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Practical Power Guidelines for Cisco VoIP and Internet Telephony Applications

by David Slotten

CISCO SYSTEMS



Technology
Developer
Partner

Tripp Lite is a Cisco Technology Developer Partner in the Cisco Technology Developer Program.

**WHITE
PAPER
95-2493**

Integrate Backup Power into VoIP Networks

Voice over IP (VoIP) is exploding in popularity as an application for business data networks. VoIP promises to consolidate a company's data and telecommunications infrastructure as well as its support resources. As a result, a company can lower its hardware and service costs while raising productivity through the use of more elaborate and customizable telephony applications.

Unfortunately, there are serious limitations inherent to the data networks that are increasingly called upon to support VoIP. The primary limitation is power availability. Before moving voice traffic from traditional circuit-switched public phone systems to private data network connections, one must consider a public phone system's unique attribute—battery support. In order to deliver extremely high availability for such vital services as emergency 911 support in the event of extended power outages, public phone systems are connected to massive battery arrays.

While most data networks have some type of backup support during power outages (provided by UPS Systems and/or generators), the backup runtime is generally much less than the 4 to 8 hours of backup that is typically provided for public phone systems. Because of this shortcoming, VoIP applications generally require an increase in the UPS System-supported power capacity (e.g. more or larger UPS Systems). Increased UPS System capacity provides power for network-dependent phones and increases overall backup runtime to ensure that normal telephone operation (including 911 service) remains available in the event of an extended power outage.

Reflecting on important lessons learned during its own transition to IP telephony, Cisco provides several best-practice recommendations. One of the most important recommendations is installing a UPS System to guarantee availability:

“Plan Your Power: When an IP network carries voice, reliability is essential. In case of an emergency, people need to summon assistance by dialing 911. When using inline power to switches and routers, make sure they are connected to an uninterruptible power supply [UPS System] to guarantee dial tone if the power should go out.”

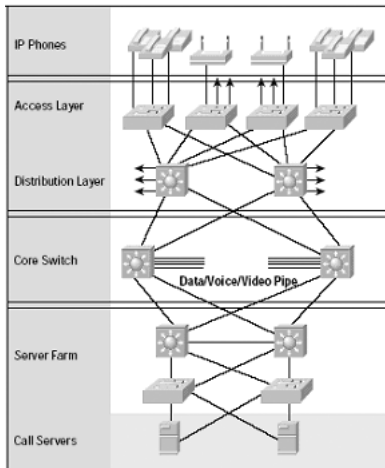
Source: Cisco Systems white paper “The Transition to IP Telephony at Cisco Systems”.

http://www.cisco.com/en/US/tech/tk652/tk701/technologies_white_paper09186a00800cb7fd.shtml

Consider the Diverse Needs of VoIP Network Equipment

Before selecting a UPS System to ensure 100% availability of IP telephony systems, it's important to consider the unique requirements of VoIP network equipment. Network designs hosting VoIP applications will vary widely from business to business due to a number of variables, including the scale of the network and the variety of legacy equipment involved. However, three devices are common to all networks:

Typical Cisco VoIP Network Design



Source: Cisco Systems white paper
"Power and Cooling for VoIP and IP
Telephony Applications".

http://www.cisco.com/application/pdf/en/us/guest/netso/ns412/c654/cdccont_0900aec801a2c5f.pdf

Client Devices (phones, PC-based soft phones, etc.)

During the transition to IP telephony, these devices will either (a) derive their power from the network cable via a Power over Ethernet (PoE) connection scheme, or (b) plug into a local AC source.

If they plug into a local AC source, they must be protected by a UPS System. Often a desktop UPS not only safeguards phone service, but also guarantees file integrity for associated PC users.

Networking Devices (switches, routers, etc.)

During the transition to IP telephony, port capacity on the network and in wiring closets will increase to accommodate additional devices (phones) connected to the network. Increased port capacity will increase the power requirements placed on your UPS System, either reducing runtime or overloading the UPS. Note that if a networking device also supplies Power over Ethernet, the aggregate load of all client devices will also be borne by the networking device's UPS System.

Generally, an existing UPS will be inadequate to (a) power the increased load [watts] and (b) power the load for an acceptable length of time. Five to fifteen minutes of runtime provided to gracefully shut down the typical data network is inadequate for IP telephony users who expect phone service to continue for HOURS, not minutes.

Call Processing Devices (servers and related storage systems)

During the transition to IP telephony, dedicated servers are typically added to drive voice and messaging applications, while storage systems are required for voicemail and other messaging applications. Similar to the increased burden placed on networking devices, call processing devices will experience increased loads and will require increased runtime.

Select a UPS System which Provides the Highest Availability, Resiliency and Manageability

When selecting a UPS System, the most obvious criterion to consider is whether a UPS System has enough capacity (VA/watts) to power equipment while having enough battery capacity to operate during a power outage for your required duration. Specific Tripp Lite UPS System recommendations are listed at the end of this document. Often overlooked during the selection process, however, are more subtle, yet critical, criteria that should be considered, including availability, resiliency to power anomalies and manageability.

1. Availability

Availability hinges on three considerations: the VoIP equipment's power supply configuration, the UPS System's battery configuration and the UPS System's power electronics topology.

A. VoIP Equipment Power Supply Configuration

Many Cisco switches and routers are equipped with redundant power supply capability. If one power supply fails, a second power supply steps in and powers the device. Redundant power supply configurations are strongly recommended to ensure continuous system availability.

Whether one or two power supplies are deployed, the equipment can draw power from one of three sources: directly from facility power alone (for simplicity's sake we will term this "wall"), from a single UPS System or from multiple UPS Systems.

The following tables detail a switch's operational status, from a power perspective, in both redundant and combined (non-redundant) modes. The tables detail switch status under a variety of operational scenarios, including power supply failure, utility failure and UPS System failure.

Note: Larger switches often have the capability to be alternatively configured to operate in a combined (non-redundant) configuration. In combined mode, two power supplies' capacities will be summed. A true doubling is not generally achieved. A factor of 1.67x is typical. In combined mode, there is no redundancy. Should a power supply fail, the available power is generally reduced to the capacity of a single power supply.

