Environmental Monitoring and Power Management

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, refer to the *Catalyst 4500 Series Switch Cisco IOS Command Reference* and related publications at http://www.cisco.com/univercd/cc/td/doc/product/software/ios121/121cgcr/index.htm

Understanding Environmental Monitoring

You can monitor your system with a few commands and an understanding of the system alarms. 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 these critical system components, so you can identify and rapidly correct hardware-related problems in your system.

Using CLI Commands to Monitor your Environment

To monitor the system, you use the **show environment** CLI command. This section gives a basic overview of the command and keywords you are likely to need.

Enter the **show environment** [**alarm** | **status** | **temperature**] command to display system status information. Keyword descriptions are listed in Table 33-1.

Table 33-1 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.

The following example shows how to display the environment conditions. Notice that this output indicates that the power supplies are different. The switch will only use one power supply and disable 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#
```

System Alarms

The 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 just informational—it alerts you to a problem that could turn critical if corrective action is not taken.

When the system issues an alarm (major or minor) indicating an over-temperature condition, the alarm is not canceled nor is any action taken (such as module reset or shutdown) for five minutes. If the temperature falls 5 degrees Celsius below the alarm threshold during this period, the alarm is canceled.

An LED is associated with each alarm. The LEDs are used as environmental indicators for the supervisor engine and switching modules. (See Table 33-2 for more information.)

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

Table 33-2 Alarms for Supervisor Engine and Switching Modules

Event	Alarm Type	LED Color	Description and Action
Supervisor engine temperature sensor exceeds major threshold[1]	Major	Status[2] LED red	Syslog message. If the over-temperature condition is not corrected, the system shuts down after 5 min. Alarm thresholds: • Chassis temperature = 32°C • Chassis over temperature threshold = 75°C • Chassis critical temperature threshold = 95°C
Supervisor engine temperature sensor exceeds minor threshold	Minor	Status LED orange	Syslog message. Monitor the condition.

1. Temperature sensors monitor key supervisor engine components including daughter cards.
2. A Status LED is located on the supervisor engine front panel and all module front panels.

Power Management

This section describes the power management feature in the Catalyst 4500 series switches.

The following major sections are included:

Power Management for the Catalyst 4500 Series Switches

You can select from several different power supplies to ensure that you have enough power for the modules installed in your switch. The Catalyst 4500 series switches support the following power supplies:

- Fixed Wattage—This power supply always delivers a fixed amount of inline and system power.
  - 1000 W AC
  - 2800 W AC—Supports inline power.
- Variable Wattage—This power supply automatically adjusts the wattage to accommodate inline and system power requirements.
  - 1300 W AC—Supports inline power.
  - 1400 W DC—Supports up to 1400 W of system power and variable amounts of inline power, depending on the input feed to the power supply. See "Special Considerations for the 1400W DC Power Supply" section on page 33-9 for more information.

When you insert power supplies in your switch, use power supplies that are of the same wattage. If you mix power supplies, the switch will use the one it recognizes first; the other power supply is ignored. 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 Supply    Max     Min     Max     Min     Absolute
(Nos in Watts)  Inline  Inline  System  System  Maximum
--------------  ------  ------  ------  ------  --------
PS1             1400    1400    1360    1360    2800
→ PS2              0       0       0       0       0
Switch#
```

Power Management Modes

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. The 1400W DC power supply does not support Combined mode.

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 IP phone support.
- 1300 W can support a fully loaded Catalyst 4503 switch with Cisco IP phones.
- 1300 W does not support a Catalyst 4507 fully loaded with Cisco IP phones in Redundant mode.

- 2800 W can support a fully loaded Catalyst 4503 switch with Cisco IP phones or a fully loaded Catalyst 4506 switch or Catalyst 4507 switch with limited Cisco IP phone support.
- Each inline power port on a WS-X4148-RJ45V module requires 6.3 W. Five fully loaded WS-X4148-RJ45V modules in a switch comprises 240 ports. This configuration will require 1512 W of inline power plus 300 W for the modules.

See Table 33-4 on page 33-15 for the power requirements of Catalyst 4500 series switch modules.

