# Power and Cooling Requirements

This chapter describes the power and cooling requirements for the Cisco CRS Series 16-Slot Line Card Chassis Enhanced. It contains the following sections:



# Line Card Chassis 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. At the shelf level, the power system provides 2N redundancy; the PMs themselves provide load-share redundancy. The power system also includes SNMP MIBS and XML support.

The line card chassis can be either DC or AC powered. The AC power system requires single-phase AC input power to the power shelves. If you have 3-phase AC Delta or AC Wye at your equipment, a Cisco CRS 3-Phase AC Power Distribution Unit*(PDU)* will be required to convert 3-phase AC input power to single-phase AC input power for the power shelf.

**Note** In an AC power system, PDU refers to the Cisco CRS 3-Phase AC Power Distribution Unit which is required to convert 3-phase AC-Wye or AC-Delta input power to single-phase AC input power for the AC power shelf. For further information and installation instructions, see http://www.cisco.com/en/US/docs/routers/crs/crs1/mux_box/installation/quick_start/guide/crs_pdu_qs.html Cisco CRS 3-Phase AC Power Distribution Unit Installation Guide.

Maximum input power requirements for the Cisco CRS 16-Slot Line Card Chassis Enhanced router are as follows:

- DC-powered chassis requires up to a maximum of 19,091 watts (19.09 kW) of DC input power when the chassis is fully loaded.
- AC-powered chassis requires up to a maximum of 19,565 watts (19.56 kW) of AC input power when the chassis is fully loaded.

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

**Note** These power requirements are for a fully loaded Cisco CRS 16-Slot Line Card Chassis Enhanced router with sixteen PLIMs. A chassis with fewer PLIMs uses slightly less power. However, it is a good idea to allocate this much power for each chassis to ensure that enough power is available for future system expansion.

See the Cisco CRS Carrier Routing System 16-Slot Line Card Chassis Enhanced Router System Description for detailed information about how each power system operates and distributes power to the components in the chassis.

# General Power and Grounding Requirements

This section describes the power and grounding requirements you must consider when planning the site facilities for the line card chassis. In addition, see the DC Power System, on page 7 section or the AC Power System, on page 9 section for additional power requirements.

**Note** A certified electrician should review the information in these sections to ensure that the installation site meets these requirements. For larger system configurations, consult a facilities electrical expert to understand the load that the routing system may put on the facility power plant.

General power and grounding requirements are:

- Installation of the Cisco CRS 16-Slot Line Card Chassis Enhanced router must follow national and local electrical codes:
  - In the United States—United States National Fire Protection Association (NFPA) 70 and United States National Electrical Code (NEC)
  - In Canada—Canadian Electrical Code, part I, CSA C22.1
  - In other countries—International Electrotechnical Commission (IEC) 60364, parts 1 through 7
- Two separate and independent AC or DC power sources are needed to provide 2N redundancy for system power. Each power source requires its own circuit breaker.
- Site must provide short-circuit (over-current) protection for devices.
- Proper grounding is required at the site to ensure that equipment is not damaged by lightning and power surges. In addition:
  - Chassis grounding is required for AC and DC-powered systems.

- For AC-powered systems, a grounding-type AC power outlet is required.

- Site power planning must include the power requirements for any external terminals and test equipment you will use with your system.

