Technical white paper

HP Flexible Slot Power Supply Unit and Flexible Slot Battery Backup Unit

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Introduction

Powering and cooling IT equipment at optimum energy efficiency is a top concern for IT and facilities managers. Since their introduction, HP Common Slot Power Supplies have helped data centers achieve the highest levels of power efficiency.

Now HP ProLiant Gen9 Flexible Slot Power Supplies (HP Flex Slot PSUs) are featured in all HP ProLiant 300 Gen9 Servers, simplifying your spares strategy and reducing data center costs. HP Flex Slot PSUs give you the same efficiencies as HP Common Slot PSUs in a smaller form factor. In addition to the HP Flex Slot PSUs, the HP Flexible Slot Battery Backup Unit (HP Flex Slot BBU) is the industry's first battery backup unit in the smaller HP Flex Slot form factor. HP Flex Slot PSUs and HP Flex Slot BBUs improve serviceability with a common electrical and physical design that allows for hot plug[1], tool-less[2] installation into HP ProLiant 300 Gen9 Servers. This technical white paper describes how HP Flex Slot PSUs and the Flex Slot BBU help to increase compute capacity (more available power), promote higher compute density by using less rack space, and reduce operating costs by improving power efficiency in the data center.

HP Flexible Slot Power Supply

HP Flex Slot PSUs achieve the same degree of efficiency as Common Slot PSUs but reduce the form factor size by 25%, allowing more room for compute and I/O connectivity functions in the server chassis. HP Flex Slot PSUs are rated for 80 Plus[3] Platinum-level certification, with of up to 94%, with the option for 80 Plus Titanium-level certification with efficiency of up to 96%. Table 1 describes the range of HP Flex Slot PSU features.

Table 1. HP Flex Slot PSU features

Flex Slot design	• Tool-less hot plug design improves serviceability buy allowing quick and easy access to system PSUs • Common form factor across all ProLiant Gen9 Performance servers allows multiple server platforms to share PSU spares, reducing cost and space requirements for spares
Right-sizing HP Flex Slot PSUs	• Multiple output options allow you to "right-size" a PSU for a specific server configuration and avoid "trapped power"[4] capacity in their data centers caused by over-subscribing power needs
Multiple input voltages	• Accepts both low-line and high-line AC input voltages providing additional flexibility to operate in multiple It environments (500W and 800W Platinum only)
80 Plus certified power efficiency	• Platinum (94%) power efficiency certification from 80 PLUS program, one of the highest power efficiency certifications available in the IT industry • Reduces data center operating costs related to power by reducing server power requirements and power waste • Optional Titanium-level certification with efficiency of up to 96%
Power management	• Works with multiple operating modes to maximize power efficiency when configuring servers with redundant PSUs • Integrated support for HP Power Discovery Services which communicates with the intelligent PDU to monitor and manage power usage (1400W Platinum Plus only)

HP Flex Slot PSUs and BBU are available in the following models:

- HP 800W Flex Slot -48VDC Hot Plug Power Supply Kit (720480-B21)
- HP 500W Flex Slot Platinum Hot Plug Power Supply Kit (720478-B21)
- HP 800W Flex Slot Platinum Hot Plug Power Supply Kit (720479-B21)
- HP 1400W Flex Slot Platinum Plus Hot Plug Power Supply Kit (720620-B21)
- HP 800W Flex Slot Universal Hot Plug Power Supply Kit (720484-B21)
- HP 800W Flex Slot Titanium Plus Hot Plug Power Supply Kit (720482-B21)
- HP Flex Slot Micro UPS Hot Plug Kit (738024-B21)

[1] The ability to replace a failed hard drive without powering down the system or rebooting

[2] Replacing HP Flex Slot Power Supplies and Battery Backup Units hot plug design require no tools and improve serviceability by allowing quick and easy access to system power supplies.