Power Management Limitations in Catalyst 4500 Family Switches

It is possible that you can 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 following error message:

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

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

  If the power requirements for the installed modules exceeds the power provided by the power supplies, the switch displays following 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 that the power supplies provide, the switch immediately places the newly inserted module into reset mode and the switch displays following error message:

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

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

- The power requirements for the inline power exceed the inline power 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 initiates the five-minute evaluation countdown timer. When this timer runs out, the system attempts to resolve this power usage limitation by evaluating the type and number of modules installed.

During the evaluation cycle, the modules are in effect removed and re-inserted, thus disrupting network connectivity; the switch reactivates only the modules it is able to support with the limited power available and leaves the remaining modules in reset mode. The supervisor engine always remains enabled. Modules placed in reset mode still consume some power. If the chassis module combination, including the modules in reset, still require more power than is available, the five-minute evaluation countdown timer starts for another evaluation cycle, and additional modules are placed in reset mode until the power usage is stable. If the power requirement of the active modules and the modules in reset does not exceed the available power, the system is stable and no more evaluation cycles are run, until something again causes insufficient power usage. Multiple cycles may be required to stabilize the system. If you configure the chassis correctly, the system will not enter the evaluation cycle.

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

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 inline power). For inline power, multiply the number of IP phones by 6.3W. See the "Power Consumption of Chassis Components" section on page 33-15 for more information on the power consumption for the various components of your switch.

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**.

```
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#
```

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 that are 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 wattages installed in your switch, the switch will not recognize one of the power supplies. The switch 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 supplies enough power so that the chassis and inline power requirements are less than the maximum available power for the chassis and inline power for the power supply. Variable power supplies automatically adjust the power resources to accommodate the chassis and inline power requirements when a system is booted up. Modules are brought up first, followed by IP phones.
- The maximum available power for chassis and inline power for each power supply is listed in Table 33-3 on page 33-9.

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

Note The **power redundancy-mode redundant** command is not supported on a Catalyst 4006 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#
```

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 the power supplies that are 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 supplies enough power so that the chassis and inline power requirements are less than the maximum available power for the chassis and inline power for the power supply. Variable power supplies automatically adjust the power resources to accommodate the chassis and inline power requirements.
- The 1400 W DC power supply does not support Combined mode. If you set the power budget to 2, the switch disregards this setting.

- 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 in not the mathematical sum of the individual power supplies. The power supplies have a predetermined current sharing ratio. See Table 33-3 on page 33-9 for more information.
- The maximum available power for chassis and inline power for each power supply is listed in Table 33-3 on page 33-9.

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

Note The **power redundancy-mode combined** command does not work on a Catalyst 4006 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 33-3 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 predetermined current sharing ratio. The total power available is P + (P * ratio).

Table 33-3 Available Power

Power Supply	Redundant Mode (W)	Combined Mode (W)	Sharing Ratio
1000 W AC	Chassis[1] = 1000 Inline = 0	Chassis = 1667 Inline = 0	2/3
1300 W AC	Chassis (max) = 1000 Inline (max) = 800 Chassis + Inline + Backplane ≤ 1300	Chassis (min) = 767 Chassis (max) = 1667 Inline (min) = 433 Inline (max) = 1333 Chassis + Inline + Backplane ≤ 2166	2/3
1400 W DC	Chassis (min) = 200 Chassis (max) = 1360 Inline (max)[2] = (DC Input[3] - [Chassis (min) + Backplane] / 0.75) * 0.96	N/A	2/3
2800 W AC	Chassis = 1360 In-line = 1400	Chassis = 2473 In-line = 2545	System—9/11 Inline—2/3

1. Chassis power includes power for the supervisor(s), all line cards, and the fan tray.
2. 0.75 is the efficiency for the 1400W DC power supply. 0.96 applied to inline power.
3. The DC Input can vary for the 1400W DC power supply and is configurable. For more information, see "Special Considerations for the 1400W DC Power Supply" on page 9.

Special Considerations for the 1400W 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.
- A Supervisor Engine III and Supervisor Engine IV cannot detect the DC source plugged into the 1400 W DC power supply. If you are using the 1400 W DC power supply with a Supervisor Engine III, 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 33-10.
- The software automatically adjusts between system power (for modules, backplane, and fans) and inline power. Although inline power 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 is reflected in the **Power Used** column of the output for the **show power available** command.
- The 1400 W DC power supply does not support Combined mode. If you set the power budget to 2 (Combined mode), the switch allows you to configure Combined modes, but disregards the setting and remains in Redundant mode.

- The 1400 W DC power supply has a seperate power on/off switch for inline power. 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 the power on 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 the following procedure:

	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 both for 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#
```

Power Management for the Catalyst 4006 Switch

The power management feature for the Catalyst 4006 switch is designed to support an optimized Catalyst 4006 chassis with a limited module configuration on a reduced number of power supplies.

