Cooling System

This chapter describes the components that make up the cooling system of the Cisco CRS Series Enhanced 16-Slot Line Card Chassis (LCC). It contains the following sections:

Cooling System Overview

The LCC 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. It is designed to support the 40G, 140G, 400G and future higher capacity fabric cards and line cards. The complete LCC 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

Chassis Airflow

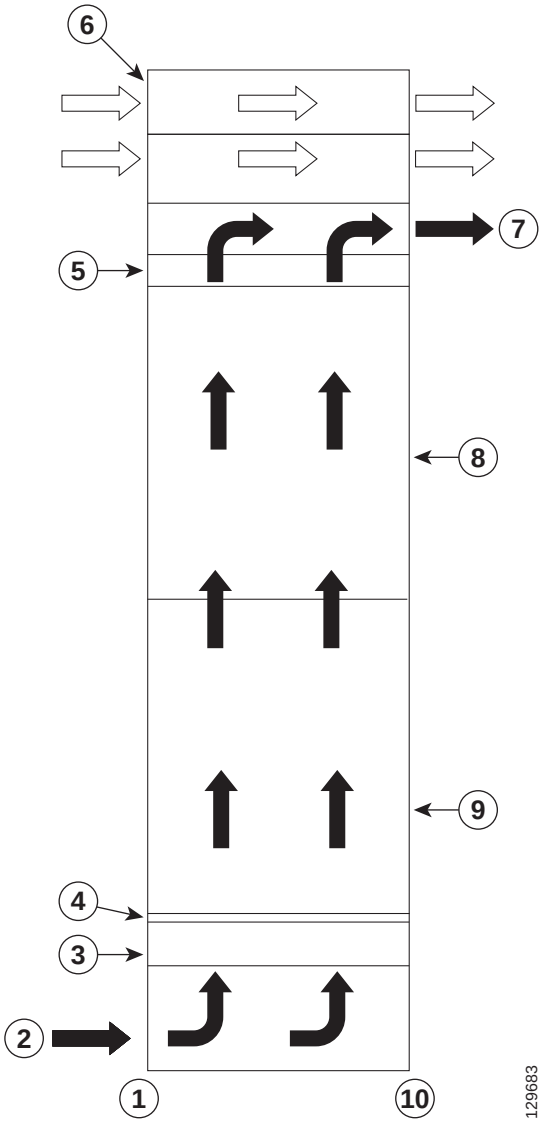
The airflow through the LCC is controlled by a push-pull configuration. As shown in Figure 3-1, ambient air flows in at the bottom front of the LCC and up through the card cages until it exhausts at the top rear. The bottom fan tray pulls ambient air in from the bottom front of the chassis; the top fan 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 Enhanced Chassis 16-Slot Line Card Chassis Installation Guide*.

The LCC has a maximum airflow of 2700 cubic feet (76,455 liters) per minute.

