Catalyst 6500

Environmental Functionality and Requirements

1.0 OVERVIEW

The goal of this paper is to educate the reader about the Environmental Requirements and Functionality of the Cisco Catalyst 6500 Series Switch. Topics covered in the paper include Airflow, Grounding, Temperature, Cooling and others. Overviews of these items as well as management and monitoring of them will be discussed.

2.0 AIRFLOW

The Cisco Catalyst 6500 Series Switch is designed to be installed in an environment where there is a sufficient volume of air available to cool the supervisor engines, modules, and power supplies. Any constraints placed on the free flow of air through the chassis or an elevated ambient air temperature can cause the switch to overheat and shut down.

To maintain proper air circulation through the Cisco Catalyst 6500 Series Switch chassis, it is recommended that a minimum 6-inch (15 cm) separation between a wall and the chassis air intake or a wall and the chassis hot air exhaust is maintained. In situations where the switch chassis are installed in adjacent racks, there should be a minimum of 12-inches (30.5 cm) between the air intake of one chassis and the hot air exhaust of another chassis. Failure to maintain adequate spacing between chassis can cause the switch chassis that is drawing in the hot exhaust air to overheat and fail. On Cisco Catalyst 6500 Series Switch chassis in which the airflow is from front to back, the chassis may be placed side-to-side.

When installing the Cisco Catalyst 6500 Series Switch in an enclosed or partially enclosed rack, it is strongly recommend that the site meets the following guidelines:

- Verify that there is a minimum of 6 inches (15 cm) of clearance between the sides of the rack and both the chassis air intake grill and the chassis air exhaust grill.

- Verify that the ambient air temperature within the enclosed or partially enclosed rack is within the chassis operating temperature limits. After installing the chassis in the rack, power up the chassis and allow the chassis temperature to stabilize (approximately 2 hours). Measure the ambient air temperature at the chassis air intake grill and at the chassis air exhaust grill by positioning an external temperature probe approximately 1 inch (2.5 cm) away from the grills, in line with the chassis slot occupied by the supervisor engine.

    – If the ambient intake air temperature is less than 104°F (40°C), the rack meets the intake air temperature criterion.

    – If the ambient intake air temperature exceeds 104°F (40°C), the system might experience minor temperature alarms and is in danger of overheating.

– If the ambient intake air temperature equals or is greater than 131°F (55°C), the system will experience a major temperature alarm and shut down.

- Verify that the enclosed or partially enclosed rack allows an adequate flow of air through the switch chassis as follows:

– If the difference between the measured intake air temperature and the exhaust air temperature does not exceed 10°C, there is sufficient airflow in the rack.

– If the difference in air temperature exceeds 10°C, there is insufficient airflow to cool the chassis.

Note The 10°C temperature differential between the intake and the exhaust must be determined by taking measurements using external digital temperature probes. Do not use the chassis internal temperature sensors to measure the temperature differential.

- Plan ahead. The Cisco Catalyst 6500 Series Switches currently installed in an enclosed or partially enclosed rack might meet ambient air temperature and air flow requirements now. However, if there are more chassis added to the rack or more modules added to a chassis in the rack, the additional heat generated might cause the ambient air temperature within the rack to exceed 104°F (40°C) and can cause minor alarms.

2.1 Selecting the Proper Rack-Enclosure or Cabinet

Cisco Systems has identified two rack-enclosures that are determined to be Cisco-compatible:

Panduit Corporation—The Net-Access Cabinet (p/n CN4-1) is determined to be Cisco-compatible for the Catalyst 6500 series product line. Contact Panduit Corporation for further information on this rack enclosure. Their corporate website is http://www.panduit.com. Their Customer Service and Technical Support phone number is 800 777-3300.

Chatsworth Products, Inc.—The N-Series TeraFrame Network Cabinet (p/n NF2K-113C-C42) is determined to be Cisco-compatible for the Catalyst 6500 series product line. Contact Chatsworth Products, Inc. for further information on this rack enclosure. Their corporate website is http://www.chatsworth.com. Their Customer Service and Technical Support phone number is 800 834-4969 (Monday to Friday, 5 a.m. to 5 p.m., (0500 to 1700) Pacific Time).

Table 1 provides an overview of the chassis air flow requirements for each Cisco Catalyst 6500 Series Switch.

Table 1 Cisco Catalyst 6500 Series Switch Air Flow Requirements

Chassis Model	Airflow Intake	Airflow Exhaust	Air Filter	Minimum Clearance (Walls)	Minimimum Clearance (Intakes to Exhausts)
Catalyst 6503	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6503-E	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6504-E	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6506	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6506-E	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6509	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6509-E	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6509-NEB	Front	Rear	No	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6509-NEB-A	Front	Rear	Yes	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6509-V-E	Front	Rear	Yes	6 in (15.2 cm)	12 in (30.4 cm)
Catalyst 6513	Right Side	Left Side	No	6 in (15.2 cm)	12 in (30.4 cm)

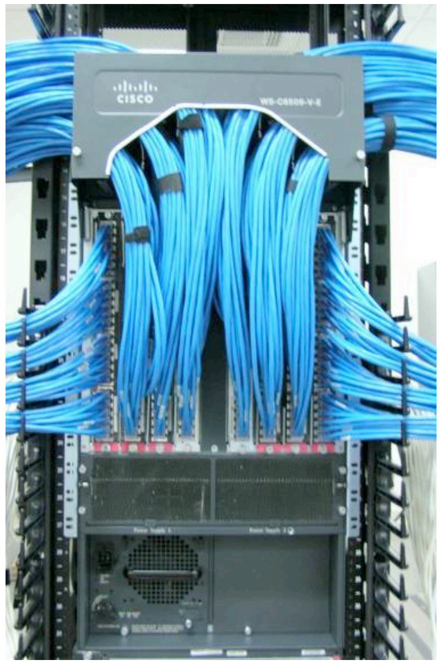
2.2 Power Supply Air Flow

Like the chassis, the power supplies also require unobstructed airflow to maintain proper temperatures to prevent shutdown due to overheating. The power supplies for the 6503, 6503-E and 6504-E do not have separate fans and rely on the system fan tray to draw in air to cool the supplies. The supplies for the remaining chassis have their own internal fans that draw air in through the front of the chassis and exhaust it out the back. The same clearances outlined in Table 1 for the chassis apply to the power supplies.

