

*High Availability Power Alternatives for  
Cisco 4500 PoE Applications*

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## Introduction

The Cisco Catalyst 4500 Series of switches is a highly versatile, chassis-based, intelligent switching platform that provides control and resiliency for converged networks (voice, video, and data). The platform is designed for LAN access, branch offices, Layer 3 distribution points, small and medium-sized businesses, and metropolitan (metro) Ethernet deployments.

## Applications

The primary function of the Cisco Catalyst 4500 is to provide network interface and switching for data and Internet Telephony (VoIP). The application is intended mainly for small-to-medium businesses, but could be and is used in large Enterprise application in a campus environment and wherever multiple sites are involved. Several deployment scenarios are possible: data only, voice/data and voice/data plus Power over Ethernet (PoE).

## Deployment Environment

The Cisco Catalyst 4500 is typically installed in 19-inch mount EIA standard cabinet (provided by others) and is typically located in Telco closets and/or Telco equipment rooms. In the Telco closets, space is at a premium and the facility infrastructure,

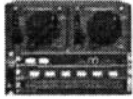
especially reliable power, is often not available. In addition, the user may not be familiar with the infrastructure requirements for high system availability. A successful deployment of the Cisco Catalyst 4500 requires simplicity of system components selection, a plug-and-play capability, ease-of-operation, and scalability for future upgrades for all system components (Cisco Catalyst 4500 and external power for phones and other PoE devices).

## Product Structure and Scalability

The Cisco Catalyst 4500 platform consists of four (4) chassis options with a variable number of slots for line cards and a set of supervisor engines delivering up to 136 Gbps of Layer 2-4 switching. This allows for scalable growth of the application by inserting line cards as needed or to migrate to a larger chassis (user can reuse existing line cards and power supplies).

There are a variety of line cards (with or without PoE) that can be used within the chassis, dependant on the desired functionality. Power for the chassis is provided via several power supply configurations insertable into two bays at the top of the chassis. Please refer to Figure 1 for Cisco Catalyst 4500 selected technical data.

**Cisco® Catalyst® 4503**



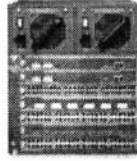
- Single Supervision
- 96 10/100/1000
- 7 RU
- 28 Gbps Backplane

**Catalyst 4506**



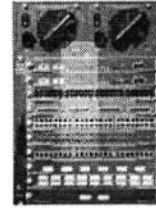
- Single Supervision
- 240 10/100/1000
- 10 RU
- 64 Gbps Backplane

**Catalyst 4507R**



- Reliability Option:  
Redundant Supervisor
- 240 10/100/1000
- 11 RU
- 68 Gbps Backplane

**Catalyst 4510R**



- Reliability Option:  
Redundant Supervisor
- 38410/100/1000
- 14 RU
- 96 Gbps Backplane

Chassis	No. of Slots for line cards	Mounting Standard 19" front	Mounting Optional 23" front	Rack Space U	Depth (inches)	Chassis Weight Only
4503	2	Std	Opt	7	12.5	31 lbs (14 kg)
4506	5	Std	Opt	10	12.5	41 lbs (18 kg)
4507R	5	Std	Opt	11	12.5	44 lbs (20 kg)
4510R	8	Std	Opt	14	12.5	52 lbs (23kg)

**Environmental**

Operating temp: 32° to 104°F (0 to 40°C)  
 Humidity: 10 to 90% non-condensing  
 Operating altitude: 60-2000m

**Air Flow**

Power supplies (two slots on upper shelf):  
 front to back  
 Chassis: side to side

**Figure 1. Cisco Catalyst Selected Technical Data**

## Power over Ethernet (PoE)

The Cisco Catalyst 4500 product platform includes line cards supporting PoE. PoE is a mechanism of delivering operating power to the network device via standard Category 5 Ethernet cable. This eliminates the need for powering a device from a wall receptacle. With PoE, the PD (power device such as phone, security camera, etc) receives the power in conjunction with data directly from the Ethernet port in the wall. This greatly increases the portability of the network devices.

The PoE application is controlled by IEEE 802.3af standard adopted internationally in June 2003 (first universally adopted power standard). The standard classifies PDs (Powered Devices) in several categories dependant on the maximum power requirement. The maximum power level today is for a Class 3 device requiring 15.4W at -48VDC per port (default level is Class 0 device - same power level as Class 3). Please note that a typical phone may consume only 7 W/port. Since the user cannot effectively control what device is plugged into the port, Cisco recommends that all ports be rated at a maximum of 15.4W.

PoE introduces -48VDC power into the Enterprise space. In larger network applications, PoE consumption can be up to 6 times the power needed for a data only network environment. PoE is inserted into the network at the Cisco Catalyst 4500 switch via a line card and is delivered from the switch's power supply.

## Redundancy in Cisco Catalyst 4500 Platform

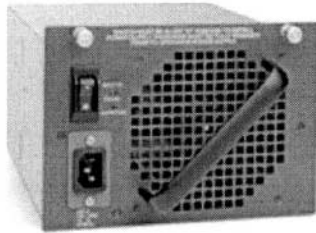
System availability is a major concern in converged network applications. The desired level of system availability is five nines or 99.999% reliability (matching traditional telephone service). This means that every critical component of the converged network must meet at least five nines of availability criteria (this applies to the power delivery system — both external power and embedded power supplies).

