CHAPTER 10

Environmental Monitoring and Power Management

Note Before reading this chapter, read the "Preparing for Installation" section of the *Catalyst 4500 Series Installation Guide*. It is important to ensure that your installation site has enough power and cooling to accommodate the additional electrical load and heat introduced by Power over Ethernet (PoE).

This chapter describes power management and environmental monitoring features in the Catalyst 4500 series switches. It provides guidelines, procedures, and configuration examples.

This chapter consists of the following major sections:

Note For complete syntax and usage information for the switch commands used in this chapter, look at the *Cisco Catalyst 4500 Series Switch Command Reference* and related publications at this location:

http://www.cisco.com/en/US/products//hw/switches/ps4324/index.html

If the command is not found inthe Catalyst 4500 Command Reference, it will be found in the larger Cisco IOS library. Refer to the *Catalyst 4500 Series Switch Cisco IOS Command Reference* and related publications at this location:

http://www.cisco.com/en/US/products/ps6350/index.html

About Environmental Monitoring

This section contains the following subsections:

Environmental monitoring of chassis components provides early warning indications of possible component failure. This warning helps you to ensure the safe and reliable operation of your system and avoid network interruptions.

This section describes how to monitor critical system components so that you can identify and rapidly correct hardware-related problems.

Using CLI Commands to Monitor your Environment

Use the **show environment** CLI command to monitor the system. This section gives a basic overview of the command and keywords you will need.

Enter the **show environment** [**alarm** | **status** | **temperature**] command to display system status information. Keyword descriptions are listed in Table 10-1.

Table 10-1 show environment Keyword Descriptions

Keyword	Purpose
alarm	Displays environmental alarms for the system.
status	Displays field-replaceable unit (FRU) operational status and power and power supply fan sensor information.
temperature	Displays temperature of the chassis.

Displaying Environment Conditions

Topics include:

- Conditions on Supervisor Engines II-Plus to V-10GE, page 10-2
- Conditions on Supervisor Engine 6-E, page 10-3

Conditions on Supervisor Engines II-Plus to V-10GE

The following example shows how to display the environment condition on Supervisor Engines II-Plus to V-10GEs. The output indicates that the power supplies differ. The switch uses only one power supply and disables the other.

```
Switch# show environment
no alarm

Chassis Temperature                    = 35 degrees Celsius
Chassis Over Temperature Threshold     = 75 degrees Celsius
Chassis Critical Temperature Threshold = 95 degrees Celsius

Power                                                  Fan     Inline
Supply  Model No          Type       Status            Sensor  Status
------  ----------------  ---------  ----------------  ------  ------
PS1     PWR-C45-2800AC    AC 2800W   good              good    good
→ PS2     PWR-C45-1000AC    AC 1000W   err-disable       good    n.a.

*** Power Supplies of different types have been detected***
Switch#
```

Conditions on Supervisor Engine 6-E

Supervisor Engine 6-E and its associated linecards support multiple temperature sensors per card. The environment condition output includes the temperature reading from each sensor and the temperature thresholds for each sensor. These linecards support three thresholds: warning, critical, and shutdown. (Supervisor Engines II-Plus to V-10GE support two threshold.)

The following example illustrates how to display the environment condition on a Supervisor Engine 6-E. The thresholds appear within parentheses.

```
Switch# show environment
no temperature alarms


Module Sensor                      Temperature          Status
------+--------------------------+--------------------+------------
2      air inlet                   23C (51C,65C,68C)             ok
2      air outlet                  29C (69C,83C,86C)             ok
5      air inlet                   38C (51C,65C,68C)             ok
5      air outlet                  38C (69C,83C,86C)             ok
6      air inlet                   34C (51C,65C,68C)             ok
6      air outlet                  37C (69C,83C,86C)             ok

Power                                                 Fan      Inline
Supply  Model No           Type       Status          Sensor   Status
------  -----------------  ---------  -----------     -------  -------
PS1     PWR-C45-2800AC     AC 2800W   good            good     good
PS2     none               --         --              --       --

Power supplies needed by system    : 1
Power supplies currently available : 1

Chassis Type : WS-C4510R-E

Power consumed by backplane : 40 Watts

Switch Bandwidth Utilization : 0%

Supervisor Led Color : Green

Module  2 Status Led Color  : Green
Module  5 Status Led Color  : Green
Module  6 Status Led Color  : Orange
Module 10 Status Led Color  : Green

Fantray : Good

Power consumed by Fantray : 80 Watts
```

Emergency Actions

Chassis with Supervisor Engine 6-E can power down a single card, providing a detailed response to over-temperature conditions on linecards. However, Supervisor Engine 6-E *cannot* safely operate when the temperature of the supervisor itself exceeds the critical threshold. Therefore, the supervisor engine will turn off the chassis' power supplies to protect itself from overheating. When this happens, you can recover the switch only by cycling the power on and off switches on the power supplies or by cycling the AC or DC inputs to the power supplies.

Critical and shutdown temperature emergencies trigger the same action. Table 10-2 lists temperature emergencies but does not distinguish between critical and shutdown emergencies.

Table 10-2 Emergency and Action for Supervisor Engines 6-E

Case 1. Complete fan failure emergency.	Power down the chassis.
Case 2. Temperature emergency on a linecard.	Power down the linecard.
Case 3. Temperature emergency on the standby supervisor engine.	Power down the standby supervisor engine.
Case 4. Temperature emergency on the active supervisor engine with the standby supervisor engine in the hot standby or cold standby redundancy state.	Reset the active supervisor engine.
Case 5. Temperature emergency on the active supervisor engine with no standby supervisor engine or with a standby supervisor engine that is not in hot standby or cold standby redundancy state.	Power down the chassis.

