Cisco CRS Carrier Routing System Multishelf System Description

First Published: 2005-07-04

Last Modified: 2014-07-01

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Preface

This preface explains the objectives of, intended audience for, organization of, and conventions used in this Cisco CRS Carrier Routing System Multishelf System Description, which is referred to as the "system description" throughout this publication.

Throughout the remainder of this system description, abbreviated terms are used to identify the formal names of the components that make up the multishelf system. See the below table for a list of these abbreviated terms.

Table 1: Abbreviated Terms

Cisco Product Name	Abbreviated Term
Cisco CRS Multishelf System	multishelf system
Cisco CRS 16-Slot Line Card Chassis	LCC
Cisco CRS Fabric Card Chassis	FCC

Note Throughout thins 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.

This preface includes these sections:

Objective

This system description provides high-level details of the Cisco CRS Fabric Card Chassis (FCC) and an overview of the multishelf system. It includes background information and basic theory of operation for anyone wanting to understand a multishelf system configuration. It includes descriptions of most of the major assemblies that make up the system.

This system description is technical reference publication that supplements the information found in the various publications that make up the multishelf system documentation set. The system description publication provides overviews of the hardware elements that make up a multishelf system and some basic theory of operation.

Audience

This guide is intended for anyone who wants a general overview of the multishelf system and its major hardware components.

Document Organization

This system description contains these chapters and appendixes:

- *Cisco CRS Multishelf System Overview* provides an overview of the multishelf system.
- Power System Overview, on page 15 provides a detailed physical description of the FCC DC and AC power systems.
- Fabric Card Chassis Cooling System, on page 61 provides an overview of the FCC cooling system.
- Multishelf System Switch Fabric, on page 67 provides an overview of the switch fabric and the switch fabric cards used in the FCC.
- Shelf Controller Gigabit Ethernet Card, on page 71 provides an overview of the 2-port and 22-port shelf controller Gigabit Ethernet (SCGE) card installed in the FCC.
- Optical Interface Modules and Optical Interface Module LED Card, on page 77 provides an overview of optical interfaces and the optical connection monitoring card installed in the FCC.
- Specifications, on page 85 provides tables of specifications for the FCC and its major components.

Document Conventions

This guide uses these conventions:

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

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

Warning Definition

Danger	**Danger** IMPORTANT SAFETY INSTRUCTIONS **Danger** 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 **Danger** SAVE THESE INSTRUCTIONS

See Regulatory Compliance and Safety Information for the Cisco CRS-1 Carrier Routing System for translations of warnings and information about the regulatory, compliance, and safety standards with which the Cisco CRS system conforms.

Related Cisco CRS Documentation

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

- Cisco CRS Carrier Routing System Hardware Documentation Guide
- About Cisco IOS XR Software Documentation

See the *Obtaining Documentation and Submitting a Service Request* section below for information on obtaining these and other publications.

Changes to This Document

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

Table 2: Changes to This Document

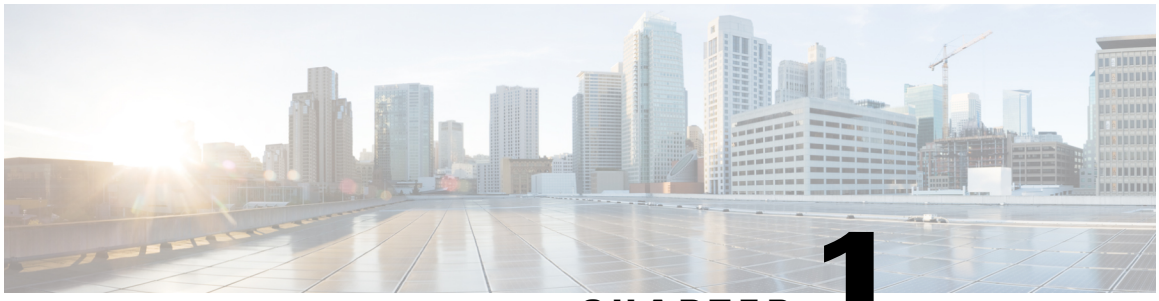
Revision	Date	Change Summary
OL-7071-08	July 2014	Added information about new CRS-FCC-SFC-400 S2 switch fabric card and new CRS-FCC-SC-22GE-B shelf controller card for 400G CRS-X system.
OL-7071-07	March 2011	Updated document to include AC modular configuration power solution and the CRS-FCC-SFC-140 for the 140G CRS-3 system.
OL-7071-06	September 2010	Updated document to include modular configuration power solution.
OL-7071-05	March 2009	Updated document to include 8+4 configuration information.
OL-7071-04	February 2007	The document was updated to include information about the 22-port shelf controller Gigabit Ethernet (22-port SCGE) card.
OL-7071-03	September 2006	The document was updated with technical corrections.
OL-7071-02	July 2006	These changes were made: • *Chapter: Cisco CRS Multishelf System Overview* was modified to introduce the two- and four-FCC multishelf system configurations.
OL-7071-01	July 2005	Initial release of this document.

Obtaining Documentation and Submitting a Service Request

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

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

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



CHAPTER 1

Cisco CRS Multishelf System Hardware Overview

This section provides high-level details of the hardware components that make up the multishelf system. These topics are included in this section:

Cisco CRS Multishelf System Hardware Overview

This section provides high-level details of the hardware components that make up the multishelf system. These topics are included in this section:

Cisco CRS 16-Slot LCC

As part of the multishelf system, the LCC houses modular services cards (MSCs) or forward processing cards (FPs), switch fabric cards (SFCs), and route processor (RP/PRP) cards. The LCC used in the multishelf system is the same as the one used in the standalone 16-slot CRS except that it uses different fabric cards and has a rear cable management kit. A minimum of one LCC is required to configure a multishelf system.

Note Please refer to the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis System Description for details about the LCC. This system description focuses on topics that are specific to the FCC and the overall multishelf system.

Cisco CRS FCC

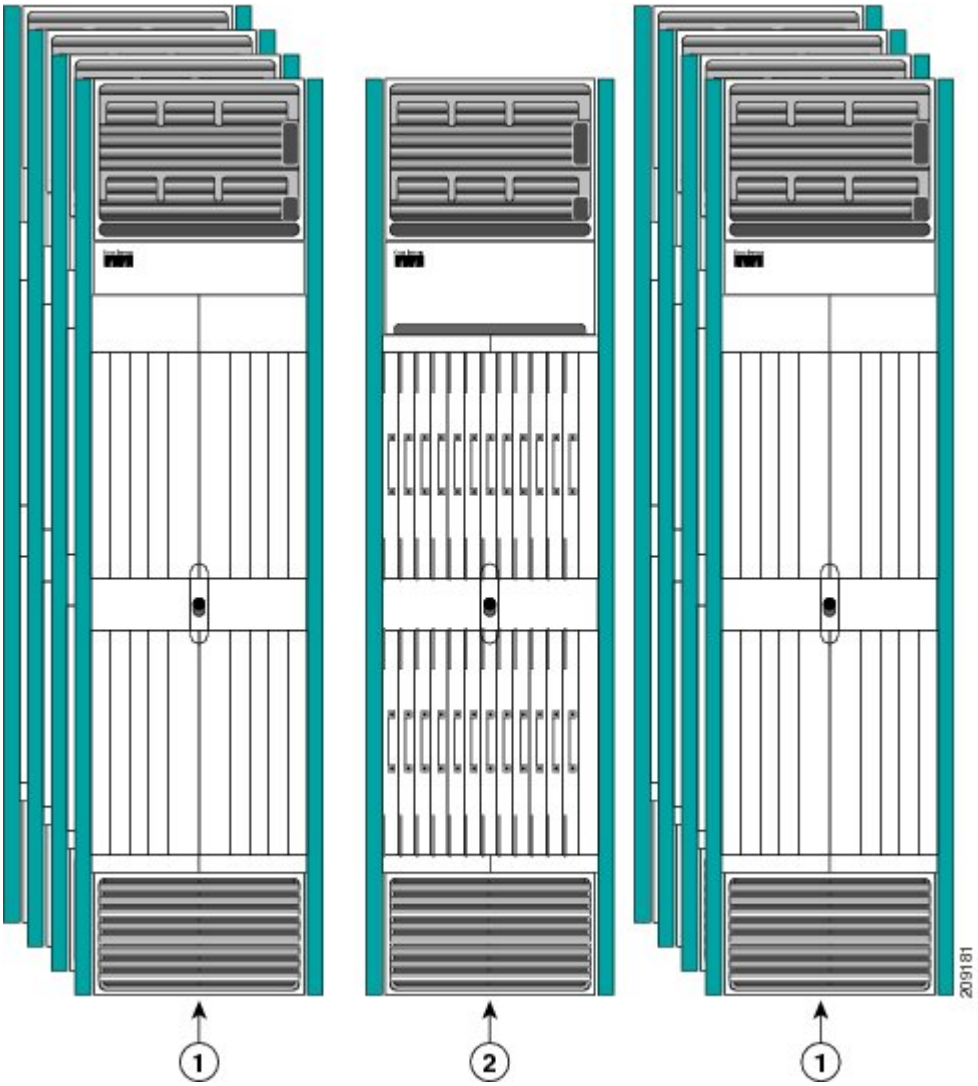
The FCC is the centerpiece of the multishelf system. It is used to connect all LCCs together. The FCC houses 24 switch fabric cards (SFCs), 24 optical interface modules (OIMs), 2 OIM light emitting diode (LED)

monitoring cards (OIM-LED), and 2 integrated shelf controller Gigabit Ethernet cards. At least one FCC is required to configure a multishelf system

Cisco CRS Series Carrier Routing System Architecture

The multishelf system allows multiple LCCs and FCCs to act as a single system. The multishelf system supports up to eight LCCs and one, two, or four FCCs. *Single-FCC Multishelf System* figure shows a single-FCC multishelf system, *Two-FCC Multishelf System* figure shows a two-FCC multishelf system, and *Four-FCC Multishelf System* figure shows a four-FCC multishelf system.

Figure 1: Single-FCC Multishelf System

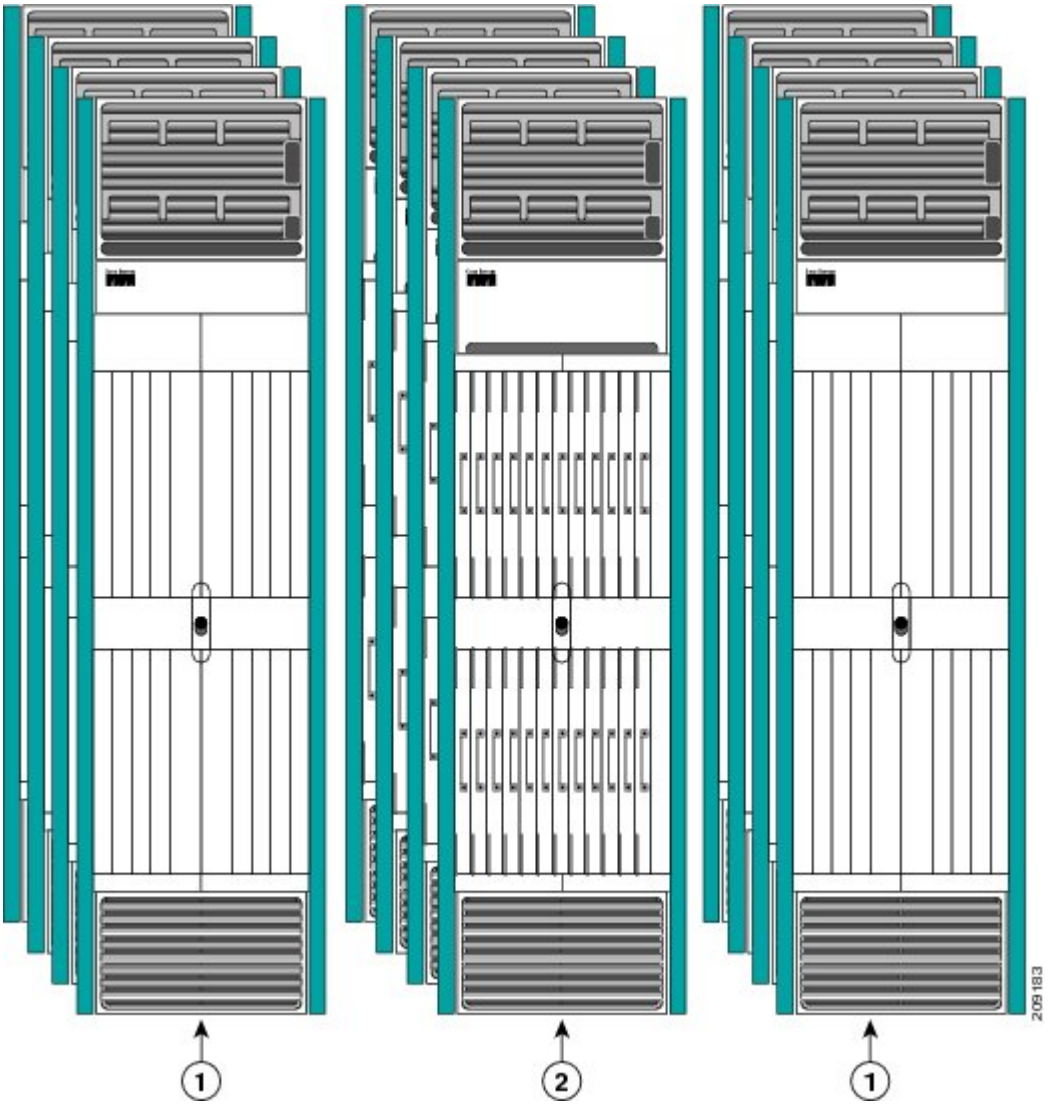


1	LCC	2	FCC

Figure 2: Two-FCC Multishelf System

1	LCC	2	FCC

Figure 3: Four-FCC Multishelf System



1	LCC	2	FCC

Main Features of the Cisco CRS Series Multishelf System

The main features of the multishelf system include:

- Scalable, nonblocking architecture that allows smooth expansion of the system from one LCC to eight LCCs, providing thousands of high-speed interfaces.

- Support for both 40G CRS-1, 140G CRS-3 and 400G CRS-X in one multishelf system.
- Seamless in-service migration to CRS-3 or CRS-X.
- Distributed control plane that scales the system to millions of interfaces, peers, and routing entries.
- Continuous system operation and availability using a distributed architecture, redundant components, and a self-healing operating system (Cisco IOS XR) that enables a multishelf carrier infrastructure that supports “always-on” operations.
- Carrier class system redundancy on power supplies, fans, controllers, and processing elements.
- Process management through redundancy, failure detection, isolation, tolerance, and recovery.
- Hitless capacity upgrade and In-Service Software Upgrade (ISSU) that supports nonstop forwarding (NSF) and graceful restart extensions of routing and signaling protocols.
- Full online insertion and removal (OIR) support.
- Unique service separation architecture among data, control, and management planes of the Cisco IOS XR software that enables deployment of new features without service disruption. Its component-based model allows components, such as Border Gateway Protocol (BGP) and Intermediate System to Intermediate System (ISIS), to be installed, updated, or deleted individually.
- Logical partitioning in the Cisco CRS system that allows service providers to keep services separate and to consolidate their networks at their own pace.

FCC Overview

The FCC contains the switch fabric and OIMs. The connection between the FCC and LCC is by way of cables from the OIMs in the FCC, to fabric cards in the LCC. The FCC is secured to the floor and has locking front and rear doors. The FCC is a complete rack enclosed in a cabinet, so external racks are not required for the installation of an FCC.

FCC Components

This is a list of the main components of the FCC. It primarily identifies the components that are considered field-replaceable units (FRUs).

The FCC contains:

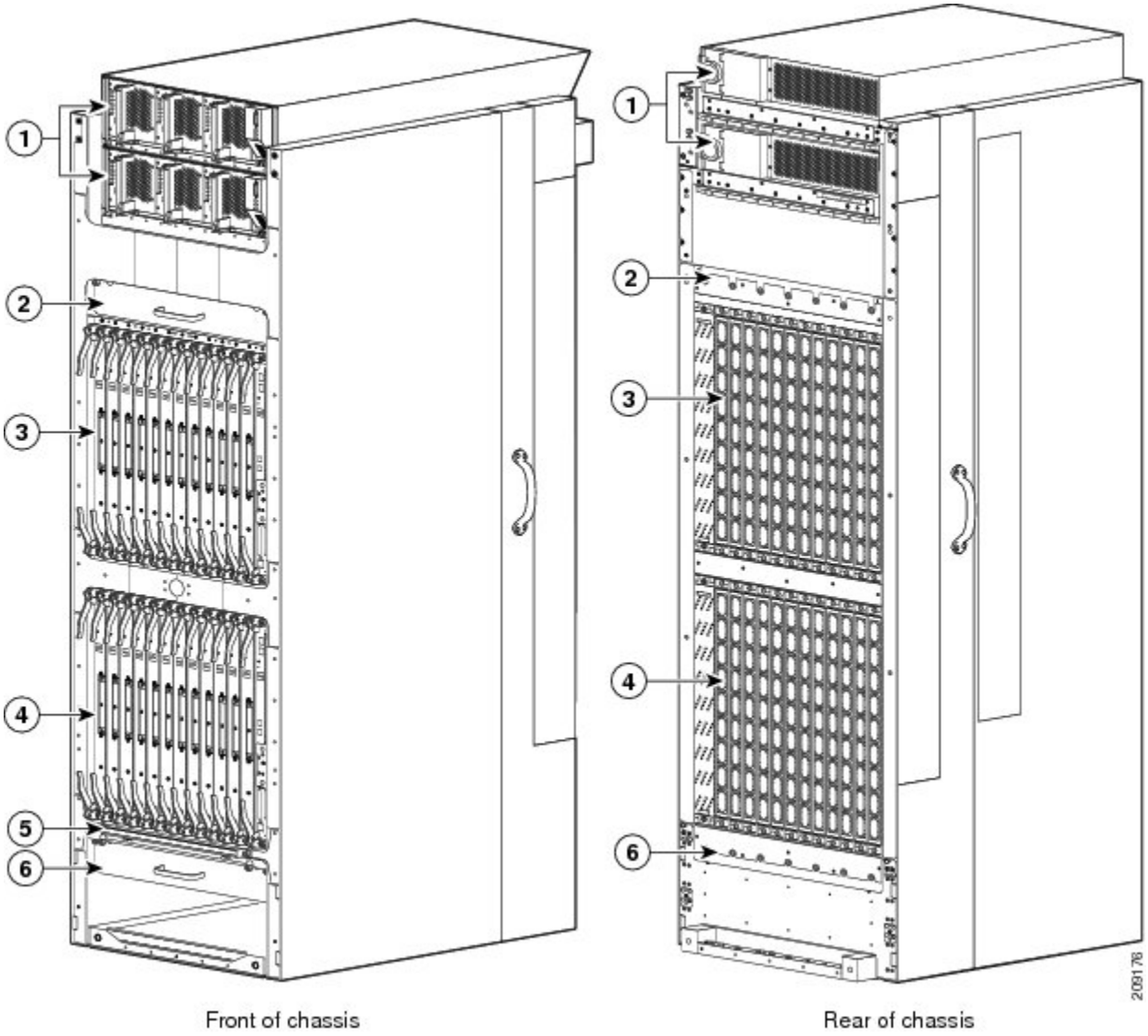
- Switch fabric cards (SFCs). The SFCs are the main component of the multishelf system. They enable packets to be switched from source to destination. The SFCs on the FCC provide Stage 2 of the three-stage Benes switch fabric for the multishelf system. The S13 SFCs in the LCC provide Stage 1 and Stage 3 of the switch fabric. Three types of SFC are supported: CRS-FCC-SFC for the 40 G CRS-1 system, CRS-FCC-SFC-140 for the 140 G CRS-3 system, and CRS-FCC-SFC-400 for the 400 G CRS-X system. Either eight or twenty-four SFCs are needed, depending on the size of the system. SFCs are located at the front of the FCC. See *Multishelf System Switch Fabric* for more information.

Caution The FCC supports either 40 GB switch fabric cards (CRS-FCC-SFC), 140 GB switch fabric cards (CRS-FCC-SFC-140), or 400 GB switch fabric cards (CRS-FCC-SFC-400). An FCC with a mix of 40 GB,140 GB and 400 GB SFCs is not a supported mode of operation. Such a mode is temporarily allowed only during the upgrade process.

- Optical Interface Modules (OIMs). The OIMs are passive devices that provide the fiber cross-connect function. The OIMs distribute the fibers within each cable bundle to the SFCs. Each OIM is matted to an SFC. The OIMs are monitored by the OIM-LED card. Each OIM has 9 interfaces. Either 8 or 24 OIMs are needed, depending on the size of the system. The OIMs and cables are located at the rear of the FCC. See *Optical Interface Modules and Optical Interface Module LED Card* for more information.
- Integrated Shelf Controller Gigabit Ethernet (SCGE) cards. The 22-port SCGE card (CRS-FCC-SC-22GE) serves as a shelf controller for the FCC, providing the control function similar to the RP for LCC. The 22-port integrated GE switch provides the connectivity for control protocol between the FCC and LCC. Two 22-port SCGE cards are included in each FCC for redundancy. Only one shelf controller card is active at a time. The second acts as a “standby” shelf controller, serving as a backup if the active card fails. SCGE cards located at the front of the chassis. See *Shelf-Controller Gigabit Ethernet Card* for more information.
- Fixed configuration power systems and modular configuration power systems are available. Both power configurations use either AC or DC power and are fully redundant. See *Fabric Card Chassis Power System* for more information.
- Upper and lower fan trays. The fan trays contain fans that push and pull air through the chassis. A removable air filter is also located above the lower fan tray. See *Fabric Card Chassis Cooling System* for more information.

This figure shows the front view (SFC side) and rear view (OIM site) of a fixed configuration AC powered FCC.

