White Paper

Cisco Catalyst 4500 Power over Ethernet Capabilities

Introduction

The Cisco® Catalyst® 4500 Series provides comprehensive support for Power over Ethernet for both Cisco Prestandard Power over Ethernet and the IEEE 802.3af standard, which was ratified in June 2003. Power over Ethernet support is provided by four chassis options, four Power over Ethernet line cards, and varying sizes of AC and DC power supplies.

The Cisco Catalyst 4500 Series is a highly versatile, chassis-based intelligent switching platform that provides control and resiliency for converged networks. Four chassis options are available—Cisco Catalyst 4510R,Cisco Catalyst 4507R, Catalyst 4506, and Catalyst 4503—and all chassis share a common set of power supplies and line cards providing operational consistency, reduced sparing, and a high degree of configuration flexibility.

Customers deploying Cisco Catalyst 4500 chassis typically have two types of deployment scenarios. The first scenario is data-only, which requires power to operate the chassis and associated line cards. The second scenario supports data and Power over Ethernet (inline power) for deployments supporting IP telephony, wireless access points, security surveillance, and other applications where the attached device derives power from the Ethernet port. This paper covers:

- Cisco Prestandard and IEEE 802.3af Power over Ethernet implementation
- Cisco Catalyst 4500 Power over Ethernet line cards
- Cisco Catalyst 4500 Switch interaction with Power over Ethernet devices
- Power supply options

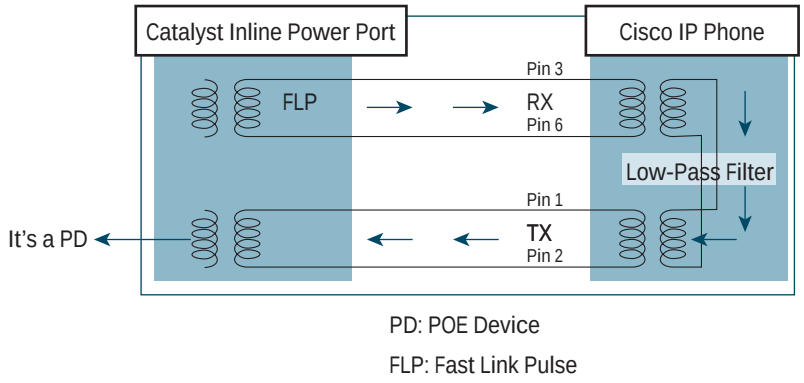
In this paper, the terms Power over Ethernet and inline power are synonymous.

Cisco Prestandard Power over Ethernet Implementation

Two entities are directly connected in a Power over Ethernet implementation: the power source equipment (PSE), which is the line card, and the powered device (PD) that is receiving power from the PSE. This would be the IP phone, wireless access point, or any other Power over Ethernet powered device. The PSE requires a power supply capable of generating the –48V of power needed. Power is provided over the same twisted pairs used by data: pins 1, 2, 3, and 6. This is also referred to as a PSE end span. Another alternative, not covered in this paper, is referred to as a PSE midspan. The midspan is a patch panel-type device that is placed between the switch and a powered device. Power is transmitted from the midspan to the powered device using the unused Ethernet pins: 4, 5, 7, and 8.

Cisco Systems® has been shipping its Power over Ethernet solution since 2000 and currently has more than 16 million IP Power over Ethernet ports installed. The Cisco Prestandard Power over Ethernet solution uses a differential discovery scheme based on a special tone. Basically the PSE sends a unique fast link pulse (FLP) over the TX pair. If the connected device is Power over Ethernet-capable, it returns this FLP back to the switch. At this point, the switch powers the device. Cisco IP phones and wireless access points use the Cisco Discovery Protocol to subsequently inform the switch how much power is required. The switch initially allocates the port default or configured Power over Ethernet allocation to the port. The current default allocation for a Cisco IP phone is 6.3W. The Cisco prestandard implementation uses the link signal of the port physical layer (PHY) to shut down the port; when the link is lost, power is removed from the port. This process of powering a Cisco powered device is shown in Figure 1.

Figure 1
Cisco Prestandard Powered Device Power Delivery



IEEE 802.3af Power over Ethernet

In June 2003, the IEEE approved a standard for Power over Ethernet. The standard specifies that switch-based PSEs may use either the signal pairs for 10/100/1000BASE-T or the spare pairs for 10/100BASE-T. The maximum power is 15.4W per PSE port, and because the specification limits current to 350 mA, the maximum power delivered to a powered device, accounting for cable loss, is 12.95W. Optionally, powered devices may also be classified based on the maximum power the powered device will draw. Cisco PSEs support this optional classification.

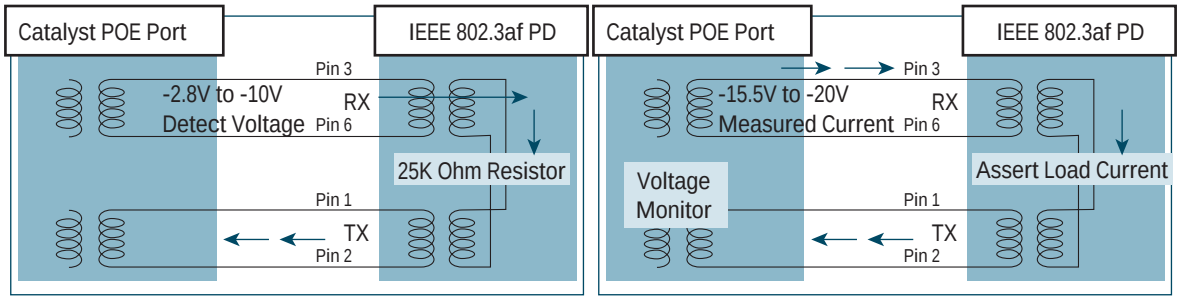
Per the specification, the main functions of the PSE are to detect a powered device, (optionally) classify the powered device, supply power to the link (only if a powered device is detected), and scale power back to the detect level when power is no longer required. The specification requires a powered device to be powered up within 1 second. This 1 second is divided into 500 milliseconds for powered-device detection, 10–75 milliseconds for powered-device classification, and 400 milliseconds for power turn-on.

The PSE detects a powered device by applying a voltage in the range of –2.8 to –10V on the cable and then looks for a 25-kohm signature resistor. A compliant powered device is required to have this level of resistance between its twisted pairs.

Classification of the powered device that Cisco supports is done by the PSE presenting a fixed voltage between –15.5 and 20V and limited to 100 mA to the powered device. This is known as the measured current method. The controller in the powered device asserts a load current into the line during classification probing. This is known as the *signature*.

The PSE then measures the powered-device load current to determine the proper classification and hence the power requirements of the powered device. The detection and classification process is depicted in Figure 2. After classification, the powered device is powered up.

Figure 2
IEEE 802.3af Powered-Device Detection, Classification, and Power Up



1. It's an IEEE PD

2. PD Classified
3. Power Up

The IEEE 802.3af classifications for the PSE and powered device are given in Table 1.

Table 1 IEEE 802.3af PSE and Powered-Device Power Classifications

Class	Usage	Minimum Power Levels Output at the PSE	Maximum Power Levels at the Powered Device
0	Default	15.4W	0.44 to 12.95W
1	Optional	4.0W	0.44 to 3.84W
2	Optional	7.0W	3.84 to 6.49W
3	Optional	15.4W	6.49 to 12.95W
4	Reserved for future use	Treat as Class 0	Reserved for future use: A Class 4 signature cannot be provided by a compliant powered device

Note: The difference between the PSE port and powered device accounts for power loss on the cable.

Table 1 shows that Classes 0 and 3 are identical. The reason for this is that Class 0 covers the case where a powered device is detected but the PSE cannot assign the powered device to Classes 1, 2, or 3. This may be in the case where a powered-device vendor has the required 25-kohm resistor but does not provide the power requirements.

Note that with the Cisco prestandard implementation, the first step, after detection, is to power the powered device by allocating the default port wattage of the PSE and, based on the Cisco Discovery Protocol exchange, the PSE then allocates the power required by the powered device. In contrast, with the IEEE implementation, the powered device is detected and is powered on after it is classified.