[3] 80 PLUS performance specification requires PSUs in servers to be 80% or greater energy efficient at 20%, 50% and 100% of rated load with a true power factor of 0.9 or greater. This makes an 80 PLUS certified PSU substantially more efficient than typical PSUs found in many other electrical devices. Read more at: plugloadsolutions.com/80PlusPowerSupplies.aspx

[4] A power circuit is "trapped" based on the required method of provisioning.

See the "HP ProLiant Gen9 Flexible Slot Power Supplies" family data sheet for current HP Flex Slot PSU and BBU models and information.

HP Flex Slot PSUs with blue connectors feature HP Power Discovery Services, and are available with the 800W Titanium and 1400W Platinum Plus PSU models. HP Power Discovery Services (which includes HP Power Discovery Services technology) uses an embedded serial communication link to automatically discover newly deployed HP servers, map their power cords to the power source, verify power redundancy, and help ensure that all power sources are connected correctly. This data can then be shared with HP Insight Control to manage power usage and efficiency in the data center.

Server compatibility

Currently, HP Flex Slot PSUs are compatible with the following HP ProLiant Gen9 Performance servers:

- HP ProLiant DL360 Gen9 Server
- HP ProLiant DL380 Gen9 Server
- HP ProLiant ML350 Gen9 Server

80 PLUS certification

HP's Platinum and Platinum Plus PSUs meet 80 PLUS requirements for Platinum certification. HP Titanium Plus PSUs meet 80PLUS requirements for Titanium certification. All HP Flex Slot PSUs are designed to operate within the 100-240 V ac[5] range and must be proven through independent testing to be 80% (or greater) energy efficient when delivering 20%, 50%, and 100% of the rated load capacity with a true power factor of 0.9 (or greater). Power supplies designed for 100-240 V ac input can be certified for 80 PLUS Bronze, 80 PLUS Silver, 80 PLUS Gold, 80 PLUS Platinum, or 80 PLUS Titanium ratings.

HP testing of HP Flex Slot PSUs shows efficiencies within the 80 Plus certification parameters. Table 2 lists the HP Flex Slot PSUs designed for 100-240 V ac, the corresponding 80 PLUS certification requirement, and the HP test results for each PSU.

Table 2. 80-PLUS certification requirements and HP Flex Slot PSU efficiency measurements

80 PLUS certification	PSU Model	Input voltage (V ac)	Percent of efficiency		
			@ 20% load	@ 50% load	@ 100% load
Titanium Plus (96% efficiency)	HP 800W Flex Slot PSU	230	95.9%	96.4%	94.8%
Platinum Plus (94% efficiency)	HP 1400W Flex Slot PSU	230	94.0%	94.2%	91.2%
Platinum (94% efficiency)	HP 800W Flex Slot PSU	230	92.9%	94.4%	92.7%
	HP 500W Flex Slot PSU	230	92.7%	94.4%	93.5%

Note

The Table 2 efficiency numbers and the HP Flex Slot 800W Platinum PSU efficiency curves presented in this document are the result of HP internal testing under ideal conditions. Results derived from testing in other environments may differ.

[5] Volts alternating current

Power management

Efficient power management within the data center directly affects your ability to increase power capacity and avoid the cost associated with trapped power. HP Flex Slot PSUs allow you to right-size and select operating modes that help you reclaim power and achieve higher levels of efficiency. HP tools and technologies such as HP Power Advisor and HP Power Discovery Services help you project power requirements, and provide an automated energy-aware network between IT systems and facilities.

Right-sizing the power supply

The availability of the HP Flex Slot PSU in multiple capacities allows IT technicians to match the PSU capacity to the actual load of a server configuration; that is, to select the right-size PSU. In addition to increased efficiency, right-sizing the PSU also offers two immediate benefits: reducing hardware cost and avoiding trapped power capacity.

