

The HP BladeSystem p-Class 1U power enclosure: hot-plug, redundant power for a server blade enclosure

technology brief



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Abstract

The HP BladeSystem p-Class 1U power enclosure provides hot-plug, redundant power for a single enclosure of HP ProLiant BL p-Class server blades from standard single-phase AC inputs. A properly configured HP BladeSystem p-Class 1U power enclosure is an ideal power solution for small office and remote site blade deployments. This technology brief explains the 1U power enclosure operation and features as well as infrastructure configuration considerations. This paper is written with the assumption that readers are already familiar with the HP BladeSystem.

Introduction

The HP BladeSystem consists of modular components that enable IT administrators to readily modify and scale their infrastructures to meet changing IT demands. The ability to provide required power to servers and use it efficiently is a critical IT need. The HP BladeSystem includes two power subsystem options: a 3U power subsystem and a 1U power subsystem. This paper describes the 1U power subsystem only. Refer to www.hp.com/go/ bladesystem for information about the 3U power subsystem.

The 1U power subsystem includes an HP BladeSystem p-Class 1U power enclosure configured with embedded power supplies and a power management module. Power supply and AC line cord redundancy is provided when powering one fully configured HP BladeSystem p-Class server blade enclosure. The power management module enables IT administrators to efficiently monitor and manage total enclosure power consumption.

Choosing an optimal power solution requires the consideration of many factors, including the number of server enclosures needed, the type of server blades to be installed, and the type of available power. The HP BladeSystem p-Class 1U power enclosure is particularly well suited to the following IT environments:

- Small or mid-size businesses using server blades in their infrastructure
- Remote or branch offices with distributed server blade deployments
- IT environments with single-phase power requirements

Components of the enclosure

The HP BladeSystem 1U power enclosure supports high availability by providing hot-plug, redundant power supplies; redundant AC inputs; and a hot-plug power management module that operates independently of the server blades and interconnects.

Hot-plug, redundant power supplies

The 1U power enclosure houses up to six hot-plug power supplies, each unit rated at 2,000 W DC output power. The enclosed six power supply bays are divided into two sides with three bays on bus A and three bays on bus B (Figure 1 and Table 1).

Figure 1. HP BladeSystem p-Class 1U power enclosure bays

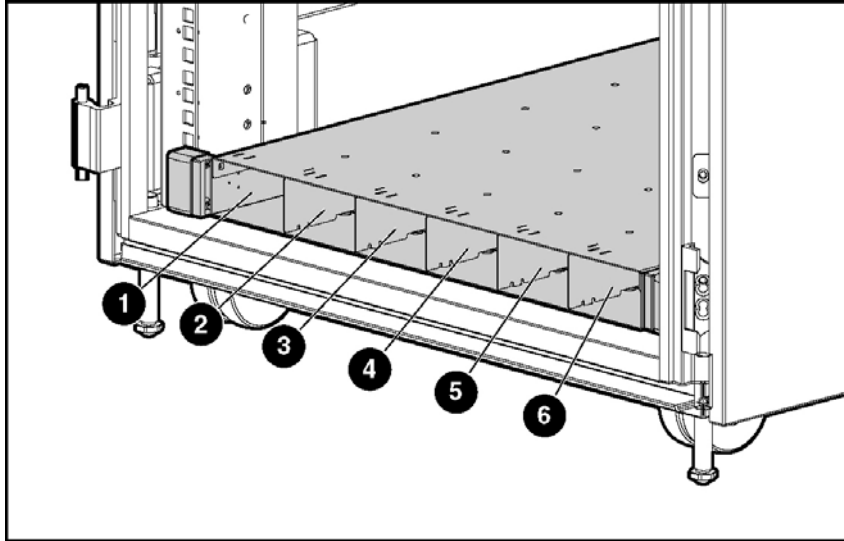


Table 1. HP BladeSystem p-Class 1U power enclosure bay descriptions

Item	Description	Configuration
1	Power supply bay 1	Bus A
2	Power supply bay 2	Bus A
3	Power supply bay 3	Bus A
4	Power supply bay 4	Bus B
5	Power supply bay 5	Bus B
6	Power supply bay 6	Bus B

To implement a redundant configuration using power supplies in the 1U power enclosure, one or more of bays 1 through 3 and an equal number of bays 4 through 6 must be populated with a power supply.

Redundant AC power

For redundant AC power, bays 1 through 3 must be supplied with AC power from a different branch circuit than bays 4 through 6. Each bay must be supplied with single-phase AC power according to the specifications in the QuickSpecs, which are located at http://h18004.www1.hp.com/products/quickspecs/12330_div/12330_div.html. The branch circuit should have adequate capacity to handle the peak current demands of a fully populated 1U power enclosure when attached to a fully populated server blade enclosure.

If only one side of the power enclosure is populated with power supplies, the power subsystem is not redundant. If AC redundancy is not required, three power supplies located in any three bays can provide adequate power for a fully loaded server blade enclosure.

Hot-plug power management module

The hot-plug power management module monitors the power subsystem components and regulates the power-up sequence of newly installed server blades and interconnect switches. The power management module is connected with cables to the server blade enclosure management module(s) to facilitate communication of management information, such as server blade and interconnect location, power supply budget, and health status.

Features of the enclosure

The HP BladeSystem p-Class 1U power enclosure provides for power subsystem management with the following features:

- Bi-directional electronic e-fuse provides prompt power up.
- Power zones provide communication and management capabilities between power enclosures and supported server blade enclosures.
- Dynamic power saver achieves efficient power consumption.
- Serial port allows direct monitoring of the 1U power enclosure status.
- Efficient cabling reduces clutter in the area behind the 1U power enclosure.

Bi-directional electronic e-fuse

The 1U power enclosure has a bi-directional electronic e-fuse switch that connects the -48-V DC outputs on bus A to the -48-V DC outputs on bus B. Once a single power supply is installed in a bay on either side of the 1U power enclosure, that side of the power enclosure is immediately powered. Approximately 3 seconds later, the internal electronic e-fuse switch automatically closes, and the other side of the 1U power enclosure is powered as a result. In short, both sides of the 1U power enclosure are powered even if only one power supply is installed, and the 1U power enclosure can operate this way indefinitely. With only one power supply installed, the built-in power management software attempts to limit the number of blade servers allowed to power on. An administrator, however, can override the warning and manually power up the servers.

The only time the electronic switch in the HP BladeSystem p-Class 1U power enclosure opens is when there is a bus short in the power enclosure. If a bus short occurs in the power enclosure, the electronic e-fuse switch quickly separates bus A from bus B. The circuitry within the 1U power enclosure automatically and continuously monitors the faulted side. Once the fault is cleared, the electronic e-fuse switch resets and closes automatically restoring full power to both sides of the server blade enclosure. This is a rare situation.

Power zones

Power zones, when set properly, associate server blade enclosures with the power enclosure(s) that support them. This allows power information and alerts to be sent to the proper power management module or server blade management module when power conditions change. For example, if an administrator removes a power supply from the HP BladeSystem p-Class 1U power enclosure, notification is sent to the affected server blade enclosure in that power zone.

