

Connector Safety Standards and Capability vs. Suitability

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Electrical connectors are used in a broad array of global applications. In addition to the performance criteria used for selecting a connector, manufacturers rely on industry or regulatory standards to show that their products meet the safety requirements of markets around the world.

Each region or country can have different standards and performance requirements for the same application. These standards are critical to ensuring human safety. In North America, the majority of standards are written by Underwriters Laboratories (UL) and in Canada CSA International (CSA). Many standards are also coordinated between UL and CSA in order to cover the American and Canadian needs under the same document.

UL / CSA standards specify electrical and mechanical performance. These standards do not specify connector design but rather how they perform. For example, a typical standard heat-rise requirement at constant current for a connector might specify a maximum amperage rating achieved when the connector being tested reaches +30°C above the ambient temperature.

Standards can change. Consider that starting on December 20, 2020, IEC/UL/CSA 60950-1 and IEC/UL/CSA 60065 “Safety of information technology equipment,” one of the world’s most widely used electrical product safety standards for IT equipment, began to be superseded by IEC/UL 62368, a new hazard-based standard for information technology and audio/visual equipment.

Types of Tests and Standards

There are several reasons for testing connectors. They include: performance verification, assessing reliability, verifying designs and qualifying parts within specific applications. The requirements for passing tests will differ for each purpose, ranging, for example, from exposure duration to temperature to the effects of corrosion on connector performance. Comparison testing of competitive product under the same test conditions can help engineers choose between products.

Dimensional standards for connectors define the size and geometry of specific connectors. These are certified to the same stan-

dard and ensure inter-operability between different manufacturers of the same connector type.

Performance standards provide a test to assess the capabilities of a connector. Unlike dimensional standards, performance standards are not necessarily an automatic determination of suitability but can help guide designers toward a solution within given conditions. Additional considerations may apply based on the particular connector being used, the application, and environment in which it’s being used. Most of these are based on the testing of capabilities parameters such as amperage, voltage, and environmental exposure. In most designs, the connector still must be evaluated for suitability in the end application. There may also be requirements for compliance with specific industry standards such as IEC60601 electrical safety standards within the medical device industry.

Current Rating and Operating Voltage

Current rating is an important criterion for selecting electrical connectors. It is a measure of the amount of current that can flow through a mating terminal while remaining below a defined temperature. It is stated in amps per circuit. The flow of current should be adjusted or de-rated on the basis of the number of circuits in a given housing, according to the rise in temperature of the adjacent terminals.

Amperage ratings are defined to stay below the maximum operating temperature of the connector housing, factoring in an ambient temperature of 25°C (or 77°F). This means connectors can be hot when used at the UL amperage ratings. For this reason UL amperage ratings should only be applied to connectors when they are used inside an enclosure not accessible to untrained persons.

The approved voltage ratings for connectors is usually limited by the category under which a safety agency such as UL approves connectors for use. UL typically defers to the National Electric Code (NEC) on the voltage limitations for any given device a connector could be used in. For most common applications NEC restricts voltage to a maximum of 600V AC or DC which is what connector voltage ratings are based on.

Compliance

To ensure compliance, laboratories around the world are accredited and approved to test to a given standard. Nationally Recognized Testing Laboratories (NRTL) play an important role in independently testing products to verify compliance to safety requirements. A Nationally Recognized Testing Laboratory is an independent laboratory recognized by the Occupational Safety and Health Administration (OSHA) to test products to the specifications of applicable product safety standards - such as those from Underwriters Laboratories (UL) and other standards-writing bodies. This accreditation is a requirement in order to test to certain safety standards.

Connectors are designed to work within a given application to deliver power, ground or power and signaling capabilities. All connectors, regardless of make, should be used according to the equipment manufacturer's instructions, as well as in compliance with local and international electrical codes.

Standards for connectors "inside" of a piece of equipment are different. While the National Electric Code defines the electrical code for commercial and residential electrical infrastructure in the United States, a connector would not necessarily be subject to NEC limitations if it were used "inside" of a piece of equipment (a server, UPS, etc.). Here the equipment safety standard would define the measurement for acceptability. Depending on where the connection is used in a device the NEC restrictions may still be indirectly applicable.

Color Coding

Why are connectors color coded and keyed? Primarily to prevent accidental cross mating of circuits. Different mechanical keys can be easily recognized by the color of the housing. This color coding corresponds to a voltage that-- in the case of industrial trucks,

batteries, and chargers-- an industry sector has adopted as a standard to prevent incompatible voltages from cross mating, resulting in damage to equipment.

Connectors are keyed to prevent misconnection. Anderson Power Products® (APP®) has developed different mechanical keys that coincide with the National Electric Code voltage levels to prevent incompatible voltages from being cross mated. However, the mechanical keying and color does not restrict the voltage capability of the connector. All colors and keys are capable of the voltage rating per the specifications for the particular connector.