In Case 4, the standby supervisor engine takes over when the active engine resets itself. Then, if the temperature emergency remains, the newly active supervisor engine resets the standby supervisor engine.

Case 5 applies to nonredundant chassis and to chassis with a standby supervisor engine that has been shutdown or which has not fully booted.

System Alarms

Any system has two types of alarms: major and minor. A major alarm indicates a critical problem that could lead to system shutdown. A minor alarm is informational—it alerts you to a problem that could become critical if corrective action is not taken.

Table 10-3 lists the possible environment alarms.

Table 10-3 Possible Environmental Alarms

A temperature sensor over its warning threshold	minor
A temperature sensor over its critical threshold	major
A temperature sensor over its shutdown threshold	major
A partial fan failure	minor
A complete fan failure	major

Fan failure alarms are issued as soon as the fan failure condition is detected and are canceled when the fan failure condition clears. Temperature alarms are issued as soon as the temperature reaches the threshold temperature and are canceled when the temperature drops more than 5 degree C below the threshold. 5 degree C is a hysteresis value designed to prevent toggling alarms.

An LED on the supervisor engine indicates whether an alarm has been issued.

When the system issues a major alarm, it starts a timer whose duration depends on the alarm. If the alarm is not canceled before the timer expires, the system takes emergency action to protect itself from the effects of overheating. The timer values and the emergency actions depend on the type of supervisor engine.

Note Refer to the *Catalyst 4500 Series Switch Module Installation Guide* for information on LEDs, including the startup behavior of the supervisor engine system LED.

Table 10-4 describes the alarms on Supervisor Engines II-Plus to V-10GE.

Table 10-4 Alarms on Supervisor Engines II-Plus to V-10GE

Event	Alarm Type	Supervisor LED Color	Timeout	Description and Action
Chassis temperature exceeds the critical threshold.	Major	Red	5 min	Syslog message displays when the alarm is issued. Linecards are put in reset when the timeout expires.
Supervisor fails power on self-test (POST).	Major	Red	—	Syslog message is displayed. The supervisor fails to come up.
Chassis fan tray fails.	Major	Red	4 min	Syslog message displays when the alarm is issued. Linecards are put in reset when the timeout expires.
Chassis temperature exceeds the warning threshold.	Minor	Orange	—	Syslog message displays when the alarm is issued.
Chassis fan tray experiences partial failure.	Minor	Orange	—	Syslog message displays when the alarm is issued.

Table 10-5 describes the alarms on Supervisor Engine 6-E.

Table 10-5 Alarms on Supervisor Engine 6-E

Event	Alarm Type	Supervisor LED Color	Timeout	Description and Action
Card temperature exceeds the critical threshold.	Major	Red	15 min	Syslog message displays when the alarm is issued. See Table 10-2 for the action on timeout.
Card temperature exceeds the shutdown threshold.	Major	Red	30 sec	Syslog message displays when the alarm is issued. See Table 10-2 for the action on timeout.
Supervisor engine fails power-on self-test (POST).	Major	Red	—	Syslog message displays. Supervisor engine fails to come up.

Table 10-5 Alarms on Supervisor Engine 6-E

Event	Alarm Type	Supervisor LED Color	Timeout	Description and Action
Chassis fan tray fails.	Major	Red	30 sec	Syslog message displays when the alarm is issued. See Table 10-2 for the action on timeout.
Chassis temperature exceeds the warning threshold.	Minor	Orange	—	Syslog message when the alarm is issued.
Chassis fan tray experiences partial failure.	Minor	Orange	—	Syslog message when the alarm is issued.

Power Management

This section describes the power management feature in the Catalyst 4500 series switches. It includes the following topics:

- Power Management for the Catalyst 4500 Series Switches, page 10-6
- Powering Down a Module, page 10-20
- Power Management for the Catalyst 4948 Switches, page 10-21

Note For power consumption of all Catalyst 4000/4500 family modules, see "Appendix A, Specifications," in the Catalyst 4500 Series Module Installation Guide. Enter the **show power** command to display the current power redundancy and the current system power usage.

Power Management for the Catalyst 4500 Series Switches

This section includes the following subsections:

- Supported Power Supplies, page 10-7
- Power Management Modes for the Catalyst 4500 Switch, page 10-8
- Selecting a Power Management Mode, page 10-8
- Power Management Limitations in Catalyst 4500 Series Switches, page 10-9
- Available Power for Catalyst 4500 Series Switches Power Supplies, page 10-13
- Insufficient Inline Power Handling for Supervisor Engine II-TS, page 10-19
- Combined Mode Power Resiliency, page 10-16
- Special Considerations for the 1400 W DC Power Supply, page 10-17
- Special Considerations for the 1400 W DC SP Triple Input Power Supply, page 10-18
- Insufficient Inline Power Handling for Supervisor Engine II-TS, page 10-19
- Power Management Modes for the Catalyst 4948 Switch, page 10-21

Supported Power Supplies

You can select from several different power supplies to ensure that you have enough power for the modules installed in your switch.

Note You should select a power supply based on the modules and the amount of PoE desired using the Cisco Power Calculator:

http://tools.cisco.com/cpc/

The choice between 1000 AC and 1400 AC should depend on the type of linecards that the customer plans to use in the chassis.