The Catalyst 4006 chassis supports only the 400 W AC, 400W DC, and 650 W DC power supplies and allows you to mix AC-input and DC-input power supplies in the same chassis. In systems with redundant power supplies, both power supplies should be of the same wattage. If you mix a 400 W power supply and a 650 W power supply, the switch performs as if there were two 400 W power supplies. For detailed information on supported power supply configurations for each chassis, refer to the *Catalyst 4000 Family Installation Guide*.

Catalyst 4000 family modules have different power requirements; thus, some switch configurations require more power than 1+1 redundancy mode (a single power supply) can provide. In those configurations, redundancy requires three power supplies. Redundant and nonredundant power configurations are discussed in the following sections.

The Catalyst 4500 series switch contains holding bays for up to three power supplies. You need two primary power supplies to operate a fully loaded Catalyst 4006 chassis. You can set the power redundancy to two primary plus one redundant power supply (2+1 redundancy mode) or to one primary plus one redundant power supply (1+1 redundancy mode). The 1+1 redundancy mode might not support a fully loaded chassis.

If your switch has only two power supplies and is in 2+1 redundancy mode (the default mode), there is no redundancy. You can create redundancy with only two power supplies by setting the power redundancy to operate in 1+1 redundancy mode (one primary plus one redundant power supply). However, 1+1 redundancy will not support all configurations.

The 1+1 redundancy mode is designed and optimized for the following hardware configurations:

- One Catalyst 4006 chassis with a WS-X4013 supervisor engine with two 400 W power supplies (in 1+1 redundancy mode) and four WS-X4148-RJ or WS-X4148-RJ21 modules
- One Catalyst 4006 chassis with a WS-X4013 supervisor engine with two 650 W power supplies (in 1+1 redundancy mode) and five WS-X4148-RJ or WS-X4148-RJ21 modules

Although other configurations are possible, we do not recommend that you use them without careful consideration of the power usage in the system. For example, other similar and possible configurations may consist of four modules that consume less power, and the total module power usage does not exceed the absolute maximum power usage for the system.

The supervisor engine uses 110 W, the fan box uses 25 W, and the backplane does not consume any power. The system total load for the modules + supervisor + fan cannot total more than the power supplied by the power supply. The 1+1 redundancy mode might not support a fully loaded chassis and, therefore, one slot of the chassis *might be empty.* An attempt to use five modules risks an oversubscription of available power.

If you opt to use the 1+1 redundancy mode, the type and number of modules supported are limited by the power available from a single power supply. To determine the power consumption for each module in your chassis, see the "Power Consumption of Chassis Components" section on page 33-15.

To choose a 1+1 redundancy configuration, you must change the system configuration from the default 2+1 redundancy mode to 1+1 redundancy mode by using the **power supplies required 1** command. The **power supplies required 1** command sets the power redundancy to 1+1 redundancy mode. In the 1+1 redundancy mode, the nonredundant power available to the system is the power of the single weakest power supply. The second power supply installed in your switch provides full redundancy.

Limitations of the 1+1 Redundancy Mode

If you attempt to configure the system to operate in 1+1 redundancy mode, and you have more modules installed in the chassis than a single power supply can handle, the system displays the following error message:

```
Insufficient power supplies for the specified configuration
```

This message will also appear in the **show power** command output.

If you are already operating in 1+1 redundancy mode with a valid module configuration and you attempt to insert additional modules that require more power than the single power supply provides, the system immediately places the newly inserted module into reset mode and issues these error messages:

```
Module has been inserted

Insufficient power supplies operating
```

Additionally, if a chassis that has been operating in 1+1 redundancy mode with a valid module configuration is powered down, and you insert a module or change the module configuration inappropriately and power on the switch again, the module(s) in the chassis (at boot up) that require more power than is available, are placed into reset mode.