2.3 Cabling

Due to the side-to-side airflow requirements of the majority of the Cisco Catalyst 6500 Series Switch chassis, care must be taken when determining how to run cables from the linecards. If these cables restrict either the air intake or air exhaust of the system, then over-temperature conditions may result in the shutting down of linecards or the system itself. With this in mind, it is recommended to use the cable guides that are shipped with the chassis to help direct the cables to the side and then up the sides of the rack, maintaining the 6" of clearance for air intake and exhaust. There are also 3rd-party solutions that can be utilized to achieve this, such as the following that shows two Catalyst 6500s in the bottom of the racks:

Not all of the Cisco Catalyst 6500 Series Switch chassis have side-to-side airflow, and one of those that doesn't is the 9-slot V-E chassis (WS-C6509-V-E). This chassis has front-to-back airflow with vertically oriented linecard slots, so the cabling considerations are different than the other chassis. Running all of the cables to the right and left from the linecards is not feasible as it would create too much of a jumble. Therefore, the chassis ships with a cable organizer that brings the cables up and then off to the sides. This prevents the air intake, located right below the linecard slots, from being inadvertently blocked. The following shows the recommended cabling with this chassis:



2.4 Chassis Installation Considerations

Where front-to-back airflow requirements are not a must and switches with side-to-side airflow can be used, the positioning of the switches within neighboring racks must be considered. While it has been previously stated that a 12-inch (30.5 cm) clearance between the exhaust of one switch and intake of another is supported, it is not the best practice recommendation for deploying switches in adjacent racks. Instead, it is recommended that the switches be staggered in a high-low manner in adjacent racks so that the exhaust of one switch is not being blown anywhere near the intake of a neighboring switch.

In environments where front-to-back airflow is a requirement, such as Data Centers where hot-aisle / cold-aisle deployments are common, there are a few options for the Cisco Catalyst 6500 Series Switches. For those switches that have side-to-side airflow, Cisco has worked with 3rd-party vendors (see Section 2.1) to develop specialized racks that can redirect the chassis exhaust to a hot aisle via baffling inside the rack. If this solution is not desirable, then the 9-slot V-E chassis (WS-C6509-V-E) has front-to-back airflow by default and does not require any specialized racks.

3.0 GROUNDING

Proper grounding practices ensure that the buildings and the installed equipment within them have low-impedance connections and low-voltage differentials between chassis. When Network Equipment Building System (NEBS) compliant system grounds are used, shock hazards can be reduced or prevented, which greatly reduces the chances of equipment damage due to transients, and substantially reduces the potential for data corruption.

Without proper and complete system grounding there an increased risk of component damage due to ESD. Additionally, the chance of data corruption, system lockup and frequent system reboot situations are greatly increased by not using a system (NEBS compliant) ground.

A NEBS-compliant system ground must be installed as part of the chassis installation process. Chassis installations that rely only on the AC third-prong ground are insufficient to properly and adequately ground the systems. Table 2 lists some of the grounding practice guidelines that can be used when installing Cisco Catalyst 6500 Series Switches.

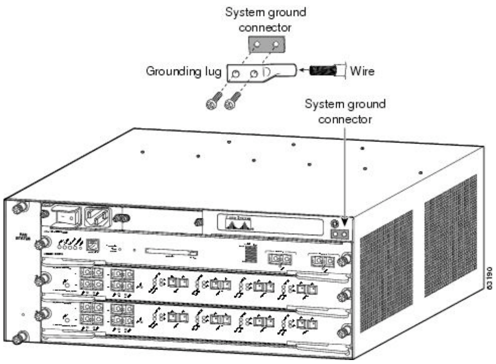
Table 2 Cisco Catalyst 6500 Series Switch Grounding Guidelines

Environment	Electromagnetic Noise Severity Level	Grounding Recommendations
Commercial building is subjected to direct lightning strikes. For example, some places in the United States, such as Florida, are subject to more lightning strikes than other areas.	High	All lightning protection devices must be installed in strict accordance with manufacturer recommendations. Conductors carrying lightning current should be spaced away from power and data lines in accordance with applicable recommendations and codes. Best grounding practices must be closely followed.
Commercial building is located in an area where lightning storms frequently occur but is not subject to direct lightning strikes.	High	Best grounding practices must be closely followed.
Commercial building contains a mix of information technology equipment and industrial equipment, such as welding.	Medium to HIgh	Best grounding practices must be closely followed.
Existing commercial building is not subject to natural environmental noise or man-made industrial noise. This building contains a	Medium	Best grounding practices must be closely followed. Determine source and cause of noise if possible, and mitigate as closely as

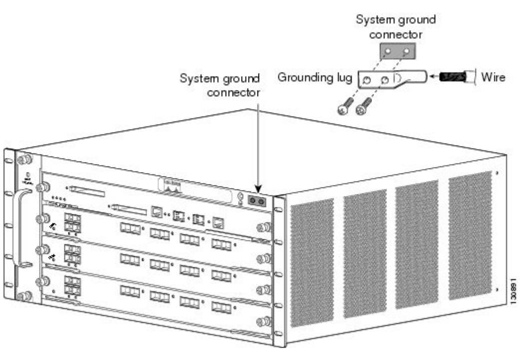
standard office environment. This installation has a history of malfunction due to electromagnetic noise.		possible at the noise source or reduce coupling from the noise source to the victim equipment.
New commercial building is not subject to natural environmental noise or man-made industrial noise. This building contains a standard office environment.	Low	Best grounding practices should be followed as closely as possible. Electromagnetic noise problems are not anticipated, but installing a best practice grounding system in a new building is often the least expensive route and the best way to plan for the future.
Existing commercial building is not subject to natural environmental noise or man-made industrial noise. This building contains a standard office environment.	Low	Best grounding practices should be followed as much as possible. Electromagnetic noise problems are not anticipated, but installing a best practice grounding system is always recommended.

The following pictures show where the system grounding points are for each of the chassis.