Figure 3-1 Airflow Through the FCC



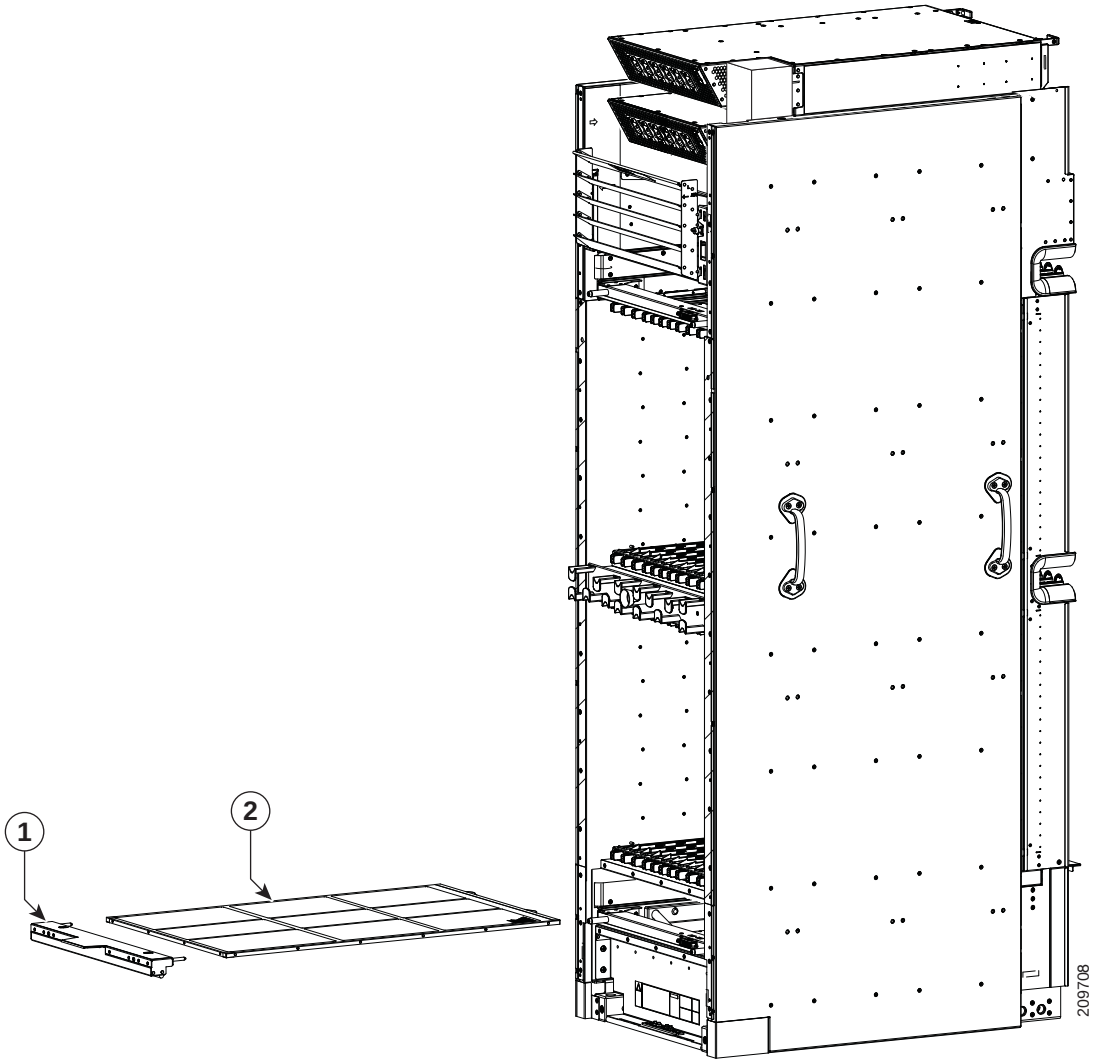
1	Front (SFC side) of chassis	**6**	Power shelves
2	Room air	**7**	Air exhaust
3	Bottom fan tray	**8**	Upper card cage
4	Air filter	**9**	Lower card cage
5	Top fan tray	**10**	Rear (OIM side) of chassis

Air Filter

The chassis has a replaceable air filter mounted in a slide-out tray above the lower fan tray. The filter, shown in Figure 3-2, 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. Insert the new air filter before removing the old one.

Figure 3-2 Air Filter



1	Air filter cover with door stop design	**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

One of the main features of the LCC cooling system is a 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 chassis is designed to run with both fan trays in place.

In a fully redundant system, equipped with dual power feeds, dual timing cards, and dual fan trays, the cooling system can withstand the failure of any one of the 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.)
- Timing Card—If one timing card fails, the other card provides all of the controls for both fan trays
- 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

For information on the rotational speeds of the fans in revolutions per minute (RPM), see the "Fan Tray" section on page 3-6.

Fan Tray

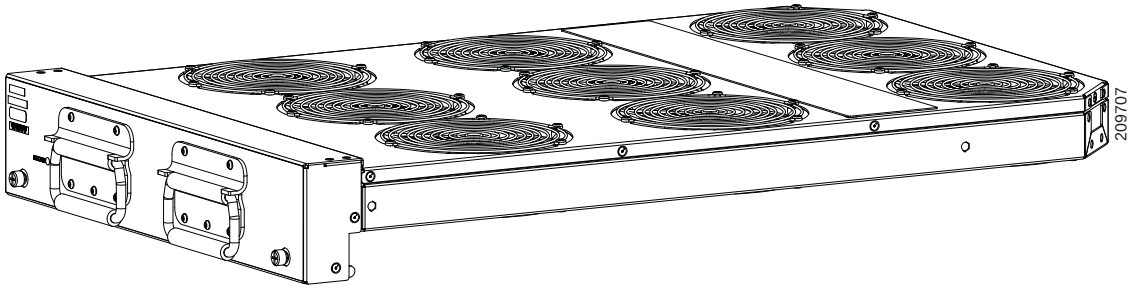
The LCC has redundant fan trays (upper and lower), which are inserted from the rear side of the chassis. Each fan tray is hot swappable and is considered an FRU. Although the chassis can operate with one fan tray, both fan trays should be installed and working during normal operations.