Single Power Supply, or Multiple Power Supplies Operating in Redundant Mode

STEP 1: Determine Configuration								
Configuration		1	2	3	4	5		
Power Supply		PS1	PS1 PS2	PS1 PS2	PS1 & PS2	PS1 PS2		
Power Source		Wall	Wall Wall	UPS1 Wall	UPS1	UPS1	UPS1	UPS2
STEP 2: Consider Failure Scenarios			STEP 3: Consider System Status					
PS1 Status	Utility Status	UPS Status	System Status	System Status	System Status	System Status	System Status	
OK	OK	OK	OK	OK	OK	OK	OK	
Failure	OK	OK	Crash	OK	OK	Crash	OK	
OK	Blackout	OK	Crash	Crash	OK	OK	OK	
OK	Blackout	UPS1 Battery Fails	Crash	Crash	Crash	Crash	OK	
OK	Blackout	UPS1 Internal Fault	Crash	Crash	Crash	Crash	OK	
OK	OK	UPS1 Battery Fails	—	—	OK Hot swap battery	OK Hot swap battery	OK Hot swap battery	
OK	OK	UPS1 Internal Fault	—	—	Line Interactive Systems			
					OK Replace UPS. System on PS2/Wall. Vulnerable to outage during UPS replacement	Crash Replace UPS.	OK Replace UPS. System on PS2/UPS2. Services OK during UPS replacement	
					Online Systems			
					OK UPS on bypass, System on PS2/Wall. Replace UPS1. Vulnerable to outage during UPS replacement	OK UPS on bypass. System on Wall. Down services* while replacing UPS1	OK UPS on bypass, System on PS2/UPS2. Replace UPS1. Services OK during UPS replacement	

*Dual Voltage output SmartOnline 6-10KVA system hardware can be hot swapped without service outage.

Multiple Power Supplies Operating in Dual (Combined, Non-Redundant) Mode

STEP 1: Determine Configuration						
Configuration		1	2	3		
Power Supply		PS1 PS2	PS1 PS2	PS1 PS2		
Power Source		Wall Wall	UPS1	UPS1	UPS2	
STEP 2: Consider Failure Scenarios			STEP 3: Consider System Status			
PS1 Status	Utility Status	UPS Status	System Status	System Status	System Status	
OK	OK	OK	OK	OK	OK	
Failure	OK	OK	Reduced Output	OK	OK	
OK	Blackout	OK	Crash	OK	OK	
OK	Blackout	UPS1 Battery Fails	Crash	Crash Replace UPS1. Output reduced during UPS replacement	Reduced Output Replace UPS1. Output reduced during UPS replacement	
OK	Blackout	UPS1 Internal Fault	—	Crash Replace UPS1	Reduced Output Replace UPS1. Output reduced until UPS1 replacement	
OK	OK	UPS1 Battery Fails	—	OK Hot swap battery	OK Hot swap battery	
OK	OK	UPS1 Internal Fault	—	Line Interactive Systems		
				Crash Replace UPS. Plug into wall until UPS replacement	Reduced Output Replace UPS1. Plug PS1 into wall to restore full power until UPS1 replacement. Output reduced until UPS1 replacement	
				Online Systems		
				OK Replace UPS1. Both PS on UPS Bypass. Down services* while replacing UPS1	OK Replace UPS1. PS1 on UPS1 Bypass circuit, vulnerable to outage. Reduced power during UPS1 replacement	

*Dual Voltage output SmartOnline 6-10KVA system hardware can be hot swapped without service outage.

B. UPS System Battery Configuration

UPS System availability, and therefore VoIP system availability, is most critically dependent upon the capacity of the UPS System's battery configuration. The number of UPS System batteries, both internal and external, determines the amount of runtime that is provided during a power outage. As mentioned previously, the runtime must fit the application. Most existing data networks are unlikely to provide reserve runtime power comparable to the public switched phone network. One has to determine a runtime estimate of what is adequate or desirable specifically for a VoIP application. Most users conclude that hours, not minutes, of backup runtime are required to maintain voice operations.

Like any estimate, a runtime estimate will be imperfect and will also be impacted by future capacity requirements (such as the addition of more phones). Therefore, it is critical that the selected UPS System can accommodate external battery packs to increase runtime as needs increase, or maintain runtime in a growing phone environment.

Runtime scalability with external battery packs also yields the ability to hot swap battery packs at the end of their useful life without a service interruption. Similar hot swap battery replacement is also the norm for the UPS System's internal batteries.

C. UPS System Power Electronics

If a UPS System's power electronics fail during a utility power outage, the supported IP telephony system will obviously crash. If the UPS System failure occurs while utility power is present, however, different UPS power electronics topologies can impact IP telephony system availability in different ways.

Online UPS System with Internal Bypass

With power present, an internal power electronics fault in an Online UPS System will result in the load automatically being powered by a bypass path inside the UPS. As long as utility power remains present, the UPS will continue to power the connected IP telephony system without interruption and will continue to condition the power against basic power anomalies. In the event of a power outage, the system will crash.

Upon development of a bypass condition, a service interruption needs to be planned to replace the UPS System.

With power present, a battery system failure will not cause a system interruption. As long as utility power remains present, the UPS System will continue to power the connected IP telephony system without interruption and will continue to condition the power against most power anomalies. In the event of a power outage, the system will crash.

Upon development of a battery system failure, the internal batteries of the UPS System and/or the external battery packs can be replaced without a service interruption.

Online UPS System with Internal Bypass and External Maintenance Bypass

With power present, an internal power electronics fault will result in the load automatically being powered by a bypass path inside the UPS. As long as utility power remains present, the UPS will continue to power the connected IP telephony system without interruption and will continue to condition the power against basic power anomalies. In the event of a power outage, the system will crash.

Upon development of a bypass condition, the power electronics module of the UPS should be replaced. This can be performed while the system remains in service, as the input and output power connections are physically and electrically separated from the power module itself. This functionality is available presently in Tripp Lite's 6-10KVA SmartOnline UPS Systems.

With power present, a battery system failure will not cause a system interruption. As long as utility power remains present, the UPS System will continue to power the connected IP telephony system without interruption and will continue to condition the power against most power anomalies. In the event of a power outage, the system will crash.

Upon development of a battery system failure, the internal batteries of the UPS System and/or the external battery packs can be replaced without a service interruption.

Line-Interactive UPS System

With power present, an internal power electronics fault can result in the load crashing. As the operational requirements of a line interactive UPS System are very simple when power is present, this is extremely rare. Line interactive power electronics failures are normally only detected when the power fails and the UPS attempts to power the load from its battery-driven inverter.

Upon development of a power electronics failure, a service interruption needs to be planned to replace the UPS System.

With power present, a battery system failure will not cause a system interruption. As long as utility power remains present, the UPS System will continue to power the connected IP telephony system without interruption and will continue to condition the power against many power anomalies. In the event of a power outage, the system will crash.

Upon development of a battery system failure, the internal batteries of the UPS System and/or the external battery packs can be replaced without a service interruption.

2. Resiliency to Power Anomalies

The fundamental outcome one hopes for in adding UPS System support to a network is to enhance system availability. But an additional concept—resiliency—is very important as well. UPS System resiliency reflects the ability to respond positively to a number of operating variables.

