



One Dell Way  
Round Rock, Texas 78682  
[www.dell.com](http://www.dell.com)



Dell Enterprise White Paper

---

**Power Distribution Systems for the  
Dell PowerEdge M1000e Modular Server Enclosure -  
Selection and Installation**

January, 2008



## Contents

---

<b>Contents .....</b>	<b>2</b>
<b>Summary .....</b>	<b>2</b>
<b>Acronyms .....</b>	<b>3</b>
<b>Introduction.....</b>	<b>3</b>
<b>Overview of Power System.....</b>	<b>4</b>
<b>PDU Selection .....</b>	<b>5</b>
PDU Selection – Model .....	5
PDU Selection – Quantity.....	7
<b>PDU Installation .....</b>	<b>12</b>
PDU Placement – 0-U Space.....	12
PDU Placement – Inside U Space ....	13
PDU Placement in 3 <sup>rd</sup> Party Racks...	13
Inlet Power Cord Routing .....	14
Cord Clearance for Hot-swappability .....	14
Jumper Power Cords.....	15
Power Cord Retainer.....	15
<b>References .....</b>	<b>18</b>
<b>Appendix A – Guidelines for Use of 24     Amp Single-Phase PDU.....</b>	<b>19</b>
<b>Appendix B – Guidelines for Use of 16     Amp Single-Phase PDU.....</b>	<b>25</b>
<b>Appendix C – Order of PSU Standby</b>	<b>30</b>

## Summary

Dell offers a variety of Power Distribution Units (PDU) in support of the PowerEdge M1000e Modular Server Enclosure system to deliver AC power from the facility to the Power Supply Units in the enclosure. Selection of the proper PDU is based upon the type of AC power the facility can provide (e.g. single or three phase, 20 Amp, 30 Amp or 60 Amp) and the amount of power required to support the customer's configuration. The quantity of PDUs required is based upon the type of PDU and the level of power redundancy required.

Best practices for PDU installation, cable connection, and cable management are discussed.



### **Acronyms**

CMC -	Chassis Management Controller
DPSE -	Dynamic Power Supply Engagement
PDU -	Power Distribution Unit
PSU -	Power Supply Unit
UPS -	Uninterruptible Power Supply

### **Introduction**

The purpose of the white paper is to provide information for the selection, installation and cabling of Power Distribution Units (PDUs) for the Dell PowerEdge M1000e Modular Server Enclosure system.

Customers should refer to the PowerEdge M1000e system and rack user guides for specific system, rack and PDU requirements.



## Overview of Power System

Power for the Dell PowerEdge M1000e Modular Server Enclosure system is provided by a set of Power Supply Units (PSUs) that are installed in the rear of the enclosure. Each PSU is capable of delivering 2360 Watts of power to the system at 12 Volts DC (note: PSUs take in single phase 180-264v AC and convert it to 12v DC to supply to the system). Three PSUs provide enough power for an entire fully loaded PowerEdge M1000e system, however the PowerEdge M1000e holds six PSUs to support redundant power modes.

Power is provided to the set of PSUs from one or more Power Distribution Units (PDUs) through jumper power cords. The PDUs are, in turn, provided power from the main AC power source or uninterruptible power source (UPS) through the inlet cord of the PDU.

The PowerEdge M1000e system has a Chassis Management Controller (CMC) that performs power monitoring and management for the enclosure. The CMC provides the following functionality:

- Power Monitoring
  - Reports the enclosure's real time AC power draw
  - Reports maximum and minimum AC power draw with a time stamp
- Power Management
  - Manages and allocates the system power budget, ensuring sufficient power is available based on PSU population, redundancy status, system configuration, and any power limits set on the enclosure
  - Allows users to select required power redundancy mode
  - Allows users to optionally set a maximum AC power draw for the enclosure
  - Allows users to set a power priority for enclosure slots in the event that the CMC needs to reduce system power consumption
  - Manages Dynamic Power Supply Engagement (explained below)

The CMC supports a new capability called Dynamic Power Supply Engagement (DPSE); this is an optional mode, settable in the CMC CLI/GUI – default is DISABLED. The CMC keeps track of the overall power consumption within the system, the maximum potential power requirements of the servers and chassis infrastructure, and the customer's requirements for power redundancy. When this mode is activated, the CMC can enable or place PSUs into standby, as needed, in order to drive up utilization on the active supplies, thus optimizing the power efficiency of the PSUs. [See Appendix C.](#)

For further details of the power consideration of the Dell PowerEdge M1000e system refer to the Dell White paper on M1000e Power Systems in the [Reference Section](#) of this white paper.



## PDU Selection

### *PDU Selection – Model*

The model of PDU that should be selected for the PowerEdge M1000e is dependent upon the type of input power to the system and the international region. Table 1 lists PDUs solutions that Dell offers for various input power configurations.

### PDU Offerings

**Table 1 – PDU Offerings**

Input Power of Facility	Class of PDU <sup>1</sup>	Dell Part Number	Recommended Qty. of PSUs supported	Comment
30 Amp Three-Phase	24 Amp Three-Phase	RY792 N. Am./Japan YT001 Europe/Asia	3	Introduced for PowerEdge M1000e system
60 Amp Single-Phase	48 Amp Single-Phase	MM780 N. Am./Japan XK509 Europe/Asia	3	Introduced for PowerEdge M1000e system
30 Amp Single-Phase	24 Amp Single-Phase	8T593 N. Am 8T601 Europe/Asia 9T632 Australia	1 <sup>2</sup>	Previously recommended for PowerEdge 1855 and 1955 systems
20 Amp Single-Phase	16 Amp Single-Phase	9T552 N. Am 6T767 Europe/Asia 6T805 Japan/China 7T560 Australia	1 <sup>3</sup>	Previously recommended for PowerEdge 1855 and 1955 systems

Note 1: PDUs with locking connectors are derated to 80% of the input current. “Class of PDU” refers to this derated current capability of the PDU.

