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Power and Data White Paper
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Topic: Making sense of AC electrical connections.

Many misnomers, improperly used terms, and confusion of genders exist regarding this topic. To simplify we need to examine Electrical Interface Types, Electrical Interface Standards, Industry Trends, and Adapters.

1) Electrical Interface Types:

There are five terms used to identify most electrical interfaces -- plug, connector, inlet, outlet, and receptacle.

A power source is always female and can be an outlet, receptacle or connector. A connector is applied to a length of cord or a block adapter. Outlets and receptacles are applied to a housing. Typically, receptacles are mounted either to a wall or floor box. Outlets are often applied to equipment and are panel mounted.

Conversely, a device receiving power is always male and is either a plug or inlet. A plug is applied to a length of cord or a block adapter. An inlet is applied to a wall or floor box.

Female and male electrical connections may exist on the same device, especially in cases where the device is used to pass power, but the end that accepts power will always be male and the end passing out the power will always be female. It is required that all power cords have male and female electrical connections per the National Electrical Code (NEC).

2) Electrical Interface Standards:

There are four common standards for electrical interfaces -- National Electrical Manufacturers Association (NEMA), NON-NEMA, and International Electrotechnical Commission (IEC) -- both IEC60320, and IEC60309.

NEMA is a North American Standard listing both straight blade (http://www.stayonline.com/reference-nema-straight-blade.aspx ) and Twist-Lock (http://www.stayonline.com/reference-nema-locking.aspx).

NON-NEMA is not technically a standard, but instead a series of designs usually with Underwriter Labs (UL) approval. The most popular NON-NEMA electrical interface is the

California Style 50 amp, which initially became popular in marine power applications (http://www.stayonline.com/reference-california-standard.aspx).

Standard male equipment interfaces are usually from the IEC60320 series, aka IEC320, 320, or Cxx (as the part numbers begin with a C) (http://www.stayonline.com/reference-iec320.aspx).

The newest standard appearing in data centers is IEC60309, aka IEC309, 309, or Pin and Sleeve. Pin and Sleeve is an inadequate name as there are many other industries outside of data using this style. In Europe, IEC309 are rated in different amperage increments (16a/32a/63a/125a) (http://www.stayonline.com/reference-iec309-international.aspx) whereas in the US the increments are 20a/30a/60a/100a (http://www.stayonline.com/reference-iec309-north-american.aspx).

3) Industry Trends

NEMA straight blade and a subset of IEC320 connectors were practically the only connections encountered in data applications for many years. This has changed dramatically due to new amperage requirements. Faster processors, high density clusters and blade servers have pushed amperage requirements through the roof. This change happened gradually so as engineers designed electrical systems, upgrades were incremental on the power supply side.

Initially NEMA straight blade delivery systems were replaced by NEMA Twist-Lock systems to minimize inadvertent disconnects. Then, the change from 125 volt / 15 amp to 20 and 30 amp requirements pushed designs to the maximum NEMA Twist-Lock offerings. Many migrated from 125 volts to 250 volts (L6-15, L6-20, L6-30) to take advantage of the efficiencies of their existing equipment. NEMA does publish both 50 and 60 amp Twist-Lock standards but the configurations are not manufactured by anyone. Thusly, NON-NEMA California style 50 amp Twist-Lock interfaces became popular. In turn, this is now giving way to IEC309 interfaces which offer 60, 63, 100, and 125 amperage options.

Alternative male inlets are increasingly being used in new equipment. IEC60320 C14 (which was the standard for many years) is being augmented by new configurations to meet higher amperage requirements including IEC60320 C16 (which has the same form factor as a C14 but has an additional notch to prevent the use of low amperage legacy cords) and IEC60320 C20 (which is a rectangular form factor with horizontal blades unlike the C14 which is six-sided with vertical blades).

4) Adapters

So ultimately the question is how do I plug it in? Short answer: Stay Online http://www.stayonline.com/power-ac-adapters.aspx). We stock many standard adapters in a

plethora of lengths and if you can't find the part you need, we have an online configuration tool (http://www.stayonline.com/custom_power_cords.aspx) that allows you to select the right cord for your needs.

There are several parameters that determine interoperability between a power source interface and a device interface:

a) Amperage is a function of your power requirements. If you have a device with an L5-30 amp plug, but it only draws 10 amps, you can put an adapter on the cord and plug it into a conventional home 5-15 amp receptacle. This is commonly done with an UPS that does not have a large load requirement.

b) Voltage is significant. A transformer is the only way to join a power source with a device of a different voltage.

c) Number of wires. A 4 wire output can often support a 3 wire device, but the opposite is not possible.

d) Three phase and single phase power. A three phase device can't be operated off of a single phase power source.

e) Outer diameter of the cord is vital. In some cases especially involving California Style NON-NEMA configurations, the OD tolerance is so tight that it limits the types of ends that may be attached on the other end.

f) Length of cord will affect the amperage rating of the cord. For every 50 feet, the gauge (AWG) requirement increases in order to support the load.

g) Type of cord is determined by voltage requirements and whether the cord is designed for internal or external use.