The Catalyst 4500 series switches support the following power supplies:

- Fixed Wattage—These power supplies always deliver a fixed amount of PoE and system power.
  - 1000 W AC—Supports up to 1050 W of system power. (Not recommended on the Catalyst 4510R switch, PoE not supported)
  - 1400 W AC—Supports up to 1400 W system power. (PoE not supported)
  - 2800 W AC—Supports up to 1400 W of system power and up to 1400 W of PoE.
- Variable Wattage—These power supplies automatically adjust the wattage to accommodate PoE and system power requirements.
  - 1300 W AC—Supports up to 1050 W of system power and 800 W of PoE, limited to a total of 1300 W.
  - 1400 W DC—Supports up to 1400 W of system power and variable amounts of PoE, depending on the input feed to the power supply. See "Special Considerations for the 1400 W DC Power Supply" section on page 10-17 for more information.
  - 1400 W DC Service Provider—Uses up to three lines (12.5 A, 15 A, 15 A) of DC input and delivers varying amounts of system power ranging from 400 W to 1400 W depending on the lines powered. See "Special Considerations for the 1400 W DC SP Triple Input Power Supply" section on page 10-18 for more information. (PoE not supported)
  - 4200 W AC and 6000 W AC—Supports varying amounts of system power and PoE depending on the number of inputs powered and input voltage.

Note All Catalyst 4500 series switch AC-input power supplies require single-phase source AC. The source AC can be out of phase between multiple power supplies or multiple AC-power plugs on the same power supply because all AC power supply inputs are isolated. Each chassis power supply should ideally have its own dedicated branch circuit sized to local and national codes.

When you insert power supplies in your switch, use power supplies that are of the same wattage. Multi-input power supplies such as 1400 W DC triple-input, 4200 W AC, and 6000 W AC have additional restrictions. Read the sections on special considerations for these power supplies. If you mix power supplies, the switch uses the one with the higher wattage and ignores the other power supply. The power supply status displays as err-disable and the summary displays as all zeros (0) for wattage values in the output for the **show power** command.

The following example shows the output for the **show power** command for mixed power supplies:

```
Switch# show power
Power                                          Fan     Inline
```

```
Supply  Model No          Type       Status       Sensor  Status
------  ----------------  ---------  -----------  ------  ------
PS1     PWR-C45-2800AC    AC 2800W   good         good    good
→ PS2     PWR-C45-1000AC    AC 1000W   err-disable  good    n.a.

*** Power Supplies of different type have been detected***

Power supplies needed by system    :1
Power supplies currently available :1

Power Summary                       Maximum
 (in Watts)              Used     Available
----------------------   ----     ---------
System Power (12V)        328         1360
Inline Power (-50V)         0         1400
Backplane Power (3.3V)     10           40
----------------------   ----
Total Used                338 (not to exceed Total Maximum Available = 750)
Switch#
```

Power Management Modes for the Catalyst 4500 Switch

The Catalyst 4500 series switches support two power management modes:

- Redundant mode—Redundant mode uses one power supply as a primary power supply and the second power supply as a back-up. If the primary power supply fails, the second power supply immediately supports the switch without any disruption in the network. Both power supplies must be the same wattage. A single power supply must have enough power to support the switch configuration.
- Combined mode—Combined mode uses the power from all installed power supplies to support the switch configuration power requirements. However, combined mode has no power redundancy. If a power supply fails, one or more modules might shut down.

Note On the Catalyst 4510R switch, the 1000 W AC power supply is not enough to support redundant mode for all possible configurations. It is able to support redundant mode for limited configurations that require less than 1050 W.

Note The 1400 W DC power supply supports combined mode for data power. It does not support combined mode for PoE power.

Selecting a Power Management Mode

By default, a switch is set to redundant mode. In the **show power** command, if the **power supplies needed by system** is 1, the switch is in redundant mode; if the **power supplies needed by system** is 2, the switch is in combined mode.

Your switch hardware configuration will dictate which power supply or supplies you should use. For example, if your switch configuration requires more power than a single power supply provides, use the combined mode. In combined mode, however, the switch has no power redundancy. Consider the following possibilities:

- The supervisor engine consumes 110 W, the fan boxes for the Catalyst 4503 switch consume 30 W each, the fan boxes for the Catalyst 4506 and Catalyst 4507 switches consume 50 W each, the backplane for the Catalyst 4503 and Catalyst 4506 switches consumes 10 W, and the backplane for the Catalyst 4507 switch consumes 40 W.
- 1000 W can support a fully loaded Catalyst 4503 switch with no powered device support.
- 1300 W can support a fully loaded Catalyst 4503 switch with Cisco powered devices.
- Each PoE port on a WS-X4148-RJ45V module requires 6.3 W. Five fully loaded WS-X4148-RJ45V modules in a switch comprise 240 ports. This configuration requires 1512 W of PoE, plus 300 W for the modules.

Power Management Limitations in Catalyst 4500 Series Switches

Limitation 1

It is possible to configure a switch that requires more power than the power supplies provide. The two ways you could configure a switch to exceed the power capabilities are as follows:

- The power requirements for the installed modules exceed the power provided by the power supplies.

  If you insert a single power supply and then set the switch to combined mode, the switch displays this error message:

  ```
  Insufficient power supplies present for specified configuration.
  ```

  This error message also displays in the output for the **show power** command. This error message displays because, by definition, combined mode requires that two working power supplies be installed in your switch.