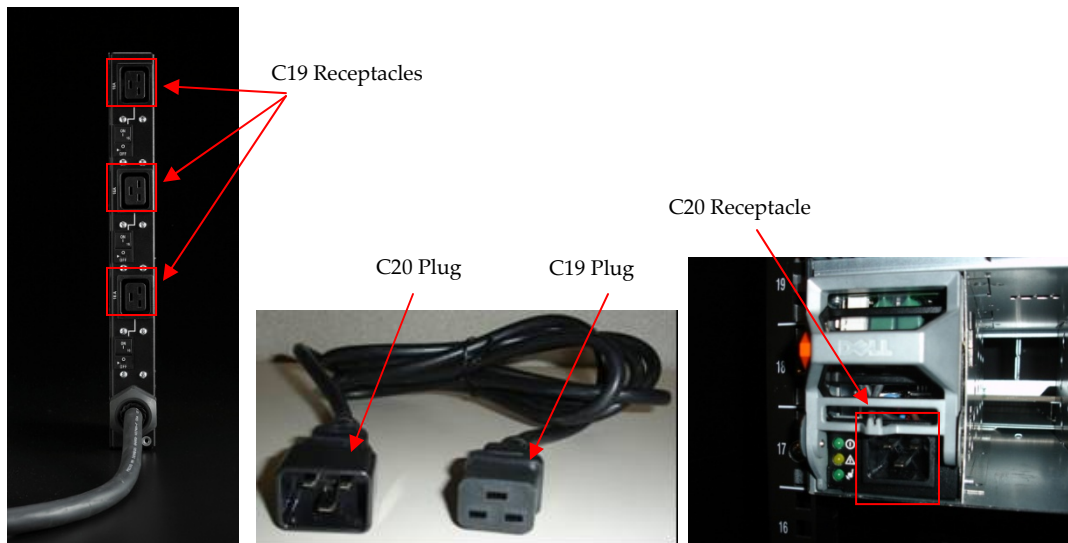
Note 2: Support of PSU densities higher than one PSU per one 24 Amp Single-Phase PDU is discussed in Appendix A.

Note 3: Support of PSU densities higher than one PSU per one 16 Amp Single-Phase PDU is discussed in Appendix B.

Two PDU options have been specifically designed for the PowerEdge M1000e system; the 24 Amp Three-Phase PDU and 48 Amp Single-Phase PDU. If systems are being upgraded from the PowerEdge 1855 or 1955 to the PowerEdge M1000e, Dell encourages upgrading the power delivery infrastructure and accompanying PDUs to these new models; although reuse of the existing PDUs is also covered in this white paper. Additional specific detail on the PDU models can be obtained from the RapidPower PDU Installation Guide. [References](#)

### Connecting PDUs to PSUs

Each PDU, regardless of model, is provided with several jumper power cords that have an IEC C19 receptacle that connects to the IEC C20 connector on the PSU on one end, and an IEC C20 plug that connects to the IEC C19 connector on the PDU on the other end. Figure 1 shows the connectors jumper power cord connections.



**Figure 1** – (Left) PDU showing C19 receptacles, (Center) Jumper Power Cord showing C20 plug for connection to PDU and C19 plug for connection to PSU, (Right) PowerEdge M1000e PSU showing C20 receptacle. Images are not to scale.

### Connecting PDUs to Source

The 24 Amp Three-Phase, 48 Amp Single-Phase, and 24 Amp Single-Phase PDUs have an inlet power cord that is hardwired to the PDU and has a locking plug connector at the other end that connects to the main AC power or UPS. A proper mating receptacle is required. The 16 Amp Single-Phase PDU has a C20 receptacle that accepts a removable inlet power cord with a C19 plug. Each supplying circuits must have its own breaker. Table 2 lists the proper mating receptacle, as well as the type and quantity of breakers on the supply circuit.

**Table 2 – Recommended Power Connections<sup>1</sup>**

PDU Model	Mating Receptacle	Breaker in External Branch	Qty of breakers
24 Amp Three-Phase N. Am	NEMA L15-30R	30 Amp	3
24 Amp Three-Phase Int'l	Hubbell 532R6W	16 Amp	3
48 Amp Single-Phase N. Am	Hubbell 363R6W	60 Amp	1
48 Amp Single-Phase Int'l	Hubbell 363R6W	50 Amp	1
24 Amp Single-Phase	NEMA L6-30R	30 Amp	1
16 Amp Single-Phase	Removable inlet cord with C19 plug	20 Amp	1

Note 1: Power connections as recommended by Dell, but circuit protection must adhere to local code.



## PDU Model Recommendations

**The 24 Amp Three-Phase PDU** is recommended for customers who:

- Already have or are willing to implement 30 Amp three phase service
- Plan to deploy enclosures / blades with high memory/cpu configurations (see the Dell Data Center Capacity Planner at [www.Dell.com/calc](http://www.Dell.com/calc) which provides guidance on the power draw you can expect from a given configuration)
- Want to ensure that there is always going to be sufficient power to deploy any type of blade configuration at a later time (i.e. provision for the max case)

**The 48 Amp Single-Phase PDU** is recommended for customers who:

- Already have or are willing to implement 60 Amp single phase service
- Plan to deploy enclosures / blades with high memory/cpu configurations (see the Dell Data Center Capacity Planner at [www.Dell.com/calc](http://www.Dell.com/calc) which provides guidance on the power draw you can expect from a given configuration)
- Want to ensure that there is always going to be sufficient power to deploy any type of blade configuration at a later time (i.e. provision for the max case)

**The 24 Amp Single-Phase PDU** is recommended for customers who already have 30 Amp Single Phase power and/or are unable to convert to either of the higher amperage services.

**The 16 Amp Single-Phase PDU** is not recommended for the PowerEdge M1000e system due to the low power density and large quantity of underutilized PDU equipment that this solution would entail. However, this PDU can be used by customers with 20 Amp single phase service that are unable or unwilling to convert to the other higher amperage services.

### *PDU Selection – Quantity*

The recommended quantity of PDUs for a PowerEdge M1000e system is dependent upon

- the model of PDU and
- the Power Redundancy mode selected by the user.

### Power Redundancy Modes for the PowerEdge M1000e

1. **AC Redundancy, DPSE DISABLED** – In this mode, all six PSUs are active and the load is shared across all of them. Three PSUs are connected into one AC grid and three PSUs into another, ensuring that the loss of an entire AC grid or any three individual PSUs will not affect the operation of any of the blades. This is the default mode for a six PSU configuration.
2. **AC Redundancy, DPSE ENABLED** – In this mode, all six PSUs start out active and the load is shared across all of them. When power draw stabilizes, the CMC determines how many supplies are required to power that configuration most efficiently and provide redundancy in the event of a grid failure. If the load requires only two supplies to power that configuration plus two more for redundancy, then two supplies will be put into standby (CMC will enable them automatically if load increases see [Appendix C](#)).