A. Voltage Variation

Currently, one of the most popular UPS System topologies for VoIP is provided by online UPS Systems. An online UPS System can deliver perfect power even if it encounters a very wide range of input voltages. The online UPS does this without relying on its batteries, leaving it well prepared to respond to a power outage. Because of its continuous AC-DC-AC conversion process, during an outage an online UPS System will also exhibit zero transfer time between failure detection and power delivery to your equipment. Online UPS Systems are widely acknowledged to be compatible with all types of telephony devices.

In many networks with distributed UPS Systems, line-interactive UPS Systems are widely deployed. If input voltage levels are below the line-interactive UPS System's automatic correction capability, the UPS will switch to battery to maintain acceptable output voltage. In areas with chronic extreme brownouts, this frequent switching to battery can reduce reserve power as well as shorten battery service life—putting critical systems at risk in an outage.

While the transfer time of a line-interactive UPS System (several milliseconds) is extremely fast, this short delay has been theorized as the cause of packet losses, or even system shutdown in some applications. Depending on your power environment and the sensitivity of your IP telephony components, a line-interactive UPS System may or may not be

adequate. Generally, line-interactive UPS Systems do not pose a problem. This is the subject of some debate and is generally presented as a major issue by vendors biased towards selling online UPS Systems.

Line-interactive UPS Systems do tend to cost less than online UPS Systems and operate with higher efficiency, reducing electrical costs.

In theory, an online UPS System battery should be used less frequently due to input voltage variation, and will therefore last longer. This advantage will manifest itself more as the frequency of input voltage variation increases.

B. Harmonic Distortion

Only an online UPS System will address input harmonic distortion. Because an online UPS System deconstructs and reconstructs the input power, it can deliver distortion-free power. A line-interactive UPS System will pass through input waveform distortions. Harmonic distortion tends to be an elusive 'gremlin' issue when it affects connected loads.

C. Transient Spikes (or “Surges”)

Both line-interactive and online UPS Systems address sudden increases in voltage.

D. Electromagnetic Interference

While both line-interactive and online UPS Systems address these phenomena, an online UPS typically offers far superior filtering capability.

3. Manageability

IP telephony system availability is closely tied to UPS System manageability. To ensure continuous availability, UPS Systems must be incorporated as an integral part of a sound hardware management scheme. UPS Systems are extremely manageable and responsive, communicating their status automatically and triggering application shutdowns prior to battery exhaustion in the event of a power outage or extreme voltage variation.

There are various methods to communicate with UPS systems, including SNMP, web, network software and direct connection. While most users choose SNMP/Web accessory cards installed inside UPS Systems for communication, the most essential requirement is to deploy and use some method of communication. Without a management application running for your UPS Systems, the day will come when the UPS batteries fail and your system fails as your power fails. Simple management steps taken at installation can save significant problems later.

Alerts available from most UPS Systems and network cards include:

- Voltage levels
- Current levels
- Temperature levels
- Humidity levels
- Dry contacts for fire, water, security, etc.
- Battery capacity
- Battery failure

Commands from the administrator to most UPS Systems include:

- Reboot system
- Reboot outlet(s)
- Shut down system
- Shut down outlet(s)
- Run inverter/battery test

Tripp Lite presents a uniquely simple management scheme for managing VoIP UPS System hardware. Whether management is through an IP-addressed SNMP/Web accessory card or PowerAlert Software, Tripp Lite provides administrators with a single JAVA-based user interface. The commonality within this design approach makes it ideal for managing VoIP applications of all scales across multiple OS platforms.

During a power failure, Tripp Lite's PowerAlert Software ensures a smooth and customizable shutdown of Cisco CallManager and Unity voice messaging applications as well as the underlying operating system.



Tripp Lite's PowerAlert Software, version 12, has tested compatible with Cisco CallManager, versions 3.3(4)-MCS and 4.0(2)-MCS. Go to www.tripp-lite.com/logodisclaimer.

Tripp Lite's PowerAlert Software, version 12—which is part of an integrated VoIP power solution that includes a Tripp Lite UPS System—has met the Cisco Technology Developer Program criteria for interoperability with Media Convergence Servers running CallManager, versions 3.3(4) and 4.0(2). Through participation in the Cisco Technology Developer Program, Tripp Lite's integrated VoIP solution provides continuous IP telephony availability to enterprise or service provider customers.

As a unique feature, Tripp Lite's PowerAlert Software and network accessory card (SNMPWEBCARD) are designed to accommodate multiple power supply and UPS System hardware deployments. With a single IP address assigned to the SNMPWEBCARD (or a single PC/Server running PowerAlert) users can manage multiple redundant UPS Systems working in tandem to provide optimal power to the IP telephony system's single or multiple power supplies.

Alternative UPS System manufacturers require each UPS to be managed individually. With these UPS Systems, there is no easy way to manage their redundant operation without expensive and space-consuming external power-switching accessories.

Another unique manageability product provided by Tripp Lite is its Watchdog Service Monitoring/Rebooting Software. Tripp Lite's Watchdog Software ensures 100% availability, eliminating CallManager server downtime by automatically rebooting locked-up or poorly performing system service applications. If a locked service cannot be rebooted, Watchdog Software will automatically direct PowerAlert Software to reboot the server. If the server is non-responsive, the UPS System will power down and then restart the attached devices.

As an additional management tool, Tripp Lite also offers PowerAlert Enterprise for centralized management within a UPS-centric, NMS-style, management tool.

Recommended Tripp Lite UPS Systems for Cisco VoIP Applications

Establishing an adequate power protection infrastructure is essential. Again, three areas of demand must be addressed: Client, Network and Call Processing.

Client Devices (phones, PC-based soft phones, etc.)

- *7900 Series Phones*

If the phone is powered by Ethernet (PoE), it is switch supported and no client UPS System is required.

If the phone plugs into the utility wall outlet, a UPS System is required.

- Up to 4 hours - Tripp Lite UPS model: INTERNET750U

- *Soft Phones (PC based)*

Typically, a UPS System is required:

- Up to 1 hours - Tripp Lite UPS model: OMNIVS1500XL

- Up to 2 hours - Tripp Lite UPS model: OMNIVS1500XL
(Plus Tripp Lite battery pack model: BP24V14)

- Up to 4 hours - Tripp Lite UPS model: OMNIVS1500XL
(Plus Tripp Lite battery pack model: BP24V34)

- *Soft Phones (Notebook PC based)*

- Up to 2 hours - internal notebook battery support

- Up to 4 hours - Tripp Lite UPS model: INTERNET750U

Networking Devices (switches, routers, etc.)

Details for most popular Cisco networking hardware, current as of this writing, are listed below along with very specific guidelines for larger, multiple power supply switches and routers.

Networking hardware will typically drive the most significant changes to your existing power infrastructure. With requirements spanning buildings and remote wiring closets, existing facility-wide backup plans are often impractical or unable to address the requirements of mid-size and large switches. Focused UPS System additions with extended runtime battery configurations more efficiently add the high level of availability that telephony users demand.