  If the power requirements for the installed modules exceeds the power provided by the power supplies, the switch displays this error message:

  ```
  Insufficient power available for the current chassis configuration.
  ```

  This error message also appears in the **show power** command output.

  If you attempt to insert additional modules into your switch and exceed the power supply, the switch immediately places the newly inserted module into reset mode, and the switch displays these error messages:

  ```
  Module has been inserted
  Insufficient power supplies operating.
  ```

  Additionally, if you power down a functioning switch and insert an additional module or change the module configuration so that the power requirements exceed the available power, one or more modules enter reset mode when you power on the switch again.

- The power requirements for the PoE exceed the PoE provided by the power supplies.

  If you have too many IP phones drawing power from the system, power to IP phones is cut, and some phones may be powered down to reduce the power requirements to match the power supplies.

In the first scenario (power requirements exceed the power supplied), the system attempts to resolve this power usage limitation by evaluating the type and number of modules installed. During the evaluation cycle, beginning from the bottom of the chassis, the system puts the modules that it is unable to support

(for lack of power) into reset mode. The supervisor engine and modules for which there is adequate power always remain enabled, with no disruption of network connectivity. Modules placed in reset mode still consume some power and can be removed from the chassis to further reduce power requirements. If you configure the chassis correctly, the system will not enter the evaluation cycle.

A module in reset mode continues to draw power as long as it is installed in the chassis; you can use the **show power module** command to determine how much power is required to bring the module online.

To compute the power requirements for your system and verify that your system has enough power, add the power consumed by the supervisor engine module(s), the fan box(es), and the installed modules (including PoE). For PoE, total the requirements for all the phones. See the "Powering Down a Module" section on page 10-20 for more information on the power consumption for the various components of your switch.

The 802.3af-compliant PoE modules can consume up to 20 W of PoE to power FPGAs and other hardware components on the module. Be sure to add at least 20 W to your PoE requirements for each 802.3af-compliant PoE module to ensure that the system has adequate power for the PDs connected to the switch.

On the WS-X4148-RJ45V PoE module, PoE consumption cannot be measured. Therefore, for all PoE calculations, the PoE consumption on this module is presumed to be equal to its administrative PoE.

You can use the **show module** command to verify which modules are active and which, if any, have been placed in reset.

The following example shows the **show module** command output for a system with inadequate power for all installed modules. The system does not have enough power for Module 5; the *Status* displays it as *PwrDeny*.

If the PoE that is consumed by the module is more than 50 W above the PoE you allocated using the **power inline consumption default** command, the Status displays as PwrOver. If the PoE consumed by the module is more than 50 W above the PoE module limit, the Status displays as PwrFault.

```
Switch# show module
Mod  Ports Card Type                              Model              Serial No.
---+-----+--------------------------------------+------------------+-----------
 1      2  1000BaseX (GBIC) Supervisor(active)    WS-X4014           JAB054109GH
 2      6  1000BaseX (GBIC)                       WS-X4306           00000110
 3     18  1000BaseX (GBIC)                       WS-X4418           JAB025104WK
➔ 5      0  Not enough power for module           WS-X4148-FX-MT     00000000000
 6     48  10/100BaseTX (RJ45)                    WS-X4148           JAB023402RP

 M MAC addresses                    Hw  Fw           Sw               Status
--+--------------------------------+---+------------+----------------+---------
 1 005c.9d1a.f9d0 to 005c.9d1a.f9df 0.5 12.1(11br)EW 12.1(20020313:00 Ok
 2 0010.7bab.9920 to 0010.7bab.9925 0.2                               Ok
 3 0050.7356.2b36 to 0050.7356.2b47 1.0                               Ok
➔ 5 0001.64fe.a930 to 0001.64fe.a95f 0.0                              PwrDeny
 6 0050.0f10.28b0 to 0050.0f10.28df 1.0                               Ok
Switch#
```

Limitation 2

Certain configurations on the Catalyst 4507R and Catalyst 4510R chassis exceeds the maximum amount of data power available. These configurations include the combination of the follow PIDs:

- 7-slot configuration
- Chassis: WS-C4507R-E, WS-C4510R-E
- Dual supervisor engines: WS-X45-Sup6-E

- One or more: WS-X4448-GB-RJ45 or WS-X4148-FX-MT

To maximize the 10/100/1000 port density of 7 and 10 slot chassis when using redundant Supervisor engine 6-E install WS-X4548-GB-RJ45 linecards instead of WS-X4448-GB-RJ45 linecards. If WS-X4448-GB-RJ45 linecards are required two options are available.

- Option 1

  Only 4 linecard slots can be used on the Cat4507R and 6 linecard slots on the Cat4510R chassis.

- Option 2

  When all slots are required only one WS-X4448-GB-RJ45 linecard can be used.

To maximize the 100-BASE-FX port density of 7 and 10 slot chassis when using Supervisor engine 6-E install WS-4248-FE-SFP linecards with FX optics instead of WS-X4148-FX-MT linecards. If WS-X4148-FX-MT linecards are required two options are available.

- Option 1

  Only 4 linecard slots can be used on the Cat4507R and 6 linecard slots on the Cat4510R chassis.

- Option 2

  When all slots are required only one WS-X4448-GB-RJ45 linecard can be used.

Configuring Redundant Mode on a Catalyst 4500 Series Switch

By default, the power supplies in a Catalyst 4500 series switch are set to operate in redundant mode. To effectively use redundant mode, follow these guidelines:

- Use two power supplies of the same type.
- If you have the power management mode set to redundant mode and only one power supply installed, your switch will accept the configuration but operates without redundancy.