Integrated resiliency enhancements offered in the Cisco Catalyst 4500 Series include 1+1 supervisor-engine redundancy (Cisco Catalyst 4507R and 4510R), redundant fans, software-based fault tolerance, and 1+1 power supply redundancy. High availability of the external power to the switch is the responsibility of the user. Cisco recommends a fault tolerant back-up system (UPS or DC) and redundant power supplies for HA (high availability) deployments.

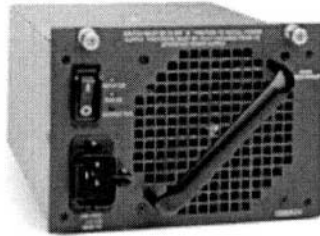
## Power Supply Options for Cisco Catalyst 4500

The power supplies Cisco currently offers for Cisco Catalyst 4500 platform are shown in Figure 2.

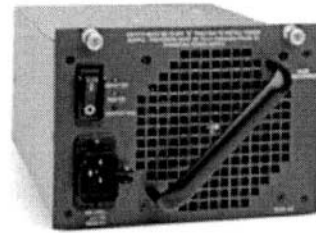
Figure 3 shows the maximum number of different PoE devices that can be used with a given power supply in a redundant or capacity (combined) mode. Figure 4 shows the maximum number of Class 3 devices that can be used with a given power supply in a redundant mode.



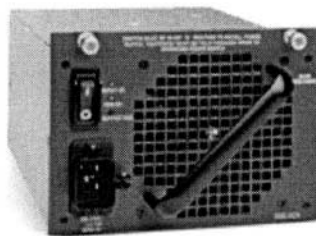
**1000 WAC**



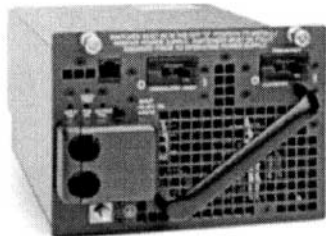
**1300 WAC**



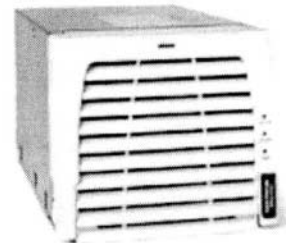
**1400 WAC**



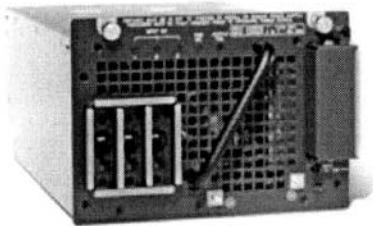
**2800 WACV**



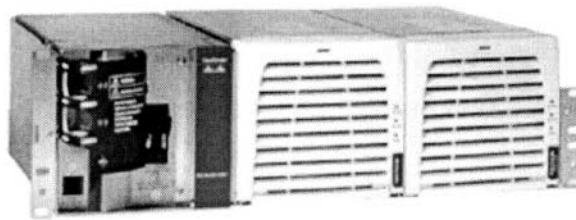
**1400 WDC with PEM**



**External AC Power Shelf 2500W**



**1400 WDC Triple Input**



**External AC Power Shelf**

- 1000 WAC - power for data only
- 1300 WAC - power for data and PoE
- 1400 WAC - power for data only
- 2800 WAC - power for data and PoE
- 4200 WAC - power for data and PoE

- External AC Power Shelf with 2X2500W AC power supplies - power for data and PoE for larger number of users (two shelves are required for larger applications)
- 1400 WDC - power for data only (triple input) - for service providers
- 1400 WDC-P - power for data and PoE

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 (2 line-card slots)	96	46	96	77	96	80	96	80
Catalyst 4506 (5 line-card slots)	102	46	170	77	179	80	240	134
Catalyst 4507R (5 line-card slots) 1 supervisor engine	102	46	170	77	179	80	240	134
Catalyst 4507R (5 line-card slots) 2 supervisor engines	102	45	170	77	179	80	240	134
Catalyst 4510R (8 line-card slots) 1 or 2 supervisor V engines	NA	NA	NA	NA	179	80	240	134

**Figure 2. Cisco Catalyst 4500 PoE Power Supply Capabilities  
For Selected Power Supply Configurations**

Chassis	No. of Slots for line cards	Max Number of PoE Ports	1300 WAC Power Supply	2800 WAC Power Supply	4200 WAC Power Supply NEW	1400 WDC-P Power Supply
4503	2	96	Opt	80	All ports	All ports
4506	5	240	Opt	80	All ports	All ports
4507R	5	240	Opt	80	202	All ports
4510R	8	384	Opt	80	190	All ports

**NOTES:**

1. Each line card can support up to 48 ports
2. Due to efficiency loss, the Class 3 single-port power at the input to the Cisco Catalyst 4500 is 17.3W.
3. 1400 WDC-P power supply includes an internal bypass for PoE power and can service all Cisco Catalyst 4500 configurations. It must always be used with external Power Shelf or DC UPS.