Power zones also define the startup sequence of the server blades when the entire rack needs to be restarted after a total power outage. The server blade enclosures communicate with the power enclosures in the rack to ensure that the server blades and enclosures are powered in sequence, rather than all at once, to prevent overloading the AC infrastructure. The sequence always runs from the top of the rack (power zone 6), top left-hand blade through the top and bottom row of the blades in that enclosure (if ProLiant BL30p or BL35p server blades are installed). The sequence then proceeds

down to the next enclosure and continues until the bottom right blade in the bottom server blade enclosure is powered.

In a rack that contains many server blade enclosures, the sequencing process may cause a significant time delay before the last server blade is powered. However, this is preferable to the alternative—the possibility that the main breakers trip due to the excessive load on the AC infrastructure as all the server blade enclosures try to power simultaneously.

Firmware in mixed environments

When 1U power enclosures and 3U power enclosures are used in the same rack, the firmware must be upgraded to the latest version for correct power zone operation. As of firmware release 2.20, there are important changes in how power zones are managed. In firmware releases prior to 2.20, there were only two power zones (zone 1 and 2) that were set by a switch on the rear of 3U power enclosures. Firmware 2.20 provides the capability to have up to six power zones, based on the absolute maximum hardware that could fit into one rack. The power zone switch on the rear of the 3U power enclosure only has a setting for zone 1 and 2; new power zones start at 3 to avoid overlap with existing power zones. The primary difference in setting the new power zones is that they are not set by a switch on the power enclosure. The switch is still present on HP BladeSystem p-Class 3U power enclosures for legacy firmware, but firmware version 2.20 and above do not use the switch. The new power zones (3 and above) are set automatically by the firmware based on rack topology. Unlike the 3U power enclosure, the 1U power enclosure does not have a power zone switch because it was released with firmware 2.20.

Every power zone must include a power source (either the 1U power enclosure or the 3U power enclosure) and at least one server blade enclosure. In the pre-2.20 firmware environment, if a server blade enclosure were in zone 2 and the power enclosure supporting it were in zone 1, the server blades and switches in that server blade enclosure would never power on automatically because the devices in the server blade enclosure must request power from a power source in their own zone in order to power on. If the power source is not in the same zone as the server blade enclosure, the request for power is not answered because power is not available in that zone.

To ensure that all power enclosures and server blade enclosures are configured in the proper zone, all enclosures in a rack should be upgraded to firmware 2.20. If one enclosure in an infrastructure is upgraded to firmware 2.20 and the other enclosures are not upgraded:

- The enclosure upgraded to 2.20 is put into power zone 3.
- The enclosures not upgraded are placed in power zone 1 or 2 (depending on the zone in which the physical switch is set).

Once all the enclosures in a rack are upgraded to firmware 2.20, the switch setting on the rear of the enclosure no longer serves a functional purpose. After an upgrade to firmware 2.20, power zone 1 and 2 are no longer used since the power zones are set automatically by the firmware based on rack topology, not switch settings. HP does not support mixed firmware versions within the same infrastructure. All enclosures should have the same firmware version.

NOTE: For more information on upgrading your firmware, see Chapter 5 of the “HP ProLiant BL System Best Practices Guide”:
http://h20000.www2.hp.com/bc/docs/support/UCR/SupportManual/TPM_351359-001_rev1_us/TPM_351359-001_rev1_us.pdf.

Dynamic power saver

The dynamic power saver feature in the HP BladeSystem p-Class 1U power enclosure provides for efficient use of power in the server blade enclosure. When this feature is enabled, total power consumption is monitored in real time. Power supplies are placed in a standby condition when the power demand from the server blade enclosure is low. As power demand increases, the standby power supplies activate as necessary to deliver the required power. This enables the power enclosure to operate at optimum efficiency.

Optimum efficiency can be achieved because of the power supply efficiency curve associated with any power supply. Power supply efficiency is simply a measure of power in versus power out, so at 50 percent efficiency 2,000 W in would equal 1,000 W out. The difference is wasted energy, which costs money.

Dynamic power saver recognizes that most power supplies operate less efficiently when lightly loaded and more efficiently when heavily loaded. A power supply installed in the 1U power enclosure running with a 10 percent load could have efficiency as low as 50 percent, but with a 50 percent load, efficiency increases to over 90 percent, providing a significant savings in power consumption. Dynamic power saver drives power supply efficiency by shifting the load so there is a heavier load on fewer power supplies as opposed to a lighter load on all the installed power supplies.

Redundancy with dynamic power saver

Redundant power is maintained in dynamic power saver mode. The 1U power enclosure ensures that at least two power supplies, one from bus A and one from bus B, are active. When dynamic power saver is enabled on a 1U power enclosure with six power supplies installed, a low load initiates the following sequence:

1. Initially all power supplies are powered as normal.
2. Power supplies installed in bay 3 and bay 6 are placed in standby.
3. Power supplies installed in bay 2 and bay 5 are placed in standby.
4. Power supplies installed in bay 1 and bay 4 are always powered at 50 percent load or less to ensure redundancy.

The reverse sequence applies as the load increases. Power supplies that are on standby are activated in pairs and the load is shared so the maximum load on each feed is 50 percent. Equal distribution of the load ensures that redundancy is always maintained.

Enabling dynamic power saver

To configure the dynamic power saver, the power management module must be removed from the 1U power enclosure and the dynamic power saver feature must be enabled. The module is hot pluggable and can safely be removed during normal server operation (Figure 2). After enabling the dynamic power saver, reinstall the power management module.

Figure 2. The 1U power enclosure power management module and location of the dynamic power saver switches

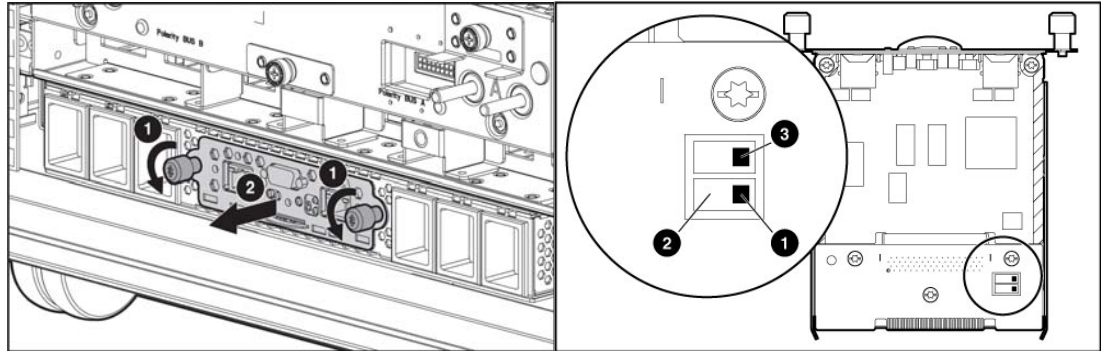


Table 2. Dynamic power saver switch positions and functions

Position	Function
1	Dynamic power saver disabled (default)
2	Dynamic power saver enabled
3	Reserved (off = default)