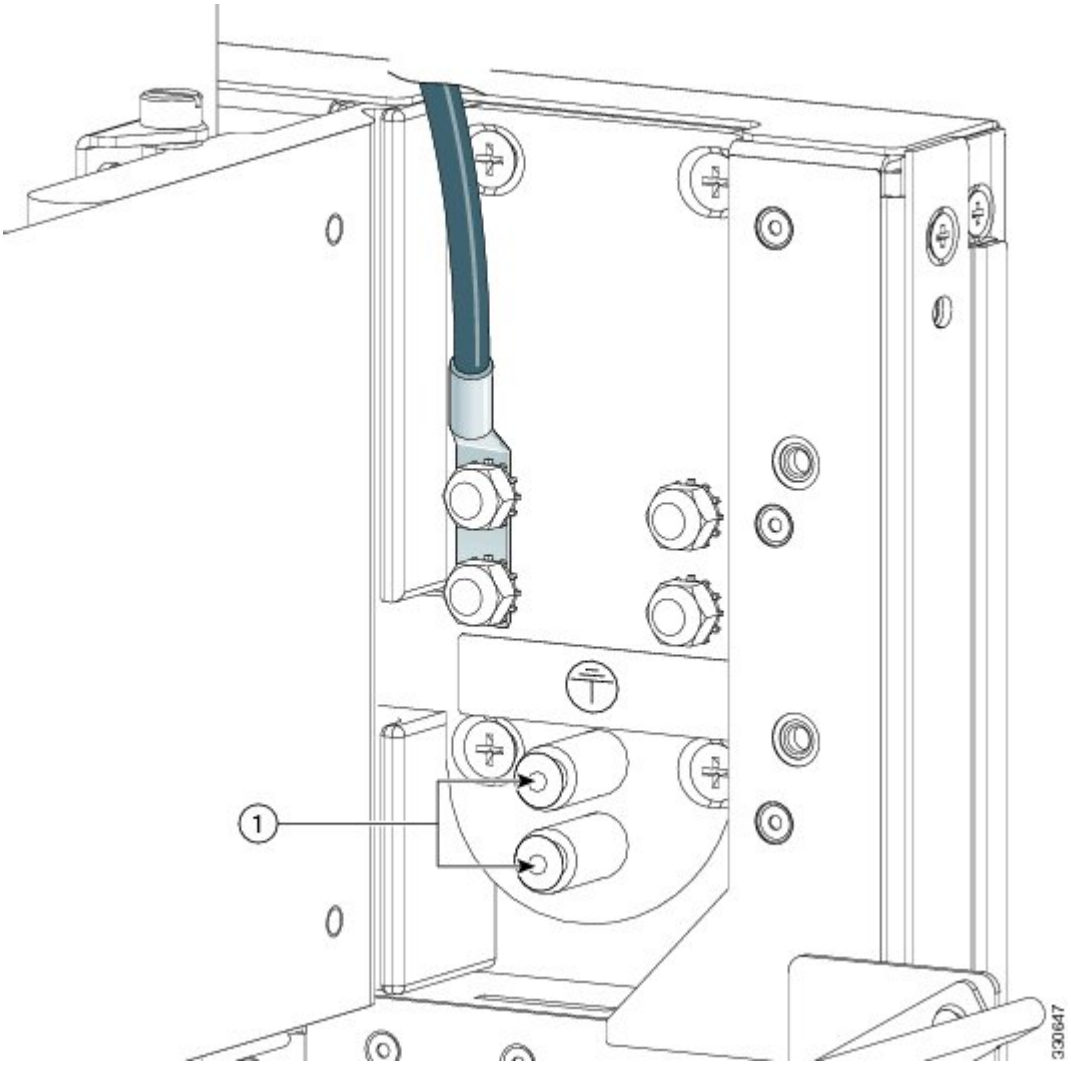
**Note** Be sure to review the safety warnings in Regulatory Compliance and Safety Information for the Cisco CRS Carrier Routing System before attempting to install the routing system.

# Bonding and Grounding Guidelines

The router chassis has two safety earth ground connections. The chassis allows you to connect the central office ground system to the bonding and grounding receptacles on the router chassis. Threaded ground inserts are located on top of the chassis rear (MSC) side panel to the right of the lower power shelf. There are also two sets of grounding studs located at the bottom of the rear (MSC) side of the chassis. The following figure shows the NEBS and grounding points at the top on the rear (MSC) side of the chassis. This grounding point is also referred to as the network equipment building system (NEBS) bonding and grounding point.

**Note** These bonding and grounding receptacles are provided to satisfy the Telcordia NEBS requirements for bonding and grounding connections.