Caution If you have power supplies with different types or different wattages installed in your switch, the switch will not recognize one of the power supplies and will not have power redundancy.

- For fixed power supplies, choose a power supply that by itself is powerful enough to support the switch configuration.
- For variable power supplies, choose a power supply that provides enough power so that the chassis and PoE requirements are less than the maximum available power. Variable power supplies automatically adjust the power resources at startup to accommodate the chassis and PoE requirements. Modules are brought up first, followed by IP phones.
- The maximum available power for chassis and PoE for each power supply are listed in Table 10-6 on page 10-13.

To configure redundant mode on your Catalyst 4500 series switch, perform this task:

	Command	Purpose
Step 1	`Switch# configure terminal`	Enters configuration mode.
Step 2	`Switch(config)# power redundancy-mode redundant`	Sets the power management mode to redundant mode.

	Command	Purpose
Step 3	`Switch(config)# end`	Exits configuration mode.
Step 4	`Switch# show power supplies`	Verifies the power redundancy mode for the switch.

The following example shows how to set the power management mode to redundant mode.

```
Switch (config)# power redundancy-mode redundant
Switch (config)# end
Switch#
```

The following example shows how to display the current power redundancy mode. The power supplies needed by system: 1 indicates that the switch is in redundant mode.

```
Switch# show power supplies
Power supplies needed by system:1
Switch#
```

An option in the combined mode provides a form of redundancy available with only the 4200 W AC and 6000 W AC power supplies. Refer to the section "Combined Mode Power Resiliency" on page 16.

Configuring Combined Mode on a Catalyst 4500 Series Switch

If your switch configuration requires more power than a single power supply can provide, set the power management mode to combined mode. Combined mode utilizes the available power for both power supplies; however, your switch will have no power redundancy.

To effectively use combined mode, follow these guidelines:

- Use power supplies of the same type and wattage (fixed or variable and AC or DC).
- If you use power supplies with different types or wattages, the switch will utilize only one of the power supplies.
- For variable power supplies, choose a power supply that provides enough power so that the chassis and PoE requirements are less than the maximum available power. Variable power supplies automatically adjust the power resources at startup to accommodate the chassis and PoE requirements.
- If you have the power management mode set to combined mode and only one power supply installed, your switch will accept the configuration, but power is available from only one power supply.
- When your switch is configured to combined mode, the total available power is not the mathematical sum of the individual power supplies. The power supplies have a predetermined current sharing ratio (See Table 10-6 on page 10-13 for more information.)
- The maximum available power for chassis and PoE for each power supply are listed in Table 10-6 on page 10-13.

To configure combined mode on your Catalyst 4500 series switch, perform this task:

	Command	Purpose
Step 1	Switch# **configure terminal**	Enters configuration mode.
Step 2	Switch(config)# **power redundancy-mode combined**	Sets the power management mode to combined mode.

	Command	Purpose
Step 3	`Switch(config)# end`	Exits configuration mode.
Step 4	Switch# `show power supplies`	Verifies the power redundancy mode for the switch.

The following example shows how to set the power management mode to combined mode.

```
Switch (config)# power redundancy-mode combined
Switch (config)# end
Switch#
```

The following example shows how to display the current power redundancy mode. The power supplies needed by system: 2 indicates that the switch is in combined mode.

```
Switch# show power supplies
Power supplies needed by system:2
Switch#
```

Available Power for Catalyst 4500 Series Switches Power Supplies

Table 10-6 lists the power available for use in the various Catalyst 4500 series switches power supplies. When your switch is configured to combined mode, the total available power in not the mathematical sum of the individual power supplies. The power supplies have a sharing ratio predetermined by the hardware. In combined mode, the total power available is P + (P * sharing-ratio), where P is the amount of power in the power supply.

Table 10-6 Available Power for Switch Power Supplies

Power Supply	Redundant Mode (W)	Combined Mode (W)	Sharing Ratio
1000 W AC	Chassis[1] = 1050 PoE = 0	Chassis = 1667 PoE = 0	2/3
1300 W AC	Chassis (max) = 1050 PoE (max) = 800 Chassis + PoE + Backplane ≤ 1300	Chassis (min) = 767 PoE (max) = 1333 Chassis (max) = 1667 PoE (min) = 533 Chassis + PoE + Backplane ≤ 2200	2/3
1400 W DC	Chassis (min) = 200 Chassis (max) = 1360 PoE (max)[2] = (DC Input[3] - [Chassis (min) + Backplane] / 0.75) * 0.96	Chassis = 2267[4] PoE[5]	Chassis—2/3 PoE—0
1400 W AC	Chassis = 1360 PoE = 0[6]	Chassis = 2473 PoE = 0	9/11
2800 W AC	Chassis = 1360 PoE = 1400	Chassis = 2473 PoE = 2333	Chassis[7]—9/11 PoE[8]—2/3

1. Chassis power includes power for the supervisor(s), all linecards, and the fan tray.

2. The efficiency for the 1400 W DC power supply is 0.75, and 0.96 is applied to PoE.
3. DC input can vary for the 1400 W DC power supply and is configurable. For more information, see "Special Considerations for the 1400 W DC Power Supply" on page 17.
4. Not available for PoE.
5. Not available for PoE.
6. No voice power.
7. Data-only.
8. Inline power.

Special Considerations for the 4200 W AC and 6000 W AC Power Supplies

The 4200 W AC and 6000 W AC power supply has two inputs: each can be powered at 110 or 220 V.