The specification identifies two disconnect schemes in the PSE based on either impedance or current. IEEE-powered devices support both types of diconnect schemes.

More details on the IEEE Power over Ethernet specification can be found in Section 33 of the published IEEE specification 802.3af-2003.

Cisco Catalyst 4500 Intelligent Power over Ethernet Line Cards

Table 2 shows the four Power over Ethernet line cards supported in the Cisco Catalyst 4500 Series.

Table 2 Power over Ethernet Line Cards

Model Number	Description	Support for Cisco Prestandard Power over Ethernet	Support for IEEE 802.3af Standard	Maximum Wattage per Port
WS-X4148-RJ45V	10/100 Power over Ethernet with RJ-45 connectors	Yes	No	7W
WS-X4248-RJ45V	10/100 Power over Ethernet with RJ-45 connectors	Yes	Yes	15.4W
WS-X4248-RJ21V	10/100 Power over Ethernet with RJ-21 connectors	Yes	Yes	15.4W
WS-X4548-GB-RJ45V	10/100/1000 Power over Ethernet with RJ-45 connectors	Yes	Yes	15.4W

The IEEE-capable line cards support both the Cisco Prestandard Power over Ethernet and the IEEE 802.3af standard. Keep in mind that the PSE allocates power from which the powered device draws. Therefore, it is not possible for an IEEE line card to damage an existing Cisco prestandard IP phone. The PSE allocates or provides up to 15.4W, but the Cisco prestandard IP phone draws only a maximum of 6.3W. Also, the pinouts for the RJ-21 card are identical to the pinouts for the currently shipping RJ-21 data line card (product number WS-X4148-RJ21). The detailed specifications for these line cards are given in the respective data sheets. Finally, note the IEEE line cards are simultaneously trying to detect Cisco pre-Standard as well as IEEE PD's, there is no order sequence.

The IEEE line cards are also supported in the Cisco Catalyst 4006 chassis. When used in a Cisco Catalyst 4006 chassis, a power entry module and the auxiliary power shelf are required to support the inline power requirements. In addition, there is a per-slot 400W maximum power allocation in the Cisco Catalyst 4006, which limits the maximum number of Class 3 IEEE 802.3af powered devices that can be supported on a single line card to approximately 23. No such restrictions apply to the Cisco Catalyst 4500 chassis. The IEEE line cards are also supported in the Cisco Catalyst 4003 chassis, but in data mode only.

The required IOS SW release to support the IEEE 802.3af line cards is12.2(18)EW. These cards will also be supported in. Cat OS 8.3(1) GLX. The newer line cards, which support both Cisco and IEEE 802.3af Power over Ethernet, provide 89-percent efficiency when converting the regulated –48 VDC coming from the backplane into the –48 VDC isolated required by the PSE ports. For example, if the line card has to provide 15.4W of power for a powered device connected to the switch port, with an 89-percent efficiency, the power supply must present 17.3W to the backplane (15.4/0.89) so the line card can present 15.4W to the switch port. Similarly, 7.1W would be required to power a Cisco powered device. This can be seen in the command-line interface (CLI) output in the following section.

```
4507#show power inline (note:this is selected output)
Available:1333(w)  Used:813(w)  Remaining:520(w)
Interface  Admin    Oper        Power(Watts)         Device          Class
                             From PS    To Device
---------- ----- ---------- ---------- ---------- --------------  -----------
Fa4/3      auto     on           17.3      15.4     Ieee PD              3
Fa4/10     auto     on            7.1       6.3     Cisco IP Phone 7960  n/a
Totals               2           24.4      21.7
```

The CLI also shows the total amount of inline power from the power supply to the line card. This information is useful in determining how much inline power is being drawn from the power supply.

A summary table with the maximum number of Cisco and IEEE-compliant devices supported with the various Cisco Catalyst 4500 power supplies is provided in the "Power Supply Configuration Modes" section of this paper.

Cisco Catalyst 4500 Switch Interaction with Power over Ethernet Devices

This section describes how the Cisco Catalyst 4500 with Power over Ethernet line cards interact with powered devices.

1. Power over Ethernet-capable ports are by default configured to "auto." This means that powered-device discovery, as previously described, is enabled. The powered devices are powered up on a first-come, first-served basis. If not enough inline power is available from the power supplies for all the powered devices in auto mode, there is no guarantee which powered devices will be powered up.
2. To provide more predictability, static mode has been added as a port configuration option. Static ports have a higher priority than auto ports in terms of power allocation and shutdown. The switch allocates power for a static port when it is configured. Power is then reserved for the port even when nothing is connected. The amount of power allocated can either use the default maximum value (15.4W) or can be specified using the <max-wattage> option. This allocated amount is never adjusted by IEEE class or by Cisco Discovery Protocol messages.

   With the static mode, the powered device is guaranteed to come online when plugged in. This is typically used for higher-priority users such as corporate executives or wireless access points. However, if the IEEE class wattage of the powered device is greater than the maximum wattage of the static port, the powered device is not powered up. Similarly, in the case of Cisco prestandard Power over Ethernet, if the Cisco Discovery Protocol message from the powered device indicates that the wattage required is greater than the maximum allocated on the static port, the port is powered down. In situations where the number of static ports desired exceeds the capabilities of the power supply, a newly designated static port is placed in an error-disable state, and 0W are allocated. If the switch needs to shut down powered devices because a power supply fails and there is insufficient power, auto powered devices are shut before "static" powered devices. In general, the Cisco Catalyst 4500 powers down auto Power over Ethernet ports from the bottom line-card slots to the top from right to left, for example, starting at interface 7/48 and ending at interface 3/1. When the inline power of the port is shutdown, data still works for that port. Of course a PC plugged into the back of the phone that has been powered down will lose connectivity.

3. Power over Ethernet ports may be configured to never provide inline power, thus turning them into data-only ports. Powered-device discovery is disabled in this case. If it is known that the Power over Ethernet power available to power up a full chassis of powered devices is insufficient, the administrator should configure specified ports to <off (CATALYST OS) > or <never (IOS) > to prevent a user from plugging a powered device in and possibly oversubscribing the Power over Ethernet power.
4. To disallow higher-wattage powered devices on specific ports, an interface configurable maximum wattage option is available.

```
r3_4507R_S4(config-if)#power inline auto max ?
  <4000-15400>  milli-watts
r3_4507R_S4(config-if)#power inline static max ?
  <4000-15400>  milli-watts
```

   This is the maximum wattage allowed on the Power over Ethernet switch port in auto or static mode. When maximum wattage is configured on a static port, it has the effect of increasing the number of possible static ports, because less wattage is allowed per port. If the Cisco Discovery Protocol indicates the powered device requires more than this allowed amount, the port is powered down in the case of Cisco IP phones. For IEEE powered devices, if the class power requirement exceeds the allowed amount, the port is never powered up.
5. The best practice is to use the default inline power configuration. However, if the user knows exactly how much the powered devices draw, and has strict change control in the environment, it is possible to manually configure how much a powered device consumes, overriding the IEEE class and Cisco Discovery Protocol information from the powered device.

```
r3_4507R_S4(config)#power inline consumption default ?
  <4000-15400>  milli-watts
r3_4507R_S4(config-if)#power inline consumption ?
  <4000-15400>  milli-watts
```

   The global and interface versions of the commands provide flexibility. The per-interface command overrides the global command; that is, the global command is in effect on any interface that does not have the per-interface command configured. The most prevalent type of powered device can be handled by the global command, and other types of powered devices can be handled by the interface command.

   This command is most useful when the Cisco Discovery Protocol is not available, either because it is disabled or because the customer has third-party IEEE powered devices. When the Cisco Discovery Protocol is not available, the PSE allocates the maximum of the IEEE class, or 15.4W if the IEEE class is not available (Class 0). By using this command to manually configure how much the powered device consumes, the PSE allocates a value closer to the amount the powered device consumes, allowing more powered devices to be powered up.

   Note that if the powered device consumes more than is configured with this command, there is the possibility of oversubscribing the power supply, because the line card provides any amount of power drawn by the powered device (up to the maximum supported in hardware—refer to Table 2.