3. **Power Supply Redundancy, DPSE DISABLED** – In this mode four PSUs are active and the load is balanced across them – while the remaining two supplies (if connected to AC power) are put into standby. The PSUs in standby will be made active in the event of a PSU failure to any of the four active PSUs as long as they are connected to AC power.
4. **Power Supply Redundancy, DPSE ENABLED** – In this mode, four PSUs start out active and the load is shared across all of them – while the remaining two supplies (if connected to AC power) are put into standby. When power draw stabilizes, the CMC determines how many are required to power that configuration most efficiently while providing redundancy in the event of a PSU failure. If the load requires only two PSUs to power that configuration plus one more for redundancy, then one additional supply will be put into standby (the CMC will enable it automatically if load increases). The PSUs in standby will be made active in the event of a PSU failure to any of the four active supplies as long as they are connected to AC power. For more details on DPSE see [Appendix C](#).
5. **Non-Redundant, DPSE DISABLED** – In this mode with six PSUs present and connected to AC power, three PSUs are active and three are put into standby. With only three PSUs supplies present, all three are active. A failure to any power supply in this configuration may result in some blades shutting down if the load requires the capacity of all three PSUs.
6. **Non Redundant, DPSE ENABLED**- In this mode with six PSUs present, three PSUs start out active (3+0) and the load is balanced across them while three PSUs are in standby. When the power draw stabilizes, the CMC determines how many supplies are required to power that configuration most efficiently with no provision for redundancy. If the load requires only two PSUs to power that configuration, then one additional PSU (four in total) will be put into standby. The CMC will enable it automatically if load increases. A failure to any power supply or AC grid may result in some blades shutting down.



#### Quantity Recommendation - 24 Amp Three-Phase and 48 Amp Single-Phase PDUs

The 24 Amp Three-Phase and 48 Amp Single-Phase PDUs have three 20 amp breakers (one per connector) and thus each can supply three individual PSUs to their maximum capacity. Each PowerEdge M1000e system with the full allotment of six PSUs requires two of these PDUs. Each PowerEdge M1000e system with only three PSUs requires one of these PDUs. Each outlet of the PDU can be used to power a PSU as demonstrated in Figure 2.



**Figure 2** – The 24 Amp Three-Phase PDU connected to Power Supply Units. The 48 Amp Single-Phase PDU (not shown) is connected in the same manner. Note that the jumper power cords are secured to the system strain relief bar.

#### Quantity Recommendation - 24 Amp Single-Phase PDU

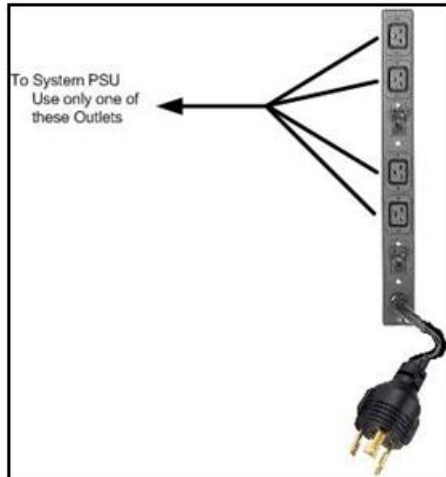
The 24 Amp Single-Phase PDU has two pairs of outlets – four in total – with each pair supported by a 20 amp breaker.

The maximum current draw for a single M1000e PSU could be as much as 14A (in heavily loaded configurations when an AC grid fails or there is only a single AC grid provided); this value is more than 50% of both the 20 Amp breaker protection on the PDU and the derated current capacity of a 30 Amp single phase circuit. **Dell recommends, therefore, that only one of the four outlets on the 24 Amp Single-phase PDU should be utilized (as shown in Figure 3).** Therefore to support heavily configured systems, each PowerEdge M1000e chassis requires six of these PDUs for a full allotment of six PSUs (redundant power) or three of these PDUs for systems with three PSUs (non-redundant power).

#### Using the 24 Amp Single-Phase PDU with a Higher Density of PSUs

The previous paragraph describes what may be considered an extreme case. Customers who plan to deploy more moderately configured blades where the overall power draw does not meet the maximum capability of the PowerEdge M1000e PSUs, and who already have 30 Amp single phase service **may be able to use the 24 Amp Single-Phase PDU at a higher ratio** than the recommended one PSU per PDU. However, there are specific system settings

and cabling configuration that must be implemented. These considerations are discussed in [Appendix A](#).



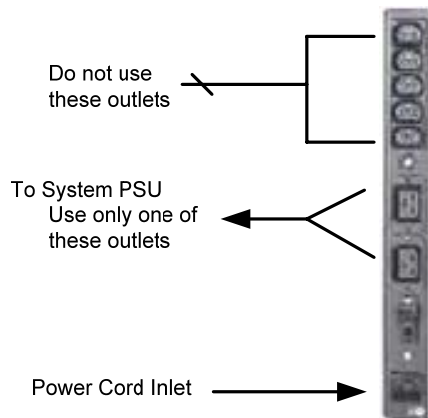
**Figure 3 - Connecting the 24 Amp Single-Phase PDU to Power Supply Units.** Dell recommends that only a single PSU be connected to each 24 Amp Single-Phase PDU **unless the system and cabling configurations discussed in Appendix A are understood and implemented.**

#### Quantity Recommendation - 16 Amp Single-Phase PDU

The 16 Amp Single-Phase PDU has two C19 outlets supported by a single 20 amp breaker. Because the maximum current draw for a single PSU could be as much as 14A (in heavily loaded configurations when an AC grid fails or there is only a single AC grid provided) Dell recommends that only a single PSU be connected to each 16 Amp Single-Phase PDU. Therefore each PowerEdge M1000e chassis requires six of these PDUs for a full allotment of six PSUs (redundant power) or three of these PDUs for systems with three PSUs (non-redundant power). Only one of the two C19 outlets on the 16 Amp Single-Phase PDU should be utilized, as Figure 4 demonstrates.

#### Using the 16 Amp Single-Phase PDU with a Higher Density of PSUs

Customers who plan to deploy extremely lightly configured blades where the overall power draw does not meet the maximum capability of the PowerEdge M1000e PSUs, and who already have 20 Amp single phase service **may be able to use the 16 Amp Single-Phase PDU at a ratio** of two PSUs per PDU. However, there are specific system settings and cabling configuration that must be implemented. These considerations are discussed in [Appendix B](#)



**Figure 4** –Connecting the 16 Amp Single-Phase PDU to Power Supply Units. Dell recommends that only a single PSU be connected to each 16 Amp Single-Phase PDU **unless the system and cabling configurations discussed in Appendix B are understood and implemented.**

## PDU Installation

### *PDU Placement – 0-U Space*

It is recommended that each PDU be placed as closely as possible to the PSU that it serves. Therefore, PDUs should be installed on the rear vertical rails of the Dell 4210 or 2410 rack, on either side of the PowerEdge M1000e chassis. This placement keeps the PDUs out of the U-space and thereby supports the placement of up to four PowerEdge M1000e chassis in one 42-U rack (each PowerEdge M1000e system occupies 10-U of rack space).

