Conditions

Condition	AC OK LED	DC OK LED	Service LED	Fault LED
OK	On	On	Off	Off
Thermal Alarm (5C before shutdown)	On	On	On	Off
Thermal Shutdown	On	Off	On	On
Defective Fan	On	Off	Off	On
Blown AC Fuse in Unit	On	Off	Off	On
No AC >15ms (single unit)	Off	On	Off	Off
AC present but not within limits	On (blinking)	Off	Off	Off
AC not present	Off	Off	Off	Off
Boost Stage Failure	On	Off	Off	On
Over Voltage Latched Shutdown	On	Off	Off	On
Over Current	On	On (blinking)	Off	Off
Noncatastrophic Internal Failure	On	On	Off	On
Standby (remote)	On	Off	Off	Off
Service Request (PMBus mode)	On	On	On (blinking)	Off

DC Power System

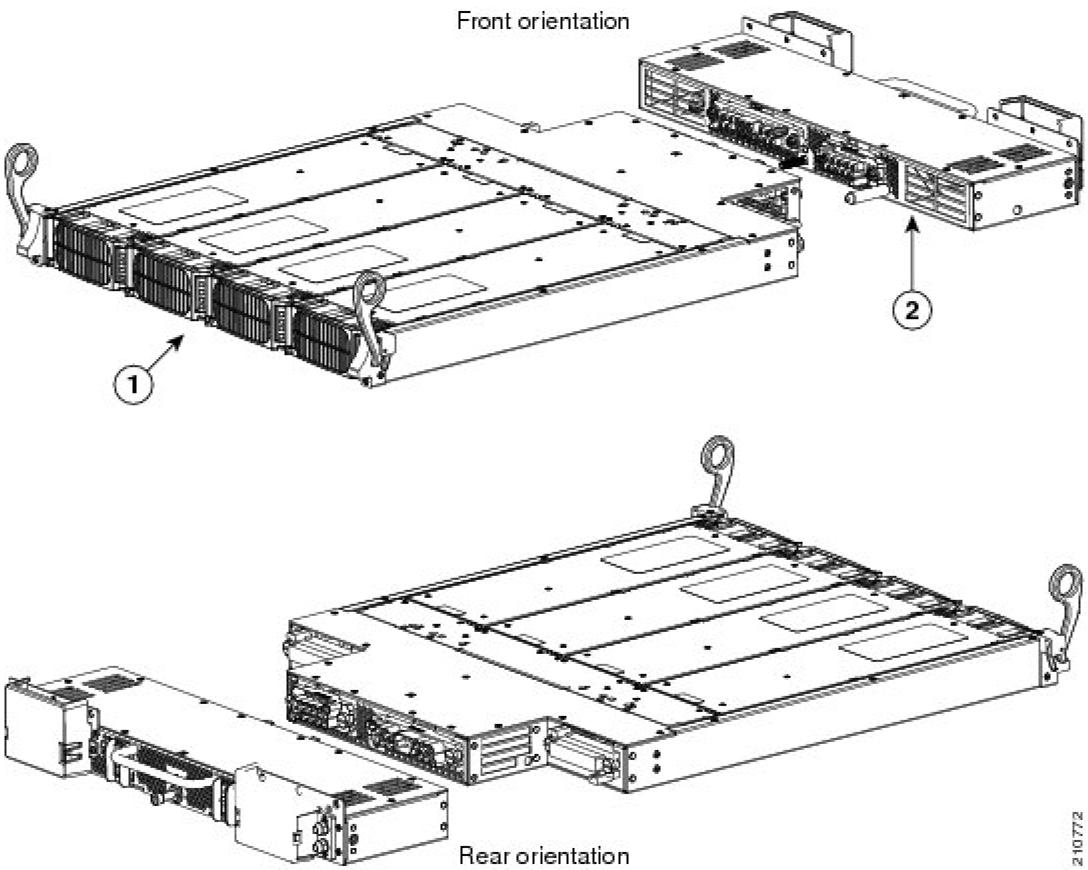
This section provides an overview of the DC power system on the Cisco CRS 4-slot line card chassis. For a complete description of DC power on this routing system, see the *Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Installation Guide* . The DC power shelf consists of two major components, as shown in the following figure:

- DC power input shelf (Cisco product number: CRS-4-DC-INPUT)

The figure shows the power supplies installed in the DC power input shelf.

- Power input module (PIM) (Cisco product number: CRS-4-DC-PIM)

Figure 9: DC Power Shelf: DC Power Input Shelf and Power Input Module (PIM)



1	DC power input shelf	2	Power input module (PIM)

When installing the DC power shelf, these two components are mated to create the complete DC power shelf.

The Cisco CRS 4-slot line card chassis DC power system provides 4,000 watts to power the chassis. (To provide power redundancy, up to 8,000 watts are available.) Each DC-powered chassis contains four DC power supplies for 2N redundancy. The power input module (PIM) provides the input power connections. Note that each power connection has two cables: –48 VDC and return. The power input module (PIM), DC power input shelf, and the power supplies are field replaceable.

The Cisco CRS 4-slot line card chassis requires a total of four dedicated pairs of 60-A DC input power connections, one pair for each of the power supplies, to provide redundant DC power to the Cisco CRS 4-slot line card chassis midplane.

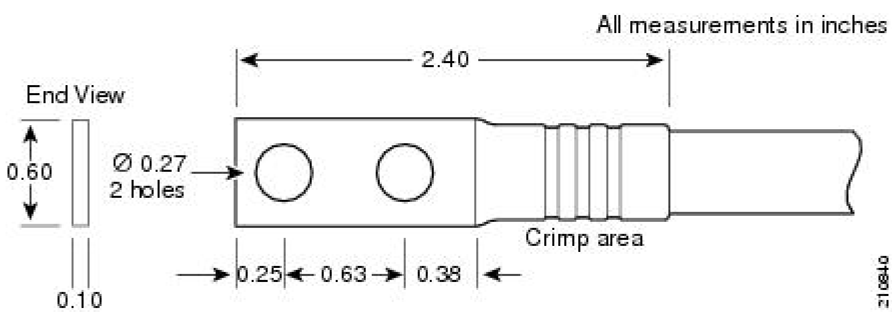
For full 2N redundancy, we recommend that you have two independent –48 VDC power sources to provide power to the Cisco CRS 4-slot line card chassis. Connect the two 60-A DC inputs on the left to one wiring block, and the two 60-A DC inputs on the right to the other wiring block.

DC Power Shelf Guidelines

At sites where the Cisco CRS 4-slot line card chassis is equipped with a DC power input shelf and power supplies, 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 power entry module connection is rated at 60-A maximum. A dedicated, commensurately rated DC power source is required for each power supply connection.
- Each power supply requires one –48 VDC input, or four inputs for each power shelf (in which each input consists of a pair of positive and negative wires), and one power-shelf grounding wire.
- For DC power cables, we recommend that you use commensurately rated, high-strand-count copper wire cable. Each DC power supply requires one 48 VDC input, which means that there are two wires for each power supply, or eight total wires (four pairs) for each power shelf, plus the grounding wire. The length of the wires depends on the router’s location. These wires are not available from Cisco Systems; they are available from any commercial vendor.
- DC power cables must be terminated by cable lugs at the power-shelf end. The lugs should be dual hole and able to fit over M6 terminal studs at 0.625-in (15.88-mm) centers (for example, Panduit part number LCD2-14A-Q or equivalent).

Figure 10: DC Power Cable Lug



Color Coding of the Source DC Power Cable

The color coding of the source DC power cable leads depends on the color coding of the site DC power source. Typically, green or green and yellow indicates that the cable is a ground cable. Because no color code standard exists for the source DC wiring, you must ensure that the power cables are connected to the DC-input power shelf terminal studs in the proper positive (+) polarity and negative (–) polarity.

DC Cable Polarity Labels

Sometimes, the source DC cable leads might have a positive (+) or a negative (–) label. This label is a relatively safe indication of the polarity, but you must verify the polarity by measuring the voltage between the DC cable leads. When making the measurement, the positive (+) lead and the negative (–) lead must always match the (+) and (–) labels on the power shelf.

Caution The DC-input power supplies contain circuitry to prevent damage due to reverse polarity, but you should correct a reverse-polarity condition immediately.

Table 5: DC Input Current and Voltage Information

Nominal input voltage	Supports –48 VDC and –60 VDC systems(range: –40 to –72 VDC) **Note** The *turn-on* voltage of the DC power supplies is –43.5 +/- 0.5 VDC. When a power supply is powered on, it continues to operate down to an input voltage of –40 VDC.
Input line current	50-A maximum at –48 VDC40-A maximum at –60 VDC
Inrush current	60-A peak at –75 VDC(maximum for 1 ms)

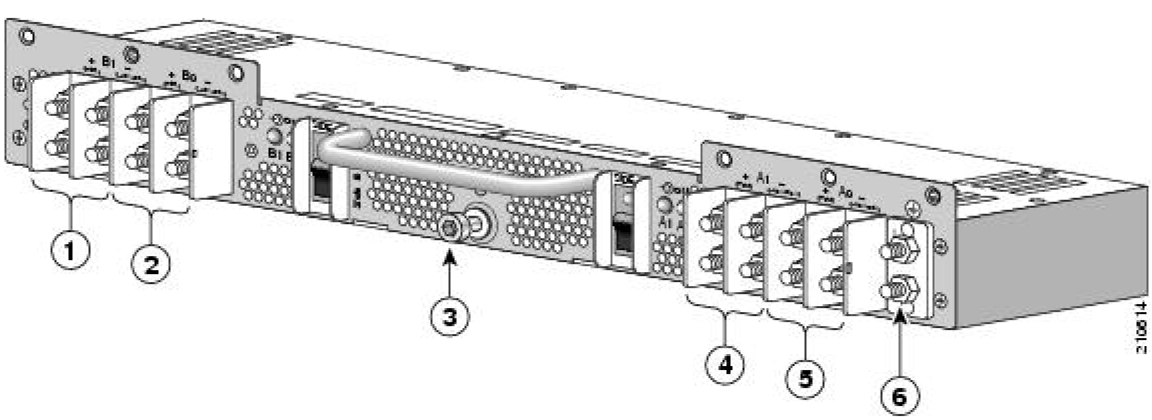
Note When wiring the DC power shelf, be sure to attach the ground wire first. When removing the wiring, be sure to remove the ground wire last. The ground wire must be attached with a torque value of 30 in-lb. The power cables should also be attached with a torque value of 30 in-lb.

