Cooling System

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

- 16-Slot Line Card Chassis Fan Tray, on page 5
- 16-Slot Line Card Chassis Fan Controller Card, on page 6
- Cooling System Overview, on page 1
- 16-Slot Line Card Chassis Fan Tray, on page 5
- 16-Slot Line Card Chassis Fan Controller Card, on page 6

Cooling System Overview

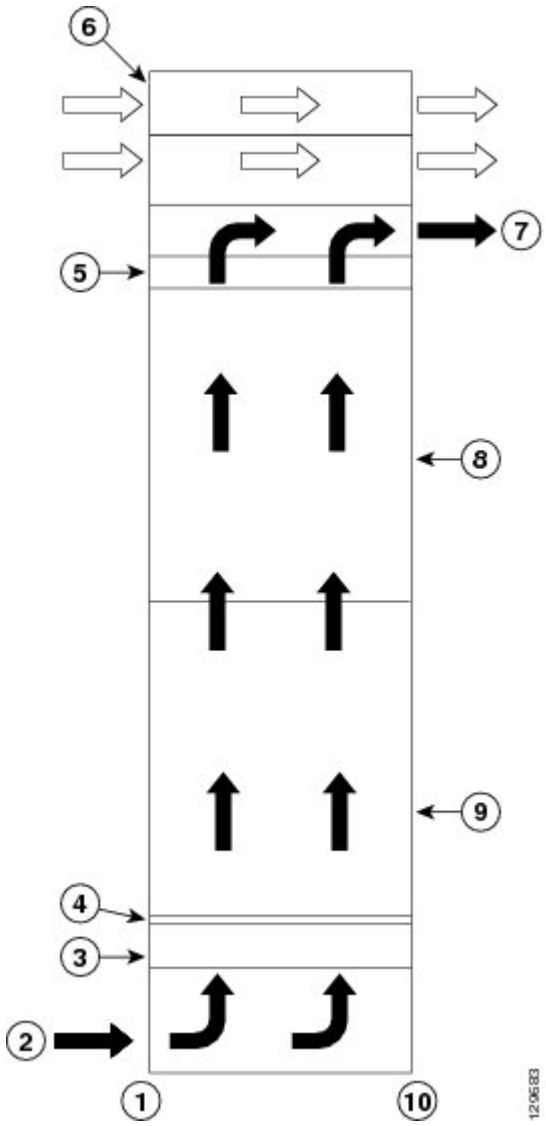
The Cisco CRS 16-slot line card chassis cooling system includes the components and control system that draw ambient air through the system to dissipate heat and keep the system operating in a desired temperature range. The complete Cisco CRS 16-slot line card chassis cooling system includes:

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

16-Slot Line Card Chassis Airflow

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

Figure 1: Airflow Through the FCC



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

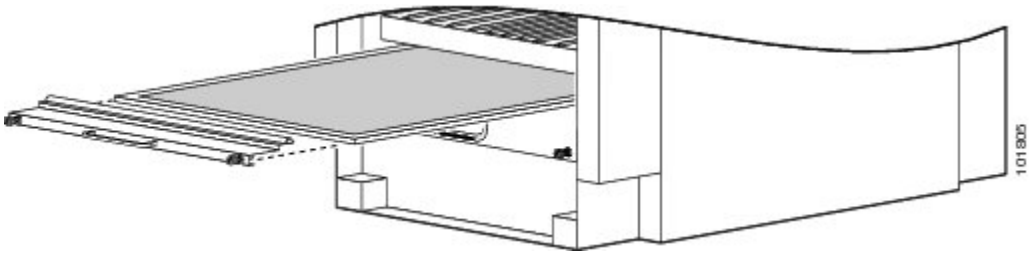
Note The Cisco CRS 16-slot line card chassis has a maximum airflow of 2050 cubic feet per minute.

The bottom fan tray pulls in ambient air from the bottom front of the chassis and the top fan pulls the air up through the card cages where the warm air is exhausted out the top rear of the chassis.