Serial port

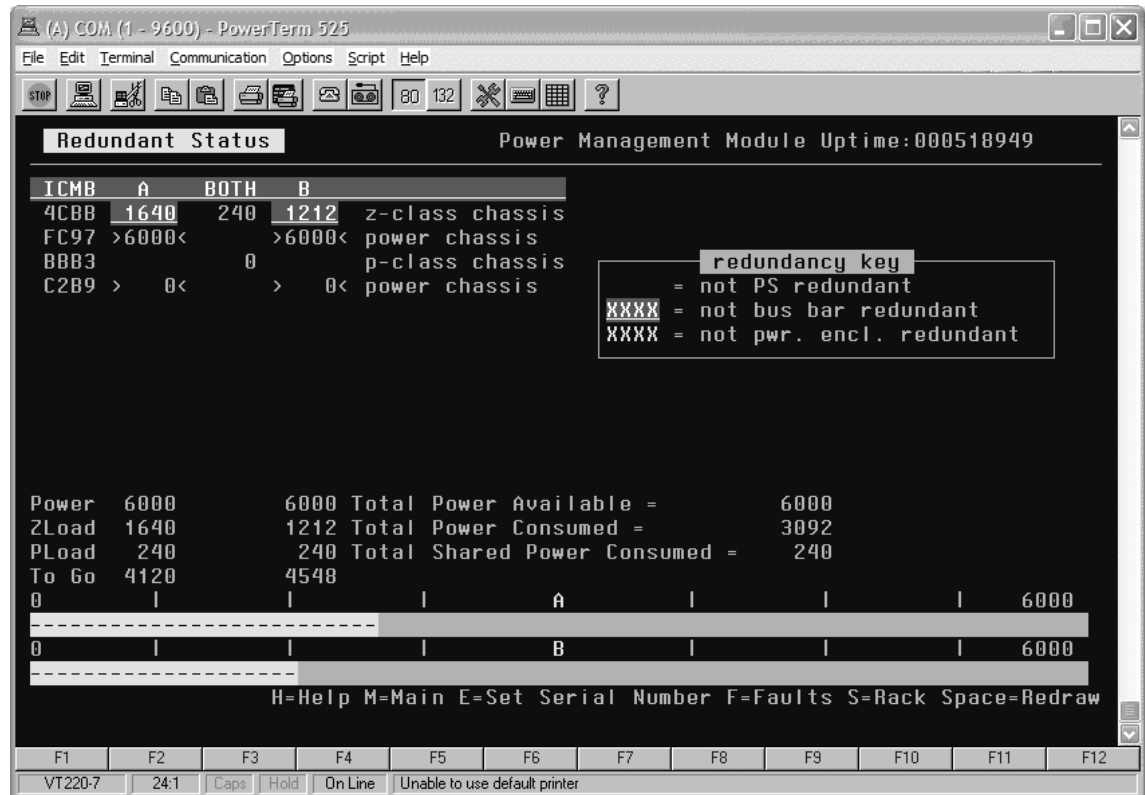
The serial port on the back of the HP BladeSystem p-Class 1U power enclosure provides a way for IT administrators to directly monitor the status of the 1U power enclosure. As shown in Figure 3 and explained in Table 3, detailed information can be obtained through the serial port.

Table 3. Status information displayed through the serial port

Status information	Description
Uptime	Shows the amount of time the system has been powered on.
Power supply location (slot number), status, power usage, input/output temperature	Provides the physical location of power supplies, their fault status, power usage, and operating temperatures.
Enclosure backplane temperature	Displays the temperature on the enclosure backplane.
Number of fault conditions	Shows the number of unresolved faults in the system.
Status of unit identification (UID) LED	Specifies whether UID LED is active or not.
Status of enclosure link	Provides information as to whether the link is connected or not (the enclosure link connects to the blade enclosure).
Management module firmware version	Shows revision of the management firmware.
Overall power usage	Tabulates total power usage of all the power supplies in the enclosure.

Status information	Description
Power supply redundancy (enclosure N+1 redundancy)	Indicates whether there are sufficient power supplies to take over the load in the event that one power supply failed without causing an enclosure power failure.
AC feed redundancy	Specifies whether sufficient power supplies are installed for the enclosure to remain powered on if an AC feed is lost.
Bus balancing	Ensures that the load is balance across the Bus A and Bus B feeds. Only applies to original p-Class enclosure.

Figure 3. Serial port display



A null modem cable can be used to connect the serial port to a terminal. Terminal software, such as Microsoft® Windows® HyperTerminal or Minicom for Linux, can be used to access the 1U power enclosure status display. On the terminal, configure the following settings to allow communication through the serial port:

- 9,600 bps
- No parity
- 8 data bits
- 1 stop bit
- Software flow control, may also be called XON/XOFF
- VT100 terminal emulation

The serial port on the HP BladeSystem p-Class 1U power enclosure does not support hardware flow control settings.

Remote access to the serial port

IT administrators can enable remote access to the serial port in two different ways:

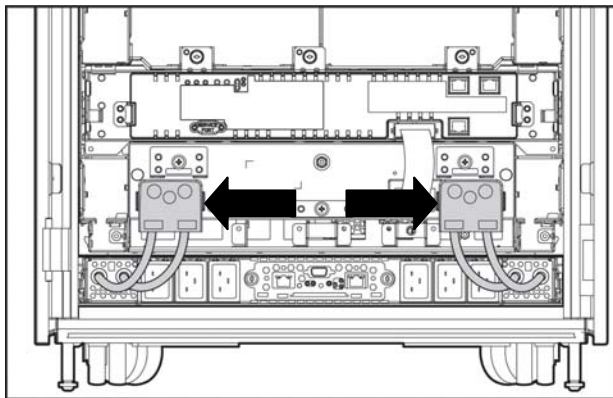
1. Through the HP Serial Console Servers software, which allows serial devices to be accessed remotely through an IP network, or
2. Through the HP IP Console with the Serial Interface Adapter.

NOTE: HP Serial Console Servers and HP IT Console with Serial Interface Adapter can also be used for remote access to other devices with a serial port. For additional information about HP Serial Console Servers and HP Serial Interface Adapter: www.hp.com/go/kvm.

Efficient cabling

The HP BladeSystem p-Class 1U power enclosure uses a well-organized cabling system to connect to the server blade enclosure and any attached Power Distribution Units (PDUs). The 1U power enclosure provides a direct power connection to the server blade enclosure through two dedicated DC power cables (Figure 4).