Wiring Block on the PIM

Each wiring block on the power input module (PIM) contains four sets of terminals, two positive and two negative. Each wiring block is covered by a plastic block cover that snaps onto the wiring block and is secured by a screw to a torque value of 50 in.-lb.

You must remove the block cover before you work with the wires.

Figure 11: Power Input Module (PIM)



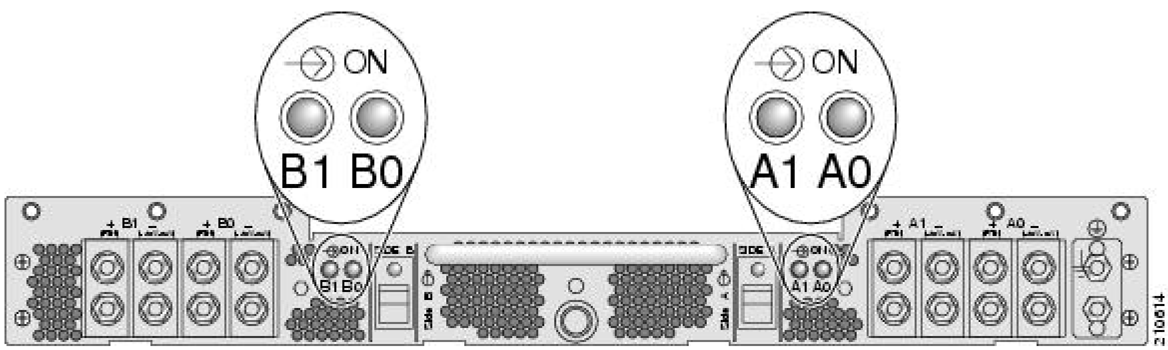
1	Power supply B1 wiring block	4	Power supply A1 wiring block
2	Power supply B0 wiring block	5	Power supply A0 wiring block
3	Coupling screw	6	Ground lug nuts

Input-Power-Present LEDs

The DC power Input-Power-Present LEDs provide a visual indication to service personnel that there is voltage present across the input terminal's connection. The LED provides a warning to the service person that there is power present.

Note Power should be disconnected before servicing the input power connections. Always check for hazardous voltage with a multimeter device before servicing the unit.

Figure 12: Input-Power-Present LEDs



The input-power-present LED starts to light up when the input voltage reaches 20 VDC; the LED gets brighter as voltage increases. The input-power-present LED is fully lit when the input voltage reaches 38 VDC.

Note If an input-power-present LED is not lit, check for 1) the presence of voltage, and 2) the polarity of the corresponding wiring block.

DC Power Wire Characteristics

For signal degradation to be averted, a conductor must be large enough to prevent its impedance from creating a voltage drop equal to 2 percent of the reference voltage. Also, the protective earth conductor must be large enough to carry all the current if the –48 VDC return fails. This latter requirement is for safety. Full fault redundancy is achieved by having conductors of equal size for the protective earth ground and the –48 VDC return of the switch.

For site preparation, proper wire size and insulation must be selected. For a planned power distribution, calculation must be done prior to distribution to meet the proper voltage drop and temperature rise.

For wire gauges that prevent unacceptable voltage drops over different lengths of copper wire, see the following table. For the resistance of 1000 feet of copper wire for each gauge of wire. see "Resistance for Each Gauge of Copper" table. These references are for planning purposes and might be further subject to local laws and practices.

The following table provides the gauges of wire needed for wire lengths and DC power currents.

Note We recommend using at least 50-A of DC current and 6-gauge wire.

Table 6: Wire Gauge for Current Loads over Copper Wire Lengths

DC Current (Amps)	25 Feet	50 Feet	75 Feet	100 Feet	150 Feet	200 Feet	400 Feet
5-A	18 gauge	14 gauge	14 gauge	12 gauge	10 gauge	8 gauge	6 gauge
10-A	14 gauge	12 gauge	10 gauge	8 gauge	8 gauge	6 gauge	2 gauge
15-A	14 gauge	10 gauge	8 gauge	8 gauge	6 gauge	4 gauge	2 gauge
20-A	12 gauge	8 gauge	8 gauge	6 gauge	4 gauge	2 gauge	0 gauge
25-A	12 gauge	8 gauge	6 gauge	4 gauge	4 gauge	2 gauge	0 gauge
30-A	10 gauge	8 gauge	6 gauge	4 gauge	2 gauge	2 gauge	00 gauge
35-A	10 gauge	6 gauge	4 gauge	2 gauge	2 gauge	1 gauge	000 gauge
40-A	8 gauge	6 gauge	2 gauge	2 gauge	2 gauge	0 gauge	000 gauge
45-A	8 gauge	6 gauge	4 gauge	2 gauge	1 gauge	0 gauge	0000 gauge
50-A	8 gauge	4 gauge	4 gauge	2 gauge	1 gauge	00 gauge	N/A
55-A	8 gauge	4 gauge	2 gauge	2 gauge	0 gauge	00 gauge	N/A
60-A	8 gauge	4 gauge	2 gauge	2 gauge	0 gauge	00 gauge	N/A
65-A	6 gauge	4 gauge	2 gauge	1 gauge	0 gauge	000 gauge	N/A
70-A	6 gauge	4 gauge	2 gauge	1 gauge	00 gauge	000 gauge	N/A
75-A	6 gauge	4 gauge	2 gauge	1 gauge	00 gauge	000 gauge	N/A
100-A	4 gauge	2 gauge	1 gauge	00 gauge	000 gauge	N/A	N/A

The following table provides the correlation between wire gauge and the resistance (in Ohms for each 1000 feet of wire) for copper wire.

Table 7: Resistance for Each Gauge of Copper Wire

Wire Gauge	Ohms for each 1000 Feet of Wire
0000	0.0489
000	0.0617
00	0.0778
0	0.098
1	0.1237
2	0.156
3	0.1967
4	0.248
5	0.3128
6	0.3944
7	0.4971
8	0.6268
9	0.7908
10	0.9968
11	1.257
12	1.5849
13	1.9987
14	2.5206
15	3.1778
16	4.0075
17	5.0526

Wire Gauge	Ohms for each 1000 Feet of Wire
18	6.3728
19	8.0351
20	10.1327
21	12.7782
22	16.1059

CHAPTER 3

Chassis Cooling System

This chapter describes the components that make up the cooling system of the line card chassis. The following sections are included:

Cooling System Overview

The cooling system dissipates the heat generated by the line card chassis and controls the temperature of chassis components. The cooling system has a redundant architecture that allows the chassis to continue operating with a single fan failure. See the Cooling System Redundancy, on page 28 section for more information.

The complete chassis cooling system includes:

- One fan tray (holds four fans and fan controller)
- Temperature sensors (on cards and modules throughout the chassis)
- Control software and logic
- An air filter and air inlet vent
- Impedance carriers for empty chassis slots

The power modules in the power shelf also have their own self-contained cooling fans and air filter.

All four fans in the fan tray operate as a group. So, if it is necessary to increase or decrease airflow, all of the fans in the tray increase or decrease their rotation speed together.

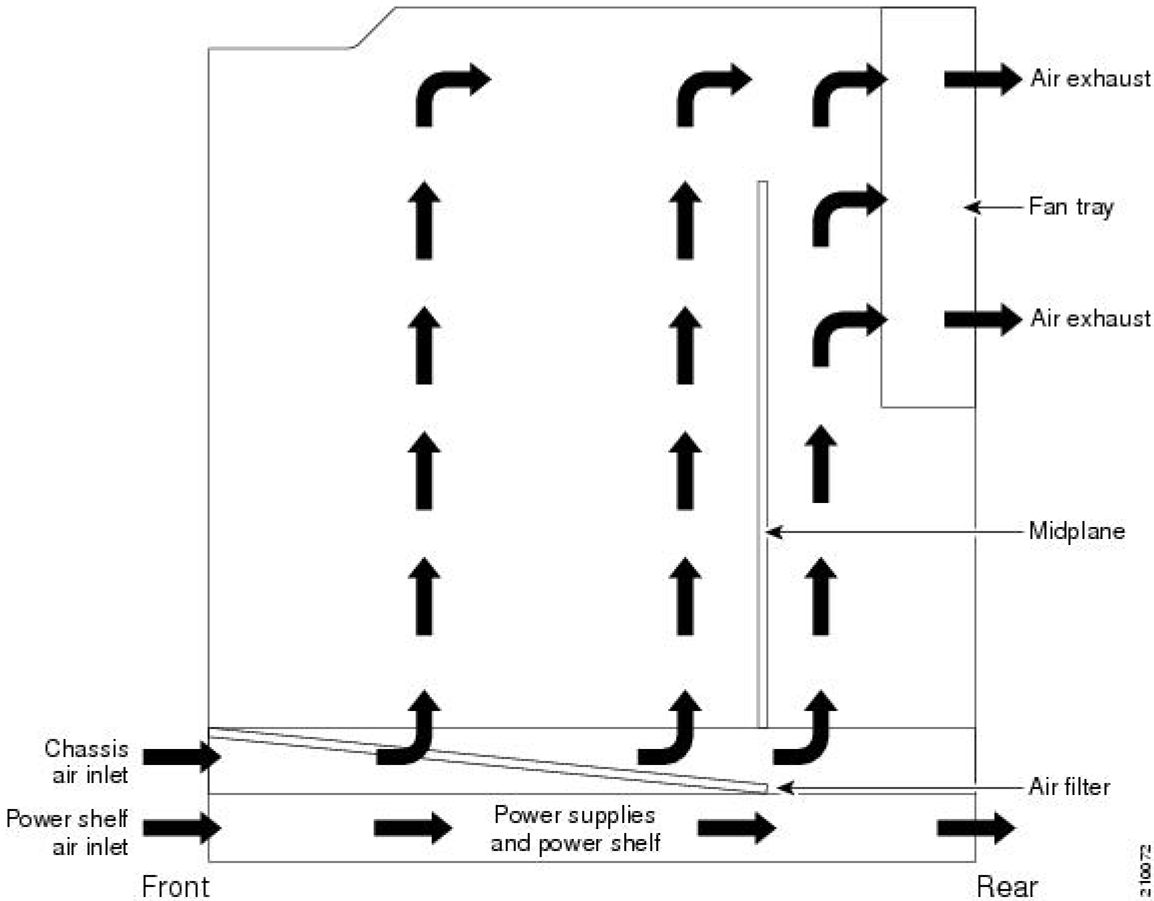
Thermal sensors (inlet, exhaust, and hot-spot) are located on the system boards throughout the chassis and are used to monitor temperature readings and identify when the system is not cooling properly.