**Figure 3. Cisco Catalyst 4500 PoE Power Supply Capabilities For Selected Power Supply Configurations**

Cisco recommends that a PoE system be designed for the maximum number of expected PoE ports with redundant power supplies. If power supplies are used in a combined mode (capacity) and one fails or if the user oversubscribes the PoE (plugs in too many PDs), the power supply shuts down and the system goes down until the situation is corrected. This puts a burden of properly selecting power supplies on the user and requires continuous power management.

In order to fully utilize the capacity of the Cisco Catalyst 4500, and the only option, beyond 190 PoE ports, (384 is the limit) is to employ the 1400 WDC-P power supply with an External AC Power Shelf (and UPS as a back-up) for AC application or the 1400W DC-P Power Supply with an external AC Powered, DC UPS system.

If the power supply and the external power back-up system are not selected properly at the initial deployment, future growth of the system will require replacement of the power system (at additional expense and loss of the initial investment). To take advantage of the scalability of the Cisco Catalyst 4500, the user should select the maximum power supply and UPS for the maximum expected system size.

However, a better alternative is to use the 1400W DC-P power supply and an external AC powered, DC UPS. This solution offers scalable growth of power to maximize the Cisco Catalyst 4500 platform capability without the risk of under-sizing the system at the initial deployment and with minimum up front investment.

## External Power Consideration for Cisco Catalyst 4500

To achieve high availability and avoid PoE oversubscription, Cisco recommends the use of redundant power supplies as well as an external power back-up system for the Cisco Catalyst 4500 applications. There are several deployment scenarios for the external power system.

Figure 5 shows the external power back-up alternatives for the Cisco Catalyst 4500 applications with up to 202 Class 3 ports (190 ports for Cisco Catalyst 4510R). The limitations of the AC power supplies ability to power PoE (regardless of chassis size) in a redundant mode are as follows:

- 1300 WAC - max number of Class 3 PoE ports - 46
- 2800 WAC - max number of Class 3 PoE ports - 80
- 4200 WAC - max number of Class 3 PoE ports - 202 for 4507R chassis, 190 for 4510R