In the highest populated configuration; i.e. four PowerEdge M1000e systems each with six PSUs in an AC redundancy configuration; a total of eight 24 Amp Three-Phase or eight 48 Amp Single-Phase PDUs must be placed in the 0-U space of the rack. Figure 5 shows four PDUs mounted on the rear vertical rail in the 0-U space on one side of a Dell 4210 rack. Four more PDUs can be mounted on the rear vertical rail on the other side of the rack.



**Figure 5** – Mounting of four PDUs in the 0-U Space of the Dell 4210 Rack.

Use of 24 Amp Single-Phase PDUs or 16 Amp Single-Phase PDUs may require additional PDUs; depending upon the number of PowerEdge M1000e chassis in the rack and the state of redundancy. There is sufficient space in the 0-U space in the sides of the Dell 4210 rack to support twenty-four 16 Amp Single-Phase PDUs. Mounting this many PDUs may require utilizing the rear vertical rails, the front vertical rails, and/or the top, middle, and bottom horizontal rails. Refer to the PDU Installation Guide for details of these mounting configurations. [References](#)

There is sufficient space in the 0-U space in the sides of the Dell 4210 rack to support a maximum of twenty 24 Amp Single-Phase PDUs. If the rack holds more than twenty PSUs, the user is **STRONGLY** encouraged to convert to one of the higher amperage power services and the corresponding PDUs. Failing this recommendation, the user may consider reviewing the Appendix A of this white paper for guidelines for connecting more than one PSU to each 24 Amp Single-Phase PDU.

#### *PDU Placement – Inside U Space*

An alternative to 0-U mounting is to mount PDUs inside the U-Space of the rack by use of adapter kits provided with the PDUs. Each PDU, when mounted inside the U-Space, consumes 1-U and, thus, may limit the total number of PowerEdge M1000e chassis that can be held in a rack. Figure 6 shows a PDU mounted inside the U-Space.



**Figure 6** - Mounting of PDU inside the U-Space using adapter kit provided with PDU.

The 24 Amp Three-Phase and 48 Amp Single-Phase PDUs may be mounted either vertically in the 0-U space as shown in Figure 5 or horizontally in the 1-U space as shown in Figure 6. These PDUs are not certified for installation on the horizontal side rails with their C19 outlet connectors directed vertically (either upward or downward). The 24 Amp Single-Phase PDU and 16 Amp Single-Phase PDU do not have this limitation and can be mounted in any of these orientations.

#### *PDU Placement in 3<sup>rd</sup> Party Racks*

Dell PDUs are designed to fit in the 0-U space of Dell racks. Other rack manufacturers generally do not use the same attachment features for 0-U mounting of PDUs, so Dell PDUs may not fit in 0-U space of other racks. However, Dell PDUs can be mounted in the U space of all racks meeting the IEC standard, by use of adapter kits provided with the PDUs.

When installed in the U space, each PDU consumes 1-U of rack space. Therefore, a maximum of three M100e chassis can fit in a 42-U rack when deploying PDUs in this manner.

### *Inlet Power Cord Routing*

PDU inlet power cables should be directed to run vertically in the 0-U space at the sides of the rack, as demonstrated in Figure 5. The inlet power cords for the 24 Amp Three-Phase PDU and 48 Amp Single-Phase PDUs are too large in diameter to fit in the wireform cord guides provided with the Dell 4210 rack. Therefore if these PDUs are used, it is recommended that the cord guides be removed and the inlet power cords be secured to the rack with either tie wraps or hook and loop fastener straps as demonstrated in Figure 7. The PowerEdge M1000e Rail Kits are provided with hook and loop fastener straps that can be used for this purpose.



**Figure 7**– Remove cord guides (leftmost picture) and secure PDU inlet cords to the rack by tie wraps or hook and loop fastener straps.

### *Cord Clearance for Hot-swappability*

The PSUs of the PowerEdge M1000e system are designed to be hot-swappable. For the most part, routing the inlet power cords upward or downward in the 0-U space along the sides of the rack provides sufficient clearance for the removal or insertion of PowerEdge M1000e PSUs. However, at the bottom of the rack the inlet power cord must be directed out through the opening in the rack door without blocking access to the bottom corner PSU.

If inlet power cords are to be routed downward to exit the bottom of the rack, it is recommended to leave a gap of 2U below the bottom PowerEdge M1000e chassis, i.e. mount the lowest PowerEdge M1000e chassis in U3, so as to provide as much room as possible for the routing of the inlet cord. Figure 8 shows how the inlet cords can be routed and secured to retain access to the bottom corner PSU.



**Figure 8** – Routing of inlet power cord around bottom corner PSU. Chassis is installed with a 2U gap underneath.

### *Jumper Power Cords*

The PowerEdge M1000e Blade System is provided with a 0.61 m (2.0 ft) power jumper cord for each PSU. This is the preferred jumper cord to connect the PDU to each PSU because it supports the intention of placing the PDU in close proximity to the PSUs with a minimum of cable management issues. Alternatively, PDUs are shipped with jumper power cords of various lengths depending upon the kit. Specifically, the 24 Amp Three-Phase PDU and 48 Amp Single-Phase PDU are shipped with three 2.5 m (8.2 ft) power jumper cables. These longer cords can be used when PDUs cannot be placed in the close proximity of the PSUs.

Each jumper cord has an IEC C19 receptacle on one end and an IEC C20 plug on the other, as shown in Figure 1. The PowerEdge M1000e is provided with a Strain Relief Bar that attaches to the rear of the chassis. The primary purpose of the Strain Relief Bar is for securing and relieving static loads off of data cables and jumper power cords. Figure 2 shows jumper power cords secured to the Strain Relief Bar.

### *Power Cord Retainer*

Each PSU is supplied with a Power Cord Retainer clipped to the PSU handle. This retainer is designed to secure the end of the jumper power cord that is plugged into the PSU in place against vibration or cable sag.

### *Attachment of Power Cord Retainer*

The Power Cord Retainer connects to the jumper power cord itself, rather than the overmold at the end of the cord, so that different varieties of jumper power cords can be secured. Figure 9 a – f demonstrates how the retainer is attached.



**Figure 9a** - Start with secured retainer



**Figure 9b** -Insert power cord



**Figure 9c** - Clip retainer onto cord



**Figure 9d** - Retainer clipped onto cord



**Figure 9e** - Slide retainer against overmold



**Figure 9f** - Secure beaded tie into cleat on PSU handle



### Detachment of Power Cord Retainer

Removal of the jumper cable from the PSU is the prescribed method of emergency power disconnect. Therefore, the retainer is designed to disconnect with light finger pressure. Figure 10a- f demonstrates how the retainer is detached.