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

Chassis Airflow

The following figure shows how air moves through the line card chassis. The air inlet at the bottom front of the chassis pulls in ambient air and passes it through the card cage. Warm air is exhausted out the top rear of the chassis through the fans. An air filter above the power shelf filters the incoming air.

Figure 13: Airflow Through Cisco CRS 4-Slot Line Card Chassis



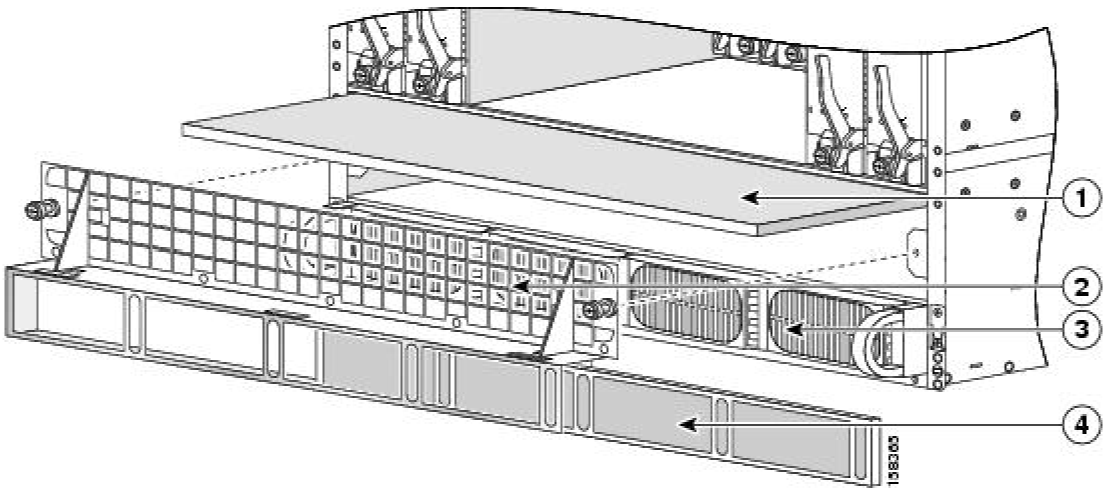
Note The chassis card cage has a maximum airflow of 880 cubic feet (24,919 liters) per minute.

The chassis has a replaceable air filter mounted in the front of the chassis in a slide-out tray above the power shelf. The chassis air filter is shown in the following figure .

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.

Caution See the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Installation Guide for the specific air filter replacement procedure.

Figure 14: Air Filter



1	Chassis air filter	3	Power shelf and power modules
2	Air intake grille	4	Power shelf air filter

Cooling System Operation

The fan control software and related circuitry varies the fan speed signal to individual fans to control their speed. This increases or decreases the airflow needed to keep the system operating in a desired temperature range. The chassis cooling system uses multiple fan speeds to optimize cooling, acoustics, and power consumption.

At initial power up, the fans default to 4000 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 three to five minutes. The fan control software then adjusts the fan speeds appropriately, up to 7500 RPM.

During normal operation, the chassis averages the temperatures reported by inlet temperature sensors. 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. To avoid dynamic oscillation of the fan speed, the fan speed control is regulated in discrete steps.

Note When there are no active alarms or failures, the fan control software checks temperature sensors every two to three 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 the fan controller. 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 prevent permanent damage to the components.

Cooling System Redundancy

The redundant architecture of the cooling system allows the cooling system to continue operating even when certain components fail. The cooling system can withstand the failure of any one of the following components and still continue to properly cool the line card chassis:

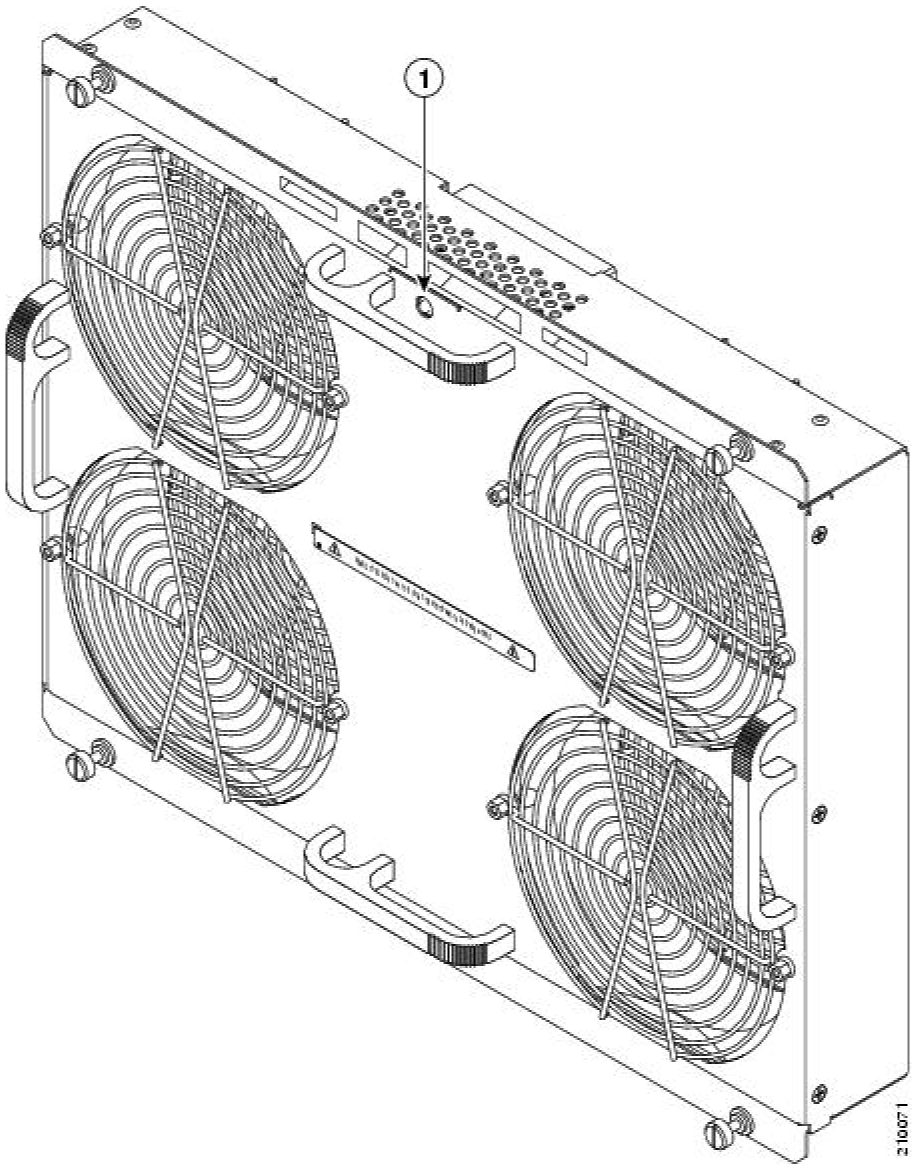
- Any one of the four fans in the fan tray
- One or two of the four AC rectifiers in the AC power shelf
- One or two of the four DC power supplies in the DC power shelf

Note When a cooling system component fails, it should be replaced within 24 hours.

Fan Tray

The following figure shows a fan tray, which plugs into the rear of the chassis.

Figure 15: Fan Tray



1	Status LED

The fan tray contains the following components:

- Four fans—Each fan uses –36 to –72 VDC as its input power. The fans operate in the range of 3500 to 7500 RPM.

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

- Fan controller—The board terminates signals to and from the fans, filters common-mode noise, and contains tracking and indicator parts. The fan controller is not user accessible or field replaceable.
- Status LED—The LED indicates the following:
  - Green—The fan tray is operating normally.
  - Yellow—The fan tray or a fan has experienced a failure and should be replaced.
  - Off—The RP has not booted, the LED is faulty, or no power is being received.