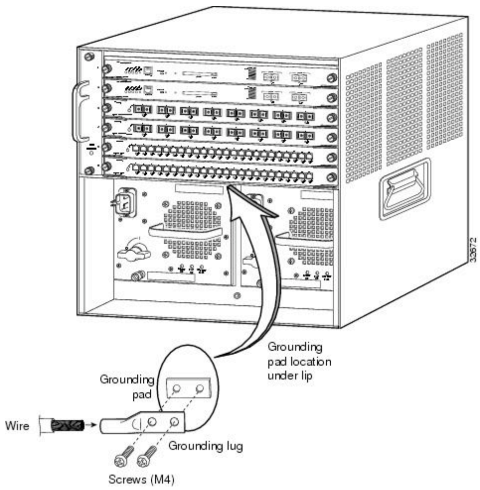
Catalyst 6503 and 6503-E



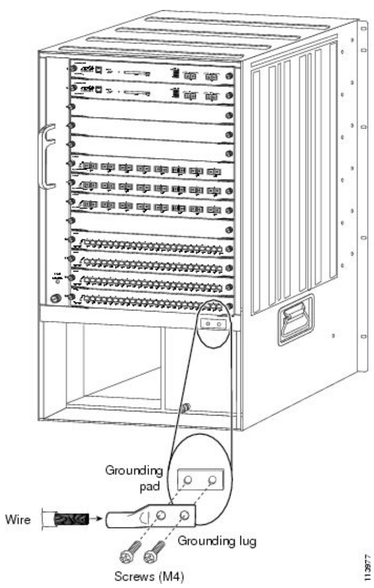
Catalyst 6504-E



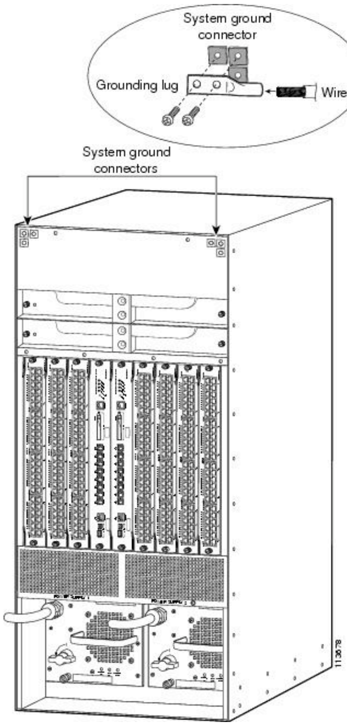
Catalyst 6506, 6509 and 6509-NEB



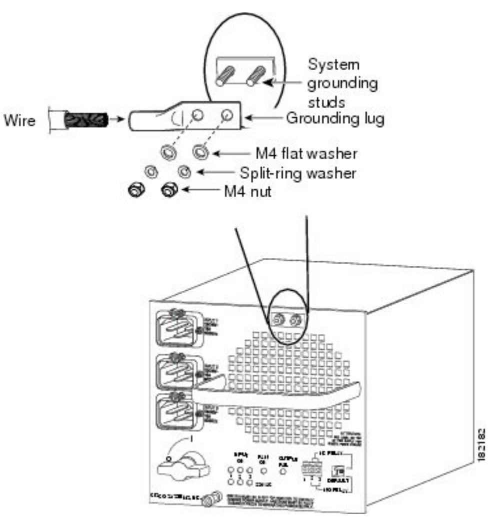
Catalyst 6506-E, 6509-E, 6513



Catalyst 6509-NEB-A, 6509-V-E



Due to the size of the 8700W power supply, it may cover up the grounding points on the 6506 and 6509 chassis. As a result, a grounding point was added to the 8700W power supply as seen in the following picture.



Additional information about system grounding can be found in the *Catalyst 6500 Series Switch Installation Guide* on cisco.com .

3.1 Grounding Best Practices

1. Establish a bus bar in the wiring closet.

    - The bus bar should be properly sized and spaced in order to facilitate connecting to the systems in the room.

    - The bus bar should be plated with a non-corrosive conductive finish, such as tin.

    - The bus bar should be placed close to the systems in the room in order to minimize conductor length.

2. Connect the bus bar to the electrical service ground on the building.

    - Use the shortest possible conductor. This conductor might be longer than 36 inches.

    - The bus bar is typically installed to satisfy NEC requirements in conjunction with the guidelines below.

3. Connect the bus bar to the building's steel frame ground.

    - Use the shortest possible conductor. If the conductor between the bus bar and the steel frame ground on the building is greater than 36 inches (approximately 90cm) , install an additional supplemental ground rod in the wiring closet.

        -Drive a ground rod approximately 8 feet (about 2.4 m) in length adjacent to the equipment, close to where the bus bar is located.

        - Attach the bus bar to this additional ground rod using the shortest possible conductor, preferably less than 36 inches (approximately 90cm) in length. The bus bar will now be connected to the building steel frame ground and the grounding rod.

        - Some buildings are fabricated with rebar structures such that the rebar pieces are not bonded together. In these cases, do not rely on the rebar for grounding.

        - Bond this supplemental ground rod to other primary and supplemental ground rods in the installation. This bonding is often required by local NEC requirements. Confirm with qualified licensed personnel.

4. Connect the bus bar to the equipment rack and the cable trays (if any) by using the shortest possible conductor.

5. The cable trays carrying the network cables should be grounded to the building steel frame close to the electronic equipment. This procedure should be repeated periodically throughout the building.

6. Use 6 AWG wiring or larger in all cases. Use a size that is appropriate for current carrying capabilities in fault conditions.

7. Minimize the length of all ground wires. When providing grounding for multiple racks, consider installing a ground mat or mesh.

8. Verify that all components such as wires, clamps, and screws, are properly sized, cleaned, and tightened. Welded, brazed or soldered connections are preferred.

9. In all cases, installations must comply with local safety codes, and all electrical work should be completed by qualified licensed personnel.

3.2 Electrostatic Discharge (ESD) Best Practices

Electrostatic discharge (ESD) damage, which can occur when modules or other FRUs are improperly handled, results in intermittent or complete failures. Modules consist of printed circuit boards that are fixed in metal carriers. Electromagnetic interference (EMI) shielding and connectors are integral components of the carrier. Although the metal carrier helps to protect the board from ESD, always use an ESD grounding strap when handling modules.