***Figure 1: NEBS Bonding and Grounding Points—Top Rear (MSC) Side of Chassis***

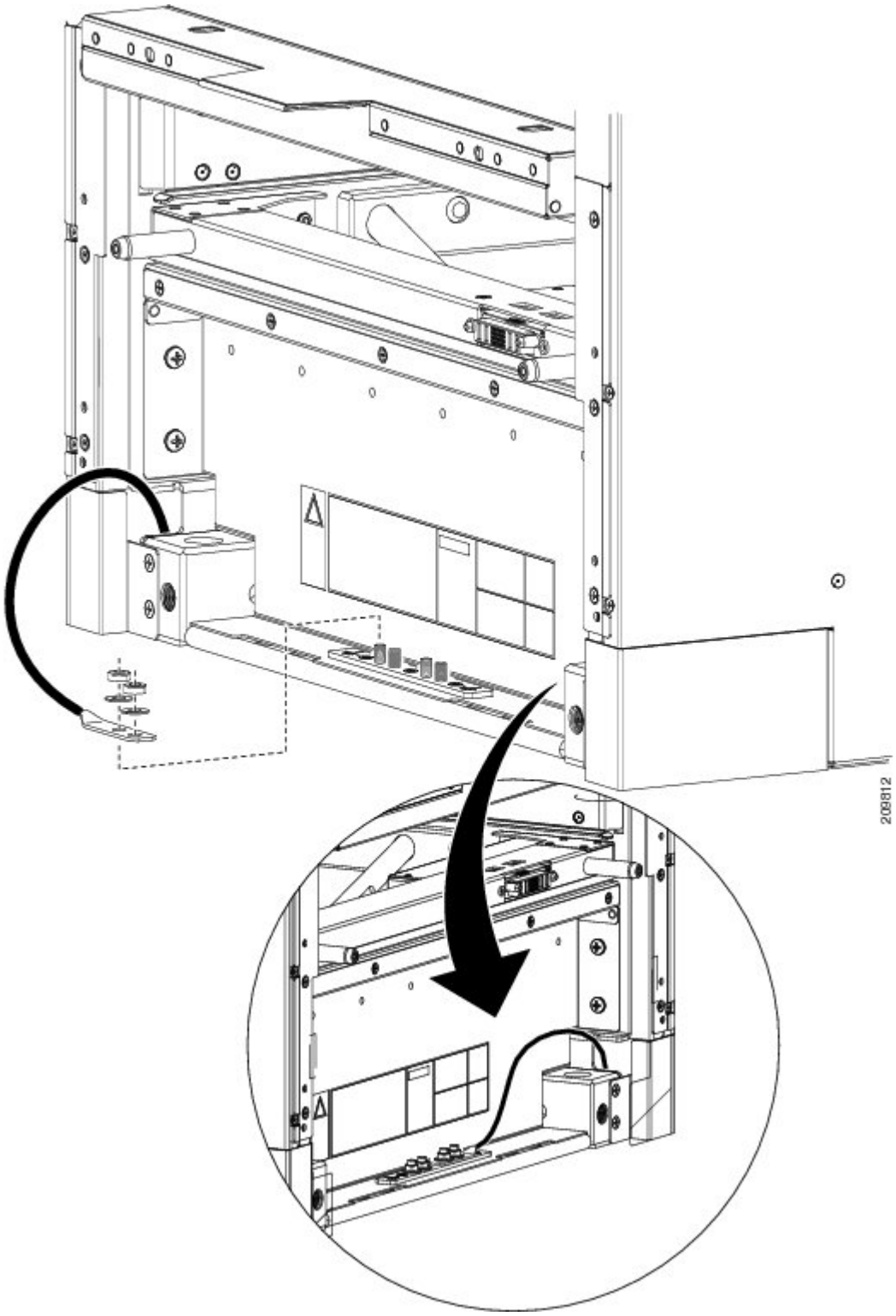



| | |
|---|---|
| 1 | Two Torx security screws |

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

The following figure shows the grounding points located at the bottom of the rear (MSC) side of the chassis.

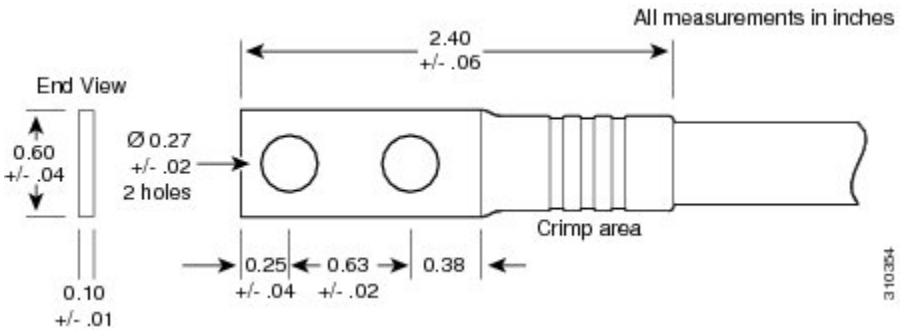
***Figure 2: NEBS Bonding and Grounding Points - Bottom Rear of Chassis***




To connect the chassis to a ground connection, you must have the following:

- One straight (180 degree) grounding lug that has two M6 bolt holes with 0.63 inch (5/8 inch) (1.60 cm) of spacing center to center between them and a 6-AWG or larger multistrand copper cable. See the following figure.

*Figure 3: 180-Degree (Straight) Chassis Ground Lug*




- Two M6 hex head bolts and integrated locking washers are pre-installed on the chassis.
- Cisco recommends at least 6 AWG multistrand copper cable. This cable is not available from Cisco Systems; it is available from any commercial cable vendor. The cable should be sized according to local and national installation requirements.

**Note** The DC return of this system should remain isolated from the system frame and chassis (DC-I: Isolated DC Return).

# DC Power System

Each DC powered chassis contains two DC power shelves for 2N redundancy. The power shelves contain the input power connectors. Each shelf can contain up to eight DC PMs. The power shelves and DC PMs are field replaceable.

## DC Power Requirements

Observe the following guidelines for DC-powered chassis. In addition, be sure to review the requirements in the General Power and Grounding Requirements, on page 2 section.

- Each DC-powered chassis requires up to a maximum of 19,091 watts (19.09 kW) of DC input power when the chassis is fully loaded.
- Two separate and independent power sources are required for N+N redundancy, each providing nominal –48/-60 VDC, 60 A service (eight inputs per shelf). The system will operate with power to only one shelf but will not have N+N redundancy.
- The power shelves are grounded internally.