The fan tray has the following physical characteristics:

- Height—13.7 in. (34.7 cm)
- Width—17.4 in. (44.1 cm)
- Depth—3.7 in. (9.3 cm)—Includes rear connector and front handles
- Weight—16 lb (7.2 kg)

CHAPTER 4

Switch Fabric

This chapter describes the Cisco CRS 4-slot line card chassis switch fabric and switch fabric card (SFC). The following sections are included:

Switch Fabric Overview

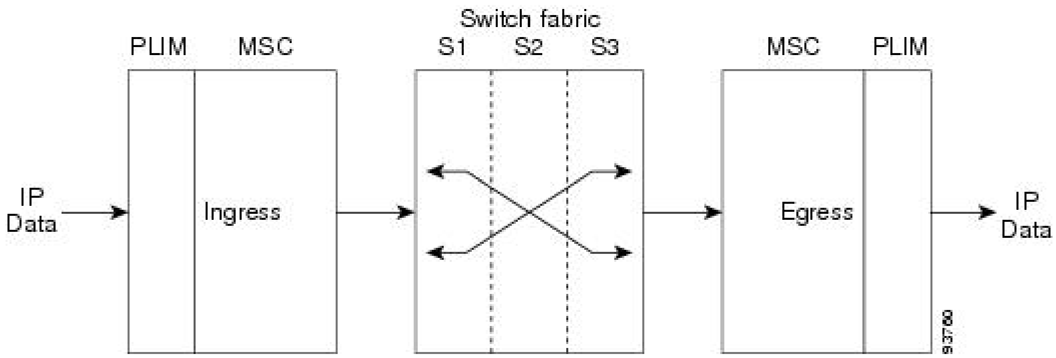
The switch fabric is the core of the Cisco CRS 4-slot line card chassis. The switch fabric is implemented through switch fabric cards installed in the chassis. The switch fabric uses a cell-switched, buffered three-stage Benes switch fabric architecture. The switch fabric receives user data from an MSC and performs the switching necessary to route the data to the appropriate egress MSC.

The switch fabric is divided into four planes (plane 0 to plane 3) that are used to evenly distribute traffic across the switch fabric. Each switch fabric plane is independent and is 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.)

There are two types of switch fabric cards used in the line card chassis: QQ123 (40G fabric) and QQ123-140G (140G fabric). Each fabric card implements all three stages of the switch fabric.

The following figure shows the basic path of IP data packets through the Cisco CRS 4-slot line card chassis switch fabric. Note that the figure shows all three stages of the switch fabric provided by the fabric cards in the line card chassis.

Figure 16: Basic 4-Slot Line Card Chassis 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 4-slot line card chassis switch fabric is a Cisco design and is not related to Asynchronous Transfer Mode (ATM) cells.

Switch Fabric Operation

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

- Stage 1 (S1)—Distributes traffic to Stage 2 of the fabric plane. Stage 1 elements receive cells from the ingress MSC and PLIM (or RP) and distribute the cells to Stage 2 (S2) of the fabric plane.
- Stage 2 (S2)—Performs switching and 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.
- 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

A line card chassis can contain up to 4 MSCs, each with 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 At least two planes of the switch fabric (an even plane and an odd plane) must be active at all times for the Cisco CRS 4-slot line card chassis to operate. Otherwise, the switch fabric fails, causing a system failure.

Switch Fabric Cards

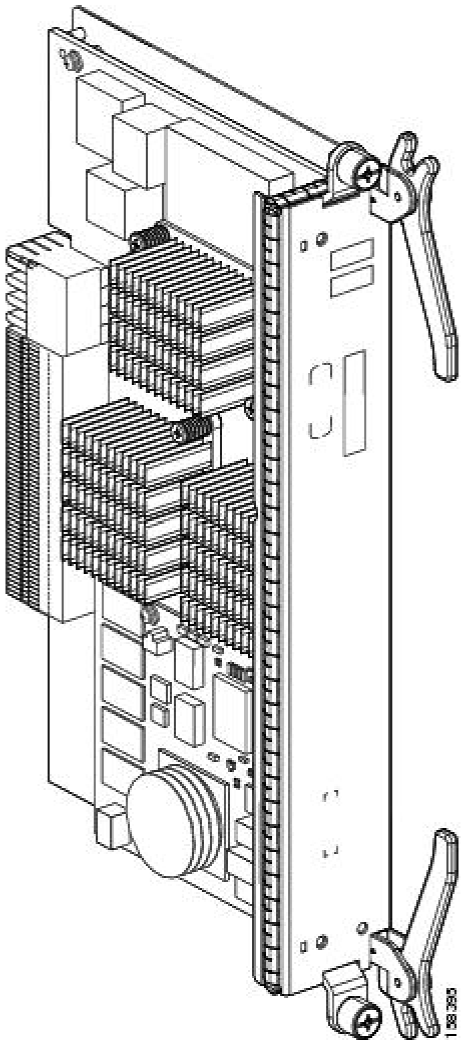
The Cisco CRS 4-slot line card chassis supports two types of switch fabric card. This section describes the cards and their indicators.

Switch Fabric Card Description

This section describes both the QQ123 and QQ123-140G switch fabric cards.

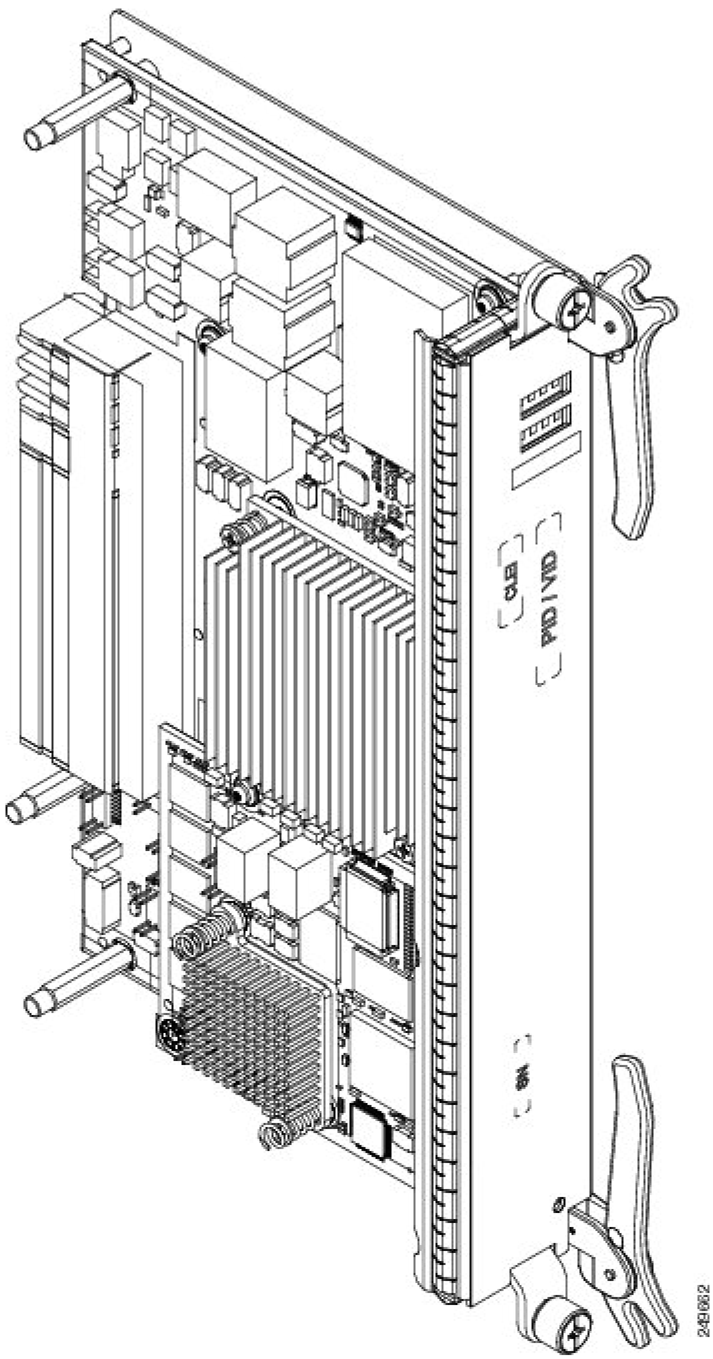
The switch fabric cards implement all three stages of the three-stage Benes switch fabric. Each card also implements one plane of the four-plane switch fabric. The following figure shows the QQ123 switch fabric card.

Figure 17: QQ123 Switch Fabric Card



The following figure shows the QQ123-140G switch fabric card.

Figure 18: QQ123-140G Switch Fabric Card



Switch Fabric Card Components

The switch fabric cards contain the following major components:

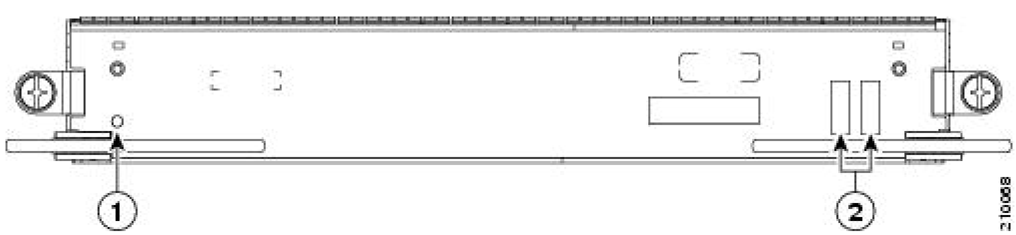
- S1 switch element—Implements Stage 1 of the switch fabric. Receives cells from the MSC (or RP) and distributes them to Stage 2.
- S2 switch element—Implements Stage 2 of the switch fabric. Receives cells from Stage 1, performs 2x speedup, and routes the cells toward the appropriate egress S3 element.
- S3 switch element—Implements Stage 3 of the switch fabric. Receives data cells from Stage 2 and performs switching of incoming cells to the appropriate egress links. 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.

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 QQ123 switch fabric card. The front panel of the QQ123-140G card is similar.

Figure 19: QQ123 SFC Front Panel



1	Status LED	2	Alphanumeric LEDs

The front panel of the switch fabric cards contains:

- Status LED—Indicates the status of the fabric card.
    - Green—Indicates that the SFC is operating normally.
    - Yellow—Indicates that a fault condition exists.

- Alphanumeric display—Displays switch fabric card messages.

The physical characteristics of both the QQ123 and QQ123-140G switch fabric cards are:

- Height—2 in. (5.0 cm)
- Depth—7.1 in. (18.0 cm)
- Width— 12.1 in. (30.7 cm)
- Weight—6 lb (2.7 kg)
- Power consumption—up to 130 W

CHAPTER 5

Line Cards, Physical Layer Interface Modules, and Shared Port Adapters Overview

This chapter describes the modular services cards (MSCs), forwarding processor (FP), label switch processor (LSP), and associated physical layer interface modules (PLIMs). This chapter also describes the optional use of shared port adapters (SPAs). The cable-management system is also described.