Figure 4. The 1U power enclosure power cables connected to the server blade enclosure

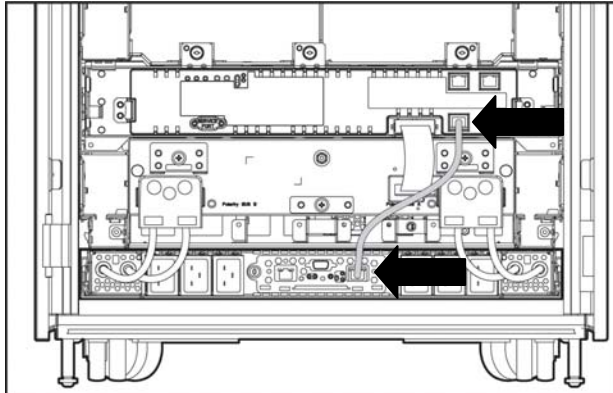


Each server blade enclosure is rated to support up to 6,000 W (3,000 W per side and thus 3,000 W per cable). The individual DC power cables are sized to support the worst-case power tolerances. At the lowest possible power supply voltage of -48.8 V, the maximum rated sustained output current would be 61.5 A per side and per cable.

Management link cable

To provide two-way communication, connect a management link cable from the power management module of the 1U power enclosure to the server blade enclosure (Figure 5).

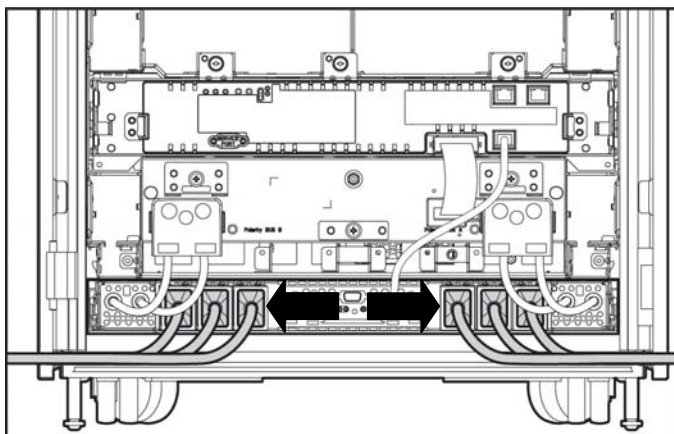
Figure 5. Management link cable connected from the 1U power enclosure power management module to the server blade enclosure



Power distribution unit cables

If PDUs are being used, they must be connected to the 1U power enclosure in three steps. First, before connecting any PDU power cables, turn off or disconnect facility AC power from the PDUs. Secondly, connect the PDU power cables to the AC power input connectors on the 1U power enclosure (see Figure 6). Lastly, once the PDU power cables are connected to the PDUs, power to the PDUs can be restored.

Figure 6. PDU power cables connected to the 1U power enclosure



Infrastructure configurations

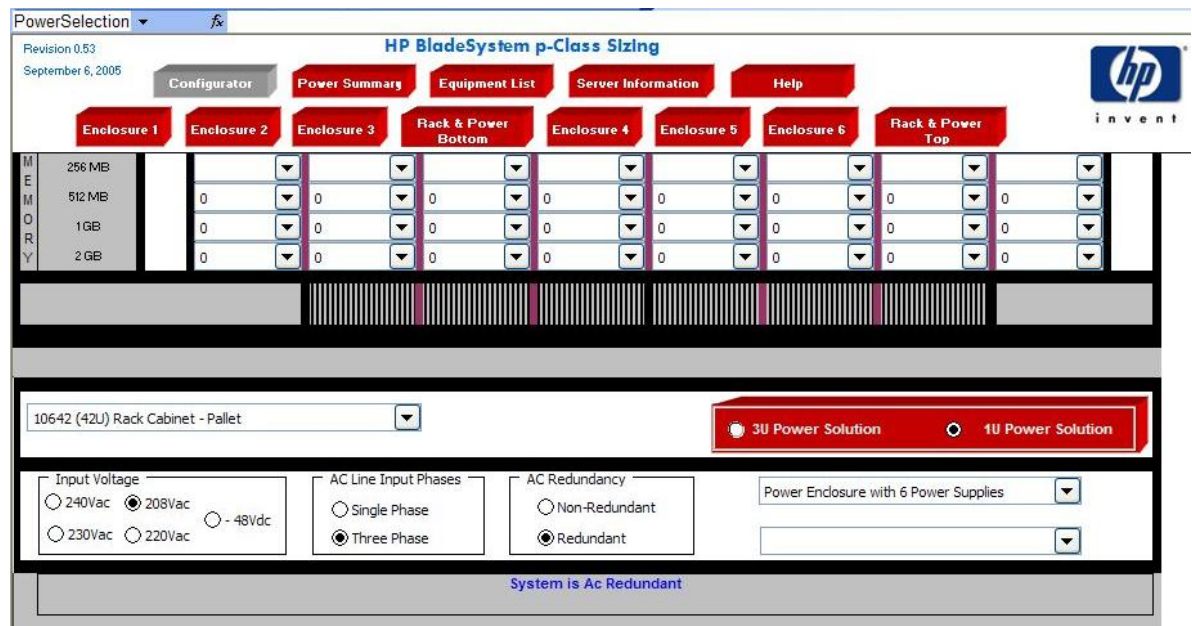
When using the HP BladeSystem p-Class 1U power enclosure, follow the general guidelines in Table 4 to install the proper amount of power supplies.

Table 4. General guidelines for power supply installation in the 1U power enclosure

Infrastructure	Required power supplies installed in 1U power enclosure
Server blade enclosure populated with ProLiant BL20p, BL25p, or BL35p server blades	4
Server blade enclosure populated with ProLiant BL35p dual-core server blades	6
Server blade enclosure populated with ProLiant BL30p server blades	6
More than 3,000 W required per enclosure	4
More than 4,000 W required per enclosure	6

To determine power requirements for an enclosure, use the HP Power Calculator available at www.hp.com/go/ bladesystem/ powercalculator. The HP BladeSystem p-Class sizing utility is a Microsoft® Excel workbook with a power calculator; it can be used to help determine the correct modular components for specific IT environments.

Figure 7. The HP BladeSystem p-Class Sizing utility



Using PDUs with the 1U power enclosure

When using PDUs within an HP BladeSystem environment, key considerations include redundancy, volt-ampere (VA) capacity of the PDU, number of PDU outlets, and using PDUs with single-phase or three-phase inputs.

Redundancy

Planners must consider redundancy when determining how to distribute power using PDUs. The normal method of delivering AC redundancy is to use two separate feeds to each side of the 1U power enclosure, referred to as the A feed and the B feed. To ensure that the power subsystem remains redundant in the event of an AC line feed failure, both feeds and the associated PDUs must be sized to take the full load of the attached 1U power enclosures.

Maximum rated VA capacity

The key variable to consider when using PDUs with the 1U power enclosure is the maximum rated VA load capacity for the PDU. The HP Power Calculator allows the calculation of the input VA requirements of the 1U power enclosure to support any given server blade configuration. Once the total input VA rating requirement for the 1U power enclosure is obtained, compare this to the rated load capacity of available PDUs to determine how many 1U power enclosures can be supported.