Note also that the value configured must include power cable loss. For example, if the maximum consumption of a powered device is 8W, the user needs to configure this to some value greater than 8W, because there is efficiency loss over the cable between the switch port and the powered device. IEEE class and Cisco Discovery Protocol information account for this cable loss, but when manually configuring the powered-device consumption, the user must account for it.

6. When the switch receives either an IEEE classification or a Cisco Discovery Protocol message indicating that the powered device requires less than the default maximum power, the difference is returned to the global power budget of the switch. So, for example, if the default PSE Power over Ethernet port allocation is 15.4W and a Class 2 IEEE powered device requires only 6W, 9.4W is returned to the switch global power budget. Similarly, if Cisco Discovery Protocol indicates that more power is required than was initially allocated or is more than the <max-wattage> of the port, the switch powers the powered device back down and returns the allocated power of the port to the switch global power budget. If the powered device is an IEEE device, the port is never powered up. This mechanism is used for auto ports.

It is desirable to make the newer PDs, which are capable of drawing more than 7 watts of PoE per port, backward compatible with the large installed base of WS-X4148-RJ45V line cards, which support up to 7 watts of PoE per port. This relieves the customer of the burden of having to keep track of which line cards support which PoE maximums and is available via new CDP extensions which are available in IOS 12.2(18)EW and Cat OS 8.3(1)GLX. Backward compatibility with the Cisco Pre-Standard line cards requires PDs that also support the new CDP extensions, such as the Cisco 7970 IP Phone, which support both Cisco Pre-Standard and IEEE 802.3af.

Backward compatibility is achieved as follows:

- The PD initially comes up in low powered mode (less than 7watts). Whenever possible this low powered mode should be functionally usable.
- Via CDP, the PSE tells the PD the maximum amount of PoE the PSE is capable of providing
- If the PSE is a Cisco Pre-Standard line card, WS-X4148-RJ45V, with a maximum of 7 watts, the PD remains in the low powered state
- If the PSE is one of the new IEEE capable linecards, capable of supplying up to 15.4 watts per port, it will inform the PD via the CDP exchange. The PD can then transition to Normal (high power) operations.

If a IEEE PD is plugged into a n existing Cisco Pre-Standard line card, WS-X4148-RJ45V, the PD will never be powered on since this line card does not support IEEE 802.3af PD discovery.

Backward compatibility using new CDP extensions is supported with the IOS 12.2(18)EW release.

The major benefit of using a Cisco VOIP solution with CDP is the IEEE capable PDs such as the 7970 Phone inform the PSE via CDP of the actual power draw required. If CDP is disabled or not available, the PSE simply provides the maximum power for the PDs IEEE class, for example, 15.4 watts for a Class 3 PD.

Power Supplies for the Cisco Catalyst 4500 Series

With the Cisco Catalyst 4500 Series chassis, a new power supply form factor was developed. The design of the Cisco Catalyst 4500 chassis provides separate power delivery traces for the +12 VDC and 48 VDC power, providing a high degree of versatility and the ability to support high-wattage power delivery environments.

This new form factor integrates a data power supply for line cards and supervisor engines, as well as an inline power supply for Power over Ethernet devices such as IP phones or wireless access points. Currently four internal AC power supply options are available for the Cisco Catalyst 4500 Series:

- *1000 WAC*—A data-only 110–220 VAC power supply that can provide up to 1000W of 12 VDC for line cards and supervisor engines
- *1300 WACv*—A combined data and inline 110–220 VAC power supply that can provide up to 1000W of 12 VDC for line cards and supervisor engines, and up to 800W at –48 VDC for inline power devices; the maximum combined data power and inline-powered devices cannot exceed 1300W
- *1400 WACv*—A data only 110-220V AC power supply that can provide up to 1,400 watts of 12 VDC for line cards and supervisor engines. This is the minimum wattage power supply for the Cisco Catalyst 4510R chassis.
- *2800 WACv*—A combined data and inline 220 VAC power supply that can provide 1360W of 12 VDC for line cards and supervisor engines; 40W are reserved for the 3.3 VDC components, such as clock oscillators; 1400W are reserved for the –48 VDC inline-powered devices

The Cisco Catalyst 4500 External AC Power Shelf is a rack-mounted, external power source that provides native DC power to the Cisco Catalyst 4500 DC Power Supply when operating in an AC power environment. The external AC power shelf is supported only with the Cisco Catalyst 4500 Series chassis, and it requires the Cisco Catalyst 4500 DC Power Supply.

The Cisco Catalyst 4500 Series can also operate in a DC power environment.

- DC power supply—Up to 1360W are available for the 12 VDC components such as line cards, and 40W are reserved for the 3.3 VDC components such as clock oscillators. There is also an integrated –48 VDC pass-through function that enables inline power delivery through inline power-capable line cards. Both current Cisco Power over Ethernet implementation line cards and IEEE 802.3af-compliant line cards are supported by the DC power supply. Each DC power supply is rated to provide a maximum of 7500W. The DC input power can be from any DC source, such as a battery plant, or from an AC-connected source that delivers DC output power, such as the Cisco Catalyst 4500 External AC Power Shelf.

The Cisco Catalyst 4500 Series chassis has two power supply bays that support two of the same supplies in a redundant mode or in a combined power-sharing mode. The supplies must be of the same type, although the system does support upgrading to a larger supply or to an inline power-capable supply from a non-inline-power-capable supply without powering down the switch; a warning message displays during the upgrade to a larger-capacity power supply. The sole exception to this is that AC and DC power supplies cannot be mixed in the same chassis, even for upgrades.

Power Supply Configuration Modes

In redundant mode, the second supply is online, and it provides half the power the system is using. The supervisor engine allocates the total available power to be less than or equal to the power available from a single supply. This provides fault coverage for the complete loss of a power supply. It is recommended that the power supplies be plugged into the different power rails and preferably that they each be protected by an appropriately sized uninterruptible power supply. Redundant mode is the default mode used by the system.

In combined mode, the supervisor engine manages the combined power budget of both supplies to provide more power than a single supply (refer to Table 3). This mode is required only for powering inline Power over Ethernet devices that need more than the 800W or 1400W of inline power provided by the current 1300 WACv and 2800 WACv AC power supplies. The DC power supply with its integrated inline power capability can support well beyond 1400W of Power over Ethernet power and hence can be configured in redundant mode only. Further details are provided in the "Cisco Catalyst 4500 DC Power Supply" section

As with the redundant configuration, it is recommended that the power supplies be connected to an uninterruptible power supply for added resiliency. This is especially important for inline power devices because in combined mode they can use more power than a single supply can provide, and the loss of a single supply may cause some Power over Ethernet devices to be disabled. Currently, there is no combination of line cards and supervisor engines available that would require more than 1000W of 12V or 3.3V power for data or system operations.. However, as previously noted, the Catalyst 4510R chassis must be ordered with a 1400 W or greater power supply.

Power by the Numbers

Cisco Catalyst 4500 Series switches can use virtually all the switching line cards from Cisco Catalyst 4000 Series switches. The Cisco Catalyst 4000 chassis can also use the IEEE 802.3af line cards with the limitations previously described. Table 3 lists available data and inline power for each of the four AC power supplies and their modes.

Table 3 Power Supply Capacities

Supply Type	Data Redundant	Data Combined	Inline Redundant	Inline Combined
1000 WAC	1000W	1666W	–	–
1300 WACv	1000W	1666W	800W (–48V)	1333W (–48V)
1400W AC	1400W	NA	NA	NA
2800 WACv	1360W	2472W	1400W (–48V)	2333W (–48V)

Note: Data (system) power includes power available for the chassis, supervisor engines, line cards, and fan trays. Some additional power is allocated in each power supply for DC-DC conversion, clock modules, and redundancy modules (Cisco Catalyst 4507R).