- All power connection wiring should conform to the rules and regulations in the National Electrical Code (NEC) and any local codes. In addition, make sure that the wiring conforms to any internal requirements at the installation site
- Each DC power source must comply with the safety extra-low voltage (SELV) requirements in UL 60950-1, CSA-C22.2 No. 60950-1, EN60950-1, AS/NZS 60950, and IEC60950-1.
- A DC-powered system should be installed in a restricted access area in accordance with the National Electric Code, ANSI/NFPA 70.
- All components in the area where DC input power is accessible must be properly insulated.
- If it is not possible to rely on the identification of the earthed conductor in the DC mains supply, whereby the equipment is not provided with a two-pole disconnect device, then a two-pole disconnect device is to be provided external to the equipment.

The following table lists the DC input current and voltage specifications.

***Table 1: DC Input Current and Voltage Information***

| | |
|---|---|
| Nominal input voltage | –48 VDC North America–60 VDC European Community(range: –40 VDC to –72 VDC) |
| Input line current | 50 A maximum at –48 VDC40 A maximum at –60 VDC60 A maximum at -40 VDC |

# DC Power Shelf Wiring

Each DC power shelf contains eight pairs of double-stud terminals, covered by a plastic terminal block cover. To provide 2N power redundancy, one power shelf should be connected to the central office “A” power bus and the other power shelf should be connected to the “B” power bus.

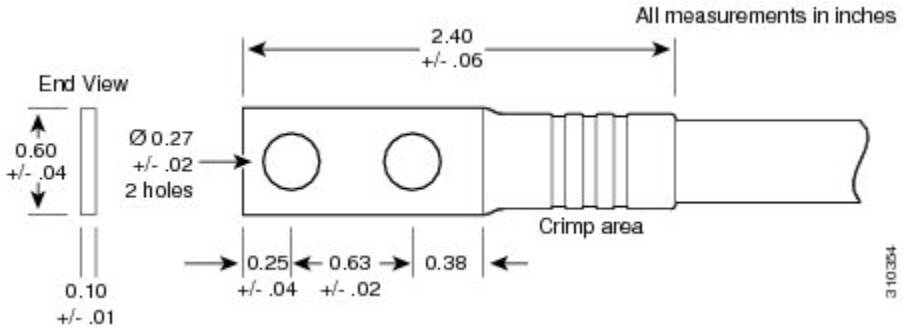
The requirements for the DC input power connections are as follows:

- Each power shelf requires up to eight pairs of distribution cables, DC (–48) and RTN (+).
- Paired battery and RTN cables should have the same cable lengths and should run together for equalization.
- Use the appropriate wire gauge for –48/-60 VDC, 60 A service. We recommend that you use a commensurately rated, high-strand-count copper cable. This cable is not available from Cisco Systems; it is available from any commercial vendor.

**Caution** A certified electrician must select the appropriate DC input power cable based on standard electrical practices, such as derating factors, wiring type, operating temperatures, and so on. The electrician must verify that the cable complies with the National Electrical Code (NEC) and local codes and any guidelines in effect at the installation site. At minimum, DC input power cables must be 6-AWG or heavier and rated for 90°C (194°F) temperature or higher.

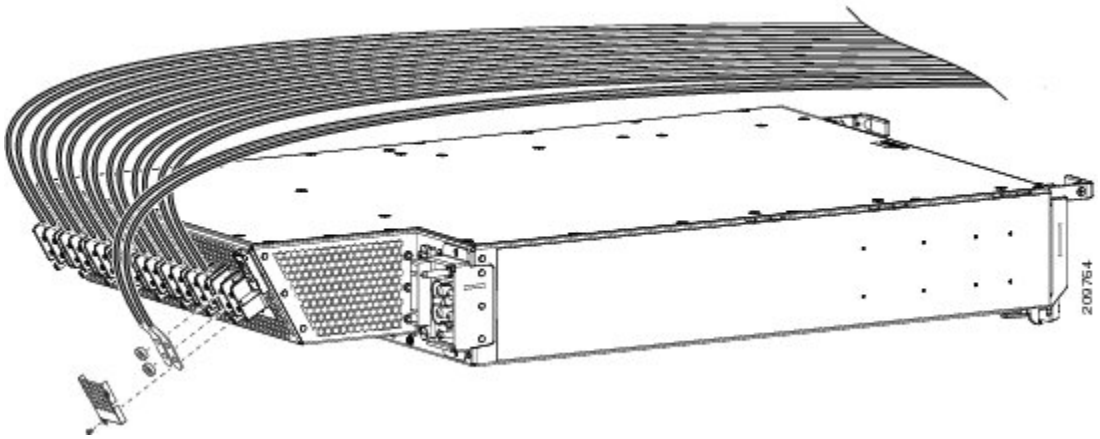
- Each DC input power cable is terminated at the power shelf by a cable lug. The cable lug must be dual hole and able to fit over M6 terminal studs at 0.63-inch (1.60 cm) centers. For example, you could terminate a 6-AWG power cable with a cable lug such as Panduit part number LCD2-14A-Q or equivalent. See the following figure.