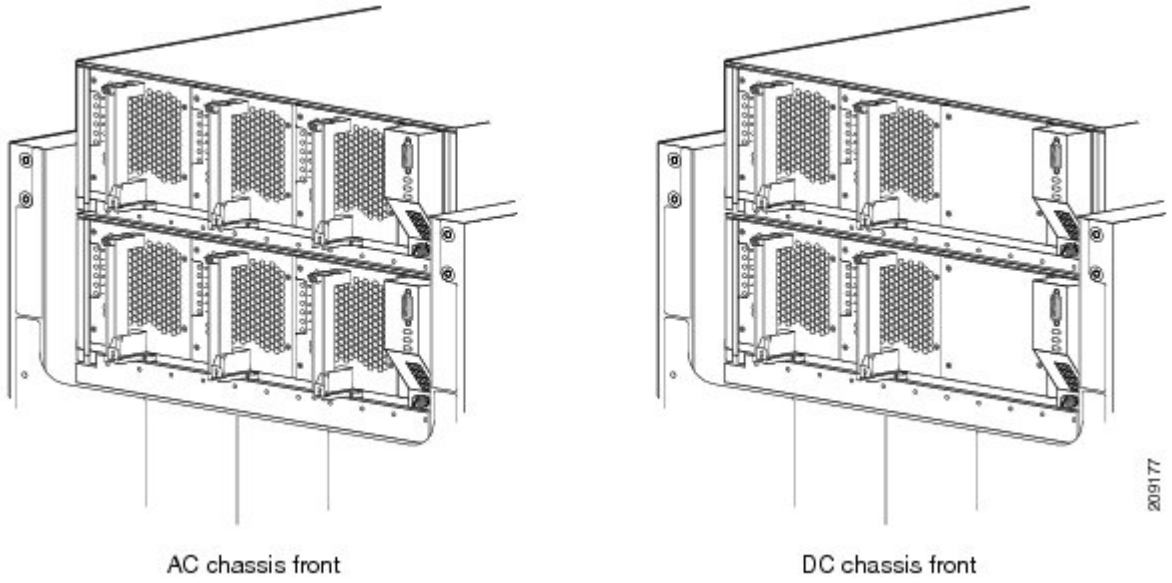
Figure 4: Front and Rear View of FCC



1	Power shelves	4	Lower SFC card cage
2	Upper fan tray	5	Chassis air filter
3	Upper SFC card cage	6	Lower fan tray

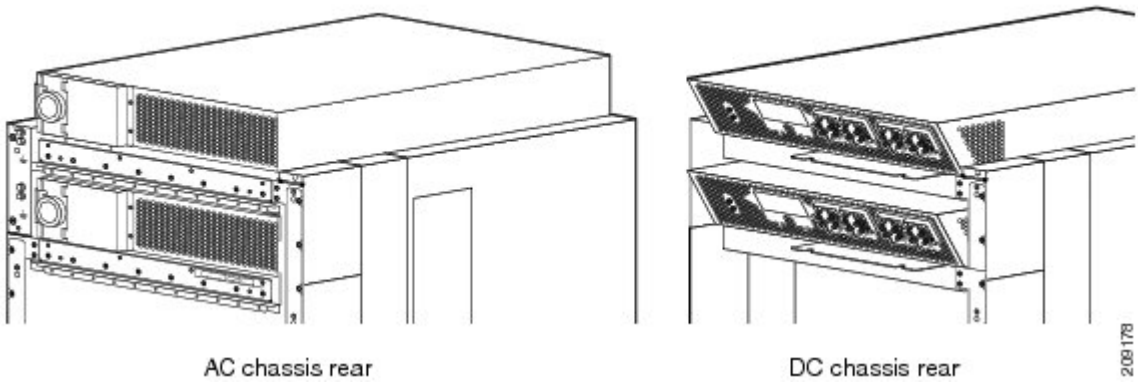
This figure shows the front (SFC) view of a fixed configuration AC and DC power supply installed at the top of the FCC.

Figure 5: Front (SFC) View of FCC—Fixed Configuration Power



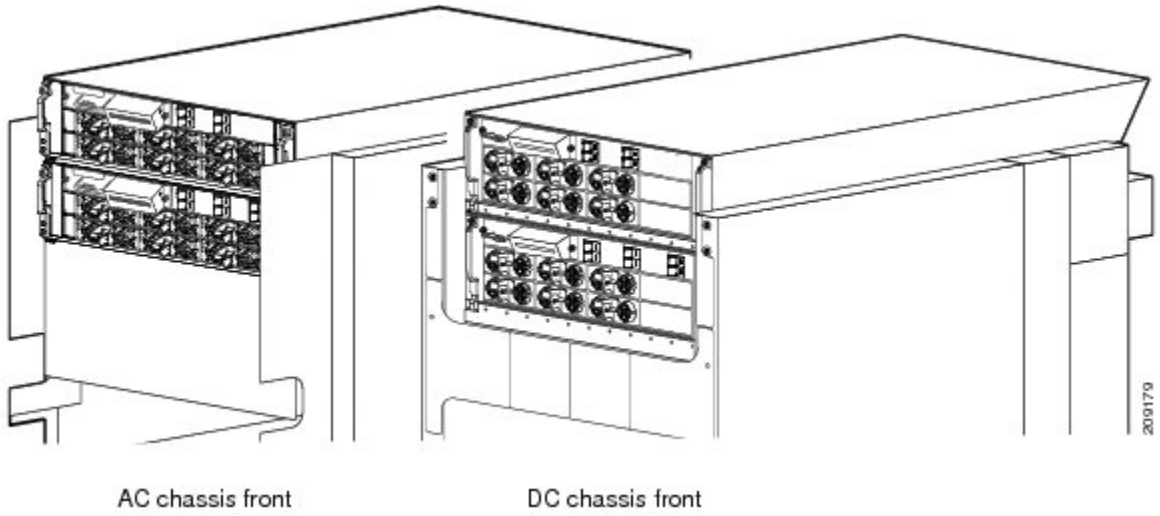
This figure shows the rear (OIM) view of a fixed configuration AC and DC power supply installed at the top of the FCC.

Figure 6: Rear (OIM) View of a FCC—Fixed Configuration Power



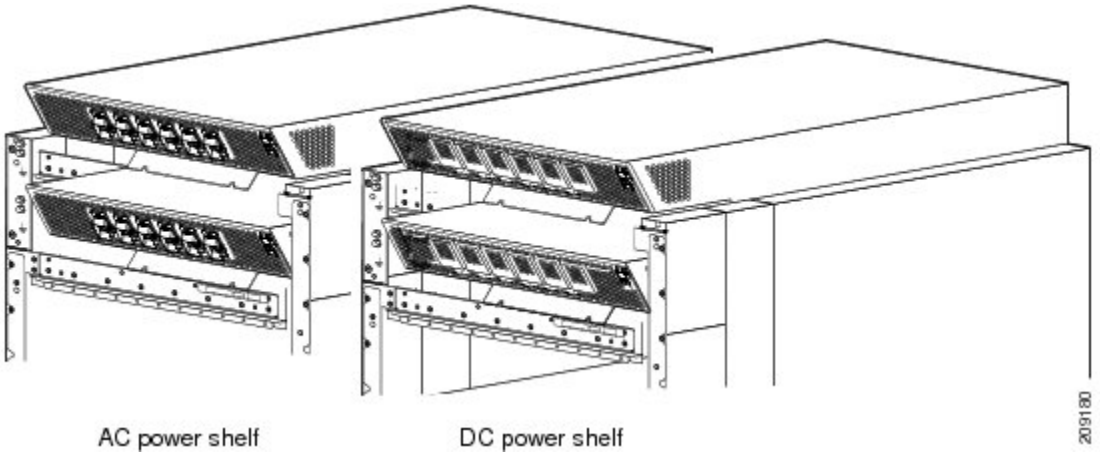
This figure shows the front (SFC) view of a modular configuration AC and DC power supply installed at the top of the FCC.

Figure 7: Front (SFC) View of Modular Configuration Power Shelves Installed in FCC



This figure shows the rear (OIM) view of a modular configuration AC and DC power supply installed at the top of the FCC.

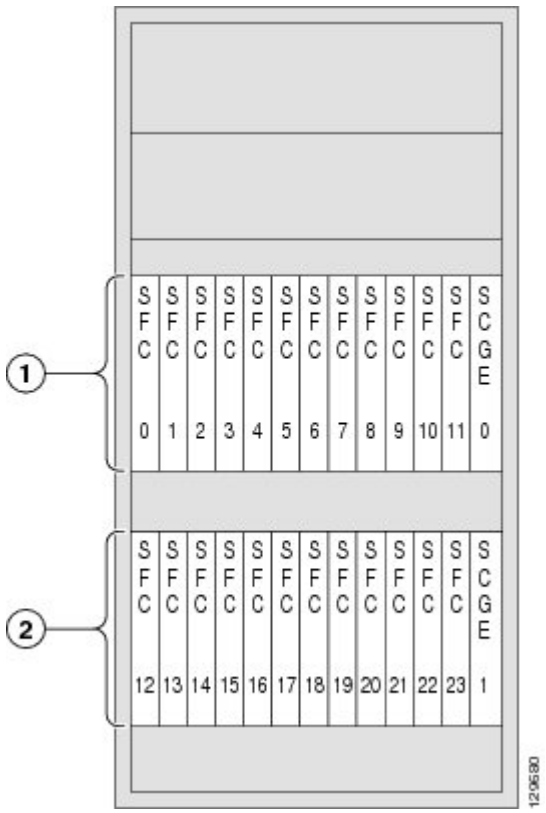
Figure 8: Rear (OIM) View of Modular Configuration Power Shelves Installed in FCC



FCC Chassis Slot Numbers

This section identifies the locations and slot numbers for major cards that plug into the FCC. This figure shows the chassis slot numbers on the front (SFC) side of the FCC.

Figure 9: FCC Front (SFC) Side Slot Numbers



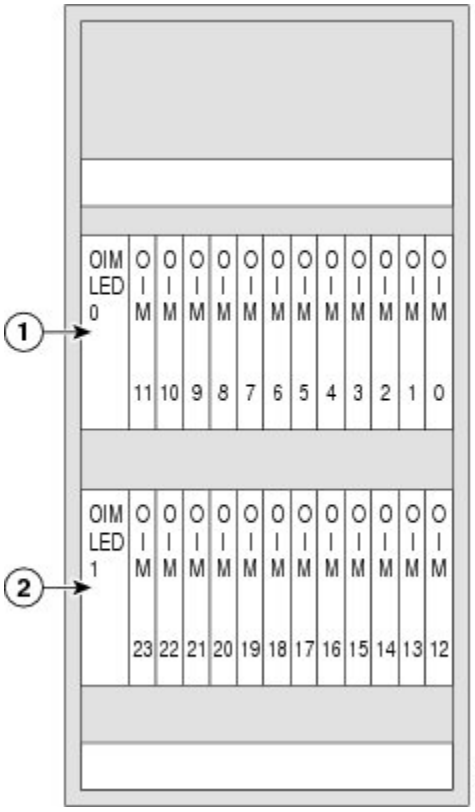
1	Upper SFC Card Cage	2	Lower SFC Card Cage

As shown in above figure, the components on the front (SFC) side of the FCC include:

- Upper card cage with 12 switch fabric slots (left to right: 0, 1, 2, 3 . . . 10, 11) followed by one 2-port or 22-port SCGE card slot (SCGE0) on the far right.
- Lower card cage with 12 switch fabric slots (left to right: 12, 13, 14 . . . 21, 22, 23) followed by one 2-port or 22-port SCGE card slot (SCGE1) on the far right.

This figure shows the component numbers on the back (OIM) side of an FCC.

Figure 10: FCC Back (OIM) Side Slot Numbers



1	Upper SFC Card Cage	2	Lower SFC Card Cage

As shown in above figure, the slot numbers on the back (OIM) side of the FCC include:

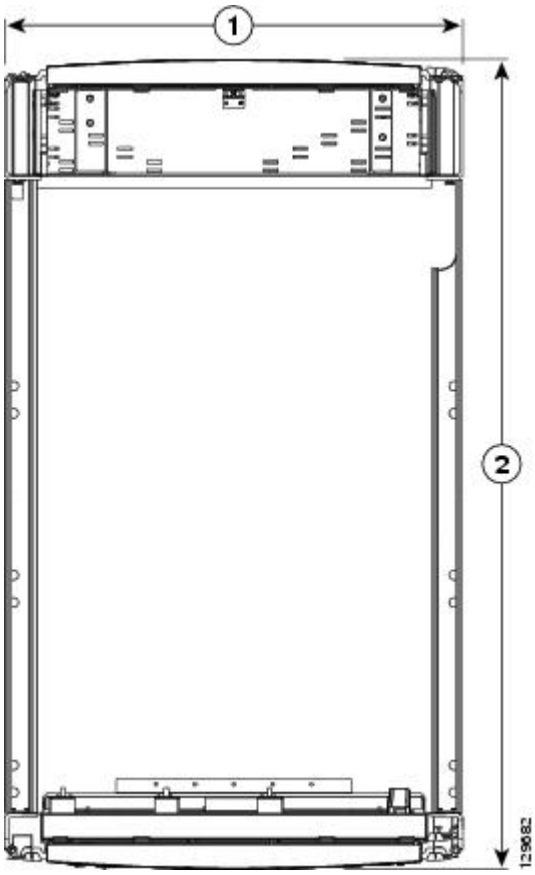
- Upper OIM cage, 12 OIM slots (0 through 11) and one OIM-LED card (OIM-LED0).
- Lower OIM cage, 12 OIM slots (12 through 23) and one OIM-LED card slot (OIM-LED1).

The OIM slot numbers are aligned with the SFC slot numbers on the other side of the chassis. Because an OIM mates with its associated SFC through the backplane, OIM slot 0 is on the far right side of the chassis looking at it from the OIM (rear) side; SFC slot 0 is on the far left side of the chassis looking at it from the SFC (front) side. OIM slot 0 and SFC slot 0 mate with one another through the backplane, as do all other OIM and SFC slots.

FCC Footprint

This figure is a top view of the FCC footprint (with front and rear cosmetics installed).

Figure 11: Top View of the FCC



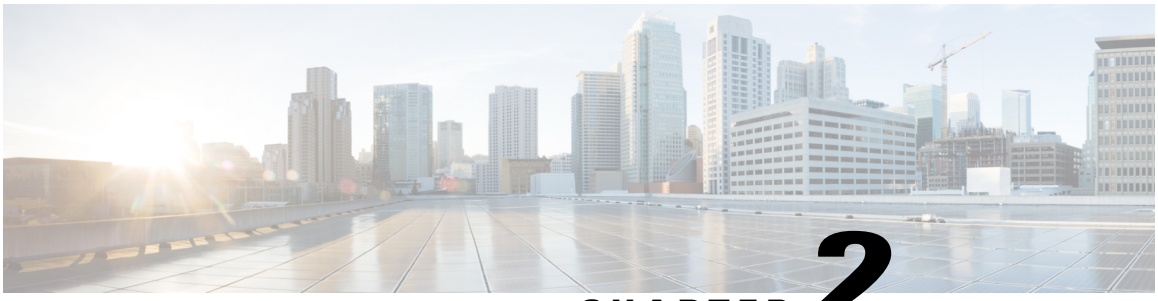
1	Chassis width 23.6 in. (60 cm)	2	Chassis depth 41.3 in. (105 cm)

FCC Cable Management

The FCC has cable management features for both the front (SFC) side of the chassis and the rear (OIM) side of the chassis. Both the front (SFC) and rear (OIM) sides have vertical cable troughs on the left and right sides of the chassis. In addition, the rear (OIM) side of the chassis has three horizontal cable management brackets close to the card cages.

FCC Exterior Components

The FCC also includes front and rear locking doors, bezels, and side panels. The cosmetic components are shipped in a separate package and must be installed on the FCC during system installation.



CHAPTER 2

Fabric Card Chassis Power System

This chapter describes the power system used in the fabric card chassis (FCC). It includes these sections:

Power specifications are provided in Specifications, on page 85

Power System 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 FCC can be either DC or AC powered. There are two options for power systems:

- The 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 a redundant configuration, the fixed configuration power system provides power sharing per load zone. The fixed configuration power system includes SNMP MIBS and XML support.
- The 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) is 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 the Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide.

Maximum input power requirements for the FCC with a fixed configuration power system installed are:

- DC-powered chassis requires up to a maximum of 9300 W (9.3 kW) of DC input power when the chassis is fully loaded.
- AC-powered chassis requires up to a maximum of 9800 W (9.8 kW) of AC input power when the chassis is fully loaded.

Maximum input power requirements for the FCC with a modular configuration power system installed are:

- DC-powered chassis requires up to a maximum of 14,300 watts (14.3 kW) of DC input power when the chassis is fully loaded.
- AC-powered chassis requires up to a maximum of 16,300 watts (16.3 kW) of AC input power when the chassis is fully loaded.

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.

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 these topics:

Basic Chassis Power Details

The FCC 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.

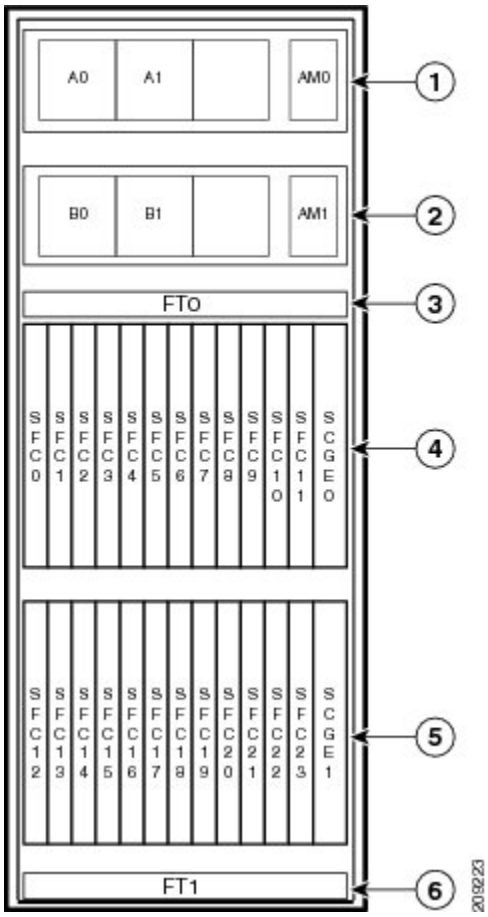
Follow these precautions and recommendations when planning power connections to the router:

- 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 FCC 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.

- 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.

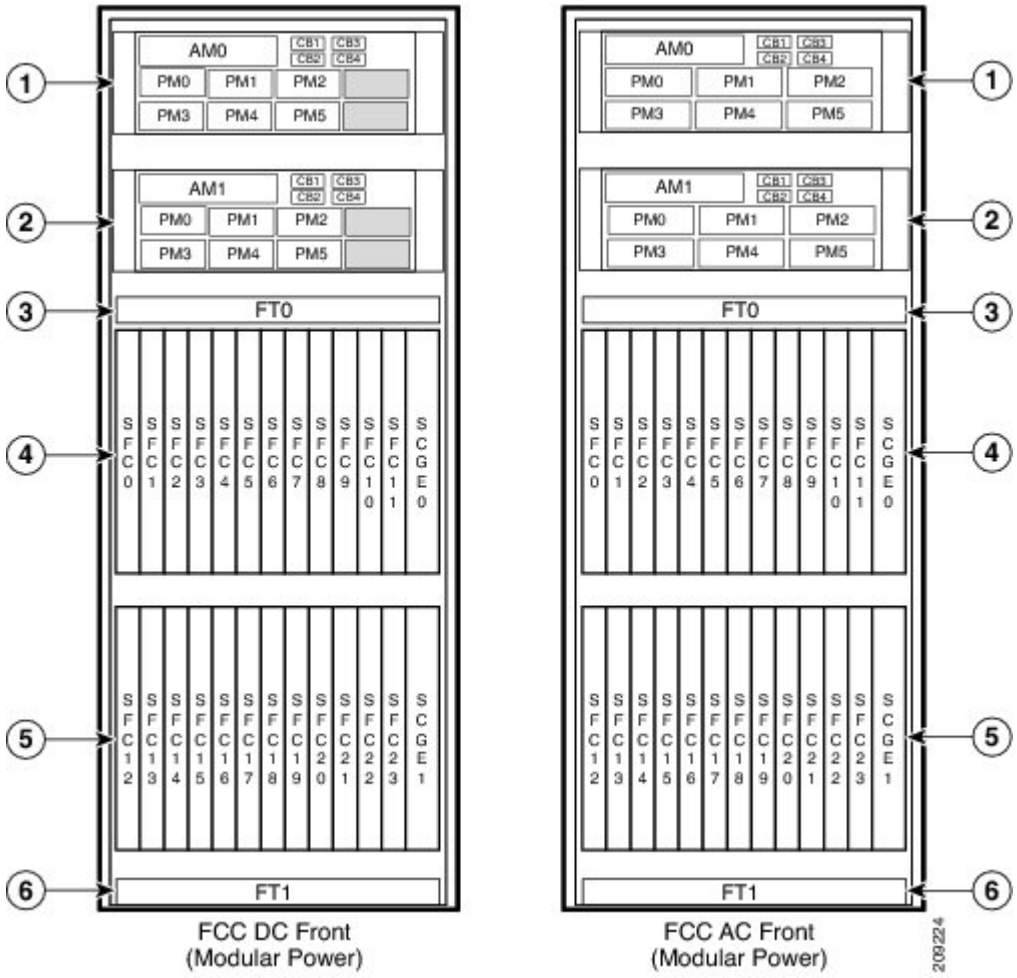
Figure 12: FCC DC/AC Fixed Configuration Power - Slot Numbering



1	PS0 (Power Shelf)	4	Upper SFC Card Cage
2	PS1 (Power Shelf)	5	Lower SFC Card Cage
3	Fan Tray (FT0)	6	Fan Tray (FT1)

- Modular configuration — AC power shelf houses the AC power modules, while a modular configuration DC power shelf houses the DC power modules.