Custom Versus Off-the-Shelf

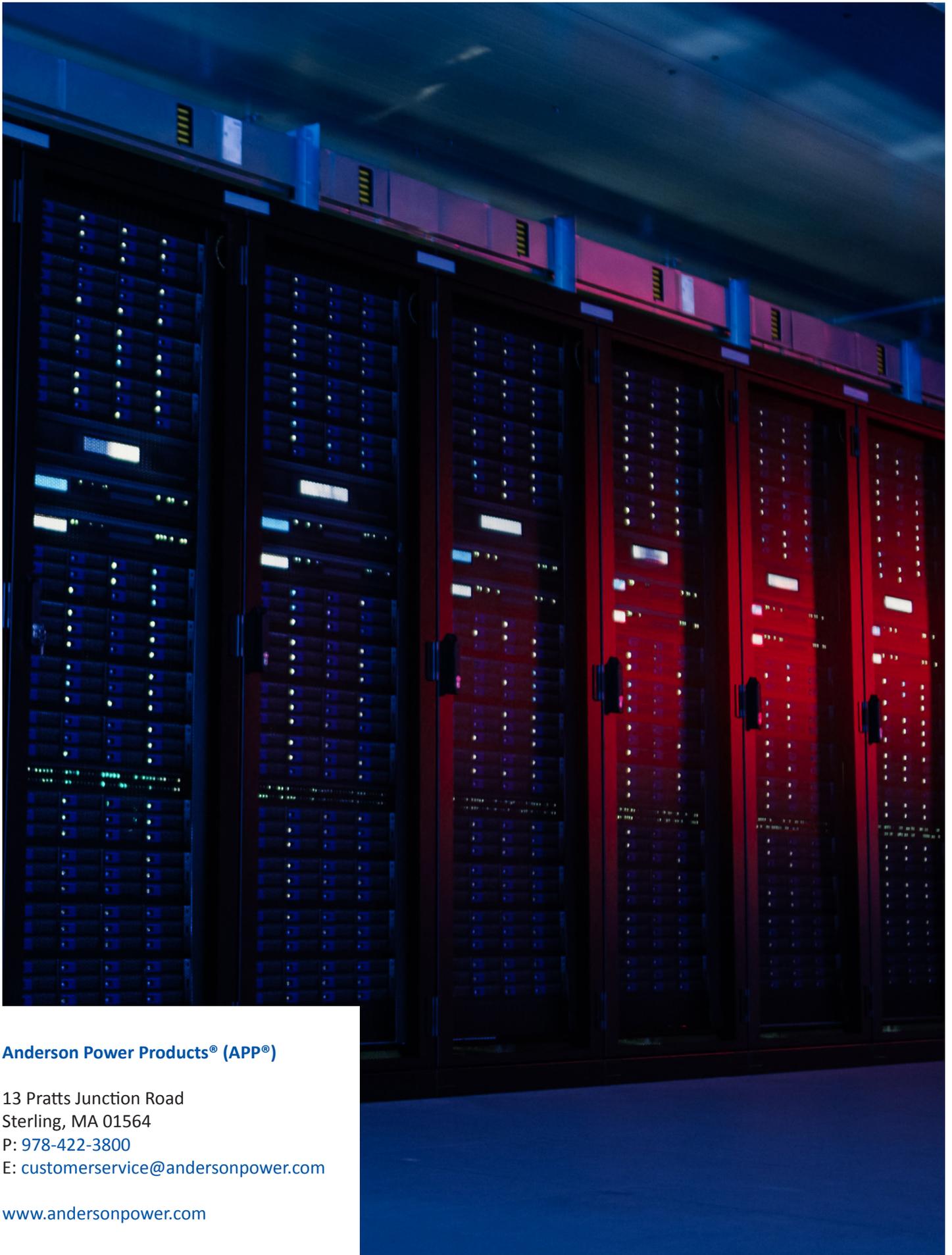
Engineers are at times faced with the challenge of finding the right connector for a specific application. Standard connectors can be an attractive option due to immediate availability. But if the standard option won't work, connectors can be customized to each connection need.

These requests compel connector manufacturers to dive into the details of the application's requirements; all of the elements of the customer's design, mechanical or performance requirements and their cost targets.

Custom solution can be engineered to meet all applicable regulatory requirements. Anderson Power Products® connectors are designed to allow the user to create custom solutions. For example, a wide range of colored housing options can be stacked together to create a reliable custom connector. These housings can be used with different contacts to create wire-to-wire, wire-to-board, or wire-to-busbar connections. With expertise in multiple types of contact technology and molded plastic insulators, the company can provide power connectors built to customer needs.



Safety considerations may demand that a connector be touch-proof. APP's SAF-D-GRID® connectors provide touch safety and arc protection for low voltage applications.



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