The amount of equipment that can be deployed in a given location, such as a rack, is in direct relation to the size of the circuit that is provisioned. Often, the use of power capping allows more equipment to be deployed than nominally available, but that can also result in performance capping when used aggressively. And depending on local regulations, large data centers may be required by law to size their power circuit (that is, size the availability of power to the location) based on the servers' maximum PSU output rating or regulatory-plate rating. This method of provisioning can quickly use up the data center power budget. Most servers, even fully configured and operating at 100% utilization, will typically require only 70% of the PSU capacity. Even if only 70% of power will ever be used, the data center will not be able to expand because the power circuit is trapped based on the required method of provisioning. When using PSUs that more closely match the required power, trapped capacity can be reclaimed to power more equipment while staying in the same power budget.

Operating modes

An HP ProLiant Gen9 Performance Server configured with HP Flex Slot PSUs (500W, 800W, or 1400W) can use the following three operating modes:

- Operation with a single HP Flex Slot PSU
- Operation with redundant HP Flex Slot PSUs in load-balanced mode
- Operation with redundant HP Flex Slot PSUs in high-efficiency mode

Single HP Flex Slot PSU mode

A single HP Flex Slot PSU providing all of the power requirements for a server can achieve the highest efficiency when operating in the middle range (50%) of its capacity (curve A in Figure 1).

Load-balanced mode

For redundant HP Flex Slot Power PSUs operating in load-balanced mode (the default mode when adding redundant PSUs), the load is shared equally between the two PSUs (curve B in Figure 1). In general, the load-balanced mode offers better efficiency for loads requiring more than 60% of the primary PSU capacity.

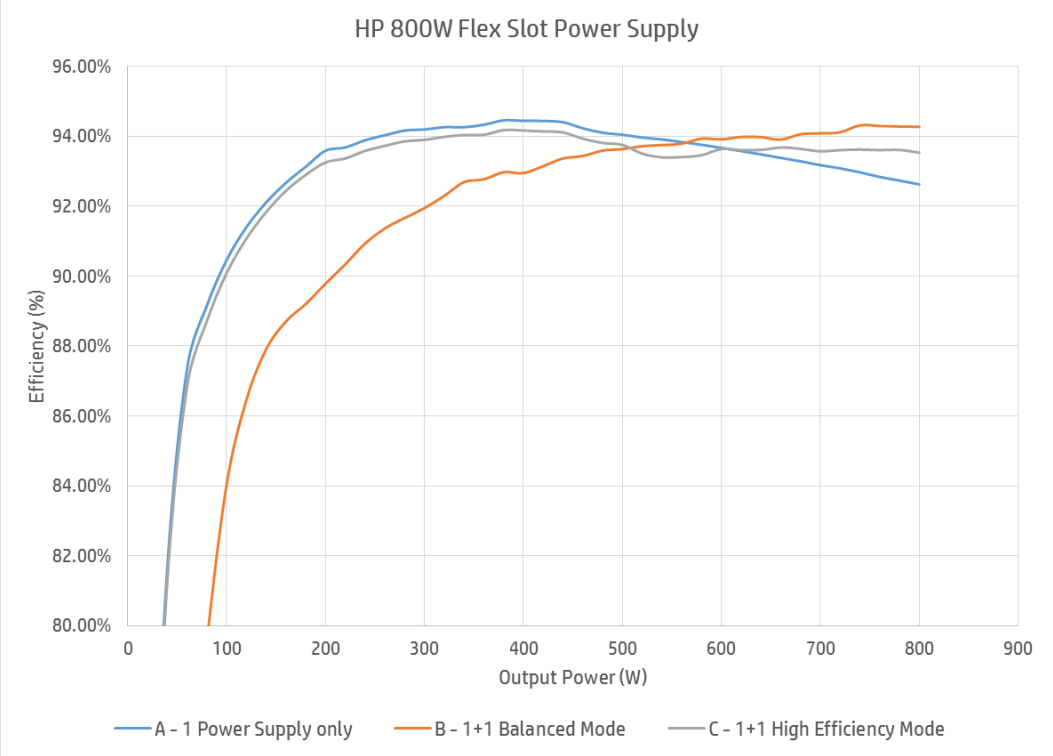
High-efficiency mode

You can use high-efficiency mode when an HP ProLiant Gen9 Performance Server is configured with redundant HP Flex Slot PSUs. High-efficiency mode allows the primary PSU to operate more efficiently (at higher efficiency points on the load curve) while the redundant PSU remains idle (in standby. When the redundant PSU is idle, it provides no output power and consumes very little energy (typically, 2 – 4 Watts).