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

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

Figure 2: Air Filter



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

Cooling System Operation

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

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

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

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

Thermal Alarms

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

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

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

Quick-Shutdown Mode

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

Fan Controller Redundancy in the Line Card Chassis

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

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

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

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

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

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

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

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

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

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

16-Slot Line Card Chassis Fan Tray

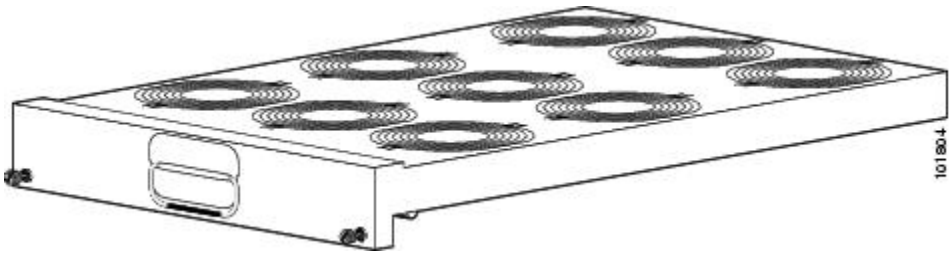
The Cisco CRS 16-slot line card chassis has two fan trays (Figure 1: Airflow Through the FCC, on page 2), one just below the lower card cage and the other just above the upper card cage. The chassis can run with only one fan tray operating. If a failure occurs in one fan tray, the other fan tray acts as the redundant fan tray to assure fault-tolerant system performance; the chassis continues to operate while the failed fan tray is replaced.

Figure 1: Airflow Through the FCC, on page 2 shows the Cisco CRS 16-slot line card chassis fan tray operates in either the upper or lower fan tray slots.

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

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

Figure 3: Fan Tray



The fan tray has the following physical characteristics:

- Overall depth—30.9 in. (78.5 cm)

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

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

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

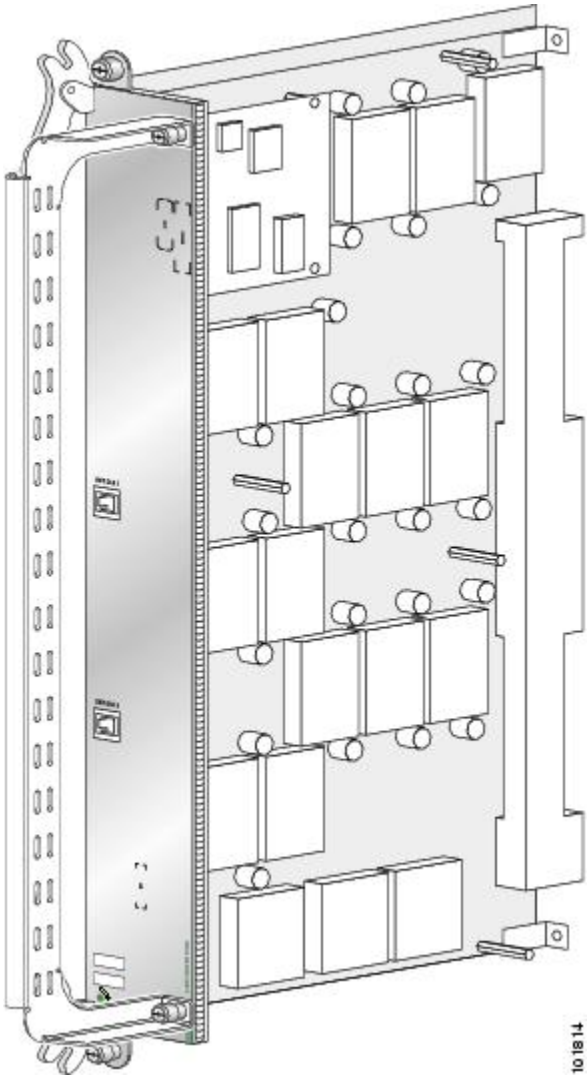
16-Slot Line Card Chassis Fan Controller Card

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

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

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

Figure 4: 16-Slot Line Card Chassis Fan Controller (LCFC) Card



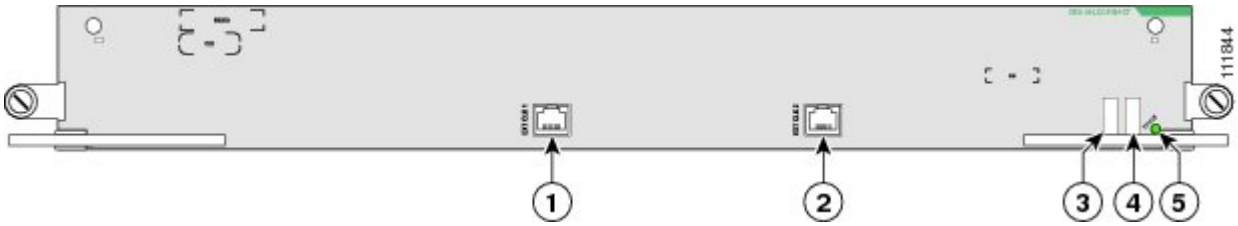
The line card chassis fan controller cards provide the following functions:

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

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

The following figure shows the fan controller card front panel.

Figure 5: Fan Controller Card Front Panel



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