To prevent ESD damage, follow these guidelines:

- Always use an ESD wrist strap and ensure that it makes maximum contact with bare skin. ESD grounding straps are available with banana plugs, metal spring clips, or alligator clips. All Catalyst 6500 series chassis are equipped with a banana plug connector (identified by the ground symbol next to the connector) somewhere on the front panel. If it is an older Cisco Catalyst 6500 Series Switch equipped with a plastic banana plug connector, we recommend that either the supplied ESD grounding wrist strap (with a metal clip) or an ESD grounding wrist strap equipped with an alligator clip be used. If it is a newer Cisco Catalyst 6500 Series Switch that has a bare metal hole as the banana plug connector (also identified by the ground symbol next to the connector), we recommend that a personal ESD grounding strap equipped with a banana plug be used.

- If the disposable ESD wrist strap supplied with most FRUs or an ESD wrist strap equipped with an alligator clip is used, the system ground lug must be attached to the chassis in order to provide a proper grounding point for the ESD wrist strap.
- If the chassis does not have the system ground attached, the system ground must be installed.

When handling modules, follow these guidelines:

- Handle carriers by available handles or edges only; avoid touching the printed circuit boards or connectors.
- Place a removed component board-side-up on an antistatic surface or in a static shielding container. If the component must be returned to the factory, immediately place it in a static shielding container.
- Never attempt to remove the printed circuit board from the metal carrier.

4.0 HUMIDITY

High-humidity conditions can cause moisture migration and penetration into the system. This moisture can cause corrosion of internal components and degradation of properties such as electrical resistance, thermal conductivity, physical strength, and size. Extreme moisture buildup inside the system can result in electrical shorts, which can cause serious damage to the system. Each system is rated to operate at 8 to 80 percent relative humidity, with a humidity gradation of 10 percent per hour. In storage, a system can withstand from 5 to 95 percent relative humidity. Buildings in which climate is controlled by air-conditioning in the warmer months and by heat during the colder months usually maintain an acceptable level of humidity for system equipment. However, if a system is located in an unusually humid location, a dehumidifier can be used to maintain the humidity within an acceptable range.

Too low humidity is also a concern as the removal of moisture can in some cases change the mechanical structure and cause embrittlement. Often this is also accompanied by shrinkage and loss of weight. Additionally, low humidity can cause the generation of static, which in turn can cause the build up of dust since static charges attract dust. A build up of dust in an unsealed unit can result in malfunction by:

(i) causing bad contacts

(ii) creating a path which can allow the tracking of high voltage discharges to earth such as in a TV or computer monitor

5.0 ALTITUDE

Operating a system at high altitude (low pressure) reduces the efficiency of forced and convection cooling and can result in electrical problems related to arcing and corona effects. This condition can also cause sealed components with internal pressure, such as electrolytic capacitors, to fail or perform at reduced efficiency. Each system is rated to operate at altitudes from -50 to 6500 feet (-16 to 1981 meters) and can be stored at altitudes of -50 to 35,000 feet (-16 to 10,668 meters).

6.0 DUST AND PARTICLES

Fans cool power supplies and system components by drawing in room temperature air and exhausting heated air out through various openings in the chassis. However, fans also ingest dust and other particles, causing contaminant buildup in the system and increased internal chassis temperature. A clean operating environment can greatly reduce the negative effects of dust and other particles, which act as insulators and interfere with the mechanical components in the system. The standards listed below provide guidelines for acceptable working environments and acceptable levels of suspended particulate matter:

- Network Equipment Building Systems (NEBS) GR-63-CORE
- National Electrical Manufacturers Association (NEMA) Type 1
- International Electrotechnical Commission (IEC) IP-20

6.1 Chassis Air Filters

The majority of the Cisco Catalyst 6500 Series Switch chassis do not have any air filtration device that accompanies them. In addition, it is not recommended to install any air filtration device on any chassis that does not come with one as such a device may restrict air flow which can in turn cause over-temperature conditions for the system. Cisco has not tested any 3rd-party filtration devices and cannot, therefore, recommend the use of any.

There are two chassis that come with optional air filter: the 9-slot V-E (WS-C6509-V-E) and the 9-slot NEB-A (WS-C6509-NEB-A, currently End of Sale). The filter assembly is designed to prevent dust and other contaminants from being drawn into the switch chassis. It is not included with the chassis or bundle configurations because it is not needed in normal installation environments. We recommend that this assembly only be used in exceptionally dusty installation sites. The parts required to install the filter assemblies on these two chassis are:

INTAKEPNL-09=	Intake panel
FLTRASSM-09=	Filter cage assembly, no filter inserts included
FLTRINSERTS-09=	Set of five replacement air filter inserts for FLTRASSM-09=

The filter assembly installation requires that INTAKEPNL-09= be installed on the chassis. This intake panel can be identified by the two filter assembly support loops extending from the bottom front of the panel and the thumbscrews on the front left and right sides of the panel.

Information about installing the filter assembly can be found at http://www.cisco.com/en/US/docs/switches/lan/catalyst6500/hardware/Chassis_Installation/Cat6500/04remrep.html#wp1053371 .

Once optional air filter assembly has been installed on the Catalyst 6509-NEB-A or Catalyst 6509-V-E switch chassis, periodically check the air filter for damage and cleanliness. We recommend that a visual inspection of the filter be performed at least once a month, or more often in dusty environments. Replace the filter if appears clogged with dust, or if an increase in the chassis internal operating temperature is detected.

7.0 SHOCK AND VIBRATION

Cisco Catalyst 6500 Series Switches have been shock- and vibration-tested for operating ranges, handling, and earthquake standards to NEBS (Zone 4 per GR-63-Core). These tests have been conducted in earthquake environment and criteria, office vibration and criteria, transportation vibration and criteria, and packaged equipment shock. Following are the shock and vibration parameters:

Shock

Operational—5 G 30 ms, half-sine (IEC 68-2-27)

Nonoperational—20 G, 7.5 ms, trapezoidal

Vibration

Operational—3 Hz to 500 Hz

Power Spectral Density (PSD)—0.0005 G^2/Hz at 10 Hz and 200 Hz. 5 dB/octave roll off at each end. 0.5 hours per axis (1.12 Grms).

Some customers prefer to install the Cisco Catalyst 6500 Series Switch in rack in a central location and then ship that rack to a remote location. When the switch is shipped in this way, the stress due to shock and vibration may cause the system to fail even if it tested good in the original location. To alleviate this issue, Cisco has developed a special kit (WS-C6509-E-IBMKIT=) for the 6509-E chassis (but no others at this time).