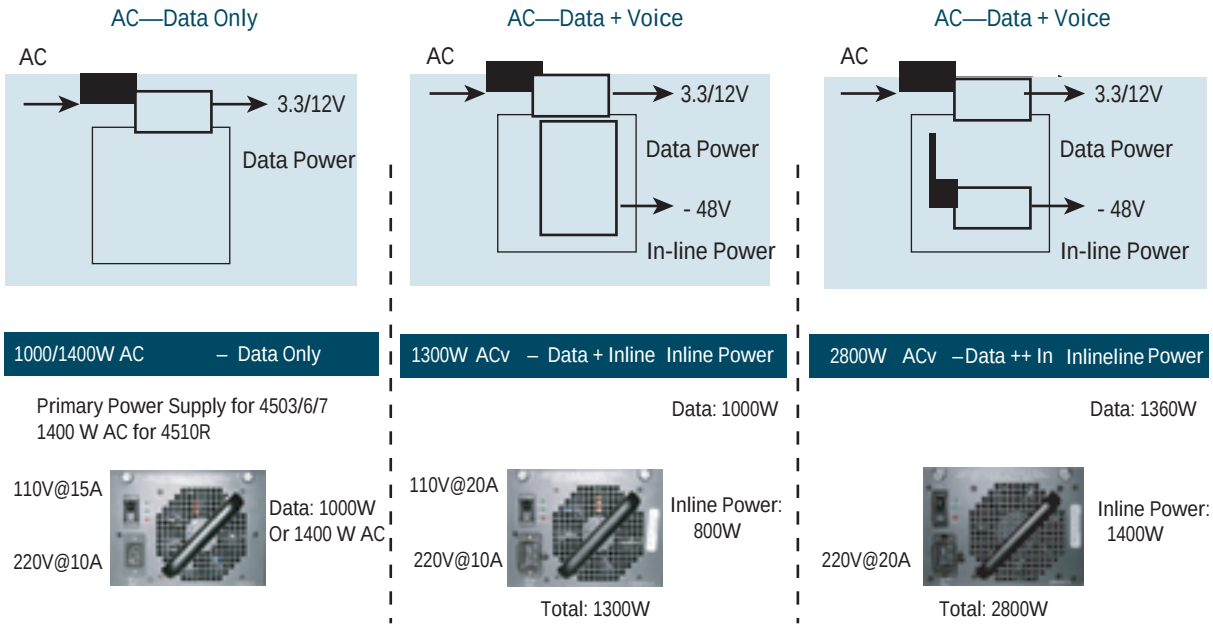
For Cisco prestandard powered devices with five 48-port inline power-capable 10/100 line cards in the system, each delivering 6.3W per port to a device, the power system needs to deliver 1512W of inline power for all 240 ports to be powered. This is beyond the capabilities of a single 2800W supply today, because the 2800W supply provides 1400W of power for inline devices. However, if two power supplies are run together in combined mode, the system has 2333W of inline power available. Power in combined mode does not sum linearly because of limitations in the output of each supply. Note that the total power available in a redundant configuration is equivalent to the power of a single supply. For example, two 1300W power supplies in redundant mode provide only 1300W of power to the system. Support of 240 IEEE phones in a chassis requires more than 3000W for a Class 3 powered device. This would require the use of a DC power supply, which is discussed in the section "Cisco Catalyst 4500 DC Power Supply."

When running in redundant mode, if a power supply fails, the remaining power supply can support the powered devices. However, if combined mode is used and a single power supply fails, the following cases can happen:

- The number of powered devices actually online can be handled by a single power supply. In this case, all powered devices stay up.
- The powered devices are actually consuming less power at the moment of failure than the remaining power supply is providing. However, the switch has allocated more inline power than is now available. This can happen because the software allocates the maximum power a powered device needs but normally the powered device is consuming less than that maximum. Powered devices will be shut down until the power allocated to the powered devices by the software is less than the remaining inline power. Auto mode ports are shut down before static ports. If shutting down auto ports is insufficient, static ports are shut down as needed. The order of shutdown is from the bottom of the chassis to the top from right to left; that is, starting at interface 7/48 and ending at interface 3/1.
- The powered devices are actually consuming more power at the moment of failure than the remaining power supply is providing. *In this case, the hardware shuts down the power supply and manual intervention is required to restart the switch.* This can also occur when the Power over Ethernet power is oversubscribed in combined mode with two power supplies. The switch goes through a power evaluation cycle, with the supervisor and line cards being activated first. The static Power over Ethernet ports are brought up next, and then with the remaining power, as many auto mode ports as possible are brought up. This scenario happens when the Power over Ethernet requirements are manually configured and underestimated. It can also occur when rogue IEEE powered devices are not providing accurate information to the PSE as to their power requirements.

Note that to avoid unexpected results, it is important to plan properly and to understand the power characteristics of powered devices attached to the system to properly size the system power capacity. In the future, there will be a Cisco Catalyst 4500 Power Budget Calculator available for customers at Cisco.com. Figure 3 shows the internal interconnections for the AC power supplies.

Figure 3
Cisco Catalyst 4500 Series Power Supplies



Note that the 3.3V and 12V in Figure 3 refers to the power used by the DC-DC converters, the chassis fans, and each line card.

It is also important to note that the 1300W supply shares the total supply power between inline power devices, the line cards, and the supervisor engine. The 2800W supply has 1360W dedicated to data (supervisor engine, line cards, and fan trays) and 1400W dedicated to inline power. The supervisor engine first allocates power to the line cards, and then allocates the remaining power randomly (auto mode) to inline power devices until the available power is exhausted. So, in planning it is important to make sure sufficient power remains for the inline power devices as well as any additional line cards that may be added in the future. In the case of insufficient power being available for inline-powered devices such as phones, these devices are held in a down state until sufficient power becomes available.

In the case of line cards, there are two types of power modes: online and reset. In reset mode, the line card is recognized but is in a standby state. A line card is placed in this state when there is insufficient power available to bring it online but sufficient power to place the line card in this reset mode. Prior to IOS Release 12.2(18)EW, if there is insufficient power to place the newly added line card into reset, the chassis will go into a power evaluation cycle. *This is disruptive to network connectivity.* During this evaluation cycle, line cards are in effect removed until the power usage is stable with some line cards being online and some line cards being placed in reset mode. In this situation, the Supervisor Engine always remains enabled. Remember, power for line cards will be allocated before inline power, so after the evaluation cycle, the new line card will be added at the expense of the inline powered devices. Starting with IOS Release 12.2(18) EW, the power evaluation cycle is less disruptive. Starting from the bottom of the chassis, the software shuts down only as many line cards as needed to decrease the system power usage. Line cards higher up in the chassis, which fit within the new reduced amount of system power available are not disrupted. In a data only implementation, there is no combination of line cards and Supervisor Engines that would result in a line card being placed in reset mode or triggering a power evaluation. However, when inline power devices are introduced, it is possible and can be avoided by proper planning.

All four AC power supplies as well as the DC power supply operate in the Cisco Catalyst 4503, Catalyst 4506, and Catalyst 4507R switches. However the Catalyst 4510R can only be ordered with the 1400 W AC or higher wattage power supplies. These new supplies are not compatible with the Cisco Catalyst 4000 Series chassis, because the new supplies have a different form factor. Redundant or combined mode supplies must be of the same type, although the system does support dissimilar supplies to allow for upgrading to a larger supply type. However, mixing AC and DC power supplies in the same chassis is not supported, even for upgrades. Downgrading power supplies is supported but not recommended because it may cause a loss of power to inline power devices or line cards. Note that the Supervisor Engine 2 in Cisco Catalyst 4503 and Catalyst 4506 switches requires the set power budget 1 or 2 command if the system has one or two power supplies. This command tells the system the number of power supplies for inline power budgeting.