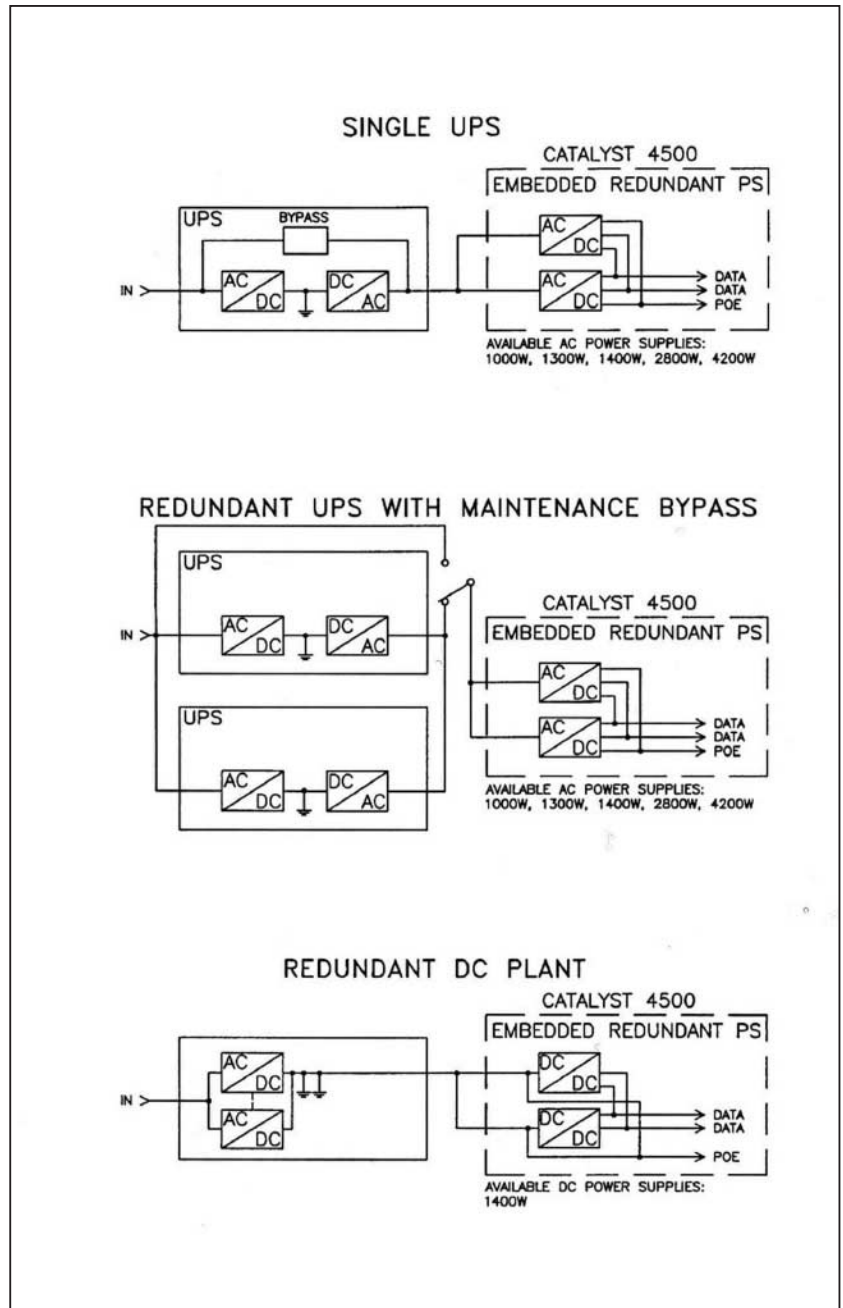


Figure 4. AC and DC Power Concept for Catalyst 4500

## Possible Scenarios for External Back-up Time

- A. Site is already equipped with an existing UPS. The UPS-protected AC power can be delivered to the Cisco Catalyst 4500 location. Dependant on the cabling distance, this option may not be the most cost effective solution and the power availability is dependant on the quality of the existing system.
- B. Single UPS. The UPS should be sized up front for the ultimate application to preserve the initial investment and provide for future system growth. This also includes AC service size and careful consideration for the back-up time. True on-line, double conversion UPS is the preferred solution (best load protection versus other UPS types). A maintenance bypass is highly recommended with the UPS to allow a quick resumption of service in case of UPS failure and allow for maintenance actions without disruption of service.

Scenario B offers the lowest system availability as it may present a single point failure in the power delivery system.

- C. Redundant UPS. Utilizing redundant UPS greatly enhances power availability. However, it can substantially increase the overall cost. UPS size selection considerations are the same as for a single UPS.
- D. AC powered DC UPS with 1400 WDC-P power supplies. The 1400 WDC-P power supply (with DC UPS) can support the

maximum number of Class 3, PoE ports within the Cisco Catalyst 4500 platform. Therefore, this configuration has no growth limitations. An external AC-powered DC UPS offers the highest availability and flexibility. It provides for redundancy, scalability and minimizes the number of system components.

Figure 6 shows the external back-up power alternatives for the Cisco Catalyst 4500 deployment with more than 190 ports. In this case, a 1400 WDC-P power supply must be used as follows:

- A. AC Solution. External AC Power Shelf (2) with four 2500 WAC power supplies must be added to provide AC power to the 1400WDC-P power supplies. The AC power shelves require additional space in the cabinet. As in the previous case, either a single UPS or redundant UPS can be deployed to power the AC shelves. The UPS should be sized to supply 7500W plus the efficiency loss of the External AC power shelf. At the maximum, the redundant configurations with two external power shelves fully populated can support 354 PoE ports (maximum capability of the Cisco Catalyst 4510 chassis is 384 ports).
- B. DC Solution. No external power shelves are required. The 1400 WDC-P power supplies are powered directly from the AC power, DC UPS (Figure 5). The only difference is the number of DC power modules needed to support a given number of PoE ports (all 384 PoE ports can be supported).

In summary, DC solutions are transparent to any Cisco Catalyst 4500 application and can use 1400WDC-P (redundant mode) power supply for all Cisco Catalyst 4500 configurations.