Both of these scenarios initiate the five-minute evaluation countdown timer. When this timer runs out, the system attempts to resolve this power usage limitation by evaluating the type and number of modules installed. The evaluation process may require several cycles to stabilize the chassis' power usage.

During the evaluation cycle, the modules are in effect removed and re-inserted, thus causing disruption of network connectivity; the switch reactivates only the modules it is able to support with the limited power available and leaves the remaining modules in reset mode. The supervisor engine always remains enabled. Modules placed in reset mode still consume some power. If the chassis module combination,

including the modules in reset, still require more power than is available, the five-minute evaluation countdown timer starts for another evaluation cycle, and additional modules are placed in reset mode until the power usage is stable.

If the power requirement of the active modules and with the modules in reset does not exceed the available power, the system is stable and no more evaluation cycles are run, until something again causes insufficient power usage. One or possibly two cycles are required to stabilize the system. If you configure the chassis correctly, the system will not enter the evaluation cycle.

Note If you have all three power supplies installed and you still choose to operate in 1+1 redundancy mode but later add additional modules which exceed the power available, the five-minute evaluation timer starts again. The switch may require several evaluation cycles to stabilize the system. To correct this power situation caused by the additional modules, you can either remove the extra modules or change the power redundancy to 2+1 redundancy mode. If you choose to return to the 2+1 redundancy mode, each module held in reset mode is brought up one-by-one to an operational state.

A module in reset continues to draw power as long as it is installed in the chassis; however, the **show module** command output indicates that there is not enough power for the module.

A single power supply provides 400 W or 650 W. Two 400 W power supplies provide 750 W. Two 650 W power supplies supply only 750 W, and is a restriction on the power supply cooling capacity for the Catalyst 4006 switches.

If you mix a 400 W power supply and a 650 W power supply, the switch performs as if there were two 400 W power supplies. If you have one 400 W power supply and one 650 W power supply in 1+1 redundancy mode, and a second 650 W power supply set as the backup, the system performs as if there were 400 W. If the 400 W power supply fails, the backup 650 W power supply comes into service; however, the switch still has only 400 W available. You need to remove the failed 400 W power supply for the switch to make use of the 650 W available.

To compute the power requirements for your system and verify that your system has enough power, add up the power consumed by the supervisor engine module, the fan box, and the installed modules. (See the "Power Consumption of Chassis Components" section on page 33-15 for more information on the power consumption for the various components of your switch.) For 1+1 redundancy mode, verify that the total is less than 400 W or 650 W, depending on the power supplies installed in your switch. The following examples are provided to further explain the use of power supplies.

The following configuration requires a minimum of 395 W:

- WS-X4013 supervisor engine—110 W
- Four WS-X4148-RJ modules—65 W each (260 W total—the optimized module configuration)
- Fan box—25 W

This configuration requires less than the maximum that a single power supply can provide in 1+1 redundancy mode.

The following configuration requires more power than a single 400 W power supply can provide:

- WS-X4013 supervisor engine—110 W
- Two WS-X4148-RJ modules in slots 2 and 3—65 W each (130 W total)
- Two WS-X4448-GB-LX modules in slots 4 and 5—90 W each (180 W total)
- Fan box—25 W

This configuration requires 445 W and cannot be used in 1+1 redundancy mode for a 400 W power supply. A single 650 W power supply provides enough power for 1+1 redundancy mode for this configuration.

The following configuration requires more power than either a single 400 W or 650 W power supply can provide:

- WS-X4013 supervisor engine—110 W
- Five 48-port 100BASE-FX modules in slots 2 through 6—120 W each (600 W total)
- Fan box—25 W

This configuration requires 735 W and cannot be used in 1+1 redundancy mode for either a 400 W or 650 W power supply.

Remember, when considering the 1+1 redundancy mode, you must carefully plan the configuration of the module power usage of your chassis. An incorrect configuration will momentary disrupt your system during the evaluation cycle. To avoid this disruption, carefully plan your configuration to ensure it is within the power limits, or return to the default 2+1 redundancy configuration by installing a third power supply in your switch and set the power redundancy to 2+1 redundancy mode.

Use the **power supplies required 2** command to set the power redundancy to the 2+1 redundancy mode.

