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Understanding Power for POWER

January 2015 | by Jaqui Lynch

As servers have become more powerful, the requirements for power connections and the rules about power distribution units (PDUs) have become more constrictive. IBM publishes maximum power usage for each of its servers in the technical overview manuals, but the rules confuse many people. These details are typically provided in the operating environment section. I'm asked about electrical power all the time and much of the confusion is centered on planning for power and what's actually being measured, as well as why IBM requires so many PDUs when the measurements show less power is actually being used. Hopefully, I can clear this up and I'll start by covering some terminology.

Terminology

The details provided typically consist of watts, kVA (kilovolt-amps) and voltage and are either per server (scale out) or per node (scale up). Numbers provided in the Redbooks publications are the maximum power consumption but you should still plan for that in case you end up using all the resources at some point.

Volts is a measure of the strength of an electrical source at a given amperage (similar to water pressure in a pipe). Amps (amperes) is a measure of the total electrical current that can flow (similar to water current). kVA (kilovolt-amps) is the key number typically provided by vendors for power planning and is 1,000 volt-amps. A volt-amp is the unit used for apparent power in an electrical circuit. Volt-amps are used with AC (alternating current) power. Other calculations are available for DC (direct current) power.

I normally plan using kVA but if you want to plan using Amps then the following calculations can be used:

Single phase Amps = ((kVA x 1000)/voltage) or (Watts / (voltage x power factor))

Typically we divide by either 200 or 208 for voltage. If using three phases then calculations can be found at the useful power formulas link provided.

PDUs and Line Cords

The first key thing to understand is that power planning is required to adhere to the National Electrical Code. Because of past issues with overloading and fires, etc., PDUs have been derated. This means that a 60 amp PDU is only allowed to have up to 48 amps (9.6 kVA) of equipment connected to it and a 30 amp PDU is derated to 24 amps (4.8 kVA). This is a critical consideration in all of your power planning.

As a starting point, let's look at IBM PDUs and their associated line cords. IBM currently provides two PDUs—the 9188/7188 and the 5889/7109. All four PDUs have six pairs of IEC320-C13 outlets rated at 200-240 volts. Each outlet is rated at 10 amps and each pair of outlets is connected to a 20-amp circuit breaker in the PDU and each circuit breaker is derated to 16 amps. The full amperage rating for the PDU (derated) is 16 amps, 24 amps or 48 amps, depending on the line cord chosen. The difference between the PDUs is that the 5889/7109 combination provides power-monitoring capabilities whereas the 9188/7188 doesn't.

The two most common line cords to the PDUs that we see in the United States are:

6492	14' 200/240v/48A	UTG0247 IEC309 60A
6654	14' 200/240v/24A	UTG0247 L6-30P 30A

The 6492 uses a plug type 262P6W, which means the electrician needs to provide a 60-amp circuit with a 363P6W receptacle. The 6654 uses a NEMA L6-30P plug, which requires a 30-amp circuit and a NEMA L6-30R receptacle. There are multiple other line cord options so it's important to discuss these with your electrician and data center personnel to ensure the correct ones are ordered. If they provide the PDUs, then you'll need to know the voltage and derated amperage of the PDUs to plan for your power needs. Details and pictures can be found at the line cord reference.

Designing for Power

Much of the confusion comes from the way redundant power supplies work and the requirements this puts in place for additional PDUs. As an example, the S824 has four power supplies set up as two redundant pairs. This means that two cords should go to one PDU and two should go to another so if a circuit or PDU fails the server can continue to run. For the most part, two of the power cords may never draw power, however we don't get to state which ones will. This means that redundant power supplies can hide the problem of accidentally exceeding the 4.8 kVa loading on a 30-amp PDU in normal operation, since we'll never see one of the PDUs in the pair being used. However, if one PDU in a redundant pair happens to fail—for example, if a PDU cord is unplugged or an input circuit fails—the entire load of all the devices will be forced to the remaining PDU where it's likely to fail due to the overloading. I have seen this happen several times and the result is never good.

So the first thing you need to determine is whether your circuits are 60 amp or 30 amp. POWER7 and POWER8 servers draw plenty of power so wherever possible it's recommended you go with 60-amp circuits. If you remain with 30-amp circuits, you'll need to provide a lot more PDUs. Once you determine the amperage and voltage, then it's a simple case of planning connections such that you don't exceed the rules for power usage.

Here's an example for a system consisting of an S824, a three-node 770 MMD and an HMC and monitor.

Using the maximum use numbers from the Technical Overview Redbooks: Each 770 node is 1.649 kVA and 1,600 watts, the S824 is 2.38 kVA and 2,300 watts and the 7042-CR8 HMC is about 0.55 kVA and 523 watts. The monitor requirements are negligible. So for planning purposes we need:

	kVA	**Power Plugs**
3 node 770	4.947	6 (3 pairs)
S824	2.38	4 (2 pair)
HMC	0.55	2 (HMC) + 1 monitor
TOTAL	**7.877 kVA**	

If we're using 30-amp (derated to 24 amp) PDUs, then we can only support up to 4.8 kVA on a PDU so the example configuration would require four PDUs (two to support the 7.877 kVA primary needs and two for failover). With 60-amp PDUs, we can support up to 9.6kVA so we would only need one pair of PDUs (one PDU for primary and one for failover). It should be noted that the E870 and E880 have higher power requirements with each node potentially drawing 4.2 kVA across four power cords. This means that a pair of 30-amp PDUs can only support one E870 or E880 node and nothing else.

For Your Safety

IBM has taken great care to ensure its support statements adhere to the electrical codes. Even though you can use the energy estimator to determine numbers closer to what you would really use, it's still important to plan for enough power to support the servers if they were to have all the resources activated or in use. I normally plan for power using the energy estimator as well as the published maximums, and I

use the larger of the two numbers. I don't expect to draw that amount of power, but to be supported and in compliance with electrical codes, I must plan for the potential additional power. Plus I also ensure that the requirements for redundancy are taken into account and that IBM's rules for maximum servers per PDU are followed. This ensures that the servers are fully supported and that PDU failure doesn't cause servers to go down due to lack of power or, worse, cause fires. These redundancy requirements along with the regulations mean that you need to plan for what you could use, not just what you're currently drawing when all is normal. This is why it's important that, any time a server or I/O drawer or similar is added, a review should be done of the PDU layouts and usage. This is also why it's important to have a preinstall planning meeting before servers or upgrades are ordered.

References

< Return to main article

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For more information on electrical power, check out the following reading materials:

Useful Power Formulas

http://www.elec-toolbox.com/Formulas/Useful/formulas.htm

http://www.rapidtables.com/electric/ampere.htm

Power cord details

http://www.quail.com/

Supported PDU Power Cords (IBM)

http://www-01.ibm.com/support/knowledgecenter/api/content/POWER8/p8had/p8had_pdupowercords.htm?locale=en

IBM PDUs and Power Cord Options

http://www-01.ibm.com/support/knowledgecenter/api/content/POWER8/p8had/p8had_specsheetpdu.htm?locale=en

IBM System Energy Estimator

http://www-947.ibm.com/systems/support/tools/estimator/energy/index.html

< Return to main article