**Figure 10a** - Start with retainer attached



**Figure 10b** - Flip off retainer with thumb



**Figure 10c** - Remove power cord from PSU



**Figure 10d** - Power cord removed



**Figure 10e** - Re-secure retainer to PSU handle



**Figure 10f** - Retainer secured



## References

There are other resources that may be useful in selecting and installing the Power Distribution System for the 10G Blade System

### On Line Guides

Dell Data Center Capacity Planner [www.Dell.com/calc](http://www.Dell.com/calc)

PowerEdge M1000e On line Cable Advisor tool [URL]

Rack advisor tool [URL]

### User's guides

PowerEdge M1000e Hardware Owner's Manual (P/N NT250)

PowerEdge M1000e Getting Started Guide (P/N NT248)

[Rapid Power PDU Installation Guide](#) (P/N JU272)

PowerEdge M1000e Rack Installation Guide (P/N DX845)

### PowerEdge M1000e White papers:

PowerEdge M1000e Modular System Architecture

PowerEdge M1000e Rack and Cable Management Guidelines

Additional high density power distribution options are available from American Power Conversion. Contact APC [www.APC.com](http://www.APC.com) for selection criteria and technical support for rack installation.

## Appendix A – Guidelines for Use of 24 Amp Single-Phase PDU

### Disclaimers

Dell recommends that the PowerEdge M1000e be operated with either a RapidPower 24 Amp Three-Phase PDU on an input of 30 Amp three-phase service or a RapidPower 48 Amp Single-Phase PDU on an input of 60 Amp single phase service.

If the PowerEdge M1000e is to be operated on 30 Amp single phase service, Dell recommends that an individual RapidPower 24 Amp Single-Phase PDU be connected to each PowerEdge M1000e PSU.

If the user, upon understanding these recommendation, wishes to configure and operate a PowerEdge M1000e system on 30 Amp single phase service with a higher than recommended ratio of one PSU to one PDU, then the issues, limitations, and configuration options discussed in this Appendix must be reviewed and understood.

### PDU Offering for 30 Amp Single Phase Power

Dell offers a 24 Amp Single-Phase PDU for use with 30 Amp Single Phase power. The 24 Amp Single-Phase PDU might be used by for customers who:

- Already have 30 Amp Single Phase power and/or are unable to convert to a higher amperage service.
- Plan to deploy moderately configured blades where the overall power draw required from the enclosure is LESS THAN 24A (see the Dell Data Center Capacity Planner at [www.Dell.com/calc](http://www.Dell.com/calc) which provides guidance on the power draw you can expect from a given configuration)
- Do not wish to have the extra power capacity available with the higher amperage PDUs go unused.

The 24 Amp Single-Phase PDU has four C19 outlets and two 20 amp breaker. Each breaker protects two of the C19 outlets. Figure A1 shows the 24 Amp Single-Phase PDU.

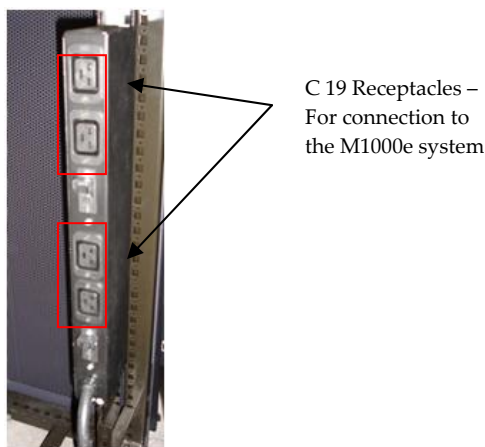


Figure A1 – 24 Amp Single-Phase PDU



### **Over-current Considerations**

Each Power Supply of the PowerEdge M1000e could draw up to 14 Amps (in heavily loaded configurations when an AC grid fails or there is only a single AC grid provided). If more than a single PSU is connected to a 24 Amp Single-Phase PDU there exists a possibility, depending upon the state and settings of the M1000e power management tools and the physical configuration of the system, for a situation in which

- More than 20 Amps is pulled through the pair of outlets served by the common 20 Amp breaker inside the PDU, or
- More than the derated value of 24 Amps is drawn by the PDU from the source power, without tripping either of the 20 Amp breakers in the PDU.

### *Power Redundancy Modes*

The performance of the PowerEdge M1000e system depends upon the Power Redundancy Mode selected by the user. These modes, listed here, are defined in the [main body of the paper](#).

1. AC Redundancy, DPSE DISABLED
2. AC Redundancy, DPSE ENABLED
3. Power Supply Redundancy, DPSE DISABLED
4. Power Supply Redundancy, DPSE ENABLED
5. Non-Redundant, DPSE DISABLED
6. Non Redundant, DPSE ENABLED

### **Order of PSU Standby**

The order in which the CMC selects PSUs to be put into standby in the various Power Redundancy Modes is described in [Appendix C](#).

### **Power Restriction for 24 Amp Single-Phase PDU**

The total power draw on any individual 24 Amp Single-Phase PDU must not exceed 24 Amps to comply with US electrical code. Customers should first use the Dell DataCenter Capacity Planner and then validate these by actual power measurements. It is also recommended that the CMC's optional AC Power Limiting feature be used to help ensure the total draw is kept under this limit.

If the AC Power Limiting feature is used to hold the total power draw of the system below 24 Amps then a single 24 Amp Single-Phase PDU can be used to power up to four PSUs (the number of connections is limited by the four outlets on the face of the PDU). However, care must still be taken that the 20 Amp breakers in the PDU are not overloaded. Specific jumper power cord arrangements might be necessary.

### **Power System Recommendations**

Dell always recommends powering an enclosure off of redundant AC circuits to ensure maximum redundancy. It is particularly important in this case. It is NOT recommended to deploy a non-redundant power option – only three PSUs on a single 30 Amp Single Phase circuit and, therefore, only one PDU. Failure of any one of the PSUs may result in blade shutdowns.