8.0 POWER

The Cisco Catalyst 6500 Series Switches have a variety of AC and DC power supply options that can be used to deliver power to the fan trays, linecards, Supervisors, attached PoE devices and other system components. The following sections outline guidelines that should be followed when deploying power for the Cisco Catalyst 6500 Series Switch.

8.1 General Guidelines

When preparing the site for the switch installation, follow these requirements:

- In systems configured with two power supplies, connect each of the two power supplies to a separate input power source. If this is not done, the system might be susceptible to total power failure due to a fault in the external wiring or a tripped circuit breaker.
- To prevent a loss of input power, be sure that the total maximum load on each source circuit is within the current ratings of the wiring and breakers.
- In some installations, an uninterruptible power supply (UPS) may be used to protect against power failures at the site. Be aware when selecting a UPS that some UPS models that use ferroresonant technology can become unstable when operating with the Catalyst 6500 series switch power supplies which use power factor correction (PFC). This can cause the output voltage waveform to the switch to become distorted resulting in an undervoltage situation in the system.

8.2 AC Power Guidelines

This section provides the basic guidelines for connecting the Catalyst 6500 series switch AC power supplies to the site power source:

- Each chassis power supply should have a separate, dedicated branch circuit.
- For North America:
  - The 950 W power supply requires a 15 A circuit.
  - The 1000 W power supply requires a 15 A or 20 A circuit.
  - The 1300 W, 1400 W, 2500 W, 2700 W, and 3000 W power supplies require a 20 A circuit.
  - The 4000 W power supply requires a 30 A circuit.
  - The 6000 W power supply requires one or two 20 A circuits.
  - The 8700 W power supply requires one, two, or three 20 A circuits.
- For International:
  - Circuits should be sized according to local and national codes.
- If using a 200/240 VAC power source in North America, the circuit must be protected by a two-pole circuit breaker.
- The source AC outlet must be within 6 feet (1.8 meters) of the system and should be easily accessible.
- 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.
- All AC power supply inputs are fully isolated.
  - Source AC can be out of phase between multiple power supplies in the same chassis, which means that PS1 can be operating from phase A and PS2 can be operating from phase B.
  - For high-line operation, the power supply operates with the hot conductor wired to a source AC phase and the neutral conductor wired either to ground or to another source AC phase as long as the net input voltage is in the range of 170 to 264 VAC.
  - Source AC can be out of phase between AC inputs on power supplies that are equipped with multiple AC inputs, which means that power cord 1 can be plugged into phase A and power cord 2 can be plugged into phase B.
- Power factor correction is a standard feature on all Catalyst 6500 series AC-input power supplies. PFC reduces the reactive component in the source AC current

allowing higher power factors (typically 99 percent or better) and lower harmonic current components.

8.3 DC Power Guidelines

This section provides the basic guidelines for connecting the Catalyst 6500 series switch DC-input power supplies to the site power source:

- All power connection wiring should conform to the rules and regulations in the National Electrical Code (NEC), as well as any local codes.

- The DC return must remain isolated from the system frame and the chassis (DC-I).

- For DC power cables, we recommend that commensurately rated, high-strand-count copper wire cable is used. Connection to the DC-input power supply requires one earth ground cable, one source DC (-), and one source DC return (+). The length of the cables depends on the switch location. These cables are not available from Cisco Systems. They are available from any commercial cable vendor.

- The color coding of the source DC power cable leads depends on the color coding of the site DC power source. Typically, green or green and yellow indicate that the cable is a ground cable. Because there is no color code standard for source DC wiring, ity should be ensured that the power cables are connected to the DC-input power supply terminal block in the proper (+) and (-) polarity. In some cases, the source DC cable leads might have a positive (+) or a negative (-) label. This label is a relatively safe indication of the polarity, but the polarity must be verified by measuring the voltage between the DC cable leads. When making the measurement, the positive (+) lead and the negative (-) lead must always match the (+) and (-) labels on the DC-input power supply terminal block.

- DC power cables must be terminated by cable lugs at the power supply end.

- The circuit breaker is considered to be the disconnect device and should be easily accessible.

- The circuit must be protected by a dedicated two-pole circuit breaker. The circuit breaker should be sized according to the power supply input rating and local or national code requirements.

- For proper DC-input redundant power configurations on systems with multiple-input DC-input power supplies, all pairs of source DC cables for one DC-input power supply must come from the same battery system (A feed); all pairs of source DC cables for the second DC-input power supply must come from a different battery system (B feed).

- For DC-input power supplies with multiple inputs, each DC input must be protected by a dedicated circuit breaker or a fuse. The circuit breaker or the fuse must be sized according to the power supply input rating and local or national electrical codes.