Figure 4
Output of show power Command

```
4507R#show power detail (selected output)
Power                                                 Fan      Inline
Supply  Model No          Type       Status           Sensor   Status
------  ----------------  ---------  -----------      -------  -------
PS1     PWR-C45-1300ACV   AC 1300W   good             good     good
PS2     PWR-C45-1300ACV   AC 1300W   good             good     good


Power Supply    Max     Min     Max     Min     Absolute
(Nos in Watts)  Inline  Inline  System  System  Maximum
--------------  ------  ------  ------  ------  --------
PS1              800     260    1000     460    1300
PS2              800     260    1000     460    1300

Power Summary
 (in Watts)    Available   Used   Remaining
-------------  ---------  ------  ---------
System Power     1000       535      465
Inline Power      800        21      779
Maximum Power    1300       596      704

Power supplies needed by system : 1

                          Power Used  Power Used
Mod   Model                (online)   (in Reset)
----  -----------------  ----------  ----------
 1    WS-X4515              110          110
 2    WS-X4515              110          110
 3    WS-X4148-RJ45V         60           50
 4    WS-X4418               80           50
 5    WS-X4306-GB            35           30
 6    WS-X4448-GB-LX         90           50
 7    WS-X4148-RJ45V         60           50
                                 Inline  Power Admin    Inline    Power Oper
Mod   Model                PS     Device       PS        Device    Efficiency
----  -----------------  -------  -------- ------------ ----------  ----------
 1    WS-X4515             -       -           -          -           -
 3    WS-X4248-RJ45V      17      15          17         15          89

----------------------  -------  -------- ------------ ----------  ----------
       Total              17      15          17         15

4507R#show power inline fastEthernet 7/1

Interface  Admin    Oper     Power        Device
                            (Watts)
---------- -----  ---------- -------  --------------------
Fa7/1      auto   on            6.3   cisco phone device
```

The show power command is used with Cisco IOS® Software supervisor engines to determine the true available system power. The show environment power command for Catalyst OS provides similar information. Figure 4 shows an example of the Cisco IOS Software output using a 1300W power supply. Note that system power refers to the power available to a supervisor engine and data-only line cards. The minimum values shown are the minimum power reserved for data and inline power, respectively. The system also has additional watts reserved, as explained earlier in the note under Table 1. Also in IOS Release 12.2(18)EW, the show power detail command has been expanded to show how much inline power is actually being consumed per line card. This information is important when a number of powered devices are actually consuming more power than advertised, which could eventually oversubscribe the power supply. The actual inline power consumed in the line card is the operational value. The inline power consumed based on what the individual powered devices are advertising is the administrative value. When the operational value on the line card exceeds the administrative value, a logging message is generated as a warning of this condition. This capability is only available on the new IEEE line cards. The existing pre-standard power administrative and operational values are assumed to be the same.

Appendix A, at the end of this paper, shows the power requirements for the different supervisor engines and line cards in the Cisco Catalyst 4500/4000 Series switches.

How Many Power over Ethernet Powered Devices: Cisco Prestandard and IEEE 802.3af

Table 4 shows the maximum number of current-generation Cisco IP phones that can be provisioned with both the existing line card (product number WS-X4148-RJ45V) and the newer line cards that support both Cisco prestandard Power over Ethernet and IEEE 802.3af. The number of Cisco prestandard powered devices supported by the IEEE line cards may be lower because, as previously mentioned, the power efficiency of the line card is 0.89, so to provide 6.3W of Power over Ethernet, 7.1W need to be provided by the line card.

Table 4 Maximum Number of Cisco Prestandard Phones Supported with Prestandard or IEEE Line Cards

Chassis with Supervisor Engine IV or II-Plus	1300 ACv redundant		1300 ACv combined		2800 ACv redundant		2800 ACv combined	
	Current Line Card	IEEE Line Card	Current Line Card	IEEE Line Card	Current Line Card	IEEE Line Card	Current Line Card	IEEE Line Card
Catalyst 4503 (two line-card slots)	96	96	96	96	96	96	96	96
Catalyst 4506 (five line-card slots)	126	112	211	187	222	197	240	240
Catalyst 4507R (five line-card slots) 1 supervisor engine	126	112	211	187	222	197	240	240
Catalyst 4507R (five line-card slots) 2 supervisor engines	126	112	211	187	222	197	240	240

Table 4 Maximum Number of Cisco Prestandard Phones Supported with Prestandard or IEEE Line Cards

Chassis with Supervisor Engine IV or II-Plus	1300 ACv redundant		1300 ACv combined		2800 ACv redundant		2800 ACv combined	
Catalyst 4510R(eight line-card slots) with 1 or 2 Supervisor V engines	NA	NA	NA	NA	222	197	240	240

Tables 4 and 5 assume that the system is configured with the number of Power over Ethernet line cards needed to support the indicated powered devices and the maximum number of supported supervisor engines. To manually calculate the maximum number of devices that can be powered, do the following:

1. Determine the total inline power available in the particular power supply.

   This step is primarily for the 1300W supply that allocates its total available power between 12V data and –48V inline power based on the ratio between the two in the chassis.

2. Divide the available inline power by the maximum power required for each Power over Ethernet device. This determines the maximum number of inline-powered devices that can be supported.
   - For the 1300W supply—The available inline power is the lesser of 1300W total power minus the data power required, or 800W (which is the maximum inline power supported). This difference would then be divided by the per-device inline power required to give the number of inline devices that can be supported. For example, assume the chassis, line cards, and fan tray consume 600W of power; then 700W (1300W–600W) is available for inline power. Because this is less than the inline power maximum of 800W, this 700W number should be used.
   - For the 2800W supply—Because the power supply is not shared between data and inline power, the computation is as follows: 1400W divided by the per-device inline power required equals the number of inline devices that can be supported.

Table 5 shows the maximum number of IEEE Class 2 and Class 3 powered devices that can be supported on the various chassis and AC power supplies. Remember from Table 1 that a Class 3 powered device requires a maximum of 15.4W from the PSE and a Class 2 powered device requires 7W. However, once again, because of the 0.89 power efficiency of the IEEE line cards, the power supply needs to allocate 17.3W for a Class 1 powered device and 7.87W for a Class 2 powered device.

Table 5 Maximum IEEE Class 2 and Class 3 Powered Devices Supported with Cisco Catalyst 4500 IEEE Line Cards

Chassis with Supervisor Engine IV or II-Plus	1300 ACv redundant		1300 ACv combined		2800 ACv redundant		2800 ACv combined	
	Class 2 7 watts	**Class 3 15.4 watts**	**Class 2 7 watts**	**Class 3 15.4 watts**	**Class 2 7 watts**	**Class 3 15.4 watts**	**Class 2 7 watts**	**Class 3 15.4 watts**
Catalyst 4503 (two line-card slots)	96	46	96	77	96	80	96	80
Catalyst 4506 (five line-card slots)	102	46	170	77	179	80	240	134
Catalyst 4507R (five line-card slots) 1 supervisor engine	102	46	170	77	179	80	240	134
Catalyst 4507R (five line-card slots) 2 supervisor engines	102	45	170	77	179	80	240	134
Catalyst 4510R eight line-card slots) 1 or 2 Supervisor V engines	NA	NA	NA	NA	179	80	240	134

For customers who require a chassis fully populated with IEEE Class 3 powered devices requiring 15.4W from the PSE, the DC power supply discussed in the section “Cisco Catalyst 4500 DC Power Supply” offers a solution. Refer to that section for the maximum number of IEEE powered devices that can be supported.

Temporary Oversubscription of Power over Ethernet

With the advent of higher-powered powered devices requiring as much as 15.4W from the PSE port and the different combinations of power supplies and chassis port densities, it becomes quite possible to oversubscribe the Power over Ethernet capacity of the power supplies. In most cases, this should be a temporary scenario because it would not make sense to design a Power over Ethernet system where not all powered devices can receive power. This temporary

oversubscription typically occurs when a power supply configured in combined mode fails or when the user does not kept track of the powered devices and finally plugs in one too many. It must be emphasized that the best practice is to design a Power over Ethernet system where all powered devices receive the power needed at all times. It must be remembered that when a power supply is oversubscribed—that is, more power is being pulled from it than it can supply—the power supply shuts down. Given that, several capabilities are available in the switch to predictably manage a temporary Power over Ethernet oversubscription. These capabilities were discussed previously in this document.

1. Configure a port to never receive Power over Ethernet through "off" in Catalyst OS and "never" in Cisco IOS Software. This protects against a user inadvertently plugging a powered device into a port and causing problems for other powered devices.
2. Configure ports to be in static mode. This is for ports that have highest priority, such as phones for executives or wireless access points. If ports need to be shut because of a power shortage, auto ports are shut before static ports.
3. Configure the maximum wattage on ports to be less than the default, based on the maximum power consumption of the powered device. This disallows higher-powered powered devices and also stretches the finite resources of the power supplies. For example, the default port wattage is 15.4W. By configuring a maximum wattage of 7W, twice as many Power over Ethernet powered devices can be supported with the same power supply.