Number of PDU outlets

Planners must also factor in the number of outlets available on the PDU. For example, the HP 40A NA PDU (252633-B4) has a maximum capacity of 9,200 VA. Theoretically, in a redundant configuration, three full server blade enclosures populated with ProLiant BL30p server blades (with 3.06 GHz processors) rated at 5,300 VA, could be connected to four of these PDUs. However, each PDU has only four outlets while each enclosure requires six connections at 5,300VA; resulting in 16 available outlets to accommodate 18 required connections—an impossible configuration.

Three-phase input

Planners should consider whether using a three-phase input PDU is a viable option. Three-phase PDUs take standard three-phase power input feeds and convert the power to standard single-phase outputs to power industry-standard IT equipment. One advantage of using three-phase PDUs is that more power can be delivered to a rack with fewer power drops. For example, at 208 V a 30 A single-phase circuit delivers 4,992 VA, while a three-phase circuit delivers 8,640 VA. Also, when comparing similar power levels, the size for the wiring and connectors is significantly smaller with three-phase power.

Phase balance is an important consideration when working with three-phase power. For optimum efficiency, the load attached to a three-phase source should be balanced across all three phases. It is possible to balance the load by simply installing six power supplies in the 1U power enclosure; however, this may not lead to the most efficient use of PDU outlets or power. Manually balancing the load by plugging in power supplies across phases when using a three-phase PDU may provide for a more efficient usage of outlets and power.

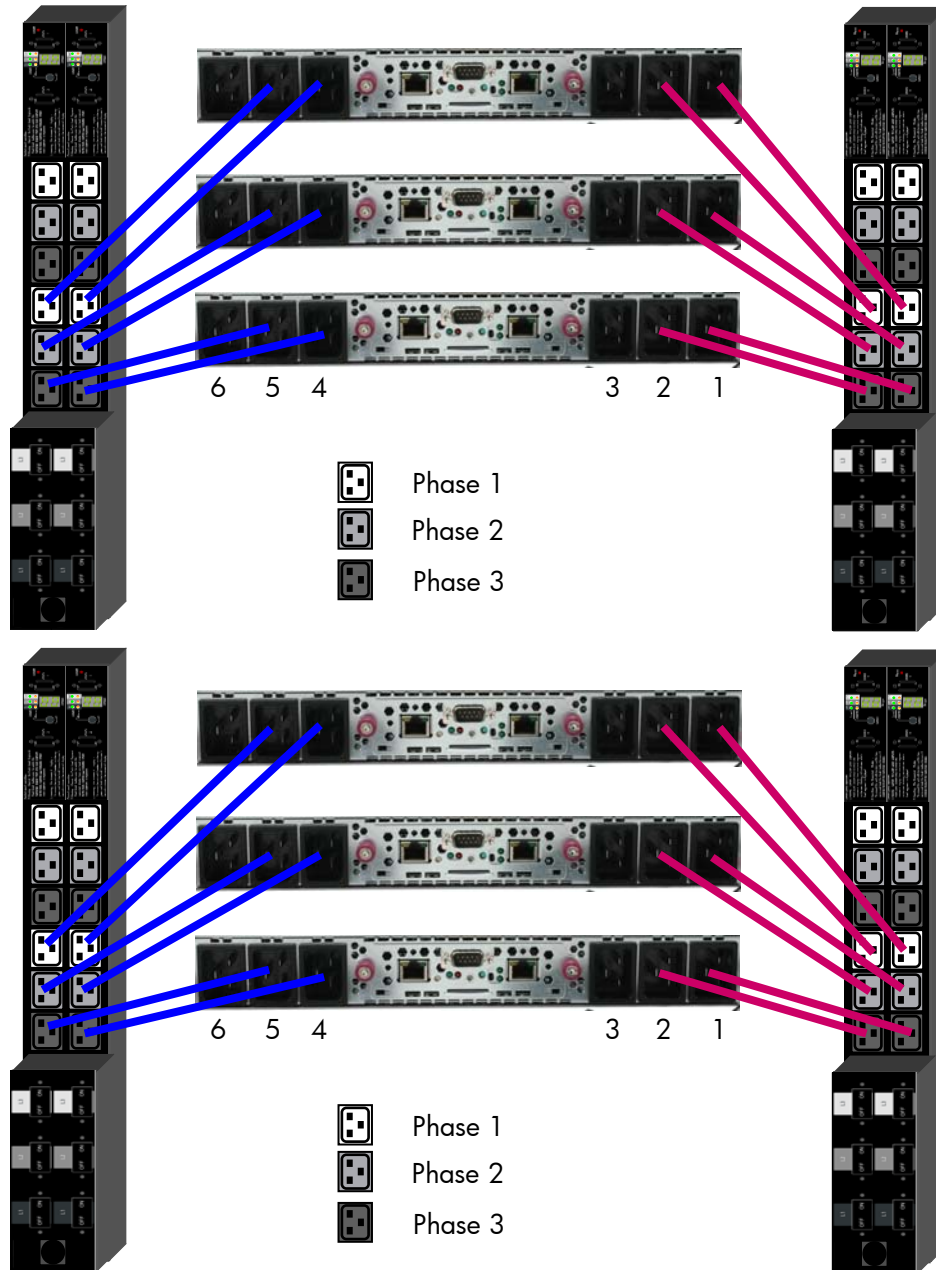
Dynamic power saver and three-phase input PDUs

Dynamic power saver also affects the phase loads on a three-phase input PDU. The key is to ensure that the load is balanced as well as possible across all three phases. The determined sequence in which the power supplies are placed into standby should prevent any single phase from being excessively loaded. When dynamic power saver is enabled, power supplies one and four are always powered; power supplies two and five are powered next; and power supplies three and six are powered last. In a rack with multiple 1U power enclosures, the power supplies installed in bay 1 in each of the 1U power enclosures should not be plugged into the same phase. Each installed power supply in bay 1 should be connected to a different phase on the PDU.

Power supplies installed in bay 2 in each of the 1U power enclosures should also be connected to a different phase on the PDU. Figure 8 illustrates how 1U power enclosures should be connected with four power supplies installed.

NOTE: The grayscale outlets on the PDU in Figure 8 indicate which phase the outlet is attached to. The wires are color coded to distinguish the connections to power supplies installed in bus A and bus B. Power supplies are numbered in reverse because the view is from the rear of the 1U power enclosure.