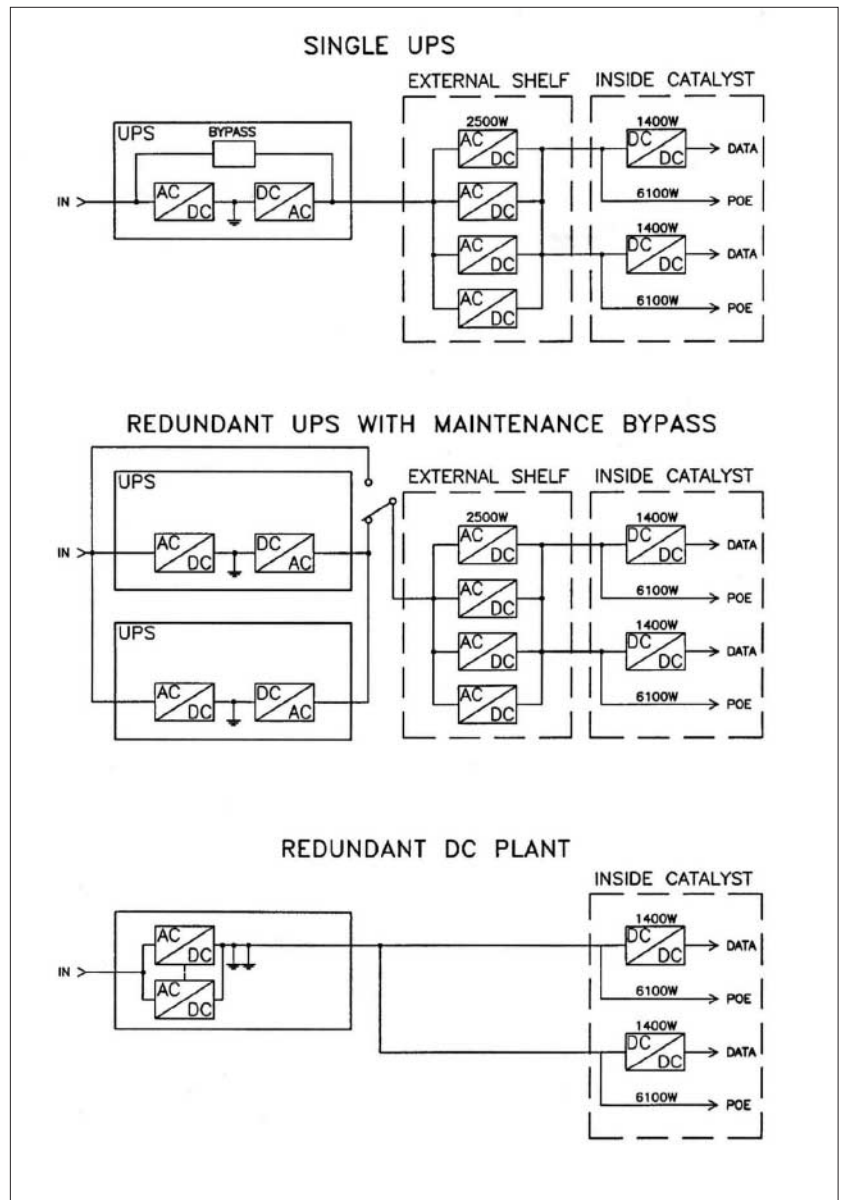
### Battery Back-up Time Considerations

Listed below are some considerations for the battery back-up selection.

1. Criticality of the network to the business operation.
2. Is there an existing generator backup on site and how easy it is to incorporate the Cisco Catalyst 4500 into existing critical power system (length of cables, complexity of infrastructure changes, etc).
3. Ease and speed of power restoration in case of site-induced failures (to minimize system downtime).
4. Future growth requirements.
5. Cooling at the point of use.

For the high availability application, the best strategy is to provide a separate back-up system at the switch, thus isolating the application from the rest of the electrical system.

Typical back-up times recommended by Cisco are 1-2 hrs. This time should be sufficient to ride through most of the utility glitches and to correct any problems within the site electrical system without a network shutdown. Some applications (Government, critical processes, etc) require much longer back-up times – up to 8 hrs. or more.



**Figure 5. Comparison of AC and DC Power System Solutions for Critical Networks – Cisco Catalyst 4510 with Redundant Power Supplies**

## The AC-powered DC UPS Alternative

**A solution that solves many of the issues an Enterprise customer will face when deploying Cisco Catalyst 4500 with fully populated line cards up to 384 PoE ports.**

The AC-powered DC UPS offers significant benefits/advantages to the Cisco Catalyst 4500 series user by combining the adaptive power architecture of the DC solution with an innovative package for a simple plug-and-play deployment. The system is comprised of pre-packaged discrete building blocks determined by the customer's requirements, which drives the optimal system for a specific business application.

1. Correlates to customer business goals.
2. Allows for maximum system flexibility and scalability (matches Cisco scalability approach and hardware configurations).
3. Matches Cisco availability goals.
4. Provides for the lowest cost of total ownership.

### The AC-powered DC UPS Concept

A totally pre-wired, self-contained 19" EIA cabinet including an AC powered, DC UPS, with batteries, space for the Cisco Catalyst 4500, cabling and accessories for a plug-and-play installation including the following:

1. All major components are from a standard Emerson Network Power portfolio.

2. DC power modules.
3. Batteries
4. Single AC input interface (with internal TVSS), or multiple receptacles for scalable growth
5. Monitoring (SNMP and web based) compatible with existing Emerson Network Power systems.
6. Scalable input power, output power and battery back up.
7. Optional battery monitoring system.
8. Optional UPS to support Cisco IP Communication Servers (Call Manager, etc.)
9. Easy to configure and grow.

### Product Configurations for Cisco Catalyst 4500 Series

Three different power capacities are provided:

- NterpriseIP™ 4500 - Up to 4500W of redundant power (Figure 7)
- NterpriseIP™ 6000 - Up to 6000W of redundant power (Figure 8)
- NterpriseIP™ 15000 - Up to 15000W of redundant power (Figure 9)