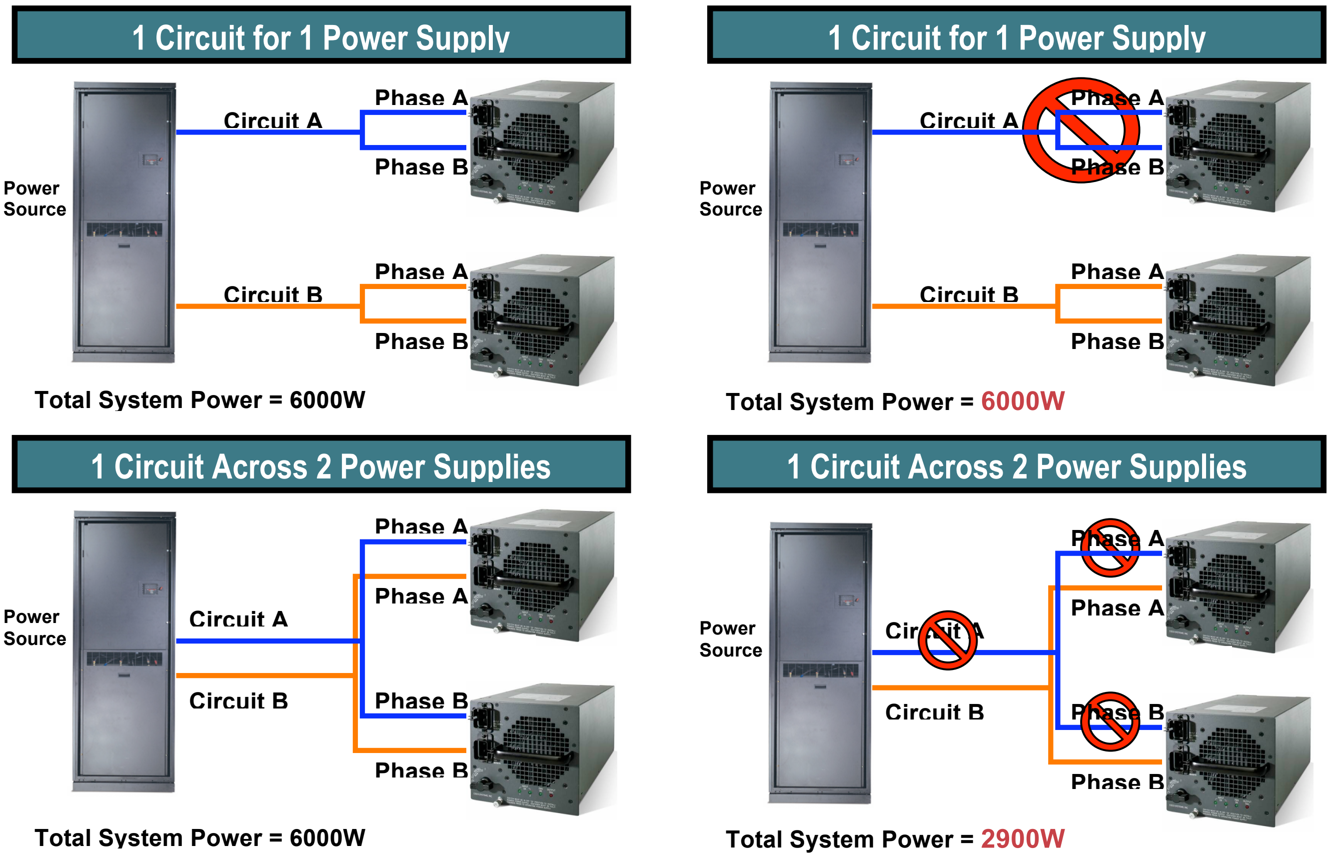
8.4 Multi-Input Circuit Distribution

There are several Cisco Catalyst 6500 Series Switch power supplies that have multiple inputs that are needed to provide the full capacity of the supplies. When deploying these supplies, an issue that ultimately arises is: what is the best way to distribute circuits among the multiple inputs of a multi-input power supply, especially in a redundant configuration? The best way to address this would be to feed each input with a dedicated circuit, however this is not always possible. Sometimes customers have a multi-phase circuit from which they feed individual phases to each input. In this case, multiple inputs will be relying on a single base circuit for their input power. In this case, there are two options:

1. Supply each input on a supply with a single phase from the main circuit.

2. Supply an input on each supply with a single phase from the main circuit.

For reasons that will become obvious in the following picture, it is recommended that Option #2 be utilized wherever possible (if the customer cannot feed each input with its own dedicated main circuit).



In scenario #1, a main circuit failure results in no degradation of power capacity for the system, while in scenario #2 the power capacity of the system is reduced by over 50%.

This concept can be applied to any of the multi-input AC or DC supplies supported by the Cisco Catalyst 6500 Series Switch.

9.0 COOLING

Each Cisco Catalyst 6500 Series Switch has a fan tray (or two in the case of the Catalyst 6509-V-E) that draws in air from outside the chassis to provide cooling for the Supervisor(s) and linecard(s) in the chassis. Table 3 lists the Cisco Catalyst 6500 Series Switch chassis along with the supported and unsupported fan trays.

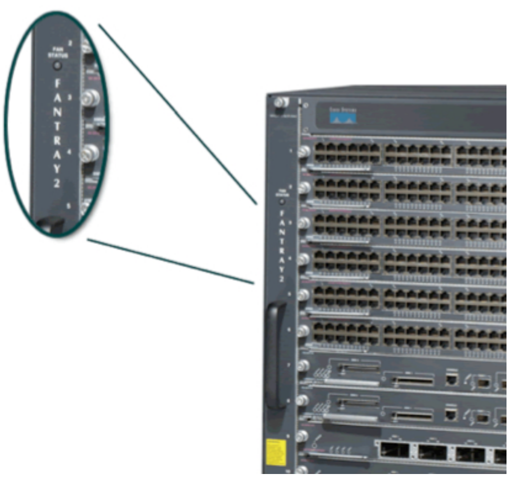
Table 3 Cisco Catalyst 6500 Series Switch Grounding Guidelines

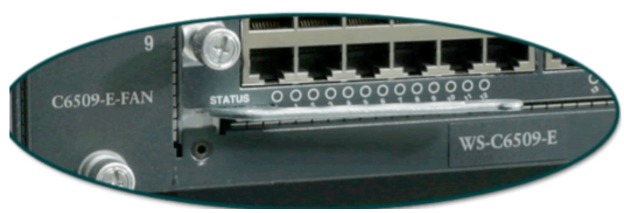
Chassis Model	Supported Fan Trays	Unsupported Fan Trays
Catalyst 6503	FAN-MOD-3	WS-C6503-E-FAN

	FAN-MOD-3HS (high speed)	
Catalyst 6503-E	WS-C6503-E-FAN	FAN-MOD-3 FAN-MOD-3HS (high speed)
Catalyst 6504-E	FAN-MOD-4HS (high speed)	N/A
Catalyst 6506	WS-C6K-6SLOT-FAN WS-C6K-6SLOT-FAN2 (high speed)	WS-6506-E-FAN
Catalyst 6506-E	WS-6506-E-FAN	WS-C6K-6SLOT-FAN WS-C6K-6SLOT-FAN2 (high speed)
Catalyst 6509	WS-C6K-9SLOT-FAN WS-C6K-9SLOT-FAN2 (high speed)	WS-6509-E-FAN
Catalyst 6509-E	WS-6509-E-FAN	WS-C6K-9SLOT-FAN WS-C6K-9SLOT-FAN2 (high speed)
Catalyst 6509-NEB-A	FAN-MOD-09 (high speed)	N/A
Catalyst 6509-V-E	WS-C6509-V-E-FAN (high speed)	N/A
Catalyst 6513	WS-C6K-13SLOT-FAN WS-C6K-13SLT-FAN2 (high speed)	N/A

The high speed fan trays are required when installing any Supervisor 32, Supervisor 32-PISA, Supervisor 720 or Supervisor 720-10G into a non-E series chassis. If the lower speed fan tray is present and one of these supervisors is installed, the chassis will power down after 5 minutes. The E-Series chassis come with high speed fan trays by default, so there is no need to replace them when installing these supervisors.