Cisco Wireless Access Points

As with Cisco IP phones, Cisco wireless access points can also use an inline power infrastructure, and follow the same rules as previously identified for the IP phones. The access points also communicate their maximum power requirements to the supervisor engine with the Cisco Discovery Protocol. Table 6 shows the power requirements for various access points.

Table 6 Wireless Access Point Power Requirements

Wireless Access Point	Power Required
1100	4.9W
1200, 802.11a	8W
1200, 802.11b	6W
1200, 802.11a/b	11W
340, 350	<5W

Cisco Catalyst 4500 DC Power Supply

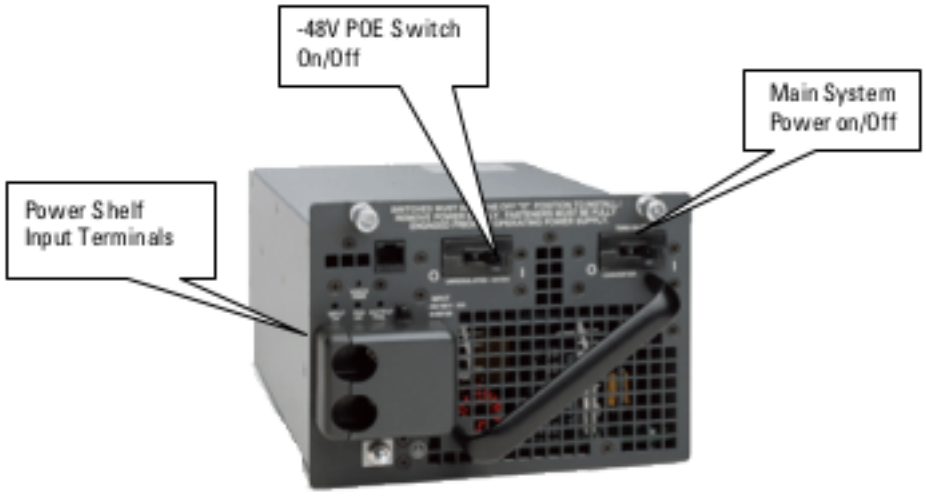
As shown in Table 5, if it is required to power a fully populated chassis with IEEE Class 2 or Class 3 powered devices in a redundant mode, the DC power supply would be needed to provide sufficient inline power to achieve this.

The DC power supply generates the regulated +12 VDC and +3.3 VDC output voltages for line cards, supervisors, fan trays, and other physical components of the chassis. Up to 1360W are available for the 12 VDC components such as line cards, and 40W are reserved for the 3.3 VDC components such as clock oscillators. An integrated –48 VDC pass-through function also enables Power over Ethernet delivery through Power over Ethernet-capable line cards. Both current Cisco Prestandard Power over Ethernet line cards and IEEE 802.3af-compliant line cards are supported

by the DC power supply. Each DC power supply is rated to provide a maximum of 7500W. Maximum power available to the chassis and for Power over Ethernet is based upon the total source power provided. To determine the amount of Power over Ethernet power available from a DC power supply, subtract the amount required for system power from the total wattage available. For example, if 800W are required for system power, 6700W are available for Power over Ethernet, assuming that sufficient source power is available.

The power supply as shown in Figure 5 has two separate input power switch breakers: one for the main 12 or 3.3 VDC power element and the other for the –48V pass-through. These power switches on the power supply can be seen in Figure 5. A DC input range of –40.5V to –72V is supported, but the maximum input voltage for inline power is –58V. The inline power pass-through function shuts down beyond –58V. The DC power supply supports a fully loaded Cisco Catalyst 4510R, Catalyst 4507R, Catalyst 4506, or Catalyst 4503 Series chassis for both data-only applications and inline power deployments of up to 15.4W on every port as long as sufficient DC source power is available to support the total wattage required, and inline-capable line cards are used.

Figure 5
DC Power Supply



The DC power supply accepts DC input power (source power) from either an external DC battery plant (DC-only environment) or an external AC power shelf that provides DC power output (AC-only environment). If an external AC-to-DC power supply is used, Cisco recommends the Cisco Catalyst 4500 External AC Power Shelf, discussed in the next section, because it provides a fully integrated solution that is designed especially for the Cisco Catalyst 4500 Series chassis and delivers integration benefits to the chassis. One example of the benefits is that input power needs to be regulated to support inline power, and the minimum input voltage level range must be between –40.5V and –58V.

Some other important considerations to note for the Cisco Catalyst 4500 Series DC Power Supply follow:

- The supplies are hot-swappable. However, for safety it is advisable that if connected to the external AC power shelf, the shelf power feed switch should be turned off before hot-swapping.

- DC power supplies operate in redundant mode only. The combined-mode CLI is accepted but is nonfunctional. Combined mode is not needed because a single power supply supports a fully loaded Cisco Catalyst 4510R Series chassis for data and inline power operation of up to 336 15.4W powered devices with a 7500 WDC power source.

Note: Mixing AC and DC power supplies in the same chassis is not supported, even for upgrades.

Power Efficiency Considerations

The DC power supply has a 75-percent efficiency factor when providing system power. This means that if a line card draws 75W, 100W are required from the power supply.

The DC supply has a 96-percent efficiency for inline power deployments. So, if inline power draws 96W, 100W are required from the power supply.

Illustrative Examples

Following are some examples that illustrate how the Cisco Catalyst 4500 DC Power Supply could be provisioned. *These examples are designed to illustrate how power is allocated when using the DC power supply and are not based on specific or maximum values.*

Example 1—Data Only with an External DC Battery as a Power Source

The Cisco Catalyst 4500 DC Power Supply provides a maximum of 1400 WDC power for data-only applications. For data-only applications, the efficiency factor is 75 percent; therefore, the input power required is 1866W (1400/0.75). At the minimum voltage of –40.5V, this requires a current draw of 46A (1866/40.5). At the maximum voltage of –72V, a current draw of 25.9A is required.

For a data-only application, the type of chassis and the types of line cards determine the DC input power required, as shown in the following steps:

1. Required DC output = Sum (Chassis + Fan trays + Supervisor(s) + Line cards)
2. Required DC input power = Required DC output sum/(0.75 Power supply efficiency factor)

The required DC input power also determines the gauge of the 1400 WDC power supply terminal connector cable required. Often the important criterion for a wire is the amount of amps it can carry. This depends on the length of the wire and the size of the conductors (or gauge). It is what the wire itself is rated, but the plug ends must have an equal or better rating as well. From a safety standpoint, the wire size must be large enough to support the maximum current that the customer's protection circuit allows (the circuit breaker). Also, the input cable from the external AC

power source to the DC power supply must be less than 10 meters for compliance reasons. Refer to the URL in the next section for information about the different gauges of wire available from electrical suppliers. The customer would provide the terminal connector wire. Customers should refer to their local and national electrical codes to select the proper connector cable.

Example 2—Data and Inline Power with an External DC Power Source

For this example, refer to Table 7. Note that the wattage for system and inline power are for illustrative purposes only.

Table 7 Data and Inline Power with an External DC Power Source Example

Component	Required DC Output Power	Power Supply Efficiency Factor	Required DC Input (source) Power
System: Chassis, fan trays, supervisor engines, and line cards	595W	0.75	793W
Power over Ethernet	3100W	0.96	3230W

A total of 4023W of DC input power into the 1400 WDC power supply is required.

Connecting Power

When the power supply is connected to a customer-provided DC power source, the input connector cables are provided by the customer. Figure 5, shown previously, shows the input terminals that are used to connect to the external DC power source. Note that when using the external AC power shelf, the input cable from the shelf to the DC power supply must be less than 10 meters for EMC regulatory compliance reasons. The Cisco Catalyst 4500 External AC Power Shelf (see next section) ships with a 1/0 gauge (thick) connector cable.

When selecting cables for connection to the DC power supply, it is very important that the correct gauge (size) wire be used for the deployment. Wire size must be matched to the load and the breaker or fuse it will be connected to. The lower the number of the gauge, the heavier the wire, and the heavier the wire, the more current it can carry. The following URL provides useful practical information on terminal connector wiring: http://www.tylersdisplay.com/electrinfo.html. Local electrical codes must also be referenced.