Figure 8. HP BladeSystem p-Class 1U power enclosures connections (rear view)



Standard configurations

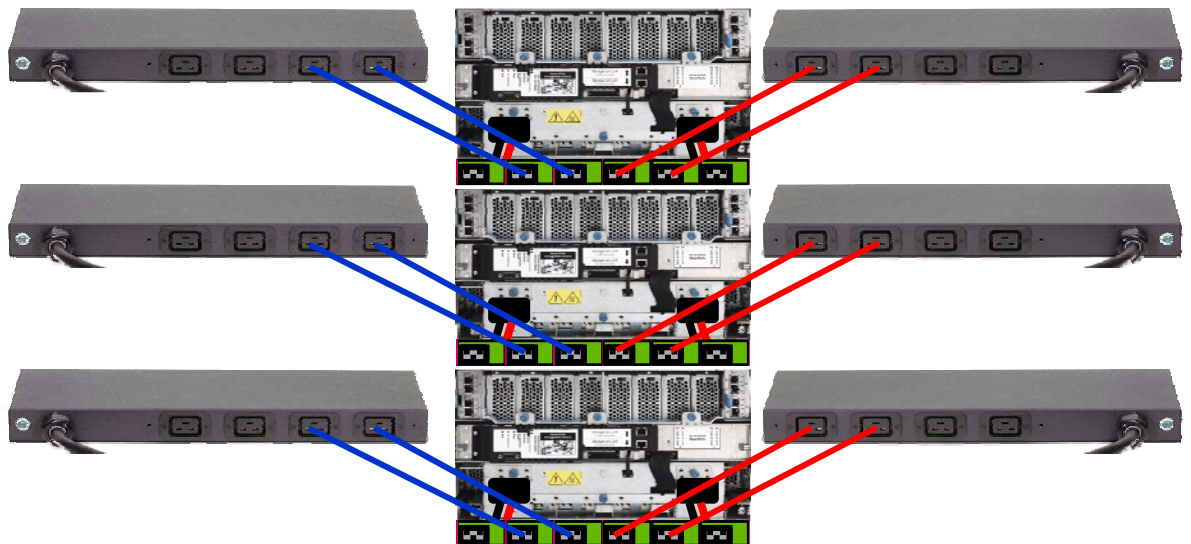
The following configurations review some common usage scenarios for the HP BladeSystem p-Class 1U power enclosure, including the type of server blades populated and PDU options.

Using ProLiant BL35p server blades

In this configuration, the rack contains three enhanced server blade enclosures, three 1U power enclosures, and six PDUs (Figure 9). Each enhanced server blade enclosure is populated with ProLiant BL35p server blades and supported by a 1U power enclosure with four power supplies installed. The 1U power enclosures are attached to two 24 A modular PDUs.

The ProLiant BL35p server blades have two single-core 2.4-GHz processors with 1 MB L2 cache, 4 GB of RAM, and one 60-GB hard drive, resulting in 4,270 VA input. Four power supplies are needed in the 1U power enclosures for redundant power. The 24 A modular PDU used in this configuration has a load capacity of 4,992 VA, so it can support one server blade enclosure populated with ProLiant BL35p server blades.

Figure 9. Rack with enhanced server blade enclosures populated with ProLiant BL30p server blades, three 1U power enclosures and six 24 A modular PDUs

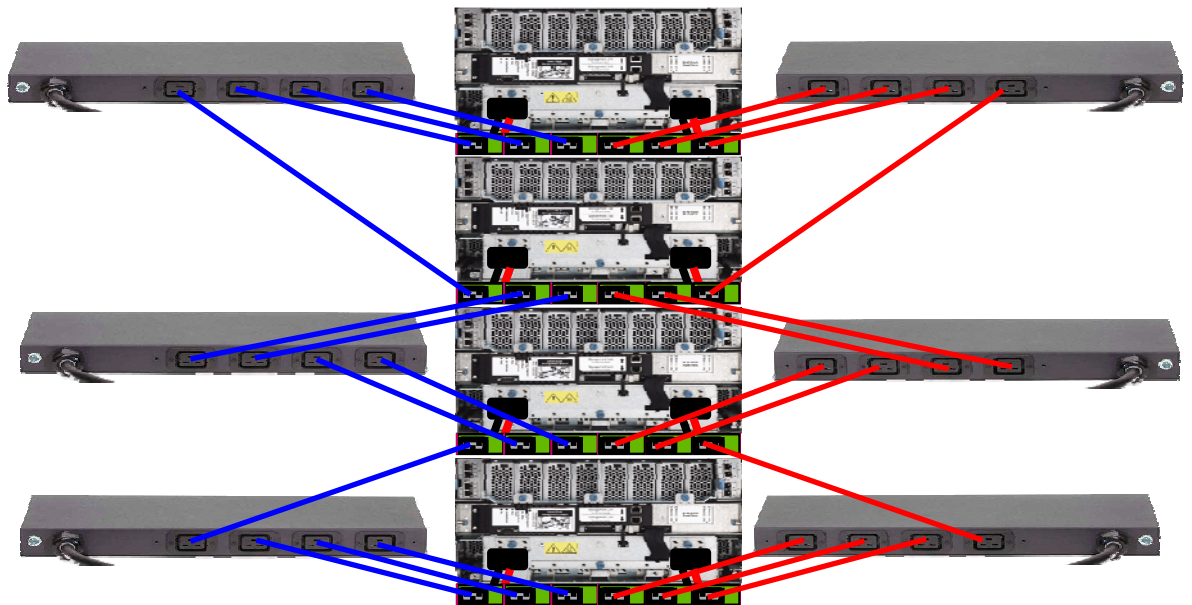


Using ProLiant BL30p server blades

In this configuration the rack contains four enhanced server blade enclosures, four 1U power enclosures and six PDUs (Figure 10). Each enhanced server blade enclosure is populated with ProLiant BL30p server blades and has a 1U power enclosure with six power supplies installed. The 1U power enclosures are connected to two 40 A modular PDUs.

The ProLiant BL30p server blades have two single-core 3.2-GHz processors with 2 MB L3 cache, 4 GB of RAM, and one 60-GB hard drive, resulting in 5,768 VA input. Six power supplies are needed in the 1U power enclosures for redundant power. The 40 A modular PDU has a load capacity of 8,320 VA, so it can support one server blade enclosure fully populated with ProLiant BL30p server blades, with 2,552 VA extra capacity. Each power supply has a load of 1,923 VA; an extra power supply unit can be connected to each PDU and cross-wired, as shown in Figure 10.

Figure 10. Proposed configuration using four enhanced server blade enclosures populated with ProLiant BL30p server blades, four 1U power enclosures and six 40 A modular PDUs