***Figure 4: DC Power Cable Lug***




The following figure shows the DC input power cables connected to the DC power shelf terminal studs.

***Figure 5: DC Power Shelf Cable Connections***



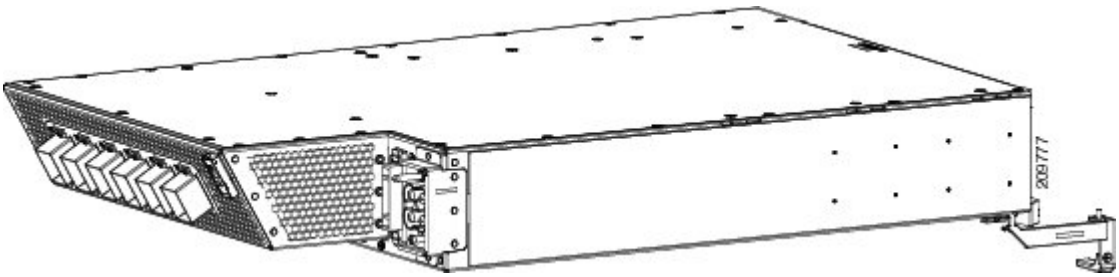

# AC Power System

The chassis power system provides the necessary power for chassis components. Site power configurations may differ, depending on the input source available, i.e. single-phase AC, AC Delta or AC Wye.

Each AC powered chassis contains two AC power shelves for 2N redundancy. The power shelves contain the input power connectors. Each shelf can contain up to six AC PMs. The power shelves and AC PMs are field replaceable.

The following figure shows the rear side of the AC power shelf.

***Figure 6: Rear of AC Power Shelf***




# AC Power Requirements

In addition to the requirements in the General Power and Grounding Requirements, on page 2 section, AC input power requirements are as follows:

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

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

For detailed AC power specifications, see the Line Card Chassis Specifications section.

# AC Power Shelf Wiring

The AC power shelf is shipped with AC power cords. Each AC power shelf accepts up to six power cords. Each power cord is 4.25 m in length and different plug types (pre-attached) are available, depending on the locale. AC cords are available for the following locales:

- North America
- Europe
- United Kingdom
- Italy
- Australia

The following table lists the single-phase AC-input cord power options and Cisco product numbers for the Cisco CRS 16-Slot Line Card Chassis Enhanced router with an AC power shelf installed. The table also references power cord illustrations.

***Table 2: AC-Input Power Cord Options***

| Locale | Cisco Product Number | Plug Rating | Reference Illustration |
|---|---|---|---|
| North America | CRS-AC-CAB-NA(=) | 20 A/250 VAC | Figure 7: North America—AC-Input Power Cord |
| Europe | CRS-AC-CAB-EU(=) | 16 A/250 VAC | Figure 8: Europe—AC-Input Power Cord |
| United Kingdom | CRS-AC-CAB-UK(=) | 13 A/250 VAC | Figure 9: United Kingdom—AC-Input Power Cord |
| Italy | CRS-AC-CAB-IT(=) | 16 A/250 VAC | Figure 10: Italy—AC-Input Power Cord |
| Australia | CRS-AC-CAB-AU(=) | 15 A/250 VAC | Figure 11: Australia—AC-Input Power Cord |