Tripp Lite maintains impressive sizing and configuration resources on its website at www.tripplite.com/selector. We welcome your contact with our technical staff via techsupport@tripplite.com or 773-869-1234.

Basic sizing is as simple as...

- 1- Determining the power consumption of your system(s)
Volts x Amps = VA
- 2- Ensuring that the UPS System has appropriate power and receptacles to accommodate your IP telephony systems.

Cisco Networking Products with Basic Power Supplies

Series	Power Supply	Circuit Requirements	Power Source Connection	Power Supply Inlet	Applicable Models	Estimated Maximum Power Consumption (watts)
7200	PWR-7200-AC=	120V, 15a	5-15P		Most	350
3800	Included, Not Modular	120V, 15a	5-15P		3825 versions	650
	Included, Not Modular	120V, 15a	5-15P		3845 versions	720
2800	Included, Not Modular	120V, 15a	5-15P		2801 2811	480
	Included, Not Modular	120V, 15a	5-15P		2821 2851	720
3700	Included, Not Modular	120V, 15a	5-15P		3725 versions	650
	Included, Not Modular	120V, 15a	5-15P		3745 versions	720
2600	Included, Not Modular	120V, 15a	5-15P		Most	50
	Included, Not Modular	120V, 15a	5-15P		2691	105
1800	Included, Not Modular	120V, 15a	5-15P		All	50
1700	Included, Not Modular	120V, 15a	5-15P		All	50
800	Included, Not Modular	120V, 15a	5-15P		All	20
10000	PEM connection	20a, 120V or 20a, 200-240V	5-20P or L6-20P	C19	10008, 10005	1400w
Catalyst 4900	PWR-C49-300AC(=) or PWR-C49-300AC/2	120V, 15a	5-15P		4948 4948-E 4948-S	300
Catalyst 3750	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-24TS	190
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-24T	165
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-12S	120
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750-24TS	50
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750-48TS	75
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750-24PS	495
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750-48PS	540
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-16TD	180
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-24TS-1U	100
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-24PS	170
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-48TS	160
Catalyst 3560	Included, Not Modular	120V, 15a	5-15P		Catalyst 3750G-48PS	220
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3560-24PS	485
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3560-48PS	530
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3560G-24TS	100
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3560G-24PS	540
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3560G-48TS	160
	Included, Not Modular	120V, 15a	5-15P		Catalyst 3560G-48PS	590

Cisco Networking Products with Basic Power Supplies

Series	Power Supply	Circuit Requirements	Power Source Connection	Power Supply Inlet	Applicable Models	Estimated Maximum Power Consumption (watts)
Catalyst 3550	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 3550-12G Catalyst 3550-12T	190
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 3550-24 PWR	525
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 3550-24	65
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 3550-48	110
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 3550-24-FX	85
Catalyst 2950	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2950T-24	30
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2950C-24	30
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2950G-12	30
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2950G-24	30
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2950G-48	45
Catalyst 2970	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2970G-24TS	190
	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 2970G-24T	160
RPS 675	Included, Not Modular	120V, 15a	5-15P	—	Catalyst 3750 3560 3550 2980G-A 2970 2950 2900 LRE XL	375. Accessory to add redundancy to select single power supply devices
7900 Series Phones	External	120V, 15a	5-15P	—	Most	5-15
	PoE	—	Ethernet	—	Most	5-15
SAN PRODUCTS						
MDS 9100	DS-CAC-300W	120V, 15a	5-15P	—	ALL	300
MDS 9200	DS-CAC-845W	120V, 15a	5-15P	—	ALL	845
MDS 9500	DS-CAC-1900W	200--240V, 20a	L6-20P	C19	MDS 9506	2500
	DS-CAC-2500W	200--240V, 20a	L6-20P	C19	MDS 9509	3350
	DS-CAC-4000W	200--240V, 30a	L6-30P	C19	MDS 9509	4800
SN 5400	Internal	120V, 15a	5-15P	—	ALL	150

Cisco Multiple Power Supply Switches and Routers (4000/4500/6000/6500/7600)

Series	Power Supply	Circuit Requirements	Typical Input Cord Connection	Power Supply Input Cord Termination	Applicable Models	Comments
Catalyst 6500	PWR-950-AC	120V, 15a	5-15P	C15	Catalyst 6503 Catalyst 6503-E	Capable of Dual or Redundant modes
	WS-CAC-1000W	120V, 15a	5-15P	C15	Catalyst 6506 Catalyst 6509 Catalyst 6509-NEB	Capable of Dual or Redundant modes
	WS-CAC-1300W	120V, 20a	5-20P	C19	Catalyst 6506 Catalyst 6509 Catalyst 6509-NEB	Capable of Dual or Redundant modes
	PWR-1400-AC	120V, 20a	5-20P	C19	Catalyst 6503 Catalyst 6503-E	Capable of Dual or Redundant modes
	WS-CAC-2500W	200--240V, 20a	L6-20P	C19	Catalyst 6506 Catalyst 6505-E Catalyst 6509 Catalyst 6509-E Catalyst 6509-NEB Catalyst 6509-NEB-A Catalyst 6513	Capable of Dual or Redundant modes
	WS-CAC-3000W	200--240V, 20a	L6-20P	C19	Catalyst 6506 Catalyst 6505-E Catalyst 6509 Catalyst 6509-E Catalyst 6509-NEB Catalyst 6509-NEB-A Catalyst 6513	Capable of Dual or Redundant modes

Cisco Multiple Power Supply Switches and Routers (4000/4500/6000/6500/7600)