Setting the Power Redundancy Mode

To configure the power redundancy mode on a Catalyst 4006 switch, perform this task:

	Command	Purpose
Step 1	`Switch# configure terminal`	Enters configuration mode.
Step 2	`Switch(config)# power supplies required {1 | 2}`	Sets the power redundancy mode.
Step 3	`Switch(config)# end`	Exits configuration mode.
Step 4	`Switch# show power`	Verifies the power redundancy mode and the current power usage for the switch.

Note The **power supplies required** command is not supported on a Catalyst 4500 series switch.

The default power redundancy mode is 2 (2+1) redundancy mode.

The following example shows how to set the power redundancy mode to 1 (1+1 redundancy mode).

```
Switch (config)# power supplies required 1
Switch (config)# end
Switch#
```

The following example shows how to display the current power status of system components and the power redundancy mode. The **Power supplies needed by system: 1** indicates that the switch is in 1+1 redundancy mode:

```
Switch# show power
Power                                                 Fan     Inline
Supply  Model No          Type       Status           Sensor  Status
------  ----------------  ---------  -----------      ------  ------
PS1     WS-X4008          AC 400W    good             good    n.a.
PS2     WS-X4008          AC 400W    good             good    n.a.
PS3     none              --         --               --      --
PEM     none              --         --               --      --

Power Supply    Max     Min     Max     Min     Absolute
(Nos in Watts)  Inline  Inline  System  System  Maximum
--------------  ------  ------  ------  ------  --------
PS1                0       0     400     400     400
PS2                0       0     400     400     400
PS3               --      --      --      --     --

Power Summary
 (in Watts)    Available   Used   Remaining
-------------  ---------  ------  ---------
System Power       400       260      140
Inline Power         0         0        0
Maximum Power      400       260      140

→ Power supplies needed by system :1

                          Power Used  Power Used
Mod   Model                (online)   (in Reset)
----  -----------------  ----------  ----------
 1    WS-X4014               110          110
 3    WS-X4306                35           30
 6    WS-X4424-GB-RJ45        90           50
Switch#
```

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**.

```
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#
```

Power Consumption of Chassis Components

For power consumption of common Catalyst 4000 family modules, see Table 33-4.

Enter the **show power** command to display the current power redundancy and the current system power usage.

Table 33-4 Power Consumption for Catalyst 4000 Family Components

Module	Power Consumed During Operation (W)	Power Consumed in Reset Mode (W)
Supervisor Engine II-Plus	110	110
Supervisor Engine III	110	110
Supervisor Engine IV	110	110
Catalyst 4006 fan box	25	25
Catalyst 4503 fan box	30	30
Catalyst 4506 and 4507 fan box	50	50
Catalyst 4006 switch backplane	0	0
Catalyst 4503 switch backplane	10	10
Catalyst 4506 switch backplane	10	10
Catalyst 4507 switch backplane	40	40
6-port 1000BASE-X (GBIC) Gigabit Ethernet WS-X4306-GB	35	30
32-port 10/100 Fast Ethernet RJ-45 WS-X4232-RJ-XX	50	35
24-port 100BASE-FX Fast Ethernet switching module WS-X4124-FX-MT	90	75
32-port 10/100 Fast Ethernet RJ-45, plus 2-port 1000BASE-X (GBIC) Gigabit Ethernet WS-4232-GB-RJ	55	35
48-port 100BASE-FX Fast Ethernet switching module WS-4148-FX-MT	120	10
18-port server switching 1000BASE-X (GBIC) Gigabit Ethernet WS-4418-GB	80	50
Catalyst 4006 Backplane Channel Module WS-X4019	10	10
48-port 10/100 Fast Ethernet RJ-45 WS-X4148-RJ	65	40
12-port 1000BASE-T Gigabit Ethernet, plus 2-port 1000BASE-X (GBIC) Gigabit Ethernet WS-X4416	110	70
24-port 1000BASE-X Gigabit Ethernet WS-X4424-GB-RJ45	90	50

Table 33-4 Power Consumption for Catalyst 4000 Family Components (continued)