Cisco Catalyst 4500 Series External AC Power Shelf

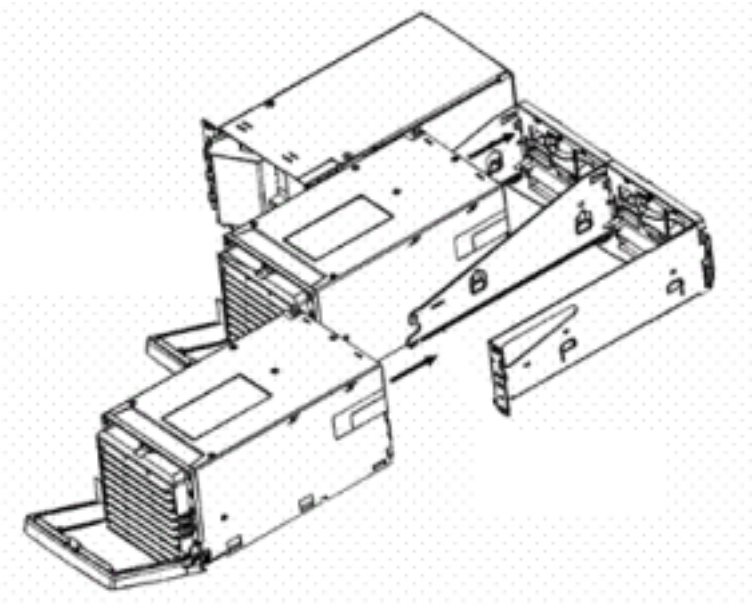
The Cisco Catalyst 4500 External AC Power Shelf is a rack-mounted, external power source that provides native DC power to the Cisco Catalyst 4500 DC Power Supply when operating in an AC power environment. The external AC power shelf is supported only with the Cisco Catalyst 4500 Series chassis, and it requires the Cisco Catalyst 4500 DC Power Supply. Typically, the external AC power shelf is used when Cisco Catalyst 4500 chassis power requirements exceed the maximum power available from an internal chassis power supply—an example may be a fully loaded chassis of 15.4W inline powered devices.

The external AC power shelf connects to a 200–240 VAC 20A power source; refer to the data sheets for the detailed specifications:

http://www.cisco.com/en/US/products/hw/switches/ps4324/products_data_sheet09186a00801f3dd9.html

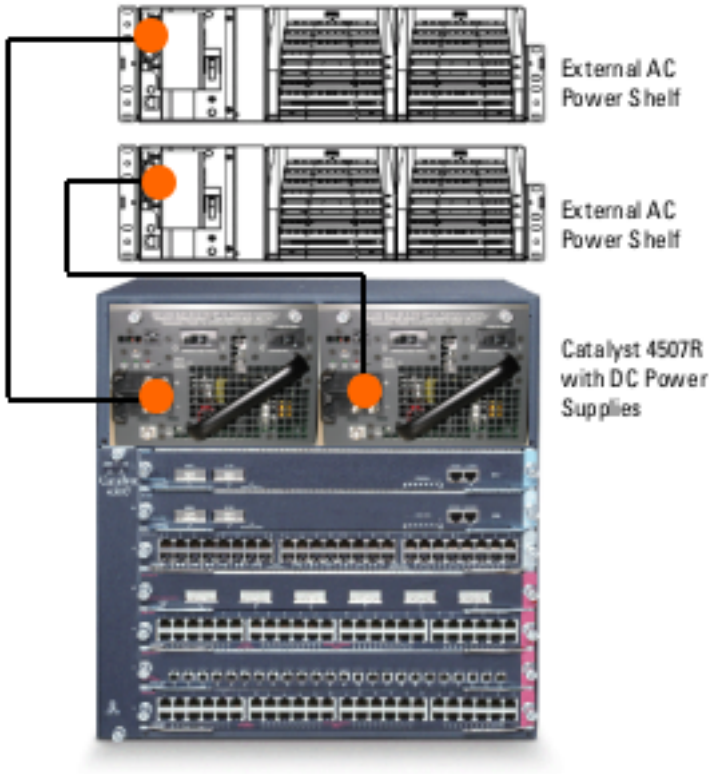
The external AC power shelf houses two 2500 WAC power supplies. Each AC power supply connects to separate AC source power for added resiliency. A total of 5000W of DC output is provided per shelf. The Cisco Catalyst 4500 External AC Power Shelf with two bays for 2500 WAC power supplies is shown in Figure 6. Plan to consume the entire circuit with each 2500 WAC power supply within the power shelf.

Figure 6
Cisco External AC Power Shelf



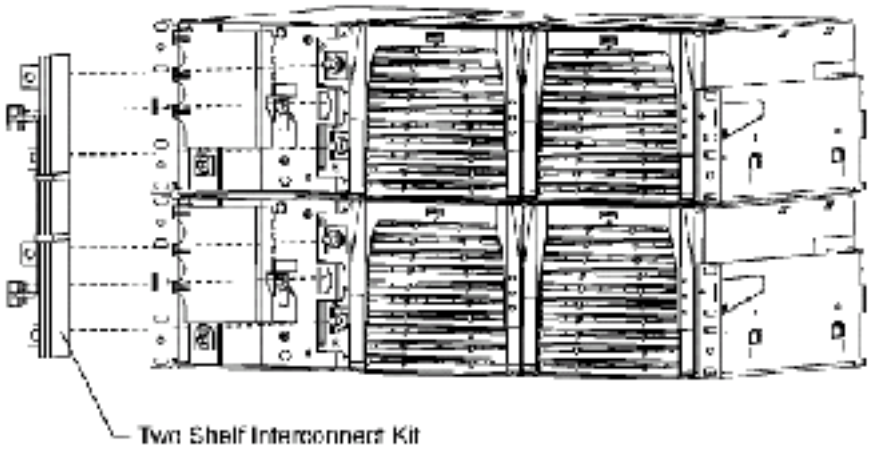
Two power shelves can be installed for fully redundant operations, with each power shelf connected to a DC power supply in the Cisco Catalyst 4500 chassis. This configuration provides 1 + 1 redundancy, providing resiliency in case of failure of either an AC power shelf internal power supply or a DC power supply. Again, each power supply within the AC power shelf connects to its own 200–240 VAC 20A power source for added resiliency. A redundant power shelf or power supply configuration providing a total of 5000 WDC input power is shown in Figure 7.

Figure 7
Redundant Catalyst 4500 AC Power Shelves and DC Power Supplies



Both the Cisco Catalyst 4500 Series DC Power Supply and the Cisco Catalyst 4500 External AC Power Shelf are supported starting with Cisco IOS Software Release 12.1(13) EW(1) and Catalyst OS 7.5(1). A maximum of 7500W from any DC power source may be provisioned into a single DC power supply by strapping the power shelves. Strapping of the power shelves is used not only to provide 7500W of DC input power to a single Cisco Catalyst 4500 DC Power Supply but also to enable N +1 redundancy. For example, with the 7500W configuration, strapping protects against a single power shelf power supply failing in the two power shelves (N +1). In a 5000W configuration (refer to the Provisioning DC Input Power section"), strapping protects against a single power supply failing on each shelf (2 + N), a highly unlikely event. Strapped power shelves are shown in Figure 8.

Figure 8
Strapped Power Shelves



Example 3—Data and Power over Ethernet with the Cisco Catalyst 4500 AC Power Shelf

In this example, the Cisco Catalyst 4500 External AC Power Shelf provides the source DC input power and connects to the Cisco Catalyst 4500 DC Power Supply. The DC power supply provides up to 7500W of power. The total of 7500W may be variably assigned either to data or to support inline power. As stated earlier, a maximum of 1400W of system power is available: 1360W for the 12 VDC components such as line cards, with 40W reserved for the 3.3 VDC components such as clock oscillators.

Table 8 Data and Power over Ethernet with the Cisco Catalyst 4500 AC Power Shelf power allocation example

Examples	AC Power Shelf DC Input Power	Required DC Input Power (includes 0.75 power efficiency factor)	Available DC Input Power for Inline Powered Devices
Example 3a	7500W	650W	6850W
Example 3b	7500W	1000W	6500W

Example 3 shows that the available inline power depends on the power remaining after the system power has been allocated. A fully populated Catalyst 4510R with 336 IEEE Class 3 PDs requires 5,812 watts of power. This can be easily accommodated with the DC power supply.