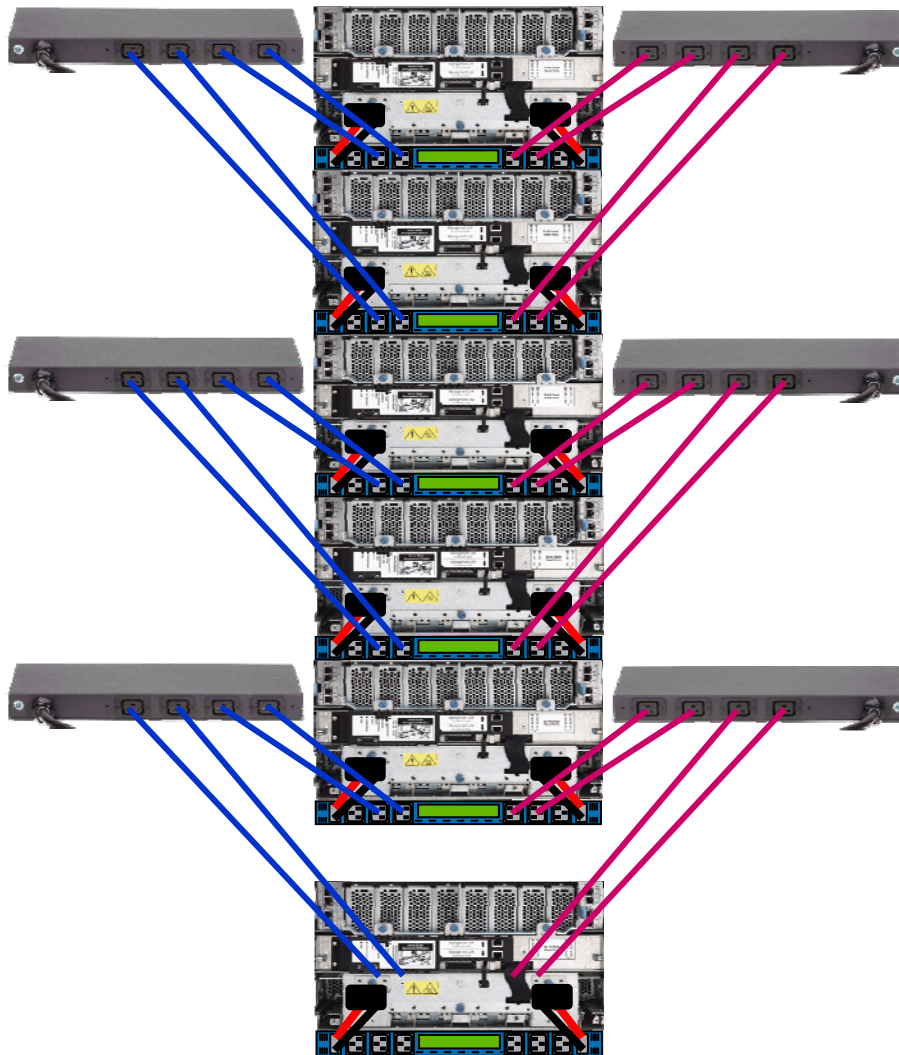


Using ProLiant BL20p server blades

In this configuration, the rack contains six enhanced server blade enclosures, six 1U power enclosures, and six PDUs. Each enhanced server blade enclosure is populated with ProLiant BL20p server blades and has a 1U power enclosure with four power supplies installed. The 1U power enclosures are connected to two 40 A modular PDUs.

The ProLiant BL20p server blades have a single-core 3.6-GHz processor with 2 MB L2 cache, 4 GB of RAM, and two 18-GB 15,000 RPM SCSI hard drives, resulting in 3,714 VA input. Four power supplies are needed in the 1U power enclosure for redundant power. The 40 A modular PDU has a load capacity of 8,320 VA, so it can support two server blade enclosures fully populated with ProLiant BL20p server blades.

Figure 11. Proposed configuration using six enhanced server blade enclosures populated with ProLiant BL20p server blades, six 1U power enclosures and six 40 A modular PDUs



Risks associated with extreme density

While it is possible to build a fully populated a rack with server blades and retain power supply and line cord redundancy using HP BladeSystem p-Class 1U power enclosures, several items should be considered prior to implementation.

The primary issues associated with extreme density that must be seriously considered include: heat, weight, PDU placement and PDU breaker and line cord access after the rack is built. Before deploying these configurations, consider the heat load placed on the data center air-conditioning system and the weight load placed on the floor.

There are two methods of properly implementing a rack with six 1U power enclosures installed.

1. Install six 40 A modular PDUs in the rack. This PDU setup provides power for up to six 1U power enclosures, with a maximum of four power supplies in each enclosure. It provides sufficient power for all ProLiant BL20/25p configurations, ProLiant BL40/45p configurations, and the majority of ProLiant BL35p configurations. The ProLiant BL30p configuration requires six power supplies per power enclosure. Some of the dual-core ProLiant BL35p configurations may require six power supplies, which can risk overloading the PDUs.
2. Use the HP S348 Monitored PDU or S332 Monitored PDU.

NOTE: International configurations can be assembled using the 32 A modular PDU. This PDU has slightly less power capacity (7,680 VA versus the 8,320 VA) than the 40 A modular PDU. Always check the power calculators.

Supported configurations for the S348 Monitored PDU and S332 Monitored PDU

The S348 and S332 PDUs mount in the rear of the rack so there are no issues with access to breakers or line cords. However, access can be enhanced using a rear extension kit, which adds an extra 155 mm or 6 inches of depth to the rear of the rack. The addition of the rack light kit can also significantly increase ease of use and access.

North America/Japan

Install four HP 17.3 kVA S348 Monitored PDUs. This provides 24 four C19 outlets and 34.6 kVA of power and supports up to six 1U power enclosures of 5.7 kVA each. For 1U power enclosures of 2.8 kVA or less, two S348 Monitored PDUs are sufficient.

International

Install four S332 Monitored PDUs. This provides 42 kVA of power and can support six 1U power enclosures of any configuration. For 1U power enclosures of 3.52 kVA or less, two S332 Monitored PDUs are sufficient.

Supported configurations for the 40 A PDU

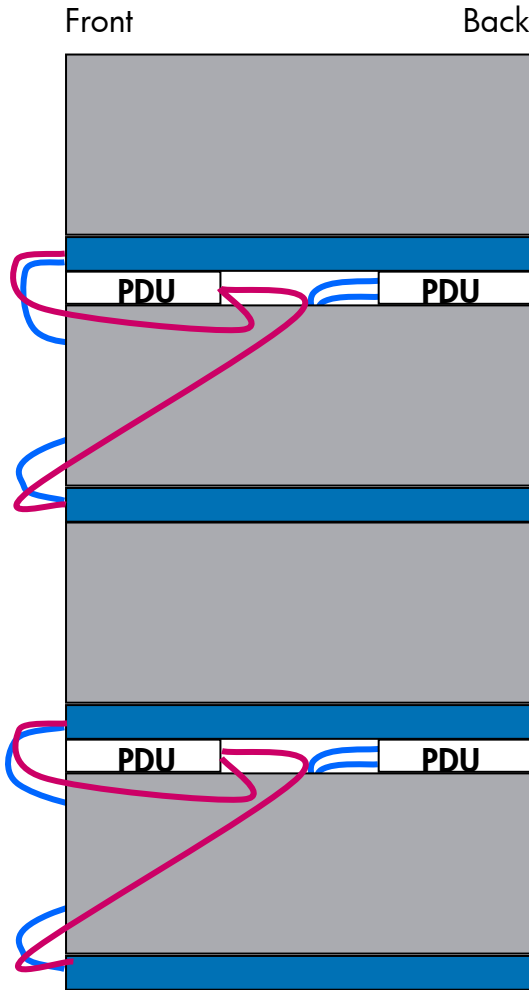
The 40 A PDUs can be mounted in a 1U configuration, which is recommended for best access, or in the "OU" space in the side of the rack, which may provide restricted access to the PDU breakers.