You can enable high-efficiency mode through the HP ROM-Based Setup Utility (RBSU) under System options→Redundancy options. The user can also specify that odd or even PSUs will be designated manually or automatically as standby supplies. This flexibility allows you to balance the load across a rack manually or automatically.

Figure 1 displays an efficiency curve comparison of the HP 800W Flex Slot Platinum PSUs when used in the single, redundant, and high efficiency modes.

Figure 1. Efficiency curves for HP Flex Slot 800W Platinum PSU



HP Power Advisor

HP Power Advisor is a tool that estimates your data center power requirements for server and storage configurations. Version 6.x includes the new HP ProLiant Gen 9 Servers and options as well as a new HP Smart Update feature that automatically updates your application when opened.

HP Power Advisor is available as a downloadable Microsoft® Windows® tool or a web-based application. HP Power Advisor can help you with the following tasks:

- Accurately estimate power consumption of your HP server and storage products
- Select the appropriate PSUs and other system components
- Configure and plan power usage at a system, rack, and multi-rack level
- Access useful tools including a cost-of-ownership calculator, power report, and bill of materials

You can find out more about the HP Power Advisor at: hp.com/go/poweradvisor.

HP Power Discovery Services

HP Power Discovery Services (PDS), Formerly HP Intelligent Power Discovery, is a feature of Automated Energy Optimization. HP PDS is the first technology to create an automated energy-aware network between IT systems and facilities, and allows you to reclaim millions of dollars in wasted power capacity and downtime across data centers.

HP PDS combines the HP Intelligent Power Distribution Unit (iPDU), select HP Titanium and Platinum Plus PSUs, and HP Insight Control software to automatically track new server installations and automate power distribution with precise control. HP PDS automatically discovers newly deployed HP servers, maps them to the power source, verifies power redundancy, and ensures all power sources are connected correctly.

Embedded serial communication technology in the HP 1400W Flex Slot Platinum Plus and 800W Titanium PSUs allow HP ProLiant Gen9 Performance Servers to automatically provide identification information. Such information can include server name, UUID number, and IP address to the HP iPDU - and to HP Insight Control power management software. This information reduces the amount of time needed to configure the power distribution software and hardware. Additionally, HP PDS intuitively detects redundant PSUs to ensure they are running on different iPDUs. This helps reduce unscheduled down

time and the possibility of human error, one of the biggest challenges of data center management. For more information on HP PDS refer to the website referenced in the "Resources" section of this document.

HP Flex Slot Battery Backup Unit

The HP Flex Slot BBU is designed to integrate into a single HP Flex Slot PSU bay on select HP ProLiant Gen9 Performance Servers, providing the power and reliability you need in a small HP Flex Slot form factor. This new option for the HP ProLiant DL360 Gen9 and HP ProLiant DL380 Gen9 Servers gives you another choice when it comes to ensuring that power is not interrupted to the server.

The HP Flex Slot BBU provides backup power in the same form factor as HP Flex Slot PSUs. In the event of a power outage (for example switching from a bridge to a generator set), the HP Flex Slot BBU produces up to 750W for 60 seconds, or up to 500W in parallel configuration. The length of the run time is a function of the load. For example, if the server is using 375W, then the expected run time would be about 5 minutes.

With the HP Flex Slot BBU, if power is interrupted briefly, the unit will terminate the BBU discharge mode after incoming power has stabilized. This saves battery capacity in the event of a back-to-back outage.