The output of the **show power** command for the 4200 W AC and 6000 W AC power supplies are similar to that of 1400 W DC triple-input power supply (that is, the status of the sub-modules (multiple inputs) is displayed). With these two power supplies, you can distinguish sub-module "failed" versus "off," and the status of the sub-modules (good, bad, or off):

```
Switch# show power
Power                                                Fan      Inline
Supply  Model No          Type       Status          Sensor   Status
------  ----------------  ---------  -----------     -------  -------
PS1     PWR-C45-4200ACV   AC 4200W   good            good     good
PS1-1                         220V   good
PS1-2                                   off
PS2     PWR-C45-4200ACV   AC 4200W   bad/off         good     bad/off
PS2-1                         220V   good
PS2-2                         220V   bad

Power supplies needed by system    : 1
Power supplies currently available : 2

Power Summary                        Maximum
 (in Watts)              Used      Available
----------------------   ----      ---------
System Power (12V)        140         1360
Inline Power (-50V)         0         1850
Backplane Power (3.3V)      0           40
----------------------   ----      ---------
Total                     140 (not to exceed Total Maximum Available = 2100)
Switch#
```

As with other power supplies, the two power supplies must be of the same type (6000 W AC or 4200 W AC or 1400 W DC). Otherwise, the right power supply will be put in err-disable state and the left one will be selected. In addition, all the inputs to the chassis must be at the same voltage. In redundant mode, the inputs to the left and right power supplies must be identical. If the left and right power supplies are powered in redundant mode, the power values will be based on the power supply that has higher output wattage.

Note When the system is powered with a 4200 W or 6000 W power supply either in 110 V or 220 V combined mode operation, the available power is determined by the configuration of the system (the type of linecards, the number of linecards, number of ports consuming inline power etc.) and does not reflect the absolute maximum power.

Note In a matched redundant power supply configuration, if a power supply sub-module fails, the other (good) power supply will provide power to its full capability.

Table 10-7 illustrates how the 4200 W AC power supply is evaluated in redundant mode.

Table 10-7 Power Output in Redundant Mode for the 4200 W AC Power Supply

Power Supply	12 V	3.3 V	-50 V	Total
110 V	660	40	700	1050
110 V+110 V or 220 V	1360	40	1850	2100
220 V+220 V	1360	40	3700	4200

In combined mode, all the inputs to the chassis must be at the same voltage.

Table 10-8 illustrates how the 4200 W AC power supply is evaluated in combined mode.

Table 10-8 Combined Mode Output for the 4200 W AC Power Supply

Power Supply	12 V	3.3 V	-50 V	Maximum
Both sides (bays) at 110 V	1200	40	1320	1870
110 V+110 V, other side 110 V	1800	40	2000	2730
Both sides at 110 V+110 V	2200	40	3100	3800
Both sides at 220 V	2200	40	3100	3800
220 V+220 V, other side 220 V	2200	40	4700	5500
Both sides at 220 V+220 V	2200	40	6200	7600

Table 10-9 illustrates how the 6000 W AC power supply is evaluated in redundant mode.

Table 10-9 Power Output in Redundant Mode for the 6000 W AC Power Supply

Power Supply	12 V	3.3 V	-50 V	Total
110 V	850	40	922	1050
110 V+110 V or 220V	1700	40	1850	2100
220 V+220 V	2200	40	4800	6000

In combined mode, all the inputs to the chassis must be at the same voltage.

Table 10-10 illustrates how the 6000 W AC power supply is evaluated in combined mode.

Table 10-10 Combined Mode Output for the 6000 W AC Power Supply

Power Supply	12 V	3.3 V	-50 V	Maximum
Both sides (bays) at 110 V	1400	40	1670	1700
110 V+110 V, other side 110 V	2360	40	2560	2800

Table 10-10 Combined Mode Output for the 6000 W AC Power Supply

Power Supply	12 V	3.3 V	-50 V	Maximum
Both sides at 110 V+110 V	3090	40	3360	3700
Both sides at 220 V	4000	40	4360	5400
220 V+220 V, other side 220 V	4000	40	6600	6200
Both sides at 220 V+220 V	4000	40	8700	10900

Combined Mode Power Resiliency

Note This feature only applies in combined mode when both power supply bays contain the 4200 W AC or 6000 W AC power supply.

Using the combined mode power resiliency feature, you can limit the power usage to a maximum of two or three (configurable) inputs.

With two 4200 W AC or 6000 W AC power supplies, a maximum of four inputs are available. This feature allows you to cap the power usage to that of two or three inputs. If one of the power supplies fails, no loss of power occurs because you have capped its usage to a smaller number of inputs.

To configure the combined mode resiliency feature, perform this task:

	Command	Purpose
Step 1	`Switch# configure terminal`	Enters configuration mode
Step 2	`Switch(config)# power redundancy combined max inputs {2 | 3}`	Limits the power usage to two or three inputs. **Note** The max inputs part of the command is ignored by all power supplies other than the 4200 W AC or 6000 W AC.
Step 3	`Switch(config)# end`	Exits configuration mode.