Series	Power Supply	Circuit Requirements	Typical Input Cord Connection	Power Supply Input Cord Termination	Applicable Models	Comments
Catalyst 6500	WS-CAC-4000W-US1	200--240V, 30a	L6-30P	Wired	Catalyst 6506 Catalyst 6505-E Catalyst 6509 Catalyst 6509-E Catalyst 6509-NEB Catalyst 6509-NEB-A Catalyst 6513	Capable of Dual or Redundant modes
	WS-CAC-6000W	2 circuits. 200--240V, 20a	(2) L6-20P	(2) C19	Catalyst 6506, Catalyst 6506-E, Catalyst 6509, Catalyst 6509-E, Catalyst 6509-NEB, Catalyst 6509-NEB-A Catalyst 6513	Current chassis support Redundant mode only. Requires 2 input power cords per power supply for full output.
Catalyst 4500	PWR-C45-1000AC (DATA ONLY)	120V, 15a	5-15P	C15	Catalyst 4503 Catalyst 4506 Catalyst 4507R	Capable of Dual or Redundant modes
	PWR-C45-1400AC (DATA ONLY)	120V, 20a	5-20P	C19	Catalyst 4503 Catalyst 4506 Catalyst 4507R Catalyst 4510R	Capable of Dual or Redundant modes
	PWR-C45-1300ACV (PoE)	120V, 20a	5-20P	C19	Catalyst 4503 Catalyst 4506 Catalyst 4507R	Capable of Dual or Redundant modes
	PWR-C45-2800ACV (PoE)	200--240V, 20a	L6-20P	C19	Catalyst 4503 Catalyst 4506 Catalyst 4507R Catalyst 4510R	Capable of Dual or Redundant modes
7600 Series	PWR-950-AC	120V, 15a	5-15P	C15	7603 & 7606	Capable of Dual or Redundant modes
	PWR-1400-AC	120V, 20a	5-20P	C19	7603 & 7606	Capable of Dual or Redundant modes
	PWR-1900-AC/6	200--240V, 20a	L6-20P	C19	7603 & 7606	Capable of Dual or Redundant modes
	WS-CAC-3000W	200--240V, 20a	L6-20P	C19	7609 & 7613	Capable of Dual or Redundant modes
	WS-CAC-4000W-US1	200--240V, 30a	L6-30P	Wired	7609 & 7613	Capable of Dual or Redundant modes
	WS-CAC-6000W	2 circuits. 200--240V, 20a	(2) L6-20P	(2) C19	OSR-7609, 7609, & 7613	Current chassis support Redundant mode only. Requires 2 input power cords per power supply for full output.

Once you have identified your Cisco power supply type and quantity, use the following details to find a specific UPS System solution for your needs:

- 1-Identify power supply configuration
 - a. Single power supply or two supplies operating in redundant mode
 - b. Dual (combined) mode
- 2-Determine UPS System protection scheme
 - a. Single UPS System for both power supplies
 - b. Single UPS System per power supply (higher availability)
- 3-Estimate desired runtime during power outage

PWR-950-AC (Operating @120V)		Redundant Mode			
		One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.	
		Online	Line Interactive	Online	Line Interactive
UPS		Up to 1350W (total) (1) SU2200RTL2U	Up to 1350W (total) (1) SMART2200RMXL2U	Up to 1350W (total) (2) SU2200RTL2U	Up to 1350W (total) (2) SMART2200RMXL2U
Minutes		8	10	16	20
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min		(1) BP48V21-2U	(1) BP48V24-2U	(1) BP48V21-2U	(1) BP48V24-2U
1hr		(2) BP48V21-2U	(1) BP48V60RT-3U	(1) BP48V21-2U	(1) BP48V24-2U
2hr		(4) BP48V21-2U	(2) BP48V60RT-3U	(2) BP48V21-2U	(1) BP48V60RT-3U
4hr		(8) BP48V21-2U	(3) BP48V60RT-3U	(4) BP48V21-2U	(2) BP48V60RT-3U
		Dual (Combined) Mode			
		One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.	
		Online	Line Interactive	Online	Line Interactive
UPS		Up to 2250W (total) (1) SU3000RTL3U	Up to 2250W (total) (1) SMART5000XFMXL	Up to 2250W (total) (2) SU2200RTL2U	Up to 2250W (total) (2) SMART2200RMXL2U
Minutes		7	21	11	13
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min		(1) BP72V21RT-3U	(1) BP48V60RT-3U	(1) BP48V21-2U	(1) BP48V24-2U
1hr		(2) BP72V21RT-3U	(1) BP48V60RT-3U	(2) BP48V21-2U	(1) BP48V60RT-3U
2hr		(4) BP72V21RT-3U	(2) BP48V60RT-3U	(4) BP48V21-2U	(2) BP48V60RT-3U
4hr		(8) BP72V21RT-3U	(4) BP48V60RT-3U	(8) BP48V21-2U	(3) BP48V60RT-3U

WS-CAC-1000W PWR-C45-1000AC (Both Operating @120V)		Redundant Mode			
		One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.	
		Online	Line Interactive	Online	Line Interactive
UPS		Up to 1400W (total) (1) SU2200RTL2U	Up to 1400W (total) (1) SMART2200RMXL2U	Up to 1400W (total) (2) SU2200RTL2U	Up to 1400W (total) (2) SMART2200RMXL2U
Minutes		7	9	14	18
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min		(1) BP48V21-2U	(1) BP48V24-2U	(1) BP48V21-2U	(1) BP48V24-2U
1hr		(2) BP48V21-2U	(1) BP48V60RT-3U	(1) BP48V21-2U	(1) BP48V24-2U
2hr		(4) BP48V21-2U	(2) BP48V60RT-3U	(2) BP48V21-2U	(1) BP48V60RT-3U
4hr		(8) BP48V21-2U	(3) BP48V60RT-3U	(4) BP48V21-2U	(2) BP48V60RT-3U
		Dual (Combined) Mode			
		One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.	
		Online	Line Interactive	Online	Line Interactive
UPS		Up to 2400W (total) (1) SU3000RTL3U	Up to 2400W (total) (1) SMART5000XFMXL	Up to 2400W (total) (2) SU2200RTL2U	Up to 2400W (total) (2) SMART3000RM2U
Minutes		6	20	10	12
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min		(1) BP72V21RT-3U	(1) BP48V60RT-3U	(1) BP48V21-2U	(1) BP48V24-2U
1hr		(2) BP72V21RT-3U	(1) BP48V60RT-3U	(2) BP48V21-2U	(1) BP48V60RT-3U
2hr		(4) BP72V21RT-3U	(2) BP48V60RT-3U	(4) BP48V21-2U	(2) BP48V60RT-3U
4hr		(8) BP72V21RT-3U	(5) BP48V60RT-3U	(8) BP48V21-2U	(3) BP48V60RT-3U

WS-CAC-1300W PWR-C45-1300ACV (Both Operating @120V)				
Redundant Mode				
One UPS backs up 1 or 2 power supplies for required time.			Two UPS - One for each power supply. Each delivers 50% of required runtime.	
Online		Line Interactive	Online	Line Interactive
UPS	Up to 1800W (total) (1) SU3000RTXL3U	Up to 1800W (total) (1) SMART5000XFMRXL	Up to 1800W (total) (2) SU3000RTXL3U	Up to 1800W (total) (2) SMART5000XFMRXL
Minutes	9	30	18	60
	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min	(1) BP72V21RT-3U	none required	(1) BP72V12-2U	none required
1hr	(2) BP72V21RT-3U	(1) BP48V60RT-3U	(1) BP72V21RT-3U	none required
2hr	(3) BP72V21RT-3U	(2) BP48V60RT-3U	(2) BP72V21RT-3U	(1) BP48V60RT-3U
4hr	(6) BP72V21RT-3U	(4) BP48V60RT-3U	(3) BP72V21RT-3U	(2) BP48V60RT-3U
Dual (Combined) Mode				
One UPS backs up both power supplies for required time.			Two UPS - One for each power supply. Each UPS delivers required runtime.	
Online		Line Interactive	Online	Line Interactive
UPS	Up to 3000W (total) (1) SU5000RT3U	Up to 3000W (total) (1) SMART5000XFMRXL	Up to 3000W (total) (2) SU3000RTXL3U	Up to 3000W (total) (2) SMART5000XFMRXL
Minutes	14	16	12	35
	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min	(1) BP240V10RT-3U	(1) BP48V60RT-3U	(1) BP72V21RT-3U	none required
1hr	(2) BP240V10RT-3U	(2) BP48V60RT-3U	(2) BP72V21RT-3U	(1) BP48V60RT-3U
2hr	(4) BP240V10RT-3U	(3) BP48V60RT-3U	(3) BP72V21RT-3U	(2) BP48V60RT-3U
4hr	(7) BP240V10RT-3U	(6) BP48V60RT-3U	(6) BP72V21RT-3U	(4) BP48V60RT-3U