Advantages of choosing the HP Flex Slot BBU as your power backup strategy include:

- Integrates easily into a single HP Flex Slot PSU bay on HP ProLiant DL360 Gen9 and HP ProLiant DL380 Gen9 Server and is designed to integrate across the HP portfolio of server and storage products
- You can build your configuration with any 500W or 800W HP Flex Slot PSU.
- Managed by the HP Integrated Lights-Out (iLO) management tool, a complete set of embedded management features supporting the full lifecycle of the server, maximizing server and application availability through proactive notification
- Smaller rack space requirements. The HP Flex Slot PSU is 25% smaller, and the HP Flex Slot BBU doesn't require as much rack space as a traditional distributed UPS. Both of which combine to give you more rack space to increase compute density.

Another significant advantage of using the HP Flex Slot BBU instead of traditional battery backup configurations is that you get power on the 12V dc bus with no rack penalty. This allows you to grow your data center without having to consider the associated rack-level or room-level UPS implications.

HP Flexible Slot Battery Backup Unit design

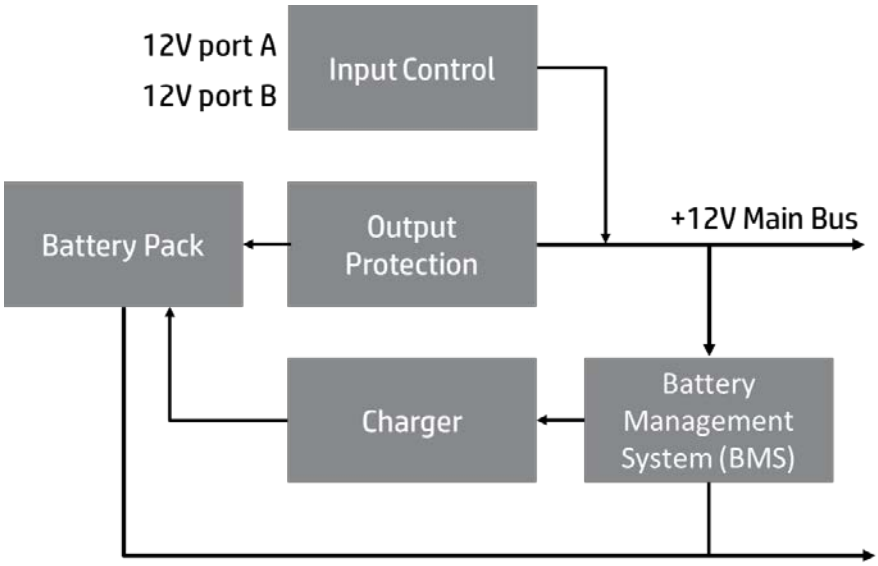
Until the introduction of the HP Flex Slot BBU, the traditional (AC line source) uninterruptible power supply (UPS) was the industry standard for power loss protection. Traditional UPS design can include Standby Mode (Offline), Interactive Mode, and Double Conversion Mode (Online)[6].

The HP Flex Slot BBU uses an alternate approach to provide backup power by powering IT equipment through the back-end 12V dc bus. This approach provides an independent power backup for each end-use device.

The HP Flex Slot BBU is a self-contained unit with internal lithium-ion batteries (Figure 2).The HP Flex Slot BBU provides 12V dc current to the main bus during a power failure or when the 12V dc output from the power supply is beyond specified parameters.

[6] For more information on UPS designs, see "Best practices for selecting a UPS" at hp.com/hpsc/doc/public/display?docId=emr_na-c02492972

Figure 2.



Advantages of the HP Flex Slot BBU versus the traditional UPS or BBU configuration include:

- Higher efficiency
- More flexibility and improved maintenance access – Maintenance is straight forward in the "one BBU to one server" relationship.
- Hot swappable and compliant form factor– The HP Flex Slot BBU modular design and form factor matches that of the HP Flex Slot PSU. Both are hot swappable. You can daisy chain up to two HP Flex Slot BBUs for additional runtime.