Figure 13: FCC DC and AC Modular Configuration Power - Slot Numbering



1	Power A (Power Shelf)	3	Upper SFC Card Cage
2	Power B (Power Shelf)	4	Lower SFC Card Cage

- It is required that you use only one type of power shelf in a chassis at a time.

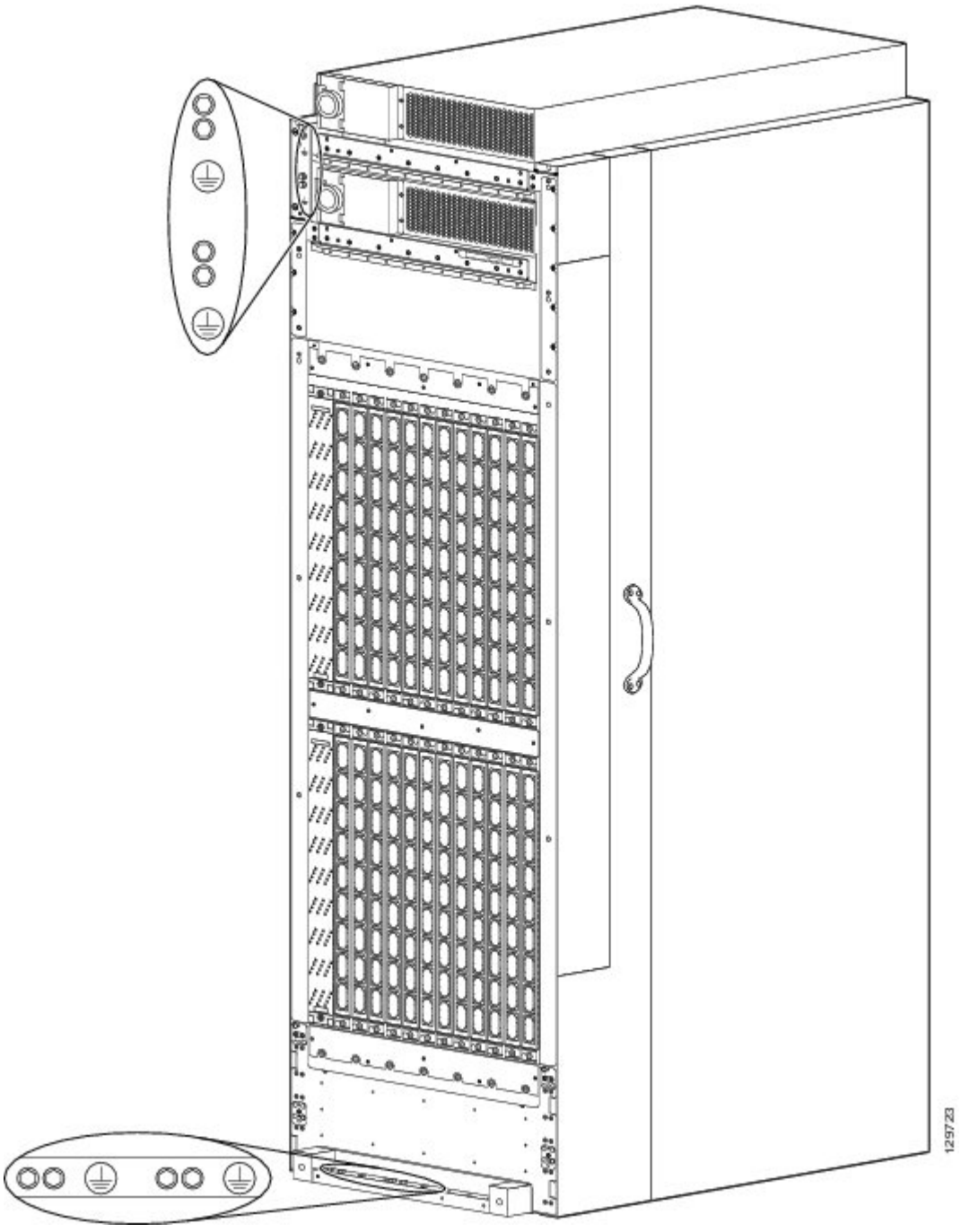
Note In a modular configuration power system, both AC and DC power supplies are referred to as PMs (power modules).

Chassis Grounding Guidelines

The FCC 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.

Figure 14: Grounding Locations on the FCC



DC Power Systems

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

- In the fixed configuration power system, each power shelf contains two 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 six DC power modules; however, the system is shipped with four DC power modules. The power shelves and DC power modules 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 FCC fixed configuration AC power system provides 8800 W 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 FCC 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 FCC.

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 AC input power cables for the power shelves are shipped unattached and need to be assembled.

Modular Configuration DC Power

The FCC modular configuration DC power system can provide up to 12,600 watts to power the chassis. However, by default, the power capability of a system when shipped, with 4 power modules per power shelf, is 8400 watts.

At sites where the FCC is equipped with a DC-input power supply shelf and DC power modules, observe these 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 module connection is rated at 60 A maximum. A dedicated, commensurately-rated DC power source is required for each power module connection.
- Each PM requires two –48/–60 VDC inputs, 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. The length of the wires depends on the router location. These wires are not available from Cisco Systems; they are available from a 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.

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 power modules; however, the system is shipped with three modules. The power shelves and the AC power modules 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 FCC fixed configuration AC power system provides 8800 W 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 FCC 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 FCC.

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 AC input power cables for the power shelves are shipped unattached and need to be assembled.

Modular Configuration AC Power

The FCC modular configuration AC power system can provide up to 15,000 W to power the chassis. However, by default, the power capability of a system when shipped, with 5 AC power modules per power shelf, is 15,000 W.

Each modular configuration power shelf supports up to six power modules. The power shelves and power modules 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 level of 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, refer to Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide.

The modular configuration AC power shelf has these input VAC 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 female plugs, depending on how many AC power modules are installed in the shelf.

Note In order to maintain a balanced 3-phase power load, either three or six AC power modules are required to be installed in a FCC 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 these topics for fixed configuration power systems.

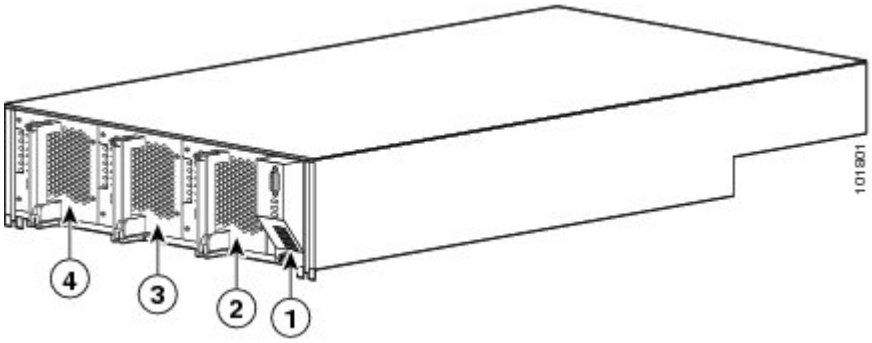
The fixed configuration power includes these major components:

- Two (redundant) AC or DC power shelves
- Three AC rectifiers or two 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. This 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.

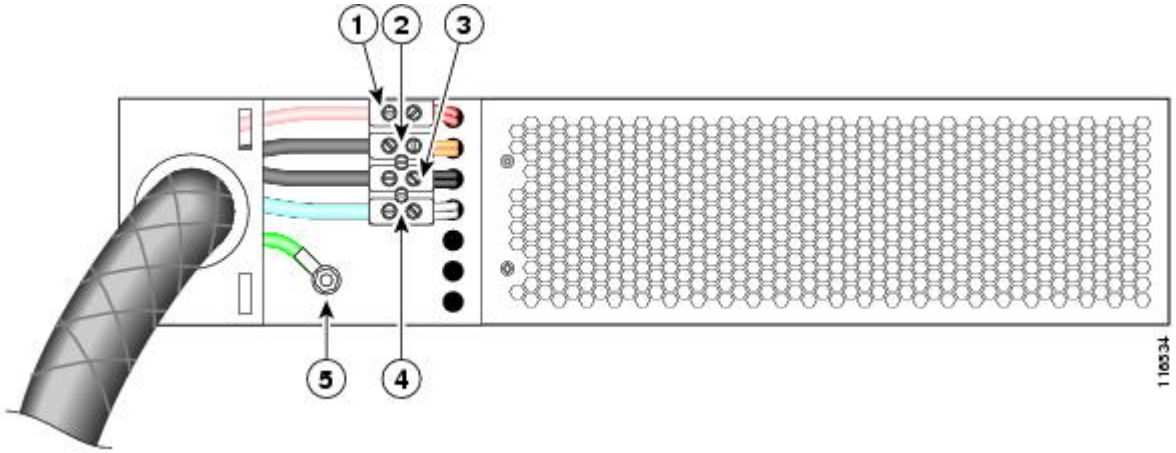
Figure 15: AC WYE Power Shelf with AC Rectifiers Installed - Front View



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

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

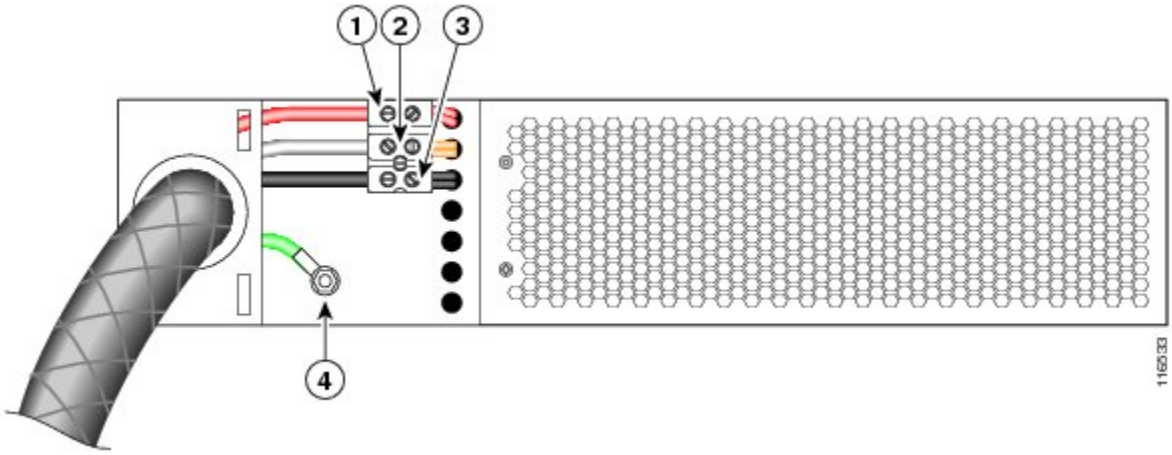
Figure 16: Fixed AC Wye Power Shelf - Rear View



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

This 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 17: 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.

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 line cards, switch fabric, RP, and fan controller card slots. For details showing the FCC power routing distribution for a fixed DC configuration, see Figure 22: DC Power Wiring (Fixed Configuration), on page 31 and for an AC fixed configuration, see Figure 23: DC Fixed Configuration Power Entry Module, on page 32.

- 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 FCC chassis can continue to operate normally, if:

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

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

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, which is also called hot-swapping.

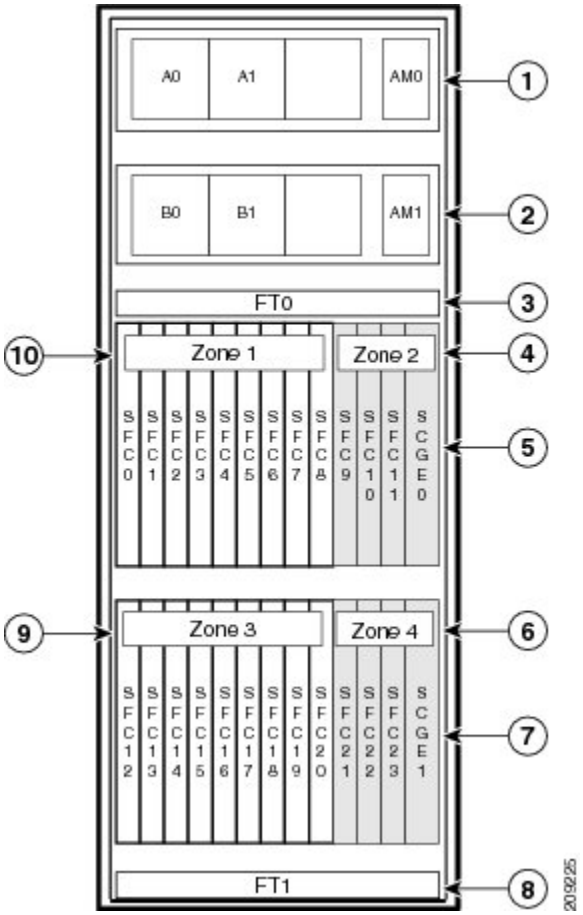
Fixed Configuration Chassis Load Zones

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

An FCC can lose a single power module or an entire power shelf and still have the power to operate. For a load zone to lose complete power, a power module in each power shelf would have to fail.

This figure shows the four load zones on the SFC side of the FCC.

Figure 18: DC Power System FCC Load Zones (SFC Side)



1	Power Module A0	6	Power Zone 4
2	Power Module A0	7	Lower SFC Card Cage
3	Fan Tray 0 (FT0)	8	Fan Tray 1 (FT1)
4	Power Zone 2	9	Power Zone 3
5	Upper SFC Card Cage	10	Power Zone 1

As shown in above figure, each power module (DC PEM) powers two load zones:

- Power module A0 powers zones 1 and 2 (Z1 and Z2)
- Power module A1 powers zones 3 and 4 (Z3 and Z4)
- Power module B0 powers zones 1 and 2 (Z1 and Z2)

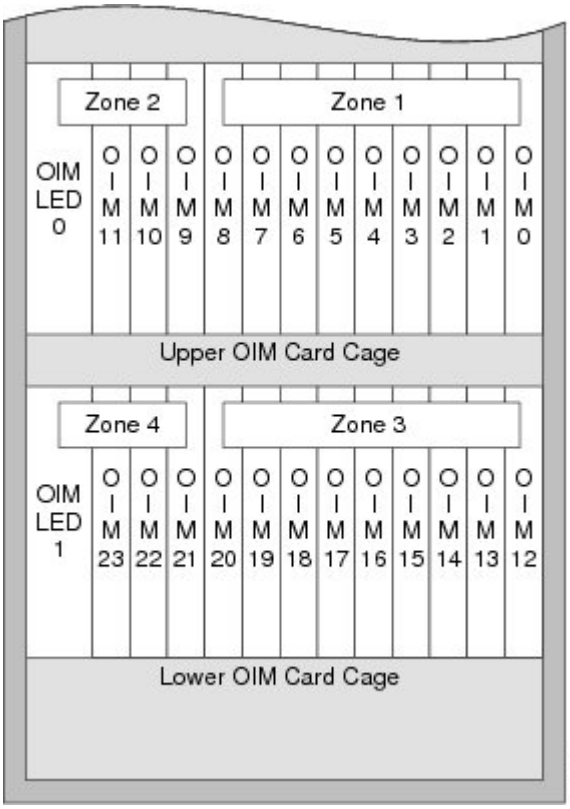
- Power module B1 powers zones 3 and 4 (Z3 and Z4)

Above figure also shows which zones power which chassis slots:

- Load zone 1 (Z1) powers chassis slots 0 through 8
- Load zone 2 (Z2) powers chassis slots 9 through 11 and the SCGE0 (2-port or 22-port) card
- Load zone 3 (Z3) powers chassis slots 12 through 20
- Load zone 4 (Z4) powers chassis slots 21 through 23 and the SCGE1 (2-port or 22-port) card

This figure shows the four load zones on the OIM side of the FCC.

Figure 19: DC Power System FCC Load Zones (OIM Side)



1	Power Zone 1	4	Lower OIM Card Cage
2	Upper OIM Card Cage	5	Power Zone 4
3	Power Zone 3	6	Power Zone 2

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

- Load zone 2 (Z2) powers the OIM-LED0 card and chassis slots 11 through 9

- Load zone 1 (Z1) powers chassis slots 8 through 0
- Load zone 4 (Z4) powers the OIM-LED1 card and chassis slots 23 through 21
- Load zone 3 (Z3) powers chassis slots 20 through 12
- The fan trays (FT0 and FT1) receive their operating power from the SCGE (2-port or 22-port) cards (SCGE0 and SCGE1).

DC Fixed Configuration Power Systems

The FCC DC power system receives 9300 W maximum when powering a full chassis. The DC PEMs can deliver 8800 W of power to the system. The remaining 500 W equal the efficiency of the PEM. The DC power system, which provides 2N power redundancy for the routing system, contains these components:

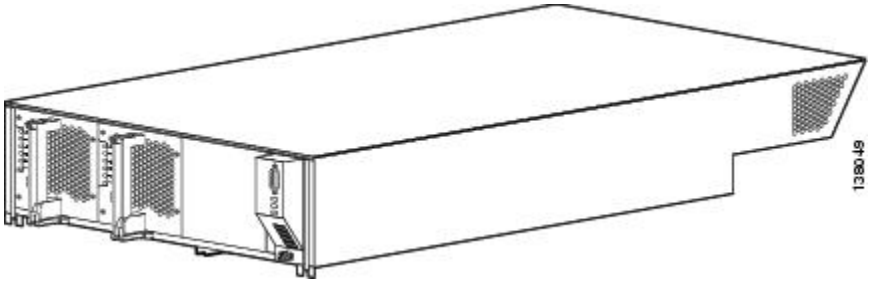
- Two DC power shelves—Contain the input DC power connectors and house the DC power entry modules (PEMs).
- Two DC PEMs (for each power shelf)—Take input DC power from the power shelf, provide filtering and surge protection, and pass the power to either the A or B bus bar. Each PEM is field-replaceable.

Each power shelf and each PEM has its own circuit breaker.

Fixed Configuration DC Power Shelf

The DC power shelf is the enclosure that houses two DC power entry modules (PEMs), the alarm module, and power distribution connections and wiring. The DC power shelf is installed in the FCC from the front and plugs into the chassis power interface connector panel.

Figure 20: DC Fixed Configuration Power Shelf



The DC power shelf physical dimensions are:

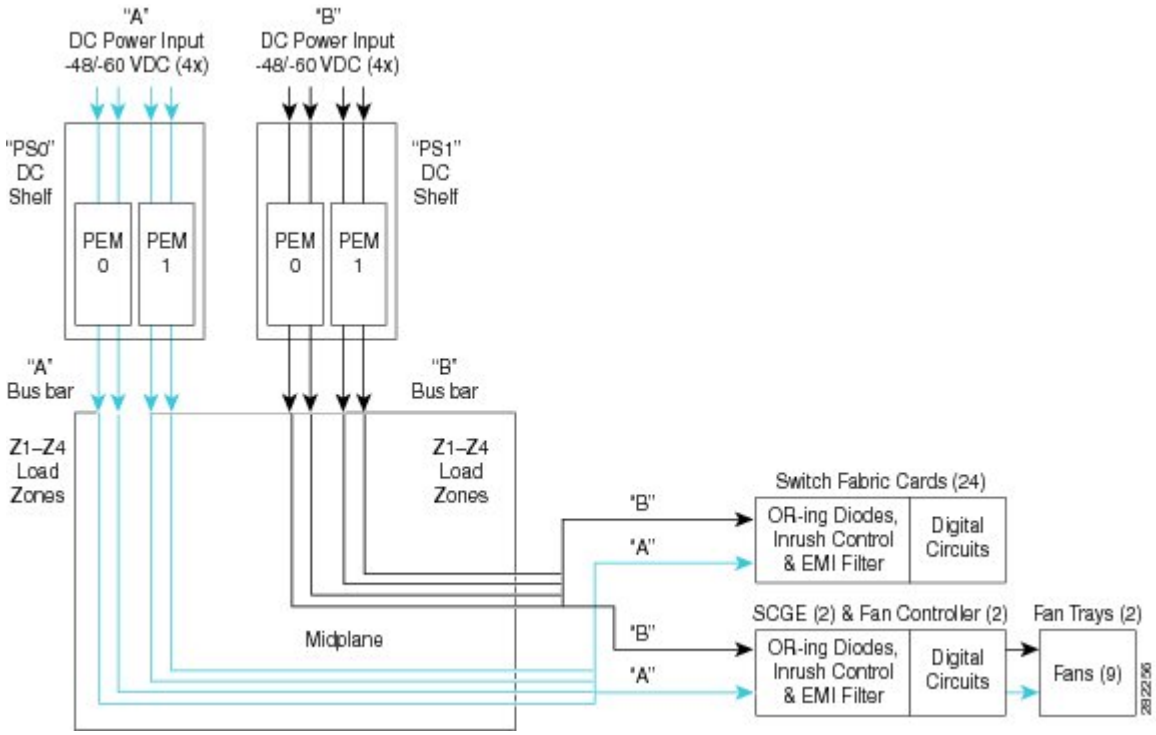
- Height—6.2 in. (15.8 cm)
- Width—20 in. (50.8 cm)
- Depth—25 in. (63.5 cm)
- Weight—38 lb (17.24 kg) (without DC PEMs)

Each power shelf has four input power connectors to connect input DC power (nominal –48 VDC or –60 VDC, 60 A). Each connector consists of two terminals (– and +). Each terminal consists of two M6 threaded studs, 0.6 inches long, and centered 0.625 inches apart. The terminals have a safety cover.

A service processor is located in the alarm module that monitors the condition of each PEM and provides status signals that indicate the health of the power supplies.