The following configurations are potential solutions to provide power for six server blade enclosures powered by six 1U power enclosures and a 40 A PDU.

47U rack

Mounting the PDUs in the 1U configuration requires an additional 3U of vertical space in the rack. Three PDUs must be mounted facing the front of the rack and three PDUs must be mounted facing the back of the rack (Figure 12). This provides 42U of vertical space for the servers and power enclosures and 3U additional space for the PDU mounting. This configuration must be assembled onsite, as it is not available through Factory Express.

Figure 12. Partial diagram of front and back mounted PDUs



800-mm-wide 42U rack

The 800-mm-wide rack ships standard with vertical blanking panels that block air recirculation back to the front of the rack. Each side of the rack provides 100mm (approximately 4 inches) of space on either side of the rack for access to the OU space. Access to the PDUs from the front of the rack can be gained by removing the three screws that secure the vertical blanking panels. This configuration must be assembled onsite, as it is not available through Factory Express.

Standard 42U rack

This configuration, while possible, may cause issues because of the limited access to the PDUs in the OU space after all the servers are installed. HP recommends mounting the modular PDU in the 1U configuration for best access to breaker actuators and receptacles. Otherwise, in the event of a failure, access to the PDU breakers requires the removal of server blade and power enclosures from the rack.

This configuration is only recommended in these situations:

- The rack is a stand-alone unit and there is clear access to both sides of the rack by simply removing side panels.
- There is sufficient space on each side of the rack to provide access to the PDUs for breaker and receptacle access.
- The rack can be rolled forward away from the row to allow side access to the PDUs.

NOTE: For more information on the PDUs discussed in this section, visit:
<http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/power-distribution/index.html>

Using uninterruptible power supplies (UPS) with the 1U power enclosure

The key factor to consider when sizing a UPS is the supported output wattage for the UPS. The UPS output wattage must be matched to the total input wattage of the supported 1U power enclosure. When connecting a UPS it is important to remember that VA and W are not the same.

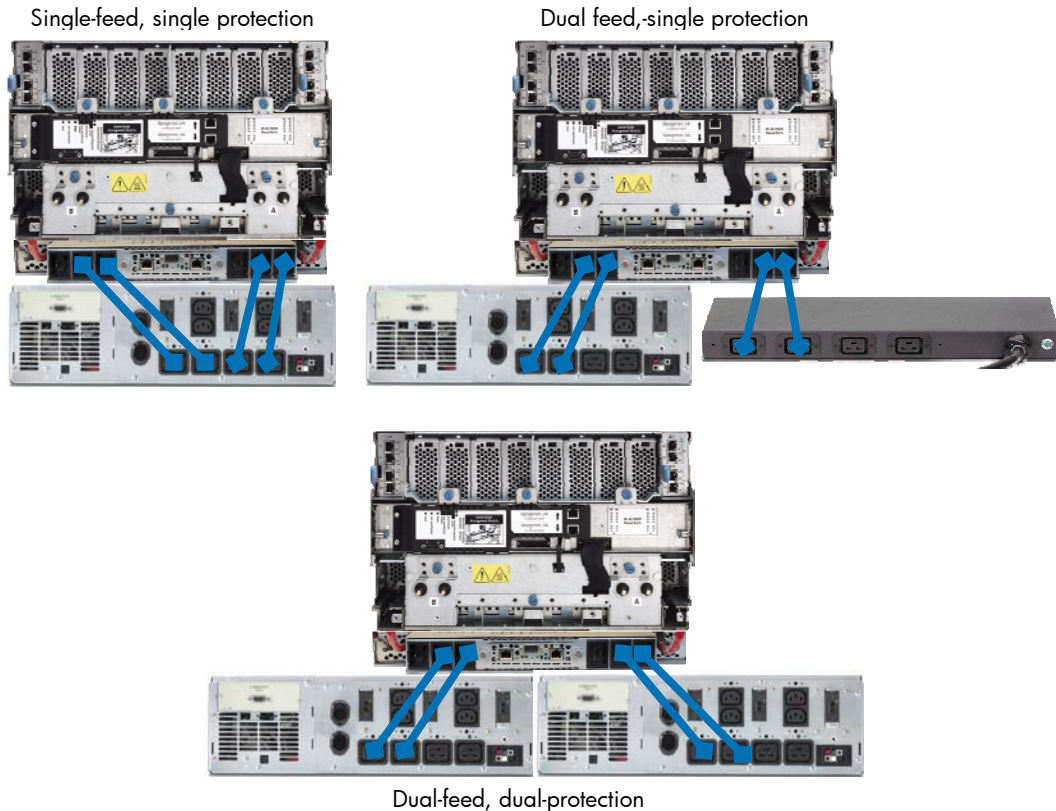
The HP R5500XR UPS provides the highest level of availability when used with the 1U power enclosure. In a single-feed environment (Figure 13, top left), the R5500XR can support a single 1U power enclosure with up to four installed power supplies. This setup can be used to protect the system from unstable power lines and provide a limited amount of backup time for orderly shut down in the event of AC failure.

A dual-feed, single-protection setup (Figure 13, top right) can be used to provide an extra level of availability. If the AC fails and the PDU side has no power, the full load shifts to UPS power to allow for a controlled shutdown. UPS software can also be used to perform a controlled shutdown.

Using this configuration, a potential problem can occur in the event of a cascading failure where the UPS side fails first. If the AC power fails, the UPS handles the load on its side, which begins to discharge the UPS. If the PDU side fails, the whole system can potentially fail without initiating a controlled shutdown because of the power drain on the UPS.

The ultimate level of availability and protection is provided by the dual-feed, dual-protection configuration (Figure 13, bottom). This configuration always provides for an orderly shutdown when a complete loss of utility power occurs.

Figure 13. AC feed redundancy using the HP R5500XR UPS



Conclusion

The HP BladeSystem p-Class 1U power enclosure is a vital component of the HP BladeSystem infrastructure and plays an important role in helping HP customers build an adaptive enterprise. It provides cost-effective, efficient, hot-plug, redundant power for single server blade enclosure deployments. IT environments can use this solution for blade evaluation purposes, distributed server blade deployments to remote locations, and heterogeneous server blade deployments within a single rack. IT environments with deeply entrenched power distribution environments can leverage the 1U power enclosure to help accommodate existing PDU strategies. The HP BladeSystem p-Class 1U power enclosure also has backwards compatibility, allowing IT administrators at small and medium-sized businesses to leverage their previous IT investments by fitting the 1U power enclosure into existing racks in their infrastructure.

For more information

For additional information, refer to the resources listed below.

Resource description	Web address
HP BladeSystem website	www.hp.com/go/bladesystem
HP BladeSystem p-Class Enclosure Installation Instructions	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00383406/c00383406.pdf
HP BladeSystem p-Class 1U Power Supply Installation Instructions	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00383401/c00383401.pdf
HP power distribution units website	http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/power-distribution/index.html
HP rack-mountable uninterruptible power supplies website	http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/rackups/index.html

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