This chapter includes the following sections:

Line Cards and PLIMs Overview

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

There are three versions of the MSC card: CRS-MSC, CRS-MSC-B, and CRS-MSC-140G.

There are two versions of the FP card: CRS-FP40 and CRS-FP-140.

There is one LSP card: CSR-LSP.

Note See the CRS Hardware Compatibility, on page 8 section for information about CRS fabric, line card, 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 140 Gbps aggregate bandwidth). Additional services, such as class of service (CoS) processing, multicast, traffic engineering (TE), including statistics gathering, are also performed at the 140-Gbps line rate.

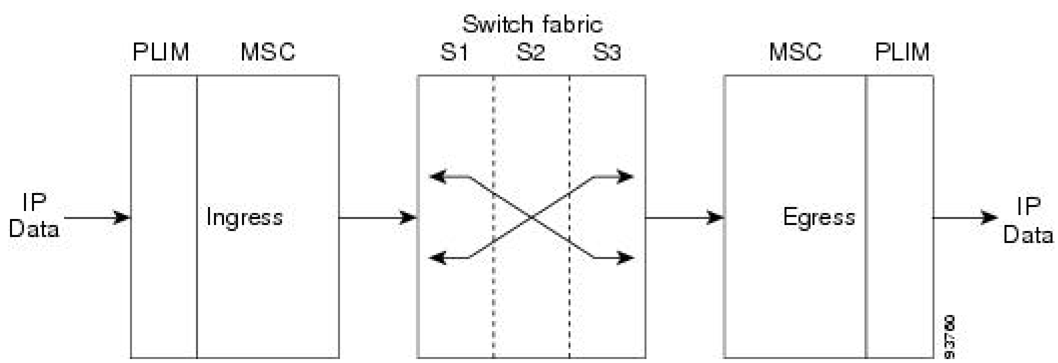
Line cards support several forwarding protocols, including IPV4, IPV6, and MPLS. Note that the route processor (RP) performs routing protocol functions and routing table distributions, while the line cards actually forwards the data packets.

In the Cisco CRS 4-Slot line card chassis, both the line cards and PLIMs are installed in the front of the chassis, and mate through the chassis midplane.

Note The following MSC functional description is also generally applicable to FP and LSP cards.

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, or LSP, which passes the egress data out its associated PLIM.

Figure 20: Data Flow through the 4-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 MSC converts packets to and from cells and provides a common interface between the routing system switch fabric and the assorted PLIMs. PLIMs 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).

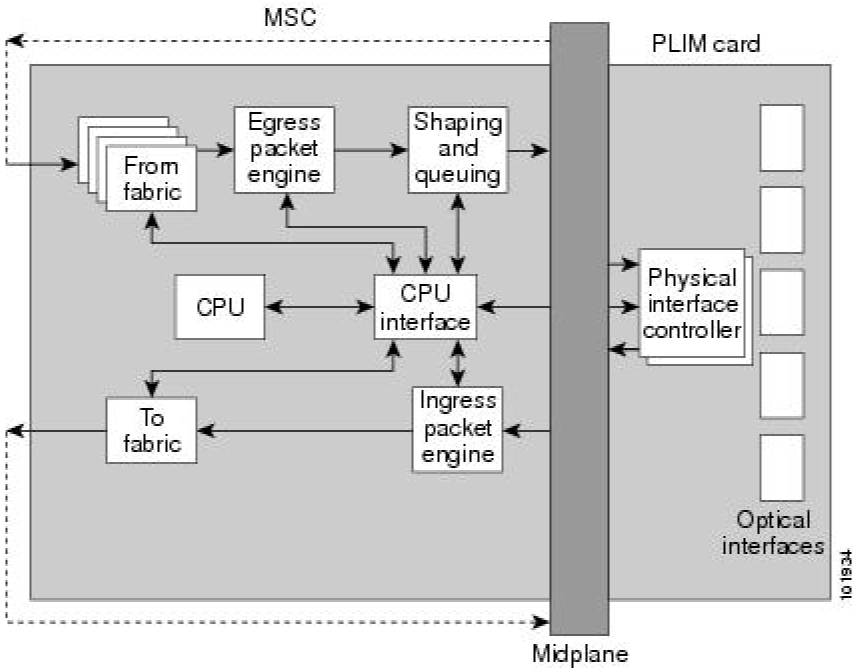
A PLIM eight-byte header is built for packets entering the fabric. The PLIM header includes the port number, the packet length, and some summarized layer-specific data. The L2 header is replaced with PLIM headers and the packet is passed to the MSC for feature applications and forwarding.

The transmit path is essentially the opposite of the receive path. Packets are received from the drop side (egress) from the MSC through the chassis midplane. The L2 header is based on the PLIM eight-byte header received from the MSC. 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.

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

Figure 21: 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 MSC. For received (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 of the board. To perform Layer 3 forwarding, the packet engine performs the following functions:

- Classifies packets by protocol type and parses the appropriate headers on which to do the forwarding lookup 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 four 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 "MSC and PLIM Simple Block Diagram").

- 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 MSC, 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. This section of the card then places the IP packets in one of its 8-K 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 "MSC and PLIM Simple Block Diagram" 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 MSC 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 "MSC and PLIM Simple Block Diagram", the MSC contains a central processing unit (CPU) that performs these functions:

- MSC configuration
- Management
- Protocol control

The CPU subsystem includes:

- A CPU chip
- A Layer 3 cache
- NVRAM
- A flash boot PROM
- A memory controller
- Memory, a dual in-line memory module (DIMM) socket, providing 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, and up to 8GB of 533MHz DDR2 SDRAM on the CRS-MSC-140G.

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

Line Card Descriptions

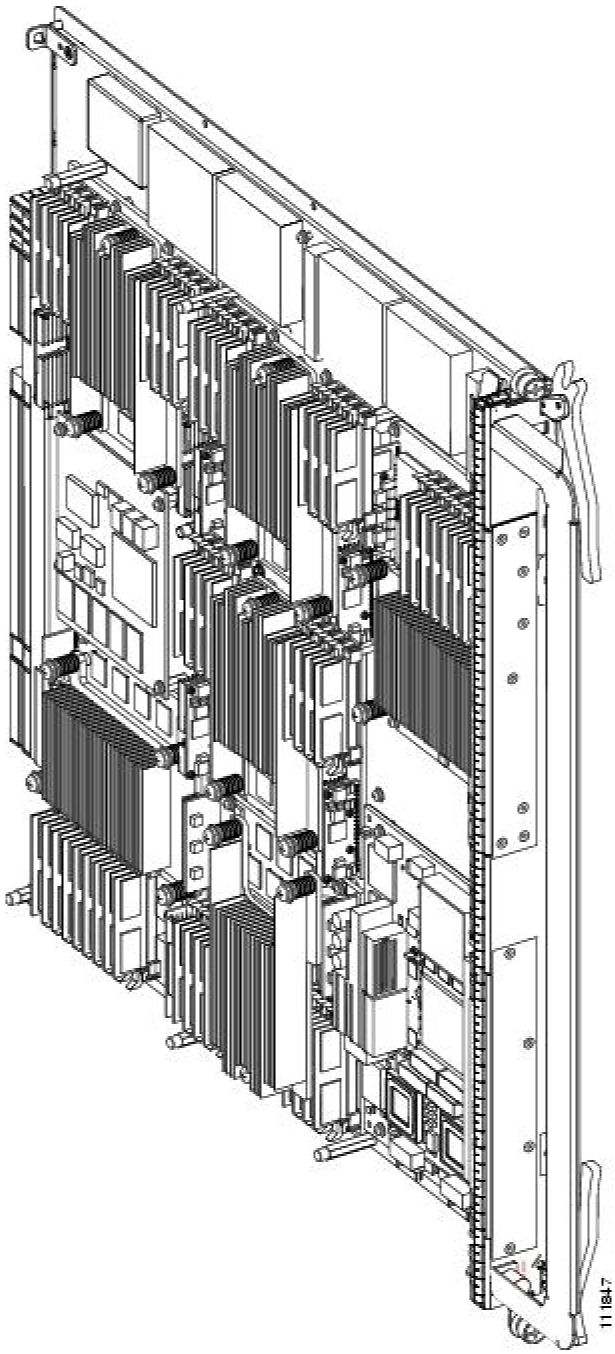
The following figure shows a Cisco CRS routing system MSC. An MSC, FP, or LSP fits into any available MSC slot and connects directly to the midplane. All three versions of the MSC (CRS-MSC, CRS-MSC-B, and CRS-MSC-140G) are similar in appearance. The primary difference is the CRS-MSC-B and CRS-MSC-140G are a flat design, instead of modular.

The CRS-FP40 and CRS-FP140 cards are similar in appearance to the CRS-MSC-B.

The CRS-LSP card is similar in appearance to the CRS-FP140 card.

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

Figure 22: Modular Services Card (CRS-MSC)

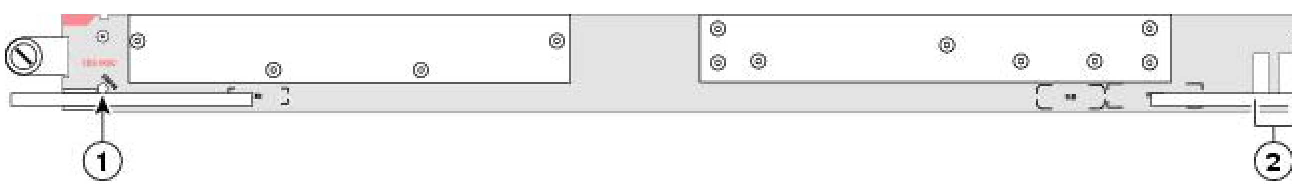


The main physical characteristics of the MSC, FP, and LSP cards are:

- Height—20.6 in.(52.3 cm)
- Depth—18.6 in. (47.2 cm)
- Width—1.8 in. (4.6 cm)
- Weight:
  - CRS-MSC = 18.7 lb (8.5 kg)
  - CRS-MSC-B = 12 lb (5.44 kg)
  - CRS-FP40 = 12 lb (5.44 kg)
  - CRS-MSC-140G = 14.75 lb (6.68 kg)
  - CRS- FP140 = 14.75 lb (6.68 kg)
  - CRS-LSP = 14.75 lb (6.68 kg)
- Power consumption:
  - CRS-MSC = 375 W
  - CRS-MSC-B = 300 W
  - CRS-FP40 = 270 W
  - CRS_MSC-140G = 446 W
  - CRS- FP140 = 446 W
  - CRS- LSP = 446 W

The following figure shows the CRS-MSC front panel.