*Figure 7: North America—AC-Input Power Cord*

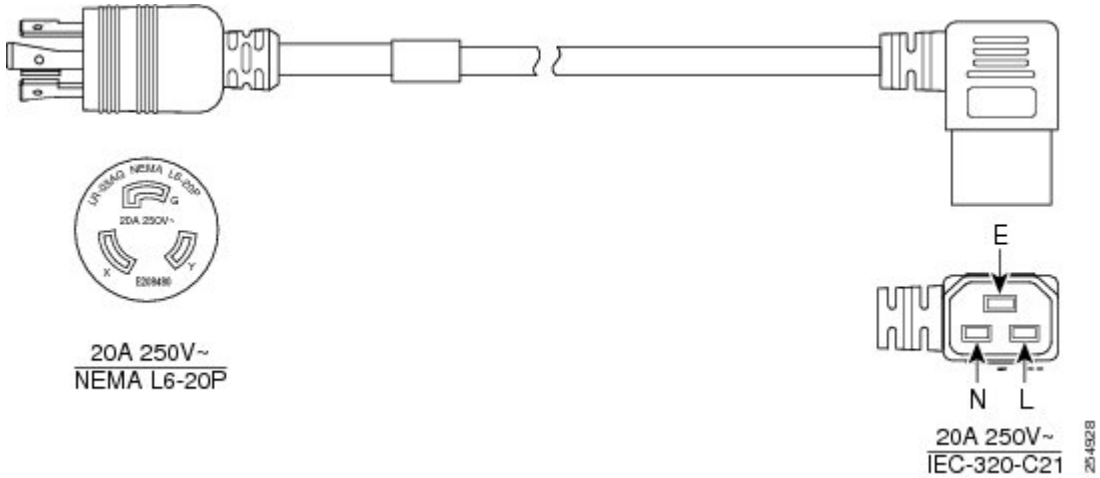



*Figure 8: Europe—AC-Input Power Cord*

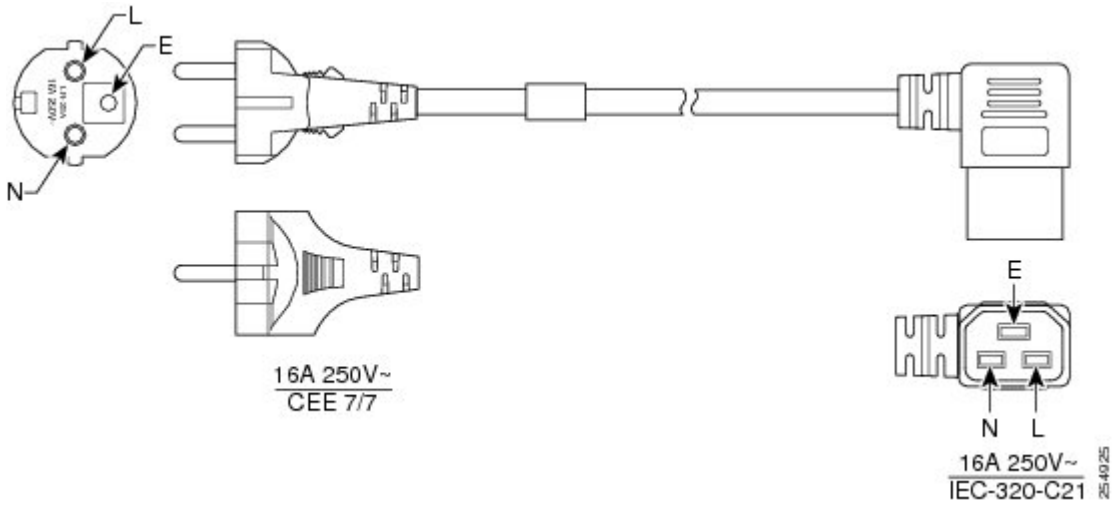
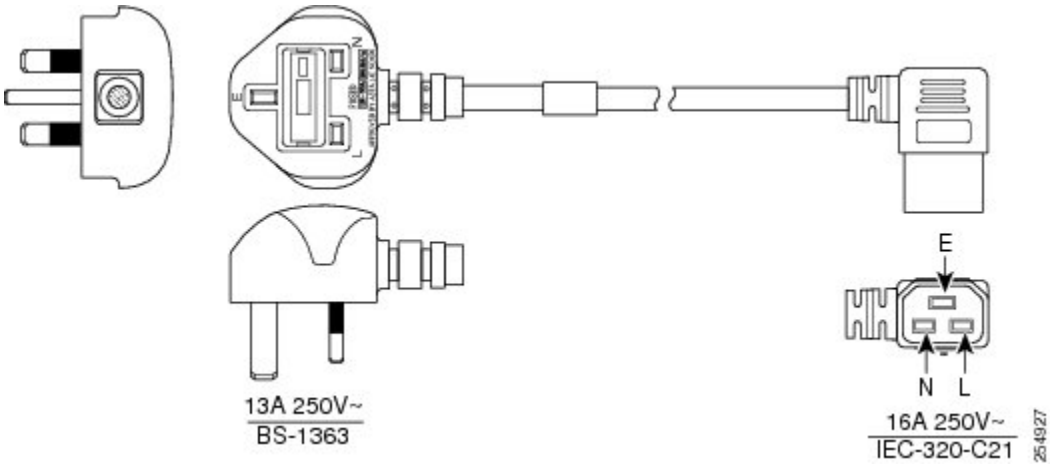



*Figure 9: United Kingdom—AC-Input Power Cord*


E
N
L
13A 250V~
BS-1363
16A 250V~
IEC-320-C21
254927

**Note** The BS-1363 standard rates cord sets up to a maximum of 13 A, 250 VAC for the C-21 plug. Therefore, the building circuit breaker must be 13 A maximum. Installation of the Cisco CRS 16-Slot Line Card Chassis Enhanced router must follow national and local electrical codes.