Provisioning DC Power

When DC power supplies are deployed in the Cisco Catalyst 4500, the chassis is preconfigured with a default DC power input value of 2500W. Therefore, if a power source providing more than 2500W is connected to the DC power supply, the default value of 2500W should be changed to enable the chassis to be able to draw more than 2500W. If the default is not changed, the chassis uses the default value and limits the chassis draw to 2500W, even though the power source is capable of providing more power, or the chassis requires more power.

The CLI given in the following paragraph is used to configure the input source power into the DC power supply.

```
For IOS
Sup4(config)#power dc input ?
  <300-7500>  range of input

For Cat OS
Sup 2 (config) set power dcinput <wattage>
```

It is important to note that the input power specified as a result of the command line is applied to both of the power supply slots in the chassis; therefore, the same or higher DC power source should be used for both power supplies—note that the DC power supply draws what it requires from the power source up to the maximum allocated power. The purpose of these commands is to enable software to control what is allocated by the power supply for the purpose of powering chassis components and monitoring the usage with the show power (Cisco IOS Software) or show environment power (Catalyst OS) CLI commands.

These commands also can be used to limit the power draw to the wattage specified in the CLI. So if a 2500W power source is used and the user provisions 500W, the chassis power draw is limited to 500W.

Number of IEEE Powered Devices Supported with the AC Power Shelf

Class 3 IEEE powered devices require 15.4W from the PSE port. For customers who need to support a maximum number of IEEE Class 3 powered devices, the AC power shelf combined with the DC power supply can provide this support.

Table 9 shows the maximum number of IEEE powered devices supported in the Catalyst 4506 and 4507R with the DC power supply and the AC power shelf.

Table 9 IEEE Powered Device Support in the Catalyst 4506 and 4507R with AC Power Shelf

	IEEE Class 1 4W at the PSE Port	IEEE Class 2 7W at the PSE Port	IEEE Classes 3 and 0 15.4W at the PSE Port
AC power shelf with two 2500W rectifiers	240	240	240[1] 231[2]
Two strapped AC power shelves with four (three active) 2500W rectifiers (N + 1 redundancy)	240	240	240

1. Cisco Catalyst 4506 or 4507R with a single supervisor engine and five IEEE Power over Ethernet line cards
2. Cisco Catalyst 4507 R with redundant supervisor engines and five IEEE Power over Ethernet line cards

The number of powered devices supported, as shown in Table 9, is based on the maximum power required by a powered device in an IEEE class. If the exact power required by a powered device is known to be less than this maximum, and the users have strict change control in their environment, it is possible to manually configure the amount of power allocated to the PSE port and, therefore, be able to support more powered devices with the given power supply. This was discussed earlier in the Cisco Catalyst 4500 Switch Interaction with Power over Ethernet devices section. This manual configuration capability makes it possible to support 240 IEEE Class 3 phones in a Cisco Catalyst 4507R with redundant supervisor engines and a single AC power shelf with dual 2500W rectifiers.

Table 10 IEEE Powered Device Support in the Cisco Catalyst 4510R with the AC Power Shelf

Catalyst 4510R with the Supervisor Engine V (1 or 2)	IEEE Class 1 4 watts at the PSE port	IEEE Class 2 7 watts at the PSE port	IEEE Class 3 & Class 0 15.4 watts at the PSE port
AC Power Shelf w 2 2500 W rectifiers	336	336	209
2 Strapped AC Power Shelves with 4 (3 active) 2500 w rectifiers (N+1 redundancy)	336	336	336

The Catalyst 4510R chassis with the Supervisor Engine V supports redundant Supervisor Engines in slots 1 and 2 and all line cards in slots 3 to 9. Slot 10 is reserved for an additional 2 port Gigabit Uplink card only. Therefore, the Catalyst 4510 R with the Supervisor Engine V has a maximum capacity of 336 PoE ports.

Additional Information

For additional information about power management for the Cisco Catalyst 4500 Series, refer to the Cisco.com documentation at:

http://www.cisco.com/univercd/cc/td/doc/product/lan/cat4000/12_1_19/config/pwr_envr.htm.

For detailed information about the appropriate power supply power cords and plugs, refer to the Cisco.com documentation at:

http://www.cisco.com/univercd/cc/td/doc/product/lan/cat4000/hw_doc/4500inst/02pspg.htm#1025393.

Summary

The Cisco Catalyst 4500 offers a full range of power supply options, including support for Power over Ethernet or standard data-only applications, as well as flexible support for AC or DC source power. These options are summarized in Table 11.

Table 11 Cisco Catalyst 4500 Power Supply Options

	1000 W AC	1300 W AC	1400W AC	2800 W Acv	1400 W DC-PEM
Input Requirements	110V@15A 220V @ 10A	110V@20A 220V@10A	110V@20A 220V@10A	220V@20A	26 A @ -60VDC (data only) 180A @ -48VDC (PoE)
Data (12V/3.3V)	Yes	Yes	Yes	Yes	Yes
Integrated Inline power (-48V)	No	Yes	No	Yes	Yes
IEEE 802.3af Ready	NA	Yes	NA	Yes	Yes
Chassis Support	Catalyst 4503 Catalyst 4506 Catalyst 4507R	Catalyst 4503 Catalyst 4506 Catalyst 4507R	Catalyst 4503 Catalyst 4506 Catalyst 4507R Catalyst 4510R	Catalyst 4503 Catalyst 4506 Catalyst 4507R Catalyst 4510R	Catalyst 4503 Catalyst 4506 Catalyst 4507R Catalyst 4510R

Appendix A: Power Requirements for Cisco Catalyst 4500 Supervisor Engines and Line Cards

Line card and part number	Description	Power consumption—online	Power consumption—RESET mode
WS-X4302-GB	2-port 1000Base-X	7.5	7.5
WS-X4306-GB	6-port 1000BASE-X	35	30
WS-X4232-GB-RJ	2 1000BASE-X + 32 10/100	55	35
WS-X4232-RJ-XX	32 10/100 ports+ 4 port 100 FX	50	35
WS-X-4124-FX-MT	24-port 100BASE-FX MTRJ	90	75
WS-X-4148-FX-MT	48-port 100BASE-FX MTRJ	120	10
WS-X4148-RJ21	48-port 10/100BASE-T Telco	65	40
WS-X4148-RJ	48 10/100 ports	65	40
WS-X4412-2GB-T	2 1000BASE-X + 12 1000BASE-T	110	70
WS-X4418-GB	18-port 1000BASE-X	80	50
WS-X4148-RJ45V	48-port 10/100BASE-T Cisco Pre-Standard PoE	60	50

Appendix A: Power Requirements for Cisco Catalyst 4500 Supervisor Engines and Line Cards (Continued)

Line card and part number	Description	Power consumption—online	Power consumption—RESET mode
WS-X4248-RJ45V	48-port 10/100 Base T with IEEE 802.3af PoE	65	25
WS-X4248-RJ21V	48-port 10/100 RJ-21 with IEEE 802.3af PoE	65	25
WS-X4548-GB-RJ45V	48 port 10/100/1000 BaseT with IEEE 802.3af PoE	65	60
WS-X4424-GB-RJ45	24 10/100/1000 ports	90	50
WS-X4448-GB-RJ45	48 10/100/1000 ports	120	72
WS-X4448-GB-LX	48-port 1000BASE-X	85	50
WS-X4604-GWY	Access Gateway Module	120	60
WS-X4013	Supervisor Engine II	110	110
WS-X4013+	Supervisor Engine II-Plus	105	105
WS-X4014	Supervisor Engine III	110	110
WS-X4515	Supervisor Engine IV	110	110
WS-X4515 with WS-F4531	Supervisor Engine IV with NetFlow Services Card	110	110
WS-X4516	Supervisor Engine V	170	170
WS-X4515 with WS-F4531	Supervisor Engine V with NetFlow Services Card	170	170

Note: Technical specifications are subject to change.

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