Each fan tray is populated with nine PWM fans. The fans are controlled through a digital signal and are internally able to correct any variation in setting fan speed. Operating fan speed range is from 3300 up to 9000 RPM with a 5% tolerance.

Figure 3-3 shows the fan tray. Each fan tray 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 3-3 Fan Tray



The fan tray has the following physical characteristics:

- Overall depth-32.6 in.
- Height of tray body-2.4 in.
- Height of front panel-4 in. (10.2 cm)
- Depth of front panel-2.9 in.
- Weight-44 lb (20 kg)

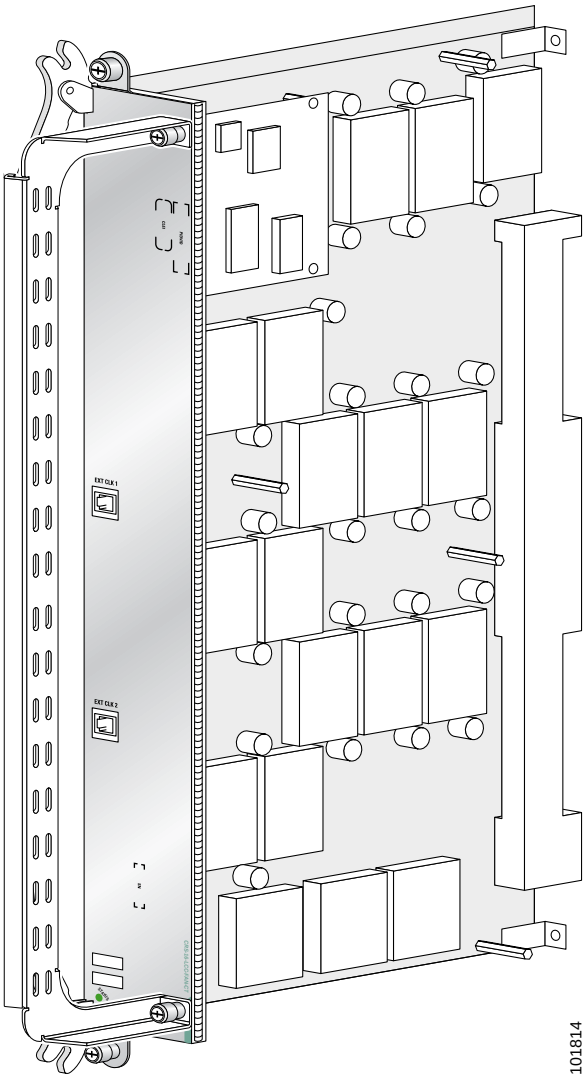
During normal operation, the fans operate in the range of 3300 to 5150 RPM. The system automatically adjusts the speed of the fans to meet the cooling needs of the entire chassis. If one fan controller card or one power feed fails, the fans continue to operate within the ranges specified above (up to 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.

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

Fan Controller Card

The LCC contains two fan controller cards, shown in Figure 3-4. Each controls one or both fan trays.

Figure 3-4 Fan Controller Card



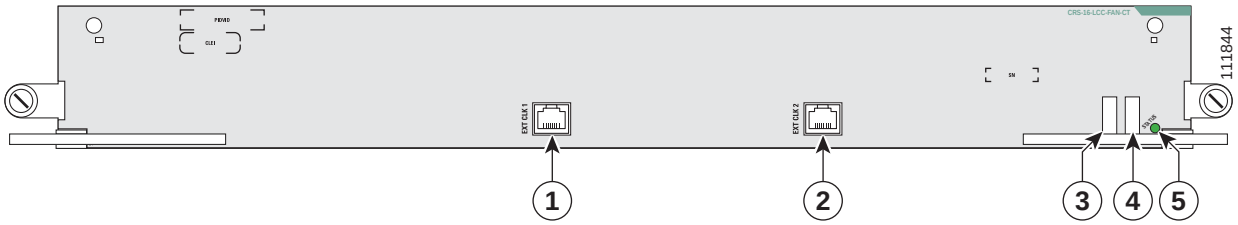
The LCC fan controller cards provide the following functions:

- 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 LCC fan controller cards also contain the circuitry and input connector for the building integrated timing source (BITS) clock.

Figure 3-5 shows the fan controller card front panel.

Figure 3-5 Fan Controller Card Front Panel



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