The HP Flex Slot BBU has four operating modes:

- Ship/Storage Mode - When the 12V dc main bus or the input of the BBU is less than 11.65Vdc (+- 50mV), the BBU is completely powered off to preserve the battery capacity.
- Active mode - When the 12V dc main bus is above 11.65Vdc (+- 50mV) and EFUSEV#[7] signal from system is less than 1V, the BBU is in Standby Mode.
- Online Mode - When 12V dc main bus is above 11.65Vdc (+- 50mV) and EFUSEV# signal is greater than 2V, the BBU is online and ready to discharge in the event of a utility power or 12V dc main bus failure.
- Discharge Mode - When utility power is lost or the 12V dc bus drops below 11.65Vdc (+- 50mV), the BBU will maintain the output load. The BBU is automatically returned to Active Mode for battery charging when EFUSEV# is <1V and 12V dc bus is in regulation.

The HP Flex Slot BBU can provide an output load up to 60 seconds at a maximum of 750 Watts. When adjusted to load conditions, battery runtime is limited to five minutes as default setting for discharging at lighter loads. Table 3 lists the HP Flex Slot BBU battery run times.

Table 3. Battery run times

Load conditions	Run Time @ 10 °C to 50°C @100% battery capacity
5%	5min
25%	5min
50%	>3min
75%	>2min
100%	>60s

[7] The term EFUSE is used when a Blade system has to be reset virtually (without physically reseating the server). An e-fuse reset causes the server blade to lose power momentarily as the e-fuse is tripped and reset.

Embedded management

HP iLO 4 v2.10 and higher, manages the HP Flex Slot BBU. iLO provides a complete set of embedded management features for the full lifecycle of the server from initial deployment, through ongoing management, to service alerting and support. This comprehensive embedded management helps you speed time-to-deployment, maximize server and application availability through proactive notification, and dramatically accelerate time-to-resolution when issues arise.

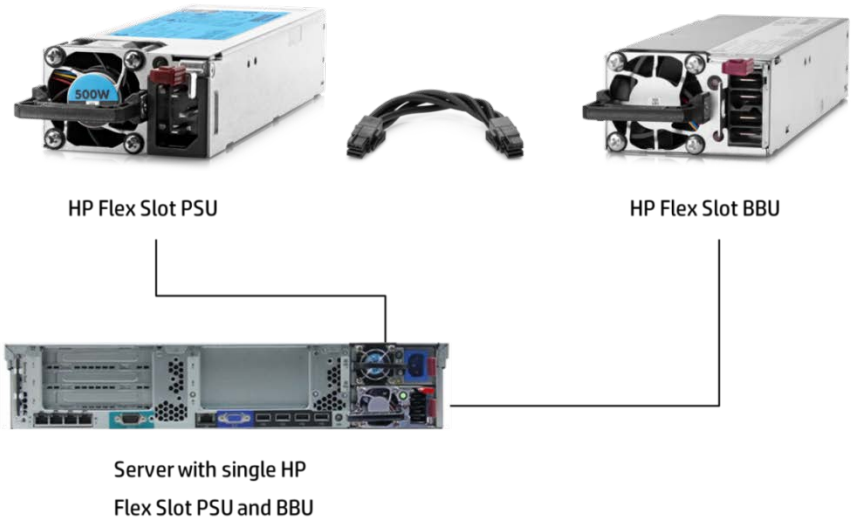
Use cases for HP Flex Slot Power Supplies and Battery Backup Units

There are two basic use cases for the HP Flex Slot PSUs and HP Flex Slot BBUs. The first is installation and use in in a single server. The second is a HP Flex Slot PSU and HP Flex Slot BBU source and redundancy configuration between two servers.

Single server use case

The HP 750W Flex Slot BBU installs into a single HP Flex Slot PSU bay (Figure 3) to free up space for a rack mountable UPS without compromising server uptime.

Figure 3.