This figure is a block diagram of the connections between the DC power shelves and FCC. See the Cisco CRS Carrier Routing System Fabric Card Chassis Installation Guide for information about the input power connections to the DC power shelf.

Figure 21: DC Power Shelves in a Fixed Configuration FCC



Each DC power shelf supports two PEMs. Each power shelf accepts four pairs of 60 A battery feeds. Input DC power enters the power shelf and is processed by the PEMs before being distributed to the chassis backplane. 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 backplane.

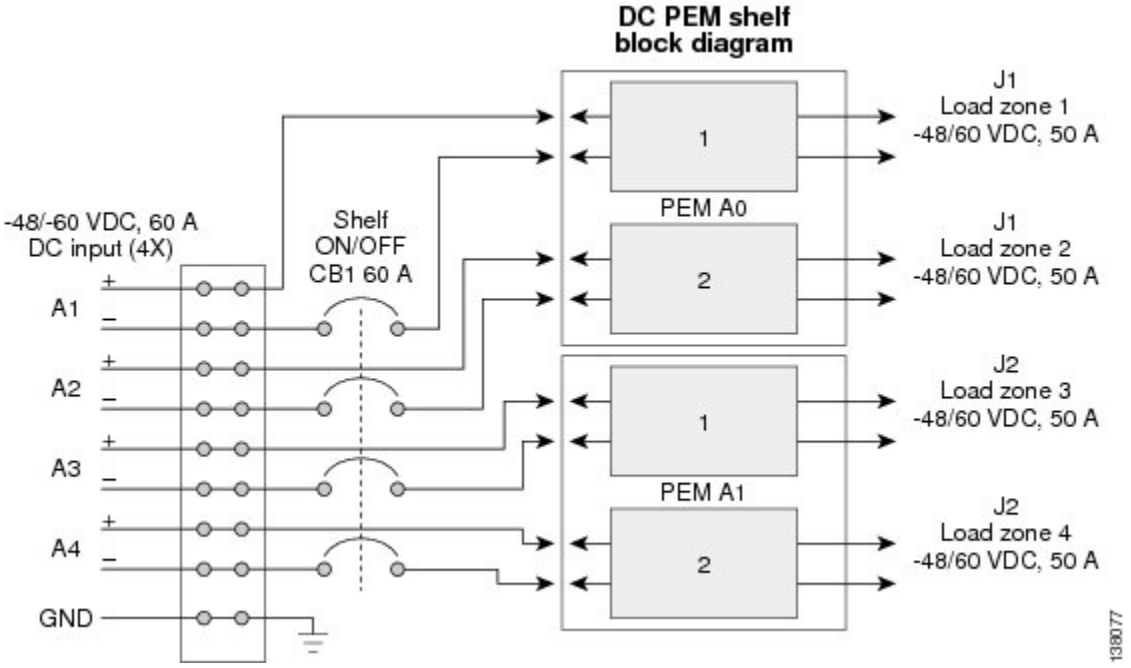
To provide 2N redundancy, one DC power shelf powers the A bus and the other shelf powers the B bus. Load zones in the chassis backplane provide power from both the A and B buses to each card and module in the chassis. For detailed information about how power is distributed through the chassis, see the Fixed Configuration Power Architecture, on page 25 and the Fixed Configuration Chassis Load Zones, on page 26.

A service processor is located in the alarm module that monitors the condition of each PEM and provides status signals to indicate the health of the power supplies.

This figure shows the wiring of a DC power shelf. Four sets of two-wire 60 A DC power are wired into the DC power shelf at a terminal block. The DC power is then routed through the shelf circuit breaker to the two DC PEMs (A0 and A1) in the power shelf. The DC PEMs are passive units that provide power conditioning

to the system. PEMs provide circuit protection, EMI filtering, soft-start circuitry, and OIR for the system. Each DC PEM powers two of the chassis load zones.

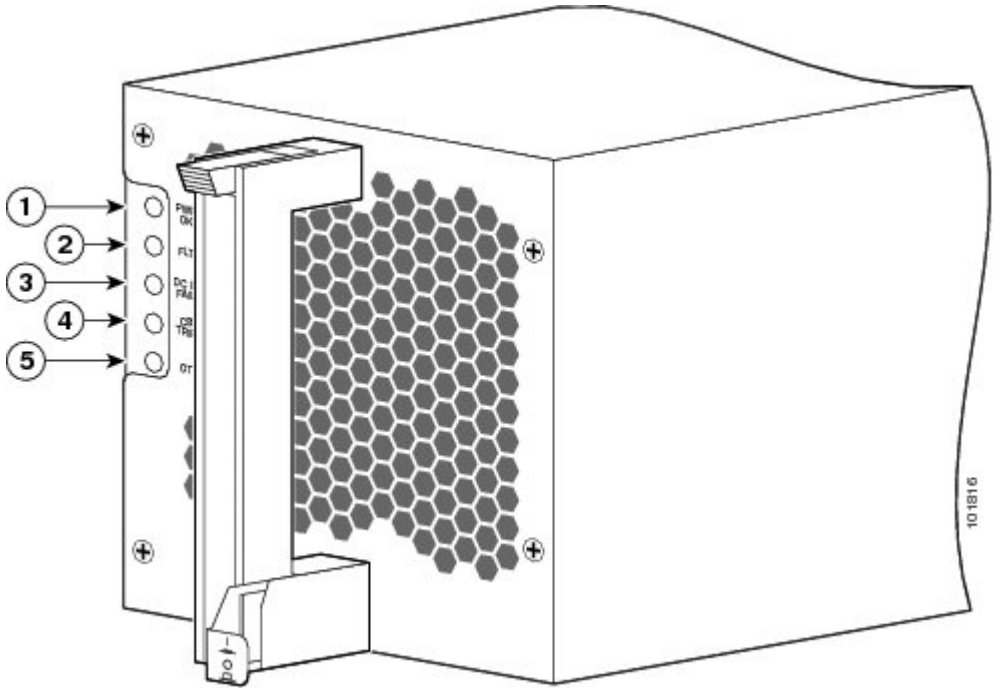
Figure 22: DC Power Wiring (Fixed Configuration)



Fixed Configuration DC Power Entry Module

The DC power entry module (PEM), shown in the below figure, processes input power from the power shelf and passes the power to the A or B bus bar. A PEM is field-replaceable.

Figure 23: DC Fixed Configuration Power Entry Module



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

The DC PEM physical dimensions are:

- Height—5.4 in. (13.7 cm)
- Width—5.3 in. (13.5 cm)
- Depth—18 in. (45.7 cm)
- Weight—18 lb (8.2 kg)

Two –48/–60 VDC inputs enter the PEM at the rear of the power shelf through a connector on the power shelf backplane. 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 backplane.

A service processor is located in the alarm module that 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 Fixed Configuration PEM Indicators, on page 33).

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

Fixed Configuration PEM Indicators

Each 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 PEM is not being powered from its input voltage. The *Fixed Configuration DC PEM Status Indicators* table lists the PEM status indicators and their functions. The *Fixed Configuration DC PEM LED Conditions* table lists the conditions of the LEDs under certain failure conditions.

Table 3: Fixed Configuration DC PEM Status Indicators

Name	Color	Function
PWR OK	Green	The PEM is operating normally with power.
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 is present, or DC input is out of range.
OT	Yellow	The PEM is overheated and has been shut down.
BREAKER TRIP	Yellow	The circuit breaker has tripped and is in the off position.

Table 4: Fixed Configuration 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

Condition	PWR OK LED	FAULT LED	DC INPUT FAIL LED	OT LED	BREAKER TRIP LED
Tripped breaker	Off	Off	Off	Off	On

AC Fixed Configuration Power Systems

The fixed configuration AC power system provides 8800 W to power the FCC. The AC power system, which provides 2N power redundancy for the routing system, contains these 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 FCC. 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:

- 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.

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:

- 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, 24 A. For redundant operation, two 3-phase Wye branch circuits are required: 40 A (North America) or 32 A (International). One power connection is allocated 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 is allocated to each power shelf.

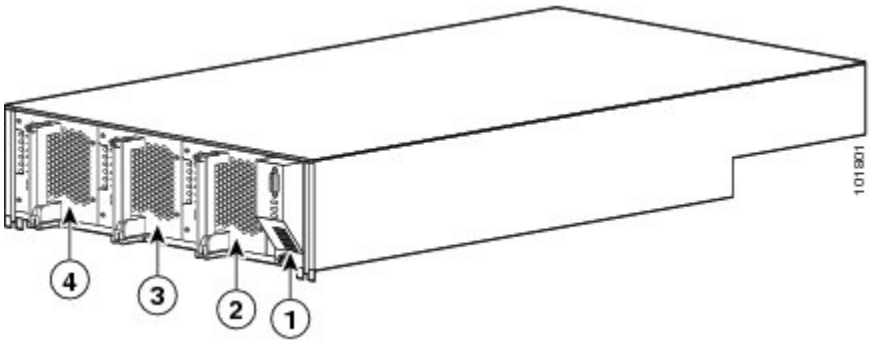
Note The power cables for the power shelves are not shipped preattached.

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 *AC Delta Power Shelf*, is

installed in the FCC from the front and plugs into the chassis power interface connector panel. See Fixed Delta Power Shelf - Rear View for the back panel wiring.

Figure 24: AC Delta Power Shelf



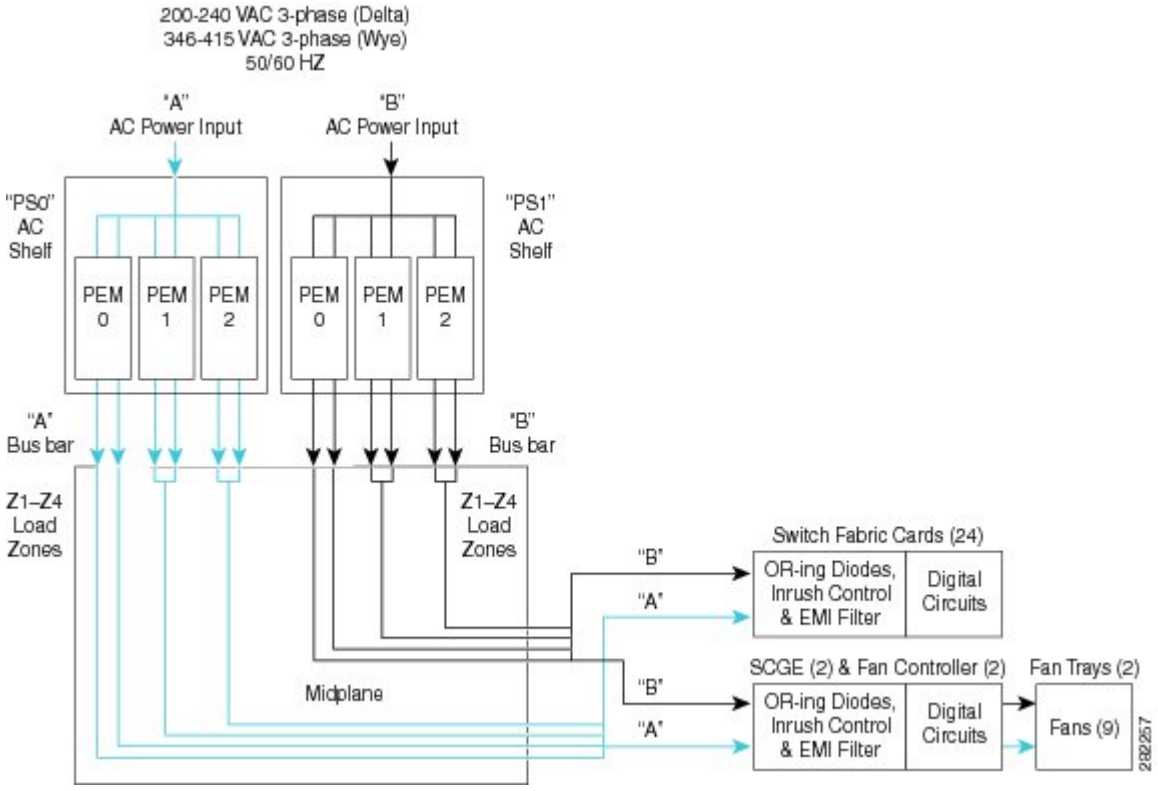
1	Alarm module	3	AC rectifier 1
2	AC rectifier 2	4	AC rectifier 0

The AC Delta power shelf physical dimensions are:

- Height—6.2 in. (15.8 cm)
- Width—20 in. (50.8 cm)
- Depth—25 in. (63.5 cm)
- Weight—36 lb (16.3 kg) (without AC rectifier modules)

This figure illustrates the basic power architecture of an AC Delta-powered FCC.

Figure 25: AC Delta Power Architecture (Fixed 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 backplane.

To provide 2N redundancy, one AC power shelf powers the A bus and the other shelf powers the B bus. Load zones in the chassis backplane provide power from both the A and B buses to each card and module in the chassis. For detailed information about how power is distributed through the chassis, see the Fixed Configuration Power Architecture, on page 25 and the Fixed Configuration Chassis Load Zones, on page 26.

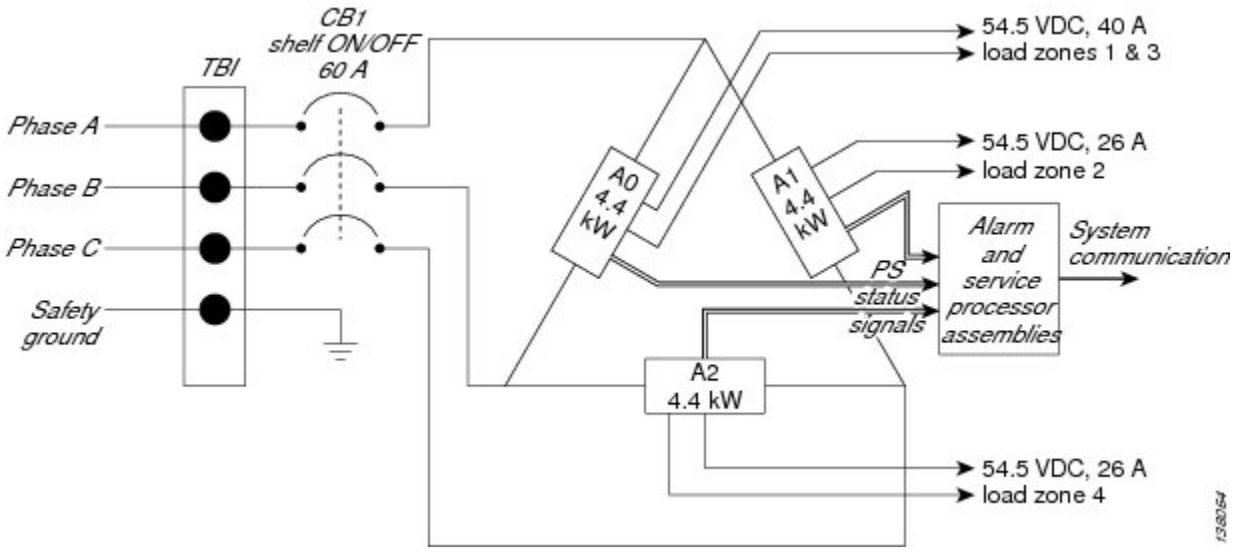
A service processor is located in the alarm module that monitors the condition of each AC rectifier and provides status signals that indicate the health of the power supplies.

Note The same AC rectifier is used in both the AC Delta and AC Wye power shelves.

This figure shows the wiring of an AC Delta power shelf. 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 54.5 VDC power for the chassis. Each AC rectifier powers two of the chassis load zones.

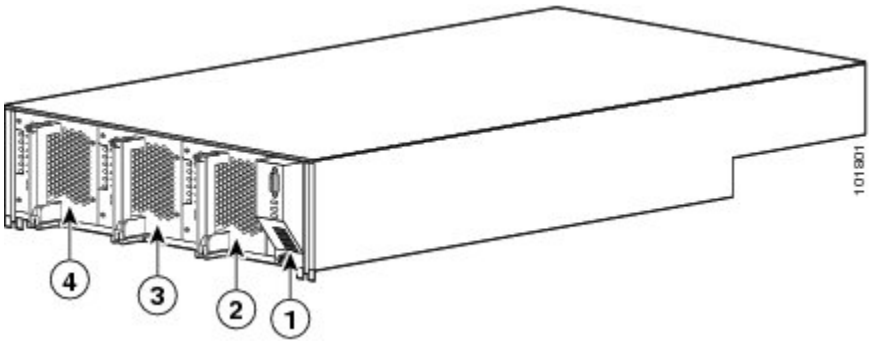
Figure 26: AC Delta Power Wiring



Fixed Configuration AC Wye Power Shelf

The AC Wye power shelf (CRS-FCC-PS-ACW) is the enclosure that houses three AC rectifier modules, an alarm module, and power distribution connections and wiring. The power shelf is installed in the FCC from the front and plugs into the chassis power interface connector panel.

Figure 27: 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 AC Wye power shelf physical dimensions are:

- Height—6.2 in. (15.8 cm)
- Width—20 in. (50.8 cm)
- Depth—25 in. (63.5 cm)
- Weight—36 lb (16.3 kg) (without AC rectifier modules)

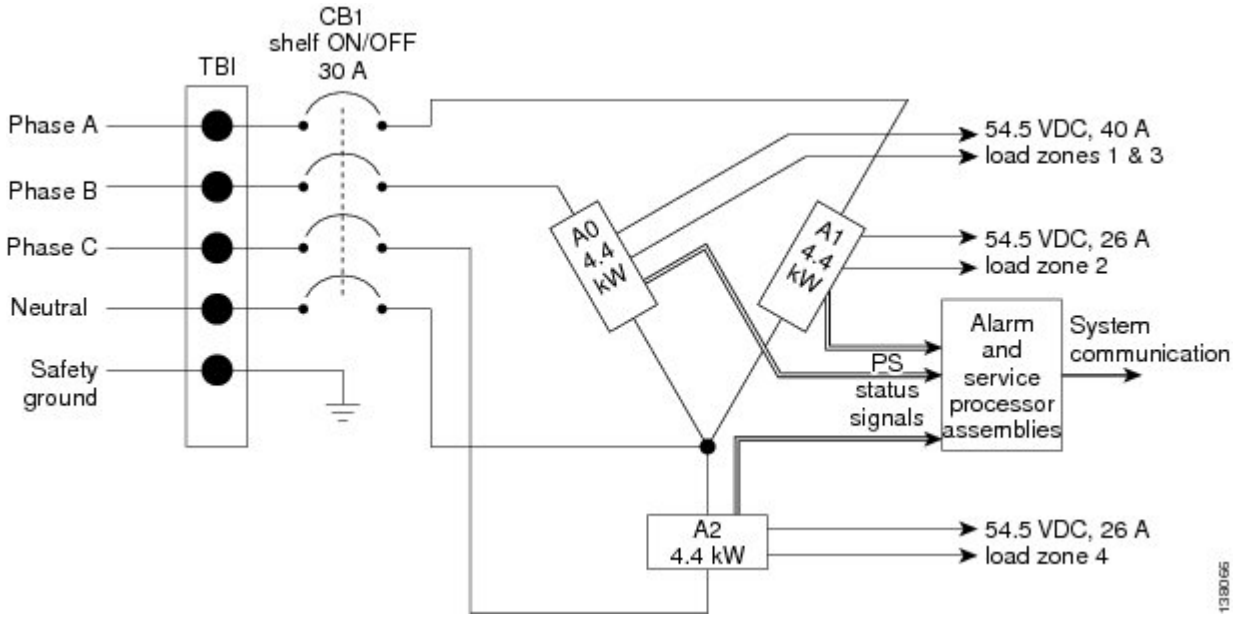
Input AC power enters the power shelf and is distributed to the three AC rectifiers in the power shelf. The AC rectifiers convert AC power into DC power, provide filtering, and then pass the DC power to either A or B bus bar in the chassis midplane. For redundancy, one AC power shelf powers the A bus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

Note The same AC rectifier is used in AC Delta and AC Wye power shelves.

This figure shows the wiring of an AC Wye power shelf. 5-wire AC Delta 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 three AC rectifiers in the power shelf. The AC rectifiers (PS0, PS1, and PS2) convert the AC power into the DC (54.5 VDC) power. Each AC rectifier powers two of the chassis load zones. The DC power is distributed to the FRUs in the various load zones through the bus bar and the chassis backplane.

Figure 28: AC Wye Power Wiring

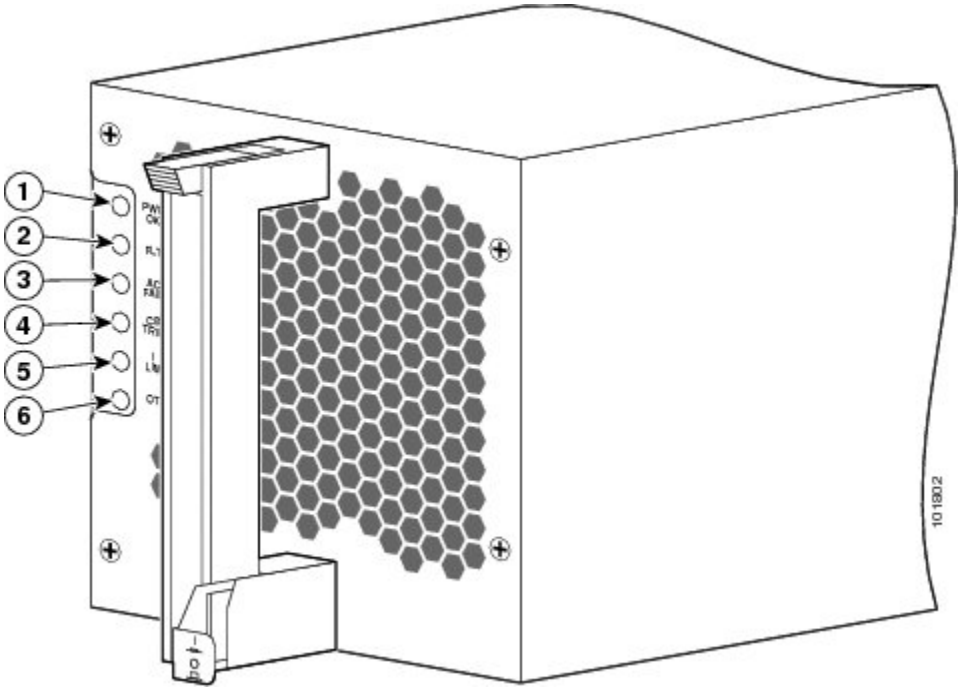


Fixed Configuration AC Rectifier

The AC rectifier is an AC power supply that converts input AC power into the DC power necessary to power chassis components. The 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 the B bus bar in the chassis backplane. Each AC rectifier has a self-contained cooling fan that draws air through the module.