If a single 30A Single Phase circuit is to be used to power the enclosure:

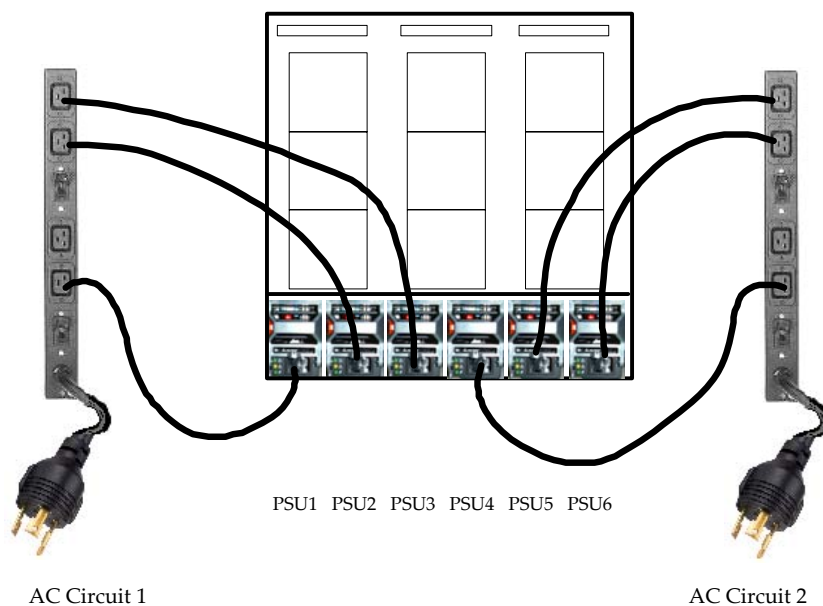
- Six supplies should be present in the enclosure, with PSU 1 and PSU 4 connected to separate breakers on the 24A Single-Phase PDU
- Power Supply Redundancy mode should be selected in the CMC
- Use of DPSE is NOT recommended when deploying an enclosure on a 30A Single Phase environment. If DPSE IS required, it is critical to follow the guidelines which follow as to which PSUs to connect to specific connectors in the PDU to account for the order in which supplies would be put into standby by the CMC.

### Jumper Power Cord Configurations for 24 Amp Single-Phase PDU

The following diagrams show the deployment options for the 24 Amp Single-Phase PDU when utilized at a density higher than the recommended one PSU per PDU.

#### AC Redundancy

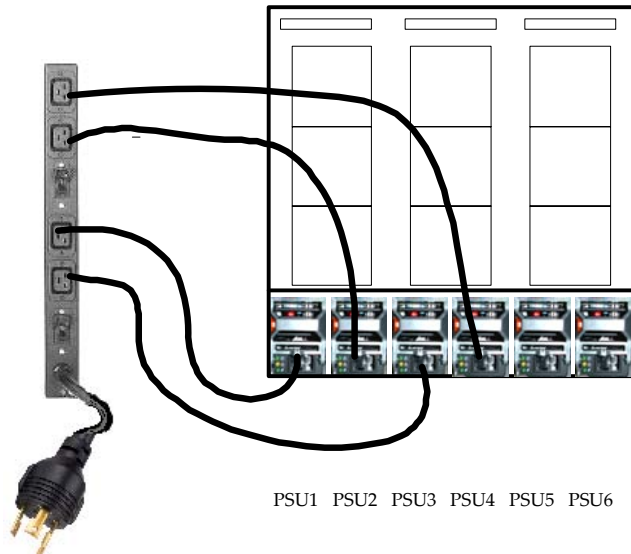
AC redundancy (2 x 30A circuits) – Connect three PSUs into one PDU and three PSUs into the other. If DPSE is used it is critical to plug PSU 1 and PSU 2 into outlets served by separate breakers on the PDU, as DPSE will first shut down PSU 3 first. Likewise PSU 4 and PSU 5 must be plugged into outlets served by separate breakers, as DPSE will first shut down PSU 6 first.



**Figure A2** – Jumper Power Cord Configuration for 24 Amp Single-Phase PDU with AC Redundancy and DPSE enabled. If DPSE is disabled then power is shared evenly across PSUs; no special configuration is needed as long as each AC circuit is serving three PSUs.

### *Power Supply Redundancy*

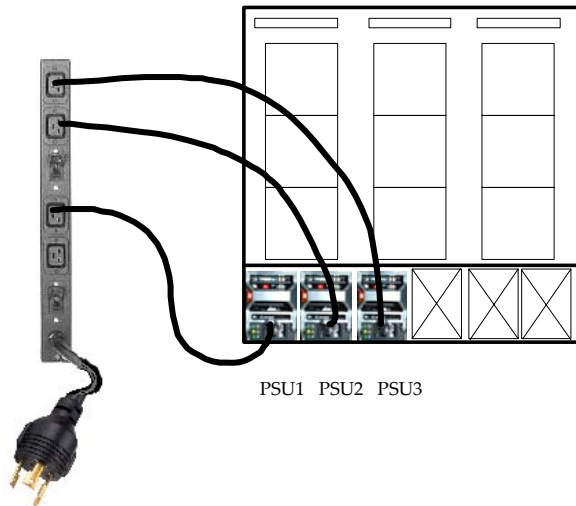
PSU redundancy (1 x 30A circuit) – Connect four Power Supplies into a single PDU. If DPSE is used, PSU 1 and PSU 4 should be plugged into connectors served by separate breakers because these two PSUs always remain online.



**Figure A3** – Jumper Power Cord Configuration for 24 Amp Single-Phase PDU with Power Supply Redundancy and DPSE enabled. If DPSE is disabled then power is shared evenly across PSUs; no special configuration is needed

### *Nonredundancy*

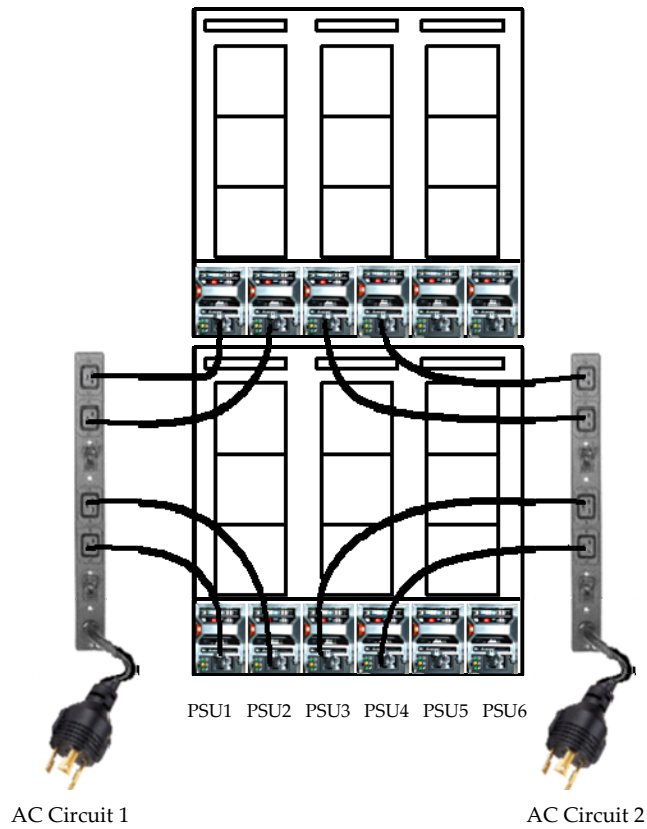
Non-redundancy (1 x 30 Amp circuit) - Connect three Power Supplies into a single PDU. If DPSE is used, PSU 1 and PSU 2 should be plugged into connectors served by separate breakers as DPSE will shut down PSU 3 first.