WS-CAC-1300W PWR-C45-1300ACV (Both Operating @208V)				
Redundant Mode				
One UPS backs up 1 or 2 power supplies for required time.			Two UPS - One for each power supply. Each delivers 50% of required runtime.	
Online		Line Interactive	Online	Line Interactive
UPS	Up to 1800W (total) (1) SU3000RTXL3UHV	Up to 1800W (total) (1) SMART5000XFMRXL	Up to 1800W (total) (2) SU3000RTXL3UHV	Up to 1800W (total) (2) SMART5000XFMRXL
Minutes	9	30	18	60
	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min	(1) BP72V21RT-3U	none required	(1) BP72V12-2U	none required
1hr	(2) BP72V21RT-3U	(1) BP48V60RT-3U	(1) BP72V21RT-3U	none required
2hr	(3) BP72V21RT-3U	(2) BP48V60RT-3U	(2) BP72V21RT-3U	(1) BP48V60RT-3U
4hr	(6) BP72V21RT-3U	(4) BP48V60RT-3U	(3) BP72V21RT-3U	(2) BP48V60RT-3U
Dual (Combined) Mode				
One UPS backs up both power supplies for required time.			Two UPS - One for each power supply. Each UPS delivers required runtime.	
Online		Line Interactive	Online	Line Interactive
UPS	Up to 3000W (total) (1) SU5000RT3U	Up to 3000W (total) (1) SMART5000XFMRXL	Up to 3000W (total) (2) SU3000RTXL3UHV	Up to 3000W (total) (2) SMART5000XFMRXL
Minutes	14	16	12	35
	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
30min	(1) BP240V10RT-3U	(1) BP48V60RT-3U	(1) BP72V21RT-3U	none required
1hr	(2) BP240V10RT-3U	(2) BP48V60RT-3U	(2) BP72V21RT-3U	(1) BP48V60RT-3U
2hr	(4) BP240V10RT-3U	(3) BP48V60RT-3U	(3) BP72V21RT-3U	(2) BP48V60RT-3U
4hr	(7) BP240V10RT-3U	(6) BP48V60RT-3U	(6) BP72V21RT-3U	(4) BP48V60RT-3U

PWR-1400-AC PWR-C45-1400AC (Both Operating @120V)	Redundant Mode				
	One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.		
		Online	Line Interactive	Online	Line Interactive
	UPS	Up to 2000W (total) (1) SU3000RTXL3U	Up to 2000W (total) (1) SMART5000XFMRXL	Up to 2000W (total) (2) SU3000RTXL3U	Up to 2000W (total) (2) SMART5000XFMRXL
	Minutes	8	25	16	50
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
	30min	(1) BP72V21RT-3U	(1) BP48V60RT-3U	(1) BP72V12-2U	none required
	1hr	(2) BP72V21RT-3U	(1) BP48V60RT-3U	(1) BP72V21RT-3U	(1) BP48V60RT-3U
	2hr	(4) BP72V21RT-3U	(2) BP48V60RT-3U	(2) BP72V21RT-3U	(1) BP48V60RT-3U
	4hr	(7) BP72V21RT-3U	(4) BP48V60RT-3U	(4) BP72V21RT-3U	(2) BP48V60RT-3U
	Dual (Combined) Mode				
	One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.		
		Online	Line Interactive	Online	Line Interactive
	UPS	Up to 3340W (total) (1) SU5000RT3U	Up to 3340W (total) (1) SMART5000XFMRXL	Up to 3340W (total) (2) SU3000RTXL3U	Up to 3340W (total) (2) SMART5000XFMRXL
	Minutes	12	13	10	31
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
	30min	(1) BP240V10RT-3U	(1) BP48V60RT-3U	(1) BP72V21RT-3U	none required
	1hr	(2) BP240V10RT-3U	(2) BP48V60RT-3U	(2) BP72V21RT-3U	(1) BP48V60RT-3U
	2hr	(4) BP240V10RT-3U	(4) BP48V60RT-3U	(4) BP72V21RT-3U	(2) BP48V60RT-3U
	4hr	(8) BP240V10RT-3U	(8) BP48V60RT-3U	(7) BP72V21RT-3U	(4) BP48V60RT-3U

PWR-1900-AC/6 DS-CAC-1900W (Both Operating @208V)	Redundant Mode				
	One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.		
		Online	Line Interactive	Online	Line Interactive
	UPS	Up to 2500W (total) (1) SU5000RT3UHV	Up to 2500W (total) (1) SMART5000XFMRXL	Up to 2500W (total) (2) SU5000RT3UHV	Up to 2500W (total) (2) SMART5000XFMRXL
	Minutes	16	19	32	38
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
	30min	(1) BP240V10RT-3U	(1) BP48V60RT-3U	none required	none required
	1hr	(2) BP240V10RT-3U	(1) BP48V60RT-3U	(1) BP240V10RT-3U	(1) BP48V60RT-3U
	2hr	(3) BP240V10RT-3U	(3) BP48V60RT-3U	(2) BP240V10RT-3U	(1) BP48V60RT-3U
	4hr	(6) BP240V10RT-3U	(5) BP48V60RT-3U	(3) BP240V10RT-3U	(3) BP48V60RT-3U
	Dual (Combined) Mode				
	One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.		
		Online	Line Interactive	Online	Line Interactive
	UPS	Up to 4200W (total) (1) SU6000RT3U & (2) SUPDM12	N/A	Up to 4200W (total) (2) SU5000RT3UHV	Up to 4200W (total) (2) SMART5000XFMRXL
	Minutes	15	N/A	21	22
		Add'l BP per UPS	N/A	Add'l BP per UPS	Add'l BP per UPS
	30min	(1) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	(1) BP48V60RT-3U
	1hr	(2) BP240V10RT-3U	N/A	(2) BP240V10RT-3U	(1) BP48V60RT-3U
	2hr	(5) BP240V10RT-3U	N/A	(3) BP240V10RT-3U	(3) BP48V60RT-3U
	4hr	(10) BP240V10RT-3U	N/A	(6) BP240V10RT-3U	(5) BP48V60RT-3U