Figure 29: AC Rectifier



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

The AC rectifier physical dimensions are:

- Height—5.43 in. (13.8 cm)
- Width—5.24 in. (13.3 cm)
- Depth—18 in. (45.7 cm)
- Weight—19 lb (8.6 kg)

As shown in above figure, 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 these 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, including part number, serial number, assembly deviation, special configurations, test history, and field traceability data.

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.

AC Rectifier Status Indicators lists the AC rectifier status indicators and their functions. *AC Rectifier LED Conditions* lists the LED readings during failure conditions.

Table 5: 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.

Name	Color	Function
BREAKER TRIP	Yellow	Input circuit breaker is off (in the off position).
ILIM	Yellow	AC rectifier is operating in a current limiting condition.

Table 6: 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

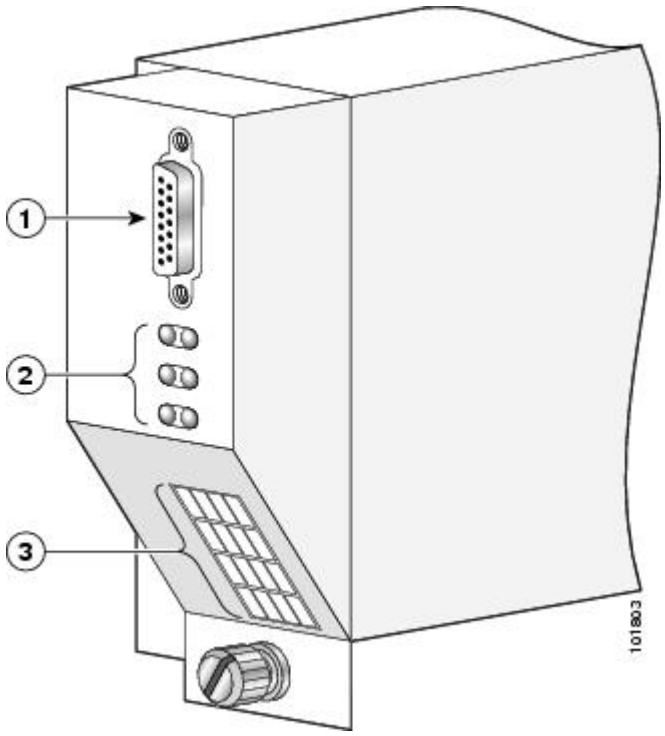
Alarm Module for Fixed Configurations

This section describes an alarm module in a fixed configuration power supply in the FCC. An alarm module can be installed only in the far right slot of the power shelf.

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.

Note Only safety extra-low voltage (SELV) circuits can be connected to the ALARM connector on the alarm module faceplate. The maximum rating for the alarm circuit is 2 A, 50 VAC.

Figure 30: Alarm Module



1	External alarm connector	3	LED display
2	Alarm LEDs		

The physical dimensions of the alarm module are:

- Height—5.5 in (14 cm)
- Depth—18 in. (45.72 cm)
- Width—3.2 in. (8.13 cm)
- Weight—4.2 lb (2 kg)

The alarm module performs these functions:

- Alarm output, both LEDs and relay:

- 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, the service processor module 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 performance and error conditions that may exist on the AC rectifier or PEM. Because 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 having 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 having a problem.

This table lists the pinouts for the alarm relay connector.

Table 7: Alarm Relay Connector Pinouts

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 contains these topics for modular configuration power systems.

Modular Configuration Power Architecture

The modular configuration power system includes these major components:

- Two (redundant) AC or DC power shelves (different power shelves are used for AC and DC power)
  - Up to six 3000 W AC power modules (PMs) per shelf; however, the product is shipped with three
  - Up to six 2100 W DC PMs per shelf; however, the product is shipped with four

- Removable alarm module, one per power shelf

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.

Note For further information on the AC power system PDU, refer to the Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide.

The power architecture and power distribution of a Cisco CRS FCC, as shown in the below figure, is the same for fixed and modular configuration power systems.

Figure 31: FCC DC Modular Power Distribution

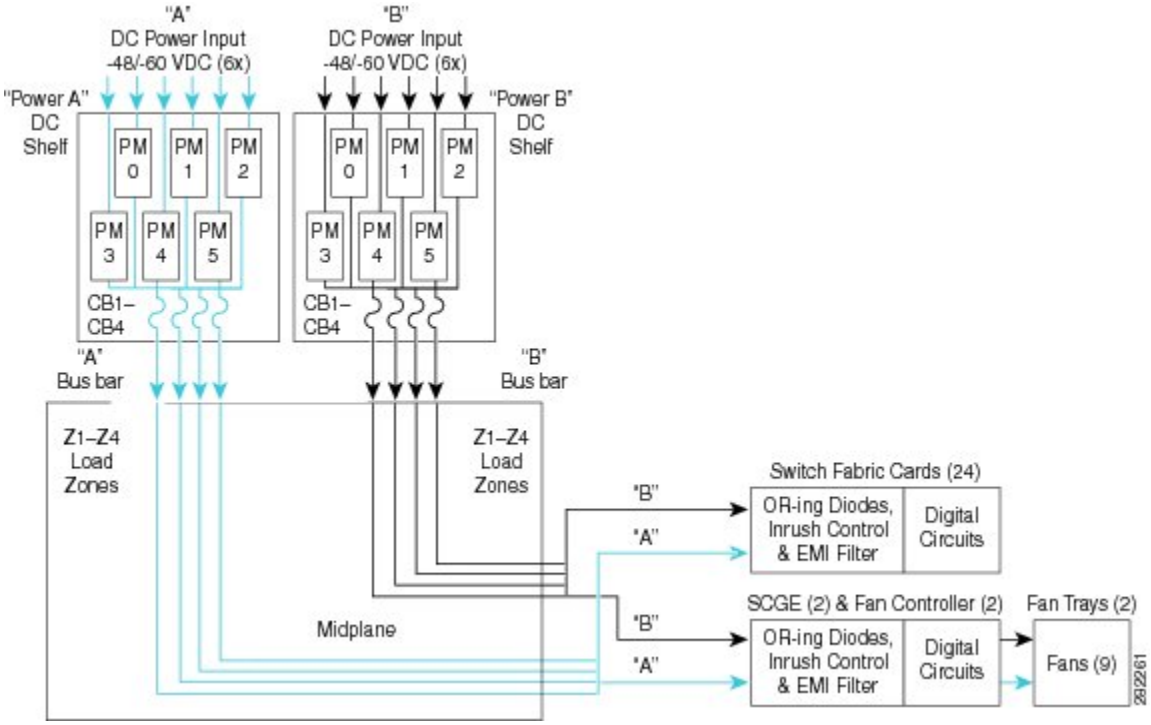
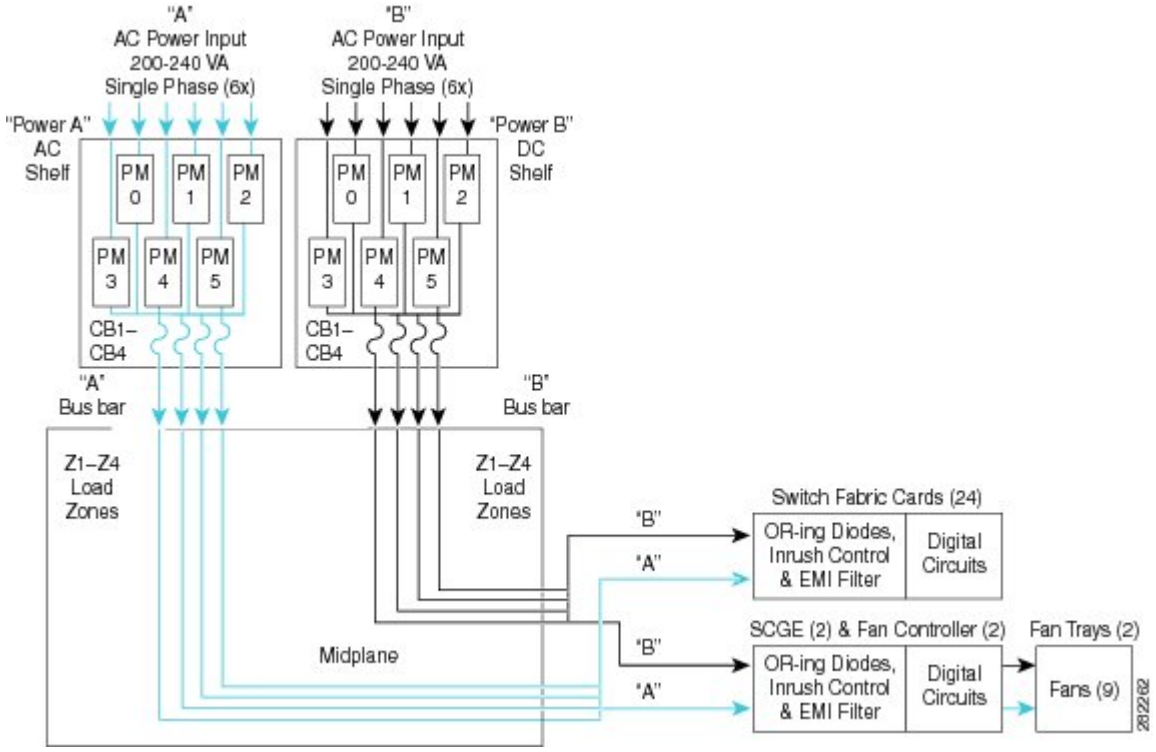


Figure 32: FCC AC Modular Power Distribution



Above figure shows AC or DC 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 backplane to the SCGE cards (2-port or 22-port), fan trays, and SFCs.

- The A power shelf supplies –48 VDC to the A bus bar.
- The B power shelf supplies –48 VDC to the B bus bar.

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

- One AC power module or DC power module fails
- One entire power shelf fails
- One bus bar fails

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

Individual chassis components have power-related devices (online insertion and removal [OIR] 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 buses) architecture and enable OIR of the component, which is also called hot-swapping.

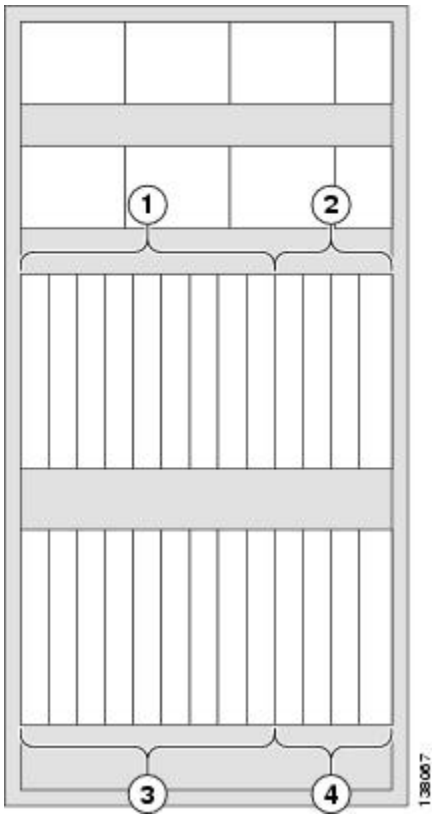
Modular Configuration Chassis Power Zones

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

An FCC can lose a single power module or an entire power shelf and still have the power to operate. For a load zone to lose complete power, a power module in each power shelf would have to fail.

This figure shows the four load zones on the SFC side of the FCC.

Figure 33: FCC Power Zones (SFC Side)



1	Power zone 1	3	Power zone 3
2	Power zone 2	4	Power zone 4

These properties apply to the power shelves and power zones:

- Power shelf A supports everything in it. PM 0-5 supports everything in the entire chassis that needs power which are cards, fans, alarm modules. CB1 supports Z1, CB2 supports Z2 ... CB4 supports Z4
- Power shelf B supports everything in it. PM 0-5 supports everything in the entire chassis that needs power which are cards, fans, alarm modules. CB1 supports Z1, CB2 supports Z2 ... CB4 supports Z4

- Power zone 1 supports chassis slots 0 to 8
- Power zone 2 supports chassis slots 9 to 11
- Power zone 3 supports chassis slots 12 to 20
- Power zone 2 supports chassis slots 21 to 23
- The fan trays (FT0 and FT1) receive their operating power from the SCGE cards (SCGE0 and SCGE1)

DC Modular Configuration Power Systems

The FCC DC modular power system provides up to 12,600 W DC power to the chassis. The DC modular power system contains these components:

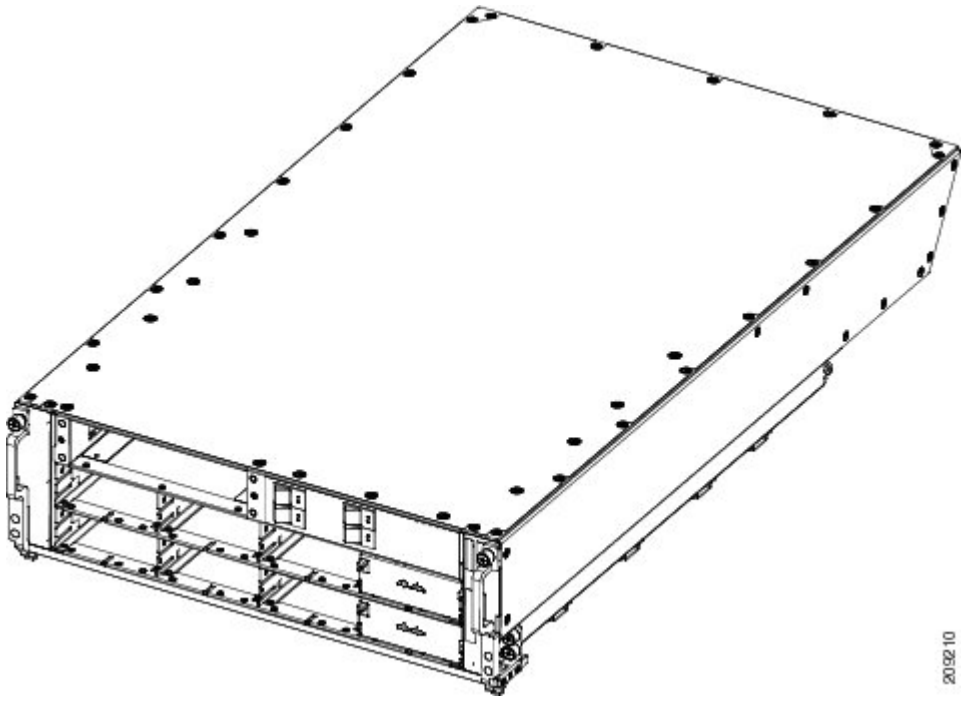
- Two DC power shelves. Each power shelf contains the DC input power connections and houses the DC power modules and alarm module.
- Up to six DC power modules per shelf. Each power module has its own fuse and is field-replaceable.

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 FCC from the front and plugs into the chassis power interface connector panel.

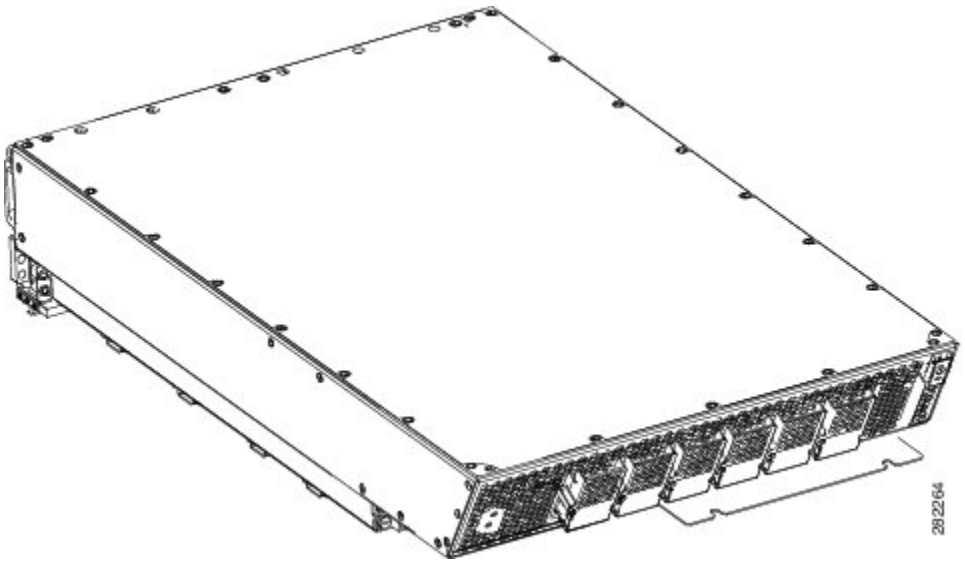
This figure shows the front view of the modular configuration DC power shelves.

Figure 34: DC Modular Configuration Power Shelf - Front View



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

Figure 35: DC Modular Configuration Power Shelf - Rear View



The DC power shelf physical dimensions are:

- Height—6.2 in. (15.8 cm)
- Width—20 in. (50.8 cm)
- Depth—25 in. (63.5 cm)
- Weight—38 lb (17.2 kg) (without DC power modules)

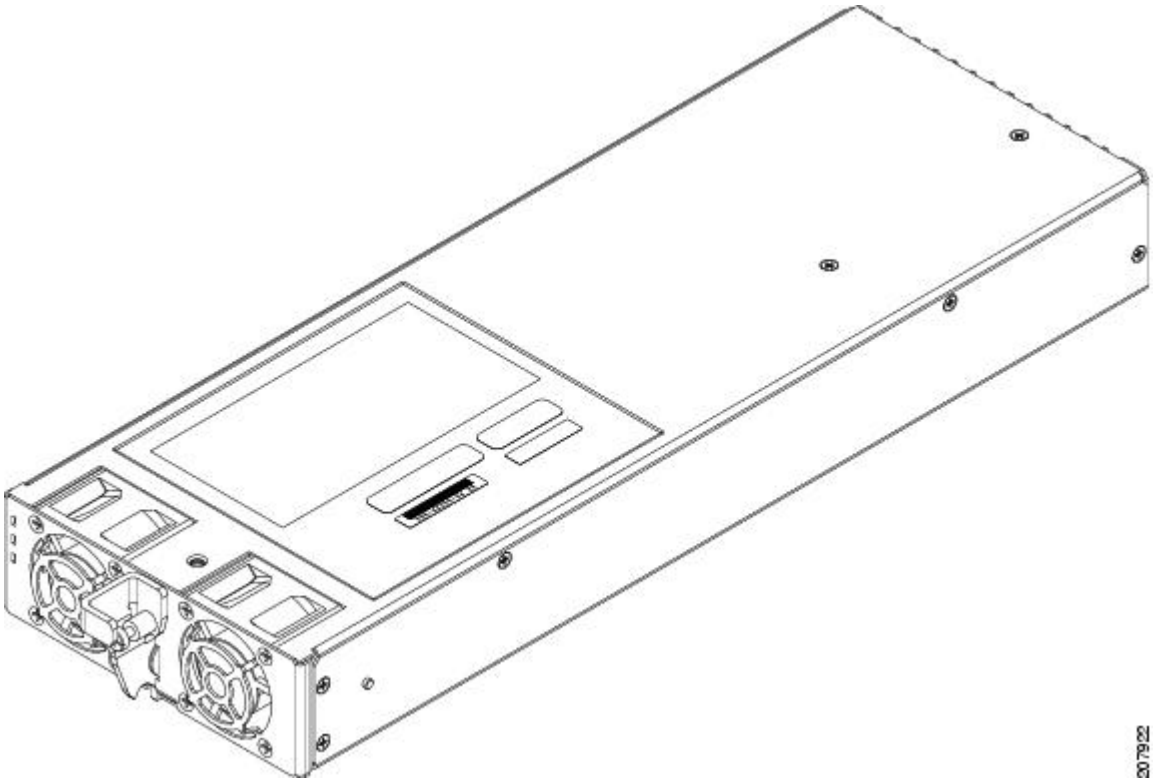
Each power module has its own power connector to connect input DC power (nominal –48/–60 VDC, 50 A or 40 A service). Each connector consists of two terminals (– and +). Each terminal consists of two M6 threaded studs, 0.6 inches long, and centered 0.625 inches apart. The terminals have a safety cover.

Each DC power shelf supports up to six power modules, and accepts two 60 A battery feeds per power module. Input DC power enters the power shelf and is processed by the power modules before being distributed to the chassis midplane. The power modules perform inrush current limiting, EMI filtering, surge protection, and circuit isolation on the input DC power, and then distribute the power via the internal bus bar in the chassis midplane.

Modular Configuration DC Power Module

Each DC power module provides 2100 W. The DC power module shown in the below figure passes the power via the internal bus bar to the system. power modules are field-replaceable.

Figure 36: DC Modular Configuration Power Module .