Module	Power Consumed During Operation (W)	Power Consumed in Reset Mode (W)
48-port 1000BASE-X Gigabit Ethernet WS-X4448-GB-RJ45	120	72
48-port 1000BASE-X Gigabit Ethernet WS-X4448-GB-LX	90	50
48-port Telco 10/100BASE-TX switching module WS-X4148-RJ21	65	40
48-port inline power 10/100BASE-TX switching module WS-X4148-RJ45V	60	50
4-port MT-RJ Uplink module WS-U4504-FX-MT	10	10
48-port 10/100/1000BASE-T switching module WS-X4548-GB-RJ45	58	15

Configuring Inline Power

The Catalyst 4006 switch and Catalyst 4500 series switches can sense if a powered device is connected to an inline power module. The Catalyst 4006 switch and Catalyst 4500 series switches can supply inline power to the powered device if there is no power on the circuit. The powered device can also be connected to an AC power source and supply its own power to the voice circuit. If there is power on the circuit, the switch does not supply it.

Note A powered device is any device connected to the switch that requires external power or can utilize inline power. For example, an access point or IP phone.

Power Management Modes

If your switch has a module capable of providing inline power to end stations, you can set each interface on the module to automatically detect and apply inline power if the end station requires power.

The Catalyst 4500 series switch has three inline power modes:

- **auto**—The supervisor engine directs the switching module to power up the interface *only* if the switching module discovers the phone and the switch has enough power. You can specify the maximum wattage that is allowed on the interface. If you do not specify a wattage, then the switch will deliver no more than the hardware-supported maximum value.
- **static**—The supervisor engine directs the switching module to power up the interface to the wattage you specify *only* if the switching module discovers the phone. You can specify the maximum wattage that is allowed on the interface. If you do not specify a wattage, then the switch allows the hardware-supported maximum value. The maximum wattage, whether determined by the switch or specified by you, is preallocated to the interface. If the switch does not have enough power for the allocation, the command will fail.

- **never**—The supervisor engine does not direct the switching module to power up the interface even if an unpowered phone is connected.

The switch allocates inline power to the interfaces configured to **static** mode before it allocates power to the interfaces configured to **auto** mode. In the event of insufficient inline power due to a partial power supply failure, interfaces configured to **auto** mode are shutdown before interfaces configured to **static** mode.

To set an interface to automatically detect an end station requiring power and apply the inline power, perform this task:

	Command	Purpose
Step 1	`Switch(config)# interface {fastethernet | gigabitethernet} slot/port`	Selects the interface to configure.
Step 2	`Switch(config-if)# power inline {auto [max [milli-watts]] | never | static [max [milli-watts]] | allocation}`	Sets the interface to automatically detect if the end device requires power and apply inline power to the end device if necessary. If necessary, you can use the **max** keyword to specify the maximum wattage allowed on the interface (2000 to 15400 milliwatts). Use the **never** keyword to disable detection and power for the inline-power capable interface.
Step 3	`Switch(config-if)# end`	Exits configuration mode.
Step 4	`Switch# show power inline {fastethernet | gigabitethernet} slot/port`	Displays the inline power state for the switch.

If you set a non-inline-power-capable interface to automatically detect and apply power, an error message indicates that the configuration is not valid.

The following example shows how to set the Fast Ethernet interface 4/1 to automatically detect inline power and send power through that interface:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface fastethernet 4/1
Switch(config-if)# power inline auto
Switch(config-if)# end
```

This example shows how to verify the inline power configuration for the Fast Ethernet interface 5/8:

```
Switch# show power inline fastethernet 4/1
Available:665(w)  Used:663(w)  Remaining:2(w)
Interface  Admin    Oper     Power        Device        Class
                            (Watts)
---------- ----- ---------- ------- --------------  -----------
Fa4/1      auto   on            5.0  Cisco IP Phone 7960  n/a
Interface  AdminPowerMax    AdminAllocation
             (milli-watts)    (milli-watts)
---------- ---------------  --------------------
Fa4/1      15400           15400
Switch#
```

The following example shows to configure an interface so that it never supplies power through the interface:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface fastethernet 5/2
Switch(config-if)# power inline never
Switch(config-if)# end
Switch#
```

Configuring Power Allocation for an Interface

By default, the switch allocates 15.4 W to an interface when it discovers a powered device on the interface. This number automatically adjusts downward to the amount the powered device actually requires, when the switch receives a CDP packet from the powered device. Normally, this automatic method works well, and no further configuration is required. However, if CDP is disabled or you want the switch to allocate less power to a powered device than the amount requested by the powered device (not recommended), you can specify the power allocation for the entire switch or by interface.