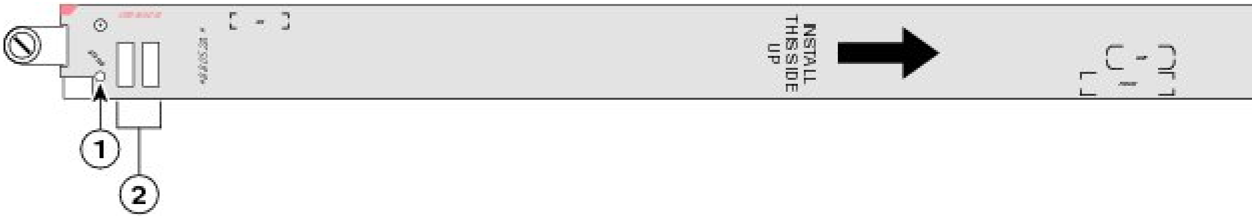
Figure 23: CRS-MSC Front Panel



1	Status LED	2	Alphanumeric LEDs

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

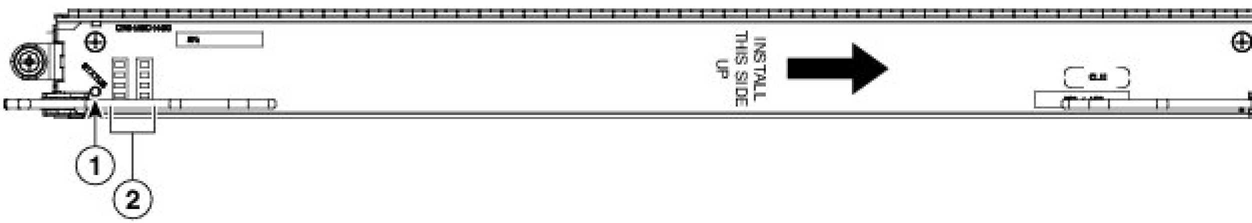
Figure 24: CRS-MSC-B Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the CRS-MSC-140G front panel.

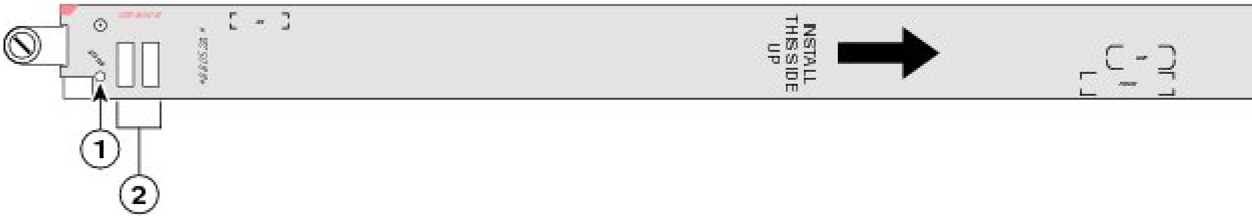
Figure 25: CRS-MSC-140G Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the CRS-FP40 front panel.

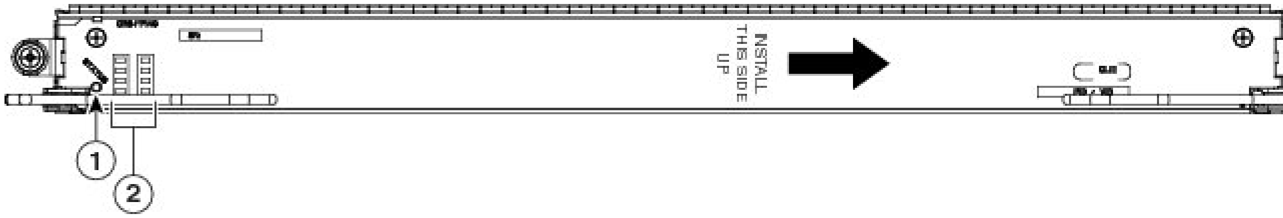
Figure 26: CRS-FP40 Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the CRS-FP140 front panel.

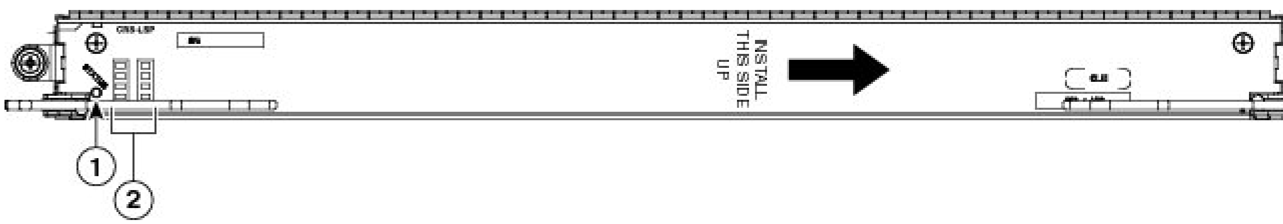
Figure 27: CRS-FP140 Front Panel



1	Status LED	2	Alphanumeric LEDs

The following figure shows the CRS-LSP front panel.

Figure 28: CRS-LSP Front Panel



1	Status LED	2	Alphanumeric LEDs

Physical Layer Interface Modules

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

In the Cisco CRS 4-Slot Line Card Chassis, line cards and PLIMs are both installed in the front of the chassis, and mate through the chassis midplane. 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

Warning Class 1 Laser Product. Statement 113

Warning Class 1 LED product. Statement 126

Warning For diverging beams, viewing the laser output with certain optical instruments within a distance of 100 mm may pose an eye hazard. For collimated beams, viewing the laser output with certain optical instruments designed for use at a distance may pose an eye hazard. Statement 282

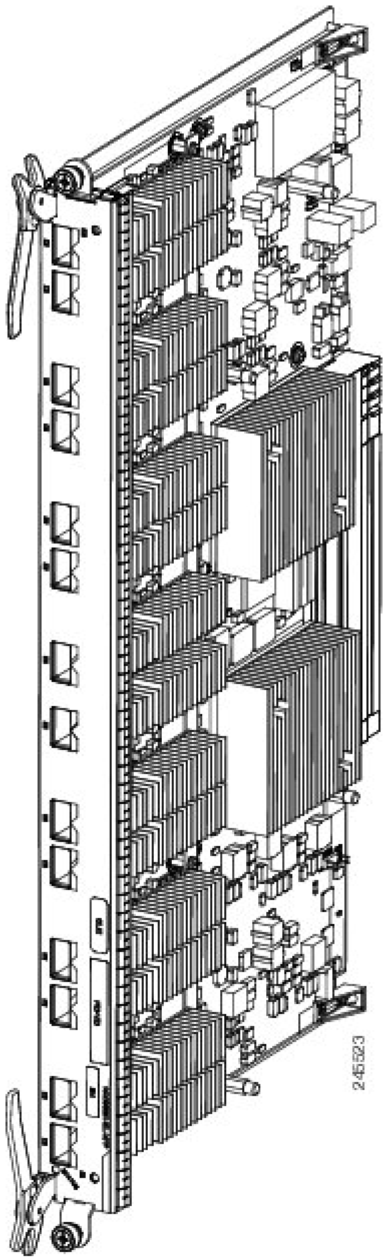
Warning Laser radiation. Do not view directly with optical instruments. Class 1M laser product. Statement 283

Various types of PLIM interfaces are available for the line card chassis. These interfaces are described in detail, in the following Cisco publications:

- Cisco CRS Carrier Routing System Packet-over-SONET/SDH Physical Layer Interface Module Installation Note
- Cisco CRS Carrier Routing System Gigabit Ethernet Physical Layer Interface Module Installation Note

Here is an example of a typical PLIM (in this case, a 14-port 10-GE XFP PLIM. Other PLIMs are similar.

Figure 29: Typical PLIM —14-Port 10-GE XFP PLIM



Chassis Cable Management

The line card chassis has cable-management features for the front of the chassis. These cable-management features consist of horizontal cable-management trays above the card cage. These 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 in installing the cables in the chassis.

See the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis Installation Guide for detailed information about chassis cabling and cable management.

SPA Interface Processors and Shared Port Adapters

An optional interface solution (to PLIMs) is also available. SPA interface processors (SIPs) and shared port adapters (SPAs) can be installed instead of PLIMs. A SIP is a carrier card that is similar to a PLIM and inserts into a line card chassis slot and interconnects to an MSC like a PLIM. Unlike PLIMs, SIPs provide no network connectivity on their own.

A SPA is a modular type of port adapter that inserts into a subslot of a compatible SIP carrier card to provide network connectivity and increased interface port density. A SIP can hold one or more SPAs, depending on the SIP type and the SPA size. POS/SDH and Gigabit Ethernet SPAs are available. For complete SIP and SPA information, see the Cisco CRS Carrier Routing System SIP and SPA Hardware Installation Guide.