The DC power module physical dimensions are:

- Height—1.6 in. (4.06 cm)
- Width—4.0 in. (10.16 cm)
- Depth—13.56 in. (34.44 cm)

Two –48 or –60 VDC inputs enter the power module at the rear of the power shelf, and exits the power module and is distributed to the chassis midplane. The power module does not perform any filtering or status monitoring. Instead, the alarm module provides these features, monitoring power module status and processing alarm functions.

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

Modular Configuration DC Power Module Indicators

These three LED status indicators are located on the front of each modular configuration DC power module:

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

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

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

Table 8: Power Module Status Indicators

Name	Color	Function
Input OK	Green	Input OK LED turns on continuously when input voltage is present and within the regulation range. Input OK LED flashes when input voltage is present, but not within the regulation range. Input OK LED is off when input voltage is not present. Input OK LED flashes when hot-unplugging the power supply from the power shelf to indicate that there will be 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 power module.

The Internal Fault LED on the DC power module is turned on continuously to indicate that one or more of these 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

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

AC Modular Configuration Power Systems

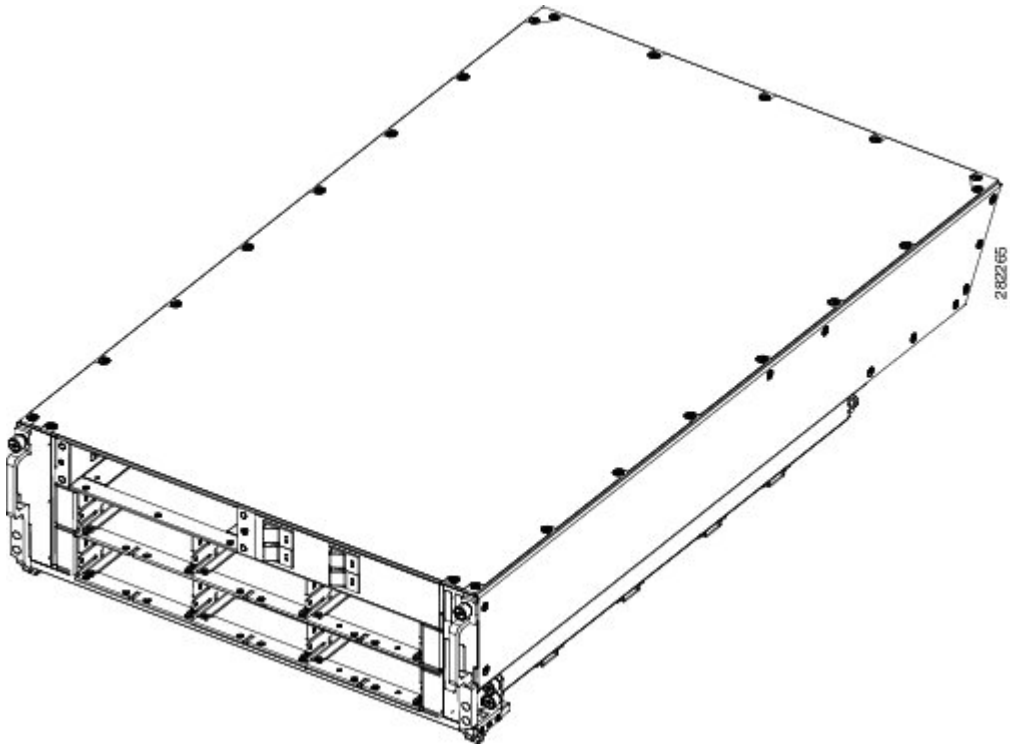
The modular configuration AC power system provides up to 15,000 W to power the FCC. The AC power system, which provides 2N power redundancy for the routing system, contains these components:

- Two AC power shelves (per chassis). Each power shelf contains the input AC power connectors and holds the AC power modules. The chassis requires two power shelves for redundancy.
- Up to six AC power modules per power shelf.
- Each AC power module has its own fuse and is field-replaceable.

Modular Configuration AC Power Shelf

The AC power shelf is the enclosure that houses the AC power modules, the alarm module, and power distribution connections and wiring. The AC power shelf, shown in the below figure, is installed in the FCC from the front and plugs into the chassis power interface connector panel.

Figure 37: AC Modular Configuration Power Shelf



The AC power shelf physical dimensions are:

- Height—6.2 in (15.8 cm)
- Width—20 in (50.8 cm)
- Depth—25 in (63.5 cm)
- Weight—36 lb (16.3 kg) (without AC power modules)

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

See the Cisco CRS Carrier Routing System Fabric Card Chassis Installation Guide for detailed information about the input power connections to the AC power shelf.

Each AC power shelf supports up to four AC power modules. The AC power modules convert AC power into DC power, provide filtering, and then distribute the DC power to the chassis midplane. For detailed information about how power is distributed through the chassis, see the Modular Configuration Power Architecture, on page 43 section.

The power shelf also has a service processor module that monitors the condition of each AC power module and provides status signals that indicate the health of the power supplies (see the Modular Configuration AC Power Module Indicators, on page 54 section).

Modular Configuration AC Power Module

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

The AC power module 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.

Each power module has its own power connector to connect input AC power. The input AC power for each power module is:

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

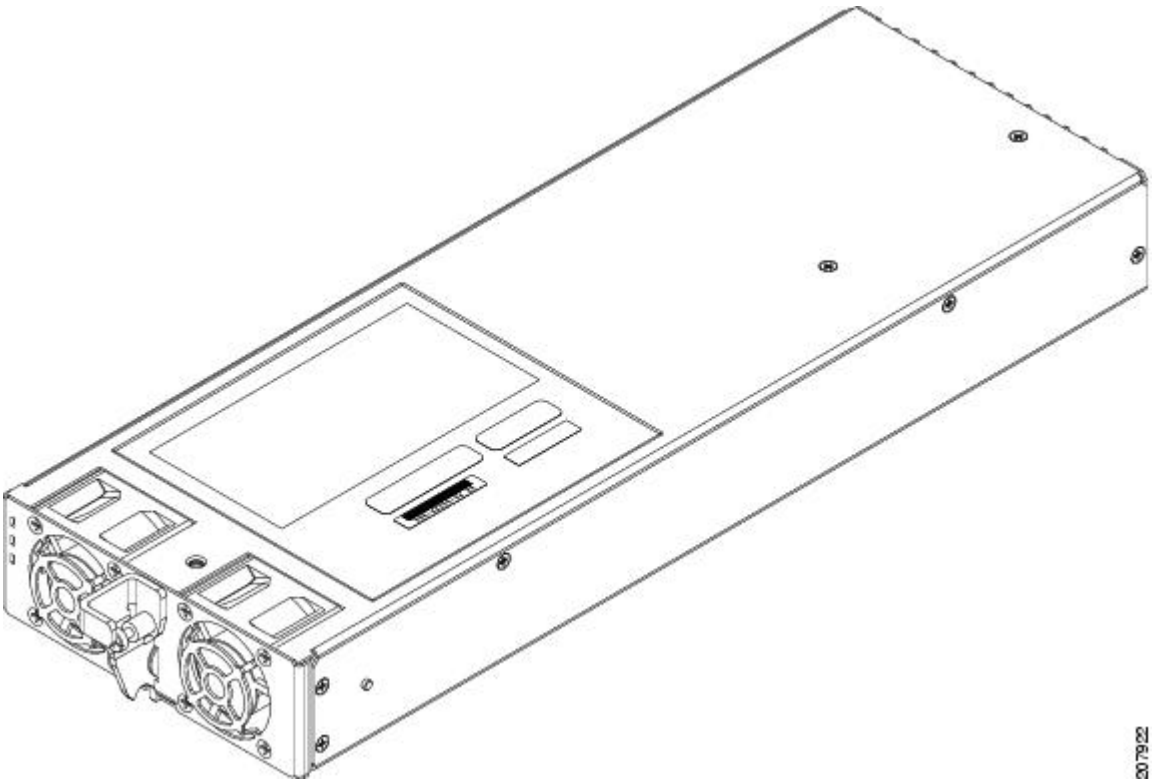
  Input: 200 to 240 VAC, 50 to 60 Hz, 16 A.

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

- A 3-pin IEC-320 C21 90 degree female plug is inserted into a 3-pin IEC-320 C22 male plug at the rear of each power module.

This figure shows the AC modular configuration power module

Figure 38: AC Modular Configuration Power Module



The AC power module physical dimensions are:

- Height—1.6 in (4.06 cm)
- Width—4.75 in (12.0.6 cm)
- Depth—13.56 in (34.44 cm)

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

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

Each AC power module contains an ID EEPROM that stores information used by control software, including part number, serial number, assembly deviation, special configurations, test history, and field traceability data.

Modular Configuration AC Power Module Indicators

These three LED status indicators are located on the front of each DC power module:

- Input OK - Green

- Output OK - Green
- Internal Fault - Red

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

Table 9: AC Power Module Status Indicators

Name	Color	Function
Input OK	Green	Input OK LED turns on continuously when input voltage is present and within the regulation range. Input OK LED flashes when input voltage is present, but not within the regulation range. Input OK LED is off when input voltage is not present. Input OK LED flashes when hot-unplugging the power supply from the power shelf to indicate that there will be 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 power module.

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

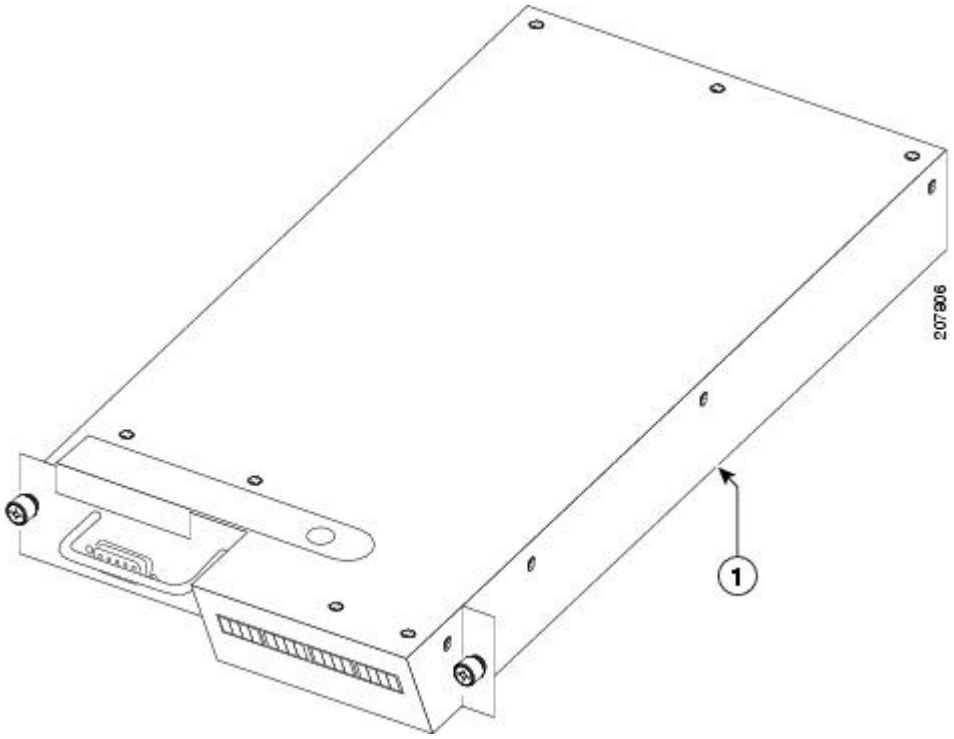
- 5V out of range
- Output Stage OT
- Fan Fault
- OR-ing fault (Output voltage less than bus voltage)
- OC shutdown
- OT shutdown
- OV shutdown
- Input stage OT
- Fault induced shutdown occurred
- Thermal sensor fault
- Vout out of range
- Boost Vbulk fault

When all 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 DC power shelf contains an alarm module. It monitors the presence and performance of the modular configuration AC and DC power modules. It also monitors the status of the power shelf and provides an external interface for system alarms. This figure shows a modular configuration alarm module.

Figure 39: 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 these 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 service processor module on the alarm module activates the relay. The alarm relay connector is a standard DA-15S connector.

- AC or DC power module status monitoring — The alarm module monitors the performance and status of the AC or DC power modules. The alarm module monitors Power Good, Power Fail, Internal Fault, Over Temp conditions, AC or DC power module presence, and voltage and current output levels. The alarm module can report these statuses even for 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.

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

- Fault—Indicates a failure in a power module, 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.
- Circuit Breaker Trip—Indicates that the power module circuit breaker has tripped.
- Over temperature—Indicates that the power module has exceeded the maximum allowable operating temperature.
- Power Module Present—Indicates that the power module 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 power module are within range.

This 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 Power Distribution Unit (PDU) for the FCC. The PDU is intended for use with the CRS modular power system in environments where 3-phase input power needs to be converted to single phase output power.

The PDU includes 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 19 inch racks or other locations such as the sides of the FCC by using custom mounting brackets.

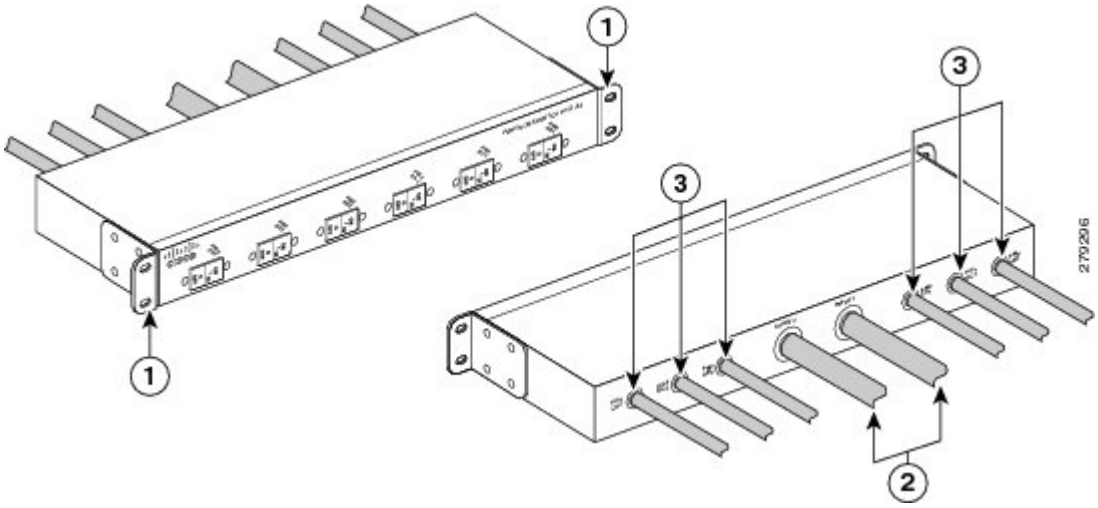
One PDU is required for each modular power shelf installed in the chassis for system redundancy. A PDU can be installed on either the left or right side of the chassis.

There are two versions of the FCC PDU:

- Power Distribution Unit D—CRS 3 phase AC Delta input
- Power Distribution Unit W—CRS 3 phase AC Wye input

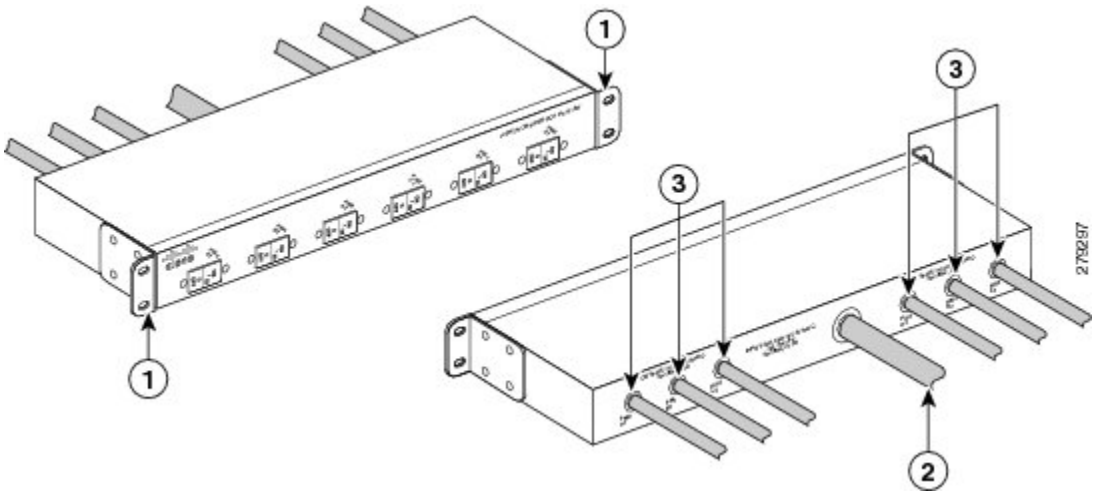
This figure shows the Power Distribution Unit that converts 3-phase AC Delta input power to single phase output power.

Figure 40: AC Delta Power Distribution Unit



This figure shows the Power Distribution Unit that converts 3-phase AC Wye input power to single phase output power.

Figure 41: AC Wye Power Distribution Unit



The power distribution unit physical dimensions are:

- Height—2.0 in (5.1 cm)
- Width—19.3 in (49.1cm)—with rack mounting ears
- Width—17.5 in (44.4 cm)—without rack mounting ears
- Depth—6.0 in (15.2 cm)

Note The power cables for the power distribution unit come pre-attached.

The FCC PDU is shipped with this hardware for specific configurations:

- Two single AC Delta PDUs with 19 inch rack mounting bracket. Each AC Delta PDU has two power inputs and six outputs
- Two Single AC Wye PDUs with 19 inch rack mounting bracket. Each AC Wye PDU has one power input and six outputs
- FCC PDU mounting bracket kit, available as an optional accessory

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.

- 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, 32 A.

  Tolerance: +/-10% (180 to 264)(L-N)/(311 to 456)(L-L) VAC, 50 to 60 Hz, 32 A.
- The AC Wye PDU has six single phase output power connections.

Output: 200 to 240 VAC, 50 to 60 Hz, 16 A.

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

- 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, 27.7 A.

  Tolerance: +/-10% (180 to 264) VAC, 50 to 60 Hz, 27.7 A.

- The AC Delta PDU has six single phase output power connections.

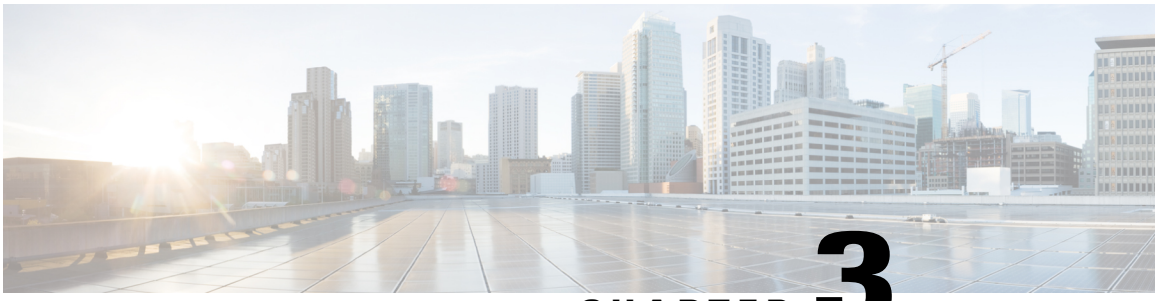
  Output: 200 to 240 VAC, 50 to 60 Hz, 16 A.

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

The 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.
- 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

Fabric Card Chassis Cooling System

This chapter describes the components that make up the cooling system of the fabric card chassis (FCC). It includes these sections:

Cooling System Overview

The FCC cooling system dissipates the heat generated by the routing system and controls the temperature of components in the FCC. The cooling system has a fully-redundant architecture that allows the routing system to continue operating with a single-fault failure (such as a single fan or fan tray failure). The architecture also supports a redundant load-sharing design.

The complete FCC cooling system includes:

- Two fan trays (each holds nine fans)
- Temperature sensors (on cards and modules throughout the FCC)
- Control software and logic
- An air filter, inlet and outlet air vents, and bezels
- Impedance carriers for empty FCC slots

The power modules in the power shelves also have their own self-contained cooling fans.

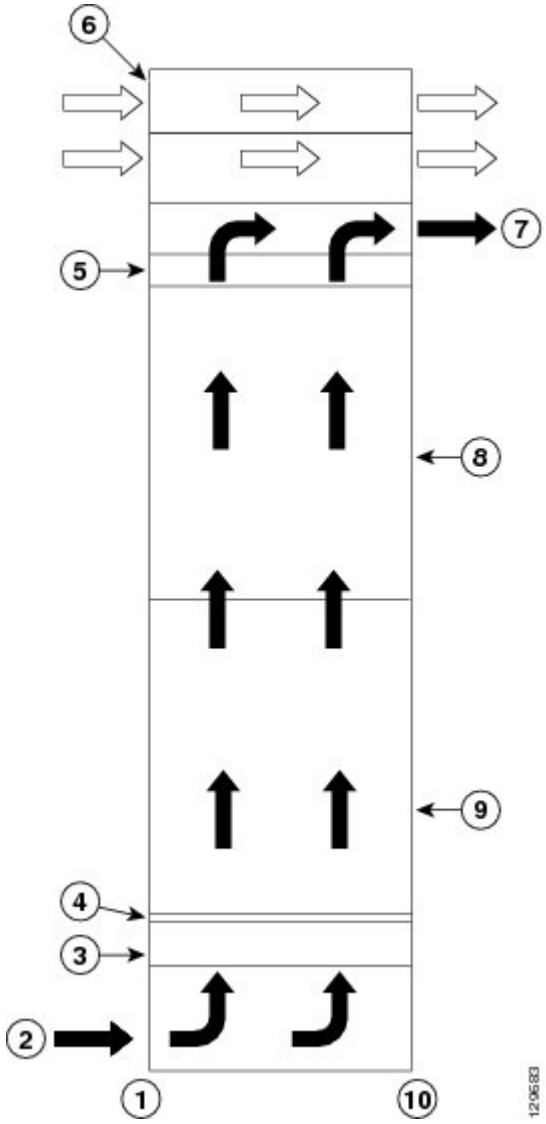
All nine fans in a fan tray operate as a group. So, if it is necessary to increase or decrease airflow, all fans in the tray increase or decrease their rotation speed together. When two fan trays are operational in an FCC, the speed of the fans in both trays is adjusted together.