**Figure A4** – Jumper Power Cord Configuration for 24 Amp Single-Phase PDU with Nonredundancy and DPSE enabled. If DPSE is disabled then power is shared evenly across PSUs; no special configuration is needed.

*Special Case – Power Supply Redundancy for two Chassis using two 24 Amp Single-Phase PDUs*

In some circumstances a customer may wish to deploy multiple PowerEdge M1000e chassis with some level of AC Redundancy but with a minimal number of source circuits or minimal investment in PDUs. In this instance a variant of Power Supply Redundancy can be deployed that uses two PDUs across two M1000e chassis. Two PSUs in each chassis are connected to each of the PDUs. Because of the order that the DPSE places PDUs into standby each of the two PSUs in the first position and each of the two PSUs in the fourth position should all be on separate breakers.



**Figure A5** – Jumper Power Cord Configuration for Power Supply Redundancy using two chassis and two 24 Amp Single-Phase PDUs. Each PSU in the first and fourth position is served by a separate breaker.





## **Appendix B – Guidelines for Use of 16 Amp Single-Phase PDU**

### **Disclaimers**

Dell recommends that the PowerEdge M1000e be operated with either a RapidPower 24 Amp Three-Phase PDU on an input of 30 Amp three-phase service or a RapidPower 48 Amp Single-Phase PDU on an input of 60 Amp single phase service.

Dell recommends that the PowerEdge M1000e not be operated on 20 Amp single phase service. If the PowerEdge M1000e is to be operated on 20 Amp single phase power, Dell recommends that an individual RapidPower16 Amp Single-Phase PDU be connected to each PowerEdge M1000e PSU.

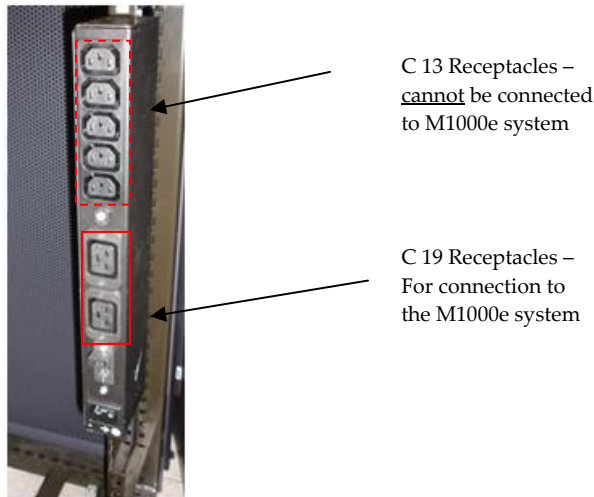
If the user, upon understanding these recommendation, wishes to configure and operate a PowerEdge M1000e system on 20 Amp single phase service with a higher than recommended ratio of one PSU to one PDU, then the issues, limitations, and configuration options discussed in this Appendix must be reviewed and understood.

### **PDU Offering for 20 Amp Single phase Power**

Dell offers a 16 Amp Single-Phase PDU for use with 20 Amp Single phase power. The 16 Amp Single-Phase PDU might be used by for customers who:

- Already have 20 Amp Single Phase power and/or are unable to convert to a higher amperage service.
- Plan to deploy lightly configured blades where the overall power draw required from the enclosure is LESS THAN 16A (see the Dell Data Center Capacity Planner at [www.Dell.com/calc](http://www.Dell.com/calc) which provides guidance on the power draw you can expect from a given configuration)
- Do not wish to have the extra power capacity available with the higher amperage PDUs go unused.

The 16 Amp Single-Phase PDU has two C19 outlets protected by a single 20 Amp breaker. It also has five C13 outlets on its face that cannot be connected to the M1000e PSUs. Figure B1 shows the 16 Amp Single-Phase PDU.



**Figure B1** – 16 Amp Single-Phase PDU

### **Over-current Considerations for 16 Amp Single-Phase PDU**

Each Power Supply of the PowerEdge M1000e could draw up to 14 Amps (in heavily loaded configurations when an AC grid fails or there is only a single AC grid provided). If more than a single PSU is connected to a 16 Amp Single-Phase PDU there exists a possibility, depending upon the state and settings of the M1000e power management tools and the physical configuration of the system, for a situation for a situation in which

- More than 20 Amps is pulled through the pair of outlets served by the common 20 Amp breaker inside the PDU, or
- More than the derated value of 16 Amps is drawn by the PDU from the source power.

### *Power Redundancy Modes*

The performance of the PowerEdge M1000e system depends upon the Power Redundancy Mode selected by the user. These modes, listed here, are defined in the [main body of the paper](#).

- 1 AC Redundancy, DPSE DISABLED
- 2 AC Redundancy, DPSE ENABLED
- 3 Power Supply Redundancy, DPSE DISABLED
- 4 Power Supply Redundancy, DPSE ENABLED
- 5 Non-Redundant, DPSE DISABLED
- 6 Non Redundant, DPSE ENABLED

### **Order of PSU Standby**

The order in which the CMC selects PSUs to be put into standby in the various Power Redundancy Modes is described in [Appendix C](#).

### Power restriction for 16 Amp Single-Phase PDU

The total power draw on any individual 16 Amp Single-Phase PDU must not exceed 16 Amps to comply with US electrical code. Customers should first use the Dell DataCenter Capacity Planner and then validate these by actual power measurements. It is also recommended that the CMC's optional AC Power Limiting feature be used to help ensure the total draw is kept under this limit.

The M1000e system is configured with either three or six PSUs, yet the 16 Amp Single-Phase PDU has only two C19 receptacles. Therefore, there must always be more than one PDU, and more than one corresponding 20 Amp circuit, in use. Specific jumper power cord arrangements might be necessary.