There are a few ways that the fan tray version can be determined. The most obvious way is to look at the fan tray as the fan tray type is silk screened right on the fan tray itself:





If physical inspection of the fan tray is not possible, then there are a couple of CLI commands that may assist in determining the fan tray version:

```
6509-1#show environment cooling
fan-tray 1:
  fan-tray 1 type: WS-C6K-9SLOT-FAN2
  fan-tray 1 version: 2
  fan-tray 1 fan-fail: OK
```

```
6500-1#show environment status fan-tray
fan-tray 1:
  fan-tray 1 type: WS-C6K-9SLOT-FAN2
  fan-tray 1 version: 2
  fan-tray 1 fan-fail: OK
```

These commands are not needed for the E-Series chassis since they only have E-Fans, and those fans support all Supervisors.

9.1 Cubic Feet per Minute (CFM)

The capacity of a fan tray's cooling capability is measured in cubic feet per minute (cfm). Each linecard has an associated cooling requirement, also measured in cfm, that determines which fan tray is required for that linecard. The output below shows the various cfm requirements and capabilities for the linecards and fan tray in the chassis:

```
6500-x#show module
Mod Ports Card Type                              Model              Serial No.
--- ----- -------------------------------------- ------------------ -----------
  1   48  CEF720 48 port 10/100/1000mb Ethernet  WS-X6748-GE-TX     SAD074400Y3
  2    4  CEF720 4 port 10-Gigabit Ethernet      WS-X6704-10GE      SAL08486FEN
  3   24  CEF720 24 port 1000mb SFP              WS-X6724-SFP       SAL08414SKH
  4    4  SLB Application Processor Complex      WS-X6066-SLB-APC   SAD062805F1
  6    2  Supervisor Engine 720 (Active)         WS-SUP720-BASE     SAD07250221
  8   48  SFM-capable 48-port 10/100 Mbps RJ45   WS-X6548-RJ-45     SAD051008Z5

<remainder of output omitted>

6500-x#show environment cooling
fan-tray 1:
  fan-tray 1 type: WS-C6K-9SLOT-FAN2
  fan-tray 1 version: 2
  fan-tray 1 fan-fail: OK
chassis per slot cooling capacity: 70 cfm
  module 1 cooling requirement: 70 cfm
  module 2 cooling requirement: 70 cfm
  module 3 cooling requirement: 70 cfm
  module 4 cooling requirement: 30 cfm
  module 6 cooling requirement: 35 cfm
  module 8 cooling requirement: 30 cfm
```

Notice that modules 1, 2 and 3 (67xx-series linecards) all require 70 cfm for cooling, the Supervisor 720 (module 6) requires 35 cfm and the older modules 4 and 8 require only 30 cfm. It is the higher cooling requirements of the newer modules and Supervisor 720 that drive the need for the Fan Tray 2 when deploying those modules. Notice that the Fan Tray 2 provides the required 70 cfm while a Fan Tray 1 cannot provide this level of cooling.

The high speed fan trays (Fan2 and E-Fan) have a temperature sensor which can determine if the exhaust air temperature is increasing, which would indicate increasing component or ambient air temperatures. When certain thresholds are crossed according to those sensor readings, the high speed fans can speed up or slow down to meet the changing temperature requirements of the system. There is no user configuration needed to enable this function.

9.2 6708 / 6716 Exceptions

While all of the modules are supported in both the E-Series and non-E Series chassis, the WS-X6708-10G-3C/3CXL and WS-X6716-10G-3C/3CXL have higher cooling requirements (84 cfm) than any of the other linecards. As a result of these higher requirements, these linecards should be installed in E-Series chassis whenever possible since the E-Fan's cooling capacity is 94 cfm. This does not preclude these linecards from being installed in no-E Series chassis, but there is a ramification of doing so that should be understood.

Installing these linecards in the following chassis may result in over-temperature alarms if the ambient temperature exceeds 40C :

WS-C6513
WS-C6509
WS-C6506

This means that if NEBS compliance is a requirement, installing these linecards in these chassis will not be NEBS compliant since the system must be able to operate up to 55C to meet that standard.

9.3 Fan Failures

The high speed (Fan2 and E-Fan) versions of the fan trays for the Cisco Catalyst 6500 Series Switches are comprised of multiple fans. In the case where a single fan within the high speed fan tray fails, the remaining fans can be sped up to compensate for the loss of the single fan. Should two fans within a fan tray fail, the entire fan tray will be considered failed and will be shut down. How long a system will stay online when no fan is operating is a factor of the environment in which the system is operating as well as the amount of activity in the system. Therefore, if a fan tray fails it is recommended to replace it as soon as possible so that over-temperature conditions are not created within the system.

10.0 TEMPERATURE MONITORING

The Cisco Catalyst 6500 Series Switch has a number of sensors that are used to monitor the temperatures of various system components. These sensors have associated minor and major thresholds that are used to determine if that component's temperature is reaching a critical level. If a minor threshold is crossed, a system message is generated to alert the networking staff that the component temperature is on the rise. A message is generated only when the threshold is crossed. If the temperature remains above the minor threshold, a second message will not be generated unless the temperature goes back below the threshold and then crosses above it another time.

If a major threshold is crossed, a system message is sent and a 3 minute (sometimes longer depending on the generation of linecard, but 3 minutes is a good rule to go by since the newer cards use this) timer begins to count down. If the temperature crosses back below the major threshold, then the timer is turned off and normal system operation continues. If the temperature is still above the major threshold when the timer expires, then that component is shut down. In some cases this could result in total system shutdown (e.g. if the Supervisor is the component that is shut down), and in other cases the system may continue to operate just without the component that is shut down (e.g. if a single linecard is shut down).