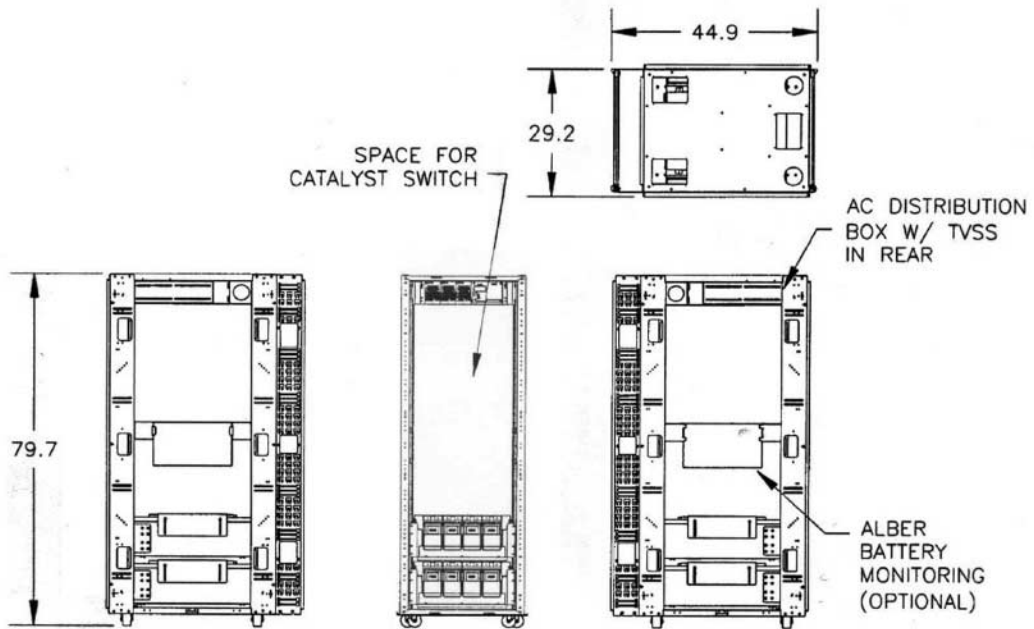


**Figure 6.**  
**NterpriseIP™**  
**front view**



The NterpriseIP™ Solution has tested compatible with Cisco CallManager 4.1(2), Cisco CallManager 4.0(2), Cisco Unity and Cisco Unity Bridge.\*

\* The Cisco Compatible logo signifies that the NterpriseIP™ Solution has undergone interoperability testing by Emerson Network Power together with Cisco and a third-party test house based on testing criteria set by Cisco. Emerson Network Power is solely responsible for the support and warranty of its product. Cisco makes no warranties, express or implied, with respect to the NterpriseIP™ Solution or its interoperation with the listed Cisco products and disclaims any implied warranties or merchantability, fitness for a particular use or against infringement.

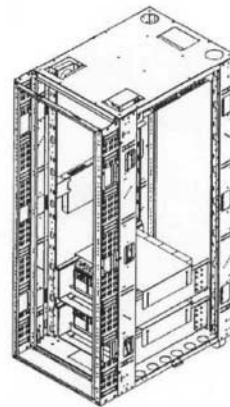


Battery Ah	Approx Reserve Time		Space for OEM Equipment (U)
	1 Shelf Min	2 Shelves Min	
105	30	75	27
125	40	90	27
155	60	120	27

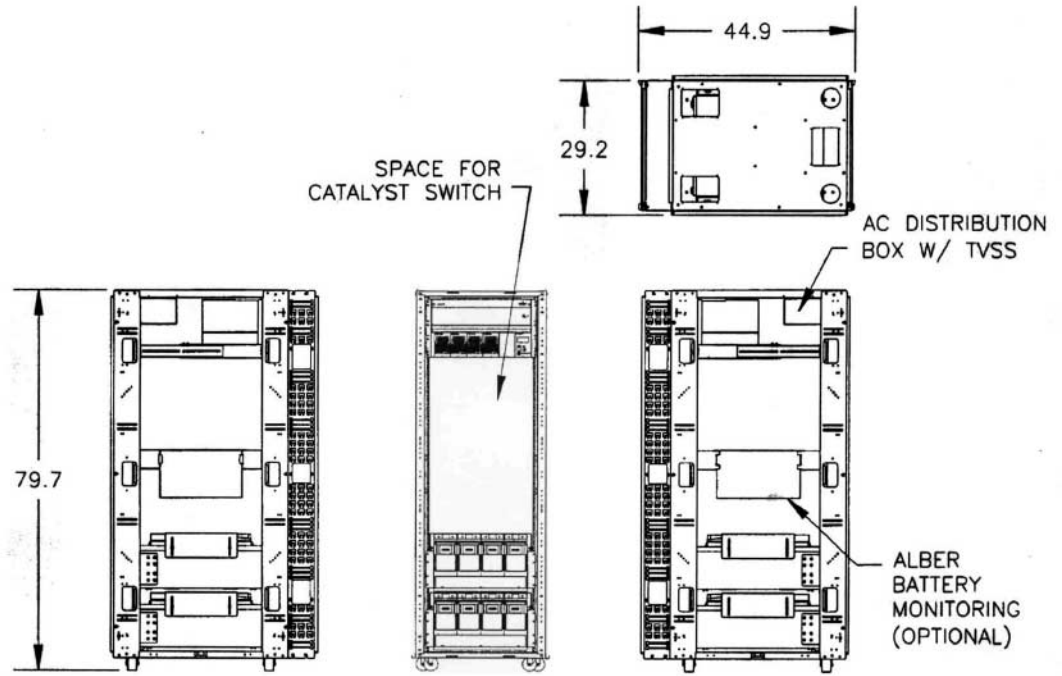
Note 1      Note 1

**Notes:**

1. Reserve time calculation based on max Frame rating- 4500W
2. Additional cabinet is required for longer back-up times

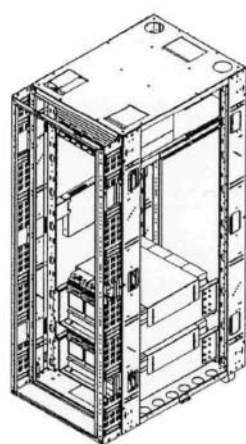


**Figure 7. NterpriseIP™ 4500 - Frame 1**



Battery Ah	Approx Reserve Time		Space for OEM Equipment (U)
	1 Shelf Min	2 Shelves Min	
125	30	60	21
155	40	90	21