***Figure 10: Italy—AC-Input Power Cord***

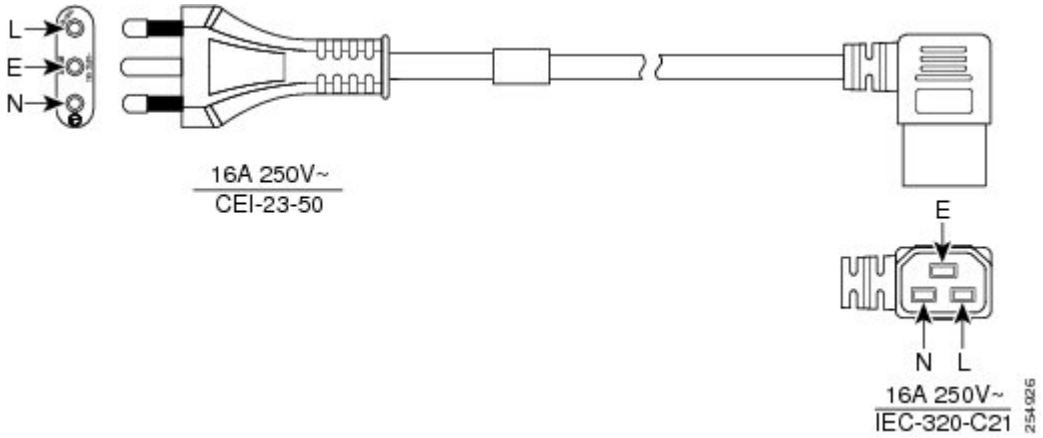
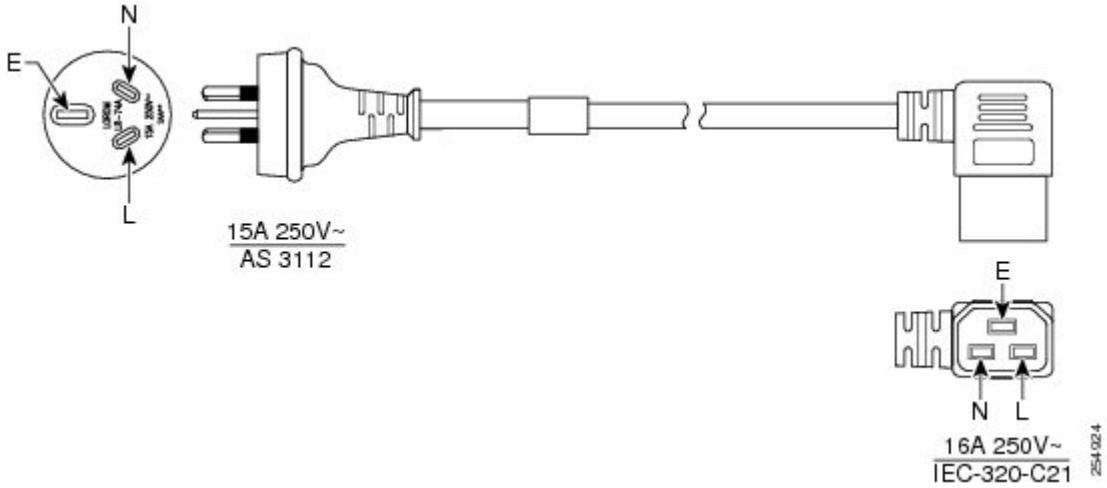



***Figure 11: Australia—AC-Input Power Cord***




**Note** The AS 3112 standard rates cord sets up to a maximum of 15 A, 250 VAC for the C-21 plug. Therefore the building circuit breaker must be 15 A maximum. Installation of the Cisco CRS 16-Slot Line Card Chassis Enhanced router must follow national and local electrical codes.

# Converting 3-Phase AC to Single-Phase AC

If you have 3-phase AC Delta or AC Wye input power at your equipment, a Cisco CRS 3-Phase AC PDU will be required to convert 3-phase AC Delta or AC Wye input power to single-phase AC input power that connects directly to the rear of the AC power shelf. The Cisco CRS 3-Phase AC PDU includes either an AC Delta or AC Wye power interface, and has power input and power output cords entering and exiting the box.

There are two versions of the Cisco CRS 3-Phase AC PDU for the Cisco CRS 16-Slot Line Card Chassis Enhanced router available:

- CRS-16-PDU-Delta—Redundant 3-phase to single-phase Delta PDU for the Cisco CRS 16-Slot Line Card Chassis Enhanced router, 4 input/12 output
- CRS-16-PDU-Wye—Redundant 3-phase to single-phase Wye PDU for the Cisco CRS 16-Slot Line Card Chassis Enhanced router, 2 input/12 output

In addition to the requirements in the General Power and Grounding Requirements, on page 2 section, AC input power requirements are as follows:

- Two separate and independent AC power sources are required, one for each PDU. Each PDU should be connected to a different power source to provide 2N power redundancy in case a power source fails. The system will operate with power to only one shelf but will not have N+N redundancy.
- Each AC power source must provide 3-phase VAC power, and have its own circuit breaker.
- AC Delta input:
  - 3-phase, 200 to 240 VAC (phase-to-phase), 50 to 60 Hz.
  - Input current: 2 x 27.7A.
  - Each PDU has two Delta input power cords preattached, each with a 4-pin IEC 60309 plug (3 wire + protective earthing [3W+PE]). The power cord is rated for 250 VAC, 60 A, and plugs into a similarly rated IEC 60309 receptacle.
  - Each PDU has six single phase output cords preattached, each with a 90 degree IEC-320-C21 plug that plugs into a IEC-320-C22 inlet on the rear of the AC power shelf.
- AC Wye input:
  - 3-phase, 200 to 240/346 to 415 VAC (phase-to-neutral), 50 to 60 Hz.
  - Input current: 32 A.
  - Each PDU has one Wye input power cord preattached, with a 5-pin IEC 60309 plug (3 wire + neutral + protective earthing conductor (ground wire) [3W+N+PE]). The cord is rated for 415 VAC, 16 A, and plugs into a similarly rated IEC 60309 receptacle.
  - Each single PDU has six single phase output cords preattached, each with a 90 degree IEC-320-C21 plug that plugs into a IEC-320-C22 inlet on the rear of the AC power shelf.

- Grounding-type AC power outlet is required. The PDUs are shipped with AC power cords that have a grounding-type plug. As a safety feature, the plugs fit only a grounding-type AC power outlet.

***Figure 12: AC Delta Power Cord Plug***


***Figure 13: AC Wye Power Cord Plug***


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

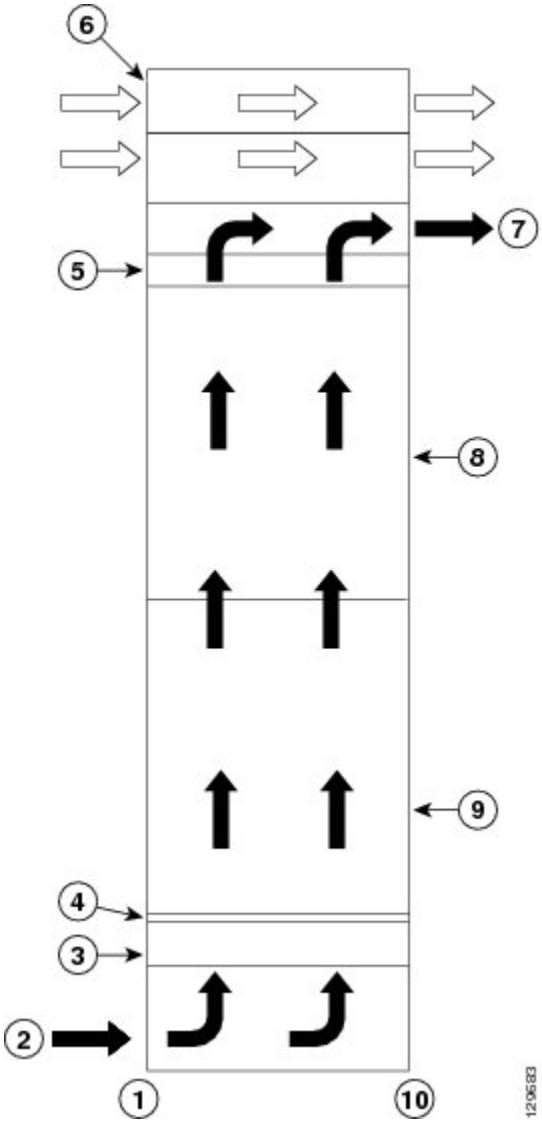
# Cisco CRS 16-Slot Line Card Chassis Enhanced Router Airflow

The airflow through the Cisco CRS 16-Slot Line Card Chassis Enhanced router is controlled by a push-pull configuration. As shown in the following figure, ambient air flows in at the bottom front of the Cisco CRS 16-Slot Line Card Chassis Enhanced router and up through the card cages until it exhausts at the top rear. The bottom fan tray pulls ambient air in from the bottom front of the chassis; the top fan tray pushes warm air out the back of the chassis. The power modules in the power shelves have their own self-contained cooling fans.

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

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

***Figure 14: Airflow Through Line Card Chassis***




| | | | |
|---|---|---|---|
| 1 | Front (PLIM) side of chassis | 6 | Power shelves (two installed) |
| 2 | Air intake | 7 | Air exhaust |
| 3 | Lower fan tray | 8 | Upper card cage |
| 4 | Air filter | 9 | Lower card cage |

| | | | |
|---|---|---|---|
| 5 | Upper fan tray | 10 | Rear (MSC) side of chassis |

The Cisco CRS 16-Slot Line Card Chassis Enhanced router has a maximum airflow of 2,700 cubic feet (76,455 liters) per minute.