CHAPTER 6

Route Processor

This chapter describes the route processor (RP) card. The following sections are included:

Route Processor Overview

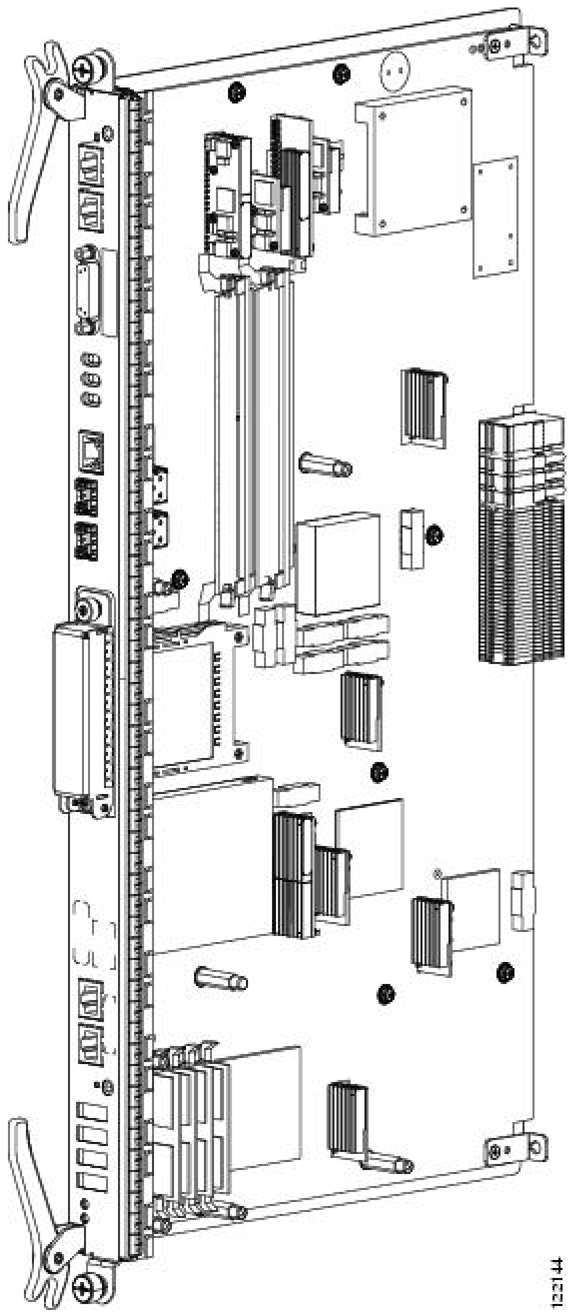
The route processor (RP) card is the system controller for the Cisco CRS 4-slot line card chassis. It performs route processing and distributes forwarding tables to the MSCs. Although the routing system contains two RP cards, only one RP is active at a time. The other RP operates in standby mode, ready to assume control if the primary RP fails.

The RP card provides route processing, alarm, fan, and power supply controller function in the Cisco CRS 4-slot line card chassis. The RP card controls fans, alarms, and power supplies through the use of an *i2c* communication link from the RP card to each fan tray/power supply.

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

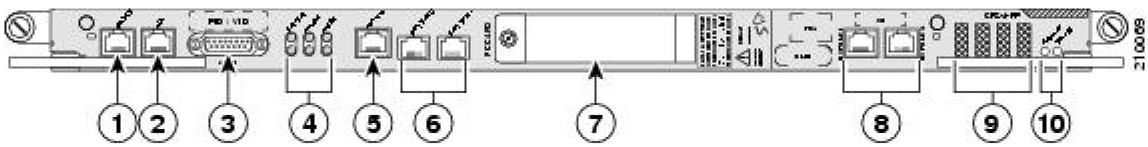
This figure illustrates the route processor card.

Figure 30: Route Processor Card



Details on the faceplate of the RP card are shown in this figure and are described in the succeeding table.

Figure 31: Route Processor Card Front Panel Details



1	Console port	6	Control Ethernet ports
2	AUX port	7	PC card slot
3	Alarm port	8	EXT CLK ports
4	Error LED array	9	Alphanumeric LEDs
5	Management Ethernet port	10	Status LEDs

Table 8: Description of RP Card Components

RP Card Component	Description
Hard drive	An IDE hard drive is used to gather debugging information, such as core dumps from the RP or MSCs. It is typically powered down and activated only when there is a need to store data.
Memory	Memory resides in a SIMM module on the RP card. The RP can be configured with 2 or 4 GB of memory.
PCMCIA Subsystems	Two PCMCIA flash slots provide support for 1 Gb of flash subsystem storage, each. One of the PCMCIA flash subsystems is accessible externally and is removable, and allows you to transfer images and configurations by plugging in a PCMCIA flash card. The other PCMCIA flash subsystem is fixed to the RP, for permanent storage of configurations and images.
CPU	A single MPC7457 (1.2-Ghz) Power-PC module 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.

RP Card Component	Description
RJ45 Ethernet port	An RJ-45 10/100/1000 copper Ethernet port is available for providing connectivity to network management systems.
Fast Ethernet Midplane Connector	Internal 100 Mbps Fast Ethernet (FE) midplane connections connect each MSC in the chassis to both RP cards. These FE connections are traces in the midplane. There are also FE connections to the power supplies of the fans. These connections all form part of the control plane.

Primary and Standby Arbitration

The two RP cards in a Cisco CRS 4-slot line card chassis operate in a primary-standby relationship. The routing system performs the following tasks to determine which RP is primary and which is standby:

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

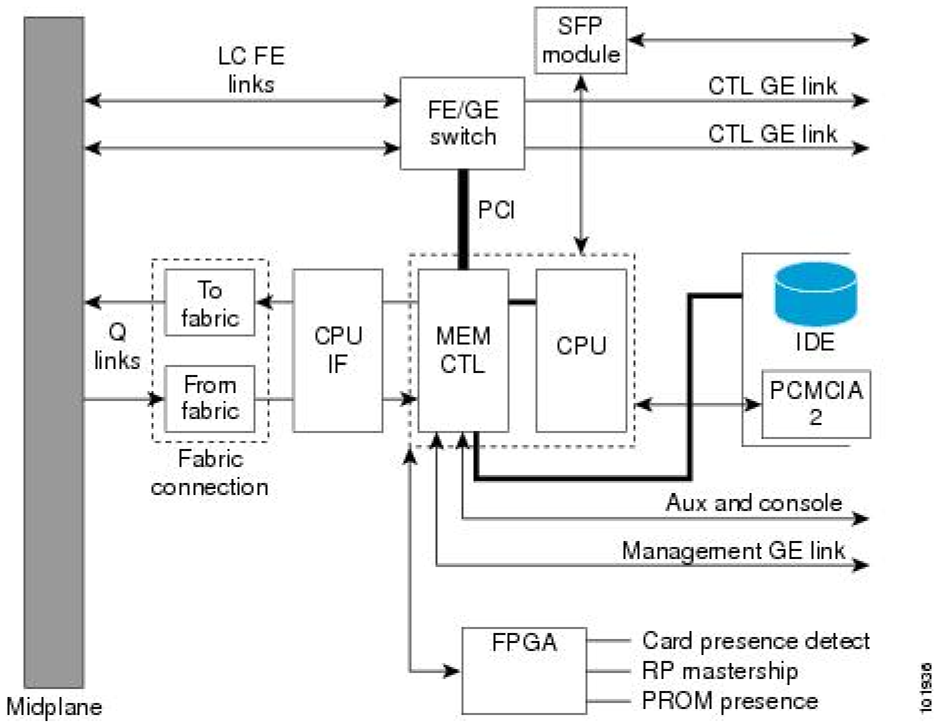
RP Card to Fabric Module Queuing

As shown in the following figure, the RP mates with the Cisco CRS 4-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 the MSC To Fabric Section and Queuing , on page 42).

- The "From fabric" module (on the RP receive path) queues the data from the switch fabric and reorders and reassembles the cells into packets before queuing them for slow-path processing.

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

Figure 32: Route Processor Architecture Diagram



Performance Route Processor

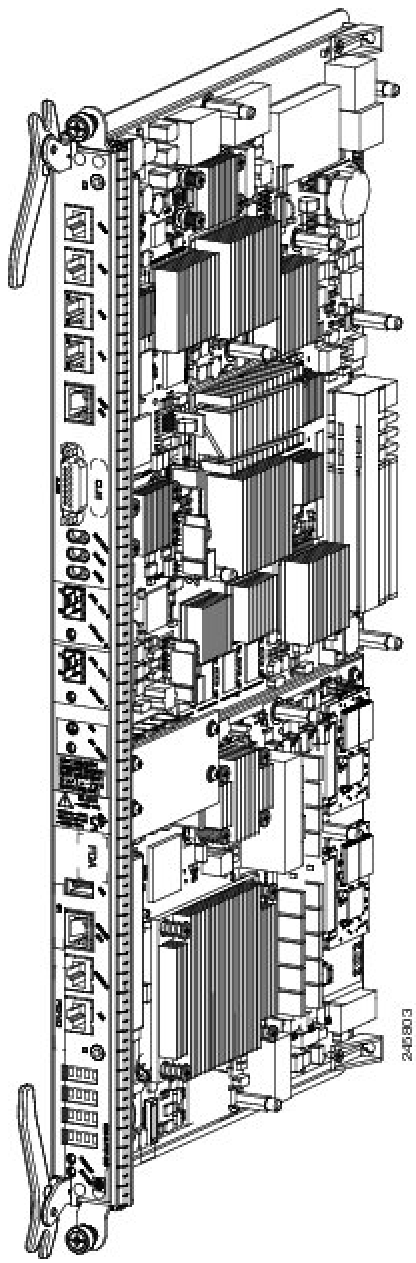
The Performance Route Processor (PRP) is also available for the Cisco CRS 4-slot line card chassis. The PRP provides enhanced performance for both route processing and system controller functionality.

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 4-slot line card chassis. When two PRPs are installed, one PRP is the "Active" RP and the other is the “Standby” RP.

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).

This figure shows the PRP card.