Thermal sensors (inlet, exhaust, and hot-spot) located throughout the FCC are used to monitor temperature readings and identify when the system is not cooling properly. Software running on the SCGE (2-port or 22-port) card is used to control the operation of the fans.

FCC Airflow

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

Figure 42: Airflow Through the FCC



1	Front of chassis	7	Air exhaust
2	Room air	8	Upper card cage
3	Bottom fan tray	9	OIM side of chassis

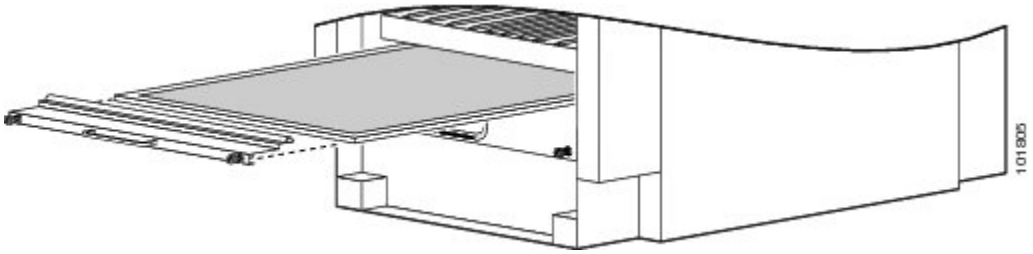
4	SFC side of chassis	10	Lower card cage
5	Top fan tray	11	Air filter
6	Power shelves	12	Rear of chassis

Note The FCC has a maximum airflow of 2050 cubic feet per minute.

The FCC has a replaceable air filter mounted in a slide-out tray above the lower fan tray. The FCC air filter, shown in the below figure, plugs into the front (SFC) side of the FCC.

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 replacement, you should have a spare filter on hand. Then, when you remove the dirty filter, install the spare filter in the FCC.

Figure 43: 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 speeds. The software and circuitry increase or decrease the airflow needed to keep the routing system operating at a desired temperature range. The FCC cooling system uses multiple fan speeds to optimize cooling, acoustics, and power consumption. Four fan speeds are used for normal operation and one high-speed setting is used when a fan tray has failed.

At initial power up, the routing system control software powers on the fans to a range of 4300 to 4500 RPM. This control software provides airflow during system initialization and software boot and ensures that adequate cooling exists for the system, if the software hangs during boot. The fan control software is initialized after the routing system software boots, which can take from 3 to 5 minutes. The fan control software then adjusts the fan speeds appropriately.

During normal operation, the system averages the temperatures reported by inlet temperature sensors in the 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 average 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 no active alarms or failures exist, 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 system is not cooling properly. A temperature sensor might trip in response to an elevated ambient air temperature, a clogged air filter or other airflow blockage, or a combination of these conditions. 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 SCGE (2-port or 22-port) card. The fan control software on the SCGE (2-port or 22-port) card 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 FCC components from getting anywhere near reliability-reducing, chip-destroying temperatures. If the fault continues, the software shuts down the card or module, to save components.

Quick-Shutdown Mode

The fan trays have a quick-shutdown mode that turns off power when a card or fan tray is disengaged from the FCC backplane. The quick-shutdown mode minimizes inrush current during a hot swap or OIR. In normal maintenance conditions, the software gracefully turns off power to the failed part, allowing ample time for capacitors to discharge.

Fan Controller Redundancy in the FCC

This section describes the redundant architecture of the cooling system, which allows the cooling system to continue operating even when certain components have failed.

The SCGE (2-port or 22-port) cards provide fully redundant input power and control logic for fan trays and fans. Each SCGE card receives its input power (-48 VDC) from both the A and B power shelves. The SCGE 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 provision ensures that the upper fan tray is powered from the A bus on one SCGE card and from the B bus on the second SCGE card.

In a fully redundant system that is equipped with dual power feeds, dual SCGE cards, and dual fan trays-the cooling system can withstand the failure of any one of these 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.)
- SCGE card — If one SCGE card fails, the other SCGE card provides all of the power to the fan trays.

- Power shelf or power module (DC PEM or AC rectifier) — 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 SCGE cards, two power shelves, two power modules (DC PEMs or AC rectifiers), 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 within 24 hours, or sooner.

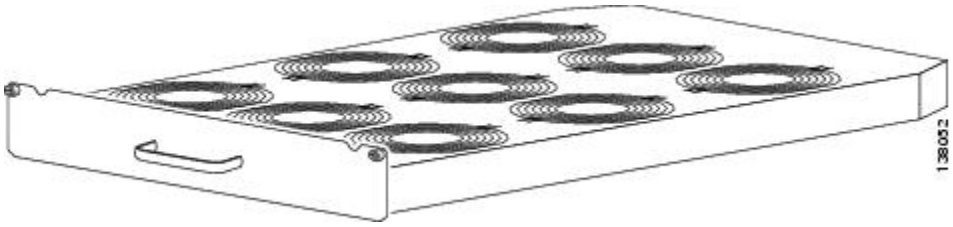
The SCGE (2-port or 22-port) cards provide fully-redundant input power and control logic for fan trays and fans. Each SCGE (2-port or 22-port) card receives its input power (–48 VDC) from both the A and B power shelves. The SCGE (2-port or 22-port) card then provides one fan tray with input power from its A bus and provides power to the other fan tray from its B bus. This provision ensures that the upper fan tray is powered from the A bus on one SCGE (2-port or 22-port) card and from the B bus on the second SCGE (2-port or 22-port) card.

For information on the rotational speeds of the fans in revolutions per minute (RPM), see the *FCC Fan Tray* section.

FCC Fan Tray

This figure shows a fan tray, which plugs into the front (SFC) side of the FCC. Each fan tray is hot swappable and is considered a field-replaceable unit. The FCC is designed to run with both fan trays in place.

Figure 44: Fan Tray



Each fan tray contains:

- Nine fans — The FCC fans are powered up with regulated –54 VDC for the AC system. For the DC system, the fans receive the input voltage that is applied to the DC PEM modules. This input ranges from –42 VDC to –72 VDC.
- Fan tray board — The board terminates signals to and from the fans, filters common-mode noise, and contains tracking and indicator parts.
- Front-panel status LED — The LED indicates:
  - Green—The fan tray is operating normally.

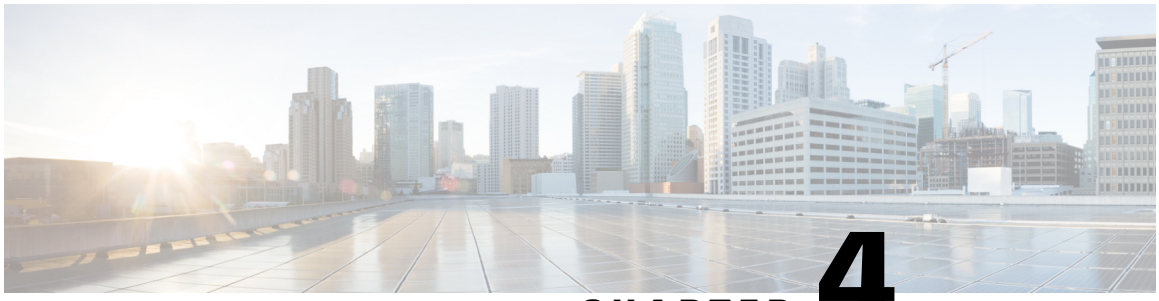
- Yellow—The fan tray has failed and should be replaced.
- Off—An unknown state exists or the LED is faulty.

During normal operation, the fans operate in the range of 3500 to 5150 RPM. The system automatically adjusts the speed of the fans to meet the cooling needs of the entire chassis. If one SCGE card or one power feed fails, the fans continue to operate within the range 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 6600 RPM.

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

The fan tray has these physical characteristics:

- Overall depth—30.9 inches (78.5 cm)
- Height of tray body—2.5 inches (6.2 cm)
- Height of front panel—4 inches (10.2 cm)
- Depth of front panel—1 inches (2.5 cm)
- Weight—44 pounds (20 kg)



CHAPTER 4

Multishelf System Switch Fabric

This chapter describes the switch fabric used in the multishelf system. It includes these sections:

The switch fabric card described in this chapter uses a Class 1M laser. This caution and warnings apply to the switch fabric card.

Caution Class 1M laser radiation when open. Do not view directly with optical instruments.

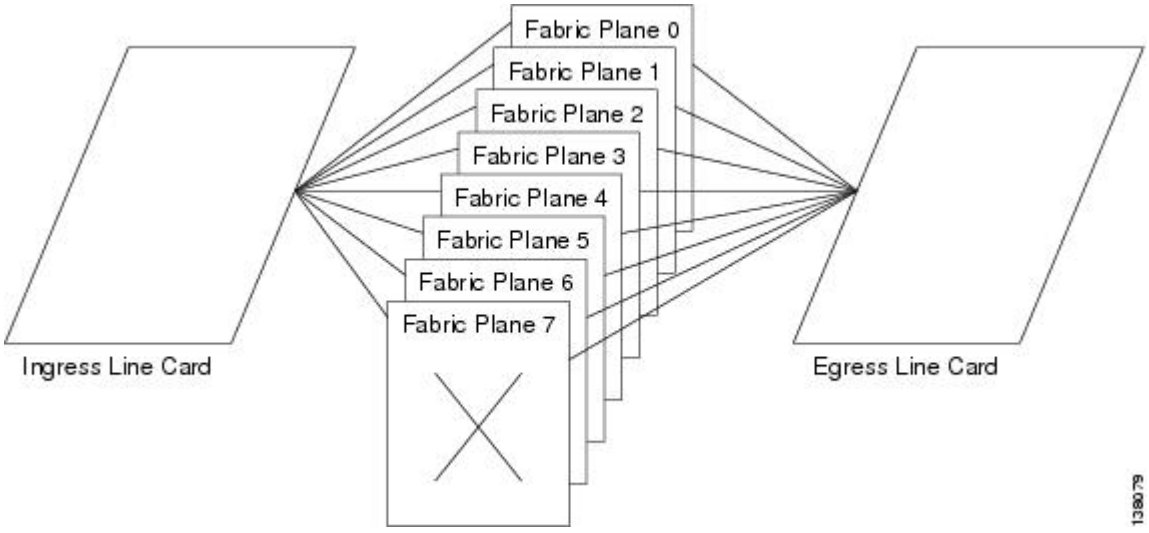
Warning For diverging beams, viewing the laser output with certain optical instruments within a distance of 100 mm may pose an eye hazard. For collimated beams, viewing the laser output with certain optical instruments designed for use at a distance may pose an eye hazard. Statement 282

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

Switch Fabric Overview

The multishelf system has eight fabric planes that support data traffic between the line cards. This figure shows a simplified view of the relationship between the line cards and fabric planes.

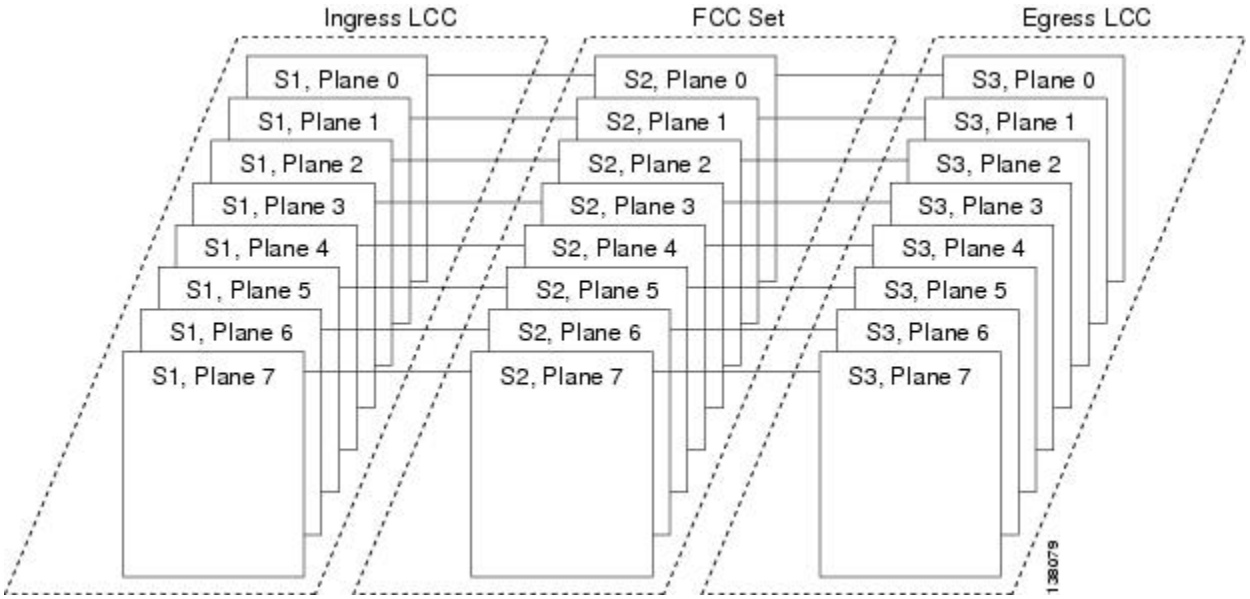
Figure 45: Relationship of Line Cards and Fabric Cards



Each fabric plane is divided into three switching stages, which are numbered S1, S2, and S3. Data arrives at the S1 stage in an LCC, passes over the fabric cables to the S2 stage in a fabric card chassis (FCC), and then

passes over the fabric cables again to the S3 stage in the destination LCC. This figure shows a simplified view of the relationship between the line cards and the fabric.

Figure 46: Fabric Plane Stages



In each LCC, eight S13 fabric cards provide stages S1 and S3 for each of the eight fabric planes. All ingress traffic enters through the S1 component of the ingress S13 card, travels over the fabric cables and S2 fabric component, and exits through the S3 component on an S13 fabric card. Data traffic can enter through the S1 component of one card, pass through the S2 component, and then exit the S3 component of the same card.

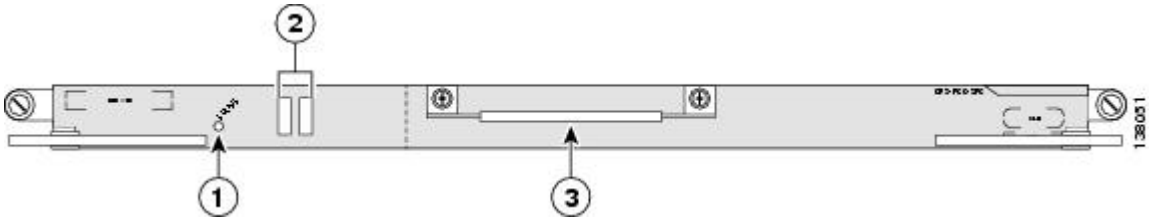
The S2 cards are distributed between one, two, or four FCCs. The S2 cards for all fabric planes can be installed in a single FCC, but distributing the planes between FCCs prevents a failure in one FCC from disrupting traffic in all eight planes.

Fabric Card Chassis Switch Fabric Cards

There are three types of switch fabric cards: CRS-FCC-SFC for 40G CRS-1 multishelf systems, CRS-FCC-SFC-140 for CRS-3 multishelf systems, and CRS-FCC-SFC-400 for CRS-X multishelf systems. They provide the same functionality. The only difference between the three cards is capacity.

The front view of a CRS-FCC-SFC switch fabric card that is installed in a 40G multishelf system is shown in the below figure. The 140G FCC switch fabric card (CRS-FCC-SFC-140) and 400G FCC switch fabric card (CRS-FCC-SFC-400) are similar.

Figure 47: CRS-FCC-SFC Switch Fabric Card

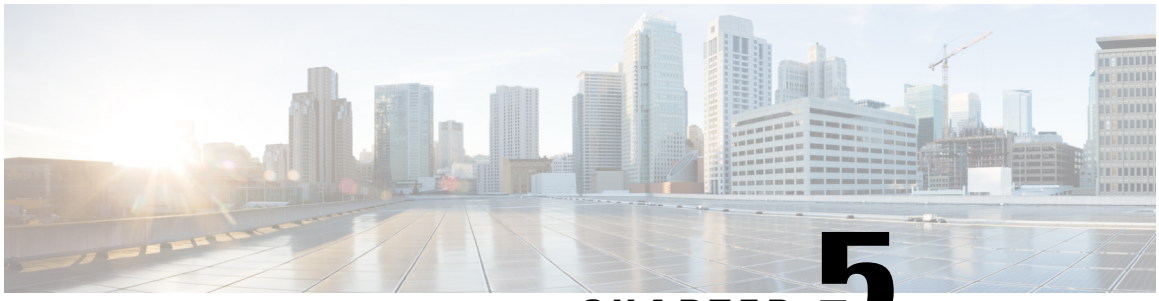


1	STATUS LED	3	Handle
2	Alphanumeric display		

Front-Panel LED Indicators

The front panel of the FCC SFC includes LED indicators that provide status and informational messages.

- Status LED—Indicates the operational status of the SFC
  - Green—Indicates that the SFC is functioning normally
  - Yellow—Indicates a hardware or communication error
- Alphanumeric LED—Displays IOS XR messages



CHAPTER 5

Shelf Controller Gigabit Ethernet Card

This chapter describes the shelf controller card (CRS-FCC-SC-22GE and CRS-FCC-SC-22GE-B) for the fabric card chassis (FCC). It includes these sections:

The SCGE card described in this chapter uses a Class 1 laser. These warnings apply to the SCGE card.

Danger Class 1 Laser Product. Statement 113

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

Shelf Controller Card Functional Overview

The Shelf Controller card is the local system management node for a FCC.

The Shelf Controller card provides system initialization, debugging, and low-level hardware control for all SFCs in an FCC and other system cards. The card includes front-panel ports and an alphanumeric LED display. Communication within the chassis takes place over a redundant set of backplane Fast Ethernet (FE) links controlled by the SCGE card. The SCGE card also controls power up, initialization, SFCs, the optical interface module LED (OIM-LED) card, alarms, power supplies, and fans in an FCC. It also includes the 48-V soft-start circuitry for the fan tray.

Note By default, two Shelf Controller cards are installed in an FCC to provide redundancy. Throughout the remainder of this chapter, these cards are identified as active and standby cards.

The Shelf Controller card:

- Provides the power-on boot of the SCGE CPU and the system management ports

- Determines control of the chassis (active or standby) with the other SCGE card in the chassis
- Provides 22 GE ports for the external system management communications across the chassis

In active mode, the SCGE:

- Downloads Ethernet MAC addresses from the backplane erasable programmable read-only memory (EPROM) and assigns them to all cards in the chassis
- Serves as the FE switch for the intrachassis system management network
- On command from the system management network, starts up and monitors power supplies, chassis fans, and thermal sensors
- On command from the system management network, downloads software images to the SFCs in the chassis, starts up card power supplies, and starts and resets card processors
- Sends alarms and resets, or shuts down portions of the chassis hardware in abnormal or dangerous conditions within the chassis
- Keeps a log of SCGE card and chassis activity on nonvolatile memory and places core dumps onto an internal hard disk
- In case of a timeout, initiates self-reset or rearbitration for chassis ownership
- Controls the fan speed

In standby mode, the SCGE card:

- Periodically tests the FE links to all chassis hardware
- Keeps local state information synchronized
- Rearbitrates for chassis ownership if the active card releases ownership

The FCC holds up to 24 SFCs, 2 SCGE cards, 2 fan trays, 24 optical interface module (OIM) cards, 2 OIM-LED cards, 2 alarm modules, and 2 AC or DC power shelves. Except for the SCGE cards, OIM cards, and fan trays, each of these components has its own service processor (SP) with two backplane FE links to the SCGE cards.

In addition, the two SCGE cards have one FE link between them, and each SCGE card has one backplane FE link routed back to itself. The 48-V soft-start circuit of the fan tray is part of the SCGE card. The SCGE card controls the fan speed and monitors the status of the fan trays through four I2C buses, with two buses going to each fan tray.

22-Port SCGE Card Overview

This section describes the 22-port SCGE card and its components.

This figure shows the front panel of the CRS-FCC-SC-22GE card in a horizontal view.

Figure 48: 22-Port CRS-FCC-SC-22GE SCGE Card Front Panel (Horizontal View)

1	RJ-45 auxiliary (AUX) port	5	Alphanumeric LEDs
2	RJ-45 CONSOLE port	6	Gigabit Ethernet interface
3	STATUS LED	7	PCMCIA card slots
4	PRIMARY LED		

This figure shows the front panel of the CRS-FCC-SC-22GE-B card in a horizontal view.

Figure 49: 22-Port CRS-FCC-SC-22GE-B SCGE Card Front Panel (Horizontal View)

1	RJ-45 auxiliary (AUX) port	4	PRIMARY LED
2	RJ-45 CONSOLE port	5	Alphanumeric LEDs
3	STATUS LED	6	Gigabit Ethernet interface

Note The shelf controller cards are located in the first slot to the right of the upper and lower card cages. They are identified as SCGE0 and SCGE1.

Front-Panel Interface

The front panel of the 22-port SCGE card includes various components that interface with the user. This section describes the front-panel interfaces.

Asynchronous Serial Ports

The 22-port SCGE card has two asynchronous serial ports, the CONSOLE and auxiliary (AUX) ports. These ports allow you to connect external serial devices so you can monitor and manage the system. Both ports use RJ-45 receptacles.