WS-CAC-2500W PWR-C45-2800ACV DS-CAC-2500W (All Operating @208V)		Redundant Mode			
		One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.	
		Online	Line Interactive	Online	Line Interactive
No External Maintenance Bypass Function	UPS	Up to 3350W (total) (1) SU5000RT3UHV	Up to 3350W (total) (1) SMART5000XFMRL	Up to 3350W (total) (2) SU5000RT3UHV	Up to 3350W (total) (2) SMART5000XFMRL
	Minutes	12	13	24	26
		Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS	Add'l BP per UPS
	30min	(1) BP240V10RT-3U	(1) BP48V60RT-3U	(1) BP240V10RT-3U	(1) BP48V60RT-3U
	1hr	(2) BP240V10RT-3U	(2) BP48V60RT-3U	(1) BP240V10RT-3U	(1) BP48V60RT-3U
	2hr	(4) BP240V10RT-3U	(4) BP48V60RT-3U	(2) BP240V10RT-3U	(2) BP48V60RT-3U
	4hr	(8) BP240V10RT-3U	(8) BP48V60RT-3U	(4) BP240V10RT-3U	(4) BP48V60RT-3U
		Online	Line Interactive	Online	Line Interactive
	UPS	Up to 3350W (total) (1) SU6000RT3U & (2) SUPDM12	N/A	Up to 3350W (total) (2) SU6000RT3U & (2) SUPDM12	N/A
	Minutes	20	N/A	40	N/A
	Add'l BP per UPS	N/A	Add'l BP per UPS	N/A	
30min	(1) BP240V10RT-3U	N/A	none required	N/A	
1hr	(2) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A	
2hr	(4) BP240V10RT-3U	N/A	(2) BP240V10RT-3U	N/A	
4hr	(8) BP240V10RT-3U	N/A	(4) BP240V10RT-3U	N/A	
		Dual (Combined) Mode			
		One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.	
		Online	Line Interactive	Online	Line Interactive
No External Maintenance Bypass Function	UPS	N/A	N/A	Up to 5600W (total) (2) SU5000RT3UHV	Up to 5600W (total) (2) SMART5000XFMRL
	Minutes	N/A	N/A	15	17
		N/A	N/A	Add'l BP per UPS	Add'l BP per UPS
	30min	N/A	N/A	(1) BP240V10RT-3U	(1) BP48V60RT-3U
	1hr	N/A	N/A	(2) BP240V10RT-3U	(2) BP48V60RT-3U
	2hr	N/A	N/A	(4) BP240V10RT-3U	(4) BP48V60RT-3U
	4hr	N/A	N/A	(8) BP240V10RT-3U	(8) BP48V60RT-3U
	Online	Line Interactive	Online	Line Interactive	
UPS	Up to 5600W (total) (1) SU10KRT3U	N/A	Up to 5600W (total) (2) SU6000RT3U & (2) SUPDM12	N/A	
Minutes	11	N/A	25	N/A	
	Add'l BP per UPS	N/A	Add'l BP per UPS	N/A	
30min	(1) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A	
1hr	(3) BP240V10RT-3U	N/A	(2) BP240V10RT-3U	N/A	
2hr	(6) BP240V10RT-3U	N/A	(4) BP240V10RT-3U	N/A	
4hr	(4) BP240V32	N/A	(8) BP240V10RT-3U	N/A	

WS-CAC-3000W (Operating @208V)		Redundant Mode				
		One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.		
		Online	Line Interactive	Online	Line Interactive	
External Maintenance Bypass Function, Included	UPS	Up to 3500W (total) (1) SU6000RT3U & (2) SUPDM12	N/A	Up to 3500W (total) (2) SU6000RT3U & (2) SUPDM12	N/A	
	Minutes	20 Add'l BP per UPS	N/A	40 Add'l BP per UPS	N/A	
	30min	(1) BP240V10RT-3U	N/A	none required	N/A	
	1hr	(2) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A	
	2hr	(4) BP240V10RT-3U	N/A	(2) BP240V10RT-3U	N/A	
	4hr	(8) BP240V10RT-3U	N/A	(4) BP240V10RT-3U	N/A	
			Dual (Combined) Mode			
			One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.	
		Online	Line Interactive	Online	Line Interactive	
External Maintenance Bypass Function, Included	UPS	Up to 5850W (total) (1) SU10KRT3U	N/A	Up to 5850W (total) (2) SU6000RT3U & (2) SUPDM12	N/A	
	Minutes	11 Add'l BP per UPS	N/A	25 Add'l BP per UPS	N/A	
	30min	(1) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A	
	1hr	(3) BP240V10RT-3U	N/A	(2) BP240V10RT-3U	N/A	
	2hr	(7) BP240V10RT-3U	N/A	(4) BP240V10RT-3U	N/A	
	4hr	(4) BP240V32	N/A	(8) BP240V10RT-3U	N/A	

WS-CAC-4000W-US1 DS-CAC-4000W (Both Operating @208V)		Redundant Mode				
		One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.		
		Online	Line Interactive	Online	Line Interactive	
External Maintenance Bypass Function, Included	UPS	Up to 4800W (total) (1) SU10KRT3U	N/A	Up to 4800W (total) (2) SU10KRT3U	N/A	
	Minutes	13 Add'l BP per UPS	N/A	26 Add'l BP per UPS	N/A	
	30min	(1) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A	
	1hr	(3) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A	
	2hr	(6) BP240V10RT-3U	N/A	(3) BP240V10RT-3U	N/A	
	4hr	(10) BP240V10RT-3U	N/A	(6) BP240V10RT-3U	N/A	
			Dual (Combined) Mode			
			One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.	
		Online	Line Interactive	Online	Line Interactive	
External Maintenance Bypass Function, Included	UPS	Up to 8000W (total) CALL	N/A	Up to 8000W (total) (2) SU10KRT3U	N/A	
	Minutes	N/A	N/A	17 Add'l BP per UPS	N/A	
	30min	N/A	N/A	(1) BP240V10RT-3U	N/A	
	1hr	N/A	N/A	(3) BP240V10RT-3U	N/A	
	2hr	N/A	N/A	(6) BP240V10RT-3U	N/A	
	4hr	N/A	N/A	(10) BP240V10RT-3U	N/A	