Figure 33: Performance Route Processor



The PRP has the following physical characteristics:

- Height—20.6 in. (52.3 cm)
- Depth—11.2 in. (28.5 cm)
- Width—1.8 in. (4.6 cm)
- Weight—9.60 lb (4.35 kg)

- Power consumption—175 W (with two SFP or SFP+ optics modules)

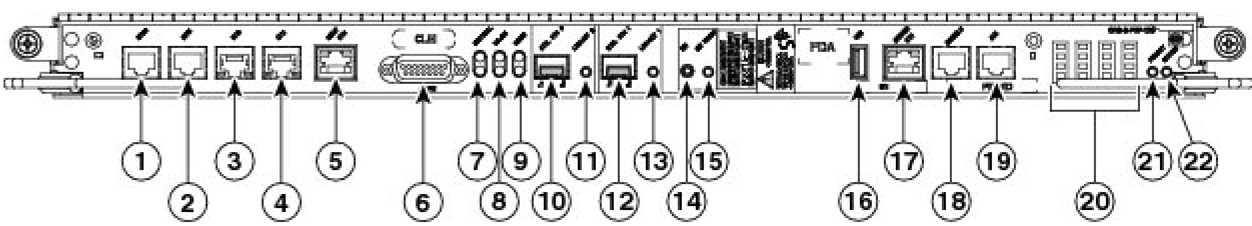
Performance Route Processor Front Panel

The PRP front panel includes:

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

This figure shows the front panel of the PRP card.

Figure 34: Performance Route Processor Front Panel



1	BITS 0	12	Control Ethernet 1 port (SFP or SFP+)
2	BITS 1	13	Link/Active 1 LED
3	DTI 0	14	OIR push button—Press to initiate OIR process
4	DTI 1	15	OIR Ready LED
5	Management Ethernet RJ45 port	16	USB socket
6	Alarm connector	17	Service Ethernet RJ45 port
7	Critical Alarm LED	18	Console port

1	BITS 0	12	Control Ethernet 1 port (SFP or SFP+)
8	Major Alarm LED	19	Auxiliary port
9	Minor Alarm LED	20	Alphanumeric LED Display
10	Control Ethernet 0 port (SFP or SFP+)	21	PRIMARY LED—PRP active or standby indicator
11	Link/Active 0 LED	22	STATUS LED—Card status indicator

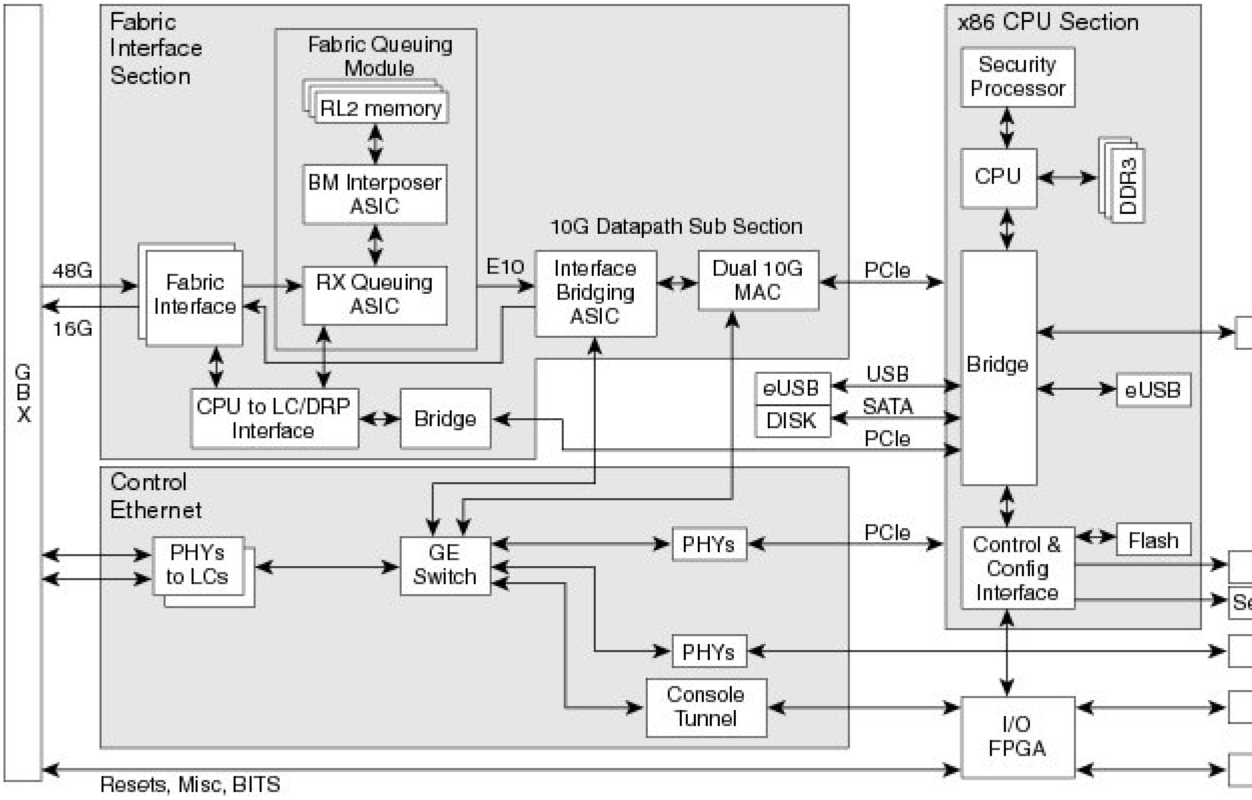
Performance Route Processor Overview

The CRS PRP for the Cisco CRS 4-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.

This figure shows a block diagram of the PRP card.

Figure 35: Performance Route Processor Block Diagram



Performance Route Processor Memory Options

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

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

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

Initiate OIR Pushbutton

The PRP front panel includes an OIR pushbutton (see figure Figure 34: Performance Route Processor Front Panel, on page 59). 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 (see figure Figure 34: Performance Route Processor Front Panel, on page 59) 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

This table lists the pinouts for the Console (CON) and Auxiliary (AUX) RJ45 ports on the PRP (see figure Figure 34: Performance Route Processor Front Panel, on page 59).

Table 9: PRP Console 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 backdoor mechanism into the PRP if the main CPU subsystem is stuck and cannot be recovered.

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

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

USB Port

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

Alarm Port

This table lists the pin outs for the Alarm port on the PRP (see figure Figure 34: Performance Route Processor Front Panel, on page 59).

Table 10: Alarm Port Pin Outs

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

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

APPENDIX A

Cisco CRS 4-Slot Line Card Chassis System Specifications

This appendix provides the specifications for the Cisco CRS Carrier Routing System 4-Slot Line Card Chassis. It contains the following sections:

Cisco CRS 4-Slot Line Card Chassis Specifications

Table 11: Cisco CRS 4-Slot Line Card Chassis Specifications

Physical Dimensions	
Height	30 in. (76.2 cm)
Depth	30.28 in. (76.9 cm)(including front doors)
Width	17.65 in. (44.8 cm)
Weight	
Chassis with fan tray, power shelf, and impedance carriers installed (as shipped)	260 lb (117.9 kg), chassis only338 lb (153.3 kg), chassis including packaging and pallet
Chassis with all components installed (without exterior cosmetic components and packaging)	361 lb (163.7 kg)

Physical Dimensions	
Cards and Modules Supported	4 modular services cards (MSCs) and forwarding processor (FP) cards (line cards). 4 physical layer interface modules (PLIMs) or 4 shared port adapter (SPA) interface processors (SIPs), each of which supports one or more SPAs 2 route processor (RP) cards or 2 performance route processor (PRP) cards 4 switch fabric cards 1 fan tray
Power Shelves	
AC power shelf	Supports four AC-to-DC rectifiers
DC power shelf	Supports four DC power supplies
Maximum Power Consumption	Total input power
Maximum AC input power	4185 W (assuming 92% efficiency)
Maximum DC input power	4278 W (assuming 90% efficiency)
Power Redundancy	
AC	1:1—Requires two independent AC sources
DC	We recommend two independent –48 VDC power sources
AC Input Power	2W+PE (2 wire + protective earthing[1])
Nominal input voltage	200 to 240 VAC(range: 180 to 264 VAC)
Nominal line frequency	50 or 60 Hz(range: 47 to 63 Hz)
Recommended AC service	20 A (per AC rectifier)
DC Input Power	
Nominal input voltage	Supports –48 VDC and –60 VDC systems (range: –40 to –72 VDC)
Input line current	50-A maximum at –48 VDC40-A maximum at –60 VDC

Physical Dimensions	
Inrush current	60-A peak at 75 VDC(maximum for 1 ms)
Chassis Cooling	1 fan tray, pull configuration
Chassis airflow	Up to 880 cubic ft (24,919 liters) per minute
Power shelf airflow	60 cubic ft (1699 liters) per minute

1 Protective earthing conductor (ground wire).

Environmental Specifications

Table 12: Cisco CRS 4-Slot Line Card Chassis Environmental Specifications

Description	Value
Temperature	Operating, nominal: 41° to 104°F (5° to 40°C) Operating, short-term: 23° to 122°F (–5° to 50°C)[2] 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 10,000 ft (3048 m) at 104°F (40°C) or below
Heat dissipation	• AC: 14,280 BTU per hour (maximum) • DC: 14,597 BTU per hour (maximum)
Power density	12,406 W per sq meter (maximum)
Average 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)

Description	Value
Acoustic noise	Fans at normal to moderate speed: 67 dBa—front of chassis77 dBa—rear of chassis Fans at maximum speed (7500 RPM): 83 dBa—front of chassis93 dBa—rear of chassis
Shock and vibration	Designed and tested to meet the NEBS shock and vibration standards defined in GR-63-CORE (Issue 2, April 2002).

2 “Short-term” refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in one year. This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that one-year period.

Compliance and Safety Reference

For information about the compliance and safety standards with which the Cisco CRS carrier routing system conforms, see *Cisco CRS Carrier Routing System Regulatory Compliance and Safety Information* .

Note Statement 273, Blower Handle Warning, is applicable only to the Cisco CRS 4-slot line card chassis.