Let's say that you have **max inputs 3** configured with 4 "good" (220 V) inputs and you limit the user to 5500 W instead of 7600 W with the following configuration. If one sub-unit fails or is powered off, the user would have three "good" inputs providing 5500 W and the chassis is powered at the same rate as it was prior to the failure event.

```
Switch# configuration terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# power redundancy combined max inputs 3
Switch(config)# end
Switch#
14:32:01: %SYS-5-CONFIG_I: Configured from console by console
```

Here is the output of the **show power** command prior to invoking this feature:

```
Switch# show power
sh power
Power                                              Fan      Inline
Supply  Model No          Type       Status        Sensor   Status
------  ----------------  ---------  ------------  -------  -------
PS1     PWR-C45-4200ACV   AC 4200W   good          good     good
```

```
PS1-1                          110V   good
PS1-2                          110V   good
PS2     PWR-C45-4200ACV   AC 4200W   good         good     good
PS2-1                          110V   good
PS2-2                          110V   good

Power supplies needed by system    : 1
Power supplies currently available : 2

Power Summary                       Maximum
 (in Watts)              Used      Available
----------------------   ----     ---------
System Power (12V)        140        1360
Inline Power (-50V)         0        1850
Backplane Power (3.3V)      0          40
----------------------   ----     ---------
Total                     140 (not to exceed Total Maximum Available = 2100)
```

Here is the output after invoking this features: Whereas before combined mode was indicated as **Power supplies needed = 2** in the output of the **show power** command, combined mode is now indicated by the phrase **Power supplies needed by system : 2 Maximum Inputs = 3**.

```
Switch# show power
sh power
Power                                                 Fan      Inline
Supply  Model No          Type       Status           Sensor   Status
------  ----------------  ---------  -----------      -------  -------
PS1     PWR-C45-4200ACV   AC 4200W   good             good     good
PS1-1                         110V   good
PS1-2                         110V   good
PS2     PWR-C45-4200ACV   AC 4200W   good             good     good
PS2-1                         110V   good
PS2-2                         110V   good

Power supplies needed by system    : 2 Maximum Inputs = 3
Power supplies currently available : 2

Power Summary                       Maximum
 (in Watts)              Used      Available
----------------------   ----     ---------
System Power (12V)        140        2400
Inline Power (-50V)         0        2000
Backplane Power (3.3V)      0          40
----------------------   ----     ---------
Total                     140 (not to exceed Total Maximum Available = 2728)


Switch#
```

Special Considerations for the 1400 W DC Power Supply

Caution Do not mix the 1400 W DC power supply with any other power supply, even for a hot swap or other short-term emergency. Doing so can seriously damage your switch.

Keep in mind the following guidelines when using a 1400 W DC power supply with your Catalyst 4500 series switch:

- The 1400 W DC power supply works with a variety of DC sources. The DC input can vary from 300 W to 7500 W. Refer to the power supply documentation for additional information.

- The supervisor engine cannot detect the DC source plugged into the 1400 W DC power supply. If you are using the 1400 W DC power supply, use the **power dc input** command to set the DC input power. For more information on this command, see the "Configuring the DC Input for a Power Supply" section on page 10-18.
- The software automatically adjusts between system power (for modules, backplane, and fans) and PoE. Although PoE is 96 percent efficient, system power has only 75 percent efficiency. For example, each 120 W of system power requires 160 W from the DC input. This requirement is reflected in the "**Power Used"** column of the output for the **show power available** command.
- The 1400 W DC power supply has a separate power on or off switch for PoE. The power supply fan status and main power supply status are tied together. If either of them fails, both the power supply and its fan report as bad/off. You should verify that the main power is on before turning on the power for the inline switch. In addition, you should verify that the power for the inline switch is off before turning off the main power.

Configuring the DC Input for a Power Supply

To configure the DC input power for the 1400 W DC power supply or a power shelf, perform this task:

	Command	Purpose
Step 1	Switch# **configure terminal**	Enters configuration mode
Step 2	Switch(config)# **power dc input** *watts*	Sets the capacity of the DC input source.
Step 3	Switch(config)# **end**	Exits configuration mode.

The same configuration is applied to both power slots. For example, if you set the **dc power input** to 1000 W, the switch expects 1000 W as the external DC source for both slot 1and slot 2 (if present) respectively.

The following example shows how to set the external DC power source to 1000 W:

```
Switch# configure terminal
Switch (config)# power dc input 1000
Switch (config)# end
Switch#
```

If you use the 1400 W DC SP power supply in combined mode, the inputs do not have to match.

Special Considerations for the 1400 W DC SP Triple Input Power Supply

Unlike the 1400 W DC power supply, the 1400 W DC SP power supply has sub-modules (multiple inputs) that can be powered on or off. With Cisco IOS Release 12.2(25)EW, the output of the **show power** command is modified to display the status of these sub-modules:

```
Switch# show power
Power                                            Fan      Inline
Supply  Model No          Type       Status      Sensor   Status
------  ----------------  ---------  ----------  -------  ------
PS1     PWR-C45-1400DC    DCSP1400W  good        good     n.a.
PS1-1                     12.5A      good
PS1-2                     15.0A      bad
PS1-3                     15.0A      off

PS2     none              --         --          --       --
```

Keep in mind the following guidelines when using a 1400 W DC SP power supply with your Catalyst 4500 series switch:

- When you use two 48 V power rails to drive two power supplies, you might employ cross-wiring to connect the power supplies (to rails) to minimize the "inrush" current drawn during an initial power up. In this situation, you should configure the switch in combined mode before you take a rail down for maintenance.
- Ordinarily, when configured for redundancy, two power supplies must be matched (have identical inputs). For example, you might provide power to inputs 1 and 3 on both PS1 and PS2. If power supplies are mismatched upon bootup, the right (second) power supply will be in err-disable state.

In a matched redundant power supply configuration, if a power supply sub-module fails, the other (good) power supply will provide power to its full capability.