WS-CAC-6000W (Operating @208V)		Redundant Mode			
		One UPS backs up 1 or 2 power supplies for required time.		Two UPS - One for each power supply. Each delivers 50% of required runtime.	
External Maintenance Bypass Function, Included		Online	Line Interactive	Online	Line Interactive
	UPS	Up to 7000W (total) (1) SU10KRT3U	N/A	Up to 7000W (total) (2) SU10KRT3U	N/A
	Minutes	8 Add'l BP per UPS	N/A	16 Add'l BP per UPS	N/A
	30min	(2) BP240V10RT-3U	N/A	(1) BP240V10RT-3U	N/A
	1hr	(4) BP240V10RT-3U	N/A	(2) BP240V10RT-3U	N/A
	2hr	(8) BP240V10RT-3U	N/A	(4) BP240V10RT-3U	N/A
	4hr	(5) BP240V32	N/A	(8) BP240V10RT-3U	
			Dual (Combined) Mode		
		One UPS backs up both power supplies for required time.		Two UPS - One for each power supply. Each UPS delivers required runtime.	
		Online	Line Interactive	Online	Line Interactive
		Future Cisco Chassis		Future Cisco Chassis	

Call Processing Devices (servers and related storage systems)

Typically, additional server and storage resources are added to handle call processing, voice messaging and other telephony applications. Such systems tend to reside within the data center and are multi-vendor in origin.

For configuration assistance specific to your rollout, please contact Tripp Lite. Tripp Lite maintains impressive sizing and configuration resources on its website at www.tripplite.com/selector. We welcome your contact with our technical staff via techsupport@tripplite.com or 773-869-1234.

Note: Cisco's multiple power supply "MDS" series of SAN switching solutions is contained within the previously listed detailed power supply recommendations.

Common Tripp Lite UPS Systems Recommended for Cisco VoIP Networking Device Applications (Specifications & Runtime Charts)

UPS System Specifications									
Model	Nominal Input Voltage Range	Nominal Output Voltage	Capacity (VA/Watts)	Outlet Quantity	Outlet Type	Input Plug Type	RU	Depth	Bypass
SmartOnline Online UPS Systems									
SU2200RTXL2U	65-138	120	2200/1600	7	6 (5-20R) 1 (L5-20R)	5-20P	2U	22 in.	Internal
SU3000RTXL3U	65-138	120	3000/2400	9	4 (5-15R) 4 (5-20R) 1 (L5-30R)	5-20P	3U	20 in.	Internal
SU3000RTXL3UHV	240	200/208/ 220/230/ 240	3000/2400	8	6 (6-20R) 2 (L6-20R)	L6-30P	3U	20 in.	Internal
SU5000RT3U	156-276	200/208/ 220/230/ 240 & 120	5000/3500	16	2 (L6-20R) 2 (L6-30R) 12 (5-20R)	L6-30P	7U	26 in.	Internal/External
SU5000RT3UHV	156-276	200/208/ 220/230/ 240	5000/3500	4	2 (L6-20R) 2 (L6-30R)	L6-30P	5U	26 in.	Internal
SU6000RT3U	156-276	200/208/ 220/230/ 240 & 120	6000/4200	Hardwire*	Hardwire*	Hardwire*	9U	26 in.	Internal/External
SU10KRT3U	156-276	200/208/ 220/230/ 240 & 120	10000/7000	Hardwire	Hardwire	Hardwire	9U	26 in.	Internal/External
SmartPro Line-Interactive UPS Systems									
SMART2200RMXL2U	120	120	2200/1600	8	6 (5-15R) 2 (5-20R)	5-20P	2U	17 in.	None
SMART3000RM2U	120	120	3000/2250	9	6 (5-15R) 2 (5-20R) 1 (L5-30R)	L5-30P	2U	17 in.	None
SMART5000XFMRXL	208	208/120	5000/3750	11	8 (5-20R) 2 (L6-20R) 1 (L6-30R)	L6-30P	3U	23 in.	None

* SU6000RT3U can provide outlets when used with optional back panel accessory (SUPDM12) which provides two L6-20R, one L6-30R and ten 5-20R outlets and a cord with a L6-30P input plug.

UPS System Extended Runtime						
SmartOnline Online UPS Systems						
Load (VA/Watts)	Runtime (minutes) with included batteries	Runtime (minutes) with additional external battery pack(s) Expandable Battery Packs*				
		1	2	3	4	
SU2200RTXL2U Extended Runtime		BP48V21-2U (Expandable)				
800	18	64	113	168	222	
1600	6	24	56	82	108	
SU3000RTXL3UHV & SU3000RTXL3U Extended Runtime		BP72V12-2U (Expandable)				
1200	17	39	62	91	111	
2400	5	17	28	37	48	
SU5000RT3UHV & SU5000RT3U Extended Runtime		BP240V10RT-3U (Expandable)				
1750	26	68	131	188	247	
3500	11	31	60	87	118	
SU6000RT3U Extended Runtime		BP240V10RT-3U (Expandable)				
2100	37	79	131	174	222	
4200	15	37	58	79	104	
SU10KRT3U Extended Runtime		BP240V10RT-3U (Expandable)				
3500	20	45	71	98	130	
7000	8	19	32	45	58	
* Included batteries are contained either internally within the UPS system or are included as an external module, depending on model. ** Battery packs which are "expandable" can be connected together for increased runtime. Call Tripp Lite's Application Specialists at (773) 869-1236 for additional extended runtime solutions to fit your specific load requirements.						
SmartPro Line-Interactive UPS Systems						
Load (VA/Watts)	Runtime (minutes) with included batteries	Runtime (minutes) with additional external battery pack(s) Expandable Battery Packs*				
		1	2	3	4	
SMART2200RMXL2U Extended Runtime		BP48V24-2U (Non-Expandable)	BP48V42-3U (Expandable)			
800	20	68	137	268	405	
1540	8	31	63	130	195	
SMART3000RM2U Extended Runtime		BP48V24-2U (Non-Expandable)	BP48V42-3U (Expandable)			
1120	13	45	91	179	268	
1600	8	30	61	125	188	
SMART5000XFMRL Extended Runtime		BP48V42-3U (Expandable)				
1890	27	N/A	72	126	177	
3710	10	N/A	34	57	85	
* Battery packs which are "expandable" can be connected together for increased runtime. Call Tripp Lite's Application Specialists at (773) 869-1236 for additional extended runtime solutions to fit your specific load requirements.						

About the author: David Slotten is Director of Product Management at Tripp Lite. Mr. Slotten joined Tripp Lite in 1990 and has extensive experience in the sale, marketing, engineering and development of power protection systems. Mr. Slotten has an MBA from Lake Forest Graduate School of Management and a Bachelors degree from the University of Wisconsin.

**For Additional VoIP and Internet Telephony
Application Assistance Call Tripp Lite's
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Tripp Lite World Headquarters • 1111 W. 35th Street • Chicago, IL 60609 USA
www.tripplite.com



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