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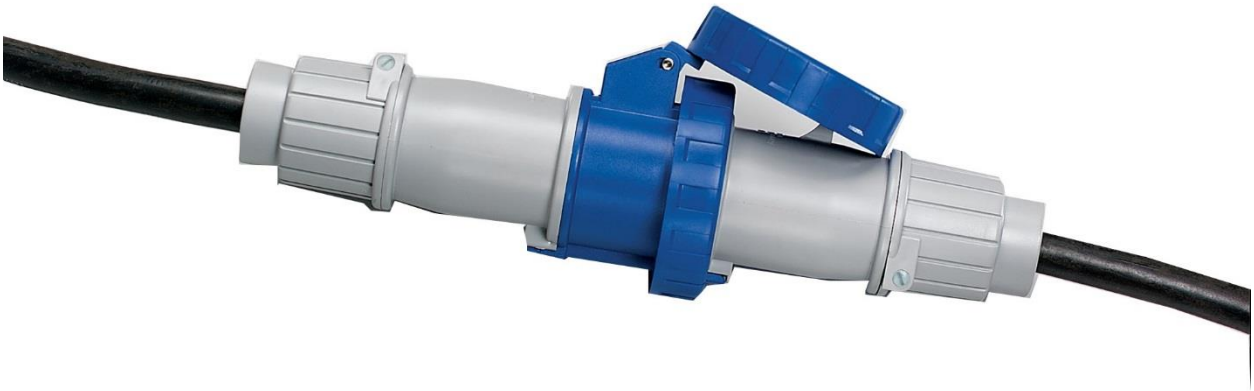

MAKING SENSE OF AC ELECTRICAL CONNECTIONS

Bringing clarity to electrical interface types, standard and trends

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Stay Online White Paper
2010-02-01 (Revised 2014-02-11)Topic: **Making sense of North American AC electrical connections used in Data Environments.**

Many misnomers, improperly used terms, and confusion of genders exist regarding wiring devices. Let's bring clarity by examining Electrical Interface Types, Electrical Interface Standards, Industry Trends, and Cords & Plug 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. Outlets and receptacles are applied to a housing. Typically, receptacles are mounted in either a wall/floor box or a Power Distribution Unit (PDU). Outlets are usually installed on a power supply or mounted in a PDU.

Conversely, a device receiving power is always male and is either a plug or inlet. A plug is applied to a length of cord. Inlets are usually panel mounted on equipment.

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

2) Electrical Interface Standards:

There are two common standards for wiring devices -- National Electrical Manufacturers Association (NEMA) and International Electrotechnical Commission (IEC). Outside of these standards are groups of wiring devices that are more application oriented which are often referred to as Non-NEMA.

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

NON-NEMA is a variety of designs often with Underwriter Labs (UL) approval. A 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 power supply female outlets and equipment male inlets are usually from the IEC60320 series aka IEC320. (http://www.stayonline.com/reference-iec320.aspx).

The IEC60309 standard aka IEC309 often appears in data centers. This series is also referred to as Pin & Sleeve but this is problematic because NON-NEMA also incorporates Pin & Sleeve designs. Internationally, IEC309 are rated in these amperage increments (16a/32a/63a/125a) (http://www.stayonline.com/reference-iec309-international.aspx) whereas in North America the increments are 20a/30a/60a/100a (http://www.stayonline.com/reference-iec309-north-american.aspx).

3) Industry Trends

Historically, NEMA straight blade and the ubiquitous IEC320 C13 connector were the common connections encountered in data applications. This century the explosive growth of data requirements has pushed design engineers to move through a series of electrical wiring devices to meet the increasing power supply demands.

Initially NEMA Straight Blade delivery systems were replaced by NEMA Twist-Lock systems to minimize inadvertent disconnects. Then 15 amp installations gave way to 20 and 30 amp power hungry installations. Migration from 125 volts to 250 volts was the next step which took advantage of the efficiencies of existing equipment. NEMA does publish both 50 and 60 amp Twist-Lock standards but the configurations are not manufactured by anyone. To fill this void NON-NEMA California style 50 amp Twist-Lock interfaces became popular. In turn, this gave way to IEC309 interfaces which offer 60, 63, 100, and 125 amperage options. Higher voltage installation at 277 volts and 415 volts are now often employed.

Alternative male inlets are increasingly being used in new equipment. IEC320 C14 is being augmented by new configurations to meet higher amperage requirements. To address existing installations the IEC320 C16 became popular because it has an additional notch to prevent the use of low amperage legacy cords. For higher amperage the IEC320 C20 and recently the IEC320 C22 have been incorporated to support up to 20 Amp equipment.

4) Cords & Plug 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 have the largest in-stock selection of cords and plug adapters in the world. If you can't find the exact part you need, we have an

online configuration tool (http://www.stayonline.com/custom_power_cords.aspx) that allows you to design and order your custom product in real time.

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 may 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.