- Console port—Provides a data terminal equipment (DTE) interface for connecting a console terminal.
- Auxiliary (AUX) port—Provides a data terminal equipment (DTE) interface and supports flow control. The port is often used to connect a modem, a channel service unit (CSU), or other optional equipment for Telnet management.

LED Displays

The 22-port SCGE card includes these LED displays:

- Alphanumeric LEDs—Displays Cisco IOS XR software status and error messages.
- PRIMARY LED—When lit, this LED indicates whether the 22-port SCGE card is operating as the active SCGE card in the chassis, or not.
- STATUS LED—Indicates the status of the 22-port SCGE cards relative to power and thermal conditions. A green LED indicates that the card is operating normally. A flashing yellow LED indicates that one of these abnormal conditions has occurred:
  - One of the power supplies is operating at 10 percent below nominal specifications.
  - The temperature at one of the three thermal sensors exceeds 90 degrees Celsius.
- ENABLE and LINK/ACTIVE LED—Each port on the CRS-FCC-SC-22GE-B card has two LEDs, one bicolor and one single color. This table describes the port LEDs.

Table 11: CRS-FCC-SC-22GE-B SCGE card Port Status LEDs

Enabled LED	Link/Active LED	Description
Blinking green	Of	The port is booting or running diagnostics.

Enabled LED	Link/Active LED	Description
Steady Amber	Off	The port is faulty.
Off	Off	Port is administratively shut down.
Steady green	Off	The port is enabled but the link is not connected.
Steady green	On	The port is enabled and the link is connected but there is no activity.
Steady green	Blinking	The port is active. The link is connected and there is activity.

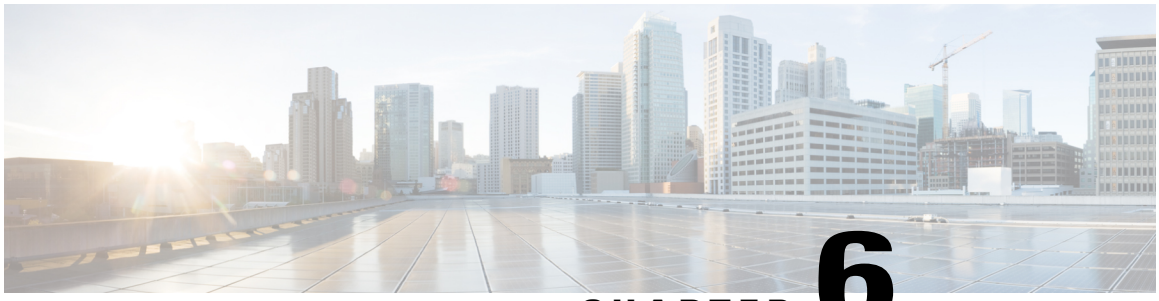
The 22-port SCGE card includes a safety shutdown circuit that powers down all voltages except the 5-V housekeeping voltage. When an abnormal condition is sensed, the STATUS LED on the front panel flashes yellow. Ten seconds later, the shutdown is triggered and power to the card is shut down until the card is reset. After the card powers down, it must be power-cycled by removing it from the chassis or powering down the entire chassis. This mechanism requires that the 5-V housekeeping voltage be functioning correctly.

Gigabit Ethernet Interface

The 22-port SCGE card includes a 22-port GE interface (1000BASE-LX) for connection to the control network that links all LCCs and FCCs. See the Cisco CRS Carrier Routing System *Multishelf System Interconnection and Cabling Guide* for complete multishelf system cabling information.

PCMCIA PC Cards

The 22-port SCGE card (CRS-FCC-SC-22GE only) includes one removable and one fixed PC Card (PCMCIA Type I / II) for local storage needs. The removable, external PC Card facilitates image files of up to 1 GB. The nonremovable, internal PC Card also facilitates image files of up to 1 GB. However, this card is for Cisco use only and is not accessible to users.



CHAPTER 6

Optical Interface Modules and Optical Interface Module LED Card

This chapter describes the optical interface module (OIM) cards and optical interface module light emitting diode (OIM-LED) cards. It includes these sections:

- OIM Card Overview, page 77
- OIM-LED Card Functional Overview, page 81
- OIM-LED Card Overview, page 82

OIM Card Overview

OIM cards are used to connect the FCC and LCC together in a multishelf system, using a set of 24 optical array cables. Each OIM card (CRS-FCC-OIM-1S) has a set of 9 connectors and are located at the rear of the FCC. Each OIM is mated with one Fabric card in the front of the chassis via internal connectors.

Up to twenty-four OIM cards can be installed in the multishelf system FCCs. Depending on the number of FCCs used in your multishelf system configuration, you can have 2, 4, or 8 OIM cards per chassis.

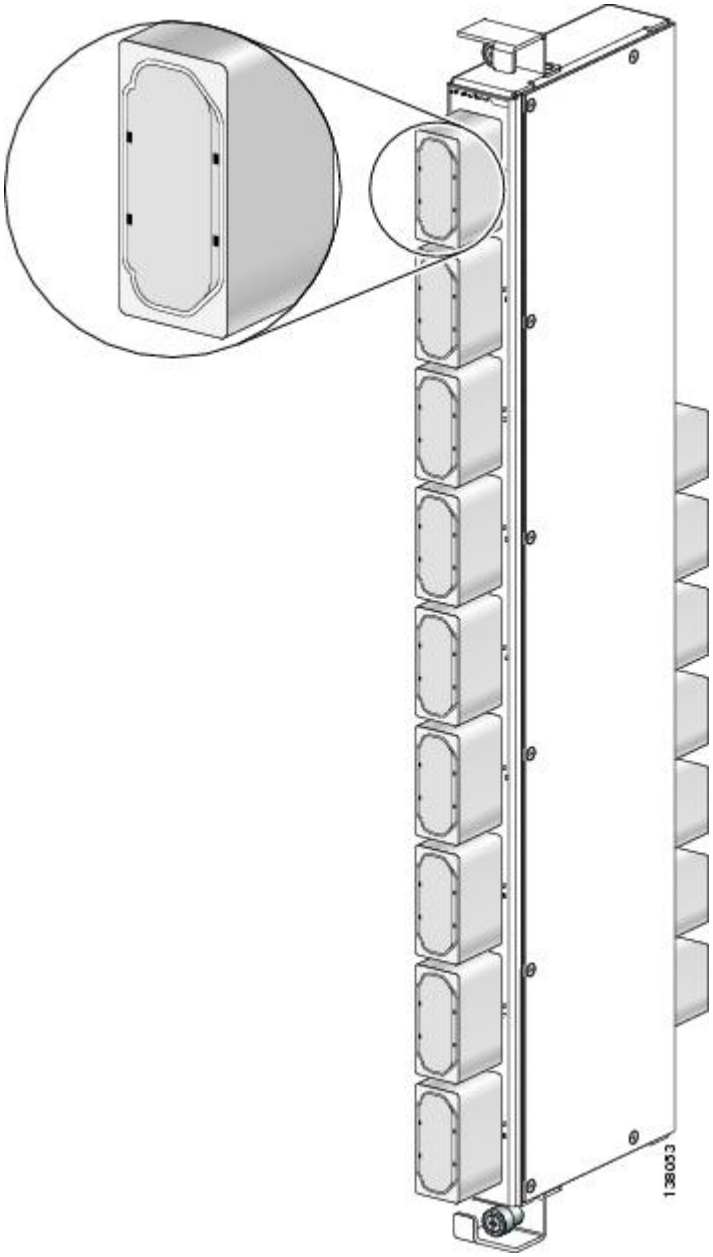
The OIM is a passive device and provides fiber X-connect functions. The OIMs distribute the fibers within each fabric cable to the ASICs on the S2 SFCs.

Note This system description includes high-level details of the OIM and OIM-LED cards. These components are an integral part of the cabling and interconnection process that must be followed when configuring a multishelf system. See Cisco CRS Carrier Routing System *Multishelf System Interconnection and Cabling Guide* for complete information on the OIM cards, fabric cables, and OIM-LED cards.

OIM Connectors

The OIM connectors on OIM cards are called bulkhead array adapters (BAAs). BAAs are used to terminate the fabric cables on the FCC side of a multishelf system. The other ends of the fabric cables are terminated on the fabric cards in the LCCs. See the Cisco CRS 16-slot LCC publications for details on the S13 SFCs. Below figure shows the BAAs on an OIM.

Figure 50: Single-Width OIM (Bulkhead Array Adapter Side)

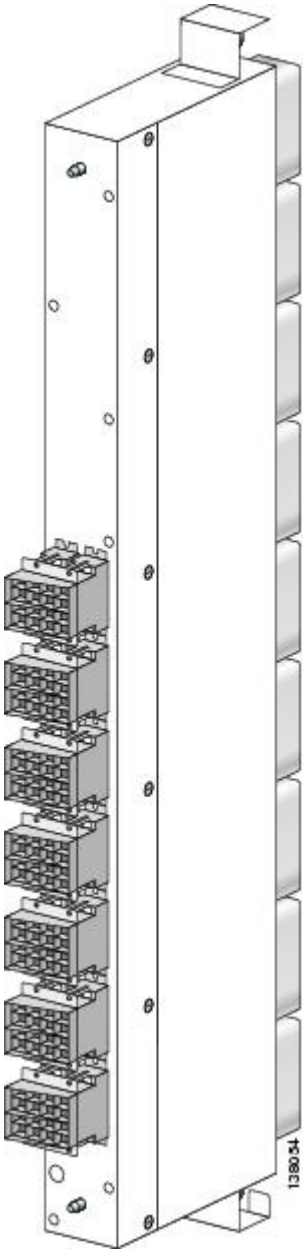


The connectors on the internal side of the OIM card are called high-density backplane mounted (HBMT) connectors, which provide a connection to the rear of the S2 SFCs within an FCC. Below figure shows the HBMT side of an OIM.

Caution Be careful while plugging the SFC to the HBMT connector. Excessive force may break the guide pins on the SFC and prevent successful connection of the SFC to the HBMT connector.

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

Figure 51: Single-Width OIM (HBMT Side)

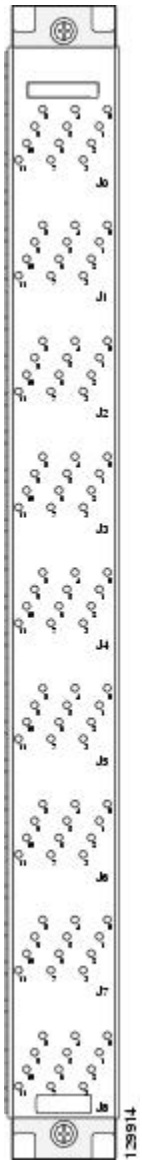


Each OIM mates with a corresponding S2 SFC within the FCC. See Cisco CRS Carrier Routing System Fabric Card Chassis Installation Guide for complete installation instructions and Cisco CRS Carrier Routing System *Multishelf System Interconnection and Cabling Guide* for complete cabling information.

OIM-LED Card Functional Overview

The OIM-LED card (CRS-FCC-LED) indicates the status of each fabric cable that connects a FCC to an LCC. The card gives visual indications of fabric cables that are operationally up or down, or incorrectly connected. It also specifies the correct place to connect or reconnect a fabric cable. Below figure shows the OIM-LED card.

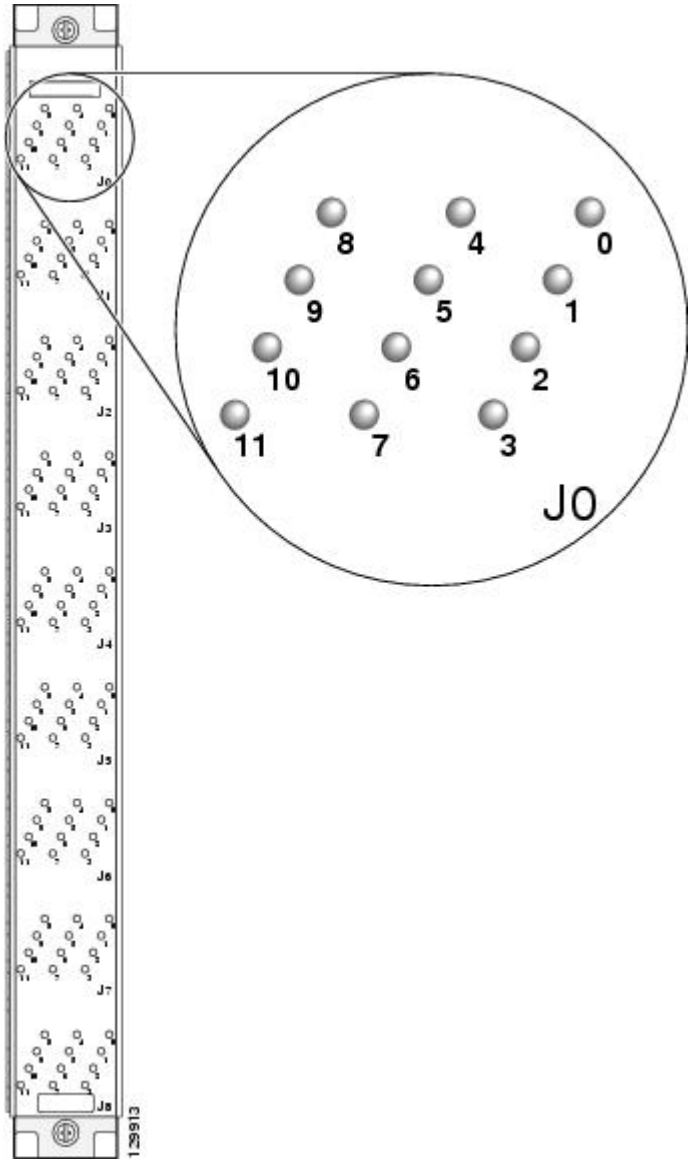
Figure 52: OIM-LED Card (Vertical View)



OIM-LED Card Overview

The OIM-LED card is used to facilitate cable installation and troubleshooting procedures. The status of a fabric cable is indicated through the various colors and states of the LED array. The below figure shows an exploded view of the LED indicators for each fabric cable.

Figure 53: Fabric Cable LEDs (Exploded View)

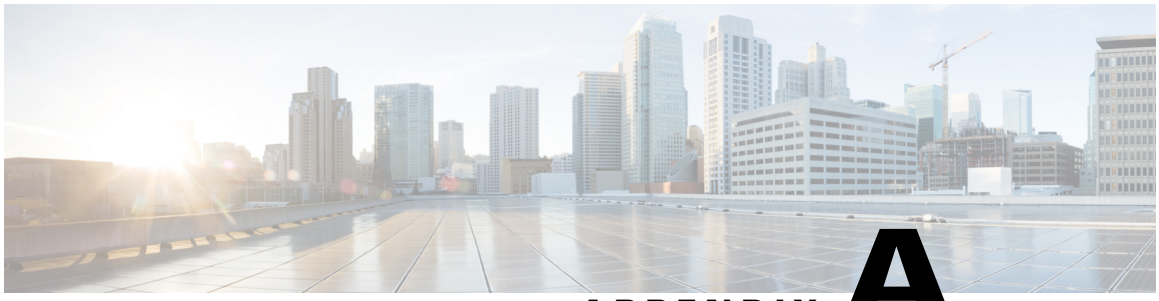


This table shows the various LED states.

Table 12: OIM-LED Card LED States

LED	Description
Off	A card to which this fabric cable is attached is either powered off or not recognized within the chassis, or the fabric cable is not connected at one end of the connection.
Green	The fabric cable is properly connected at both ends and data transmission is occurring.
Yellow	The fabric cable is properly connected at both ends, although some data errors are occurring.
Red	More than one fabric cable is not connected to the correct location.
Blinking red	A single fabric cable is not connected to the correct location.
Blinking green	The location where the incorrectly connected fabric cable should be connected is shown. This LED corresponds to the blinking red LED described previously for cases in which a single fabric cable is connected incorrectly.

Note Because the OIM-LED card is present only in the FCC, the LEDs indicate the status of the fabric cables in just the FCC. When any connection is incorrect, it is assumed that the connection at the LCC end is correct and the connection at the FCC needs to be relocated to the correct position, as indicated by the LEDs.



APPENDIX A

Specifications

This appendix contains tables that list the specifications for the main components of the Cisco CRS Multishelf System:

FCC Specifications

This table lists the system specifications for the FCC.

Table 13: FCC Specifications

Chassis Dimensions	
Height with power shelves	84 in. (213.4 cm)
Width	23.546 in. (59.807 cm)
Depth	38.264 in. (97.191 cm) without doors and cosmetics40.236 in. (102.199 cm) with front and rear doors

Chassis Dimensions	
Overhead clearance	24 in. (61 cm) overhead clearance recommended. This overhead clearance includes 12 in. (30.5 cm) for the tray and 12 in. (30.5 cm) for access to the cables.
Chassis Weight	
Chassis shipping weight	1075 lb (487.6 kg) fabric chassis with shipping crate and pallet 780 lb) chassis with fans and blanks as shipped
Chassis, fully loaded with cards and cosmetics (doors, panels, grilles, and so on)	1627 lb (738 kg)
Floor Loading	
Chassis footprint floor contact area	4.72 sq ft (4385 sq. cm) 680 sq in. (4385 sq. cm)
Maximum floor loading	1658 lb/4.72 sq ft = 351 lb/sq. ft752 kg/4385 sq cm = 0.171 kg/sq. cm
Supported Cards and Modules	24 switch fabric cards (SFCs) 2 shelf controller Gigabit Ethernet (SCGE) cards 2 fan trays 1 air filter
Power Shelves	Fixed or modular configuration power shelves(Cannot mix fixed and modular configuration power shelves) 2 AC or 2 DC power shelves(Cannot mix AC and DC power shelves)
DC power shelf	Fixed configuration power shelf supports three DC power entry modules (PEMs) and one alarm module. Modular configuration power shelf supports up to six DC power modules and one alarm module.
AC power shelf	Fixed configuration power shelf supports three AC to DC rectifiers and one alarm module. Modular configuration power shelf supports up to four power modules and one alarm module.
Maximum Power Consumption (total input power)	
Fixed Configuration	
Maximum DC	9.0 kW

Chassis Dimensions	
Maximum AC	11.1 kW (Delta or Wye 3-phase)
Modular Configuration	
Maximum DC	13.2KW (assume 95% efficiency)
Maximum AC	12.6KW (assume 95% efficiency)
	Note Proper grounding is also required at the site to ensure that equipment is not damaged by lightning or power surges.
Power Redundancy (2N)	
Fixed Configuration	
DC	2 A battery plant feeds required for one power shelf, and2 B battery plant feeds required for the other shelf
AC (Delta or Wye 3-phase)	Two independent Delta or Wye 3-phase power sources required, one for each power shelf
Modular Configuration	
DC	2N: six A battery plant feeds and six B battery plant feeds
AC	2N: four A AC single phase power sources and four B single phase power sources
DC Input	
Nominal input voltage	–48 VDC North America–54 VDC Telco (RBOC)–60 VDC European Community(range –42 to –75 VDC)
Input current	46 A maximum at –48 VDC 37 A maximum at –60 VDC 55 A maximum at –40 VDC (low voltage extreme)
AC Input, Delta 3-phase	3W + PE (3 wire + protective earthing[1])
Input voltage	3-phase 200 to 240 VAC, phase-to-phase (nominal)(range 180 to 264 VAC, phase-to-phase)
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)

Chassis Dimensions	
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)
Line frequency	50-60 Hz (nominal)(range 47 to 63 Hz)
Recommended AC service	40 A (North America)32 A (International)

1 Protective earthing conductor (ground wire).

S2 Switch Fabric Card Specifications

This table lists the system specifications for the S2 switch fabric card.

Table 14: Switch Fabric Card Specifications

Module type	Product ID	Specification
S2 switch fabric card (SFC)	CRS-FCC-SFC= CRS-FCC-SFC-140 CRS-FCC-SFC-400	Height—20.56 in. (52.22 cm) Depth—11.18 in. (28.40 cm) Width—1.4 in. (3.56 cm) Weight—11.9 lb (5.40 kg) Power consumption—up to 229 W 8 installed in one, two, or four FCCs

SCGE Card Specifications

This table lists the system specifications for the shelf controller Gigabit Ethernet card.

Table 15: SCGE Card Specifications

Module type	Product ID	Specification
22-port shelf controller Gigabit Ethernet	CRS-FCC-SC-22GE=CRS-FCC-SC-22GE-B=	Height—2 in. (5.08 cm) Depth—24.6 in. (62.48 cm) Width—20.5 in. (52.07 cm) Weight—16.35 lb (7.41 kg) Power consumption—100 W (Typical) PCMCIA flash cards: 2 cards, 1 GB each (one nonremovable) CRS-FCC-SC-22GE= only Interfaces: • RJ-45 CONSOLE and AUX • 22 Gigabit Ethernet ports for control plane and management (1000BASE-LX) Up to 2 SCGE cards installed in an FCC

OIM and OIM-LED Card Specifications

This table lists the system specifications for the optical interface module and the optical interface module LED card.

Table 16: OIM and OIM-LED Card Specifications

Module Type	Product ID	Specification
Optical interface module (OIM)	CRS-FCC-OIM-1S=	Height—20.56 in. (52.22 cm) Depth—11.18 in. (28.40 cm) Width—2.8 in. (7.11 cm) Weight—12.75 lb (5.78 kg) Power consumption—166 W 8 distributed in one, two, or four FCCs

Module Type	Product ID	Specification
Optical interface module LED card (OIM-LED)	CRS-FCC-LED=	Height—20.56 in.(52.22 cm) Depth—11.18 in. (28.40 cm) Width—2.8 in. (7.11 cm) Weight—12.25 lb (5.56 kg) Power consumption—334 W 2 in every FCC

Regulatory, Compliance, and Safety Specifications

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