The following shows how the various thresholds can be seen for the system hardware:

```
C6509E#show environment alarm thresholds ?
  all             selects all FRU-types
backplane       specify backplane
  clock           specify clock <number>
  earl            specify earl <slot>
  fan-tray        specify fan-tray <number>
  interface       interface name
  module          specify module <slot>
  power-supply    specify power-supply <number>
  rp              specify RP (MSFC) <slot>
  supervisor      specify supervisor <slot>
  vdb             specify vdb <slot>
  vtt             specify VTT <number>
  |               Output modifiers
  <cr>
```

Looking at a specific module’s information:

```
C6509E#show environment alarm thresholds module 1
module 1 power-output-fail: OK
  threshold #1 for module 1 power-output-fail:
    (sensor value != 0 ) is system minor alarm
module 1 insufficient cooling: N/A
  threshold #1 for module 1 insufficient cooling:
    (sensor value != 0 ) is system major alarm
module 1 outlet temperature: 40C
  threshold #1 for module 1 outlet temperature:
    (sensor value >= 75C) is system minor alarm
  threshold #2 for module 1 outlet temperature:
    (sensor value >= 85C) is system major alarm
module 1 inlet temperature: 23C
  threshold #1 for module 1 inlet temperature:
    (sensor value >= 45C) is system minor alarm
  threshold #2 for module 1 inlet temperature:
    (sensor value >= 55C) is system major alarm
```

Notice that the two temperature sensors have the aforementioned minor and major thresholds. Also note that the temperature thresholds are not the same as the operating temperature range (40C to 55C) that is described in the *Catalyst 6500 Series Switch Installation Guide* for the chassis. The temperatures in the output above represent temperatures inside the chassis, while the temperatures in the installation guide represent temperatures outside the chassis. The internal temperature ranges are correlated to the external temperature ranges in that the higher the external temperature, the lower the ability for that air to cool the internal components, thereby resulting in higher internal temperatures. Finally, notice that the outlet temperature range is much higher than the inlet temperature range. This is because the air has moved over the hot components of the system and is now much warmer than it was when it entered the system.

The inlet and outlet temperature sensors are placed on the linecard at points that prevent the heat from other components, such as ASICs, from affecting the readings of the sensors. As a result, some ASICs have their own internal temperature sensors that are monitored separately from the inlet and outlet sensors (which are present on all linecards). Consider the following output from a WS-X6708-10G-3C linecard:

```
6500-1#show environment temperature module 8
  module 8 outlet temperature: 39C
  module 8 inlet temperature: 31C
  module 8 aux-1 temperature: 35C
  module 8 aux-2 temperature: 32C
  module 8 asic-1 temperature: 68C
  module 8 asic-2 temperature: 62C
```

Notice the asic-1 and asic-2 temperatures. These are measured from sensors that are part of the fabric ASICs on the linecard, and it is expected that these temperatures are much higher than either the inlet or outlet temperatures (even in this case where there is no traffic traversing the switch).

11.0 SNMP

There are a number of MIBs that can be used to monitor the environmental characteristics of the Cisco Catalyst 6500 Series Switch. Cisco IOS for the Catalyst 6500 supports the following MIBs:

CISCO-ENVMON
CISCO-ENTITY
CISCO-ENTITY-FRU-CONTROL
CISCO-ENTITY-SENSOR
CISCO-STACK

Each of these MIBs supports an associated trap (or traps) that allows the system to notify a management station when specific changes occur within the switch. The following lists the traps associated with each MIB and describes the conditions that result in a trap being sent:

CISCO-ENVMON Traps

ciscoEnvMonShutdownNotification
Sent if the environmental monitor detects a test point reaching a critical state and is about to initiate a shutdown.
ciscoEnvMonFanStatusChangeNotif
Sent if there is change in the state of the fan tray.
ciscoEnvMonSuppStatusChangeNotif
Sent if there is change in the state of the power supply.
ciscoEnvMonTempStatusChangeNotif
Sent if there is change in the temperature state of a monitored device.

CISCO-ENTITY Traps

entConfigChange
Sent when a change occurs on a Physical Entity (An example would be insertion/ removal of a Power Supply).

CISCO-ENTITY-FRU-CONTROL Traps

cefcModuleStatusChange
Sent when the operational status of a module changes.
cefcPowerStatusChange
Sent when the power status of a FRU has changed.
cefcFRUInserted
Sent when a FRU is inserted into a system.
cefcFRURemoved
Sent when a FRU is removed from a system.

CISCO-ENTITY-SENSOR-Traps

entSensorThresholdNotification
Sent when the sensor threshold value listed in entSensorThresholdTable is crossed. A sensor can be created for any entity.

CISCO-STACK Traps

moduleUp
Sent when a module transitions to “OK” state.
moduleDown
Sent when a module transitions out of the “OK” state.
chassisAlarmOn
Sent when the chassisTempAlarm, chassisMinorAlarm or chassisMajorAlarm have transitioned to the “ON” state.

chassisAlarmOff

Sent when the chassisTempAlarm, chassisMinorAlarm or chassisMajorAlarm have transitioned to the "OFF" state.

Even though these traps are available, there is some configuration that first must be done in order to enable the traps to be sent. The following section shows which commands are needed to enable the traps for each MIB:

CISCO-ENVMON

ciscoEnvMonShutdownNotification
    snmp-server enable trap envmon shutdown

ciscoEnvMonFanStatusChangeNotif
ciscoEnvMonSuppStatusChangeNotif
ciscoEnvMonTempStatusChangeNotif
    snmp-server enable trap envmon status (for 3 traps above)

CISCO-ENTITY

entConfigChange
    snmp-server enable trap entity

CISCO-ENTITY-FRU-CONTROL

cefcModuleStatusChange
cefcPowerStatusChange
cefcFRUInserted
cefcFRURemoved
    snmp-server enable trap fru-ctrl (for 4 traps above)

CISCO-ENTITY-SENSOR

entSensorThresholdNotification
    snmp-server enable trap snmp

CISCO-STACK

moduleUp
moduleDown
    snmp-server enable trap module (for 2 traps above)
chassisAlarmOn
chassisAlarmOff
    snmp-server enable trap chassis (for 2 traps above)

All of the above configurations are executed in Global Configuration mode.

CONCLUSION

This paper provides an overview of the Environmental Requirements and Functionality of the Cisco Catalyst 6500 Series Switch. Topics covered in the paper include Airflow, Grounding, Temperature, Cooling and others. By understanding these requirements and knowing how to monitor them and interpret the results, network administrators can ensure that their Cisco Catalyst 6500 Series Switches are installed in the best possible environment to ensure optimal operation.