Insufficient Inline Power Handling for Supervisor Engine II-TS

When the Supervisor Engine II-TS is used with the 1400 W DC power supply (PWR-C45-1400DC), and only one 12.5 A input of the power supply is used, the supervisor engine's power consumption may vary depending on the type of linecard used and on whether a linecard is inserted at slots 2 and 3. The power consumption varies between 155 W and 330 W, which also affects the maximum amount of available inline power through the supervisor engine (0 W to 175 W). Consequently, it is possible for the supervisor engine to deny inline power to a connected inline power device when one or more linecards are inserted into the chassis.

The output of the **show power detail** and **show power module** commands reveals the variable amount of power consumption attributable to the supervisor engine and summarizes the supervisor engine's inline power.

```
Switch# show power detail
show power detail
Power                                                 Fan      Inline
Supply  Model No           Type       Status          Sensor   Status
------  -----------------  ---------  ------------  -------  -------
PS1     PWR-C45-1400DC     DCSP1400W  good          good     n.a.
PS1-1                      12.5A       good
PS1-2                      15.0A       off
PS1-3                      15.0A       off
PS2     none               --         --            --       --

Power supplies needed by system    : 1
Power supplies currently available : 1

Power Summary                       Maximum
 (in Watts)               Used     Available
----------------------   ----     ---------
System Power (12V)        360         360
Inline Power (-50V)         0           0
Backplane Power (3.3V)      0          40
----------------------   ----     ---------
Total                     360         400

Module Inline Power Summary (Watts)
(12V -> -48V on board conversion)
---------------------------------
                    Maximum
Mod      Used       Available
---      ----       ---------
1           5              25
---      ----       ---------
```

```
                          Watts Used of System Power (12V)
Mod   Model               currently  out of reset  in reset
----  ------------------  ---------  ------------  --------
 1    WS-X4013+TS            180         180         180
 2    WS-X4506-GB-T           60          60          20
 3    WS-X4424-GB-RJ45        90          90          50
 --   Fan Tray                30          --          --
-----------------------   ---------  ------------   -------
       Total                 360         330         250

                        Watts used of Chassis Inline Power (-50V)
                        Inline Power Admin  Inline Power Oper
Mod   Model                PS     Device       PS     Device     Efficiency
----  ------------------  ----------------    ----------------    ----------
 2    WS-X4506-GB-T          0        0          0        0          89
 3    WS-X4424-GB-RJ45       -        -          -        -           -
-----------------------  ----------------    ----------------    ----------
       Total                 0        0          0        0

                        Watts used of Module Inline Power (12V -> -50V)
                        Inline Power Admin  Inline Power Oper
Mod   Model                PS     Device       PS     Device     Efficiency
----  ------------------  ----------------    ----------------    ----------
 1    WS-X4013+TS            6        5          3        3          90
-----------------------  ----------------    ----------------    ----------

Switch# show power module
sh power module
                          Watts Used of System Power (12V)
Mod   Model               currently  out of reset  in reset
----  ------------------  ---------  ------------  --------
 1    WS-X4013+TS            180         180         180
 2    WS-X4506-GB-T           60          60          20
 3    WS-X4424-GB-RJ45        90          90          50
 --   Fan Tray                30          --          --
-----------------------   ---------  ------------   -------
       Total                 360         330         250

                        Watts used of Chassis Inline Power (-50V)
                        Inline Power Admin  Inline Power Oper
Mod   Model                PS     Device       PS     Device     Efficiency
----  ------------------  ----------------    ----------------    ----------
 2    WS-X4506-GB-T          0        0          0        0          89
 3    WS-X4424-GB-RJ45       -        -          -        -           -
-----------------------  ----------------    ----------------    ----------
       Total                 0        0          0        0

                        Watts used of Module Inline Power (12V -> -50V)
                        Inline Power Admin  Inline Power Oper
Mod   Model                PS     Device       PS     Device     Efficiency
----  ------------------  ----------------    ----------------    ----------
 1    WS-X4013+TS            6        5          3        3          90
-----------------------  ----------------    ----------------    ----------

Switch#
```

Powering Down a Module

If your system does not have enough power for all modules installed in the switch, you can power down a module, and place it in low power mode. To power down a module, perform this task:

Command	Purpose
`Switch(config)# no hw-module module num power`	Turns power down to the specified module by placing it in low power mode.

To power on a module that has been powered down, perform this task:

Command	Purpose
`Switch(config)# hw-module module num power`	Turns power on to the specified module.

This example shows how to power down module 6:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# no hw-module module 6 power
Switch(config)# end
Switch#
```

Power Management for the Catalyst 4948 Switches

You can select from AC or DC power supplies to ensure that you have enough power for your switch. The Catalyst 4948 switches support the following power supplies:

- 300 W AC
- 300 W DC

These power supplies are incompatible with Catalyst 4500 series switches. Since Power over Ethernet (PoE) is not supported on the Catalyst 4948 switch, only a limited wattage is needed. (For information on PoE, see Chapter 11, "Configuring Power over Ethernet.") When you insert power supplies in your switch, the EEPROM on the power supplies can be read by the system software even if the supply is not powered on. You may mix AC and DC power supplies.

Power Management Modes for the Catalyst 4948 Switch

The Catalyst 4948 switches support the redundant power management mode. In this mode, if both power supplies are operating normally, each provides from 20/80 to 45/55 percent of the total system power requirements at all times. If one power supply fails, the other unit increases power to 100 percent of the total power requirement.