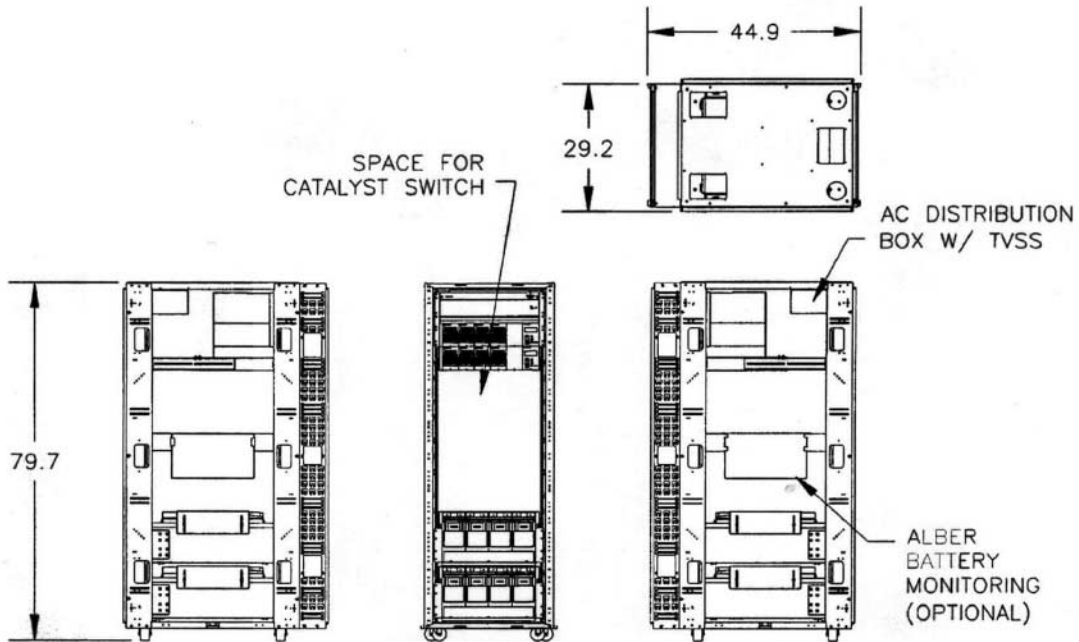
Note 1      Note 1



**Notes:**

1. Reserve time calculation based on max Frame rating- 6000W
2. Additional cabinet is required for longer back-up times

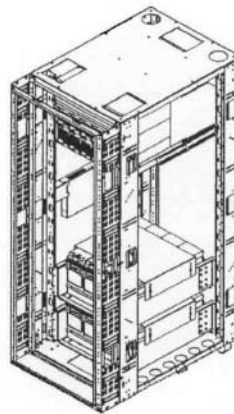
**Figure 8. EnterpriseIP™ 6000 - Frame 2**



Max Systems Power - 15000W at 208V input,  
 (n + 1) redundant  
 Max Power required for Catalyst 4500 application --  
 8500 W at 208V input (n + 1) redundant

Battery Ah	Approx Reserve Time		Space for OEM Equipment (U)
	1 Shelf Min	2 Shelves Min	
155	27	60	18

Note 1    Note 1



**Notes:**

1. Reserve time calculation based on max Catalyst 4510R rating-
2. Additional cabinet is required for longer back-up times

**Figure 9. NterpriseIP™ 15000 - Frame 3**

All NterpriseIP™ frames are provisioned (wired) for their maximum power (max power of Cisco Catalyst 4510 in case of Frame 3) including two battery trays and cabling to Cisco 1400 WDC power supplies. An integrated AC box with internal AC pre-wired distribution is provided for contractor connection.

The middle space in the cabinet is allocated for the Cisco Catalyst 4500 switch (installed on site by others). Vertical troughs for “dressing” the Ethernet cables to the Cisco Catalyst 4500 are available on each side of the cabinet in front and to the side of equipment.

#### System Selection

The NterpriseIP™, AC-powered DC UPS is always used with the Cisco 1400W DC-P power supplies (redundant). This vastly simplifies the Cisco power supply selection process. Cisco 1400W-P DC power supplies provide sufficient power for all Cisco Catalyst 4500 configurations. System selection for a given Cisco chassis configuration is very simple (Figure 10).

- **Frame 1** (NterpriseIP™ 4500) in a redundant configuration can support up to 207 Class 3 PoE ports and full data power. This covers the 4503 and partially the 4506, 4507R chassis loads.
- **Frame 2** (NterpriseIP™ 6000) in a redundant configuration can support up to 277 Class 3 PoE ports and full data power. This covers the 4503, 4506, 4507R and partially 4510 chassis loads.

- **Frame 3** (NterpriseIP™ 15000) in a redundant configuration can support all Cisco Catalyst 4500 configurations or multiple 4500 Catalyst chassis in a closet.

Each frame size can be populated with a desired number of DC power modules for the initial deployment and are easily scalable (by inserting additional power modules) up to its maximum rating without a system shutdown. Typical available battery back-up times for various power levels are shown in (Figure 10).

#### **System Features and Benefits**

1. **Availability.** All frames are offered in a redundant configuration, (n+1), that provides for .999999 or better availability (assuming 24-Hr MTTR). System availability can be enhanced further by adding DC power modules for (n+2) configurations. In all instances the availability exceeds Cisco’s recommendations. Battery reliability is also increased as fewer cells are used than in a comparable AC UPS solution.
2. **Operation Under Failures.** The NterpriseIP™ AC-powered DC UPS features a distributed intelligence, which means that no single module failure (power module, controller) will affect the power flow. Even in the unlikely case of multiple module failures, the system will continue to supply power for a prolonged time period (many hours) thus increasing the time window for repair (module replacement). All components are hot pluggable and user replaceable in 30 seconds.