You can change the power allocation for the entire switch by performing this procedure in configuration mode:

	Command	Purpose
Step 1	`Switch(config)# [no] power inline allocation default` *milli-watts*	Sets the inline power allocation (in milliwatts) for the switch. The power allocation can range from 2000 to 15,200. Use the **no** keyword to disable inline power allocation.
Step 2	`Switch(config)# end`	Exits configuration mode.
Step 3	`Switch# show power inline allocation default`	Displays the inline power state for the switch.

The following example shows how to set the inline power allocation to 5000 milliwatts.

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# power inline allocation default 5000
Switch(config)# end
Switch#
```

This example shows how to verify the inline power allocation.

```
Switch# show power inline allocation default
Default inline power allocation : 5000 mW
Switch#
```

You can change the power allocation for a single interface by performing this procedure in interface configuration mode:

	Command	Purpose
Step 1	`Switch(config)# interface {fastethernet | gigabitethernet} slot/port`	Selects the interface to configure.
Step 2	`Switch(config-if)# [no] power inline allocation milli-watts`	Sets the inline power allocation (in milliwatts) for the interface. The power allocation can range from 2000 to 15,200. Use the **no** keyword to disable inline power allocation.
Step 3	`Switch(config-if)# end`	Exits configuration mode.
Step 4	`Switch# show power inline allocation {fastethernet | gigabitethernet} slot/port`	Displays the inline power state for the interface.

The following example shows how to set the inline power allocation to 5000 milliwatts for Fast Ethernet interface 4/1:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface fastethernet 5/2
Switch(config-if)# power inline allocation 5000
Switch(config-if)# end
Switch#
```

This example shows how to verify the inline power allocation.

```
Switch# show power inline fastethernet 4/1
Available:665(w)  Used:663(w)  Remaining:2(w)
Interface  Admin    Oper      Power         Device         Class
                              (Watts)
---------- ----- ---------- ------- --------------  -----------
Fa4/1      auto   on            5.0  Cisco IP Phone 7960  n/a
Interface  AdminPowerMax    AdminAllocation
             (milli-watts)    (milli-watts)
---------- ---------------  --------------------
Fa4/1      15400            5000
Switch#
```

Displaying the Operational Status for an Interface

Each interface has an operational status which reflects the inline power status for an interface. The operational status for an interface is defined as one of the following:

- on—Power is supplied by the port.
- off—Power is not supplied by the port. If a powered device is connected to an interface with external power, the switch does not recognize the powered device. The **Device** column in the **show power inline** command displays as n/a.
- Power-deny—The supervisor engine does not have enough power to allocate to the port, or the power that is configured for the port is less than the power required by the port; power is not being supplied by the port.

- err-disable—The port is unable to provide power to the connected device that is configured in **Static** mode.
- faulty—The port failed diagnostics tests.

You can use the **show inline power** command to view the operational status for an interface.

This example shows how to display the operational status for all interfaces on module 4:

```
Switch# show power inline module 4
Available:665(w)  Used:663(w)  Remaining:2(w)
Interface  Admin    Oper     Power        Device        Class
                           (Watts)
---------- ----- ---------- ------- --------------  -----------
Fa4/1      auto   on            5.0  Cisco IP Phone 7960  n/a
Fa4/2      static on            7.0  Cisco IP Phone 7910  n/a
Fa4/3      auto   off             0  n/a                  n/a
Fa4/4      static off           7.0  n/a                  n/a
Fa4/5      static off           7.0  n/a                  n/a
Fa4/6      static off           7.0  n/a                  n/a
Switch#
```

This example shows how to display the operational status for Fast Ethernet interface 4/1:

```
Switch#show power inline fa4/1
Available:665(w)  Used:663(w)  Remaining:2(w)
Interface  Admin    Oper     Power        Device        Class
                           (Watts)
---------- ----- ---------- ------- --------------  -----------
Fa4/1      auto   on            5.0  Cisco IP Phone 7960  n/a
Interface  AdminPowerMax    AdminAllocation
             (milli-watts)    (milli-watts)
---------- ---------------  --------------------
Fa4/1      15400            5000
Switch#
```