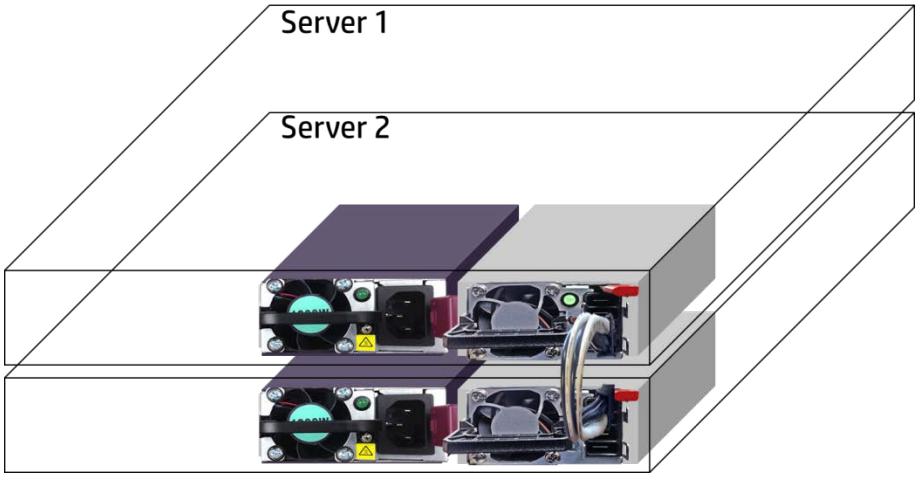
The HP 750W Flex Slot BBU pairs with any HP 500W or 800W Flex Slot PSU.

Two server source and redundancy use case

Daisy chained operation between two HP Flex Slot BBUs allows paralleled connection for pass-through power sharing between two HP ProLiant Gen9 Performance Servers.

The HP Flex Slot BBU provides a 12V dc connection between the two HP ProLiant Gen9 Performance Servers and a second power path (power redundancy) from one server to the other (Figure 4). This daisy chained operation between the two BBUs provides a parallel connection for pass-through power sharing up to 500W between the two servers.

Figure 4.



Each HP Flex Slot BBU has a back-to-back field effect transistor (FET) configuration so that, if daisy chained, each can be electrically isolated in the event of a fault condition.

These 12V dc connection FETs are monitored and controlled by the microcontroller.

Features of the HP Flex Slot BBU shared configuration (two servers, each with one HP Flex Slot PSU and one HP Flex Slot BBU) include:

- PSU redundancy
- Source redundancy
- Internal 12V dc BBU
- BBU redundancy

Conclusion

HP Flex Slot PSUs improve serviceability with hot plug, tool-less installation into HP ProLiant Gen9 Performance Servers. With certification for high-efficiency operation and multiple power output options, these PSUs allow you to right-size for specific server configurations in order to reduce power waste, lower overall energy costs, and avoid trapped power capacity in the data center.

The HP Flex Slot BBU gives you the power and reliability you need in a small form factor. The BBU installs into a single HP Flex Slot PSU bay to free up rack space, giving you the opportunity to increase compute density in your data center. The “Two server source and redundancy use case” shows that daisy chained operation between two HP Flex Slot BBUs allows a paralleled connection for pass-through power sharing between two HP ProLiant Gen9 Performance Servers.

The features available in the innovative HP Flex Slot PSUs and HP Flex Slot BBU can improve data center power efficiency without impacting IT performance, and achieve these benefits with a common electrical and physical design that uses less space within the rack.

Resources

HP Flexible Slot Power Supply and Flexible Slot Battery Backup Unit data sheet
hp.com/v2/GetDocument.aspx?docname=4AA5-7518ENW&doctype=data sheet&doclang=EN_US&searchquery=&cc=us&lc=en

HP Flexible Slot Power Supply Specifications
hp.com/hpsc/doc/public/display?docLocale=en_US&docId=emr_na-c04399928

HP Flexible Slot Power Supply and Battery Backup Unit QuickSpecs
hp.com/h20195/v2/getpdf.aspx/c04346217.pdf?ver=2

HP Power Supplies
hp.com/go/proliant/powersupply

HP Common Slot power supply technology technical white paper
hp.com/h20195/v2/GetDocument.aspx?docname=4AA5-4105ENW

HP Power Discovery Services
hp.com/products/servers/rackandpower/powersupplies/ipd/index.html

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