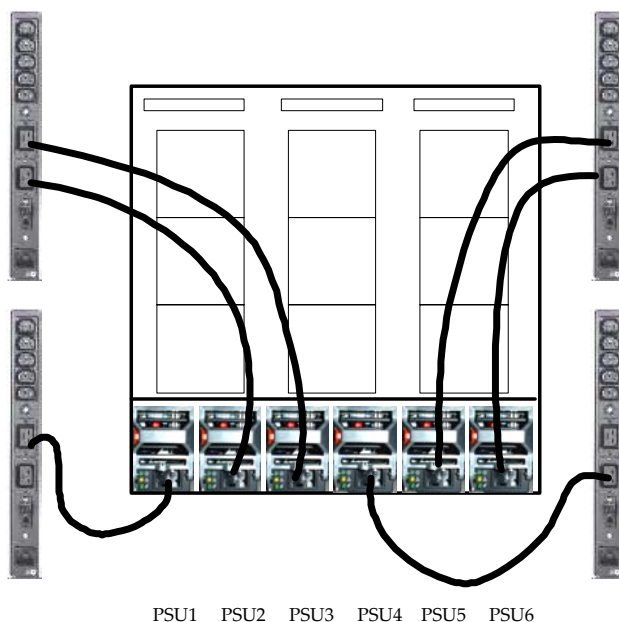
### Jumper Power Cord Configurations for 16 Amp Single-Phase PDU

The following diagrams highlight the deployment options for the 16 Amp Single-Phase PDU when used a density higher than the recommended one PSU per PDU.

#### AC Redundancy

AC redundancy (2 x 20A circuits) – To preserve redundancy three PSUs need to be connected to one AC circuit, and three to the other. However the 16 Amp Single-Phase PDU has only two C19 connectors available, so two of these PDUs are required on each circuit, or four PDUs in total, per M1000e system.

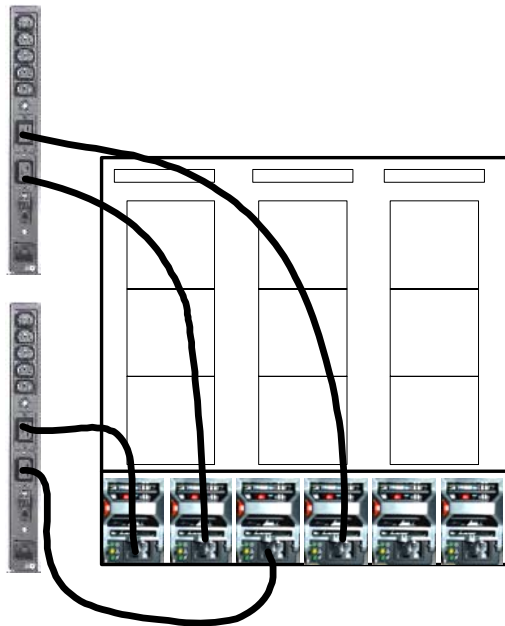
If DPSE is used it is critical to plug PSU 1 and PSU 2 into separate PDUs so that they are on separate breakers, as DPSE will first shut down PSU 3 first. Likewise PSU 4 and PSU 5 must be plugged into separate PDUs, as DPSE will first shut down PSU 6 first.



**Figure B2** – Jumper Power Cord Configuration for 16 Amp Single-Phase PDU with AC Redundancy and DPSE enabled. If DPSE is disabled then power is shared evenly across PSUs; no special configuration is needed.

*Power Supply Redundancy*

PSU redundancy (2 x 20A circuit) – Connect two PSUs into one PDU and two PSUs into a second PDU. If DPSE is used, PSU 1 and PSU 4 should be plugged into separate PDUs because these two PSUs always remain online.

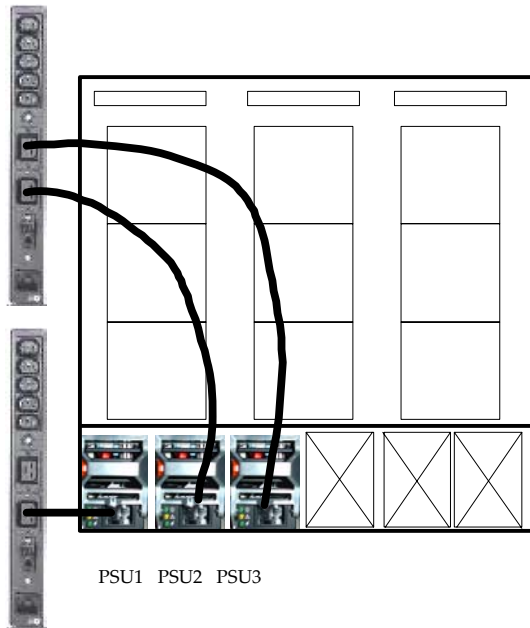


PSU1 PSU2 PSU3 PSU4 PSU5 PSU6

**Figure B3** – Jumper Power Cord Configuration for 16 Amp Single-Phase PDU with Power Supply Redundancy and DPSE enabled. If DPSE is disabled then power is shared evenly across PSUs; no special configuration is needed

*Nonredundancy*

Non-redundancy (1 x 20 Amp circuit) - Connect two PSUs into one PDU and one PSU into a second PDU. Both PDUs are connected to the same AC source. If DPSE is used, PSU 1 and PSU 2 should be plugged into separate PDUs as DPSE will shut down PSU 3 first.



**Figure B4** – Jumper Power Cord Configuration for 16 Amp Single-Phase PDU with Nonredundancy and DPSE enabled. If DPSE is disabled then power is shared evenly across PSUs; no special configuration is needed.



## Appendix C – Order of PSU Standby

The order in which the CMC selects supplies to be put into standby in the various modes is shown in Tables C1 and C2 for configurations with 6 PSUs and 3 PSUs, respectively..

**Table C1 – Order of PSU Standby for Systems Configured with 6 PSUs**

6 PSU configuration	DPSE Enabled	DPSE Disabled
AC Redundancy	PSU 3 and 6 go to standby first <sup>1</sup> PSU 2 and 5 go to standby next <sup>1</sup> PSU 1 and 4 ALWAYS online	ALL PSUs online
Power Supply Redundancy	PSU 5 and 6 ALWAYS in standby PSU 3 goes to standby first <sup>1</sup> PSU 2 goes to standby next <sup>1</sup> PSU 1 and 4 ALWAYS online	PSU 5 and 6 ALWAYS in standby
Non Redundant	PSU 4, 5, 6 ALWAYS in Standby PSU 3 goes to standby first <sup>1</sup> PSU 1 and 2 are ALWAYS online	PSU 4, 5, 6 ALWAYS in Standby

Note 1: PSUs noted will only go into standby if load drops to a level that allows this to happen

**Table C2 – Order of PSU Standby for Systems Configured with 3 PSUs**

3 PSU configuration	DPSE Enabled	DPSE Disabled
AC Redundancy	N/A - this mode is not possible with only 3 PSUs present	N/A - this mode is not possible with only 3 PSUs present
Power Supply Redundancy	N/A - this mode is not possible with only 3 PSUs present	N/A - this mode is not possible with only 3 PSUs present
Non Redundant	PSU 3 goes to standby first PSU 1 and 2 are ALWAYS online	PSU 1,2 and 3 ALWAYS online