Catalyst 4500 Chassis	Max No PCs Supp at 17.3 W	Data Power Max W	Inline Power at 17.3 W	Total Power	DC Config #1 4500 W Frame 1	DC Config #2 6000 W Frame 2	DC Config #3 1500 W Frame 3	No of rectifiers		Battery Backup Options in Single Frame	Input	
								750 W 120V	1500W 208V		120V Typ	208V Typ
All	Data only	1200	0	1200				3	2	105 min 300 min 360 min	1X40A	1X20A
4503	96	405	1660	2065				4	3	42 min 60 min 75 min 130 min 150 min	1X40A	1X40A 2X30A
4506 4507R	207	920	3580	4500					4	30 min 40 min 60 min 75 min 90 min 120 min		1X40A 2X30A
All ports	240	920	4152	5072					5	30 min 40 min 60 min 90 min		1X60A 2X30A
4510R	277	1200	4800	6000					5	30 min 40 min 60 min 90 min		1X60A 2X30A
	364	1200	6300	7500					6	30 min 60 min 70 min		1X60A 3X30A
All ports	384	1200	6643	7843					7	27 min 43 min 60 min		1X70A 3X30A
Additional Power Available for other devices							6000W					1X100A 4X30A

\* Additional power available for Call Manager, servers, routers, hubs

**NOTES:**

1. Max data power is calculated at the input to the 1400WDC-P power supply using 75% efficiency. The calculation includes the maximum possible configuration (chassis power + Supervisory Engine (s) power + power for full complement of 10/100/1000 PoE line cards

**Figure 10. Selecting Network Power System Configuration for Cisco Catalyst 4500 Based on Redundant (n+1) Configuration**

3. **Operation Under Overload.** This situation can happen if the PoE power is oversubscribed (not enough power modules to support the load) or in the case of severe (multiple) failure modes. If power modules remaining on line cannot support the load requirement, the battery will support the overload for a period of time thus allowing problem correction without system shutdown.
4. **Efficiency.** The system architecture and application eliminates the need for Cisco External AC Power Shelves. This significantly improves overall efficiency of the power train while reducing heat rejected into the closet. This characteristic is especially evident during power outages (battery operation). The heat rejection of an AC-powered DC UPS can be less than half of a comparable AC UPS solution, which means longer operation before the temperature shutdown point is reached, improving availability. In addition, energy costs can be 20-40% lower than in comparable AC UPS solution.
5. **Footprint.** The integrated cabinet design optimizes the footprint for a total solution. All equipment (including Cisco Catalyst 4500 switch) is located in a single enclosure. Enclosure dimensions allow for side-side airflow required by the Cisco Catalyst 4500 switches.
6. **Installation, Scalability, and Field Upgrades.** The NterpriseIP™ AC-powered DC UPS is designed for ease of installation. The user provides an appropriately sized AC connection (single or multiple feeds) and installs the Cisco Catalyst 4500 chassis in the allocated space.  
  
The system is pre-wired at the maximum power rating. As the need for PoE ports increases, the user simply adds hot pluggable power modules and batteries, regardless of the Cisco Catalyst 4500 chassis selection.
7. **Safety.** The AC (high voltage) input(s) to the cabinet is terminated in a completely enclosed AC termination box .The internal power distribution to the Cisco Catalyst 4500 is at a low, safe voltage level (less than 60V). Safe voltage levels at Cisco Catalyst 4500 allow servicing of the switch without powering the system down.
8. **Spare Parts.** Utilizing a single Cisco power supply and the same DC power modules for all Cisco Catalyst 4500 chassis' minimizes the spare part requirement for a multi-closet or multi-site deployment in a large Enterprise application.
9. **Cost Savings.** By employing the NterpriseIP™ AC-powered DC UPS, the use of the external AC Power Shelves can be eliminated, which will result in cost and space savings to the user. When comparing total AC to DC power solution costs, the difference between the Cisco power supply costs should be taken into account.

10. Integrated cabinet. Design offers quality and consistency.

- Properly sized components for initial and future application.
- Ease of installation.
- Scalable.
- Well-documented, consistent implementation.
- Minimum spare parts in multi-site deployment.
- Ease of maintenance and troubleshooting.
- Extensive monitoring.
- Backed by industry's largest service organization.

11. Monitoring. Extensive monitoring capability (both local and remote) is provided.

- Programmable relay contacts
- SNMP
- Web (HTML) - embedded Web browser (HTTP) allows remote system programming
- \* Monitored parameters include detailed system status, temperature, voltages, power consumption, programmable external alarms, etc.

- Optional battery monitoring features battery status and failure prediction.
- Monitoring can be used for a stand-alone system or incorporated into an existing site monitoring system.
- Interface via RJ-45 and RS 232 ports

**Applicable Standards:**

IEEE 802.3af - addresses PoE

BICSI:

ANSI/TIA/EIA -568-B - Commercial Building Telecommunication Standard

ANSI/TIA/EIA -569-A - Commercial Building Standards for Telecommunications Pathways and Spaces

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